PEBBLE PROJECT

FINAL ENVIRONMENTAL IMPACT STATEMENT

VOLUME 4: CHAPTER 4—SECTION 4.20 – SECTION 4.27

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4.20 AIR QUALITY

This section addresses air quality impacts during the project. Direct and indirect air quality impacts from all phases of the project were evaluated using project emissions, and air modeling results where applicable. Project emissions consist of criteria pollutants, hazardous air pollutants (HAPs), and greenhouse gases (GHGs). The HAP species associated with the project with the most emissions are acetaldehyde, benzene, formaldehyde, hydrochloric acid (HCl), toluene, xylenes, and methanol.

The Environmental Impact Statement (EIS) analysis area includes the area surrounding and in the vicinity of each project component. Emissions and impacts caused by a project component in its respective defined area of analysis are described as direct impacts. Direct impacts are caused by the project component's activity, occurring at the same time and location.

Scoping comments were received regarding impacts to air quality from construction, fugitive dust emissions, vehicle equipment emissions, and mining activities. Concerns were raised regarding fugitive dust pollution from the mine and roads. Scoping comments also included requests for assessment of impacts from transporting ore and materials, loading and shipping ore concentrate, and impacts to related values (e.g., visibility). Additional comments regarding GHG included requests to assess the contribution from the power plant to GHG and to provide an emissions inventory of criteria pollutants, GHG emissions, and significant HAP emissions for all project components and phases. It is important to note that all project components would be in isolated areas of Alaska, which are characterized as attainment/unclassifiable areas for air quality. Section 4.11, Aesthetics, discusses the potential effects of localized changes to smells that could result from project-related actions that alter the existing natural smells.

4.20.1 Summary of Key Issues

Table 4.20-1: Summary of Key Issues for Air Quality Resources

Impact-Causing Project Component and Phase	Alternative 1a	Alternative 1 and Variants	Alternative 2 and Variants	Alternative 3 and Variant
Mine Site				
Construction	Direct, indirect, minimal, and localized impacts to air quality may occur as a result of stationary, fugitive, and mobile sources. Once construction is complete, all emissions and impacts associated with construction would cease, and would no longer contribute to cumulative impacts.	Impacts would be similar to Alternative 1a.	Impacts would be similar to Alternative 1a.	Impacts would be similar to Alternative 1a.
Operations	Direct, indirect, minimal, and localized impacts to air quality may occur as a result of stationary, fugitive, and mobile sources. Once mine operations cease, all emissions and impacts associated with operations would cease, and would no longer contribute to cumulative impacts.	Impacts would be similar to Alternative 1a.	Impacts would be similar to Alternative 1a.	Impacts would be similar to Alternative 1a.

Table 4.20-1: Summary of Key Issues for Air Quality Resources

Impact-Causing Project Component and Phase	Alternative 1a	Alternative 1 and Variants	Alternative 2 and Variants	Alternative 3 and Variant
Closure	Direct, indirect, minimal, and localized impacts to air quality may occur as a result of stationary, fugitive, and mobile sources. Impacts would return to baseline conditions once the closure is complete.	Impacts would be similar to Alternative 1a.	Impacts would be similar to Alternative 1a.	Impacts would be similar to Alternative 1a.
Transportation Corridor				
Construction	Direct, indirect, minimal, and localized impacts to air quality may occur as a result of stationary, fugitive, and mobile sources. Once transportation corridor construction is complete, all emissions and impacts associated with construction would cease, and would no longer contribute to cumulative impacts.	Impacts would be similar to Alternative 1a.	Impacts would be similar to Alternative 1a. However, different geographic areas would be affected along the transportation corridor. Potential impacts associated with dust would vary with road length.	Impacts would be similar to Alternative 1a. However, different geographic areas would be affected along the transportation corridor. Because Alternative 3 includes a longer road, potential impacts associated with dust would occur over a larger geographic area than Alternative 1a, Alternative 1, and Alternative 2.
Operations	Direct, indirect, minimal, and localized impacts to air quality may occur as a result of stationary, fugitive, and mobile sources. Once transportation corridor operations are complete, all emissions and impacts associated with operations would cease, and would no longer contribute to cumulative impacts.	Impacts would be similar to the Alternative 1a.	Impacts would be similar to Alternative 1a. However, different geographic areas would be affected along the transportation corridor. Potential impacts associated with dust and vehicle emissions would vary with road length.	Impacts would be similar to or less than Alternative 1a. Because Alternative 3 entails a longer road and eliminates ferry traffic transportation across Iliamna Lake, potential impacts associated with dust and vehicle emissions would occur over a larger geographic area than Alternative 1a, Alternative 1, and Alternative 2.
Closure	Depending on agreements associated with the continued use of transportation corridors by the public, portions of the transportation corridor and associated impact may remain. For the portions of the	Impacts would be similar to Alternative 1a.	Impacts would be similar to Alternative 1a. Depending on agreements associated with public use of transportation	Impacts would be similar to or less than Alternative 1a. Depending on agreements associated with public use of

Table 4.20-1: Summary of Key Issues for Air Quality Resources

Impact-Causing Project Component and Phase	Alternative 1a	Alternative 1 and Variants	Alternative 2 and Variants	Alternative 3 and Variant
	transportation corridor (e.g., Iliamna Lake ferry terminals, portions of the access road) that would be reclaimed, direct, indirect, minimal, and localized impacts to air quality may occur as a result of stationary, fugitive, and mobile sources impacts, and would return to baseline conditions once the closure is complete.		corridors, different geographic areas would be affected by road dust.	transportation corridors, different geographic areas would be affected by road dust.
Port Site				
Construction	Direct, indirect, minimal, and localized impacts to air quality may occur as a result of stationary, fugitive, and mobile sources. Once the port construction is complete, all emissions and impacts associated with construction would cease, and would no longer contribute to cumulative impacts.	Impacts would be similar to Alternative 1a.	Impacts would be similar to Alternative 1a. However, different geographic areas would be affected.	Impacts would be similar to Alternative 1a. However, different geographic areas would be affected.
Operations	Direct, indirect, minimal, and localized impacts to air quality may occur as a result of stationary, fugitive, and mobile sources. Once port operations are complete, all emissions and impacts associated with construction would cease, and would no longer contribute to cumulative impacts.	Impacts would be similar to Alternative 1a.	Impacts would be similar to Alternative 1a. However, different geographic areas would be affected.	Impacts would be similar to Alternative 1a. However, different geographic areas would be affected.
Closure	Direct, indirect, minimal, and localized impacts to air quality may occur as a result of stationary, fugitive, and mobile sources. Impacts would return to baseline conditions once the closure was complete.	Impacts would be similar to Alternative 1a.	Impacts would be similar to Alternative 1a. However, different geographic areas would be affected.	Impacts would be similar to Alternative 1a. However, different geographic areas would be affected.
Natural Gas Pipeline Corridor				
Construction	Direct, indirect, minimal, and localized impacts to air quality may occur as a result of stationary, fugitive, and mobile sources. Once pipeline construction is complete, all emissions and impacts associated with construction would cease, and would no longer contribute to cumulative impacts.	Impacts would be similar to Alternative 1a.	Impacts would be similar to Alternative 1a. However, different geographic areas would be affected along the pipeline corridor.	Impacts would be similar to Alternative 1a. However, different geographic areas would be affected along the pipeline corridor.

Table 4.20-1: Summary of Key Issues for Air Quality Resources

Impact-Causing Project Component and Phase	Alternative 1a	Alternative 1 and Variants	Alternative 2 and Variants	Alternative 3 and Variant
Operations	Direct, indirect, minimal, and localized impacts to air quality may occur as a result of stationary, fugitive, and mobile sources, and would be limited to the compressor station. Once operations activities are complete, all emissions and impacts associated with operations would cease, and would no longer contribute to cumulative impacts.	Impacts would be similar to Alternative 1a.	Impacts would be similar to Alternative 1a.	Impacts would be similar to Alternative 1a.
Closure	Direct, indirect, minimal, and localized impacts to air quality may occur as a result of stationary, fugitive, and mobile sources. Impacts would return to baseline conditions after closure.	Impacts would be similar to Alternative 1a.	Impacts would be similar to Alternative 1a.	Impacts would be similar to Alternative 1a.
Variants				
	No variants were analyzed under this alternative.	***Summer Only Ferry Operations, Kokhanok East Ferry Terminal, and Pile-Supported Dock Variants***: The impacts of any of these variants are anticipated to be similar to Alternative 1 impacts without the variants, except that there would be no emissions from truck traffic and ferry operations during the winter season, and truck traffic would double during the summer period along with associated long- and short-term emissions.	***Summer-Only Ferry Operations, Pile-Supported Dock, and Newhalen River North Crossing Variants***: The impacts of any of these variants are anticipated to be similar to Alternative 2 impacts without the variants, with the exception of the Summer-Only Ferry Operations Variant. During that variant, there would be no emissions from truck traffic and ferry operations during the winter season, and that truck traffic would double during the summer period along with associated short-term emissions.	***Concentrate Pipeline Variant***: The impacts of this variant are anticipated to be similar to Alternative 3 impacts without the variant, except that construction emissions associated with the pipeline would be higher, and truck traffic and associated emissions would decrease along the transportation corridor with concentrate shipped through the pipeline. There could be added emissions at the port site, depending on treatment options for water derived from dewatering the concentrate.

4.20.2 Methodology for the Analysis of Air Quality Impacts

The assessment of the project's potential air quality impacts was completed via a characterization of existing air quality in the project region (see Section 3.20, Air Quality); an evaluation of air quality regulatory requirements for the project; and a demonstration that all project components would comply with applicable Clean Air Act (CAA) requirements. This section expands on and uses emissions inventory calculations, regulatory evaluations, and modeling demonstrations provided in Appendix K3.20, PLP 2018-RFI 007, PLP 2018-RFI 007b, PLP 2018-RFI 009, PLP 2018-RFI 009b, and PLP 2018-RFI 012 to assess air quality impacts for the project alternatives and variants. Components and phases selected for emission calculation and modeling were those anticipated to produce impacts with the highest magnitude, largest geographic extent, and longest duration. Impacts from other components and phases are smaller than those modeled and are assessed by proxy.

The approach taken does not explicitly predict impacts for all aspects of the project; however, this approach uses codified screening levels to determine whether impacts can be considered minimal or substantial, considering current regulations and standards. This approach is similar to the way the Alaska Department of Environmental Conservation (ADEC) implements CAA to provide reasonable assurance that sources would not cause or contribute to the exceedance of health- and welfare-based thresholds.

Ultimately, anticipated air quality impacts are evaluated based on the emission and estimates, dispersion modeling, screening criteria, and current regional air quality status.

Emission sources are categorized three ways: fugitive, mobile, and stationary point sources.

- **Fugitive emission sources** are those that could not reasonably pass through a stack, chimney, vent, or other functionally equivalent opening (40 Code of Federal Regulations [CFR] Part 52.21[b][20]). Some examples of fugitive sources are fugitive dust from vehicles on unpaved roads, fugitive leaks from piping and connectors, blasting, rock crushing operations not connected to baghouses[1], and uncovered conveyors and drop points.
- **Mobile sources** include on-road and off-road vehicles, non-road engines, or portable sources such as light plants, portable generators, construction equipment, vessels, and aircraft.
- **Stationary point sources** are those that pass through a stack, chimney, vent, or other functionally equivalent opening (40 CFR Part 52.21[b][20]). Examples of stationary sources associated with the project are enclosed material processing and handling activities (for which emissions pass through a stack or vent, such as mine mill activities connected to a baghouse), power plant generators, and incinerators.

Impacts are assessed based on the following factors:

- **Magnitude**—Impact magnitude is based on (either directly or by proxy) comparing modeled project impacts to Alaska Ambient Air Quality Standards (AAAQS) and Prevention of Significant Deterioration (PSD) increments (Appendix K4.20, Table K4.20-10). For this analysis, magnitude is quantified as follows:
  - Minimal impact for:
    - Near-field impact below the AAAQS and/or PSD increment
    - Far-field impact below the AAAQS, PSD increment, and/or air quality-related value (AQRV) screening thresholds

[1]A **baghouse** is a fabric filter that removes particulates out of the air.

  - Substantial impact for:
    - Near-field impact above the applicable AAAQS and/or PSD increment
    - Far-field impact above the applicable AAAQS and/or AQRV screening thresholds
- **Duration**—Impact duration is assessed by the length of time project activity would impact the air quality conditions relative to an individual project's activity duration. For this analysis, duration is quantified as follows:
  - If an activity's air quality impacts would only remain while project activities occur, the activity would be considered short-term. Once activity is complete, it would no longer contribute to cumulative impacts, and air quality would return to the baseline conditions. Note that an individual project activity could be considered short-term, even if another activity would be expected to follow (e.g., operations activity following short-term construction activity). In contrast, if a single activity is expected to last through multiple other activities (e.g., construction activity lasting through operations and closure activities), the activity would be considered long-term.
  - If an activity's air quality impact would remain after closure; the activity would be considered permanent. In contrast, a non-permanent activity is an activity where impacts would only exist while the activity is occurring; on completion, the activity would no longer contribute to cumulative impacts.
- **Geographic Extent**—Geographic extent is assessed based on the spatial range where the project activity would impact the air quality conditions. For this analysis, geographic extent is quantified as follows:
  - Localized impact—modeled concentrations return to background levels within 1,640 feet of the boundary, which preludes public access
  - Regional impact—modeled concentrations return to background levels beyond 1,640 feet of the boundary, which preludes public access
- **Potential**—Impact potential is assessed based on the likelihood that the project activity would impact the air quality conditions. For this analysis, potential is quantified as follows:
  - Air quality impacts that may occur have a greater than 50 percent chance of occurring
  - Air quality impacts that are unlikely to occur have a less than 50 percent chance of occurring

Project direct and indirect GHG emissions and impacts from project emissions present a special case when assessing impacts under the framework previously described. Because GHG emissions are long-term in the atmosphere, project GHG emissions would be integrated with the atmosphere and transported globally without directly causing short-term and local impacts. The combination of project emissions with all other global emissions past and present has the potential to translate to impacts in the analysis area. Due to these complexities, no standard methodology currently exists to assess how a proposed project's GHG emissions would translate into physical effects in the analysis area. Therefore, although the project's direct GHG emissions are presented in Appendix K4.20, the magnitude of the impacts from those emissions is not addressed. However, given that GHG emissions remain in the atmosphere for extended time periods and are globally transported, the impact duration would always be permanent, and the geographic extent global. Under all alternatives, the project would contribute to global GHG emissions during all phases of construction, operations, and closure.

The PSD increments and AAAQS criteria used to evaluate the impact to air quality based on the magnitude of the dispersion model–predicted pollutant concentrations are provided in Appendix K4.20. The comparison of impacts to PSD increments has been provided for informational purposes only and does not represent a regulatory PSD increment analysis, which would require a detailed assessment of increment consumption and expansion possibility of regional sources. PSD increment consumption would need to be assessed as part of a formal increment consumption analysis during the permitting process.

Project direct impacts are compared to applicable thresholds using near-field dispersion models for Class II areas, and far-field modeling assessment tools for federal Class I areas. The federal Class I area status is assigned to federally protected wilderness areas and allows the lowest amount of permissible deterioration. All other areas are Class II, allowing for a moderate amount of air quality deterioration. The near-field dispersion model is used to assess the impact near the project area, extending out to roughly 30 miles. The far-field modeling assessment tools are used to project impacts beyond the near-field.

4.20.3 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.

Impacts to air quality from exploration would continue at current levels. Although these activities would also cause some changes to air quality, air quality would return to baseline conditions after reclamation.

4.20.4 Alternative 1a

The results of the assessment of emissions and impacts from Alternative 1a are addressed for each project component by project phase (construction, operations, and closure) in the following sections. When discussing analyzing emissions and impacts of one project component on another, the direct impact from one of the other project components is considered an indirect impact on the project component being assessed, and vice-versa.

Alternative 1a could cause air quality impacts during construction and operations of the mine site, transportation corridor, Amakdedori port, and the natural gas pipeline corridor. The magnitude, duration, extent, and potential of impacts from each these components are described in the sections below. Based on those assessments, minimal and localized impacts (as defined under “Methodology for the Analysis of Air Quality Impacts” above) would occur while the components are being constructed and/or operated.

4.20.4.1 Mine Site

The analysis area for the direct impacts and emissions for the mine site encompasses the area where the mine site activities would occur. The direct emissions from the construction, operations, and closure phases are presented. The extent of potential mine site direct impacts is presented for mine construction activities and mine operations activities by completing a near-field and far-field impact assessment that primarily relies on the results of dispersion modeling. For indirect impacts, the analysis area includes the Amakdedori port site and transportation corridor, because these areas would be indirectly affected by the mine site.

Relevant and primary indirect air quality impacts associated with the construction, operations, and closure phases of the mine site would result from emissions associated with transporting workers, supplies, construction equipment, and materials to and from the mine site through the Amakdedori port and transportation corridor. The impacts from transporting supplies through the transportation corridor along the access roads and ferry routes are discussed under "Transportation Corridor." The impacts from transportation to and from the port are discussed as direct impacts under "Amakdedori Port." As stated in the respective sections, if indirect impacts from the mine site occur, the magnitude and extent would be minimal and localized; impacts would only occur for the duration of construction, operations, and closure.

<u>Construction</u>

Direct emissions during construction would be related to quarry crushing operations, concrete batch plant operation, incineration, and power generation. Total emissions were calculated based on the worst-case mine site construction year. The construction mine site emissions for Alternative 1a are similar to those presented in Appendix K4.20, PLP 2018-RFI 007, and PLP 2019-RFI 007b.

Near-field air quality impacts from mine site construction have been demonstrated to comply with applicable AAAQS through modeling (see Appendix K4.20 for modeling information). In addition, modeling has demonstrated that the level of project-related air quality deterioration is lower than the applicable PSD increments. Maximum impacts are less than 45 percent of the AAAQS, and less than 2 percent of the PSD Class II increments. The extent of maximum impacts reaches to the mine site safety boundary closest to the modeled sources. Minimal and localized impacts may occur during construction of the mine site. The duration of the impacts would be short-term and non-permanent. Once complete, all emissions and impacts associated with construction would cease, and would no longer contribute to cumulative impacts. Details of the near-field impact assessment are presented in Appendix K4.20.

The far-field impacts would be comparable to those described as occurring during the operations phase of the mine site. However, because construction activities are temporary and occur over a shorter time period relative to the operations phase, far-field impacts are unlikely to occur (i.e., less than 50 percent probability). If impacts do occur, the magnitude and duration would be minimal and non-permanent.

<u>Operations</u>

Direct emissions during mine site operations would be related to mining activities, ore-processing activities, incineration, and power generation. The mine site stationary emission unit inventory would include a combined-cycle combustion turbine 270-megawatt power plant, fire water pump natural gas engines, back-up diesel generator, boilers, fuel storage tanks, and a small waste incinerator. The mobile equipment inventory used for various mining activities would include haul trucks, bulldozers, graders, shovels, light-duty vehicles, and loaders that would be used in the mining activities. Fugitive emissions would result from blasting and drilling in the pit and quarry, vehicle traffic on unpaved roads, and material handling. The mine site emissions from operations for Alternative 1a are similar to those presented in Appendix K4.20, PLP 2018-RFI 007, and PLP 2019-RFI 007b.

A near-field modeling assessment was prepared to assess air quality impacts related to operations at the mine site. Compliance with applicable AAAQS has been demonstrated through modeling; modeling has also demonstrated that the level of project-related air quality deterioration is lower than applicable PSD increments. Maximum impacts are less than 55 percent of the AAAQS, and less than 90 percent of the PSD Class II increments. The extent of maximum impacts reaches just beyond 328 feet from the boundary of the mine site closest to the modeled sources.

A far-field impact assessment was prepared to assess representative air quality impacts related to the operation of a mine site and included an analysis of PSD Class I increments and impacts to AQRVs at nearby federal Class I areas, such as Denali National Park and Preserve and Tuxedni Wilderness in Alaska Maritime National Wildlife Refuge. AQRVs are a resource adversely affected by a change in air quality, such as visibility, acidic deposition, and ozone. Based on the combination of inputs, distances modeled, conservative model assumptions, and model-predicted impacts, it has been shown that the PSD Class I increments would not be exceeded; visibility and acidic deposition screening criteria established for federal Class I areas would not be exceeded, eliminating the need for a cumulative impacts analysis to demonstrate that the project would not contribute to regional haze and acidic deposition.

However, because future project assessments may require further analysis of acidic deposition impacts, a sulfur and nitrogen deposition analysis was conducted. Based on the low sulfur dioxide (SO_2) emissions, SO_2 impacts were not modeled for the mine site, and it is unlikely (i.e., less than 50 percent probable) that SO_2 emissions from the mine site operations would be large enough to contribute to sulfur deposition impacts. Although the nitrogen deposition value presented in Appendix K4.20 is a high estimate, the analysis still shows the magnitude of impacts to be equal to the lowest critical-load value for lichens and the bryophytes ecosystem, which is an ecosystem found in nearby federal Class I areas, such as Denali National Park and Preserve and Tuxedni Wilderness in Alaska Maritime National Wildlife Refuge. The extent of impact would be 0.6 mile from the source. Any nearby federal Class I areas are greater than 62 miles away, as Denali National Park and Preserve and Tuxedni Wilderness in Alaska Maritime National Wildlife Refuge are approximately 195 and 95 miles away from the mine site, respectively. Minimal impacts are expected at these distances. This aligns with the Q/D[2] analysis performed for PLP 2018-RFI 012, which also indicates that minimal impacts are likely.

Based on the near- and far-field analyses, air quality impacts that may result from mine operations would be minimal in magnitude and localized in extent. However, the duration of impacts would be short-term and non-permanent. The impacts would be certain to occur if the project were permitted and constructed (see Appendix K4.20 for additional information regarding the near-field and far-field assessments).

Closure

Closure and reclamation activities are described in Chapter 2, Alternatives. Support facilities would include operation of the camp and power generation. The reclamation emissions inventory would include internal combustion engines, a gas turbine, boilers, and an incinerator. Mobile equipment would include haul trucks, shovels, bulldozers, compactors, graders, and service and light-duty vehicles. Fugitive dust emissions would result from stockpiled overburden handling,

[2]**Q/D** is the sum of certain pollutant emissions (tons per year) divided by distance (kilometer) from Class I area.

bulldozing, grading, vehicle traffic on unpaved roads, and wind erosion of road surfaces and active reclamation areas. The duration of the closure phase at the mine site is expected to be approximately 20 years. The maximum closure and construction activities and emissions in a given year would be similar. Assuming that closure impacts would be similar to those from the construction phase, near-field impacts may occur, but far-field impacts are unlikely (i.e., a less than 50 percent probability) to occur because closure activities are temporary, and occur over a shorter period of time relative to the operations phase. If near-field impacts were to occur, they would be minimal in magnitude, localized in extent, and of short-term duration. They would also be non-permanent, only occurring while closure activities are ongoing. Impacts would be limited to the duration of mine site closure, and air quality would return to baseline conditions once closure is complete. Mine site closure emissions for Alternative 1a are similar to those presented in Appendix K4.20, PLP 2018-RFI 007, and PLP 2019-RFI 007b.

4.20.4.2 Transportation Corridor

For the analysis of direct impacts to air quality, the analysis area of the transportation corridor includes gravel access roads, ferry terminals on Iliamna Lake, port, a spur road, and the onshore pipeline segment at the port, because the pipeline and road would be constructed jointly. The transportation corridor would be operational throughout the life of the project. The area of analysis for the indirect impacts includes the area encompasing the Amakedori port site.

This section addresses the direct and indirect emissions from the construction, operations, and closure phases of the transportation corridor facilities. Because the road and onshore pipeline would be constructed in the same right-of-way (ROW) at the same time, the emissions from the construction of both the road and onshore pipeline are calculated together.

Relevant and primary indirect air quality impacts associated with the construction, operations, and closure phases of the transportation corridor would result from emissions associated with transporting labor, supplies, and construction materials to and from the Amakdedori port via marine vessels. The impacts from transporting supplies to and from the port are discussed as direct impacts under the “Amakdedori Port” section; if impacts do occur, their magnitude and duration would be minimal and localized, occurring long-term throughout construction, operations, and closure activities. They would also be non-permanent, and expected to occur if the project were permitted and constructed.

Construction

During construction, direct emission sources would include heavy-duty, non-road, and mobile construction vehicles, as well as fugitive dust generated by vehicles on unpaved roads, and wind erosion. Additional fugitive emissions would result from blasting, drilling, rock crushing, and material handling. Stationary emissions sources would include engines and vapor vented from fuel storage tanks. Emissions from material mining and crushing operations required for fill material are also included in this assessment. The representative emissions were calculated based on the total construction duration of the transportation corridor and estimated equipment operation. The duration of construction for the road corridor and onshore pipeline facilities is expected to be approximately 1 year. Construction emissions for Alternative 1a are similar to those found in Appendix K4.20, PLP 2018-RFI 007, and PLP 2019-RFI 007b for the transportation corridor because the total footprint and road length are similar.

It is anticipated that construction of the transportation corridor would have lower near-field and far-field impacts than those presented for the mine site, because the construction of the transportation corridor would require less activity, and therefore fewer emissions. As discussed in the mine site impact analysis, air quality near-field and far-field impacts would be possible, although the far-field impacts are not likely to occur. If near-field impacts did occur, they would be minimal in magnitude, localized in extent, and short-term in duration. Impacts would also be non-permanent (occurring only during construction). Once construction is complete, all emissions and impacts associated with construction would cease, and would no longer contribute to cumulative impacts.

Operations

Direct emissions during the transportation corridor operations would come from power generators at the ferry terminals, vessels crossing the waterways, vapor vented from fuel storage tanks, and other fuel-burning engines such as ferry engines, light-duty vehicles, truck/trailer vehicles, container-handing forklifts, graders, and aircraft. In addition, fugitive dust emissions would result from vehicle traffic on unpaved roads. The operations emissions for Alternative 1a are similar to those presented in Appendix K4.20 for the transportation corridor because the number of ferry and truck trips are similar.

Because of lower activity level and emissions at the transportation corridor relative to the mine site, it is anticipated that the operations of the transportation corridor would have lower near-field and far-field impacts than those presented for the mine site. As discussed for the mine site impact analysis, air quality near-field and far-field impacts may occur and would be minimal in magnitude, localized in extent, short-term, and non-permanent in duration, only occurring during the activity.

Closure

The transportation system would be retained if required for the transport of bulk supplies needed for long-term post-closure water treatment and monitoring. As operations end, the Iliamna Lake ferry terminal facilities would be removed except for those required to support shallow draft tug and barge access to the dock, and all supplies would be transported across the lake using a summer barging operation. Depending on agreements associated with the landowner for the continued use of transportation corridors, portions of the transportation corridor and associated impact during operations may remain. The closure/post-closure and construction activities and emissions would be similar to each other in a given year. Assuming impacts would be similar to those from the construction phase, near-field impacts may be possible, but far-field impacts are unlikely (i.e., less than 50 percent probable to occur because closure activities are temporary short-term). If near-field impacts did occur, they would be minimal in magnitude, localized in extent, and short-term and non-permanent in duration, only occurring during closure/post-closure activities. For the portions of the transportation corridor (e.g., Iliamna Lake ferry terminals, portions of the access road) that would be reclaimed, impacts would return to baseline conditions once the closure is complete.

4.20.4.3 Amakdedori Port

This section presents the emissions from the construction, operations, and closure phases of the Amakdedori port. In addition, the underwater pipeline portions in Cook Inlet and Iliamna Lake are included in the analysis of the port construction phase. For the port, the area of analysis for the direct impacts includes the Amakdedori port and marine vessel traffic in Cook Inlet. For the indirect impacts, the area of analysis includes the region beyond the project boundary in Cook Inlet.

The transportation of labor, supplies, and materials in Cook Inlet to Amakdedori port are included in the assessment of the direct impacts. However, relevant and primary indirect air quality impacts associated with the construction, operations, and closure phases of the port would result from emissions associated with transporting supplies and construction materials beyond the project boundary in Cook Inlet. To quantify the possible impacts from marine vessel traffic in Cook Inlet, the assessment completed for the Bureau of Ocean Energy Management (BOEM) Cook Inlet Planning Area Oil and Gas Lease Sale 244 Final EIS (FEIS) (referred to as BOEM Lease Sale

FEIS) (BOEM 2016a) was reviewed. The BOEM Lease Sale FEIS assessed oil and gas lease sales in Cook Inlet and found increased air pollutant concentrations due to emissions from engines and generators on drill rigs, platforms, marine vessel traffic in Cook Inlet, and helicopters. The emissions estimate used for the modeling assessment of the impacts included about 312 support vessel per year during the production and development phase of the BOEM Lease Sale FEIS. This is comparable to the amount of vessel traffic included in the project, which estimates about 330 support vessels per year during the operations phase. Given the BOEM Lease Sale FEIS finding of minimal impacts in Cook Inlet, and that it included other emission sources in addition to marine vessel traffic, which is comparable to the project, it is likely that indirect impacts would also be minimal, short-term, and localized. Indirect impacts are unlikely to lead to additional impacts beyond the existing air quality conditions in Cook Inlet.

Construction

The construction of the port and offshore pipeline uses similar equipment and methods. Therefore, the emissions are calculated together; however, construction would not occur at the same time. Construction of the offshore pipeline would occur after port construction. Construction emissions are calculated based on the estimated construction time, regardless of which activity would occur first.

Port site construction activity would include construction of port facilities to support later phases of construction and mine operations. Emissions from material mining and crushing operations required for fill material are captured in the road construction emissions provided for the transportation corridor. Emissions associated with operation of port facilities, including trucking or offshore pipeline construction, are assumed to be similar to emissions during mine operations, and are represented by the annual transportation emissions estimate for mine operations.

The construction activity associated with the port and offshore pipeline would include engines, an asphalt plant, boilers, fuel storage tanks, and a small incinerator. The mobile equipment inventory would include bulldozers, excavators, loaders, and cranes in the port construction; and tugs, long-reach excavators, and welders in the pipeline construction. Fugitive emissions would result from site grade preparation and mobile equipment traffic. The construction of the port and offshore pipeline is expected to take approximately 1 year. Although the subsea pipeline length is longer than what is used for emissions calculations in Appendix K4.20, resulting in higher emissions, Alternative 1a does not include construction of an earthen-filled access causeway. The causeway emissions would more than offset the added pipeline construction emissions, resulting in lower emissions than described in Appendix K4.20, PLP 2018-RFI 007, and PLP 2019-RFI 007b.

The Applicant has not specified a specific dredge technology to install the buried pipeline crossing in the outer continental shelf (OCS) of Cook Inlet. PLP 2019-RFI BSEE 1 outlines multiple methods that may be used for installing the buried portions of pipeline that include ploughing, clamshell dredge (bucket dredge), conventional excavation (hydraulic backhoe), mechanical trencher (barge-mounted chain cutter or tracked crawlers), and jet trenching (jet sled or jet remotely operated vehicle [ROV]). Each of these five dredge technologies require different equipment, but would not appreciably change the overall emissions.

It is assumed that construction of the Amakdedori port would have lower near-field and far-field impacts than those presented for the mine site during construction, because the emissions are lower for the port relative to the mine site. Based on that similarity, the magnitude, duration, and extent of air quality impacts that may occur would be minimal, localized, short-term, and non-permanent (only occurring during construction activities). Once construction is complete, all emissions and impacts associated with construction would cease, and would no longer contribute to cumulative impacts.

Operations

Direct emissions from operations would consist of marine vessels traveling in Cook Inlet, barge loading and unloading activities, lightering activities, power generation, heating, and incineration.

The Amakdedori port emission unit inventory would include power generator engines, heaters, vapor vented from fuel storage tanks, and a small incinerator. Mobile equipment would include light-duty vehicles, skidsteers, forklifts, and container-handing forklifts. Marine vessels would include barges, tugs, and bulk carriers at the lightering locations. The concentrate containers would be emptied into the bulk carriers at a bulk carrier lightering point (see Section 4.27, Spill Risk, for description of mitigation measures to prevent or reduce fugitive dust from concentrate handling). Operations emissions at the port for Alternative 1a would be the same as those in Appendix K4.20, PLP 2018-RFI 007 and PLP 2019-RFI 007b. In addition, as part of the Applicant's proposed mitigation (Chapter 5, Mitigation, Table 5-2), shore power would be provided for vessels that are docked at Amakdedori port.

Near-field air quality impacts from port operations emissions have been demonstrated through modeling to comply with applicable AAAQS. The magnitude and extent of maximum impacts would be less than 90 percent of the AAAQS, with the maximum impact occurring on the port boundary closest to the modeled sources.

The far-field impact assessment is based on a Q/D analysis of the port emissions that would affect the AQRVs in the federal Class I areas (Tuxedni Wilderness, part of the Alaska Maritime National Wildlife Refuge, and Denali National Park and Preserve, which are 78 miles and 217 miles away from the Amakdedori port, respectively). As a result of this assessment, the AQRVs would not likely be impacted at any of the federal Class I areas. Near- and far-field impacts from the port may occur, but the impacts would be minimal in magnitude, short-term for the duration of port operations, and localized in extent; impacts would be non-permanent (see Appendix K4.20 for details of the near-field and far-field impact assessment).

Closure

There would continue to be emissions and air quality impacts associated with the port until operations end, when physical site closure work would commence. At that time, Amakdedori port facilities would be removed, except for those required to support shallow draft tug and barge access to the dock for the transfer of bulk supplies. Closure and construction activities and emissions in a given year would be similar. Assuming closure impacts would be similar to those from construction, near-field impacts may be possible, but far-field impacts are unlikely (i.e., less than 50 percent probability) to occur, because closure activities are temporary and short-term. If near-field impacts were to occur, their magnitude would be minimal, short-term in duration, and localized in extent, occurring while closure activities are ongoing; impacts would be non-permanent. Although impacts may occur if the project is permitted, built, and undergoes closure, air quality would return to the baseline conditions once the closure was complete.

4.20.4.4 Natural Gas Pipeline Corridor

The analysis area for the direct impacts from the pipeline corridor consists of the onshore pipeline in the transportation corridor, the pipeline-only segment near Newhalen to the mine access road, the offshore pipeline across Cook Inlet and Iliamna Lake, and the Kenai compressor station. The construction air quality impacts of the onshore portion of the pipeline are addressed above under "Transportation Corridor." Construction air quality impacts of the offshore portion of the pipeline are addressed above under "Amakdedori Port." Therefore, this section only addresses emissions and air quality impacts from the construction of the Kenai compressor station on the eastern landfall of the natural gas pipeline corridor, as well as the air quality impacts from operations and closure of the entire pipeline corridor. For the indirect impacts, the area of analysis includes the mine site and Amakdedori port.

Relevant and primary indirect air quality impacts associated with the construction, operations, and closure phases of the pipeline corridor would result from emissions associated with transporting workers, supplies, and construction materials through Amakdedori port during the construction, operations, and closure of the pipeline and compressor station. The impacts from transporting supplies through, and to and from, the port are discussed as direct impacts under "Amakdedori Port," above. Additional indirect impacts would be from the combustion of the natural gas at the mine site. Impacts from these emissions are discussed as direct impacts under "Mine Site." As stated in the respective sections, if indirect impacts from construction activities in the pipeline corridor occur, they would be minimal in magnitude, localized in extent, and short-term, only occurring during construction, operations, and closure phases.

Construction

Construction of the compressor station would involve site grading and mobile equipment used for assembly of the compressor station from pre-constructed modules. The compressor station construction emissions inventory would include engines and mobile equipment, as well as bulldozers, loaders, excavators, cranes, and light-duty vehicles. The fuel-burning equipment would be sources of combustion-related air pollutant emissions. Fugitive dust emissions would result from site grade preparation and mobile equipment traffic. Construction emissions for the pipeline corridor under Alternative 1a are similar to those in Appendix K4.20, PLP 2018-RFI 007, and PLP 2019-RFI 007b because the pipeline lengths are similar, with the same compressor station.

It is assumed that construction of the compressor station would have lower near-field and far-field air quality impacts compared to those presented for construction of the mine site, because the construction of the compressor station has fewer emissions than the construction of the mine site, making the mine site a conservative proxy. As a result, the magnitude, duration, and extent of air quality impacts would be minimal, localized, short-term, and non-permanent, only occurring during construction. Impacts would be expected to occur if the project is permitted and constructed. On completion of construction, all associated emissions and impacts would cease, and would no longer contribute to cumulative impacts.

Operations

During operations of the natural gas pipeline corridor, direct emissions and associated impacts from the onshore and offshore pipelines would be minimal, and less than those analyzed for the Kenai compressor station. The Kenai compressor station would be the only compressor station for the natural gas pipeline, and would have emissions and possible air quality impacts. For the operations phase, only the compressor station is assessed.

The Kenai compressor station inventory would include natural-gas-fired simple-cycle combustion turbines. Because the compressor station would be same under Alternative 1a, operations emissions would be the same as those in Appendix K4.20 and PLP 2018-RFI 007.

Near-field air quality impacts from the compressor station have been demonstrated through modeling to comply with applicable AAAQS. The far-field impact assessment is based on analysis of the compressor station emissions that would affect the AQRVs in the nearby federal Class I areas. As a result of this assessment, the AQRVs would not likely be impacted at any nearby federal Class I areas. Based on the modeling screening analyses conducted, both near- and far-field impacts from the compressor station would be minimal in magnitude, short-term in duration, localized in extent, and non-permanent, lasting as long as the natural gas pipeline is in operation.

The impacts would likely occur if the project is permitted and the pipeline and compressor station are constructed (see Appendix K4.20 for details of the near-field and far-field impact assessment).

Closure

The natural gas pipeline would be maintained until it is no longer required to provide gas to the project site. The pipeline would be pigged and cleaned before being abandoned in place, which would result in minimal impacts to air quality and less than those analyzed for the compressor station. The compressor station associated with the pipeline would be removed, and the compressor site reclaimed. Closure and construction activities and emissions in a given year would be similar. Assuming closure impacts would be similar to those from the construction phase, near-field impacts may be possible, but far-field impacts are unlikely to occur because closure activities are temporary and short-term. If near-field impacts did occur, their magnitude, duration, and extent would be minimal, localized, short-term, and non-permanent, only occurring while closure activities are ongoing for compressor station closure. Impacts would likely occur if the project is permitted, the pipeline and compressor station are constructed, and eventually undergo closure. On completion of closure, air quality would return to baseline conditions.

4.20.5 Alternative 1

The mine site under Alternative 1 would be same as under Alternative 1a (see Chapter 2, Alternatives). Under Alternative 1, the locations of the transportation corridor and the natural gas pipeline corridor would be slightly different. However, it is anticipated that emissions and impacts from construction, operations, and closure of the project components from Alternative 1 would be similar to Alternative 1a because the total permanent footprint for each alternative is similar. The total footprint for the Alternative 1 is slightly smaller than Alternative 1a (see Chapter 2, Alternatives, Table 2-2). It is not anticipated that this difference would result in meaningful air quality impact differences. The results of the assessment of emissions and impacts of Alternative 1 are addressed for each component by project phase in the following sections.

4.20.5.1 Mine Site

Direct and indirect emissions from mine construction, operations, and closure would be the same as those under Alternative 1a. Although modeling was not directly assessed for Alternative 1, maximum potential near-field and far-field effects from mine construction, operations, and closure would be the same as the direct and indirect impacts predicted under Alternative 1a.

4.20.5.2 Transportation Corridor

Relative to Alternative 1a, the length of road for Alternative 1 is slightly longer, and the distance of the ferry route for Alternative 1 is shorter (see Chapter 2, Alternatives, Table 2-2). Although the total length of road and distance of the ferry route would be different under Alternative 1 as compared to Alternative 1a, it is not anticipated that the total emissions presented for Alternative 1 would differ meaningfully from Alternative 1a, and the number of ferry and truck trips would be similar. Therefore, the possible project direct and indirect impacts would be similar to those under the Alternative 1a transportation corridor.

4.20.5.3 Amakdedori Port

Direct and indirect emissions from port construction, operations, and closure would be the same as those presented for Alternative 1a. Air quality and fugitive dust impacts would not be different than those under Alternative 1a. Although dock construction would be different under Alternative 1, it is assumed that the construction equipment and duration involved would remain similar to those under Alternative 1a.

4.20.5.4 Natural Gas Pipeline Corridor

For the onshore and offshore pipeline segments, the emissions and impacts from construction of the pipeline would be similar to those presented under Alternative 1a (see Chapter 2, Alternatives, Table 2-2). Differences in emissions based on pipeline construction changes would not be meaningfully different compared to Alternative 1a, which would be expected to have minimal and localized impacts. Therefore, it is not anticipated that the small increase in emissions due to the increased pipeline footprint would result in substantial regional impacts. As a result, the impacts due to pipeline construction under Alternative 1 would be expected to be similar to those presented under Alternative 1a; emissions from operations and closure of the pipeline would be minimal, and less than those analyzed for the compressor station.

Because the compressor station would be the same for Alternative 1 as that for Alternative 1a, emissions from compressor station construction, operations, and closure would be the same; maximum potential near- and far-field effects from the compressor station construction, operations, and closure would also be the same.

4.20.5.5 Alternative 1 Variants

The magnitude, duration, extent, and likelihood of impacts on air quality of the Summer-Only Ferry Operations Variant, the Kokhanok East Ferry Terminal Variant, and the Pile-Supported Dock Variant would be similar to those described for Alternative 1 (during summer) without these variants.

Alternative 1—Summer-Only Ferry Operations Variant

Under the Summer-Only Ferry Operations Variant, concentrate would be stored at or near the mine site for up to 6 months per year. Concentrate would be stored in an enclosed structure for protection from wind and water erosion, eliminating the potential for an increase in fugitive dust (and runoff). The mine site would increase by 40 acres, resulting in a larger footprint. Under the Summer-Only Ferry Operations Variant, truck traffic and ferry traffic would approximately double during the summer, and cease in the winter, as compared to Alternative 1a (see Chapter 2, Alternatives, Table 2-2). During summer, fugitive dust and combustion emissions would increase due to a substantial increase in haul road use compared to Alternative 1 without the variant; however, annual combustion and fugitive dust emissions would be the same as Alternative 1 without the variant because the amount of road use would not change on an annual basis. As discussed in Section 4.14, Soils, and Section 4.18, Water and Sediment Quality, dust control measures would be implemented, and dust suppression water would be used. A conceptual fugitive dust control plan (FDCP) has been developed for the project (PLP 2019-RFI 134), and best management practices (BMPs) would be implemented for fugitive dust management (see Chapter 5, Mitigation).

Although the daily emissions associated with truck and ferry traffic and corresponding daily air quality impact would increase in the summer, the daily impacts would still likely be below applicable air quality thresholds based on the modeling conducted, which uses predicted mine site impacts as a proxy for impacts along the transportation corridor. Therefore, the change in the seasonal traffic pattern would not likely alter expected magnitude of air quality impacts meaningfully; expected air quality impacts would be similar to Alternative 1.

Alternative 1—Kokhanok East Ferry Terminal Variant

The Kokhanok East Ferry Terminal Variant has different access road configurations and road corridors than Alternative 1, which would generate indirect impacts from fugitive dust; the magnitude, duration, and extent of impacts from fugitive dust and other air quality parameters would be similar to or slightly lower than Alternative 1.

Alternative 1—Pile-Supported Dock Variant

Under the Pile-Supported Dock Variant, air quality and fugitive dust impacts would be the same as those described for Alternative 1. Although the dock design would be different under this variant, construction equipment and duration involved would presumably remain similar to Alternative 1.

4.20.6 Alternative 2—North Road and Ferry with Downstream Dams

The mine site under Alternative 2—North Road and Ferry with Downstream Dams would be similar to the mine site under Alternative 1a, with the exception of embankment designs (see Chapter 2, Alternatives). Under Alternative 2, the locations of the transportation corridor, natural gas pipeline corridor, and port would be different. However, it is anticipated that emissions and impacts from the construction, operations, and closure of the project components from Alternative 2 would be similar to Alternative 1a, because the total footprint for each alternative is similar. The total footprint for Alternative 2 is slightly larger than Alternative 1a (see Chapter 2, Alternatives, Table 2-2). It is not anticipated that this difference would result in a meaningful increase in air quality impacts for Alternative 2 compared to Alternative 1a. The results of the assessment of emissions and impacts of Alternative 2 are addressed for each component by project phase in the following sections.

4.20.6.1 Mine Site

Emissions from mine construction, operations, and closure would be similar to those presented for Alternative 1a. Although modeling was not directly assessed for Alternative 2, the magnitude, duration, extent, and likelihood of representative near-field and far-field air quality direct and indirect impacts from mine construction, operations, and closure would be similar to Alternative 1a.

4.20.6.2 Transportation Corridor

Relative to Alternative 1a, the length of road for Alternative 2 is shorter, and the distance of the ferry route for Alternative 2 is longer. Although the total length of road and distance of the ferry route would be different under Alternative 2 versus Alternative 1a, it is not anticipated that the total emissions presented for Alternative 1a would differ meaningfully from Alternative 2, because the number of ferry and truck trips would be similar. Therefore, possible project direct and indirect impacts would be similar to the transportation corridor under Alternative 1a.

4.20.6.3 Diamond Point Port

The Diamond Point port location would require dredging to ensure year-round marine vessel access, and would have a larger footprint, differing from Alternative 1a. Because this activity would not be required under Alternative 1a, construction of the port could result in more emissions and slightly larger near-field impacts. In addition, the area surrounding the Diamond Point port is mountainous, resulting in different topographic conditions, which may be conducive to increased air quality impacts in the vicinity of the port compared to the Amakdedori port location. Potential increases in air quality impacts due to topography would depend on the specific site location and engineering design at the time of permit-related air quality modeling.

Although operational activity and emission levels at the Diamond Point port are expected to be similar to those at Amakdedori port under Alternative 1a, topographical influences may be conducive to increased air quality impacts in the vicinity of the Diamond Point port compared to the Amakdedori port location. Modeling associated with the port showed impacts at 90 percent of the AAAQS; while those impacts are likely overestimated due to conservatism related to the modeled meteorological dataset, a refined engineering design of the port (e.g., revising emissions sources and building locations and stack heights) may be required to meet ambient air quality standards at the Diamond Point port location. However, it is anticipated that applicable air quality standards would be met. Therefore, the magnitude of impacts due to port operations for Alternative 2 should be similar to those presented under Alternative 1a.

In addition, the Diamond Point port is approximately 50 miles from a federal Class I area (Tuxedni Wilderness in Alaska Maritime National Wildlife Refuge), which is much closer than the mine site. Because of this closer distance, far-field AQRV impacts may be a greater concern. Although they are a concern, AQRV analyses performed at the mine site indicated that the impacts are local to the source location, and result in minimal impacts at the federal Class I areas. Using expected emissions for Amakdedori port and the distance from the port to Tuxedni Wilderness, a Q/D analysis results in a value indicative of minimal impacts. For this reason, far-field AQRV impacts resulting from Diamond Point port emissions would be expected to be higher than those estimated at the Amakdedori port, but not high enough to be a substantial impact.

Because construction, operations, and closure activities at the Diamond Point port would be similar to those estimated at the Amakdedori port, the duration, extent, and likelihood of impacts from emissions during operations would be similar to those for Alternative 1a. Maximum potential near-field effects from the operations at the port would be similar to or slightly higher than the direct and indirect impacts under Alternative 1a.

4.20.6.4 Natural Gas Pipeline Corridor

For the onshore and offshore pipeline segments, the magnitude, duration, extent, and likelihood of emissions and impacts from the construction of the pipeline would be similar to Alternative 1a. Although a portion of the pipeline under Alternative 2 would not follow a road alignment along the northern side of Iliamna Lake, the differences in emissions based on pipeline construction changes would not be meaningfully different compared to Alternative 1a, which would be expected to have minimal and localized impacts. Therefore, it is not anticipated that the increase of emissions due to the increased pipeline footprint in Alternative 2 would result in substantial impacts. As a result, impacts from pipeline construction for Alternative 2 would be similar to those presented under Alternative 1a. For reasons similar to those discussed under Alternative 1a, emissions from operations and closure of the pipeline would be minimal, and less than those analyzed for the compressor station.

Because the compressor station would be the same as under Alternative 1a, emissions from compressor station construction and operations would be the same as under Alternative 1a. Therefore, maximum potential near- and far-field effects from compressor station operations would be the same as the direct and indirect impacts under Alternative 1a.

4.20.6.5 Alternative 2 Variants

The magnitude, duration, extent, and likelihood of impacts on air quality of the Summer-Only Ferry Operations Variant, the Pile-Supported Dock Variant, and the Newhalen River North Crossing Variant would be similar to Alternative 2 without either of these variants.

Alternative 2—Summer-Only Ferry Operations Variant

Under the Summer-Only Ferry Operations Variant, the expected air quality impacts would be similar those described for the Alternative 1 Summer-Only Ferry Operations Variant because variant activities are the same as for Alternative 1.

Alternative 2—Pile-Supported Dock Variant

Under the Pile-Supported Dock Variant, air quality and fugitive dust impacts would not change from those described for Alternative 2. Although the dock design would change with this variant, it is assumed that construction equipment and duration involved would remain similar to Alternative 2.

Alternative 2—Newhalen River North Crossing Variant

The Newhalen River North Crossing Variant has somewhat different access road configuration and road corridors, which would generate impacts from fugitive dust; however, the magnitude, duration, and extent of impacts from fugitive dust and other air quality parameters would be similar to Alternative 2 without the variant.

4.20.7 Alternative 3—North Road Only

Alternative 3—North Road Only requires trucking of concentrate on a road to a port location north of at Diamond Point and does not include ferry operations across Iliamna Lake; this alternative includes the north access road as compared to Alternative 1a. It is anticipated that emissions and impacts from construction, operations, and closure of the project components from Alternative 3 would be similar to those for Alternative 1a, for reasons similar to those discussed under Alternative 2. The total footprint for Alternative 3 is larger than Alternative 1a due to the increase of access road length in the transportation corridor. However, it is not anticipated that this difference would result in any meaningful air quality impact differences. The assessment of emissions and impacts of Alternative 3 are addressed for each component by project phase in the following sections.

4.20.7.1 Mine Site

Direct and indirect emissions from mine construction, operations, and closure would be the same as Alternative 1a. Although modeling was not directly assessed for Alternative 3, the maximum potential near-field and far-field effects from mine construction, operations, and closure would be the same as the direct and indirect impacts predicted under Alternative 1a.

4.20.7.2 Transportation Corridor

Relative to emissions calculated for Alternative 1a transportation corridor construction, the increase in road length under Alternative 3 would increase construction emissions, while the removal of ferry traffic and terminal construction would decrease emissions. Overall, the changes in the construction, operations, and closure emissions inventory are not anticipated to be meaningfully different from Alternative 1a because the increase of the emissions due to longer road length would be balanced by the decrease in emissions from the ferry terminals and associated traffic, which would not be constructed. Therefore, the direct and indirect air quality impacts are not anticipated to be different than Alternative 1a.

4.20.7.3 Diamond Point Port

Because the Diamond Point port under Alternative 3 has the same design and operations as under Alternative 2, the direct and indirect air quality impacts would not be different. Construction, operations, and closure activities at Diamond Point port would be similar to those estimated at Amakdedori port; therefore, the duration, extent, and likelihood of impacts from emissions during operations would be similar to Alternative 1a. Maximum potential near-field effects from operations at the port would be similar to or slightly higher than the direct and indirect impacts presented under Alternative 1a.

4.20.7.4 Natural Gas Pipeline Corridor

For the onshore and offshore pipeline segments, emissions and impacts from the construction of the pipeline would be similar to Alternative 1a because Alternative 3 has a shorter pipeline length than Alternative 1a, but would require more material sites for construction. The differences in emissions, attributable to pipeline construction, between Alternative 3 and Alternative 1a would not be meaningfully different, and would be expected to have minimal and localized impacts. Therefore, it is not anticipated that the change in emissions due to the pipeline corridor differences would result in substantial and regional impacts. As a result, the impacts from pipeline construction for Alternative 3 would be similar to those presented under Alternative 1a. For reasons similar to those discussed for Alternative 1a, emissions from operations and closure of the pipeline would be minimal and less than those analyzed for the compressor station.

The compressor station would be the same as under Alternative 1a; therefore, emissions from compressor station construction and operations would be the same. Maximum potential near- and far-field effects from the compressor station operations would be also the same as under Alternative 1a.

4.20.7.5 Alternative 3 Variant

The magnitude, duration, extent, and likelihood of impacts on air quality from the Concentrate Pipeline Variant would be similar to those described for Alternative 3 without this variant.

Alternative 3—Concentrate Pipeline Variant

Under the Concentrate Pipeline Variant, the mine site footprint would be increased by approximately 1 acre. This variant would also slightly increase the north access road corridor width to incorporate the concentrate pipeline and optional return water pipeline, which would be co-located in a single trench. Truck traffic and associated emissions would decrease along the transportation corridor with copper-gold concentrate shipped through the pipeline. There could be added emissions at the port site depending on concentrate water treatment options.

4.20.8 Climate Change

As outlined in Section 3.20, Air Quality, it is projected that the project area would see an overall increase in temperatures, with an increase in precipitation (liquid equivalent) during the winter months, and a slight decrease of precipitation during the summer months. The near-field and far-field modeling impacts discussed previously would not be sensitive to small projected changes in temperature and precipitation. However, a decrease in precipitation, especially in the summer months, could result in drier exposed areas associated with the project, which could lead to more fugitive dust if left unmitigated (see Chapter 5, Mitigation). Additionally, an increase of temperature and changes in precipitation could lead to an increase of wildfire frequency and duration, as well as an increase in sparsely vegetated areas, which would increase background particulate matter concentrations. All projected impacts of climate change on the project area, including temperature, precipitation, and wildfire, are anticipated under all alternatives (including the No Action Alternative).

4.20.9 Cumulative Effects

Impacts to air quality would be those related to emissions of criteria pollutants, HAPs, and GHG.

The geographic area considered in the cumulative effects analysis for air quality would extend through a wide-reaching analysis area, including alternatives and variants, the expanded mine footprint (including road, pipeline, and port facilities), and any other reasonably foreseeable future actions (RFFAs) in the vicinity of the project that would result in potential synergistic and interactive effects. The analysis area is not near a federal Class I area, or in or near a non-attainment, maintenance, or area with local regulations.

As listed in Section 4.1, Introduction to Environmental Consequences, all RFFAs that are anticipated to occur in the development and operations period of the project have been considered in the cumulative effects analysis.

Total GHGs are expected to increase due to the RFFAs; however, the scales of these emission releases are around 1 to 2 million tons. Note that global fossil fuel related to carbon dioxide (CO_2) emissions were projected to be 32 gigatons (Gt) (IEA 2019). From a global perspective (which is the scale for climate change), the net change in GHGs resulting from RFFA impacts would be extremely small; less than 0.006 percent.

4.20.9.1 Long-term Past and Present Actions

The past and present actions that have influenced air quality in the analysis area are discussed in the context of background concentrations in greater length in Section 3.20, Air Quality. Although there are several oil and gas facilities on the Kenai Peninsula and in upper Cook Inlet, the immediate project area is relatively undeveloped and currently consists of a small number of towns, villages, and roads. Present activities include mining exploration and non-mining related projects, such as transportation, oil and gas exploration, and community development actions. All project components would be in remote areas of Alaska characterized as attainment/unclassified areas for air quality. Actions that are currently affecting air quality (or have in the past) in the analysis area are minimal.

4.20.9.2 Reasonably Foreseeable Future Actions

RFFAs in the cumulative impact study area have the potential to contribute cumulatively to impacts on air quality. Section 4.1, Introduction to Environmental Consequences, describes the past, present, and RFFAs that may impact air quality. Relevant future actions for air quality impacts include mineral exploration and mining activities occurring in southwest Alaska; oil and gas exploration and development in Cook Inlet; surface, marine, and air transportation developments such as new roads, bridge rehabilitation, shipping and barging traffic, and port and airport improvement projects; and transmission upgrades, installations, and maintenance. The increase of air emissions may result in minimal and localized cumulative impacts.

All RFFAs are similar to the proposed project in how they impact air quality by emitting combustion-related air pollutant emissions from fuel-burning equipment; and with few exceptions (the Alaska Stand Alone Pipeline [ASAP] project, Alaska Liquefied Natural Gas [LNG], and oil and gas exploration and development), all are similar in that they have fugitive emissions from blasting, drilling, vehicle traffic on unpaved roads, and material handling. The following RFFAs identified in Section 4.1, Introduction to Environmental Consequences, were carried forward in this analysis, based on their potential to impact air quality in the analysis area: Pebble Project expansion scenario; mining exploration activities for Pebble South/PEB, Big Chunk South, Big Chunk North, Fog Lake, Groundhog, Shotgun, and Jackson Tract mineral prospects; Donlin Gold; ASAP; Alaska LNG; Drift River Oil Pipeline; Cook Inlet Oil and Gas exploration and production including the proposed Hilcorp Seaview Project; onshore Alaska Peninsula oil and gas exportation; Lake and Peninsula Borough (LPB) transportation, energy, and infrastructure projects; onshore oil and gas development; road improvements; villages and communities in the project area; and the continued development of the Diamond Point Rock Quarry.

The No Action Alternative would not contribute to cumulative effects on air quality.

The contributions to cumulative effects on air quality are summarized by alternative in Table 4.20-2.

Table 4.20-2 Contribution to Cumulative Effects on Air Quality

Reasonably Foreseeable Future Actions	Alternative 1a	Alternative 1 and Variants	Alternative 2 and Variants	Alternative 3 and Variant
Pebble Project Expansion Scenario	**Mine Site:** The mine site footprint would have a larger open pit and new facilities to manage water, store tailings and waste rock, and increase daily processing throughput. Construction of the additional facilities, pipelines, and roads would generate fugitive and mobile emissions from the construction-related sources. The mine operations activities would continue to generate emissions from fugitive, stationary, and mobile sources. The power plant would be expanded 25 percent to generate 375 megawatts. The Pebble Project expansion scenario and associated development would be similar for all alternatives. **Other Facilities:** A north access road, concentrate pipeline, and diesel pipeline would be constructed along the Alternative 3 road alignment and extended to a new deepwater port site at Iniskin Bay. Pipeline construction would potentially have additional limited impacts on air quality from trenching activities. An additional compressor station would be added to the Amakdedori port site. **Magnitude:** Over the 78-year life of the Pebble Project expansion scenario, the project footprint would impact a larger area than Alternative 1a (see Section 4.1, Introduction to Environmental Consequences). Even though the daily throughput process would increase with the expansion, it is not anticipated that the operations air quality impacts would meaningfully differ from those estimated for Alternative 1a for a given year, because the worst-case emissions scenario was analyzed for Alternative 1a. Given that similar activities would occur under the expansion as with the project, fugitive, mobile, and stationary air quality impacts during	**Mine Site:** Identical to Alternative 1a. **Other Facilities:** Similar to Alternative 1a, except that the mine access road would not be constructed. The north access road and diesel and concentrate pipelines would be constructed along the Alternative 3 road alignment and extended to a new deepwater port site at Iniskin Bay. **Magnitude:** The magnitude of cumulative impacts to air quality would be similar to those of Alternative 1a, because the expansion footprint and operations under Alternative 1 would be similar regardless of the project alternative. Fugitive, mobile, and stationary air quality impacts during construction, operations, and closure from Pebble Project expansion would be similar to Alternative 1a for a given year. **Duration/Extent:** The duration and extent of cumulative impacts to air quality would be similar to Alternative 1a, except that they would extend to both	**Mine Site:** Identical to Alternative 1a. **Other Facilities:** The north access road would be extended east from the Eagle Bay ferry terminal to Iniskin Peninsula. Concentrate and diesel pipelines would be constructed along the Alternative 3 north access road alignment and extended to a new deepwater port site at Iniskin Bay. An additional compressor station would be constructed at the Diamond Point port site. **Magnitude:** The magnitude of cumulative impacts to air quality would be similar or less than the magnitude of the expansion under Alternative 1a because the expansion footprint is smaller under Alternative 2, and operations activities are similar regardless of the project alternative. Fugitive, mobile, and stationary air quality impacts during construction, operations, and closure from Pebble Project expansion would be similar to or slightly less than Alternative 1a for a given year.	**Mine Site:** Identical to Alternative 1a. **Other Facilities:** Overall Pebble Project 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. An additional compressor station would be constructed at the Diamond Point port site. **Magnitude:** The magnitude of cumulative impacts to air quality would be similar or less than the magnitude of the expansion under Alternative 1a because the expansion footprint is smaller under Alternative 3, and operations activities are similar regardless of the project alternative. Fugitive, mobile, and stationary air quality impacts during construction, operations, and closure from Pebble Project expansion would be similar to or slightly less than Alternative 1a for a given year. **Duration/Extent:** With the exception of the north access road being

Table 4.20-2 Contribution to Cumulative Effects on Air Quality

Reasonably Foreseeable Future Actions	Alternative 1a	Alternative 1 and Variants	Alternative 2 and Variants	Alternative 3 and Variant
	construction, operations, and closure from Pebble Project expansion would be similar to Alternative 1a for a given year. **Duration/Extent:** The Pebble Project expansion would result in similar duration and geographic extent of the air quality impacts described under Alternative 1a for a given year. However, with the mine and milling operations continuing for an additional 78 years, the minimal and localized air quality impact would continue until closure of the Pebble Project expansion. **Contribution:** Because the Pebble Project expansion would begin at the end of the operations phase of the project, overlapping activities between the project and the expansion leading to cumulative impacts would be largely limited to a small number of years when there are still emissions associated with the closure of the project and the expansion construction phase. During these limited years of overlap, the project would be ramping down and project emissions would be decreasing. At the same time, activities associated with the Pebble Project expansion would begin to increase over a period of years along with expansion emissions. Given the timing of the expansion and the proposed project, the potential for regional cumulative air quality impacts from the criteria pollutants and HAPs emissions would be minimal, and localized to the Pebble Project expansion activities. Because GHG emissions are long-term and globally transported in the atmosphere, GHG emissions from the project and RFFAs would have a global extent, and cumulatively would contribute to 0.006 percent of additional global GHG emissions.	the Alternative 1 and Alternative 3 corridors. **Contribution:** Similar to Alternative 1a.	**Duration/Extent:** The duration and extent of cumulative impacts to air quality would be similar to Alternative 1a but would not involve continued operation of the Amakdedori port and south access road. **Contribution:** Similar to Alternative 1a.	constructed, the duration and extent of cumulative impacts to air quality would be similar to Alternative 1a. **Contribution:** Similar to Alternative 1a.

Table 4.20-2 Contribution to Cumulative Effects on Air Quality

Reasonably Foreseeable Future Actions	Alternative 1a	Alternative 1 and Variants	Alternative 2 and Variants	Alternative 3 and Variant
Other Mineral Exploration Projects	In addition to the Pebble Project expansion scenario, activities for other mineral exploration projects include mining exploration activities, including additional borehole drilling, road and mine construction, and development of temporary camp facilities. The proposed Donlin Gold Mine would be situated roughly 175 miles northwest of the Pebble Project expansion scenario. In general, RFFAs associated with mineral development are too far away to influence regional cumulative air quality impacts. **Magnitude:** Mineral exploration activities would result in minimal changes to air quality because of their small scale and seasonal basis. The increase of air emissions from any individual project would only result in localized impacts. Regional impacts in the vicinity of the project would be minimal, and local to the mineral RFFAs themselves. **Duration/Extent:** Impacts from these RFFAs would continue until activities cease, and would be local in extent. Exploration activities typically occur at a discrete location for one season, although a multi-year program could expand the geographic area affected for a specific mineral prospect (see Section 4.1, Introduction to Environmental Consequences, Table 4.1-1, which identifies seven mineral prospects in the analysis area where exploratory drilling is anticipated [four are less than 25 miles from the project]). **Contribution:** Given the distance between the mineral RFFAs and the project components and that the majority of the mineral RFFAs are only foreseeable for exploration, the potential for regional cumulative air quality impacts would be minimal. Even when combined with the RFFAs in	Similar to Alternative 1a.	Similar to Alternative 1a.	Similar to Alternative 1a.

Table 4.20-2 Contribution to Cumulative Effects on Air Quality

Reasonably Foreseeable Future Actions	Alternative 1a	Alternative 1 and Variants	Alternative 2 and Variants	Alternative 3 and Variant
	Table 4.1-1, emissions from the Donlin Gold Mine project would be too dispersed to result in cumulative effects on air quality. The regional cumulative impacts from the criteria pollutants and HAPs emissions in the vicinity of the project would be minimal, and local to the RFFAs themselves. Because GHG emissions are long-term and globally transported in the atmosphere, GHG emissions from the project and RFFAs would have a global extent, and would cumulatively contribute to 0.006 percent of additional global GHG emissions.			
Oil and Gas Exploration and Development	Onshore oil and gas exploration activities could involve road and pad construction, temporary camps, and in some cases exploratory drilling. The nearest portions of both the proposed Alaska LNG facility and ASAP project would be roughly 140 miles east of the Pebble mine site. Decommissioning of the Drift River terminal facilities would occur approximately 100 miles north of the Pebble Project, over the course of a couple of seasons, and could be completed prior to construction of the project. The proposed Hilcorp Seaview exploration and production site is well over 100 miles east of the Pebble mine site. **Magnitude:** The impacts to air quality would be temporary, and local to the RFFAs themselves. Offshore exploration in Cook Inlet would involve similar exploration activities; and if promising, exploratory drilling. The increase of air emissions from any individual project would only result in localized impacts, and would be unlikely to interact cumulatively on a regional scale. **Duration/Extent:** The impacts from these RFFAs would continue until activities cease, and would be localized in extent. Seismic exploration	Similar to Alternative 1a.	Similar to Alternative 1a.	Similar to Alternative 1a.

Table 4.20-2 Contribution to Cumulative Effects on Air Quality

Reasonably Foreseeable Future Actions	Alternative 1a	Alternative 1 and Variants	Alternative 2 and Variants	Alternative 3 and Variant
	and exploratory drilling are typically single season temporary activities. They could occur in the analysis area, but based on historic activity, would not be expected to be intensive. Construction of either the Alaska LNG or ASAP project would last approximately 4 years, with a shorter period of activity in the Cook Inlet area. Pipeline operations and any associated LNG export activities would be long-term and potentially coincide with Pebble Project expansion activities. Potential contributions to air quality impacts from decommissioning Drift River facilities would be temporary and limited to the vicinity of decommissioning activities. **Contribution:** Oil and gas exploration and development activities would occur regionally, but would be distant from the project. Even when combined with the RFFAs in Section 4.1, Introduction to Environmental Consequences, Table 4.1-1, the projects are too far away and emissions are too dispersed to result in cumulative effects on air quality. An example of this is the Hilcorp Seaview exploration and production site, more than 100 miles from the Pebble mine site, and too far away to be considered important to a cumulative impact analysis. The regional cumulative impacts from the criteria pollutants and HAPs emissions in the vicinity of the RFFAs would be minimal, and local to the RFFAs themselves. Because GHG emissions are long-term and globally transported in the atmosphere, GHG emissions from the project and RFFAs would have a global extent but would cumulatively contribute to 0.006 percent of additional global GHG emissions.			

Table 4.20-2 Contribution to Cumulative Effects on Air Quality

Reasonably Foreseeable Future Actions	Alternative 1a	Alternative 1 and Variants	Alternative 2 and Variants	Alternative 3 and Variant
Road Improvement and Community Development Projects	Road improvements projects would take place in the vicinity of communities and have air quality impacts through construction activities and vehicle operations. Communities in the immediate vicinity of project facilities, such as Iliamna, Newhalen, and Kokhanok, would have the greatest contribution to cumulative effects. Some limited road upgrades could also occur in the vicinity of the natural gas pipeline starting point near Stariski Creek, or in support of mineral exploration previously discussed. Expansion of the Diamond Point Rock Quarry has the potential to increase air emissions in the analysis area. The estimated area that would be affected is approximately 140 acres (ADNR 2014a). **Magnitude:** The increase of air emissions from any individual project would only result in localized minimal impacts. **Duration/Extent:** Disturbance from road construction would typically occur over a single construction season. Geographic extent would be limited to the vicinity of communities and Diamond Point. **Contribution:** Road construction and other community improvement projects would occur in the analysis area. Even when combined with the RFFAs mentioned in Section 4.1, Introduction to Environmental Consequences, Table 4.1-1, the projects are too dispersed to result in cumulative effects on air quality. The regional and cumulative impacts from the criteria pollutants and HAPs emissions in the vicinity of the project would be minimal and local to the RFFAs themselves. Because GHG emissions are long-term and globally transported in the atmosphere,	Similar to Alternative 1a.	Cumulative impacts to air quality would likely be slightly less under Alternative 2 relative to Alternative 1a because of commonly shared project footprints with the quarry site at Diamond Point.	Cumulative impacts to air quality would likely be slightly less under Alternative 3 relative to Alternative 1a because of proximity to the quarry site at Diamond Point.

Table 4.20-2 Contribution to Cumulative Effects on Air Quality

Reasonably Foreseeable Future Actions	Alternative 1a	Alternative 1 and Variants	Alternative 2 and Variants	Alternative 3 and Variant
	GHG emissions from the project and RFFAs would have a global extent and would cumulatively contribute to 0.006 percent of additional global GHG emissions.			
Summary of Project Contribution to Cumulative Effects	Emissions from the project and RFFAs contribute to cumulative effects on air quality degradation through emission of criteria pollutants, HAPs, and GHGs. The project and RFFAs would have to comply with federal and state air quality standards. Overall, the cumulative impacts to air quality from the project, and RFFAs, would be expected to increase air emissions, including GHGs, in the region and the state. The increase of air emissions may result in minimal and localized cumulative impacts. In addition, because GHG emissions are long-term and globally transported in the atmosphere, GHG emissions from the project and RFFAs would have a global extent and would cumulatively contribute to 0.006 percent of additional global GHG emissions.	Similar to Alternative 1a. The increase of air emissions from the project and RFFAs may result in minimal and localized cumulative impacts.	Similar to Alternative 1a. The increase of air emissions from the project and RFFAs may result in minimal and localized cumulative impacts.	Similar to Alternative 1a. The increase of air emissions from the project and RFFAs may result in minimal and localized cumulative impacts.

Notes:
GHG = greenhouse gas
HAPs = hazardous air pollutants
LNG = Liquefied Natural Gas
RFFA = reasonably foreseeable future action

4.21 FOOD AND FIBER PRODUCTION

Although there may be small outdoor or indoor garden projects in individual communities, there are no state- or federally designated prime or unique farmlands in the project area. Therefore, there would be no impact to state or federal farmlands from the project or any of the alternatives discussed in this Environmental Impact Statement (EIS).

Subsistence activities (e.g., hunting, fishing, and gathering) are the primary sources of food and fiber production in the project area (see Section 4.9, Subsistence).

4.21.1 Cumulative Effects

There would be no contribution of cumulative impacts to farmlands from the project or any of the reasonably foreseeable future actions discussed in this EIS due to the absence of designated prime or unique farmlands in the project area.

4.22 WETLANDS AND OTHER WATERS/SPECIAL AQUATIC SITES

This section analyzes potential environmental consequences from the project on wetlands, other waters, and special aquatic sites.

4.22.1 EIS Analysis Area

The Environmental Impact Statement (EIS) analysis area for wetlands and other waters 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, port, and natural gas pipeline) and the variants under each component in each alternative. See Figure 3.22-1 in Section 3.22, Wetlands and Other Waters/Special Aquatic Sites, for an overview of the analysis area for wetlands and other waters.

Mine Site—The analysis area for the mine site includes the direct disturbance footprint extended by areas of indirect disturbance. Areas of indirect impact are those due to habitat fragmentation of wetlands and other waters (Figure 4.22-1); a 330-foot zone around the direct disturbance footprint to account for the impacts of fugitive dust deposition (Figure 4.22-2); and the modeled area of groundwater drawdown to account for impacts from dewatering (using EOM, baseline S0; Figure 4.22-3, also Section 4.17, Groundwater Hydrology).

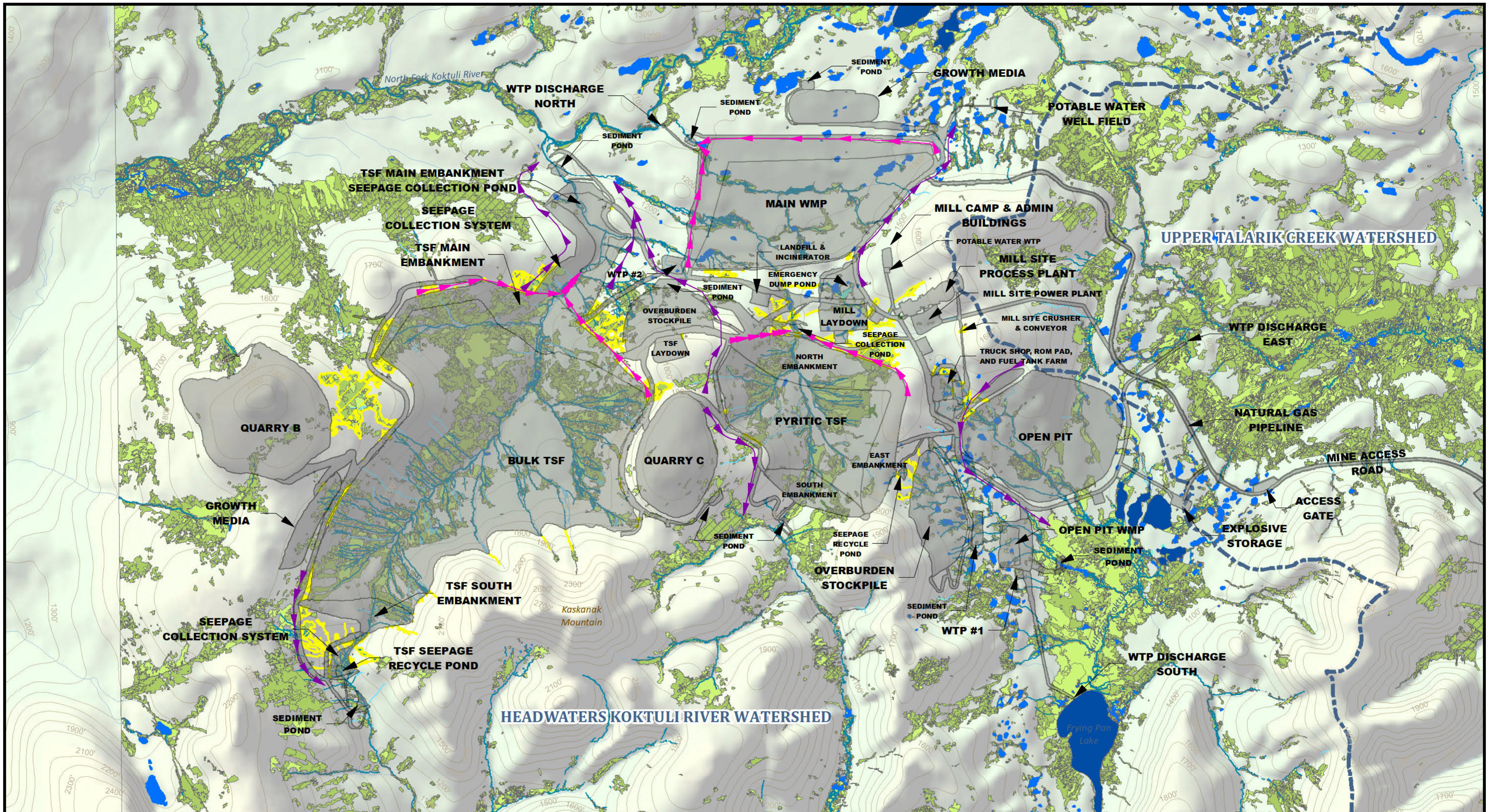
Transportation Corridor and Ports—The transportation corridor and ports analysis areas include the direct disturbance footprints of access roads, material sites, ferry terminals, and port facilities extended by 330 feet to account for the indirect impacts of fugitive dust deposition. Although the direct disturbance footprints are included for the pile-supported and caisson dock designs (both of which have concrete decking) and sea anchors associated with the lightering areas and navigational buoys, these features are not buffered as they are not expected to be sources of fugitive dust.

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, 101 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.

4.22.2 Analysis Methodology

Potential direct and indirect effects to wetlands and other waters were assessed according to four factors: the magnitude (or 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). Details of how the four factors were assessed are discussed below.

Magnitude—magnitude of impacts to wetlands and other waters is measured as the number of acres of wetlands or other waters or miles of streams impacted by the proposed project. The severity of impacts is summarized by the relative abundance of the resource, perceived value of the resource, and sensitivity of the resource to the impact, as appropriate. The relative abundance of a resource is evaluated as the percent of the total wetland and/or other water area, estimated from the National Wetland Inventory (NWI) at the hydrologic unit code (HUC) 10 watershed scale. The perceived value of the resource is summarized by type of special aquatic site or regionally important wetland as defined in Section 3.22, Wetlands and Other Waters/Special Aquatic Sites. The sensitivity of the resource is presented for fragmentation and dewatering and is evaluated by hydrogeomorphic (HGM) class.



Sources: PLP 2019-RFI116; PLP 2019 RFI-153

Fragmented Wetland Area
Mine Site Direct Impacts
Collection Ditch
Diversion Channel

NWI Classes

Aquatic Bed
Herbaceous
Broad Leaved Deciduous Shrubs
Deciduous Forest
Evergreen Shrubs
Ponds
Lakes
Rivers/Streams (Intermittent)
Rivers/Streams (Perennial)
Wetland/Upland Mosaic
Uplands/Mapped Wetlands Extent
Watershed

* Collection ditch and diversion channel locations are approximate and based on the Pebble Mine Site Operations Water Management Plan (Knight Piesold 2018a)

US Army Corps of Engineers

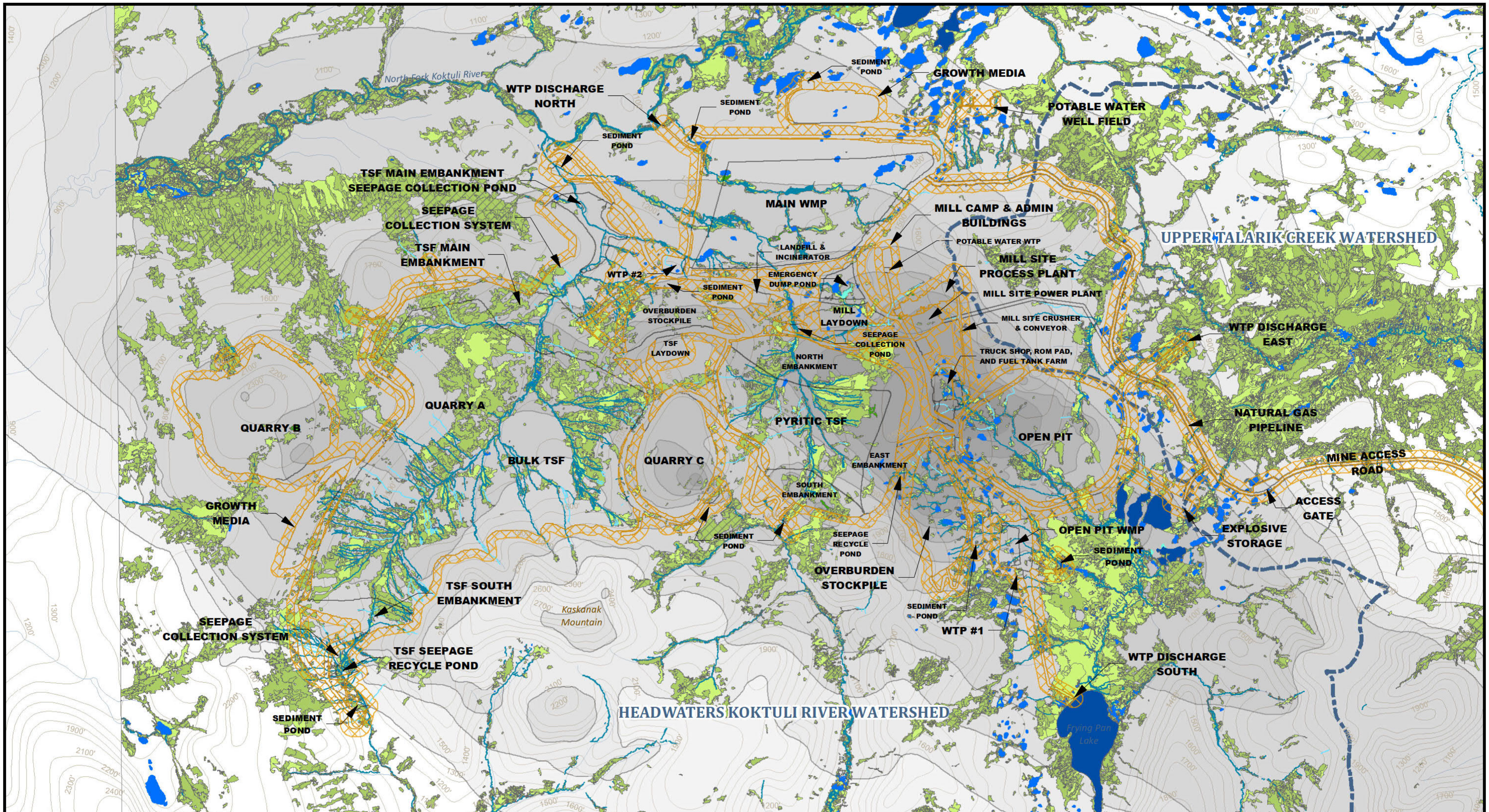
0.5 0 0.5 1

Miles

ANALYSIS AREA FOR INDIRECT IMPACTS OF FRAGMENTATION ON WETLANDS AND OTHER WATERS

PEBBLE PROJECT EIS

FIGURE 4.22-1



Sources: PLP 2019-RFI116; PLP 2019 RFI-153; PLP 2018-RFI009a

US Army Corps of Engineers®

0.5 0 0.5 1
Miles

Indirect Fugitive Dust Impact Area

Average annual PM_{10} deposition ($g/m^2/yr$)
- 0.3 - 0.5
- 0.5 - 0.7
- 0.7 - 0.9
- 0.9 - 2.0
- 2.0 - 4.0
- 4.0 - 6.0
- 6.0 - 8.0
- 8.0 - 10.0
- 10.0 - 20.0
- > 20.0

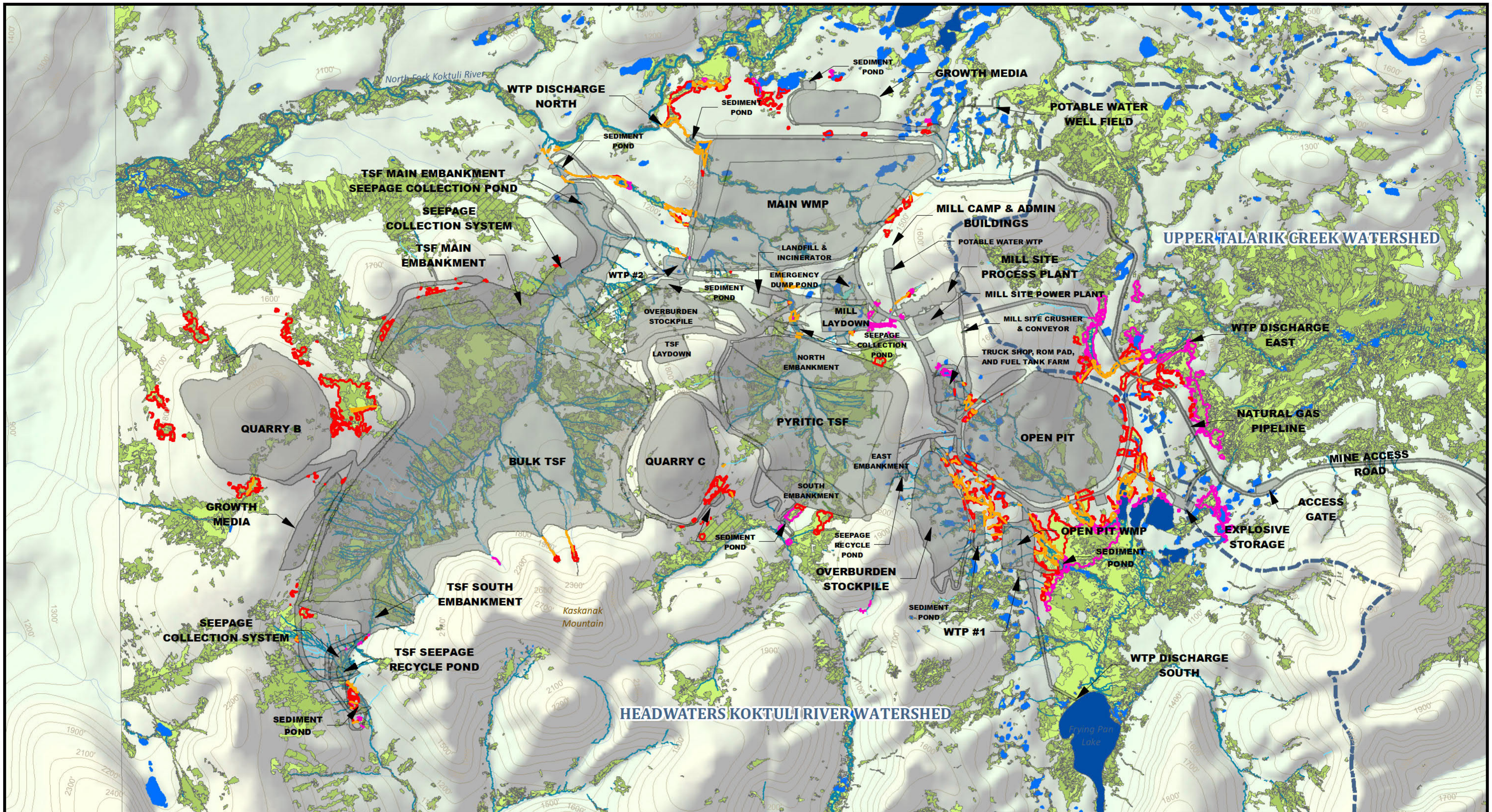
Mine Site Direct Impacts

NWI Classes
- Aquatic Bed
- Herbaceous
- Broad Leaved Deciduous Shrubs
- Deciduous Forest
- Evergreen Shrubs
- Ponds
- Lakes
- Rivers/Streams (Intermittent)
- Rivers/Streams (Perennial)
- Wetland/Upland Mosaic
- Uplands/Mapped Wetlands Extent
- Watershed

ANALYSIS AREA FOR INDIRECT IMPACTS OF FUGITIVE DUST ON WETLANDS AND OTHER WATERS

PEBBLE PROJECT EIS

FIGURE 4.22-2



Sources: PLP 2019-RFI-082a;
PLP 2019-RFI116; PLP 2019 RFI-153

US Army Corps of Engineers

0.5 0 0.5 1
Miles

Severity of Indirect Groundwater Drawdown Impacts

- High (S0, Baseline at End of Mining)
- Moderate (S0, Baseline at End of Mining)
- High Conductivity Model Impact Extent (End of Mining)
- Mine Site Direct Impacts

NWI Classes

- Aquatic Bed
- Herbaceous
- Broad Leaved Deciduous Shrubs
- Deciduous Forest
- Evergreen Shrubs
- Ponds
- Lakes
- Rivers/Streams (Intermittent)
- Rivers/Streams (Perennial)
- Wetland/Upland Mosaic
- Uplands/Mapped Wetlands Extent
- Watershed

ANALYSIS AREA FOR INDIRECT IMPACTS OF GROUNDWATER DRAWDOWN ON WETLANDS AND OTHER WATERS

PEBBLE PROJECT EIS

FIGURE 4.22-3

Duration—duration considers how long an impact is expected to last, and for wetlands and other waters is qualified as permanent, long-term, or temporary. Permanent impacts are those where the discharge of dredged or fill material cannot be practicably removed from wetlands or other waters and/or the reduction or elimination of wetland or other water function initiated in the construction phase would persist through the operations, closure, and post-closure phases. Long-term impacts are those expected to persist through the construction, operations, and into the closure period. The duration of indirect impacts due to the potential deposition of fugitive dust is considered long-term. Temporary impacts include those where dredged or fill material is placed into wetlands or other waters and removed before the end of the construction period, allowing the return of ecological function. Specific types of temporary impact recognized for the proposed project include earth disturbance and the temporary storage of fill in conjunction with construction of discharge chambers at the mine site, the transportation corridor, and overland sections of the natural gas pipeline, as well as impacts associated with the installation of the natural gas pipeline across Iliamna Lake and Cook Inlet and dredging in Iliamna Bay.

Extent—extent considers the geographic location of impacts in the analysis area. For the proposed project, the extent of impacts would be limited to the watersheds where wetlands or other waters would be lost or disturbed as a result of project-related impacts; Figure 4.22-4 and Table 4.22-39 provide an overview and areas of the HUC 10 watersheds impacted by the project.

Likelihood—likelihood evaluates the probability of impacts. The likelihood of impacts to wetlands and other waters would be certain if the project is permitted and constructed. Implementation of the project would entail filling, excavating, clearing, or otherwise altering these resources in the disturbance footprint. This analysis factor is not further discussed, because there is no difference in likelihood among the alternatives.

Scoping comments requested evaluation of impacts to special aquatic sites and regionally important wetlands; the direct impacts from the placement of fill and the removal of wetland vegetation; and the indirect impacts of fugitive dust, fragmentation, and dewatering on wetlands and other waters; see Section 3.22, Wetlands and Other Waters/Special Aquatic Sites for definitions of special aquatic sites and regionally important wetlands. Impacts to wetlands, open freshwaters, estuarine waters, marine waters, rivers, streams, and other waters are assessed here from a National Environmental Policy Act (NEPA) perspective, which will differ from how they are treated under the Clean Water Act (CWA) Section 404(b)(1) guidelines. The US Army Corps of Engineers (USACE) would complete the Section 404(b)(1) analysis as part of the Joint Record of Decision. The term “impacts” includes both direct and indirect impacts unless otherwise specified. Note that all calculations for impacts in this section are rounded to the nearest whole acre for most area calculations, or tenth of a mile for stream channel calculations. Apparent minor inconsistencies in sums are the result of rounding.

Field-verified mapping of wetlands and other waters has been completed for the entirety of the analysis area since publication of the Draft EIS (DEIS). The greater resolution and coverage gained through this mapping has eliminated data gaps previously filled by non-project specific wetland mapping and has allowed the fine-scale mapping of smaller streams and wetland-upland mosaics. As a result of the identification of additional small-scale watercourses, stream miles are increased in the direct and indirect impact analysis areas. In some instances, stream mile impacts presented here are different than those presented in Section 4.24, Fish Values; and Section 4.16, Surface Water, because these sections use a combination of project-specific stream data (available for the mine site only) and stream network developed from the National Hydrography Dataset (NHD). Alternatively, wetlands acreages are generally decreased in the direct and indirect impact analysis areas by this finer-scale mapping because wetland-upland mosaics that were previously assumed to represent 100 percent wetland habitat have been split into separate areas of wetland and upland, thereby decreasing the overall area of wetland habitat.

The following sections present the impacts to wetlands and other waters, summarized by type, under each alternative for all project components and associated variants. Quantification of impacts to wetlands and other waters are summarized by NWI group and HGM class; see Section 3.22, Wetlands and Other Waters/Special Aquatic Sites for explanations of the NWI and HGM classification systems. Although a formal functional assessment has not been completed for this project, the intersection of NWI group and HGM class allows approximation of the functions associated with impacted wetlands and other waters.

4.22.3 Direct and Indirect Impacts

The project has the potential to cause the following direct and indirect impacts to wetlands and other waters:

- Direct impacts from:
  - Clearing and removal of vegetation
  - Excavation or removal of soil and vegetation
  - Placement of fill materials
  - Dredging and discharges of dredged materials
  - Alteration and removal of stream channels
- Indirect impacts from:
  - Fragmentation of aquatic resources
  - Fugitive dust
  - Downstream habitat degradation
  - Dewatering

Direct Impacts are the effects caused by the action that occur at the same time and place as the action. Project-related direct impacts to wetlands and other waters include the excavation of or placement of fill; the removal of vegetation; the compaction, rutting, and mixing of soils; and the alteration of stream channels. Most direct impacts to wetlands and other waters would be initiated during the construction phase, and would result in the permanent or temporary loss of wetlands and other waters and/or alteration of the ecological functions they provide. Permanent impacts include cut and fill activities at facility locations where the fill cannot be practicably removed from wetlands or other waters. Temporary impacts occur where fill is placed into wetlands or other waters for a limited period during construction, then removed allowing return of wetland functions. The areas of direct impact to wetlands and other waters, special aquatic sites, and regionally important wetlands are calculated as the number or acres or miles of habitat occurring in the direct disturbance footprint. The potential loss of function attributed to these impacted wetlands and other waters is summarized by HGM class.

Direct, **permanent impacts** to wetlands and other waters would destroy habitat, result in the mortality of aquatic organisms, and reduce the collective functional capacity and value of wetlands and other waters across multiple watersheds. The elimination of wetland, stream, pond lake, and seabed habitat would cause the displacement, injury, and/or mortality of the species that rely on these aquatic environments for all or part of their life cycle. Mobile species such as fish, free-swimming crustaceans, amphibians, and macroinvertebrates are more likely to be displaced by loss of habitat, whereas sedentary aquatic species such as mollusks, fixed crustaceans, and benthic organisms are likely to suffer mortality from sedimentation or smothering by fill.

Direct, **temporary impacts** to wetlands and other waters are largely related to the storage of fill and the disturbance of lake and seabed during the construction period and are likely to result in changed rates and frequency of erosion, particulate matter suspension, sedimentation, and turbidity. The deposition of suspended particulates on attached or buried eggs can smother the eggs by limiting or sealing off their exposure to oxygenated water. Altered turbidity and suspended particulate load can redirect, delay, or stop the reproductive and feeding movements of some species of fish and crustacea, thus preventing their aggregation in accustomed places. The migration, spawning, or rearing life stages of Pacific salmon and other anadromous or resident fish species would potentially be impacted. Reduction of detrital feeding species or other representatives of lower trophic levels can impair the flow of energy from primary consumers to higher trophic levels thereby decreasing the overall productivity and nutrient export capacity of the ecosystem.

Temporary habitat loss areas include construction workspace associated with roads and other facilities, and the overland and off-shore pipeline-only sections of the natural gas pipeline. Typical road construction through wetlands would consist of the placement of a coarse rock fill and/or geotextile and fill directly to the existing surface and should not require the temporary storage of material adjacent to the roadbed. Wetlands would be flagged ahead of construction, and the temporary storage of material would be restricted to the road footprint to avoid or minimize adverse effect to wetlands and other waters to the extent practicable (see Chapter 5, Mitigation). However, a 30-foot buffer on each side of the roadbed has been adopted to account for temporary impact associated with the potential placement of fill. Impacts related to road construction are expected to occur over a period of 1 year (PLP 2020-RFI 056a).

Installation of the natural gas pipeline across Cook Inlet and Iliamna Lake would temporarily impact seabed and lakebed substrates. Such impacts are expected to last a few days to a few weeks at any given location. Overland construction of the pipeline-only sections of the natural gas pipeline (i.e. where it is not co-located with the road) will also result in construction impacts; a 150-foot wide zone centered on the pipeline has been adopted to account for these temporary impacts. Impacts related to natural gas pipeline installation are projected to occur over a period of two years (PLP 2020-RFI 056a).

Pebble Limited Partnership (PLP) has prepared a Restoration Plan (Owl Ridge 2019a; PLP 2019-RFI 123) outlining their proposed approach for restoring temporarily impacted natural habitats, including aquatic habitats, to a condition that resembles the pre-construction condition, or that of adjacent lands undisturbed by the project (see Appendix M3.0, Restoration Plan). Restoration of temporarily impacted wetlands would aim to maintain wetland hydrology and prevent sedimentation. Specific practices include the sealing of pipeline trench bottoms to minimize the diversion of wetlands waters into and along the trench; the installation of slope breakers, earthen berms, or other barriers along the road construction right-of-way to prevent the transport of sediment into nearby wetlands; and for wetlands crossed, the placement of culverts. 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 revegetate with wetland herbaceous and/or woody plant species. The restoration techniques that would be considered at specific locations include: the harvesting and transplanting of wetland sod clumps, wetland soil, herbaceous plugs, shrubs and trees, the live cutting collection, storage and planting of wetland plants, the placement of rolled erosion control products, seeding with hydric seed mix, hydro mulching, and/or mechanical mowing or tilling. Soil amendments would not be used in restoration, and temporary sediment barriers at the boundary between wetlands and adjacent upland areas would be removed after upland revegetation and stabilization of adjacent upland areas are judged to be successful (PLP 2019-RFI 123).

The restoration of waterbodies temporarily impacted by construction would aim to maintain or return their original hydrology and minimize sedimentation. For the installation of pipeline, waterbody banks would be stabilized, and temporary sediment barriers would be placed following the completion of open-cut crossings, and for dry-ditch crossings, before returning flow to the channel. Bank stabilization would return preconstruction contours or a stable angle of repose and would consider techniques set forth in Streambank Revegetation and Protection: A Guide for Alaska (ADF&G 2005). Similar to wetlands, slope breakers, earthen berms, or other barriers would be placed at the base of slopes that are proximal to waterbodies to minimize sedimentation. For stream crossings where resident or anadromous fish are present, clean gravel or native cobble would be used in the upper foot of trench backfill. Disturbed riparian habitat would be revegetated with native, preferably woody, plant species. The use of riprap for stabilization would be limited, and temporary bridges and culverts would be removed when no longer needed (PLP 2019-RFI 123). Natural circulation of waters and colonization efficiency of benthic organisms is expected to quickly return Iliamna lakebed and Cook Inlet seabed substrate disturbances to natural condition.

Restoration of wetlands and aquatic resources would be considered successful when the vegetation supports native plants typical of similar, adjacent habitats undisturbed by the project; and when vascular plant cover is at 80 percent, or a cover comparable to adjacent, undisturbed areas (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. PLP has prepared a draft Reclamation and Closure Plan (PLP 2019-RFI 115) outlining their proposed approach for reclamation of permanently impacted natural habitats (see Appendix M4.0, Reclamation and Closure Plan). The terrestrial portions of these permanently impacted areas would be reclaimed by revegetation. Growth medium would be placed, amended, seeded, and watered as necessary; hydric seed mix would be used for the revegetation of wetlands. Areas disturbed during construction that are not subject to re-disturbance during operations (e.g., construction access roads, water extraction sites, and material sites) would be reclaimed. Reclamation of these sites would be phased over a 50-year closure period. Reclamation aims to achieve 30 percent vegetative cover within 3 years, with efforts being deemed complete when 70 percent vegetation cover is achieved (PLP 2019-RFI 115).

Facilities would be sited to avoid and minimize adverse effects to wetlands and other waters where practicable, as well as to allow efficient restoration and reclamation of disturbed areas. Where feasible, mine facilities would be reclaimed to allow creation of new wetlands and ponds.

As part of the permit decision, USACE will decide if mitigation for aquatic resource losses, would be required, and, if required, whether the applicant's proposed compensatory mitigation plan would appropriately offset losses to aquatic resources. PLP has prepared a draft Compensatory Mitigation Plan (CMP) (PLP 2020-RFI 056a) outlining their proposed approach for compensatory mitigation to offset environmental losses resulting from unavoidable impacts to aquatic resources (see Appendix M2.0, Applicant's Draft Compensatory Mitigation Plan). The need for compensatory mitigation and the determination if the applicant's proposal adequately offsets aquatic resource losses would be determined as part of the Joint Record of Decision.

Indirect Impacts are the effects caused by the action that are removed from the action with respect to time and place, yet are reasonably foreseeable. Project-related indirect impacts to wetlands and other waters are expected to be related to fragmentation, fugitive dust, and dewatering. Overlap exists among the areas of indirect impact at the mine site. When presented individually, these areas of indirect impact are not corrected for overlap, when presented cumulatively the total area of indirect impact is corrected for overlap. As such, individual areas of indirect impact will not sum to the cumulative area of indirect impact for a given alternative.

Indirect impacts may occur during any phase of the project, and result in temporary or permanent loss of wetlands and waters, and/or the ecological functions they provide. Indirect impacts related to water quality and quantity changes are evaluated in Section 4.16, Surface Water Hydrology, and Section 4.17, Groundwater Hydrology; indirect impacts related to erosion and sedimentation are evaluated in Section 4.14, Soils. The areas of indirect impact to wetlands and other waters, special aquatic sites, and regionally important wetlands are calculated as the number of acres or miles of habitat occurring in the estimated areas of fragmentation, fugitive dust deposition, and drawdown, as described below. The potential reduction of function attributed to these wetlands and other waters is summarized by HGM class.

Fragmentation of wetlands and other waters results when development divides a formerly continuous aquatic resource into smaller, more isolated remnants. Fragmented aquatic resources include wetlands and other waters upgradient of the construction footprint of the work that—due to the direct impact (i.e., discharges of dredged or fill material into waters of the US [as defined in 40 Code of Federal Regulations Part 230.3] would be hydrologically disconnected from previously connected aquatic resources. Specifically, wetlands and other waters located upgradient of fill or a seepage collection and recycle pond were considered fragmented. Seepage collection and recycle ponds are located below each tailing storage facility (TSF) and are designed to capture seepage from the facilities. Because this seepage would be pumped back into the TSF, the hydrology of waters flowing into these collection and recycle ponds is considered fragmented.

Non-fragmented aquatic resources are wetlands and other waters located completely downgradient of fill, or if partially downgradient of fill, that occupy a topographic position that allows for the flow of water in an alternative direction. Also included as non-fragmented aquatic resources are wetlands and other waters for which hydrology will be maintained through culverts, drainage ditches, diversion channels, or sediment ponds. Sediment ponds are situated to collect and treat non-mine drainage stormwater and surface-water runoff from various embankment structures, and are designed to slow the flow of water so that suspended particulate may settle out, thereby decreasing turbidity. Because this water would be returned to downstream waterways, the hydrology of waters flowing into sediment ponds is not considered fragmented (Water Management Plan, Knight Piésold 2018a). The fragmentation of wetlands and other waters is not expected for other project components (i.e., the transportation corridor, port, and natural gas pipeline) because hydrology would be maintained through the installation of culverts or bridges.

The effects of fragmentation on wetlands and other waters are wide-ranging and dependent on such factors as the nature of the development; the size, shape, and complexity of the remaining remnants; the hydrogeomorphology and plant community composition of the affected habitat; and as the needs and mobility of dependent wildlife species. Reduction in wetland patch size has implications for source water catchment and the capacity of the wetland to store and discharge water, as well as cycle sediment and nutrients. Reduction in source water can initiate the conversion of wetlands to more mesic types and stream habitat from a perennial to intermittent flow regime, thereby decreasing the abundance, diversity, and connectivity of aquatic habitat in the greater watershed. Due to increased edge to area ratios of fragmented habitat and the competitive advantage of invasive plant species in ecotones, fragmented landscapes are often more susceptible to infestation by invasive plant species.

Fragmentation also affects the quality and connectivity of wildlife habitat. Decreased connectivity of aquatic ecosystems could preclude the completion of aquatic organisms' life-cycles; for example, anadromous fish may be unable to reach spawning grounds or access off-channel habitat, or wood frogs may not be able to easily access the aquatic and terrestrial habitat required for their larval and adult phases, respectively. See Section 4.23, Wildlife Values; Section 4.24, Fish Values; and Section 4.26, Vegetation, for further discussion of habitat-related impacts to wildlife.

Fragmentation of stream channels and adjacent wetlands without proposed hydrologic surface connections are expected to result in a complete loss of function. Partial functional loss would be expected for slope and depressional wetlands, which would be expected to become drier due to the diversion of shallow groundwater and surface water and reduction of catchment areas. Little functional loss would be expected for flats wetlands, which comparatively are not reliant on groundwater or surface water for the maintenance of their hydrology. Due to these differences in expected severity of impacts, impacts to riverine wetlands and stream channels are qualified as high, impacts to slope and depressional wetlands are qualified as moderate, and impacts to flats wetlands are qualified as low. These impacts would be considered an indirect but permanent consequence of development of the mine site. The magnitude of the impacts is the acres of wetlands and other waters, including mines of streams upgradient of the mine site direct disturbance footprint, that would drain to water treatment facilities, such as recycling or water management ponds.

Fragmented wetlands and other waters were manually attributed in the geographic information system (GIS) data (Figure 4.22-1) in accordance with the methodology presented above and the locations of facilities provided by the Applicant in the Water Management Plan (Section 3.4 and Figure 3.1 in Knight Piésold 2018a).

Fugitive dust would be expected to be produced from ground-disturbing actions during construction, operations, and closure, and from the wind or vehicle dispersal of exposed soil in the post-closure period. Fugitive dust has the potential to collect on wetland vegetation and accumulate in waters, with consequences for plant physiology, water quality, biotic community composition, and more broadly, the functions and values of wetlands and other waters. Impacts to wetlands and other waters due to dust would be expected to be indirect and long-term.

The type of impacts from mineral dust deposition on vegetation largely depends on the characteristics of the dust, the plant species affected, and the environmental conditions of 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 have been linked to 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 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, and then subtracting the direct disturbance footprint to exclude wetlands and other waters directly impacted by permanent facilities (Figure 4.22-2). This area of analysis is the same applied to vegetation to evaluate indirect impacts of dust, and follows methods used by recent evaluations of environmental impact in Alaska (Ambler Road DEIS [BLM 2019]; Donlin Gold EIS [USACE 2018d]; Point Thompson EIS [USACE 2012a]).

The addition of dust with a pH different from 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 minerotrophic[1] species such as the shrub (*Alnus viridis;* Gill et al. 2014), graminoids (Meyers-Smith et al. 2006), and the ruderal mosses (*Ceratodon purpureus, Bryum* spp. and *Polytrichum juniperinum;* Walker and Everett 1987). This increase in minerotrophic species typically occurs at the expense of ombrotrophic[2] mosses such as *Sphagnum* species (Hasselbach et al. 2005;

[1] Minerotrophic—influenced by groundwater, often areas with high ionic water.
[2] Ombrotrophic—receiving water and nutrients only from precipitation.

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), many of which are obligate or facultative wetland species.

Where dust deposition facilitates the dominance of tall shrubs, several ecological feedbacks are strengthened: higher-stature vegetation acts to entrap dust and further increase soil nutrient availability; and in this way, acidophilous mosses and vascular plants are further reduced 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, thereby affecting the rates of cellular and pedogenic processes. This is almost always 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 regard to environmental conditions, dust impacts may be influenced 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). Wind and precipitation would decrease the amount of dust retained on plant surfaces, and the surface saturation of wetlands would presumably promote the entrapment of fugitive dust.

The susceptibility of low-stature vegetation and species adapted to acidic soil has particular importance for wetlands and other waters. Aside from forested wetlands, which are uncommon in the analysis area, characteristic wetland species are often low growing, with a complex branching structure that, while favoring thermodynamics a northern climate, also functions to trap dust. Furthermore, many wetlands in the analysis area are dominated by mosses, which lack vascular transport mechanisms, and alternatively absorb water and nutrients through their leaf surfaces. Therefore, these bryophyte-dominated communities are particularly susceptible to airborne pollutants such as dust (DeMeglio 2019; Hasselbach et al. 2005; Neitlich et al. 2017). Wetlands dominated by sphagnum moss are abundant in the analysis area; and along with moist and wet graminoid tundra, are one of the habitats most sensitive to dust deposition (Farmer 1993). In addition, sphagnum, which through the accumulation of peat, facilitates the colonization of other acidophilic species (van Breemen 1995), which under dust deposition are consistently replaced by more minerotrophic species.

Although the greatest magnitude of impacts is expected close to the source of fugitive dust, 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; Neitlich et al. 2017; Hasselbach et al. 2005). 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 avoidance and minimization measures that would reduce the generation of metal-contaminated dust, and minimize the deposition of metal-contaminated dust beyond the mine site.

A conceptual fugitive dust control plan, identifying project design features and best management practices to minimize fugitive dust emissions has been developed by the Applicant (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 use of enclosures and dust collection systems in process plant operations, 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 wetlands and other waters 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 mineral dust only; see Section 4.26, Vegetation, for a discussion of metal toxicity to plants. Dust deposition is further discussed in Section 4.14, Soils; indirect impacts related to water quality and quantity changes are evaluated in Section 4.16, Surface Water Hydrology, and Section 4.17, Groundwater Hydrology; indirect impacts to vegetation are discussed in Section 4.26, Vegetation. Human health considerations are included in Section 4.10, Health and Safety.

Dewatering of wetlands and aquatic resources causes the alteration or loss of wetland hydrology and may result in the conversion of habitat to more mesic types. Drawdown of groundwater is expected primarily around the open pit from dewatering activities, but also around quarries, tailings storage facilities, and water management ponds from drainage/underdrain systems. Altered saturated surface flow and shallow interflow resulting from a depression of the groundwater table is expected to impact area wetlands, surface waters, and vegetation. Impacts to surface water are presented in Section 4.16, Surface Water Hydrology; impacts to groundwater are discussed in Section 4.17, Groundwater Hydrology. Dewatering represents an indirect yet permanent impact to wetlands and other waters.

The severity of impacts to wetlands and other waters relates to their natural tolerances to dewatering and can be inferred from wetland hydrogeomorphology and plant community composition. Groundwater-dependent systems, such as slope and depressional wetlands are likely to lose wetland hydrology as a result of dewatering, whereas systems such was riverine and lacustrine fringe wetlands that source their water from surface water and shallow groundwater are likely to experience an alteration wetland hydrology yet retain their wetland function. Precipitation-dependent, flats wetlands would likely be less affected by changes in groundwater levels. Following this gradation in expected severity, impacts to slope and depressional wetlands due to dewatering are qualified as high, impacts to riverine channel, riverine, lacustrine, lacustrine fringe wetlands are qualified as moderate, and impacts to flats wetlands are qualified as low (PLP 2019-RFI 082a).

Impacts to individual plant species is expected to relate to those species' applicable root depths and water tolerances. By definition, wetlands are dominated by obligate wetland plant species with limited tolerance for drought. Wetland plant communities with high abundance of non-vascular (e.g., Sphagnum spp.) and shallow-rooted, herbaceous plant species (e.g., Carex and Eriophorum spp.), which have limited capacity for the storage and transport of water relative to woody shrubs and trees, and are expected to experience the most severe impacts from dewatering. Landscape-scale patterns of drying have documented decreased areas of surface water, conversion of wetlands to more mesic types, increase in woodiness, and upward and northward migration of elevational and latitudinal shrub and treelines (Klein et al. 2005; Lloyd and Fastie 2003; Tape et al. 2012). Similar successional transitions would be expected for the wetlands and other waters impacted by project-related dewatering.

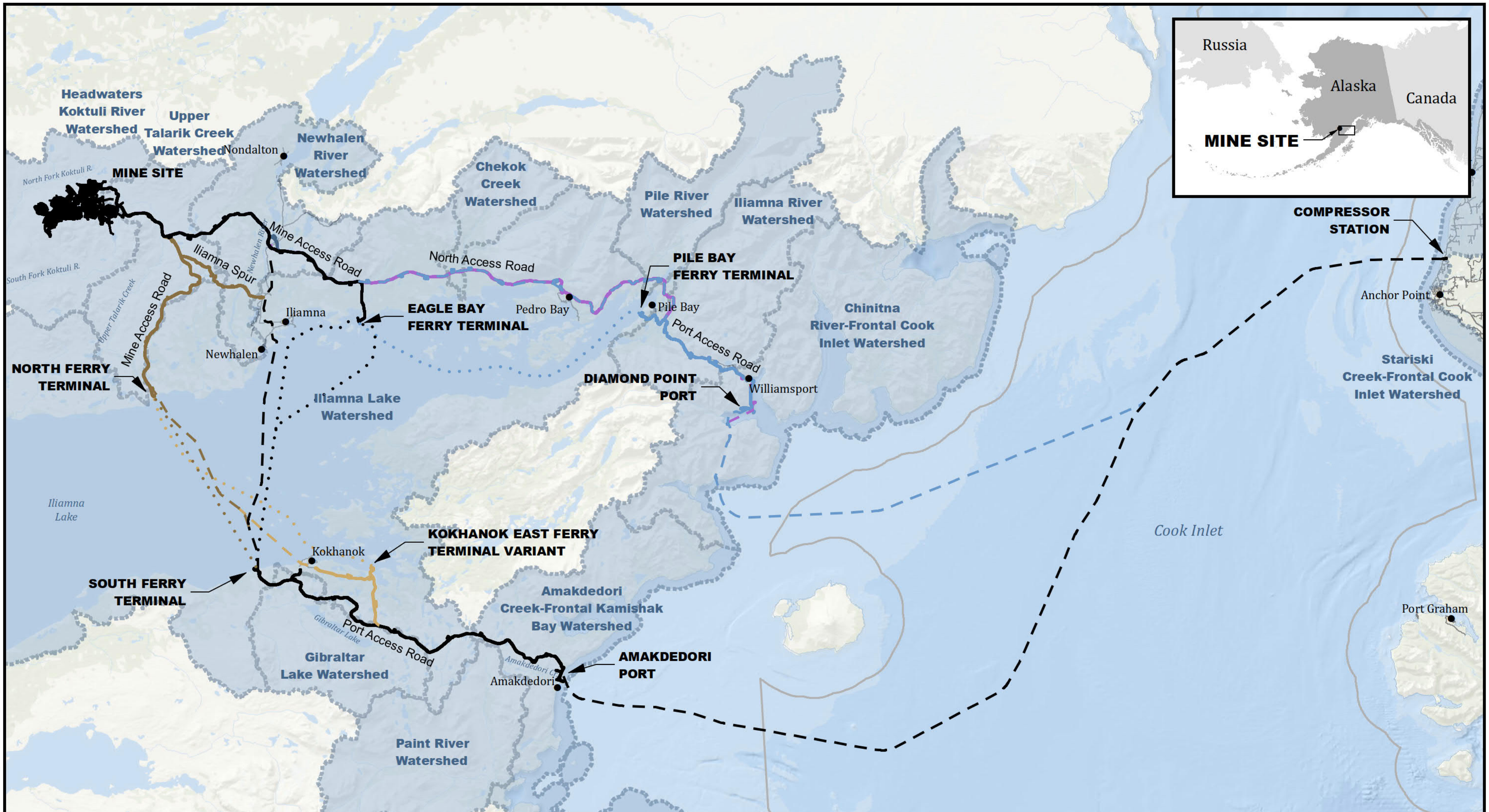
The magnitude of indirect impact to wetlands and other waters due to dewatering was calculated from the intersection of project-specific wetland mapping (HDR 2019i, j) with a layer expressing the expected change in depth to groundwater at the end of mining, when drawdown is at its maximum extent (PLP 2019-RFI 082a, b). All wetlands and other waters for which predrawdown groundwater levels were within 10 feet of the ground surface were included as potentially affected on the basis that habitat underlain by shallow groundwater is most likely to be impacted by dewatering. Wetlands and other waters predicted to experience a drawdown of less than 3 feet, were omitted from consideration as potentially affected habitat as a less than 3-foot change in groundwater is not expected to have a measurable impact on wetlands and other waters at the scale and resolution of the model. Wetlands and other waters for which the water level remained at or within 3 feet of the surface after the drawdown were not considered impacted (PLP 2019-RFI 082a, b, PLP 2018-RFI 109d; see Section 4.17, Groundwater Hydrology, for a discussion of the model and its limitations). Impacts were calculated using the baseline scenario (i.e., S0), which uses the value for hydraulic conductivity (i.e., K) to which the groundwater model was calibrated (Figure 4.22-3). The direct disturbance footprint was removed from this intersection to exclude wetlands and other waters directly impacted by permanent mine facilities. The extent of groundwater drawdown predicted by the model (i.e., S7) using the high-K value is included in calculations (Table 4.22-6) and Figure 4.22-3 as an approximation extent of detection. Wetlands and other waters in this extent of detection, exclusive of those explicitly identified as dewatered by the criteria above, can be considered potentially affected by drawdown, yet at a level that the groundwater model is not sensitive enough to predict. Wetlands and other waters outside this extent of detection can be considered not impacted by drawdown.

4.22.4 Summary of Key Issues

The loss of wetlands from development of the mine site represent about 6 percent of mapped wetlands in the Headwaters Koktuli River watershed. Depending on the alternative, discharge of dredged or fill material would permanently impact between 2,226 and 2,261 acres of wetlands and other waters, including between 104.1 and 105.8 miles of streams. The majority of permanent impacts would result from development of the mine site, and would occur in the Headwaters Koktuli River watershed. Depending on the alternative, these losses represent from 92 to 97 percent of the total permanent impacts to wetlands and other waters across all project components.

Table 4.22-1 summarizes the key issues by direct (permanent or temporary) and indirect impacts for wetlands and other waters across all alternatives, components, and variants. The No Action Alternative is not included because there would be no project-related impacts to wetlands and other waters. Direct and indirect impacts are summarized by area (acres) for wetlands and other waters; impacts to streams are summarized by length (linear miles). Stream lengths are provided as a supplemental metric for the evaluation of impact; the areas of streams are also included in the totals for "other waters" provided in Table 4.22-1. The term "stream" is used collectively to include both seasonally flooded, intermittent streams and permanently flooded, upper perennial streams (Photo 4.22-1 shows typical streams that would be impacted). These streams may provide habitat for resident and/or anadromous fish.

Overlap exists among the areas of indirect impact due to the deposition of fugitive dust, fragmentation of aquatic resources, and dewatering. When presented individually, the areas of impact are not corrected for overlap; when presented cumulatively, the total area of indirect impact is corrected for overlap. Therefore, individual areas of indirect impact will not sum to the cumulative area of indirect impact for a given alternative.



Sources: PLP 2020-RFI168;
PLP 2019-RFI153; USGS

US Army Corps of Engineers

5 0 5 10

Miles

HUC10 Watershed

Action Alternatives

Ferry Routes

Natural Gas Pipelines

Alternative 1a

Alternative 1

Alternative 1 Kokhanok East Ferry Terminal Variant

Alternative 2

Alternative 2 Newhalen River North Crossing Variant

Alternative 3

Other Features

Local Roads

Three Nautical Mile Line

OVERVIEW OF HUC 10 WATERSHEDS

PEBBLE PROJECT EIS

FIGURE 4.22-4

Table 4.22-1: Summary of Key Issues for Wetlands and Other Waters

Variant	Impact	Aquatic Resource	Alternative 1a		Alternative 1		Alternative 2		Alternative 3	
			Acres	Miles	Acres	Miles	Acres	Miles	Acres	Miles
All Project Components										
Base Case	Permanent	Wetlands	2,102		2,102		2,102		2,090	
		Other Waters	124	105.4	124	105.8	159	104.1	142	105.4
	Temporary	Wetlands	60		60		41		31	
		Other Waters	799	4.6	799	3.9	740	9.0	742	6.2
	Indirect	Wetlands	1,301		1,263		1,124		1,196	
		Other Waters	361	75.3	378	75.2	478	65.8	413	79.5
Mine Site										
Base Case	Permanent	Wetlands	2,051		2,051		2,073		2,051	
		Other Waters	111	99.7	111	99.7	111	100.3	111	99.7
	Temporary	Wetlands	<1		<1		<1		<1	
		Other Waters	<1	<0.1	<1	<0.1	<1	<0.1	<1	<0.1
	Indirect	Wetlands	774		774		771		774	
		Other Waters	82	29.9	82	29.9	82	29.8	82	29.9
Summer-Only Ferry Operations Variant	Permanent	Wetlands	—	—	2,052		2,074		—	—
		Other Waters	—	—	112	100.0	112	100.6	—	—
	Temporary	Wetlands	—	—	<1		<1		—	—
		Other Waters	—	—	<1	<0.1	<1	<0.1	—	—
	Indirect	Wetlands	—	—	773		770		—	—
		Other Waters	—	—	82	29.6	82	29.5	—	—
Concentrate Pipeline Variant	Permanent	Wetlands	—	—	—	—	—	—	2,051	
		Other Waters	—	—	—	—	—	—	111	99.7
	Temporary	Wetlands	—	—	—	—	—	—	<1	
		Other Waters	—	—	—	—	—	—	<1	<0.1

Table 4.22-1: Summary of Key Issues for Wetlands and Other Waters

Variant	Impact	Aquatic Resource	Alternative 1a		Alternative 1		Alternative 2		Alternative 3	
			Acres	Miles	Acres	Miles	Acres	Miles	Acres	Miles
	Indirect	Wetlands	—	—	—	—	—	—	774	
		Other Waters	—	—	—	—	—	—	82	29.9
Transportation										
Base Case	Permanent	Wetlands	51		52		29		38	
		Other Waters	10	5.7	10	6.1	34	3.3	28	5.7
	Temporary	Wetlands	38		36		22		26	
		Other Waters	9	3.9	8	3.7	17	2.2	14	3.9
	Indirect	Wetlands	525		487		314		422	
		Other Waters	266	45.3	252	45.2	298	30.6	323	48.5
Summer-Only Ferry Operations Variant	Permanent	Wetlands	—	—	52		29		—	—
		Other Waters	—	—	10	6.1	43	3.3	—	—
	Temporary	Wetlands	—	—	36		22		—	—
		Other Waters	—	—	8	3.7	17	2.2	—	—
	Indirect	Wetlands	—	—	487		314		—	—
		Other Waters	—	—	252	45.2	291	30.8	—	—
Kokhanok East Ferry Terminal Variant	Permanent	Wetlands	—	—	49		—	—	—	—
		Other Waters	—	—	8	5.9	—	—	—	—
	Temporary	Wetlands	—	—	33		—	—	—	—
		Other Waters	—	—	7	3.4	—	—	—	—
	Indirect	Wetlands	—	—	448		—	—	—	—
		Other Waters	—	—	221	42.4	—	—	—	—
	Permanent	Wetlands	—	—	—	—	29		—	—
		Other Waters	—	—	—	—	34	3.3	—	—

Table 4.22-1: Summary of Key Issues for Wetlands and Other Waters

Variant	Impact	Aquatic Resource	Alternative 1a		Alternative 1		Alternative 2		Alternative 3	
			Acres	Miles	Acres	Miles	Acres	Miles	Acres	Miles
Newhalen River North Crossing Variant	Temporary	Wetlands	—	—	—	—	22		—	—
		Other Waters	—	—	—	—	17	2.2	—	—
	Indirect	Wetlands	—	—	—	—	314		—	—
		Other Waters	—	—	—	—	296.5116	30.6	—	—
Port										
Base Case	Permanent	Wetlands	—		—		—		<1	
		Other Waters	2	—	11	—	14	<0.1	3	<0.1
	Temporary	Wetlands	—		—		—		—	
		Other Waters	5	—	4	—	72	0.1	88	0.1
	Indirect	Wetlands	1		1		1		<1	
		Other Waters	14	0.1	46	0.1	69	0.8	1	0.4
Summer-Only Ferry Operations Variant	Permanent	Wetlands	—	—	<1		—		—	—
		Other Waters	—	—	11	—	14	<0.1	—	—
	Temporary	Wetlands	—	—	<1		—		—	—
		Other Waters	—	—	4	—	72	0.1	—	—
	Indirect	Wetlands	—	—	3		1		—	—
		Other Waters	—	—	50	0.2	69	0.8	—	—
Pile-Supported Dock Variant	Permanent	Wetlands	—	—	—		—		—	—
		Other Waters	—	—	<1	—	4	<0.1	—	—
	Temporary	Wetlands	—	—	—		—		—	—
		Other Waters	—	—	6	—	79	0.1	—	—
	Indirect	Wetlands	—	—	1		1		—	—
		Other Waters	—	—	14	0.1	28	0.8	—	—

Table 4.22-1: Summary of Key Issues for Wetlands and Other Waters

Variant	Impact	Aquatic Resource	Alternative 1a		Alternative 1		Alternative 2		Alternative 3	
			Acres	Miles	Acres	Miles	Acres	Miles	Acres	Miles
Concentrate Pipeline Variant	Permanent	Wetlands	—	—	—	—	—	—	<1	
		Other Waters	—	—	—	—	—	—	4	<0.1
	Temporary	Wetlands	—	—	—	—	—	—	—	
		Other Waters	—	—	—	—	—	—	88	0.1
	Indirect	Wetlands	—	—	—	—	—	—	<1	
		Other Waters	—	—	—	—	—	—	1	0.4
Natural Gas Pipeline										
Base Case	Permanent	Wetlands	—		—		<1		—	
		Other Waters	1	—	4	—	<1	0.5	—	—
	Temporary	Wetlands	21		4		19		5	
		Other Waters	785	0.6	749	0.2	651	6.6	639	2.2
	Indirect	Wetlands	—		—		38		<1	
		Other Waters	—	—	—	—	29	4.7	7	0.8
Kokhanok East Ferry Terminal Variant	Permanent	Wetlands	—	—	—		—	—	—	—
		Other Waters	—	—	4	—	—	—	—	—
	Temporary	Wetlands	—	—	4		—	—	—	—
		Other Waters	—	—	759	0.2	—	—	—	—
	Indirect	Wetlands	—	—	—		—	—	—	—
		Other Waters	—	—	—	—	—	—	—	—

Notes:

Permanent and temporary impacts are direct impacts. Impact areas and lengths for variants are given as the total for that component; stream lengths are provided as a supplemental metric for the evaluation of impact; the areas of streams are also included in the total areas of "wetlands and other waters." The term "stream" is used collectively to include both seasonally flooded, intermittent streams and permanently flooded, upper perennial streams.

< = less than
— = not applicable

Photo 4.22-1: Examples of a Seasonally Flooded Intermittent Stream (top) and a Permanently Flooded Upper Perennial Stream (bottom)

4.22.5 No Action Alternative

The No Action Alternative is intended to be used as a baseline to facilitate the comparison of impacts between the alternatives. Impacts from the 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.

4.22.6 Alternative 1a

The total direct impact to wetlands and other waters under Alternative 1a would be the discharge of dredged or fill material to 3,084 acres of wetlands and other waters, including 110.0 miles of streams. Of this area of impact, 2,226 acres of wetlands and other waters, including 105.4 miles of streams, would be permanently impacted, whereas 858 acres of wetlands and other waters, including 4.6 miles of streams, would be temporarily impacted. Indirect impacts under Alternative 1a related to the fragmentation, deposition of dust, and dewatering of aquatic resources collectively have the potential to impact a total of 1,662 acres of wetlands and other waters, including 75.3 miles of streams.

The mine site is predominantly in the Headwaters Koktuli River watershed, with a lesser presence in the UTC watershed (Figure 4.22-4). The Headwaters Koktuli River watershed is 170,632 acres, with 36,458 acres classified as wetlands and other waters (based on NWI mapping). In terms of magnitude and extent, construction and operations of the mine site under Alternative 1a would have direct and indirect impact on 2,953 acres,[3] representing 8 percent of wetlands and other waters in the Headwaters Koktuli River watershed. The UTC watershed is 87,539 acres, with 13,193 acres classified as wetlands and other waters (based on NWI mapping). The mine site would have direct and indirect impact on 68 acres, or less than 1 percent of wetlands and other waters in the UTC watershed. Although NWI wetland mapping covers the entirety of the Headwaters Koktuli River watershed, only 91 percent of the UTC watershed has been mapped by NWI. Therefore, the area of wetlands and other waters presented for the UTC watershed is likely underestimated.

The transportation corridor, natural gas pipeline corridor, and Amakdedori port project components would collectively affect eight HUC 10 watersheds under Alternative 1a (Figure 4.22-4). Based on available NWI mapping, wetlands and other waters comprise 4,716,529 acres of the combined area of these watersheds (6,249,945 acres). In terms of magnitude and extent, these three project components would have direct and indirect impacts on

[3] total accounts for overlap among areas of indirect impact at the mine site.

1,728 acres of wetlands and other waters, representing less than 1 percent of the wetland and other waters habitat mapped for the combined watershed area. Although NWI mapping covers the entirety of the Cook Inlet and Stariski Creek-Frontal Cook Inlet watersheds, coverage for the remaining six watersheds averages 53 percent, with a range of 6 percent to 95 percent. Therefore, the areas of wetlands and other waters presented for these watersheds are likely underestimated.

The impact to **navigable waters** under Alternative 1a would occur in the Newhalen and Gibraltar rivers and Iliamna Lake and Cook Inlet, and would directly impact a total of 804 acres. Of this total area of direct impact, 12 acres would be permanent impacts largely associated with the construction of the Amakdedori port and ferry terminals; and 792 acres would be temporary impacts largely associated with the installation of the natural gas pipeline. These acreages are included in the "other waters" categories of Table 4.22-1, and would not result in additional areas of impact.

Special aquatic sites that would be directly and permanently impacted under Alternative 1a include mudflats, riffle and pool complexes, vegetated shallows, and wetlands. Quantifiable categories of **regionally important wetlands** that would be directly and permanently impacted under Alternative 1a include fens, and forested and riparian wetlands (see Section 3.22, Wetlands and Other Waters/Special Aquatic Sites, for a description of these types).

The greatest magnitude of impact to special aquatic sites would be to wetlands (2,012 acres), including regionally important riparian wetlands (127 acres), fens (72 acres), and forested wetlands, followed by riffle and pool habitat (46 acres, including 88.3 miles of upper perennial stream), mudflats (13 acres), and vegetated shallows (2 acres). The specific consequences of **wetland** loss and degradation are discussed throughout this section; the loss of values associated with impacts to other special aquatic sites and regionally important wetlands are discussed below.

Riparian wetlands are valued for their provision of habitat for regionally important wildlife. Under Alternative 1a, the loss of riparian wetlands would occur almost exclusively at the mine site (99 percent). This loss would likely result in a reduction of floodplain storage capacity; and subsequently, the maintenance of downstream baseflow. Reductions in sediment cycling, connection to off-channel habitat, and therefore support of the characteristic plant, fish, and wildlife communities would also be expected.

Fens are nutrient- and species-rich wetlands that are uncommon in Alaska, sensitive to disturbance, and difficult to restore. Under Alternative 1a, direct and permanent impacts to fens occur almost exclusively at the mine site (97 percent). Here, fens manifest as open low shrub habitat with herbaceous understory that is characterized by circumneutral species and significant flow of groundwater. Loss of fens would likely result in commensurate reductions to local biodiversity and functional capacity related to groundwater recharge/discharge, the moderation of surface and groundwater flow, and the sequestration of carbon and cycling of nutrients and compounds.

Riffle and pool complexes are a type of special aquatic site that, although not explicitly mapped for the Applicant's Preferred Alternative, commonly occur in upper perennial stream channels. Direct permanent impact to these channel types under the Applicant's Preferred Alternative would be 46 acres (equivalent to 88.3 stream miles), concentrated at the mine site (96 percent). The loss of this riffle and pool habitat is likely to cause the mortality of anadromous and resident fish as well as degrade the quality of downstream habitat through the reduced capacity for aeration and filtration, and increased scour, sedimentation, and turbidity.

Mudflats provide moderation of surface water, tidewater and storm surge flow, as well as habitat for aquatic organisms and food chain support for higher trophic levels. Under Alternative 1a, mudflats occur mostly at the mine site (92 percent) as the unvegetated or partially vegetated margins of lakes, ponds, and rivers; coastal mudflats are not impacted under this alternative. The loss or degradation of mudflats is likely to result in changes in water circulation and inundation, which can alter rates of erosion, accretion, and sedimentation. Specific to coastal mudflats, these changes can reduce the capacity of the greater coastal system to moderate storm surge flooding. Any change in periodicity and extent of tidal inundation resulting from the discharge of dredged or fill material would impact the rate of erosion and/or accretion, as well as chemical and biological exchange and decomposition processes. Such changes can reduce habitat productivity, deplete or eliminate mud flat biota, and displace the aquatic organisms that use mudflats for foraging and nursery grounds.

Vegetated shallows are a biologically productive aquatic resource that provides habitat and food for aquatic organisms and wildlife. Under Alternative 1a, vegetated shallows are documented exclusively in the freshwater environment, where they are associated with pond and lake margins. Impacts to vegetated shallows are concentrated at the mine site (94 percent), with limited occurrence at the Iliamna Lake ferry terminals. Loss of vegetated shallows would likely result in the mortality of sessile benthic aquatic organisms and the displacement of more mobile aquatic species. Removal and degradation of vegetated shallows would reduce the capacity of the greater pond, lake, or estuary to stabilize bottom and shoreline sediments, resulting in increased turbidity and sedimentation, and subsequent reductions in light penetration and photosynthesis.

Forested wetlands are an uncommon type valued for their maintenance of fish and wildlife communities through provision of food, cover, organic matter, and woody debris. Impacts to forested wetlands occur exclusively in the transportation corridor, and are expected to reduce the diversity—and therefore quality—of wildlife habitat in the greater ecosystem.

Although the extent of impacts would be expected to occur in six of the seven watersheds intersected by Alternative 1a, 97 percent of impacts to special aquatic sites and regionally important wetlands would occur in the Headwaters Koktuli River watershed, and would be largely associated with the construction and operation of the mine site. Direct, permanent impact to special aquatic sites and regionally important wetlands would affect 6 percent of the wetlands and other waters mapped in the Headwaters Koktuli drainage. Impacts to special aquatic sites and regionally important wetlands are calculated to represent 1 percent of waters and wetlands mapped in the Gibraltar Lake watershed; however, because only 6 percent of the Gibraltar Lake watershed has been mapped by NWI, the representation of impacts on the watershed scale is likely over estimated. The areas presented in Table 4.22-2 are those of direct permanent impacts to special aquatic sites and regionally important wetlands for all components of Alternative 1a; direct temporary and indirect impacts are not evaluated.

A summary of the direct and indirect impacts to wetlands and other waters is presented by project component in the following sections. No variants are analyzed under Alternative 1a. Areas of impact were assessed according to the analysis methodology described in under the “Analysis Methodology” subsection. A map book showing impacts in the analysis area is provided in Appendix K4.22.

4.22.6.1 Mine Site

Alternative 1a would develop the mine site with centerline construction for the bulk TSF. Excavation of the open pit, quarries, and sediment ponds and filling in the TSF and stockpiles would occur throughout the operational life of the mine.

Table 4.22-2: Alternative 1a—Direct Permanent Impacts to Special Aquatic Sites and Regionally Important Wetlands

HGM/NWI Group	Amakdedori Creek-Frontal Kamishak Bay	Gibraltar Lake	Headwaters Koktuli River	Iliamna Lake	Newhalen River	Upper Talarik Creek	Combined Watershed Area (Acres)
Percent of Watershed Mapped by NWI	53	6	100	57	95	91	
Special Aquatic Sites							
Mudflats	<1	<1	12	<1	—	<1	13
Riffle and Pool Habitat	<1	<1	44	1	<1	<1	46
Vegetated Shallows	—	—	2	<1	—	—	2
Wetlands	11	7	2,047	18	4	14	2,102
Regionally Important Wetlands							
Fens	<1	1	70	—	—	1	72
Forested Wetlands	—	—	—	2	<1	—	2
Riparian Wetlands	—	—	125	<1	1	1	127
Total Area of Special Aquatic Sites and Regionally Important Wetlands Impacted (Acres)	**12**	**8**	**2,302**	**21**	**5**	**17**	**2,364**
Total Area of NWI Wetlands and Other Waters (Acres)	**29,739**	**797**	**36,458**	**389,610**	**23,380**	**13,193**	**493,177**
Percent Total of NWI Wetlands and Other Waters	**<1**	**1**	**6**	**<1**	**<1**	**<1**	**<1**

Notes:

< = less than
— = not applicable
NWI = National Wetland Inventory

Source: Three Parameters Plus and HDR 2011b; HDR and Three Parameters Plus 2011b; HDR 20189i, j.

Direct Impacts

Project-related direct impacts to wetlands and other waters at the mine site include the excavation or placement of fill; the removal of vegetation; the compaction, rutting, and mixing of wetland soils; and the alteration of stream channels. The maximum extents of all surface disturbances were used to evaluate direct impacts to wetlands and other waters impacts at the mine site. Reduction or elimination of wetland or other water functions occurring after the construction phase, through operations, and into the closure and post-closure phases, would be considered permanent, and not able to be reclaimed. Temporary impacts include those where dredged or fill material is placed into wetlands or other waters and removed before the end of the construction period.

The direct disturbance footprint of the mine site under Alternative 1a is 8,390 acres, and represents 5 percent and less than 1 percent, respectively, of the areas of the Headwaters Koktuli River and Upper Talarik Creek (UTC) watersheds evaluated at the HUC 10 level. The magnitude of permanent impacts to wetlands and other waters at the mine site is 2,162 acres of wetlands and other waters, including 99.7 miles of streams (Table 4.22-3 and Figure 4.22-1 through Figure 4.22-3). Slope wetlands are the most impacted type, comprising 93 percent of permanent impacts to wetlands. Slope wetlands are primarily represented by the broad-leaved deciduous shrub wetlands, and secondarily by herbaceous wetlands. Ponds and streams compose 53 and 45 percent, respectively, of permanent impacts to other waters. Temporary degradation to wetlands and other waters associated with the installation of chambers at the three effluent discharge points would impact a total of 0.4 acre of wetlands and other waters, including 0.04 mile of stream. The extent of direct impacts is primarily in the Headwaters Koktuli River watershed (2,158 acres), with smaller impacts to the UTC watershed (4 acres). Direct impacts are estimated to eliminate 6 percent of the wetlands and other waters mapped by NWI for the Headwaters Koktuli River watershed, and less than 1 percent of wetlands and other waters mapped by NWI for the UTC watershed.

This direct loss of wetlands and other waters at the mine site would result in the mortality of aquatic organisms, and would reduce the collective functional capacity and value of wetlands and other waters across two watersheds. The elimination of this habitat would cause the displacement, injury, and/or mortality of the species that rely on aquatic environments for all or part of their life cycle. Mobile species such as fish, free-swimming crustaceans, amphibians, and macroinvertebrates are more likely to be displaced by loss of habitat; whereas sedentary aquatic species such as mollusks, fixed crustaceans, and benthic organisms could suffer mortality from sedimentation or smothering by fill. The discharge of dredged or fill material to these aquatic resources is expected to reduce the biological productivity of wetland ecosystems by smothering, dewatering, permanently flooding, or altering substrate elevation or the periodicity of water movement. Decreased productivity and/or alteration of current patterns and velocities could eliminate or reduce the cycling of nutrients and compounds.

Disruption of wetland hydrology can interfere with the filtration, aquifer recharge, and storm and floodwater modification functions of a wetland. Many of the impacted wetlands at the mine site, especially slope wetlands, are considered headwater wetlands from a watershed perspective. These are the primary source of intermittent and upper perennial streams. Impacts to these wetlands could alter groundwater discharge that maintains hydrology and water quality in these streams. This alteration of hydrologic function is likely to extend to the wetlands and other waters immediately downgradient from the affected wetlands.

Change in flow in the NFK, SFK, and UTC due to modification of upgradient wetlands and mine operations has the potential to change the hydrologic connectivity to off-channel habitat and associated wetlands. Off-channel habitat, including fringing riparian wetlands, provides cover important to the rearing of juvenile salmon, as well as adult and resident fish species. Furthermore, changes to flow and loss of connectivity between channels can impact the nutrient availability, invertebrate drift, and available habitat for benthic macroinvertebrate production, thereby affecting overall stream productivity (see Section 4.24, Fish Values).

Table 4.22-3: Alternative 1a—Mine Site Direct Impacts to Wetlands and Other Waters

HGM/NWI Group	Headwaters Koktuli River	Upper Talarik Creek	Combined Watershed Area	
			(Acres)	(Miles)
Percent of Watershed Mapped by NWI	100	91		
SLOPE	**1,925**	**4**	**1,929**	
Wetlands	**1,909**	**4**	**1,913**	
Herbaceous	547	1	547	
Deciduous Shrubs	1,352	3	1,355	
Evergreen Shrubs	11	—	11	
Other Waters	**16**		**16**	
Aquatic Bed	2	—	2	
Ponds	13	—	13	
DEPRESSIONAL	**50**	**<1**	**50**	
Wetlands	**12**	**<1**	**12**	
Herbaceous	5	<1	5	
Deciduous Shrubs	7	—	7	
Other Waters	**38**	**<1**	**39**	
Ponds	38	<1	39	
FLAT	**8**		**8**	
Wetlands	**8**		**8**	
Herbaceous	3	—	3	
Deciduous Shrubs	6	—	6	
LACUSTRINE FRINGE	**<1**		**<1**	
Wetlands	**<1**		**<1**	
Herbaceous	<1	—	<1	
RIVERINE CHANNEL	**50**	**<1**	**50**	
Other Waters	**50**	**<1**	**50**	
Streams (Intermittent)	4	<1	4	15.4
Streams (Perennial)	46	<1	46	84.3
RIVERINE	**125**		**125**	
Wetlands	**118**		**118**	
Herbaceous	42	—	42	
Deciduous Shrubs	76	—	76	
Other Waters	**7**		**7**	
Ponds	7	—	7	
Total Wetland Impacts (Acres)	**2,047**	**4**	**2,051**	
Total Other Waters Impacts (Acres)	**111**	**<1**	**111**	**99.7**
Total Wetlands and Other Waters Impacts (Acres)	**2,158**	**4**	**2,162**	
Total Area of NWI Wetlands and Other Waters (Acres)	**36,458**	**13,193**	**49,651**	
Percent Total of NWI Wetlands and Other Waters	**6**	**<1**	**4**	

Notes:

< = less than
— = not applicable
HGM = hydrogeomorphic
NWI = National Wetland Inventory

Source: Three Parameters Plus and HDR 2011b; HDR and Three Parameters Plus 2011b; HDR 2019i, j

The area of off-channel habitat is maximized in NFK, SFK, and UTC at flow ranges of approximately 100 to 275, 75 to 90, and 110 to 225 cfs, respectively (Section 3.24, Fish Values). Streamflow modeling described in Section 4.16, Surface Water Hydrology, indicates that average monthly and annual average monthly streamflow on the NFK, SFK, and UTC are likely to change as a result of mining, and that change would extend below the confluence of the NFK and SFK; however, in the UTC, streamflow would likely be confined to the upper reaches of the stream. Connection to off-channel habitat could be temporarily impacted during construction due to reduction in flows (Section 4.24, Fish Values).

In addition to affecting habitat availability and stream productivity, change in streamflow has the potential to alter the transport and fate of dissolved metals, nutrients, and ions in tributaries receiving treated effluent from the water treatment plant (WTP) (i.e., NFK, SFK, UTC). Wetland vegetation and soils can function to physically slow the flow of water through the system, thereby increasing the residence time, and therefore temperature of water inflowing from the main channel. Slower-moving, warmer water can increase the likelihood of chemical reactions by increasing the interaction of ions and compounds, as well as lowering the energies of activation. The prevalence of organic matter that is diagnostic of wetland soils is characterized by a weak positive surface charge, and is therefore particularly effective in the adsorption of anions or negatively charged compounds. Significant accumulations of organic matter as peat serve to lower the pH of the wetland system, which reduces the availability of nutrients in soluble form (i.e. phosphorus, nitrogen, calcium, and magnesium) and slows microbial activity. Because wetlands are typically anoxic, microbial activity is anerobic, which allows the transformation of certain compounds unavailable to aerobic decomposers (Jackson et al. 2014). Specifically, because methane (rather than carbon dioxide) is the by-product of anerobic decomposition, the methylation of inorganic mercury to the more bioaccumulative and toxic form of methylmercury might be promoted. In Southeast Alaska, concentration of methylmercury in surface water and biota has been shown positively corelated to wetland abundance in watersheds (Nagorski et al. 2014). Appendix K4.24, Fish Values, provides an analysis of the potential effects from methylmercury on aquatic resources.

The potential effects of altered flow and dissolved metal, nutrient, and ion concentrations are expected to be restricted to wetlands with a hydrologic connection to the NFK, SFK, or UTC tributaries. Impacts are expected to be greater for bogs, where histic epipedons often composed of sphagnum peat serve to both slow water and create an acidic and anoxic environment (van Breemen 1995). Effects are expected to be less for graminoid marshes and shrub wetlands fringing the riverine channels, where flow-through is high, and water pH and DO are more similar to those of the main channel water.

Under mine development and operation, the mainstems of the NFK, SFK, and UTC would be affected by change in flow and WTP effluent. Proximity analysis using GIS data indicates that 37 miles of these streams are adjacent to wetlands. Sections of the NFK intersecting or adjacent to wetland habitat total 7 miles (29 percent) of the tributary above its confluence with the SFK. Along the SFK above this same confluence, the length of wetland-associated streams totals 23 miles (62 percent). Reach F of the UTC includes 7 miles (82 percent) of stream intersecting or adjacent to wetlands. As described above, change in water flow, temperature, DO, and pH in wetlands can alter the transport and fate of and dissolved metal, nutrient, and ion concentrations in the greater stream-wetland complex. Adjacency of project-mapped stream channels to NWI-mapped wetlands was determined using best professional judgement guided by map scale and associated positional accuracy of wetland boundaries. Downstream flow changes beyond the confluence of the north and south forks of the Koktuli River are expected to be in the range of historic and seasonal variations. See Section 4.16, Surface Water Hydrology; Section 4.18, Water and Sediment Quality; and Appendix K4.18, Water and Sediment Quality, for a discussion of surface water hydrology impacts. Impacts to fish from changes in surface flows are discussed in Section 4.24, Fish Values.

Indirect Impacts

At the mine site, overlap exists among the areas of indirect impact due to the deposition of fugitive dust, fragmentation of aquatic resources, and dewatering. Correcting for these areas of overlap, the cumulative area of indirect impact at the mine site is 856 acres of wetlands and other waters (774 acres of wetlands and 82 acres of other waters, including 29.9 miles of stream). The areas of indirect impact presented in the following sections are considered individually, and are not corrected for overlap.

Fragmentation

The magnitude of indirect impacts related to the fragmentation of aquatic resources is 257 acres of wetlands and other waters, including 9.2 miles of streams (Table 4.22-4). The severity of impact relates to the type of wetland affected with high impact expected for the Riverine and Riverine Channel wetlands and waters, moderate impact expected for Slope and Depressional wetlands, and low impact expected for Flats wetlands (under "Analysis Methodology"). The magnitude of fragmentation impacts is highest for broad leaved deciduous shrub and herbaceous wetlands in the slope HGM class, which represent 72 percent and 24 percent, respectively, of the total fragmented wetlands. Considering the groundwater storage and organic matter production and nutrient cycling capacity of slope wetlands, losses of this HGM type would likely reduce the functional capacity of the watershed to maintain downstream baseflows, as well as reducing the subsidy of organic matter and nutrients to downstream aquatic ecosystems and organisms. Further discussion of slope wetland functions and values is provided in Section 3.22, Wetlands and Other Waters/Special Aquatic Sites; a general discussion of fragmentation is provided under the "Direct and Indirect Impacts" subheading.

These impacts would be considered an indirect but permanent consequence of development of the mine site. The extent of impacts is limited to the Headwaters Koktuli River watershed, and may overlap with or extend beyond impacts from the potential deposition of fugitive dust and dewatering, described below. The 257 acres of wetlands and other waters impacted by fragmentation represent 0.7 percent of the wetlands and open waters mapped by NWI in the Headwaters Koktuli River watershed.

Fugitive Dust

Fugitive dust would be generated during construction and operations. 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 erode dust from bare soil at the mine site. Fugitive dust impacts are considered an indirect but long-term consequence of project development.

The magnitude of indirect impact at the mine site due to fugitive dust is the exposure of 588 acres of wetlands and other waters, including 24.1 miles of streams, to the potential deposition of dust (Table 4.22-5). The extent of impact is concentrated in the Headwaters Koktuli River watershed (547 acres), with lesser impacts to the UTC watershed (41 acres). The area of potential fugitive dust impacts may overlap with impacts from fragmentation and dewatering.

Broad-leaved deciduous shrub and herbaceous wetlands in the slope HGM class represent 61 percent and 30 percent, respectively, of the total wetlands expected to be exposed to fugitive dust at the mine site. Ponds represent 67 percent of the waters expected to be exposed to fugitive dust. Vascular plants are generally susceptible to dust deposition through the physical shading of their leaf surfaces and blocking of leaf stomata, which can reduce photosynthetic rate and bioproductivity. The broad-leaved deciduous shrub wetland type is often composed of dwarf, or prostrate shrubs, which due to their architecture are effective traps of fugitive dust, and due to their lack of protective leaf cuticles, are more susceptible to abrasion by windblown dust.

Furthermore, shrub wetlands are often characterized by an abundance of bryophytes, which due to their lack of vascular transport mechanisms are particularly susceptible to airborne pollutants such as dust. General discussions of fugitive dust impacts are provided under the "Direct and Indirect Impacts" subheading and in Section 4.26, Vegetation.

Table 4.22-4: Alternative 1a—Mine Site Indirect Impacts to Wetlands and Other Waters from Fragmentation

HGM/NWI Group	Headwaters Koktuli River			Total Area	Total Length
	High	Moderate	Low	(Acres)	(Miles)
SLOPE		**243**		**243**	
Wetlands		**242**		**242**	
Herbaceous	—	61	—	61	
Deciduous Shrubs	—	180	—	180	
Evergreen Shrubs	—	1	—	1	
Other Waters		**1**		1	
Ponds	—	1	—	1	
DEPRESSIONAL		**2**		**2**	
Wetlands		**1**		**1**	
Herbaceous	—	1	—	1	
Deciduous Shrubs	—	<1	—	—	
Other Waters		**1**		**1**	
Ponds	—	1	—	1	
FLAT			**4**	**4**	
Wetlands			**4**	**4**	
Deciduous Shrubs	—	—	4	4	
RIVERINE CHANNEL	**3**			**3**	
Other Waters	**3**			**3**	
Streams (Intermittent)	1	—	—	1	3.0
Streams (Perennial)	2	—	—	2	6.2
RIVERINE	**5**			**5**	
Wetlands	**5**			**5**	
Herbaceous	2	—	—	2	
Deciduous Shrubs	3	—	—	3	
Other Waters	**1**			**1**	
Ponds	1	—	—	1	
Total Wetland Impacts (Acres)	**5**	**243**	**4**	**251**	
Total Other Waters Impacts (Acres)	**3**	**3**	**—**	**6**	**9.2**
Total Wetlands and Other Waters Impacts (Acres)	**8**	**245**	**4**	**257**	

Notes:

— = not applicable
HGM = hydrogeomorphic
NWI = National Wetland Inventory

Source: Three Parameters Plus and HDR 2011b; HDR and Three Parameters Plus 2011b; HDR 2019i, j

Table 4.22-5: Alternative 1a—Mine Site Indirect Impacts to Wetlands and Other Waters from Fugitive Dust

HGM/NWI Group	Headwaters Koktuli River	Upper Talarik Creek	Combined Watershed Area (Acres)	(Miles)
SLOPE	**451**	**34**	**485**	
Wetlands	**445**	**34**	**478**	
Herbaceous	144	13	156	
Deciduous Shrubs	298	21	319	
Evergreen Shrubs	2	—	2	
Other Waters	**6**	**<1**	**6**	
Ponds	6	<1	6	
DEPRESSIONAL	**36**	**3**	**39**	
Wetlands	**4**	**<1**	**5**	
Herbaceous	3	<1	3	
Deciduous Shrubs	1	<1	1	
Other Waters	**32**	**2**	**35**	
Ponds	32	2	35	
FLAT	**5**		**5**	
Wetlands	**5**		**5**	
Herbaceous	1	—	1	
Deciduous Shrubs	3	—	3	
LACUSTRINE	**9**		**9**	
Other Waters	**9**		**9**	
Lakes	9	—	9	
LACUSTRINE FRINGE	**3**		**3**	
Wetlands	**3**		**3**	
Herbaceous	3	—	3	
Deciduous Shrubs	<1	—	<1	
RIVERINE CHANNEL	**9**	**<1**	**9**	
Other Waters	**9**	**<1**	**9**	
Streams (Intermittent)	1	<1	1	4.2
Streams (Perennial)	8	<1	8	19.9
RIVERINE	**34**	**4**	**38**	
Wetlands	**30**	**3**	**33**	
Herbaceous	13	2	**15**	
Deciduous Shrubs	17	1	**19**	
Other Waters	**4**	**1**	**5**	
Ponds	4	1	5	
Total Wetland Impacts (Acres)	**487**	**37**	**524**	
Total Other Waters Impacts (Acres)	**60**	**4**	**64**	**24.1**
Total Wetlands and Other Waters Impacts (Acres)	**547**	**41**	**588**	

Notes:

< = less than
— = not applicable
HGM = hydrogeomorphic
NWI = National Wetland Inventory

Source: Three Parameters Plus and HDR 2011b; HDR and Three Parameters Plus 2011b; HDR 20189i, j

Dewatering

The magnitude of indirect impacts due to dewatering is the acres of wetlands and other waters at the mine site that are predicted to experience groundwater drawdown (HDR 2019i, j; PLP 2019-RFI 082a, b). The severity of impact is related to the susceptibility of a wetland type to dewatering, and is inferred from HGM class. Impacts to slope and depressional wetlands due to dewatering are qualified as high; impacts to riverine channel, riverine, lacustrine, and lacustrine fringe wetlands are qualified as moderate; and impacts to flats wetlands are qualified as low (PLP 2019-RFI 082a). Dewatering at the mine site would indirectly impact 355 acres of wetlands and other waters, including 10.4 miles of streams. The extent of impacts would be restricted to the mine site, with the majority of impacts occurring in the Headwaters Koktuli River watershed (317 acres), and the remaining 38 acres of impacts occurring in the UTC watershed. The area of impacts may overlap with or extend beyond impacts from the potential deposition of fugitive dust and fragmentation.

Table 4.22-6 shows the predicted impacts calculated for the end of mining, when drawdown is at its maximum extent, using the baseline scenario (i.e., S0), which uses the same value for hydraulic conductivity value (i.e., K) as the calibrated groundwater model (Figure 4.22-3). Under this scenario and conductivity value, dewatering impacts are highest for broad-leaved deciduous shrub and herbaceous wetlands in the slope HGM class, which represent 52 percent and 32 percent, respectively, of the total wetlands expected to be impacted by dewatering. Due to the groundwater storage and organic matter production and nutrient cycling capacity of slope wetlands, their loss would likely reduce the functional capacity of the watershed to maintain downstream baseflows, as well as reducing the subsidy of organic matter and nutrients to downstream aquatic ecosystems and organisms. Further discussion of slope wetland functions and values is provided under the “Alternative 1” subheading; general discussion of dewatering and the limitations of the groundwater drawdown model is provided under the “Direct and Indirect Impacts” subheading.

The 317 acres of wetlands and other waters impacted by dewatering in the Headwaters Koktuli River watershed represent less than 1 percent of the wetlands and open waters mapped by NWI in the watershed; the 38 acres of wetlands and other waters impacted by dewatering in the UTC watershed represent 0.3 percent of the wetlands and open waters mapped by NWI in the watershed.

Impacts were also calculated for the post-closure phase when the pit lake has reached its long-term maximum level. The magnitude and extent of impacts to wetlands and other waters would be less under this scenario and are not presented here. Alternate calculations were made for the end of mining using high (S7) and low (S8) values for hydraulic conductivity. Under a scenario of low hydraulic conductivity, total impacts to wetlands and other waters would be less: 191 acres, including 7.2 miles of streams. Under a scenario of high hydraulic conductivity, total impacts to wetlands and other waters would be greater: 431 acres, including 13.5 miles of streams. The extent of drawdown modeled for the end of mining under a high hydraulic conductivity can be considered an approximation of the maximum extent of detectable drawdown, beyond which impacts to wetlands and other waters due to dewatering would not be expected; this extent of detection is shown on Figure 4.22-3 The duration of all dewatering impacts would be permanent, because they would last until the post-closure phase (HDR 2019i, j; PLP 2019-RFI 082a, b).

Table 4.22-6: Alternative 1a—Mine Site Indirect Impacts to Wetlands and Other Waters from Drawdown of Groundwater

HGM/NWI Group	Headwaters Koktuli River		Upper Talarik Creek		Combined Watershed Area	
	High	Moderate	High	Moderate	(Acres)	(Miles)
SLOPE	**244**		**29**		**273**	
Wetlands	**241**		**28**		**270**	
Herbaceous	92	—	10	—	102	
Deciduous Shrubs	149	—	18	—	167	
Evergreen Shrubs	<1	—		—	<1	
Other Waters	**3**		**1**		**4**	
Ponds	3	—	1	—	4	
DEPRESSIONAL	**22**		**3**		**24**	
Wetlands	**7**		**<1**		**7**	
Herbaceous	4	—	<1	—	4	
Deciduous Shrubs	3	—		—	3	
Other Waters	**14**		**3**		**17**	
Ponds	14	—	3	—	17	
LACUSTRINE		**3**			**3**	
Other Waters		**3**			**3**	
Lakes	—	3	—	—	3	
LACUSTRINE FRINGE		**6**			**6**	
Wetlands		**6**			**6**	
Herbaceous	—	6	—	—	6	
Deciduous Shrubs	—	1	—	—	1	
RIVERINE CHANNEL		**4**		**<1**	**5**	
Other Waters		**4**		**<1**	**5**	
Ponds	—		—	<1	<1	
Streams (Intermittent)	—	<1	—	<1	<1	1.2
Streams (Perennial)	—	4	—	<1	4	9.2
RIVERINE		**37**		**6**	**43**	
Wetlands		32		5	37	
Herbaceous	—	18	—	2	20	
Deciduous Shrubs	—	14	—	2	16	
Other Waters		**5**		**1**	**6**	
Ponds	—	5	—	1	6	
Streams (Intermittent)	—	<1	—	—	<1	
Total Wetland Impacts (Acres)	**248**	**38**	**29**	**5**	**320**	
Total Other Waters Impacts (Acres)	**18**	**12**	**3**	**2**	**35**	**10.4**
Total Wetlands and Other Waters Impacts (Acres)	**266**	**51**	**32**	**6**	**355**	

Notes:

< = less than
— = not applicable
HGM = hydrogeomorphic
NWI = National Wetland Inventory

Source: Three Parameters Plus and HDR 2011b; HDR and Three Parameters Plus 2011b; HDR 2019i, j

4.22.6.2 Transportation Corridor

Alternative 1a would have a transportation corridor with a mine access road from the mine site to the Eagle Bay ferry terminal, with a southern crossing of the Newhalen River; a ferry crossing of Iliamna Lake from Eagle Bay to the south terminal west of Kokhanok; and a port access road with a crossing of the Gibraltar River, from the south ferry terminal to Amakdedori port on the western side of Cook Inlet. The transportation corridor includes the sections of the natural gas pipeline that are co-located with road alignments.

Direct Impacts

The magnitude and duration of direct impacts from construction of the transportation corridor would be the permanent loss of 60 acres of wetlands and other waters, including 5.7 miles of streams (Table 4.22-7); and temporary impacts to 47 acres of wetlands and other waters, including 3.9 miles of streams (Table 4.22-8). Slope wetlands are the most impacted type, comprising 94 percent and 92 percent, respectively, of permanent and temporary impacts to wetlands. The majority of slope wetlands are represented by broad-leaved deciduous shrub and herbaceous wetlands, the loss and degradation of which are discussed above. Ponds are the most impacted type, comprising 75 percent and 71 percent, respectively, of permanent and temporary impacts to other waters. The extent of direct impacts in the transportation corridor would affect wetlands and other waters across six watersheds. Direct impacts are highest in the Iliamna Lake watershed, where they represent 36 percent of permanent and 36 percent of temporary impacts of all permanent and temporary impacts to wetlands and other waters. For all watersheds, total direct permanent or temporary impacts represent 1 percent or less of all wetlands and other waters mapped by NWI.

Impacts to wetlands and other waters coincident with the roadbed are considered permanent because the road would remain to facilitate long-term water treatment and monitoring in the post-closure period. The functional capacity of wetlands and other waters coincident with the roadbed would be permanently lost. Construction-related impacts occurring within the 30 feet of the roadbed are considered temporary. Reduction of wetlands and other waters function due to temporary direct impacts would be restored by the end of the construction period.

Road construction, bridge and culvert installation, and the temporary placement of fill could result in temporary increases in turbidity and changes in patterns of erosion and sedimentation. In addition to direct habitat loss, material and water extraction sites developed in riverine floodplains could cause localized and temporary increases in turbidity and level of suspended sediment. Water would be withdrawn from waterbodies adjacent to the construction zone on an as-needed basis, and could result in localized and temporary alterations in flow pattern, rate, and volume with subsequent impacts to aquatic organisms, and adjacent wetland vegetation and hydrology. Previous disturbance to wetlands and other waters in the transportation corridor is minimal (HDR 2018c), and the corridor has been sited to avoid and minimize impacts to wetlands and other waters, as well as allowing for the efficient reclamation of disturbed areas.

Eagle Bay and South Ferry Terminals

Discharge of fill to construct the Eagle Bay and South ferry terminals would result in a combined permanent loss of 0.2 acre of wetland and 1.4 acres of lacustrine habitat with temporary increases in turbidity from in-water work or from construction runoff expected across additional 0.1 acre wetland and 2.0 acres of lacustrine habitat; these areas are included in Table 4.22-7 and Table 4.22-8, and do not represent additional areas of impact. The placement of in-water structures is likely to alter local water circulation patterns, with subsequent change to shoreline and substrate erosion and deposition rates. These physical changes have the potential to alter the location, structure, and dynamics of aquatic communities, including prey. However, the loss and degradation of wetland and lacustrine habitat associated with construction of the two terminals is minimal relative to the approximately 300 miles of shoreline that will remain undisturbed in Iliamna Lake.

Table 4.22-7: Alternative 1a—Transportation Corridor Permanent Impacts to Wetlands and Other Waters

HGM/NWI Group	Amakdedori Creek-Frontal Kamishak Bay	Gibraltar Lake	Headwaters Koktuli River	Iliamna Lake	Newhalen River	Upper Talarik Creek	Combined Watershed Area	
							(Acres)	(Miles)
Percent of Watershed Mapped by NWI	53	6	100	57	95	91		
SLOPE	**14**	**8**		**19**	**3**	**9**	**54**	
Wetlands	**11**	**7**		**18**	**3**	**9**	**48**	
Herbaceous	5	2	—	5		1	13	
Deciduous Shrubs	6	3	—	10	3	8	30	
Evergreen Shrubs	<1	2	—	2	<1	—	4	
Deciduous Forest	—	—	—	2	<1	—	2	
Evergreen Forest	—	—			<1	—	<1	
Other Waters	**3**	**1**		**2**		**<1**	**5**	
Aquatic Bed	—	—	—	<1	—	—	<1	
Ponds	3	1	—	1	—	<1	5	
DEPRESSIONAL	**<1**		**<1**	**1**		**<1**	**1**	
Wetlands			**<1**	**<1**		**<1**	**<1**	
Herbaceous	—	—	<1	—	—	<1	<1	
Evergreen Shrubs	—	—	—	<1	—	—	<1	
Other Waters	**<1**		**<1**	**<1**		**<1**	**<1**	
Ponds	<1	—	<1	<1	—	<1	<1	
FLAT					**<1**	**<1**	**1**	
Wetlands					**<1**	**<1**	**1**	
Herbaceous	—	—	—	—	—	<1	<1	
Deciduous Shrubs	—	—	—	—	<1	<1	<1	
LACUSTRINE	**<1**	**<1**		**1**			**2**	
Other Waters	**<1**	**<1**		**1**			**2**	
Lakes	<1	<1	—	1	—	—	2	

Table 4.22-7: Alternative 1a—Transportation Corridor Permanent Impacts to Wetlands and Other Waters

HGM/NWI Group	Amakdedori Creek-Frontal Kamishak Bay	Gibraltar Lake	Headwaters Koktuli River	Iliamna Lake	Newhalen River	Upper Talarik Creek	Combined Watershed Area	
							(Acres)	(Miles)
RIVERINE CHANNEL	**1**	**<1**	**<1**	**1**	**<1**	**<1**	**2**	
Other Waters	**1**	**<1**	**<1**	**1**	**<1**	**<1**	**2**	
Streams (Intermittent)	<1	<1	—	<1	—	<1	<1	
Streams (Perennial)	<1	<1	<1	1	<1	<1	2	
RIVERINE				**<1**	**1**	**1**	**2**	
Wetlands				**<1**	**1**	**1**	**2**	
Herbaceous	—	—	—	—	—	<1	<1	
Deciduous Shrubs	—	—	—	<1	1	1	1	
Deciduous Forest	—	—	—	—	<1		<1	
Other Waters						**<1**	**<1**	
Ponds	—	—	—	—	—	<1	<1	
Total Wetland Impacts (Acres)	**11**	**7**	**<1**	**18**	**4**	**10**	**51**	
Total Other Waters Impacts (Acres)	**4**	**1**	**<1**	**4**	**<1**	**<1**	**10**	**5.7**
Total Wetlands and Other Waters Impacts (Acres)	**15**	**8**	**<1**	**22**	**4**	**11**	**60**	
Total Area of NWI Wetlands and Other Waters (Acres)	**29,739**	**797**	**36,458**	**389,610**	**23,380**	**13,193**	**493,177**	
Percent Total of NWI Wetlands and Other Waters	**<1**	**1**	**<1**	**<1**	**<1**	**<1**	**<1**	

Notes:

< = less than
— = not applicable
HGM = hydrogeomorphic
NWI = National Wetland Inventory

Source: Three Parameters Plus and HDR 2011b; HDR and Three Parameters Plus 2011b; HDR 2019i, j

Table 4.22-8: Alternative 1a—Transportation Corridor Temporary Impacts to Wetlands and Other Waters

HGM/NWI Group	Amakdedori Creek-Frontal Kamishak Bay	Gibraltar Lake	Headwaters Koktuli River	Iliamna Lake	Newhalen River	Upper Talarik Creek	Combined Watershed Area	
							(Acres)	(Miles)
Percent of Watershed Mapped by NWI	53	6	100	57	95	91		
SLOPE	**11**	**6**		**13**	**4**	**5**	**40**	
Wetlands	**9**	**5**	—	**12**	**4**	**5**	**35**	
Herbaceous	3	2	—	3	<1	1	9	
Deciduous Shrubs	5	3	—	7	3	4	21	
Evergreen Shrubs	<1	1	—	1	1	—	4	
Deciduous Forest	—	—	—	1	<1	—	1	
Evergreen Forest	—	—	—	—	<1	—	<1	
Other Waters	**3**	**1**		**1**			**4**	
Aquatic Bed	—	—	—	<1	—	—	<1	
Ponds	3	1	—	1	—	—	4	
DEPRESSIONAL			**<1**	**1**	**<1**	**<1**	**1**	
Wetlands	—	—	**<1**	**<1**	**<1**	**<1**	**<1**	
Herbaceous	—	—	<1	—	<1	<1	<1	
Evergreen Shrubs	—	—	—	<1	<1	—	<1	
Other Waters			**<1**	**<1**		**<1**	**1**	
Ponds	—	—	<1	<1	—	<1	1	
FLAT					**<1**	**<1**	**1**	
Wetlands					**<1**	**<1**	**1**	
Herbaceous	—	—	—	—	—	<1	<1	
Deciduous Shrubs	—	—	—	—	<1	<1	<1	
LACUSTRINE	**<1**	**<1**		**2**		**<1**	**2**	
Other Waters	**<1**	**<1**		**2**		**<1**	**2**	
Lakes	<1	<1	—	2	—	<1	2	
RIVERINE CHANNEL	**<1**	**<1**	**<1**	**1**	**<1**	**<1**	**2**	
Other Waters	**<1**	**<1**	**<1**	**1**	**<1**	**<1**	**2**	

Table 4.22-8: Alternative 1a—Transportation Corridor Temporary Impacts to Wetlands and Other Waters

HGM/NWI Group	Amakdedori Creek-Frontal Kamishak Bay	Gibraltar Lake	Headwaters Koktuli River	Iliamna Lake	Newhalen River	Upper Talarik Creek	Combined Watershed Area	
							(Acres)	(Miles)
Streams (Intermittent)	<1	<1	—	<1	—	<1	<1	1.1
Streams (Perennial)	<1	<1	<1	1	<1	<1	1	2.8
RIVERINE		**<1**		**<1**	**1**	**1**	**1**	
Wetlands		**<1**		**<1**	**1**	**1**	**1**	
Herbaceous	—	—	—	—	<1	<1	<1	
Deciduous Shrubs	—	—	—	<1	<1	<1	1	
Deciduous Forest	—	<1	—	—	<1	—	<1	
Other Waters						**<1**	**<1**	
Ponds	—	—	—	—	—	<1	<1	
Total Wetland Impacts (Acres)	**9**	**6**	**<1**	**13**	**5**	**6**	**38**	
Total Other Waters Impacts (Acres)	**3**	**1**	**<1**	**4**	**<1**	**1**	**9**	**3.9**
Total Wetlands and Other Waters Impacts (Acres)	**12**	**6**	**<1**	**17**	**5**	**6**	**47**	
Total Area of NWI Wetlands and Other Waters (Acres)	**29,739**	**797**	**36,458**	**389,610**	**23,380**	**13,193**	**493,177**	
Percent Total of NWI Wetlands and Other Waters	**<1**	**1**	**<1**	**<1**	**<1**	**<1**	**<1**	

Notes:

< = less than
— = not applicable
HGM = hydrogeomorphic
NWI = National Wetland Inventory

Source: Three Parameters Plus and HDR 2011b; HDR and Three Parameters Plus 2011b; HDR 2019i, j

Newhalen River Bridge

Construction of the multi-span Newhalen River bridge would require the placement of piles below the ordinary high-water mark. The direct footprint of these pilings is 201 square feet (approximately 0.005 acre)[4] in perennial stream habitat. Impacts to these waters would be permanent. Temporary impacts to 0.1 acre of herbaceous riverine wetlands are expected during construction. These areas are included in Table 4.22-7 and Table 4.22-8, and do not represent additional areas of impact.

Gibraltar River Bridge

Construction of the Gibraltar River bridge would not place fill or piles below the ordinary high-water mark, and the bridge is situated to avoid direct permanent impacts to wetlands. Construction of a temporary bridge would impact 0.2 acre of broad-leaved forested wetland and 0.04 acre of perennial stream. These areas of temporary impact are included in Table 4.22-8, and do not represent additional areas of impact.

Indirect Impacts—Fugitive Dust

Because the transportation corridor crosses several watersheds, indirect impacts due to fugitive dust deposition have the potential to affect a greater geographic extent compared to the mine site. However, rates of dust deposition are expected to be lower along the access roads, because the frequency of vehicle travel would be less (compared to ongoing movement of materials at the mine site), and the size of the dust-producing area would be smaller (road width compared to the entire mine site). During operations, transportation of materials (concentrate, fuel, reagents, and consumables) would require multiple truck round-trips per day on the port access road; Section 4.12, Transportation and Navigation, describes the number of trips and the type of vehicles expected. In addition to dust produced by the operation of vehicles on gravel roads, dust is also likely to be generated during the placement and compaction of gravel during road construction.

Under Alternative 1a, the magnitude of indirect impacts would be the potential deposition of dust over 791 acres of wetlands and other waters, including 45.3 miles of streams. Slope wetlands comprise 92 percent of the wetland area exposed to fugitive dust, and are chiefly represented by broad-leaved deciduous shrub and herbaceous wetlands, the degradation of which are discussed above. With respect to other waters, lakes and ponds represent 54 percent and 27 percent of the other water types exposed to fugitive dust (Table 4.22-9). The extent of impact transects seven watersheds. Except for the Gibraltar Lake watershed, indirect impacts represent 1 percent or less of all wetlands and other waters mapped by NWI; because only 6 percent of the Gibraltar Lake watershed has been mapped by NWI, the high (16) percent of wetlands and other waters impacted for this watershed is artificial. The highest severity of dust deposition to wetlands, other waters, and their functions are expected to occur proximal to the road edge, but may be detectable up to 330 feet distant. Note that the 330-foot dust zone overlaps with the 30-foot temporary construction impact zone in the transportation corridor. Dust impacts are considered an indirect yet long-term consequence of development.

[4] Construction plans for the Newhalen River bridge place 16 4-foot-diameter piles in the waters of the Newhalen River.

Table 4.22-9: Alternative 1a—Transportation Corridor Fugitive Dust Impacts on Wetlands and Other Waters

HGM/NWI Group	Amakdedori Creek-Frontal Kamishak Bay	Gibraltar Lake	Headwaters Koktuli River	Iliamna Lake	Newhalen River	Paint River	Upper Talarik Creek	Combined Watershed Area	
								(Acres)	(Miles)
Percent of Watershed Mapped by NWI	53	6	100	57	95	16	91		
SLOPE	**138**	**111**	**1**	**205**	**59**	**<1**	**68**	**582**	
Wetlands	**102**	**88**	**<1**	**164**	**59**	**<1**	**68**	**482**	
Herbaceous	41	25	<1	54	12	<1	10	143	
Deciduous Shrubs	59	44	<1	82	44	<1	57	286	
Evergreen Shrubs	3	19	—	19	2	—	<1	44	
Deciduous Forest	—	—	—	8	1	—	—	9	
Evergreen Forest	—	—	—	<1	<1	—	—	<1	
Other Waters	**35**	**20**	**<1**	**42**	**<1**		**<1**	**98**	
Aquatic Bed	—	—	—	<1	—	—	—	<1	
Ponds	35	20	<1	42	<1	—	<1	98	
DEPRESSIONAL	**<1**	**6**	**<1**	**25**	**9**		**19**	**59**	
Wetlands		**3**	**<1**	**3**	**4**		**1**	**12**	
Herbaceous	—	3	<1	1	3	—	1	9	
Deciduous Shrubs	—	—	—	—	1	—	<1	1	
Evergreen Shrubs	—	—	—	1	<1	—		1	
Other Waters	**<1**	**3**	**<1**	**22**	**5**		**17**	**48**	
Aquatic Bed	—	<1	—	<1	1	—	—	1	
Ponds	<1	3	<1	22	5	—	17	47	
FLAT					**1**		**13**	**14**	
Wetlands					**1**		**13**	**14**	
Herbaceous	—	—	—	—	—	—	8	8	
Deciduous Shrubs	—	—	—	—	1	—	5	6	

Table 4.22-9: Alternative 1a—Transportation Corridor Fugitive Dust Impacts on Wetlands and Other Waters

HGM/NWI Group	Amakdedori Creek-Frontal Kamishak Bay	Gibraltar Lake	Headwaters Koktuli River	Iliamna Lake	Newhalen River	Paint River	Upper Talarik Creek	Combined Watershed Area	
								(Acres)	(Miles)
LACUSTRINE	**8**	**10**		**42**	**6**		**6**	**72**	
Other Waters	**8**	**10**		**42**	**6**		**6**	**72**	
Lakes	8	10	—	42	6	—	6	72	
LACUSTRINE FRINGE		**<1**			**<1**		**<1**	**<1**	
Wetlands					**<1**		**<1**	**<1**	
Herbaceous	—	—	—	—	<1	—	—	<1	
Deciduous Shrubs	—	—	—	—	—	—	<1	<1	
Other Waters		**<1**						**<1**	
Aquatic Bed	—	<1	—	—	—	—	—	<1	
RIVERINE CHANNEL	**6**	**3**	**<1**	**13**	**21**	**<1**	**5**	**48**	
Other Waters	**6**	**3**	**<1**	**13**	**21**	**<1**	**5**	**48**	
Streams (Intermittent)	1	<1	—	<1	<1		<1	2	12.1
Streams (Perennial)	5	3	<1	13	21	<1	4	46	33.2
RIVERINE	**<1**	**1**		**<1**	**7**		**10**	**18**	
Wetlands	**<1**	**1**		**<1**	**7**		**9**	**17**	
Herbaceous	—	—	—	<1	1	—	1	2	
Deciduous Shrubs	<1	1	—	<1	6	—	7	14	
Deciduous Forest	—	<1	—	—	<1	—		1	
Other Waters							**1**	**1**	
Aquatic Bed	—	—	—	—	—	—	<1	<1	
Ponds	—	—	—	—	—	—	1	1	
Total Wetland Impacts (Acres)	**103**	**93**	**<1**	**166**	**72**	**<1**	**91**	**525**	
Total Other Waters Impacts (Acres)	**50**	**36**	**<1**	**120**	**32**	**<1**	**29**	**266**	**45.3**

Table 4.22-9: Alternative 1a—Transportation Corridor Fugitive Dust Impacts on Wetlands and Other Waters

HGM/NWI Group	Amakdedori Creek-Frontal Kamishak Bay	Gibraltar Lake	Headwaters Koktuli River	Iliamna Lake	Newhalen River	Paint River	Upper Talarik Creek	Combined Watershed Area	
								(Acres)	(Miles)
Total Wetlands and Other Waters Impacts (Acres)	152	129	1	286	103	<1	120	791	
Total Area of NWI Wetlands and Other Waters (Acres)	29,739	797	36,458	389,610	23,380	2,762	13,193	495,939	
Percent Total of NWI Wetlands and Other Waters	1	16	<1	<1	<1	<1	1	<1	

Notes:

< = less than
— = not applicable
HGM = hydrogeomorphic
NWI = National Wetland Inventory

Source: Three Parameters Plus and HDR 2011b; HDR and Three Parameters Plus 2011b; HDR 2019i, j

4.22.6.3 Amakdedori Port

Alternative 1a would construct a caisson dock at Amakdedori on Kamishak Bay. Due to sufficient water depth, dredging is not necessary for boat access at this port location. The port would be supported by a permanent airstrip used primarily for construction, but retained for emergency access. Sea anchors for the primary and alternate lightering locations and two navigational buoys would be set on the seafloor under this alternative.

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 facilities needed for shallow draft tug and barge access to the dock for the transfer of bulk supplies.

Direct Impacts

The Amakdedori port terminal and associated shore-based facilities, including an airstrip, are sited and designed to avoid all wetlands and fresh waters. In terms of magnitude and duration, the caisson-supported causeway and jetty would permanently impact 2 acres of marine waters, with the sea anchors for the two lightering locations and two navigational buoys permanently impacting 0.1 acre of the subtidal portion of these waters (Table 4.22-10). The in-water components of marine facilities would alter water circulation, and likely patterns of erosion and sedimentation in the nearshore environment. However, because the port site at Amakdedori has a high-energy wave regime with a large tidal influence, the nearshore environment is subject to constant redistribution of substrate through littoral transport, storm surge, and ice scour. Due to this naturally dynamic environment, resident aquatic organisms are likely already adapted to changing water circulation and bottom conditions.

Construction-related impacts are expected to temporarily increase the turbidity and suspended particulate through 5 acres of marine waters (Table 4.22-10). Change in shoreline erosion and sedimentation pattern as well as disturbance to benthic fauna and bottom habitat structure are also expected during construction but would be considered temporary due to dynamic wave action and natural redistribution of nearshore sediment. The extents of direct permanent and temporary impact are restricted to the Amakdedori Creek-Frontal Kamishak Bay watershed and represent less than 1 percent of wetlands and other waters mapped by NWI for this watershed. Previous disturbance to wetlands or other waters in this area is minimal.

Table 4.22-10: Alternative 1a—Amakdedori Port Direct Impacts on Wetlands and Other Waters

HGM/NWI Group	Permanent	Temporary
	Amakdedori Creek-Frontal Kamishak Bay	
Percent of Watershed Mapped by NWI	53	
MARINE	**2**	**5**
Marine (Intertidal)	<1	1
Marine (Subtidal)	2	4
Total Other Waters Impacts (Acres)	**2**	**5**
Total Area of NWI Wetlands and Other Waters (Acres)	**29,739**	
Percent Total of NWI Wetlands and Other Waters	**<1**	

Notes:

< = less than
HGM = hydrogeomorphic
NWI = National Wetland Inventory

Source: Three Parameters Plus and HDR 2011b; HDR and Three Parameters Plus 2011b; HDR 2019i, j

Indirect Impacts—Fugitive Dust

The production of fugitive dust at Amakdedori would be generated mostly during construction of the port. Dust emissions during the period of operations expected to be limited, because the proposed caisson dock design would be decked with concrete and is not a source of fugitive dust. The magnitude of wetlands and other waters that would potentially be affected by dust deposition at the Amakdedori port is 15 acres. Marine waters compose 11 acres of this area of indirect impact, and perennial streams are subdominant at 3 acres, including 0.1 mile of stream (Table 4.22-11). The extent of indirect impact is restricted to the Amakdedori Creek-Frontal Cook Inlet Bay watershed, and represents less than 1 percent of wetlands and other waters mapped by NWI for the watershed. These impacts are considered an indirect but long-term consequence of development.

Table 4.22-11: Alternative 1a—Amakdedori Port Fugitive Dust Impacts on Wetlands and Other Waters

HGM/NWI Group	Amakdedori Creek-Frontal Kamishak Bay	
	(Acres)	(Miles)
Percent of Watershed Mapped by NWI	53	
SLOPE	**1**	
Wetlands	**1**	
Herbaceous	1	
RIVERINE	**<1**	
Wetlands	**<1**	
Herbaceous	<1	
RIVERINE CHANNEL	**3**	
Other Waters	**3**	
Streams (Perennial)	3	0.1
MARINE	**11**	
Other Waters	**11**	
Marine (Intertidal)	9	
Marine (Subtidal)	3	
Total Wetland Impacts (Acres)	1	
Total Other Waters Impacts (Acres)	14	0.1
Total Wetlands and Other Waters Impacts (Acres)	15	
Total Area of NWI Wetlands and Other Waters (Acres)	29,739	
Percent Total of NWI Wetlands and Other Waters	<1	

Notes:

< = less than
HGM = hydrogeomorphic
NWI = National Wetland Inventory

Source: Three Parameters Plus and HDR 2011b; HDR and Three Parameters Plus 2011b; HDR 2019i, j

4.22.6.4 Natural Gas Pipeline Corridor

Alternative 1a includes a natural gas pipeline crossing Cook Inlet from the Kenai Peninsula to the Amakdedori port, where it is co-located with the port access road to Iliamna Lake. The pipeline crosses the lake to Newhalen, where it is routed overland to connect to the mine access road east of the Newhalen River crossing. From this reconnection with the road, the pipeline follows the mine access road to the mine site.

Direct Impacts

Overland sections of the natural gas pipeline would be co-located with access roads to the extent possible. Impacts associated with the pipeline-only sections (i.e., where the natural gas pipeline is not co-located with roads) are assessed here; co-located sections are addressed under the transportation corridor. The stand-alone sections of the natural gas pipeline under Alternative 1a include the 1-mile Kenai Peninsula tie-in, the 104-mile Cook Inlet crossing, the 1-mile section between Cook Inlet and the port access road, the 21-mile Iliamna Lake crossing, the less than 1-mile section between Iliamna Lake and the port access road, the 10-mile segment from the north shore of Iliamna Lake, to the point of connection with the mine access road, east of the Newhalen River crossing, and the 2-mile section from the mine access road to the mine site.

Where the pipeline would cross streams, it would be placed by either horizontal directional drilling (HDD), open-cut trenching, or hung along bridge supports. Suspension of the natural gas pipeline from bridges is not expected to impact wetlands or other waters. HDD typically results in minimal disruption to riparian vegetation adjacent to the stream, and no disturbance to the stream bed. Trenching would result in a temporary loss of habitat from the diversion of streams, removal of riparian vegetation, and excavation of streambed materials and would cause temporary increases in turbidity and suspended particulate during construction. Water diversions would be temporary.

Installation of the natural gas pipeline across Iliamna Lake and Cook Inlet would occur by HDD or trenching for the nearshore sections, and by either burial or direct placement of the pipeline on the lake or seabed at depths beyond which the pipeline would not pose a navigational hazard. Impact zones of 91 feet for Iliamna Lake and ranging from 101 (Alternative 1a and Alternative 1) to 183 feet (Alternative 2 and Alternative 3) for Cook Inlet have been adopted to account for temporary impacts along these in-water, pipeline-only sections. Construction of a permanent, 13-foot-wide berm is required along a 0.6-mile section of Iliamna Lake, where the lakebed surface is too rough for direct placement of the pipeline.

Pipeline installation would occur over a period of 2 years and cause local and temporary increases in turbidity and suspended particulate. Installation of the pipeline could result in the displacement, injury, and/or mortality of benthic species. However, given the water depths, lack of light, oligotrophic status of Iliamna Lake, and high natural rates of sedimentation in Cook Inlet, impacts to deepwater benthic areas are not expected to be substantial. Furthermore, direct placement of the metal pipe would introduce a novel substrate that is expected to be quickly colonized by benthic organisms. Several trenching technologies are identified in Chapter 2, Alternatives. Although a specific technology has not been identified for the proposed project, the magnitude of temporary impacts to lake and seabed are not expected to vary among trenching methods.

Overland installation of the natural gas pipeline would directly impact wetlands and other waters by the excavation or placement of fill; the removal of vegetation; the compaction, rutting, and mixing of wetland soils; and the alteration of stream channels. A 150-foot zone centered on the pipeline has been adopted to account for any potential temporary impacts along these overland, pipeline-only sections.

In terms of magnitude and duration, the pipeline-only sections of the natural gas pipeline would permanently impact 1 acre of lacustrine waters, an impact associated with construction of a berm on the Iliamna Lake lakebed. Temporary impacts of the pipeline-only sections are expected to affect

806 acres of wetlands and other waters, including 0.6 mile of stream (Table 4.22-12). A total of 785 acres of other waters would be temporarily impacted from installation of the in-water, pipeline-only sections of the natural gas pipeline. Of these other waters, 80 percent of the area of impact is expected to be marine waters in Cook Inlet, with the remaining 20 percent expected to be made up of the fresh waters of Iliamna Lake. Due to the locations of these impacts, the Cook Inlet (610 acres) and Iliamna Lake (174 acres) watersheds would sustain the highest levels of direct impacts. The extent of impact transects seven watersheds; for all watersheds, direct impacts represent less than 1 percent of wetlands and other waters mapped by NWI in a given watershed.

Indirect Impacts—Fugitive Dust

Fugitive dust would be generated during installation of the overland, pipeline-only sections of the natural gas pipeline; dust generation during operations is expected to be minimal, because these sections would not be regularly accessed. Subsequent indirect impacts to wetlands and other waters from fugitive dust would likely be limited, and are analyzed in the transportation corridor component of Alternative 1a.

4.22.7 Alternative 1

The total direct impact to wetlands and other waters under Alternative 1 is the discharge of dredged or fill material to 3,084 acres of wetlands and other waters, including 109.7 miles of streams (Table 4.22-1). Of this area of direct impact, 2,226 acres of wetlands and other waters, including 105.8 miles of streams, would be permanently impacted; 858 acres of wetlands and other waters, including 3.9 miles of streams, would be temporarily impacted. Indirect impacts under Alternative 1 related to the fragmentation, deposition of dust, and dewatering of aquatic resources collectively have the potential to impact a total of 1,642 acres of wetlands and other waters, including 75.2 miles of streams.

The mine site is predominantly in the Headwaters Koktuli River watershed, with a lesser presence in the UTC watershed (Figure 4.22-4). The Headwaters Koktuli River watershed is 170,632 acres, with 36,458 acres classified as wetlands and other waters (based on NWI mapping). In terms of magnitude and extent, construction and operations of the mine site under Alternative 1 would have direct and indirect impacts on 2,953 acres,[5] representing 8 percent of wetlands and other waters in the Headwaters Koktuli River watershed. The UTC watershed is 87,539 acres, with 13,193 acres classified as wetlands and other waters (based on NWI mapping). The mine site would directly and indirectly impact 68 acres, representing less than 1 percent of wetlands and other waters in the UTC watershed. Although NWI wetland mapping covers the entirety of the Headwaters Koktuli River watershed, only 91 percent of the UTC watershed has been mapped by NWI. Therefore, the area of wetlands and other waters presented for the UTC watershed is likely underestimated.

Collectively, the transportation corridor, natural gas pipeline corridor, and Amakdedori port project components would affect seven HUC 10 watersheds under Alternative 1 (Figure 4.22-4). Based on available NWI mapping, wetlands and other waters comprise 4,693,149 acres of the combined area of these seven watersheds (6,130,237 acres). In terms of magnitude and extent, these three project components would have direct and indirect impacts on 1,664 acres of wetlands and other waters, representing less than 1 percent of wetland and other waters habitat mapped for the combined watershed area. Although NWI mapping covers the entirety of the Cook Inlet and Stariski Creek-Frontal Cook Inlet watersheds, coverage for the remaining five watersheds averages 44 percent, with a range of 6 to 91 percent. Therefore, the areas of wetlands and other waters presented for these watersheds are likely underestimated.

[5] total accounts for overlap among areas of indirect impact at the mine site

Table 4.22-12: Alternative 1a—Natural Gas Pipeline Corridor Direct Impacts on Wetlands and Other Waters

HGM/NWI Group	Permanent	Temporary								
	Iliamna Lake	Amakdedori Creek-Frontal Kamishak Bay	Cook Inlet	Headwaters Koktuli River	Iliamna Lake	Newhalen River	Stariski Creek-Frontal Cook Inlet	Upper Talarik Creek	Combined Watershed Area	
									(Acres)	(Miles)
Percent of Watershed Mapped by NWI	57	53	100	100	57	95	100	91		
SLOPE					**8**	**2**		**<1**	**11**	
Wetlands					**8**	**2**		**<1**	**11**	
Herbaceous	—	—	—	—	2	<1	—	—	3	
Deciduous Shrubs	—	—	—	—	4	1	—	<1	5	
Evergreen Shrubs	—	—	—	—	2	1	—	—	3	
DEPRESSIONAL					**1**	**<1**		**<1**	**2**	
Wetlands					**1**	**<1**			**1**	
Herbaceous	—	—	—	—	1	<1	—	—	1	
Deciduous Shrubs	—	—	—	—	—	<1	—	—	<1	
Other Waters					**<1**			**<1**	**<1**	
Aquatic Bed	—	—	—	—	<1	—	—	—	<1	
Ponds	—	—	—	—	<1	—	—	<1	<1	
FLAT					**8**				**8**	
Wetlands					**8**				**8**	
Herbaceous	—	—	—	—	2	—	—	—	2	
Deciduous Shrubs	—	—	—	—	4	—	—	—	4	
Evergreen Shrubs	—	—	—	—	2	—	—	—	2	
LACUSTRINE	**1**				**156**				**156**	
Other Waters	**1**				**156**				**156**	
Lakes	1	—	—	—	156	—	—	—	156	
RIVERINE					**<1**	**1**		**<1**	**2**	
Wetlands					**<1**	**1**		**<1**	**2**	
Herbaceous	—	—	—	—	—	<1	—	<1	<1	
Deciduous Shrubs	—	—	—	—	<1	<1	—	<1	1	

Table 4.22-12: Alternative 1a—Natural Gas Pipeline Corridor Direct Impacts on Wetlands and Other Waters

HGM/NWI Group	Permanent	Temporary								
	Iliamna Lake	Amakdedori Creek-Frontal Kamishak Bay	Cook Inlet	Headwaters Koktuli River	Iliamna Lake	Newhalen River	Stariski Creek-Frontal Cook Inlet	Upper Talarik Creek	Combined Watershed Area	
									(Acres)	(Miles)
Evergreen Forest	—	—	—	—	—	<1	—	—	<1	
RIVERINE CHANNEL				**<1**	**<1**	**<1**		**<1**	**<1**	
Other Waters				**<1**	**<1**	**<1**		**<1**	**<1**	
Streams (Intermittent)	—	—	—	<1	—	—	—	—	<1	0.1
Streams (Perennial)	—	—	—	—	<1	<1	—	<1	<1	0.5
MARINE		**12**	**610**				**7**		**628**	
Other Waters		**12**	**610**				**7**		**628**	
Marine (Intertidal)	—	1	—	—	—	—	—	—	1	
Marine (Subtidal)	—	11	610	—	—	—	7		628	
Total Wetland Impacts (Acres)	**<1**	**<1**	**<1**	**<1**	**18**	**3**	**<1**	**<1**	**21**	
Total Other Waters Impacts (Acres)	**1**	**12**	**610**	**<1**	**156**	**<1**	**7**	**<1**	**785**	**0.6**
Total Wetlands and Other Waters Impacts (Acres)	**1**	**12**	**610**	**<1**	**174**	**3**	**7**	**1**	**806**	
Total Area of NWI Wetlands and Other Waters (Acres)	**389,610**	**29,739**	**4,167,981**	**36,458**	**389,610**	**23,380**	**89,067**	**13,193**	**4,749,428**	
Percent Total of NWI Wetlands and Other Waters	**<1**	**<1**	**<1**	**<1**	**<1**	**<1**	**<1**	**<1**	**<1**	

Notes:

< = less than
— = not applicable
HGM = hydrogeomorphic
NWI = National Wetland Inventory

Source: Three Parameters Plus and HDR 2011b; HDR and Three Parameters Plus 2011b; HDR 2019i, j

The total direct impact to **navigable waters** under Alternative 1 occurs in Gibraltar River, Iliamna Lake, and Cook Inlet, and would impact a total of 779 acres. Of this total area of direct impact, 25 acres are permanent impacts largely associated with the construction of the Amakdedori port and ferry terminals; and 754 acres are temporary impacts largely associated with the construction of the natural gas pipeline. These acreages are included in the "other waters" categories of Table 4.22-1 and would not result in additional areas of impact.

Special aquatic sites that would be directly and permanently impacted under Alternative 1 include mudflats, riffle and pool complexes, vegetated shallows, and wetlands. Quantifiable categories of regionally important wetlands that would be directly and permanently impacted under Alternative 1 include fens and riparian wetlands (see Section 3.22, Wetlands and Other Waters/ Special Aquatic Sites, for a description).

The greatest magnitude of impact to special aquatic sites would be to wetlands (2,102 acres), including regionally important riparian wetlands (130 acres) and fens (73 acres), followed by riffle and pool habitat (46 acres, including 88.5 miles of upper perennial stream), mudflats (13 acres), and vegetated shallows (2 acres) (Table 4.22-13). The specific consequences of these losses are discussed under Alternative 1a.

Although the extent of impacts is expected to occur in six of the seven watersheds intersected by Alternative 1, 97 percent of impact to special aquatic sites and regionally important wetlands is expected in the Headwaters Koktuli River watershed, and would be largely associated with the construction and operation of the mine site. Direct, permanent impacts to special aquatic sites and regionally important wetlands would affect 6 percent of the wetlands and other waters mapped in the Headwaters Koktuli drainage. Impacts to special aquatic sites and regionally important wetlands are calculated to represent 1 percent of waters and wetlands mapped in the Gibraltar Lake watershed; however, because only 6 percent of the Gibraltar Lake watershed has been mapped by NWI, the representation of impacts on the watershed scale is likely over-estimated. The areas presented in Table 4.22-13 are those of direct permanent impacts to special aquatic sites and regionally important wetlands for all components of Alternative 1; variants, direct temporary and indirect impacts are not evaluated.

A summary of the direct and indirect impacts to wetlands and other waters follows, presented by project component and variant. Areas of impact were assessed according to the analysis methodology described under the "Analysis Methodology" subsection. A map series showing impacts in the analysis area is provided in Appendix K4.22.

4.22.7.1 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.

Direct Impacts

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 direct impacts of this variant to mine site wetlands and other waters are presented below. The Kokhanok East Ferry Terminal Variant would use 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; there would be no change to the magnitude, duration, or extent of direct impacts to wetlands and other waters at the mine site under either of these variants.

Table 4.22-13: Alternative 1—Direct Permanent Impacts to Special Aquatic Sites and Regionally Important Wetlands

HGM/NWI Group	Amakdedori Creek-Frontal Kamishak Bay	Gibraltar Lake	Headwaters Koktuli River	Iliamna Lake	Newhalen River	Upper Talarik Creek	Combined Watershed Area (Acres)
Percent of Watershed Mapped by NWI	53	6	100	57	95	91	
Special Aquatic Sites							
Mudflats	<1	<1	12	<1	—	<1	13
Riffle and Pool Habitat	<1	<1	44	1	<1	<1	46
Vegetated Shallows	—	—	2	<1	—	—	2
Wetlands	11	7	2,047	16	1	20	2,102
Regionally Important Wetlands							
Fens	<1	1	70	—	—	1	73
Riparian Wetlands	—	—	125	1	—	4	130
Total Area of Special Aquatic Sites and Regionally Important Wetlands Impacted (Acres)	**12**	**8**	**2,302**	**18**	**1**	**25**	**2,365**
Total Area of NWI Wetlands and Other Waters (Acres)	**29,739**	**797**	**36,458**	**389,610**	**23,380**	**13,193**	**493,177**
Percent Total of NWI Wetlands and Other Waters	**<1**	**1**	**6**	**<1**	**<1**	**<1**	**<1**

Notes:

< = less than
— = not applicable
HGM = hydrogeomorphic
NWI = National Wetland Inventory

Source: Three Parameters Plus and HDR 2011b; HDR and Three Parameters Plus 2011b; HDR 20189i, j

Summer-Only Ferry Operations Variant

This variant would involve summer-only operation of the ferry across Iliamna Lake. 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. This change in configuration would increase the direct permanent impacts to wetlands and other waters by 1.7 acres of broad-leaved deciduous shrub wetlands, 0.4 acre of ponds, and 0.2 acre, including 0.3 mile, of intermittent stream habitat. The additional impacts would occur exclusively in the Headwaters Koktuli River watershed. The duration and extent of impacts would be the same as the Alternative 1 base case as defined in Table 4.22-1.

<u>Indirect Impacts</u>

As discussed, the indirect impacts of fragmentation, fugitive dust, and dewatering at the mine site under Alternative 1 base case do not differ from Alternative 1a. Due to configuration of facilities at the mine site under the Summer-Only Ferry Operations Variant, the cumulative area of indirect impacts is decreased by 1 acre of wetlands. No changes are expected to the magnitude or extent of indirect impacts to wetlands and other waters at the mine site under the Kokhanok East Ferry Terminal Variant, or the Pile-Supported Dock Variant.

4.22.7.2 Transportation Corridor

The transportation corridor footprint under Alternative 1 includes a mine access road from the mine to the north ferry terminal, and a crossing of Iliamna Lake to the south ferry terminal, where the alignment rejoins the routing presented under Alternative 1a. The transportation corridor includes the sections of the natural gas pipeline that are co-located with road alignments.

<u>Direct Impacts</u>

The magnitude and duration of direct impacts from construction of the transportation corridor are the permanent loss of 61 acres of wetlands and other waters, including 6.1 miles of streams (Table 4.22-14); and temporary impacts to 44 acres of wetlands and other waters, including 3.7 miles of streams (Table 4.22-15). Impacts to wetlands and other waters coincident with the roadbed are considered permanent, whereas construction-related impacts occurring within 30 feet of the roadbed are considered temporary. Slope wetlands are the most impacted type, comprising 88 percent and 92 percent, respectively, of permanent and temporary impacts to wetlands. The majority of slope wetlands are represented by broad-leaved deciduous shrub and herbaceous wetlands, the loss and degradation of which are discussed above. With respect to other waters, ponds are the most impacted type, comprising 60 percent and 63 percent, respectively, of permanent and temporary impacts to other waters. The extent of direct impacts in the transportation corridor transects six watersheds. Direct impacts are highest in the Iliamna Lake watershed, where they represent 33 percent and 32 percent, respectively, of all permanent and temporary impacts to wetlands and other waters. For all watersheds, total direct permanent or temporary impacts represent 1 percent or less of all wetlands and other waters mapped by NWI.

North and South Ferry Terminals

Discharge of fill to construct the North and South ferry terminals would result in a combined permanent loss of 0.3 acre of wetland and 1.3 acres of lacustrine habitat with temporary impacts expected across additional 0.2 acre of wetland and 1.6 acres of lacustrine habitat. The Kokhanok East Ferry Terminal Variant avoids direct impacts to wetlands, but would result in the permanent loss of 0.7 acre of lacustrine habitat with temporary impacts expected across an additional 1 acre. These areas of permanent and temporary direct impact are included in the transportation component of Table 4.22-14 and Table 4.22-15 (base case), and Table 4.22-16 and Table 4.22-17 (Kokhanok East Ferry Terminal Variant), and do not represent additional areas of impact. Impacts to wetlands and lacustrine habitat associated with construction of the ferry terminals are discussed above under the “Transportation Corridor” subsection.

Table 4.22-14: Alternative 1—Transportation Corridor—Permanent Impacts to Wetlands and Other Waters

HGM/NWI Group	Amakdedori Creek-Frontal Kamishak Bay	Gibraltar Lake	Headwaters Koktuli River	Iliamna Lake	Newhalen River	Upper Talarik Creek	Combined Watershed Area	
							(Acres)	(Miles)
Percent of Watershed Mapped by NWI	53	6	100	57	95	91		
SLOPE	**14**	**8**		**17**	**1**	**12**	**52**	
Wetlands	**11**	**7**		**16**	**1**	**12**	**46**	
Herbaceous	5	2	—	6	<1	1	14	
Deciduous Shrubs	6	3	—	9	1	11	29	
Evergreen Shrubs	<1	2	—	1	<1	—	3	
Other Waters	**3**	**1**		**1**		**<1**	**5**	
Aquatic Bed	—	—	—	<1	—	—	<1	
Ponds	3	1	—	1	—	<1	5	
DEPRESSIONAL	**<1**		**<1**	**<1**	**<1**	**<1**	**1**	
Wetlands			**<1**	**<1**	**<1**	**<1**	**<1**	
Herbaceous	—	—	<1	—	—	<1	<1	
Deciduous Shrubs	—	—	—	<1	<1	—	<1	
Other Waters	**<1**		**<1**	**<1**		**<1**	**1**	
Ponds	<1	—	<1	<1	—	<1	1	
FLAT						**<1**	**<1**	
Wetlands						**<1**	**<1**	
Herbaceous	—	—	—	—	—	<1	<1	
Deciduous Shrubs	—	—	—	—	—	<1	<1	
LACUSTRINE	**<1**	**<1**		**1**			**2**	
Other Waters	**<1**	**<1**		**1**			**2**	
Lakes	<1	<1	—	1	—	—	2	

Table 4.22-14: Alternative 1—Transportation Corridor—Permanent Impacts to Wetlands and Other Waters

HGM/NWI Group	Amakdedori Creek-Frontal Kamishak Bay	Gibraltar Lake	Headwaters Koktuli River	Iliamna Lake	Newhalen River	Upper Talarik Creek	Combined Watershed Area	
							(Acres)	(Miles)
RIVERINE CHANNEL	**1**	**<1**	**<1**	**1**	**<1**	**<1**	**2**	
Other Waters	1	<1	<1	1	<1	<1	**2**	
Streams (Intermittent)	<1	<1	—	<1	<1	<1	<1	1.9
Streams (Perennial)	<1	<1	<1	1	<1	<1	2	4.2
RIVERINE				**1**		**4**	**4**	
Wetlands				**1**		**4**	**4**	
Herbaceous	—	—	—	1	—	1	1	
Deciduous Shrubs	—	—	—	<1	—	3	3	
Deciduous Forest	—	—	—	—	—	—	—	
Other Waters						**<1**	**<1**	
Ponds	—	—	—	—	—	<1	<1	
Total Wetland Impacts (Acres)	**11**	**7**	**<1**	**16**	**1**	**16**	**52**	
Total Other Waters Impacts (Acres)	**4**	**1**	**<1**	**3**	**<1**	**1**	**10**	**6.1**
Total Wetlands and Other Waters Impacts (Acres)	**15**	**8**	**<1**	**20**	**1**	**17**	**61**	
Total Area of NWI Wetlands and Other Waters (Acres)	**29,739**	**797**	**36,458**	**389,610**	**23,380**	**13,193**	**493,177**	
Percent Total of NWI Wetlands and Other Waters	**<1**	**1**	**<1**	**<1**	**<1**	**<1**	**<1**	

Notes:

< = less than
— = not applicable
HGM = hydrogeomorphic
NWI = National Wetland Inventory

Source: Three Parameters Plus and HDR 2011b; HDR and Three Parameters Plus 2011b; HDR 20189i, j

Table 4.22-15: Alternative 1—Transportation Corridor—Temporary Impacts to Wetlands and Other Waters

HGM/NWI Group	Amakdedori Creek-Frontal Kamishak Bay	Gibraltar Lake	Headwaters Koktuli River	Iliamna Lake	Newhalen River	Upper Talarik Creek	Combined Watershed Area	
							(Acres)	(Miles)
Percent of Watershed Mapped by NWI	53	6	100	57	95	91		
SLOPE	**11**	**6**		**11**	**1**	**8**	**37**	
Wetlands	**9**	**5**		**10**	**1**	**8**	**33**	
Herbaceous	3	2	—	4	<1	1	10	
Deciduous Shrubs	5	3	—	6	1	7	21	
Evergreen Shrubs	<1	1	—	1	<1	—	2	
Other Waters	**3**	**1**		**1**		**<1**	**4**	
Aquatic Bed	—	—	—	<1	—	—	<1	
Ponds	3	1	—	1	—	<1	4	
DEPRESSIONAL			**<1**	**<1**	**<1**	**1**	**1**	
Wetlands			**<1**	**<1**	**<1**	**<1**	**<1**	
Herbaceous	—	—	<1	—	—	<1	<1	
Deciduous Shrubs	—	—	—	<1	<1	<1	<1	
Other Waters			**<1**	**<1**		**<1**	**1**	
Ponds	—	—	<1	<1	—	<1	1	
FLAT						**<1**	**<1**	
Wetlands						**<1**	**<1**	
Herbaceous	—	—	—	—	—	<1	<1	
Deciduous Shrubs	—	—	—	—	—	<1	<1	
LACUSTRINE	**<1**	**<1**		**2**			**2**	
Other Waters	**<1**	**<1**		**2**			**2**	
Lakes	<1	<1	—	2	—	—	2	

Table 4.22-15: Alternative 1—Transportation Corridor—Temporary Impacts to Wetlands and Other Waters

HGM/NWI Group	Amakdedori Creek-Frontal Kamishak Bay	Gibraltar Lake	Headwaters Koktuli River	Iliamna Lake	Newhalen River	Upper Talarik Creek	Combined Watershed Area	
							(Acres)	(Miles)
RIVERINE CHANNEL	**<1**	**<1**	**<1**	**<1**	**<1**	**<1**	**1**	
Other Waters	<1	<1	<1	<1	<1	<1	**1**	
Streams (Intermittent)	<1	<1	—	<1	<1	<1	<1	1.2
Streams (Perennial)	<1	<1	<1	<1	<1	<1	1	2.5
RIVERINE		**<1**		**<1**		**2**	**2**	
Wetlands		**<1**		**<1**		**2**	**2**	
Herbaceous	—	—	—	<1	—	<1	<1	
Deciduous Shrubs	—	—	—	<1	—	1	1	
Deciduous Forest	—	<1	—	—	—	—	<1	
Other Waters						**<1**	**<1**	
Ponds	—	—	—	—	—	<1	<1	
Total Wetland Impacts (Acres)	**9**	**6**	**<1**	**10**	**1**	**10**	**36**	
Total Other Waters Impacts (Acres)	**3**	**1**	**<1**	**3**	**<1**	**1**	**8**	**3.7**
Total Wetlands and Other Waters Impacts (Acres)	**12**	**6**	**<1**	**14**	**1**	**11**	**44**	
Total Area of NWI Wetlands and Other Waters (Acres)	**29,739**	**797**	**36,458**	**389,610**	**23,380**	**13,193**	**493,177**	
Percent Total of NWI Wetlands and Other Waters	**<1**	**1**	**<1**	**<1**	**<1**	**<1**	**<1**	

Notes:

< = less than
— = not applicable
HGM = hydrogeomorphic
NWI = National Wetland Inventory

Source: Three Parameters Plus and HDR 2011b; HDR and Three Parameters Plus 2011b; HDR 20189i, j

Table 4.22-16: Alternative 1—Kokhanok East Ferry Terminal Variant, Transportation Corridor—Permanent Impacts on Wetlands and Other Waters

HGM/NWI Group	Amakdedori Creek-Frontal Kamishak Bay	Gibraltar Lake	Headwaters Koktuli River	Iliamna Lake	Newhalen River	Upper Talarik Creek	Combined Watershed Area	
							(Acres)	(Miles)
Percent of Watershed Mapped by NWI	53	6	100	57	95	91		
SLOPE	**14**	**3**		**17**	**1**	**12**	**46**	
Wetlands	**11**	**2**		**16**	**1**	**12**	**41**	
Herbaceous	5	1	—	5	0	1	12	
Deciduous Shrubs	6	1	—	9	1	11	27	
Evergreen Shrubs	<1	1	—	1	<1	—	2	
Deciduous Forest	—	—	—	<1	—	—	<1	
Other Waters	**3**	**<1**		**1**		**<1**	**5**	
Ponds	3	<1	—	1		<1	5	
DEPRESSIONAL	**<1**		**<1**	**1**	**<1**	**<1**	**2**	
Wetlands			**<1**	**<1**	**<1**	**<1**	**1**	
Herbaceous	—	—	<1	<1	—	<1	<1	
Deciduous Shrubs	—	—	—	<1	<1	—	<1	
Other Waters	**<1**		**<1**	**<1**		**<1**	**1**	
Ponds	<1	—	<1	<1	—	<1	1	
FLAT				**2**		**<1**	**2**	
Wetlands				**2**		**<1**	**2**	
Herbaceous	—	—	—	—	—	<1	<1	
Deciduous Shrubs	—	—	—	1	—	<1	1	
Evergreen Shrubs	—	—	—	1	—	—	1	
LACUSTRINE	**<1**			**1**			**1**	
Other Waters	**<1**			**1**			**1**	

Table 4.22-16: Alternative 1—Kokhanok East Ferry Terminal Variant, Transportation Corridor—Permanent Impacts on Wetlands and Other Waters

HGM/NWI Group	Amakdedori Creek-Frontal Kamishak Bay	Gibraltar Lake	Headwaters Koktuli River	Iliamna Lake	Newhalen River	Upper Talarik Creek	Combined Watershed Area	
							(Acres)	(Miles)
Lakes	<1	—	—	1	—	—	1	
RIVERINE CHANNEL	**1**	**<1**	**<1**	**1**	**<1**	**<1**	**2**	
Other Waters	**1**	**<1**	**<1**	**<1**	**<1**	**<1**	**2**	
Streams (Intermittent)	<1	<1	—	<1	<1	<1	<1	2.4
Streams (Perennial)	<1	<1	<1	<1	<1	<1	1	3.6
RIVERINE				**1**		**4**	**4**	
Wetlands				**1**		**4**	**4**	
Herbaceous	—	—	—	1	—	1	1	
Deciduous Shrubs	—	—		<1	—	3	3	
Other Waters						**<1**	**<1**	
Ponds	—	—	—	—		<1	<1	
Total Wetland Impacts (Acres)	**11**	**2**	**<1**	**18**	**1**	**16**	**49**	
Total Other Waters Impacts (Acres)	**4**	**<1**	**<1**	**2**		**1**	**8**	**5.9**
Total Wetlands and Other Waters Impacts (Acres)	**15**	**3**	**<1**	**21**	**1**	**17**	**57**	
Total Area of NWI Wetlands and Other Waters (Acres)	**29,739**	**797**	**36,458**	**389,610**	**23,380**	**13,193**	**493,177**	
Percent Total of NWI Wetlands and Other Waters	**<1**	**<1**	**<1**	**<1**	**<1**	**<1**	**<1**	

Notes:

< = less than
— = not applicable
HGM = hydrogeomorphic
NWI = National Wetland Inventory

Source: Three Parameters Plus and HDR 2011b; HDR and Three Parameters Plus 2011b; HDR 2019i, j

Table 4.22-17: Alternative 1—Kokhanok East Ferry Terminal Variant, Transportation Corridor—Temporary Impacts on Wetlands and Other Waters

HGM/NWI Group	Amakdedori Creek-Frontal Kamishak Bay	Gibraltar Lake	Headwaters Koktuli River	Iliamna Lake	Newhalen River	Upper Talarik Creek	Combined Watershed Area	
							(Acres)	(Miles)
Percent of Watershed Mapped by NWI	53	6	100	57	95	91		
SLOPE	**11**	**2**		**11**	**1**	**8**	**32**	
Wetlands	**9**	**2**		**10**	**1**	**8**	**29**	
Herbaceous	3	1	—	3	<1	1	8	
Deciduous Shrubs	5	1	—	6	1	7	19	
Evergreen Shrubs	<1	<1	—	1	<1	—	1	
Deciduous Forest	—	—	—	<1	—	—	<1	
Other Waters	**3**	**<1**		**1**		**<1**	**4**	
Ponds	3	<1	—	1		<1	4	
DEPRESSIONAL			**<1**	**1**	**<1**	**1**	**2**	
Wetlands			**<1**	**<1**	**<1**	**<1**	**1**	
Herbaceous	—	—	<1	<1	—	<1	<1	
Deciduous Shrubs	—	—	—	<1	<1	<1	<1	
Other Waters			**<1**	**<1**		**<1**	**1**	
Ponds	—	—	<1	<1	—	<1	1	
FLAT				**1**		**<1**	**2**	
Wetlands				**1**		**<1**	**2**	
Herbaceous	—	—	—	—	—	<1	<1	
Deciduous Shrubs	—	—	—	1	—	<1	1	
Evergreen Shrubs	—	—	—	<1	—	—	<1	
LACUSTRINE	**<1**			**1**			**2**	
Other Waters	**<1**			**1**			**2**	

Table 4.22-17: Alternative 1—Kokhanok East Ferry Terminal Variant, Transportation Corridor—Temporary Impacts on Wetlands and Other Waters

HGM/NWI Group	Amakdedori Creek-Frontal Kamishak Bay	Gibraltar Lake	Headwaters Koktuli River	Iliamna Lake	Newhalen River	Upper Talarik Creek	Combined Watershed Area	
							(Acres)	(Miles)
Lakes	<1	—	—	1	—	—	2	
RIVERINE CHANNEL	**<1**	**<1**	**<1**	**<1**	**<1**	**<1**	**1**	
Other Waters						**<1**	**<1**	
Streams (Intermittent)	<1	<1	—	<1	<1	<1	<1	1.3
Streams (Perennial)	<1	<1	<1	<1	<1	<1	1	2.2
RIVERINE				**<1**		**2**	**2**	
Wetlands				**<1**		**2**	**2**	
Herbaceous	—	—	—	<1	—	<1	<1	
Deciduous Shrubs	—	—	—	<1	—	1	1	
Other Waters						**<1**	**<1**	
Ponds	—	—	—	—		<1	<1	
Total Wetland Impacts (Acres)	**9**	**2**	**<1**	**11**	**1**	**10**	**33**	
Total Other Waters Impacts (Acres)	**3**	**<1**	**<1**	**2**		**1**	**7**	**3.4**
Total Wetlands and Other Waters Impacts (Acres)	**12**	**2**	**<1**	**14**	**1**	**11**	**40**	
Total Area of NWI Wetlands and Other Waters (Acres)	**29,739**	**797**	**36,458**	**389,610**	**23,380**	**13,193**	**493,177**	
Percent Total of NWI Wetlands and Other Waters	**<1**	**<1**	**<1**	**<1**	**<1**	**<1**	**<1**	

Notes:

< = less than
— = not applicable
HGM = hydrogeomorphic
NWI = National Wetland Inventory

Source: Three Parameters Plus and HDR 2011b; HDR and Three Parameters Plus 2011b; HDR 2019i, j

Gibraltar River Bridge

Construction of the Gibraltar River bridge would not place fill or piles below the ordinary high-water mark, and the bridge is situated to avoid direct permanent impacts to wetlands. Construction of a temporary bridge would impact 0.2 acre of broad-leaved forested wetland and 0.04 acre of perennial stream. These areas of temporary are included in Table 4.22-15, and do not represent additional areas of impact. Impacts to wetlands and open water habitat associated with construction of bridges are discussed under Alternative 1a above.

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 emissions along the transportation corridor; however, the area of direct impact would be expected to be the same as that presented for the Alternative 1 base case.

Kokhanok East Ferry Terminal Variant

This variant would decrease the magnitude of permanent impacts on wetlands and other waters from 61 acres (including 6.1 miles of streams) to 57 acres (including 5.9 miles of streams) (Table 4.22-16); and temporary impacts from 44 acres (including 3.7 miles of streams) to 40 acres (including 3.4 miles of streams) (Table 4.22-17). Slope wetlands are the most impacted type, comprising 84 percent and 88 percent, respectively, of permanent and temporary impacts to wetlands. With respect to other waters, ponds are the most impacted type, comprising 71 percent and 83 percent, respectively, of permanent and temporary impacts to other waters. The extent of impacts would be the same as the Alternative 1 base case for the transportation corridor.

Pile-Supported Dock Variant

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

Indirect Impacts—Fugitive Dust

Under Alternative 1, the magnitude of indirect impacts in the transportation corridor would be the potential deposition of dust over 739 acres of wetlands and other waters, including 45.2 miles of streams (Table 4.22-18). Slope wetlands comprise 89 percent of the wetland area exposed to fugitive dust and are chiefly represented by broad-leaved deciduous shrub and herbaceous wetlands, the degradation of which are discussed above under the “Mine Site Indirect Impacts” subheading. With respect to other waters, lakes and ponds represent 61 percent and 25 percent, respectively, of the other water types that would be exposed to fugitive dust. The extent of impact transects seven watersheds. Except for the Gibraltar Lake watershed, indirect impacts represent 1 percent or less of all wetlands and other waters mapped by NWI; because only 6 percent of the Gibraltar Lake watershed has been mapped by NWI, the high (16) percent of wetlands and other waters impacted for this watershed is artificial. The highest severity of dust deposition to wetlands, other waters, and their functions are expected to occur proximal to the road edge, but may be detectable up to 330 feet distant. Note that the 330-foot dust zone overlaps with the 30-foot temporary construction impact zone in the transportation corridor. Dust impacts are considered an indirect yet long-term consequence of development.

Table 4.22-18: Alternative 1—Transportation Corridor Fugitive Dust Impacts on Wetlands and Other Waters

HGM/NWI Group	Amakdedori Creek-Frontal Kamishak Bay	Gibraltar Lake	Headwaters Koktuli River	Iliamna Lake	Newhalen River	Paint River	Upper Talarik Creek	Combined Watershed Area	
								(Acres)	(Miles)
Percent of Watershed Mapped by NWI	53	6	100	57	95	16	91		
SLOPE	**138**	**109**	**1**	**170**	**9**	**<1**	**101**	**528**	
Wetlands	**102**	**88**	**<1**	**136**	**8**	**<1**	**98**	**434**	
Herbaceous	41	25	<1	50	<1	<1	17	134	
Deciduous Shrubs	59	44	<1	74	7	<1	80	264	
Evergreen Shrubs	3	19	—	12	1	—	1	36	
Other Waters	**35**	**20**	**<1**	**34**	**1**		**2**	**94**	
Aquatic Bed	—	—	—	<1	—	—	—	<1	
Ponds	35	20	<1	34	1	—	2	94	
DEPRESSIONAL	**<1**	**6**	**<1**	**26**	**3**		**34**	**70**	
Wetlands		**3**	**<1**	**3**	**1**		**5**	**11**	
Herbaceous	—	3	<1	2	—	—	4	9	
Deciduous Shrubs	—	—	—	<1	1	—	1	2	
Evergreen Shrubs	—	—	—	<1	—	—	—	<1	
Other Waters	**<1**	**3**	**<1**	**24**	**3**		**29**	**59**	
Aquatic Bed	—	<1	—	<1	—	—	—	<1	
Ponds	<1	3	<1	24	3	—	29	58	
FLAT				**<1**			**13**	**14**	
Wetlands				**<1**			**13**	**14**	
Herbaceous	—	—	—	<1	—	—	8	8	
Deciduous Shrubs	—	—	—	—	—	—	5	5	
LACUSTRINE	**8**	**10**		**36**			**7**	**61**	
Other Waters	**8**	**10**		**36**			**7**	**61**	
Lakes	8	10	—	36	—	—	7	61	

Table 4.22-18: Alternative 1—Transportation Corridor Fugitive Dust Impacts on Wetlands and Other Waters

HGM/NWI Group	Amakdedori Creek-Frontal Kamishak Bay	Gibraltar Lake	Headwaters Koktuli River	Iliamna Lake	Newhalen River	Paint River	Upper Talarik Creek	Combined Watershed Area	
								(Acres)	(Miles)
LACUSTRINE FRINGE		**<1**						**<1**	
Other Waters		**<1**						**<1**	
Aquatic Bed	—	<1	—	—	—	—	—	<1	
RIVERINE CHANNEL	**6**	**3**	**<1**	**12**	**9**	**<1**	**7**	**37**	
Other Waters	**6**	**3**	**<1**	**12**	**9**	**<1**	**7**	**37**	
Streams (Intermittent)	1	<1	—	<1	<1	—	<1	2	13.3
Streams (Perennial)	5	3	<1	11	9	<1	6	35	31.9
RIVERINE	**<1**	**1**		**1**			**27**	**29**	
Wetlands	**<1**	**1**		**1**			**26**	**28**	
Herbaceous	—	—	—	1	—	—	3	4	
Deciduous Shrubs	<1	1	—	<1	—	—	23	24	
Deciduous Forest	—	<1	—	—	—	—	—	<1	
Other Waters							**1**	**1**	
Aquatic Bed	—	—	—	—	—	—	<1	<1	
Ponds	—	—	—	—	—	—	1	1	
Total Wetland Impacts (Acres)	**103**	**93**	**<1**	**140**	**9**	**<1**	**143**	**487**	
Total Other Waters Impacts (Acres)	**50**	**36**	**<1**	**106**	**13**	**<1**	**47**	**252**	**45.2**
Total Wetlands and Other Waters Impacts (Acres)	**152**	**129**	**1**	**246**	**22**	**<1**	**189**	**739**	
Total Area of NWI Wetlands and Other Waters (Acres)	**29,739**	**797**	**36,458**	**389,610**	**23,380**	**2,762**	**13,193**	**495,939**	
Percent Total of NWI Wetlands and Other Waters	**1**	**16**	**<1**	**<1**	**<1**	**<1**	**1**	**<1**	

Notes:

< = less than
— = not applicable
HGM = hydrogeomorphic
NWI = National Wetland Inventory

Source: Three Parameters Plus and HDR 2011b; HDR and Three Parameters Plus 2011b; HDR 2019i, j

Summer-Only Ferry Operations Variant

With ferry operations limited to the open water season, 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 increase the deposition of fugitive dust emissions along the transportation corridor; however, the area of indirect impact would be the same as the Alternative 1 base case.

Kokhanok East Ferry Terminal Variant

The Kokhanok East Ferry Terminal Variant would reduce the magnitude of fugitive dust impacts to wetlands and other waters along the transportation corridor from 739 acres, including 45.2 miles of streams, to 670 acres, including 42.4 miles of streams (Table 4.22-19). Under this variant, slope wetlands comprise 83 percent of the wetland area exposed to fugitive dust, and are chiefly represented by broad-leaved deciduous shrub and herbaceous wetlands, the degradation of which are discussed above under. With respect to other waters, lakes and ponds represent 27 percent and 58 percent, respectively, of the other water types that would be exposed to fugitive dust. The extent of impact transects seven watersheds. Except for the Gibraltar Lake watershed, indirect impacts represent 1 percent or less of all wetlands and other waters mapped by NWI; because only 6 percent of the Gibraltar Lake watershed has been mapped by NWI the relatively high (3) percent of wetlands and other waters impacted for this watershed is artificial. The deposition of fugitive dust is considered an indirect but long-term consequence of project development.

Pile-Supported Dock Variant

There would be no change to the magnitude or extent of indirect impacts to wetlands and other waters in the transportation corridor under this variant.

4.22.7.3 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, lightering and navigational buoy locations, and the reclamation and closure of the site would be the same as Alternative 1a.

Direct Impacts

The Amakdedori port terminal and associated shore-based facilities, including an airstrip, are sited and designed to avoid all wetlands and fresh waters. In terms of magnitude and duration, the earthen fill causeway and sheet pile–supported dock would permanently impact 11 acres of marine waters, with the sea anchors for the two lightering locations and two navigational buoys permanently impacting 0.1 acre of the subtidal portion of these marine waters (Table 4.22-20). Similar to the caisson dock design proposed under Alternative 1a, the in-water components of marine facilities under Alternative 1 would alter localized currents and water circulation in the nearshore environment. These alterations are expected to be exaggerated by the earthen fill causeway and sheet pile-supported dock design, because the direct footprint is larger than the caisson-supported causeway and dock.

Construction-related impacts are expected to temporarily increase the turbidity and suspended particulate through 4 acres of marine waters (Table 4.22-20). Change in shoreline erosion and sedimentation pattern, as well as disturbance to benthic fauna and bottom habitat structure, are also expected during construction, but would be considered temporary due to dynamic wave action and natural redistribution of nearshore sediment. The extent of direct permanent and temporary impacts is restricted to the Amakdedori Creek-Frontal Kamishak Bay watershed and represent less than 1 percent of wetlands and other waters mapped by NWI for this watershed. Previous disturbance to wetlands or other waters in this area is minimal.

Table 4.22-19: Alternative 1—East Kokhanok Ferry Terminal Variant, Transportation Corridor—Fugitive Dust Impacts on Wetlands and Other Waters

HGM/NWI Group	Amakdedori Creek-Frontal Kamishak Bay	Gibraltar Lake	Headwaters Koktuli River	Iliamna Lake	Newhalen River	Paint River	Upper Talarik Creek	Combined Watershed Area	
								(Acres)	(Miles)
Percent of Watershed Mapped by NWI	53	6	100	57	95	16	91		
SLOPE	**138**	**27**	**1**	**179**	**9**	**<1**	**101**	**455**	
Wetlands	**102**	**18**	**<1**	**144**	**8**	**<1**	**98**	**371**	
Herbaceous	41	6	<1	48	<1	<1	17	113	
Deciduous Shrubs	59	10	<1	76	7	<1	80	232	
Evergreen Shrubs	3	2	—	17	1	—	1	24	
Deciduous Forest	—	—	—	2	—	—	—	2	
Other Waters	**35**	**9**	**<1**	**36**	**1**		**2**	**84**	
Aquatic Bed	—	—	—	<1	—	—	—	<1	
Ponds	35	9	<1	35	1	—	2	84	
DEPRESSIONAL	**<1**	**<1**	**<1**	**19**	**3**		**34**	**56**	
Wetlands			**<1**	**9**	**1**		**5**	**14**	
Herbaceous	—	—	<1	8	—	—	4	12	
Deciduous Shrubs	—	—	—	<1	1	—	1	2	
Evergreen Shrubs	—	—	—	1	—	—		1	
Other Waters	**<1**	**<1**	**<1**	**10**	**3**		**29**	**42**	
Ponds	<1	<1	<1	10	3	—	29	42	
FLAT				**22**			**13**	**36**	
Wetlands				**22**			**13**	**36**	
Herbaceous	—	—	—	5	—	—	8	13	
Deciduous Shrubs	—	—	—	12	—	—	5	17	
Evergreen Shrubs	—	—	—	5	—	—	—	5	
Evergreen Forest	—	—	—	1	—	—	—	1	
LACUSTRINE	**8**			**45**			**7**	**60**	
Other Waters	**8**			**45**			**7**	**60**	
Lakes	8	—	—	45	—	—	7	60	

Table 4.22-19: Alternative 1—East Kokhanok Ferry Terminal Variant, Transportation Corridor—Fugitive Dust Impacts on Wetlands and Other Waters

HGM/NWI Group	Amakdedori Creek-Frontal Kamishak Bay	Gibraltar Lake	Headwaters Koktuli River	Iliamna Lake	Newhalen River	Paint River	Upper Talarik Creek	Combined Watershed Area	
								(Acres)	(Miles)
LACUSTRINE FRINGE				**<1**				**<1**	
Wetlands				**<1**				**<1**	
Herbaceous	—	—	—	<1	—	—	—	<1	
RIVERINE CHANNEL	**6**	**<1**	**<1**	**12**	**9**	**<1**	**7**	**34**	
Other Waters	**6**	**<1**	**<1**	**12**	**9**	**<1**	**7**	**34**	
Rivers/Streams (Intermittent)	1	<1	—	<1	<1	—	<1	2	13.3
Rivers/Streams (Perennial)	5	<1	<1	11	9	<1	6	32	29.1
RIVERINE	**<1**			**1**			**27**	**28**	
Wetlands	**<1**			**1**			**26**	**27**	
Herbaceous	—	—	—	1	—	—	3	4	
Deciduous Shrubs	<1	—	—	<1	—	—	23	23	
Other Waters							**1**	**1**	
Aquatic Bed	—	—	—	—	—	—	<1	<1	
Ponds	—	—	—	—	—	—	1	1	
Total Wetland Impacts (Acres)	**103**	**18**	**<1**	**176**	**9**	**<1**	**143**	**448**	
Total Other Waters Impacts (Acres)	**50**	**10**	**<1**	**102**	**13**	**<1**	**47**	**221**	**42.4**
Total Wetlands and Other Waters Impacts (Acres)	**152**	**28**	**1**	**278**	**22**	**<1**	**189**	**670**	
Total Area of NWI Wetlands and Other Waters (Acres)	**29,739**	**797**	**36,458**	**389,610**	**23,380**	**2,762**	**13,193**	**495,939**	
Percent Total of NWI Wetlands and Other Waters	**1**	**3**	**<1**	**<1**	**<1**	**<1**	**1**	**<1**	

Notes:

< = less than
— = not applicable
HGM = hydrogeomorphic
NWI = National Wetland Inventory

Source: Three Parameters Plus and HDR 2011b; HDR and Three Parameters Plus 2011b; HDR 2019i, j

Table 4.22-20: Alternative 1—Amakdedori Port Direct Impacts on Wetlands and Other Waters

HGM/NWI Group	Permanent	Temporary
	Amakdedori Creek-Frontal Kamishak Bay	
Percent of Watershed Mapped by NWI	53	
MARINE	**11**	**4**
Marine (Intertidal)	1	1
Marine (Subtidal)	10	3
Total Other Waters Impacts (Acres)	**11**	**4**
Total Area of NWI Wetlands and Other Waters (Acres)	**29,739**	
Percent Total of NWI Wetlands and Other Waters	**<1**	

Notes:

< = less than
HGM = hydrogeomorphic
NWI = National Wetland Inventory

Source: Three Parameters Plus and HDR 2011b; HDR and Three Parameters Plus 2011b; HDR 2019i, j

Summer-Only Ferry Operations Variant

Under this variant, concentrate containers would be stockpiled at the Amakdedori port, requiring increased storage capacity. This variant would increase the magnitude of the permanent and temporary impacts on wetlands at Amakdedori port by 0.4 acre and 0.3 acre, respectively. There would be no change to the extent of impacts.

Kokhanok East Ferry Terminal Variant

There would be no change to the magnitude, duration, or extent of direct impacts to wetlands and other waters at the Amakdedori port under the Kokhanok East Ferry Terminal Variant.

Pile-Supported Dock Variant

This variant proposes a pile-supported dock design at Amakdedori port. The variant would decrease the magnitude of permanent impacts on wetlands and other waters from 11 acres to 0.2 acre, but would increase temporary impacts from 4 acres to 6.3 acres. Due to the smaller direct footprint of a pile-supported dock, permanent impacts related to the alteration of water currents and circulation patterns in the nearshore environment are expected to be less than either the caisson or earthen fill dock designs. However, temporary impacts associated with the driving of piles would disturb a greater area than the caisson or earthen fill dock designs. Both the reduction of permanent impacts and the increase in temporary impacts would occur in the marine waters of the Amakdedori Creek-Frontal Cook Inlet watershed.

Indirect Impacts—Fugitive Dust

Fugitive dust is expected to be generated at the port from construction of the terminal, and from the earthen fill causeway during operations. During construction and operations, the magnitude of wetlands and other waters that would potentially be affected by dust deposition at the Amakdedori port is 47 acres. Marine waters comprise 91 percent of the area of indirect impact (Table 4.22-21). The extent of potential impacts is restricted to the Amakdedori Creek-Frontal Cook Inlet Bay watershed, and would impact less than 1 percent of the wetlands and other waters mapped by NWI for the watershed. These impacts would be considered an indirect but long-term consequence of development.

Table 4.22-21: Alternative 1—Amakdedori Port—Fugitive Dust Impacts on Wetlands and Other Waters

HGM/NWI Group	Amakdedori Creek-Frontal Kamishak Bay	
	(Acres)	(Miles)
Percent of Watershed Mapped by NWI	53	
SLOPE	**1**	
Wetlands	**1**	
Herbaceous	1	
RIVERINE CHANNEL	**3**	
Other Waters	**3**	
Rivers/Streams (Perennial)	3	0.1
RIVERINE	**<1**	
Wetlands	**<1**	
Herbaceous	<1	
MARINE	**43**	
Other Waters	**43**	
Marine (Intertidal)	8	
Marine (Subtidal)	35	
Total Wetland Impacts (Acres)	**1**	
Total Other Waters Impacts (Acres)	**46**	**0.1**
Total Wetlands and Other Waters Impacts (Acres)	**47**	
Total Area of NWI Wetlands and Other Waters (Acres)	**29,739**	
Percent Total of NWI Wetlands and Other Waters	**<1**	

Notes:

< = less than
HGM = hydrogeomorphic
NWI = National Wetland Inventory

Source: Three Parameters Plus and HDR 2011b; HDR and Three Parameters Plus 2011b; HDR 2019i, j

Summer-Only Ferry Operations Variant

In terms of magnitude, an additional 6 acres of wetlands and other waters would be potentially affected by dust deposition during construction of this variant. This additional area of indirect impact is composed of lower perennial stream waters (4 acres, including an additional 0.1 mile of stream) and riverine wetlands (2 acres). The extent and duration of indirect impacts would be unchanged from the Alternative 1 base case.

Kokhanok East Ferry Terminal Variant

There would be no change to the magnitude, duration, or extent of indirect impacts to wetlands and other waters at the Amakdedori port under the Kokhanok East Ferry Terminal Variant.

Pile-Supported Dock Variant

Construction of a pile-supported dock at Amakdedori port would decrease the exposure of wetlands and other waters to the potential deposition of dust from 47 acres to 15 acres. This reduction is due to the concrete deck of the pile-supported dock, which is not expected to be a source of fugitive dust. The reduced area of indirect impact remains dominated by marine waters (11 acres), with streams (3 acres, including 0.1 mile of stream) subdominant. The extent and duration of indirect impacts would be unchanged from the Alternative 1 base case.

4.22.7.4 Natural Gas Pipeline Corridor

The natural gas pipeline corridor under Alternative 1 follows the alignment presented under Alternative 1a from the Kenai Peninsula to the south ferry terminal at Iliamna Lake. From there, it diverges from the Alternative 1a routing across Iliamna Lake to the north ferry terminal, where it is co-located with the mine access road to the mine site. Impacts evaluated here are for the pipeline-only sections of the natural gas pipeline, and include the 1-mile Kenai Peninsula tie-in, the 104-mile Cook Inlet crossing, the 1-mile section from Cook Inlet to the port access road, the less-than-1-mile section from the port access road to Iliamna Lake, the 19-mile Iliamna Lake crossing, the 1-mile section from Iliamna Lake to the mine access road, and the 2-mile section from the mine access road to the mine site.

Direct Impacts

Under Alternative 1, 4 acres of lacustrine waters would permanently impacted by construction of berms along approximately 2 miles of the Iliamna Lake lakebed, where the surface is too rough for the direct placement of the natural gas pipeline. Temporary impacts to 753 acres of wetlands and other waters, including 0.2 mile of stream, are expected from installation of the pipeline-only sections (Table 4.22-22). A total of 749 acres of other waters would be temporarily impacted from installation of the in-water, pipeline-only sections of the natural gas pipeline. Of these other waters, 83 percent are marine waters in Cook Inlet, with the remaining 16 percent represented by Iliamna Lake. Due to the locations of these impacts, the Cook Inlet (610 acres) and Iliamna Lake (124 acres) watersheds would sustain the highest levels of direct impacts. The extent of impact transects six watersheds; for all watersheds, direct impacts represent less than 1 percent of wetlands and other waters mapped by NWI in a given watershed. Aside from permanent impacts related to construction of lakebed berms, the duration of impacts from the installation of in-water sections of the natural gas pipeline would be temporary, because sedimentation rates in the benthic environment are expected to quickly return the substrate to its natural condition; the "Natural Gas Pipeline Corridor" subsection, above, provides a discussion of impacts.

Kokhanok East Ferry Terminal Variant

In terms of magnitude and extent, changes in the natural gas pipeline corridor under the Kokhanok East Ferry Terminal Variant would result in a net addition of 11 acres of temporary impacts to Iliamna Lake waters. The extent would remain unchanged from the Alternative 1 base case for the natural gas pipeline corridor.

Other Variants

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

Table 4.22-22: Alternative 1—Natural Gas Pipeline Corridor—Direct Impacts on Wetlands and Other Waters

HGM/NWI Group	Permanent	Temporary							
	Iliamna Lake	Amakdedori Creek-Frontal Kamishak Bay	Cook Inlet	Headwaters Koktuli River	Iliamna Lake	Stariski Creek-Frontal Cook Inlet	Upper Talarik Creek	Combined Watershed Area (Acres)	Combined Watershed Area (Miles)
Percent of Watershed Mapped by NWI	57	53	100	100	57	100	91		
SLOPE					**4**		**<1**	**4**	
Wetlands					**4**		**<1**	**4**	
Herbaceous	—	—	—	—	2	—		2	
Deciduous Shrubs	—	—	—	—	2	—	<1	2	
DEPRESSIONAL							**<1**	**<1**	
Other Waters							**<1**	**<1**	
Ponds	—	—	—	—	—	—	<1	<1	
LACUSTRINE	**4**				**120**			**120**	
Other Waters	**4**				**120**			**120**	
Ponds	4	—	—	—	120	—	—	120	
RIVERINE CHANNEL				**<1**			**<1**	**<1**	
Other Waters				**<1**			**<1**	**<1**	
Ponds	—	—	—	<1	—	—	—	<1	
Streams (Perennial)	—	—	—	—	—	—	<1	<1	0.2
RIVERINE							**<1**	**<1**	
Wetlands							**<1**	**<1**	
Herbaceous	—	—	—	—	—	—	<1	<1	
Deciduous Shrubs	—	—	—	—	—	—	<1	<1	
MARINE		**12**	**610**			**7**		**628**	
Other Waters		**12**	**610**			**7**		**628**	

Table 4.22-22: Alternative 1—Natural Gas Pipeline Corridor—Direct Impacts on Wetlands and Other Waters

HGM/NWI Group	Permanent	Temporary							
	Iliamna Lake	Amakdedori Creek-Frontal Kamishak Bay	Cook Inlet	Headwaters Koktuli River	Iliamna Lake	Stariski Creek-Frontal Cook Inlet	Upper Talarik Creek	Combined Watershed Area	
								(Acres)	(Miles)
Ponds	—	1		—	—	—	—	1	
Marine (Subtidal)	—	11	610	—	—	7	—	628	
Total Wetland Impacts (Acres)	**—**	**—**	**—**	**—**	**4**	**—**	**<1**	**4**	
Total Other Waters Impacts (Acres)	**4**	**12**	**610**	**<1**	**120**	**7**	**<1**	**749**	**0.2**
Total Wetlands and Other Waters Impacts (Acres)	**4**	**12**	**610**	**<1**	**124**	**7**	**1**	**753**	
Total Area of NWI Wetlands and Other Waters (Acres)	**389,610**	**29,739**	**4,167,981**	**36,458**	**389,610**	**89,067**	**13,193**	**4,726,048**	
Percent Total of NWI Wetlands and Other Waters	**<1**	**<1**	**<1**	**<1**	**<1**	**<1**	**<1**	**<1**	

Notes:

< = less than
— = not applicable
HGM = hydrogeomorphic
NWI = National Wetland Inventory

Source: Three Parameters Plus and HDR 2011b; HDR and Three Parameters Plus 2011b; HDR 2019i, j

Indirect Impacts—Fugitive Dust

Fugitive dust would be generated during installation of the overland, pipeline-only sections of the natural gas pipeline; dust generation during operations is expected to be minimal, because these sections would not be regularly accessed. Subsequent indirect impacts to wetlands and other waters from fugitive dust would likely be limited and are analyzed in the transportation corridor component of Alternative 1a.

Other Variants

There would be no change to the magnitude or extent of indirect impacts to wetlands and other waters in the natural gas pipeline corridor under the Summer-Only Ferry Operations Variant, the Kokhanok East Ferry Terminal Variant, or the Pile-Supported Dock Variant.

4.22.8 Alternative 2—North Road and Ferry with Downstream Dams

The total direct impact to wetlands and other waters under Alternative 2 is the discharge of dredged or fill material to 3,042 acres of wetlands and other waters, including 113.1 miles of streams. Of this area of direct impact area, 2,261 acres of wetlands and other waters, including 104.1 miles of streams, would be permanently impacted; 781 acres of wetlands and other waters, including 9.0 miles of streams, would be temporarily impacted. Indirect impacts under Alternative 2 related to the fragmentation, deposition of dust, and dewatering of aquatic resources collectively have the potential to impact a total of 1,602 acres of wetlands and other waters, including 65.8 miles of streams.

The mine site is predominantly in the Headwaters Koktuli River watershed, with a lesser presence in the UTC watershed (Figure 4.22-4). The Headwaters Koktuli River watershed is 170,632 acres, with 36,458 acres classified as wetlands and other waters (based on NWI mapping). In terms of magnitude and extent, construction and operations of the mine site under Alternative 2 would have direct and indirect impacts on 2,950[6] acres, representing 8 percent of wetlands and other waters in the Headwaters Koktuli River watershed. The UTC watershed is 87,539 acres, with 13,193 acres classified as wetlands and other waters (based on NWI mapping). The mine site would directly and indirectly impact 68 acres, representing less than 1 percent of wetlands and other waters in the UTC watershed. Although NWI wetland mapping covers the entirety of the Headwaters Koktuli River watershed, only 91 percent of the UTC watershed has been mapped by NWI. Therefore, the area of wetlands and other waters presented for the UTC watershed is likely underestimated.

The transportation corridor, natural gas pipeline corridor, and Diamond Point port project components would collectively affect nine HUC 10 watersheds under Alternative 2 (Figure 4.22-4). Based on available NWI mapping, wetlands and other waters comprise 4,771,931 acres of the combined area of these watersheds (6,385,867 acres). In terms of magnitude and extent, these three project components would have direct and indirect impacts on 1,608 acres of wetlands and other waters, representing less than 1 percent of the wetland and other waters mapped for the combined watershed area. Although NWI wetland mapping covers the entirety of six watersheds intersected by the transportation corridor, natural gas pipeline corridor, and the port components under Alternative 2, coverage for the remaining three watersheds (Iliamna Lake, Newhalen River, and Upper Talarik Creek) averages 81 percent, with a range of 57 to 95 percent. Therefore, the areas of wetlands and other waters presented for these watersheds are likely underestimated.

[6] Total accounts for overlap among areas of indirect impact at the mine site

The total direct impact to **navigable waters** under Alternative 2 would occur in the Newhalen and Iliamna rivers, Iliamna Lake, and Cook Inlet, and would impact a total of 782 acres. Of this total area of direct impact, 49 acres are permanent impacts largely associated with the construction of ferry terminals and the Diamond Point port; 734 acres are temporary impacts largely associated with the construction of the natural gas pipeline. These acreages are included in the "other waters" categories of Table 4.22-1, and would not result in additional areas of impact.

Special aquatic sites that would be directly and permanently impacted under Alternative 2 include mudflats, riffle and pool complexes, vegetated shallows, and wetlands. Quantifiable categories of regionally important wetlands that would be directly and permanently impacted under Alternative 2 include fens and estuarine, riparian, and forested wetlands (see Section 3.22, Wetlands and Other Waters/Special Aquatic Sites, for a description of these types).

The greatest magnitude of impact to special aquatic sites would be to wetlands (2,102 acres), including regionally important riparian wetlands (132 acres), fens (73 acres), forested wetland (3 acres), and estuarine wetlands (less than 1 acre), followed by riffle and pool habitat (46 acres, including 87.6 miles of upper perennial stream), mudflats (31 acres), and vegetated shallows (2 acres. The specific consequences of these losses are discussed under Alternative 1a; because estuarine wetlands are only impacted under Alternative 2 and Alternative 3, these regionally important wetlands are discussed here.

Estuarine wetlands are tidally influenced wetlands that develop along protected shorelines, and in Alaska, compose an uncommon component of the broader coastal landscape. In addition to providing the physical attenuation of tidal and storm surge flooding, estuarine wetlands perform the important biogeochemical functions of carbon sequestration and nutrient cycling. Because these wetlands are variably inundated, they provide diverse habitat for a variety of wildlife species, including fish, waterfowl, and shellfish. Under Alternative 2, impacts to estuarine wetlands would occur exclusively in the transportation corridor, where the access road meets the coast on its approach to the port. Loss and degradation of estuarine wetlands along this stretch would likely cause the mortality and displacement of sessile and mobile aquatic organisms, respectively; and could reduce the biological productivity and habitat diversity of the greater coastal ecosystem, with commensurate impacts to the higher trophic levels that are supported by these environments.

Although the extent of impacts to special aquatic sites and regionally important wetlands is expected to occur in seven of the nine watersheds intersected by Alternative 2, 97 percent of the impact to special aquatic sites and regionally important wetlands is expected in the Headwaters Koktuli River watershed, and would be largely associated with the construction and operation of the mine site. Direct, permanent impact to special aquatic sites and regionally important wetlands would affect 6 percent of the wetlands and other waters mapped in the Headwaters Koktuli drainage. The areas presented in Table 4.22-23 are those of direct permanent impacts to special aquatic sites and regionally important wetlands for all components of Alternative 2; variants, direct temporary, and indirect impacts are not evaluated.

A summary follows of the direct and indirect impacts to wetlands and other waters presented by project component and variant. Areas of impact were assessed according to the analysis methodology described above. A map book showing impacts in the analysis area is provided in Appendix K4.22.

4.22.8.1 Mine Site

Mining methods and facilities would remain the same as those under Alternative 1a, but would use an alternative downstream method for construction of the bulk TSF.

Table 4.22-23: Alternative 2—Direct Permanent Impacts to Special Aquatic Sites and Regionally Important Wetlands

HGM/NWI Group	Chekok Creek	Chinitna River-Frontal Cook Inlet	Headwaters Koktuli River	Iliamna Lake	Iliamna River	Newhalen River	Upper Talarik Creek	Combined Watershed Area (Acres)
Percent of Watershed Mapped by NWI	100	100	100	57	100	95	91	
Special Aquatic Sites								
Mudflats	—	19	12	<1	<1	—	<1	31
Riffle and Pool Habitat	<1	<1	44	<1	1	<1	<1	46
Vegetated Shallows	—	—	2	—	—	—	—	2
Wetlands	<1	<1	2,069	6	8	4	14	2,102
Regionally Important Wetlands								
Estuarine Wetland	—	<1	—	—	—	—	—	<1
Fen	—	—	72	—	—	—	1	73
Forested Wetland	<1	—	—	2	1	<1	—	3
Riparian Wetland	—	<1	125		5	1	1	132
Total Area of Special Aquatic Sites and Regionally Important Wetlands Impacted (Acres)	**<1**	**19**	**2,325**	**8**	**15**	**5**	**17**	**2,390**
Total Area of NWI Wetlands and Other Waters (Acres)	**3,808**	**77,388**	**36,458**	**389,610**	**4,529**	**23,380**	**13,193**	**548,366**
Percent Total of NWI Wetlands and Other Waters	**<1**	**<1**	**6**	**<1**	**<1**	**<1**	**<1**	**<1**

Notes:

< = less than
— = not applicable
HGM = hydrogeomorphic
NWI = National Wetland Inventory

Source: Three Parameters Plus and HDR 2011b; HDR and Three Parameters Plus 2011b; HDR 2019i, j

Direct Impacts

Due to the downstream dam construction method, the direct disturbance footprint of the mine site under Alternative 2 (8,497 acres) is 107 acres larger than Alternative 1a (8,390 acres). Despite the larger footprint, the extent and percent of the watersheds impacted are the same as Alternative 1a. The magnitude of direct permanent impacts to wetlands and other waters is increased by 22 acres, including 0.6 mile of streams, relative to Alternative 1a; this increase occurs exclusively in the Headwaters Koktuli River watershed and includes 11 acres of broad-leaved deciduous shrub wetlands, 10 acres of herbaceous wetlands, and less than 1 acre of streams. The duration of direct impacts would be the same as Alternative 1a.

Summer-Only Ferry Operations Variant

The Summer-Only Ferry Operations Variant would increase the direct permanent impacts to wetlands and other waters by 1.5 acres; this increase would be permanent and occur exclusively in the Headwaters Koktuli River watershed. The additional area of impact includes 1.7 acres of broad-leaved deciduous shrub wetlands, 0.4 acre of ponds, 0.2 acre, including 0.3 mile of intermittent stream habitat; impacts to 0.7 acre of herbaceous wetlands would be avoided by the changed configuration of facilities under the Summer-Only Ferry Operations. The extent of impacts would be the same as the Alternative 2 base case as defined in Table 4.22-1.

Other Variants

There would be no change to the magnitude, duration, or extent of direct impacts to wetlands and other waters at the mine site under the Newhalen River North Crossing Variant, or the Pile-Supported Dock Variant.

Indirect Impacts

At the mine site, overlap exists among the areas of indirect impact due to the deposition of fugitive dust, fragmentation of aquatic resources, and dewatering. Correcting for these areas of overlap, the cumulative area of indirect impact at the mine site is 853 acres of wetlands and other waters (771 acres of wetlands and 82 acres of other waters, including 29.8 miles of stream). Compared to Alternative 1a, the area of cumulative indirect impact at the mine site is reduced by 3 acres of wetlands and 0.1 mile of stream under the Alternative 2 base case. A discussion of indirect impacts at the mine site is presented above.

Summer-Only Ferry Operations Variant

Under the Summer-Only Ferry Operations Variant, concentrate would be stored in a container-based system at the mine site during the period when the water is not open. Although the area of direct disturbance would be greater under this variant, the configuration of facilities results in a smaller cumulative area of indirect impact. Under the Summer-Only Ferry Operations Variant, 851 acres of wetlands and other waters (770 acres of wetlands and 82 acres of other waters, including 29.5 miles of stream) would be indirectly impacted. Compared to the Alternative 2 base case, the magnitude of indirect impacts would be 1 acre less, with impacts to streams reduced by 0.3 mile; the extent and duration of impact would be the same as the Alternative 2 base case.

Other Variants

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

4.22.8.2 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 there, it diverges from Alternative 1a with a ferry crossing of Iliamna Lake to a ferry terminal near Pile Bay, and continuation along a port access road to the Diamond Point port, crossing Cook Inlet from Ursus Cove to the Kenai Peninsula. Because the approach to Diamond Point is bordered by mountains that rise very steeply from tidewater, a portion of the road would be constructed at the toe of the mountain slope in the intertidal zone. The transportation corridor includes the sections of the natural gas pipeline that are co-located with road alignments.

Direct Impacts

The magnitude and duration of direct impacts from construction of the transportation corridor are the permanent loss of 62 acres of wetlands and other waters, including 3.3 miles of streams (Table 4.22-24); and temporary impacts to 39 acres of wetlands and other waters, including 2.2 miles of streams (Table 4.22-25). Slope wetlands are the most impacted type, comprising 76 percent and 77 percent, respectively, of permanent and temporary impacts to wetlands. The majority of slope wetlands are represented by broad-leaved deciduous shrub wetlands, the loss and degradation of which are discussed above. With respect to other waters, coastal fringe estuarine waters are the most impacted type, comprising 76 percent and 71 percent, respectively, of permanent and temporary impacts to other waters. Impacts to coastal wetlands and intertidal habitat are due to the outbuilding of approximately 1.7 miles of the access road into intertidal habitat on approach to the port (Figure 2-69). Here, rock would be placed for fill and armor protection. Rock fill would consist of durable, coarse, free-draining material to minimize sedimentation and drainage, and equalization culverts would be installed throughout the road segment. Where construction of the access road would transect inlets, modification would be expected of the flow and residence time of tidal waters in the section of the inlet bounded by the road and shoreline.

The extent of direct impacts in the transportation corridor would affect wetlands and other waters across six watersheds. Direct impacts are highest in the Chinitna River-Frontal Cook Inlet watershed, where they represent 44 percent and 36 percent, respectively, of all permanent and temporary impacts to wetlands and other waters. For all watersheds, total direct permanent or temporary impacts represent 1 percent or less of all wetlands and other waters mapped by NWI. Impacts to wetlands and other waters coincident with the roadbed are considered permanent, whereas construction-related impacts occurring within 30 feet of the roadbed are considered temporary.

Eagle Bay and Pile Bay Ferry Terminals

Discharge of fill to construct the Eagle Bay and Pile Bay ferry terminals would result in a combined permanent loss of 2 acres of wetland and 0.7 acre of lacustrine habitat with temporary impacts expected across additional 0.2 acre of wetland and 1.4 acres of lacustrine habitat; these areas are included in Table 4.22-24 and Table 4.22-25, and do not represent additional areas of impact. Impacts to wetlands and lacustrine habitat associated with construction of the ferry terminals are discussed above under Alternative 1a.

Table 4.22-24: Alternative 2—Transportation Corridor Permanent Impacts to Wetlands and Other Waters

HGM/NWI Group	Chinitna River-Frontal Cook Inlet	Headwaters Koktuli River	Iliamna Lake	Iliamna River	Newhalen River	Upper Talarik Creek	Combined Watershed Area (Acres)	Combined Watershed Area (Miles)
Percent of Watershed Mapped by NWI	100	100	57	100	95	91		
SLOPE	**<1**		**5**	**5**	**3**	**9**	**22**	
Wetlands	**<1**		**5**	**5**	**3**	**9**	**22**	
Herbaceous	—	—	<1	1	—	1	2	
Deciduous Shrubs	<1	—	1	3	3	8	15	
Evergreen Shrubs	—	—	2	<1	<1	—	3	
Deciduous Forest	—	—	2	—	<1	—	2	
Evergreen Forest	—	—	—	1	<1	—	1	
Other Waters			**<1**	**<1**		**<1**	**<1**	
Ponds	—	—	<1	<1	—	<1	<1	
DEPRESSIONAL		**<1**	**<1**	**2**		**<1**	**3**	
Wetlands		**<1**	**<1**	**1**		**<1**	**1**	
Herbaceous	—	<1	<1	<1	—	<1	1	
Deciduous Shrubs	—	—	—	<1	—	—	<1	
Evergreen Shrubs	—	—	<1	—	—	—	<1	
Other Waters		**<1**		**1**		**<1**	1	
Ponds	—	<1	—	1	—	<1	1	
FLAT					**<1**	**<1**	**1**	
Wetlands					**<1**	**<1**	**1**	
Herbaceous	—	—	—	—	—	<1	<1	
Deciduous Shrubs	—	—	—	—	<1	<1	<1	
LACUSTRINE			**1**				**1**	
Other Waters			**1**				**1**	
Lakes	—	—	1	—	—	—	1	
RIVERINE CHANNEL	**1**	**<1**	**<1**	**1**	**<1**	**<1**	**2**	
Other Waters	**1**	**<1**	**<1**	**1**	**<1**	**<1**	**2**	

Table 4.22-24: Alternative 2—Transportation Corridor Permanent Impacts to Wetlands and Other Waters

HGM/NWI Group	Chinitna River-Frontal Cook Inlet	Headwaters Koktuli River	Iliamna Lake	Iliamna River	Newhalen River	Upper Talarik Creek	Combined Watershed Area (Acres)	Combined Watershed Area (Miles)
Streams (Intermittent)	<1	—	<1	<1	—	<1	<1	1.0
Streams (Perennial)	1	<1	<1	1	<1	<1	2	2.3
RIVERINE	**<1**			**6**	**1**	**1**	**7**	
Wetlands	**<1**			**3**	**1**	**1**	**5**	
Herbaceous	—	—	—	2	—	<1	2	
Deciduous Shrubs	<1	—	—	1	1	1	2	
Deciduous Forest	—	—	—	<1	<1	—	<1	
Other Waters				**3**		**<1**	3	
Ponds	—	—	—	3	—	<1	3	
COASTAL FRINGE	**27**						27	
Wetlands	**<1**						**<1**	
Herbaceous	<1	—	—	—	—	—	<1	
Other Waters	**26**						26	
Estuarine (Intertidal)	17	—	—	—	—	—	17	
Estuarine (Subtidal)	10	—	—	—	—	—	10	
Streams (Tidal)	<1	—	—	—	—	—	<1	
Total Wetland Impacts (Acres)	**<1**	**<1**	**6**	**8**	**4**	**10**	**29**	
Total Other Waters Impacts (Acres)	**27**	**<1**	**1**	**5**	**<1**	**<1**	**34**	**3.3**
Total Wetlands and Other Waters Impacts (Acres)	**27**	**<1**	**7**	**13**	**4**	**11**	**62**	
Total Area of NWI Wetlands and Other Waters (Acres)	**77,388**	**36,458**	**389,610**	**4,529**	**23,380**	**13,193**	**544,558**	
Percent Total of NWI Wetlands and Other Waters	**<1**	**<1**	**<1**	**<1**	**<1**	**<1**	**<1**	

Notes:

< = less than
— = not applicable
HGM = hydrogeomorphic
NWI = National Wetland Inventory

Source: Three Parameters Plus and HDR 2011b; HDR and Three Parameters Plus 2011b; HDR 2019i, j

Table 4.22-25: Alternative 2—Transportation Corridor Temporary Impacts to Wetlands and Other Waters

HGM/NWI Group	Chinitna River-Frontal Cook Inlet	Headwaters Koktuli River	Iliamna Lake	Iliamna River	Newhalen River	Upper Talarik Creek	Combined Watershed Area	
							(Acres)	(Miles)
Percent of Watershed Mapped by NWI	100	100	57	100	95	91		
SLOPE			**3**	**5**	**4**	**5**	**17**	
Wetlands			**3**	**5**	**4**	**5**	**17**	
Herbaceous	—	—	<1	1	<1	1	2	
Deciduous Shrubs	—	—	1	3	3	4	11	
Evergreen Shrubs	—	—	1	<1	1	—	2	
Deciduous Forest	—	—	1	—	<1	—	1	
Evergreen Forest	—	—	—	<1	<1	—	<1	
Other Waters			**<1**	**<1**			**<1**	
Ponds	—	—	<1	<1	—	—	<1	
DEPRESSIONAL		**<1**	**1**	**1**	**<1**	**<1**	**2**	
Wetlands		**<1**	**1**	**1**	**<1**	**<1**	**2**	
Herbaceous	—	<1	<1	1	<1	<1	1	
Deciduous Shrubs	—	—	—	<1	—	—	<1	
Evergreen Shrubs	—	—	<1	<1	<1	—	<1	
Other Waters		**<1**		**<1**		**<1**	**<1**	
Ponds	—	<1	—	<1	—	<1	<1	
FLAT					**<1**	**<1**	**1**	
Wetlands					**<1**	**<1**	**1**	
Herbaceous	—	—	—	—	—	<1	<1	
Deciduous Shrubs	—	—	—	—	<1	<1	<1	
LACUSTRINE			**1**			**<1**	**1**	
Other Waters			**1**			**<1**	**1**	
Lakes	—	—	1	—	—	<1	1	
RIVERINE CHANNEL	**1**	**<1**	**<1**	**1**	**<1**	**<1**	**2**	
Other Waters	**1**	**<1**	**<1**	**1**	**<1**	**<1**	**2**	
Streams (Intermittent)	<1	—	<1	<1	—	<1	<1	0.5
Streams (Perennial)	1	<1	<1	1	<1	<1	2	1.7

Table 4.22-25: Alternative 2—Transportation Corridor Temporary Impacts to Wetlands and Other Waters

HGM/NWI Group	Chinitna River-Frontal Cook Inlet	Headwaters Koktuli River	Iliamna Lake	Iliamna River	Newhalen River	Upper Talarik Creek	Combined Watershed Area	
							(Acres)	(Miles)
Streams (Tidal)	<1	—	—	—	—	—	<1	0.0
RIVERINE	**<1**			**2**	**1**	**1**	**3**	
Wetlands	**<1**			**2**	**1**	**1**	**3**	
Herbaceous	—	—	—	1	<1	<1	1	
Deciduous Shrubs	<1	—	—	<1	<1	<1	1	
Deciduous Forest	—	—	—	<1	<1	—	<1	
Other Waters				**1**		**<1**	1	
Ponds	—	—	—	1	—	<1	1	
COASTAL FRINGE	**13**						13	
Wetlands	**<1**						**<1**	
Herbaceous	<1	—	—	—	—	—	<1	
Other Waters	**13**						13	
Estuarine (Intertidal)	7	—	—	—	—	—	7	
Estuarine (Subtidal)	5	—	—	—	—	—	5	
Streams (Tidal)	<1	—	—	—	—	—	<1	
Total Wetland Impacts (Acres)	**<1**	**<1**	**3**	**8**	**5**	**6**	**22**	
Total Other Waters Impacts (Acres)	**14**	**<1**	**2**	**1**	**<1**	**1**	**17**	**2.2**
Total Wetlands and Other Waters Impacts (Acres)	**14**	**<1**	**5**	**9**	**5**	**6**	**39**	
Total Area of NWI Wetlands and Other Waters (Acres)	**77,388**	**36,458**	**389,610**	**4,529**	**23,380**	**13,193**	**547,532**	
Percent Total of NWI Wetlands and Other Waters	**<1**	**<1**	**<1**	**<1**	**<1**	**<1**	**<1**	

Notes:

< = less than
— = not applicable
HGM = hydrogeomorphic
NWI = National Wetland Inventory

Source: Three Parameters Plus and HDR 2011b; HDR and Three Parameters Plus 2011b; HDR 2019i, j

Newhalen River Bridge

Construction of the multi-span Newhalen River bridge at the southern crossing location (base case) would require the placement of piles below the ordinary high-water mark. The direct footprint of these pilings would be 201 square feet (approximately 0.005 acre)[7] in perennial stream habitat. Impacts to these waters would be permanent. Temporary impacts to 0.1 acre of herbaceous riverine wetlands are expected during construction. These areas are included in Table 4.22-24 and Table 4.22-25, and do not represent additional areas of impact. Impacts to wetlands and open water habitat associated with construction of bridges are discussed under Alternative 1a, above.

Iliamna River Bridge

Construction of the Iliamna River bridge would not require the placement of piles; however, 2.4 acres of riverine wetlands would be permanently impacted along the transportation corridor on approach to the bridge. An additional 1.7 acres of riverine wetland could be temporarily impacted by construction of the road and installation of the natural gas pipeline along this same stretch of the transportation corridor. These areas are included in Table 4.22-24 and Table 4.22-25, and do not represent additional areas of impact. Impacts to wetlands and open water habitat associated with construction of bridges are discussed above under Alternative 1a.

Summer-Only Ferry Operations Variant

Under this variant, concentrate containers would be stored at a laydown area along a coastal stretch of the Williamsport-Pile Bay Road, thereby increasing the size of the transportation corridor (see Figure 2-75). The magnitude and duration of effects from this variant would be the direct permanent impacts to an additional 10 acres of wetlands and other waters largely composed of estuarine intertidal waters (9 acres) in Iliamna Bay. The extent of impact would be the same as the Alternative 2 base case for the transportation corridor.

Newhalen River North Crossing Variant

Under this variant, the transportation corridor would cross the Newhalen River north of the base case location. Bridge construction for the north crossing of the Newhalen River is assumed to be the same as that presented under Alternative 2 base case. As the Newhalen River North Crossing Variant locates the bridge to avoid direct impacts to wetlands, the magnitude, duration, and extent do not differ from the Alternative 2 base case for the transportation corridor.

Indirect Impacts—Fugitive Dust

Under Alternative 2, the magnitude of indirect impacts in the transportation corridor would be the potential deposition of dust over 612 acres of wetlands and other waters, including 30.6 miles of streams. Slope wetlands comprise 76 percent of the wetland area exposed to fugitive dust and are chiefly represented by broad-leaved deciduous shrub wetlands, the degradation of which is discussed above. Estuarine waters and streams represent 43 percent and 33 percent, respectively, of the other water types that would be exposed to fugitive dust (Table 4.22-26). The extent of indirect impact transects six watersheds. Indirect impacts in the Iliamna River and UTC watersheds represent 3 percent and 1 percent, respectively, of all wetlands and other waters mapped by NWI in these watersheds. The highest severity of dust deposition to wetlands, other waters, and their functions is expected to occur proximal to the road edge, but may be detectable up to 330 feet distant. Note that the 330-foot dust zone overlaps with the 30-foot temporary construction impact zone in the transportation corridor. Dust impacts are considered an indirect yet long-term consequence of development.

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[7] Construction plans for the Newhalen River bridge place 16 4-foot-diameter piles in the waters of the Newhalen River.

Table 4.22-26: Alternative 2—Transportation Corridor Fugitive Dust Impacts on Wetlands and Other Waters

HGM/NWI Group	Chinitna River-Frontal Cook Inlet	Headwaters Koktuli River	Iliamna Lake	Iliamna River	Newhalen River	Upper Talarik Creek	Combined Watershed Area	
							(Acres)	(Miles)
Percent of Watershed Mapped by NWI	100	100	57	100	95	91		
SLOPE		**1**	**52**	**67**	**59**	**68**	**247**	
Wetlands		**<1**	**45**	**67**	**59**	**68**	**239**	
Herbaceous	—	<1	7	25	12	10	54	
Deciduous Shrubs	—	<1	19	34	44	57	155	
Evergreen Shrubs	—	—	10	3	2	<1	15	
Deciduous Forest	—	—	8	—	1	—	9	
Evergreen Forest	—	—	<1	4	<1	—	5	
Other Waters		**<1**	**7**	**<1**	**<1**	**<1**	**8**	
Aquatic Bed		—	<1	—	—	—	<1	
Ponds		<1	7	<1	<1	<1	8	
Streams (Perennial)		—	—	—	<1	—	<1	<0.1
DEPRESSIONAL		**<1**	**3**	**13**	**9**	**18**	**44**	
Wetlands		**<1**	**3**	**11**	**4**	**1**	**19**	
Herbaceous		<1	1	8	3	1	14	
Deciduous Shrubs	—	—	—	2	1	<1	3	
Evergreen Shrubs	—	—	1	<1	<1	—	2	
Deciduous Forest	—	—	<1	<1	—	—	<1	
Other Waters		**<1**	**<1**	**3**	**5**	**17**	**25**	
Aquatic Bed	—	—	—	—	1	—	1	
Ponds	—	<1	<1	3	5	17	24	
FLAT	**<1**				**1**	**13**	**14**	
Wetlands	**<1**				**1**	**13**	**14**	

Table 4.22-26: Alternative 2—Transportation Corridor Fugitive Dust Impacts on Wetlands and Other Waters

HGM/NWI Group	Chinitna River-Frontal Cook Inlet	Headwaters Koktuli River	Iliamna Lake	Iliamna River	Newhalen River	Upper Talarik Creek	Combined Watershed Area	
							(Acres)	(Miles)
Herbaceous	—	—	—	—	—	8	8	
Deciduous Shrubs	<1	—	—	—	1	5	6	
LACUSTRINE			**24**		**6**	**6**	**36**	
Other Waters			**24**		**6**	**6**	**36**	
Lakes	—	—	24	—	6	6	36	
LACUSTRINE FRINGE					**<1**	**<1**	**<1**	
Wetlands					**<1**	**<1**	**<1**	
Herbaceous	—	—	—	—	<1	—	<1	
Deciduous Shrubs	—	—	—	—	—	<1	<1	
RIVERINE CHANNEL	**17**	**<1**	**2**	**53**	**21**	**5**	**97**	
Other Waters	**17**	**<1**	**2**	**53**	**21**	**5**	**97**	
Streams (Intermittent)	7		<1	1	<1	<1	9	7.3
Streams (Perennial)	9	<1	2	52	21	4	88	23.1
Streams (Tidal)	<1						<1	<0.1
RIVERINE	**<1**		**<1**	**25**	**7**	**10**	**42**	
Wetlands	**<1**			**24**	**7**	**9**	**40**	
Herbaceous	—	—	—	13	1	1	15	
Deciduous Shrubs	<1	—	—	7	6	7	21	
Deciduous Forest	—	—	—	2	<1	—	2	
Evergreen Forest	—	—	—	1	—	—	1	
Other Waters			**<1**	**1**		**1**	**2**	
Aquatic Bed	—	—	—	—	—	<1	<1	
Ponds	—	—	—	1	—	1	2	

Table 4.22-26: Alternative 2—Transportation Corridor Fugitive Dust Impacts on Wetlands and Other Waters

HGM/NWI Group	Chinitna River-Frontal Cook Inlet	Headwaters Koktuli River	Iliamna Lake	Iliamna River	Newhalen River	Upper Talarik Creek	Combined Watershed Area	
							(Acres)	(Miles)
Streams (Perennial)	—	—	<1	—	—		<1	<0.1
COASTAL FRINGE	**132**						**132**	
Wetlands	**2**						**2**	
Herbaceous	2	—	—	—	—	—	2	
Other Waters	**129**						**129**	
Streams (Tidal)	1	—	—	—	—	—	1	0.2
Estuarine (Intertidal)	50	—	—	—	—	—	50	
Estuarine (Subtidal)	79	—	—	—	—	—	79	
Total Wetland Impacts (Acres)	**3**	**<1**	**48**	**101**	**72**	**91**	**314**	
Total Other Waters Impacts (Acres)	**146**	**<1**	**33**	**58**	**32**	**28**	**297**	**30.6**
Total Wetlands and Other Waters Impacts (Acres)	**149**	**1**	**81**	**158**	**103**	**119**	**612**	
Total Area of NWI Wetlands and Other Waters (Acres)	**77,388**	**36,458**	**389,610**	**4,529**	**23,380**	**13,193**	**544,558**	
Percent Total of NWI Wetlands and Other Waters	**<1**	**<1**	**<1**	**3**	**<1**	**1**	**<1**	

Notes:

< = less than
— = not applicable
HGM = hydrogeomorphic
NWI = National Wetland Inventory

Source: Three Parameters Plus and HDR 2011b; HDR and Three Parameters Plus 2011b; HDR 2019i, j

Summer-Only Ferry Operations Variant

The Summer-Only Ferry Operations Variant would decrease the magnitude of indirect impacts to estuarine intertidal habitat by 7 acres, but increase the magnitude of intermittent stream habitat exposed to the deposition of fugitive dust by 0.2 mile. The decrease in area of indirect impact relates to the location of the container storage area in the area of potential dust deposition for the Alternative 2 base case (see Figure 2-75). In this way, the direct footprint of disturbance for the variant supersedes a portion of the indirect impact area for the base case. Both changes in magnitude would occur in the Chinitna River-Frontal Cook Inlet watershed. The duration and extent of indirect impacts would be unchanged from the Alternative 2 base case for the transportation corridor.

Newhalen River North Crossing Variant

The rerouting of the transportation corridor under the Newhalen River North Crossing Variant would expose an additional 1.1 acres of lake waters to dust deposition, but would avoid potential dust impacts to 2.9 acres of wetlands and streams. Therefore, the magnitude of indirect impact to wetlands and other waters under the Newhalen River North Crossing Variant is 1.8 acres less than the Alternative 2 base case. The duration and extent would be the same as the Alternative 2 base case for the transportation corridor.

Pile-Supported Dock Variant

There would be no change to the magnitude or extent of indirect impacts to wetlands and other waters in the transportation corridor under the Pile-Supported Dock Variant.

4.22.8.3 Diamond Point Port

Alternative 2 proposes a dock with an earthen fill causeway and sheet pile jetty design placed at Diamond Point at the junction of Cottonwood and Iliamna bays. The shallow approach to Diamond Point would require dredging 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. Sea anchors would be placed for the primary and alternate lightering locations. Navigational buoys would not be set, and an airstrip would not be constructed at this port location. Temporary facilities and reclamation and closure of the site would be the same as Alternative 1a, but would occur at Diamond Point.

Direct Impacts

Compared to Amakdedori, Diamond Point has a more rugged topography, which transitions abruptly to a shallower and lower-energy nearshore environment. The Diamond Point port terminal and associated shore-based facilities are sited to minimize direct impacts to wetlands. In terms of magnitude and duration, construction of the port would permanently impact 14 acres of estuarine waters, with the sea anchors for the lightering locations permanently impacting 0.1 acre of the subtidal portion of these estuarine waters (Table 4.22-27). The in-water components of earthen fill causeway and sheet pile cell-supported jetty would alter localized currents, water circulation, and likely patterns of erosion and sedimentation in the immediate nearshore environment.

Due to the shallow approach to the jetty, channel dredging of 58 acres of estuarine subtidal habitat would occur during construction of the port, followed by maintenance dredging expected to occur every 5 years throughout the 20-year operational period. Dredged material would be placed in two bermed storage facilities located exclusively in uplands. Dredging is included in the area of temporary impact for the port.

Table 4.22-27: Alternative 2—Diamond Point Port Direct Impacts on Wetlands and Other Waters

HGM/NWI Group	Permanent		Temporary	
	Chinitna River-Frontal Cook Inlet		Chinitna River-Frontal Cook Inlet	
	(Acres)	(Miles)	(Acres)	(Miles)
Percent of Watershed Mapped by NWI	100		100	
RIVERINE CHANNEL	**<1**		**<1**	
Other Waters	**<1**	**—**	**<1**	**—**
Streams (Intermittent)	<1	<0.1	<1	0.1
COASTAL FRINGE	**14**		**71**	
Other Waters	**14**	**—**	**71**	**—**
Estuarine (Intertidal)	2	—	<1	—
Estuarine (Subtidal)	12	—	71	—
Total Other Waters Impacts (Acres)	**14**	**<0.1**	**72**	**0.1**
Total Area of NWI Wetlands and Other Waters (Acres)	**77,388**	**—**	**77,388**	**—**
Percent Total of NWI Wetlands and Other Waters	**<1**	**—**	**<1**	**—**

Notes:
< = less than
— = not applicable
HGM = hydrogeomorphic
NWI = National Wetland Inventory

Source: Three Parameters Plus and HDR 2011b; HDR and Three Parameters Plus 2011b; HDR 2019i, j

Construction-related impacts are expected to cause temporary impact to 72 acres of subtidal estuarine waters, including 0.1 mile of streams (Table 4.22-27). Increases in turbidity and changes in sedimentation pattern with subsequent disturbance to benthic fauna and bottom habitat structure would be expected. Because the port site at Diamond Point is lower energy than Amakdedori, disturbed substrate would likely be slower to return to natural condition and resident organisms may be less adapted to changing water circulation and bottom conditions; see above for an expanded discussion of impacts to the nearshore environment. The extent of direct impacts at Diamond Point would be restricted to the Chinitna River-Frontal Cook Inlet watershed and would impact less than 1 percent of the wetlands and other waters mapped by NWI for this watershed. The Diamond Point quarry is adjacent to the proposed port site, and the Williamsport-Pile Bay Road terminates at the head of Iliamna Bay; otherwise, previous disturbance to wetlands or other waters in this area is minimal.

Pile-Supported Dock Variant

This variant proposes a pile-supported dock design at Diamond Point port. This design would reduce the area of direct permanent impact from 14 acres to 4 acres, but would increase temporary impacts from 72 to 79 acres; changes would affect subtidal estuarine waters only. Due the smaller footprint of a pile-supported dock, permanent impacts related to the alteration of water currents and circulation patterns in the immediate nearshore environment are expected to be less than those associated with the earthen fill dock design. However, temporary impacts associated with the driving of piles would cause greater temporary disturbance. Dredging would still occur with this variant. The extent of impact would be unchanged from the Alternative 2 base case for the Diamond Point port.

Other Variants

There would be no change to the magnitude, duration, or extent of direct impacts to wetlands and other waters at the Diamond Point port under the Summer-Only Ferry Operations Variant or the Newhalen River North Crossing Variant.

Indirect Impacts—Fugitive Dust

Fugitive dust would be generated from construction of the terminal, and from the earthen fill causeway during operations. The magnitude of wetlands and other waters that would potentially be affected by dust deposition at the Diamond Point port is 71 acres. Estuarine waters comprise 94 percent of the area of indirect impact (Table 4.22-28). The extent of potential impacts is restricted to the Chinitna River-Frontal Cook Inlet watershed, and would impact less than 1 percent of the wetlands and other waters mapped by NWI for this watershed. Potential impacts due to dust are considered an indirect but long-term consequence of development.

Table 4.22-28: Alternative 2—Diamond Point Port Fugitive Dust Impacts on Wetlands and Other Waters

HGM/NWI Group	Chinitna River-Frontal Cook Inlet	
	(Acres)	(Miles)
Percent of Watershed Mapped by NWI	100	
RIVERINE CHANNEL	**2**	
Other Waters	**2**	
Streams (Intermittent)	2	0.6
Streams (Perennial)	<1	0.2
COASTAL FRINGE	**69**	
Wetlands	**1**	
Herbaceous	1	
Other Waters	**67**	
Estuarine (Intertidal)	6	
Estuarine (Subtidal)	61	
Total Wetland Impacts (Acres)	**1**	
Total Other Waters Impacts (Acres)	**69**	**0.8**
Total Wetlands and Other Waters Impacts (Acres)	**71**	
Total Area of NWI Wetlands and Other Waters (Acres)	**77,388**	
Percent Total of NWI Wetlands and Other Waters	**<1**	

Notes:

< = less than
HGM = hydrogeomorphic
NWI = National Wetland Inventory

Source: Three Parameters Plus and HDR 2011b; HDR and Three Parameters Plus 2011b; HDR 2019i, j

Pile-Supported Dock Variant

Construction of a pile-supported dock at Diamond Point port would decrease the exposure of wetlands and other waters to the potential deposition of dust from 71 acres to 29 acres. Potential impacts to 19 acres of subtidal estuarine marine waters are avoided by the design of the pile-supported dock, which is decked in concrete and would not be expected to generate significant dust. The extent and duration of potential indirect impacts from fugitive dust deposition would remain unchanged from the Alternative 2 base case for the Diamond Point port.

Other Variants

There would be no change to the magnitude or extent of indirect impacts to wetlands and other waters at the Diamond Point port under the Summer-Only Ferry Operations Variant or the Newhalen River North Crossing Variant.

4.22.8.4 Natural Gas Pipeline Corridor

The natural gas pipeline corridor under Alternative 2 crosses Cook Inlet to Ursus Cove, continues northward to Diamond Point port, then follows the port access road to the cut-off to Pile Bay. From the road cut-off to Pile Bay, the natural gas pipeline travels 36 miles overland to the mine access road cut-off to Eagle Bay, where it joins the mine access road and continues to the mine site. Temporary access roads would be built at three locations along the north shore of Iliamna Lake to construct the 36-mile section of the natural gas pipeline corridor between the port and mine access roads (Figure 2-69). Impacts evaluated here are for all pipeline-only sections of the natural gas pipeline that are not co-located with roads, and include the 1-mile tie-in to the compressor station on the Kenai Peninsula, the 75-mile Cook Inlet crossing, the 6-mile overland section from Ursus Cove to Cottonwood Bay, the 3-mile Cottonwood Bay crossing, the 36-mile section along the north side of Iliamna Lake discussed above, and the 2-mile section from the mine access road to the mine site. Dust impacts from construction access roads to the natural gas pipeline corridor on the northern side of Iliamna Lake are also considered.

Direct Impacts

Under Alternative 2, material sites along the pipeline-only section of the natural gas pipeline on the north side of Iliamna Lake would permanently impact less than 1 acre of wetlands and other waters, including 0.5 mile of streams in the Chekok Creek and Iliamna Lake watersheds. Temporary impacts associated with installation of the pipeline-only sections of the natural gas pipeline are expected to impact 670 acres of wetlands and other waters, including 6.6 miles of stream (Table 4.22-29). Impacts in Cook Inlet represent 99 percent of the total area of temporary impact for the natural gas pipeline. The duration of impacts from the installation of offshore sections of the pipeline are considered temporary, because sedimentation rates in the benthic environment would be expected to quickly return the seabed to its natural condition; see the Natural Gas Pipeline Corridor section above for an expanded discussion of impacts. The extent of direct impacts transects nine watersheds. Although impacts are concentrated in the Chinitna River-Frontal Cook Inlet and Cook Inlet watersheds, impacts represent less than 1 percent of wetlands and other waters mapped by NWI in all watersheds.

Other Variants

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

Table 4.22-29: Alternative 2—Natural Gas Pipeline Temporary Impacts on Wetlands and Other Waters

HGM/NWI Group	Chekok Creek	Chinitna River-Frontal Cook Inlet	Cook Inlet	Headwaters Koktuli River	Iliamna Lake	Iliamna River	Pile River	Stariski Creek-Frontal Cook Inlet	Upper Talarik Creek	Combined Watershed Area (Acres)	Combined Watershed Area (Miles)
Percent of Watershed Mapped by NWI	100	100	100	100	57	100	100	100	91		
SLOPE	**1**	**4**			**8**	**<1**	**<1**		**<1**	**15**	
Wetlands	**1**	**4**			**8**	**0**	**0**		**0**	**15**	
Herbaceous	—	1	—	—	2	<1	<1	—	—	3	
Deciduous Shrubs	1	4	—	—	4	<1	<1	—	<1	9	
Evergreen Shrubs	—	—	—	—	1	—	—	—	—	1	
Deciduous Forest	—	—	—	—	2	—	<1	—	—	2	
Evergreen Forest	—	—	—	—	<1	—	—	—	—	<1	
Other Waters		**<1**								**0**	
Ponds	—	<1	—	—	—	—	—	—	—	<1	
DEPRESSIONAL					**<1**				**<1**	**<1**	
Wetlands					**<1**					**<1**	
Herbaceous	—	—	—	—	<1	—	—	—	—	<1	
Other Waters									**<1**	**<1**	
Ponds	—	—	—	—	—	—	—	—	<1	<1	
LACUSTRINE					**<1**					**<1**	
Other Waters					**<1**					**<1**	
Lakes	—	—	—	—	<1	—	—	—	—	<1	
LACUSTRINE FRINGE					**<1**		**<1**			**<1**	
Wetlands					**<1**		**<1**			**<1**	
Herbaceous	—	—	—	—		—	<1	—	—	<1	
Deciduous Shrubs	—	—	—	—	<1	—	—	—	—	<1	
RIVERINE CHANNEL	**1**	**1**		**<1**	**3**	**<1**	**1**		**<1**	**5**	
Other Waters	**1**	**1**		**<1**	**3**	**<1**	**1**		**<1**	**5**	
Streams (Intermittent)	<1	<1	—	<1	<1	<1	—	—	—	<1	1.4
Streams (Perennial)	1	1	—	—	3	<1	1	—	<1	5	5.3

Table 4.22-29: Alternative 2—Natural Gas Pipeline Temporary Impacts on Wetlands and Other Waters

HGM/NWI Group	Chekok Creek	Chinitna River-Frontal Cook Inlet	Cook Inlet	Headwaters Koktuli River	Iliamna Lake	Iliamna River	Pile River	Stariski Creek-Frontal Cook Inlet	Upper Talarik Creek	Combined Watershed Area	
										(Acres)	(Miles)
RIVERINE	**<1**	**<1**			**2**	**1**	**1**		**<1**	**3**	
Wetlands	**<1**	**<1**			**2**	**1**	**1**		**<1**	**3**	
Herbaceous	—	—	—	—	1	<1	<1	—	<1	1	
Deciduous Shrubs	<1	<1	—	—	1	<1	1	—	<1	2	
Deciduous Forest	—	—	—	—	<1	—	—	—	—	<1	
Evergreen Forest	—	—	—	—	<1	—	—	—	—	<1	
Other Waters					**<1**					**<1**	
Ponds	—	—	—	—	<1	—	—	—	—	<1	
COASTAL FRINGE		**27**								**27**	
Other Waters		**27**								**27**	
Estuarine (Intertidal)	—	2	—	—	—	—	—	—	—	2	
Estuarine (Subtidal)	—	25	—	—	—	—	—	—	—	25	
MARINE		**18**	**593**					**7**		**618**	
Other Waters		**18**	**593**					**7**		**618**	
Marine (Intertidal)	—	1	—	—	—	—	—	—	—	1	
Marine (Subtidal)	—	17	593	—	—	—	—	7	—	618	
Total Wetland Impacts (Acres)	**1**	**5**			**10**	**1**	**1**		**<1**	**19**	
Total Other Waters Impacts (Acres)	**1**	**46**	**593**	**<1**	**3**	**<1**	**1**	**7**	**<1**	**651**	**6.6**
Total Wetlands and Other Waters Impacts (Acres)	**2**	**50**	**593**	**<1**	**14**	**1**	**2**	**7**	**1**	**670**	
Total Area of NWI Wetlands and Other Waters (Acres)	**3,808**	**77,388**	**4,167,981**	**36,458**	**389,610**	**4,529**	**2,975**	**89,067**	**13,193**	**4,785,008**	
Percent Total of NWI Wetlands and Other Waters	**<1**	**<1**	**<1**	**<1**	**<1**	**<1**	**<1**	**<1**	**<1**	**<1**	

Notes:

< = less than
— = not applicable
HGM = hydrogeomorphic
NWI = National Wetland Inventory

Source: Three Parameters Plus and HDR 2011b; HDR and Three Parameters Plus 2011b; HDR 2019i, j

Indirect Impacts—Fugitive Dust

Under Alternative 2, construction of the natural gas pipeline would expose 67 acres of wetlands and other waters, including 4.7 miles of streams, to the deposition of dust (Table 4.22-30). These potential impacts are largely associated with the three temporary construction access roads along the north shore of Iliamna Lake. Slope wetlands comprise 84 percent of the wetland area that would be exposed to fugitive dust, and are chiefly represented by broad-leaved deciduous shrub and herbaceous wetlands. Lake and stream waters represent 45 percent and 31 percent, respectively, of area of other waters exposed to dust. The extent of impact transects four watersheds, where indirect impacts represent 1 percent or less of wetlands and other waters mapped by NWI. Dust impacts are considered an indirect but long-term consequence of development.

Other Variants

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

4.22.9 Alternative 3—North Road Only

The total direct impact to wetlands and other waters under Alternative 3 is the discharge of dredged or fill material to 3,005 acres of wetlands and other waters, including 111.6 miles of streams (Table 4.22-1). Of this area of direct impact area, 2,231 acres of wetlands and other waters and 105.4 miles of streams would be permanently impacted; 773 acres of wetlands and other waters, including 6.2 miles of streams, would be temporarily impacted. Indirect impacts under Alternative 3 related to the fragmentation, deposition of dust, and dewatering of aquatic resources collectively have the potential to impact a total of 1,609 acres of wetlands and other waters, including 79.5 miles of streams.

The mine site is predominantly in the Headwaters Koktuli River watershed, with a lesser presence in the UTC watershed (Figure 4.22-4). The Headwaters Koktuli River watershed is 170,632 acres, with 36,458 acres classified as wetlands and other waters (based on NWI mapping). In terms of magnitude and extent, construction and operations of the mine site under Alternative 3 would have direct and indirect impacts on 2,953[8] acres, representing 8 percent of wetlands and other waters in the Headwaters Koktuli River watershed. The UTC watershed is 87,539 acres, with 13,193 acres classified as wetlands and other waters (based on NWI mapping). The mine site would directly and indirectly impact 68 acres, representing less than 1 percent of wetlands and other waters in the UTC watershed. Although NWI wetland mapping covers the entirety of the Headwaters Koktuli River watershed, only 91 percent of the UTC watershed has been mapped by NWI. Therefore, the area of wetlands and other waters presented for the UTC watershed is likely underestimated.

The transportation corridor, natural gas pipeline corridor, and Diamond Point port project components would collectively affect nine HUC 10 watersheds under Alternative 3 (Figure 4.22-4). Based on available NWI mapping, wetlands and other waters comprise 4,771,931 acres of the combined area of these watersheds (6,385,867 acres). In terms of magnitude and extent, these three project components would have direct and indirect impacts on 1,595 acres of wetlands and other waters, representing less than 1 percent of the wetland and other waters habitat mapped for the combined watershed area. Although NWI wetland mapping covers the entirety of six watersheds intersected by the transportation corridor, the natural gas pipeline corridor, and the port components under Alternative 3, coverage for the remaining three watersheds (Iliamna Lake, Newhalen River, and UTC) averages 81 percent, with a range of 57 to 95 percent. Therefore, the areas of wetlands and other waters presented for these watersheds are likely underestimated.

[8] Total accounts for overlap among areas of indirect impact at the mine site

Table 4.22-30: Alternative 2—Natural Gas Pipeline Corridor Fugitive Dust Impacts on Wetlands and Other Waters

HGM/NWI Group	Chekok Creek	Chinitna River-Frontal Cook Inlet	Iliamna Lake	Pile River	Combined Watershed Area	
					(Acres)	(Miles)
Percent of Watershed Mapped by NWI	100	100	57	100		
SLOPE	**1**	**<1**	**22**	**9**	**32**	
Wetlands	**1**	**<1**	**22**	**9**	**32**	
Herbaceous	—	**<1**	5	3	8	
Deciduous Shrubs	1	—	13	5	19	
Evergreen Shrubs	—	—	1	—	1	
Deciduous Forest	1	—	2	1	4	
Evergreen Forest	—	—	1	<1	1	
DEPRESSIONAL			**1**		**1**	
Wetlands			**1**		**1**	
Deciduous Shrubs	—	—	**<1**	—	<1	
Herbaceous	—	—	1	—	1	
Other Waters			**<1**		**<1**	
Ponds	—	—	**<1**	—	<1	
LACUSTRINE			**13**		**13**	
Other Waters			**13**		**13**	
Lakes	—	—	13	—	13	
LACUSTRINE FRINGE			**1**		**1**	
Wetlands			**1**		**1**	
Deciduous Shrubs	—	—	1	—	1	
MARINE		**<1**			**<1**	
Other Waters		**<1**			**<1**	
Marine (Intertidal)	—	**<1**	—	—	<1	

Table 4.22-30: Alternative 2—Natural Gas Pipeline Corridor Fugitive Dust Impacts on Wetlands and Other Waters

HGM/NWI Group	Chekok Creek	Chinitna River-Frontal Cook Inlet	Iliamna Lake	Pile River	Combined Watershed Area	
					(Acres)	(Miles)
RIVERINE	**<1**	**<1**	**1**	**3**	**4**	
Wetlands	**<1**	**<1**	**<1**	**3**	**4**	
Deciduous Shrubs	**<1**	**<1**	—	1	1	
Herbaceous	—	—	**<1**	2	2	
Other Waters			**<1**	**<1**	**<1**	
Aquatic Bed	—	—	**<1**	—	<1	
Ponds	—	—	**<1**	<1	<1	
RIVERINE CHANNEL	**<1**	**1**	**2**	**6**	**9**	
Other Waters	**<1**	**1**	**2**	**6**	**9**	
Streams (Intermittent)	—	**<1**	**<1**	—	<1	0.7
Streams (Perennial)	**<1**	1	1	6	9	4.0
COASTAL FRINGE		**6**			**6**	
Other Waters		**6**			**6**	
Estuarine (Intertidal)	—	6	—	—	6	
Total Wetland Impacts (Acres)	**2**	**<1**	**24**	**12**	**38**	
Total Other Waters Impacts (Acres)	**<1**	**7**	**16**	**6**	**29**	**4.7**
Total Wetlands and Other Waters Impacts (Acres)	**2**	**7**	**40**	**18**	**67**	
Total Area of NWI Wetlands and Other Waters (Acres)	**3,808**	**77,388**	**389,610**	**2,975**	**473,780**	
Percent Total of NWI Wetlands and Other Waters	**<1**	**<1**	**<1**	**1**	**<1**	

Notes:

< = less than
— = not applicable
HGM = hydrogeomorphic
NWI = National Wetland Inventory

Source: Three Parameters Plus and HDR 2011b; HDR and Three Parameters Plus 2011b; HDR 2019i, j

Because Alternative 3 does not include a crossing of Iliamna Lake, the Newhalen and Iliamna rivers, and Cook Inlet are the only navigable waters impacted. The total direct impact to navigable waters under Alternative 3 would be 769 acres. Of this total area of direct impact, 32 acres would be permanent impacts largely associated with the construction the port; 737 acres would be temporary impacts largely associated with the construction of the natural gas pipeline. These acreages are included in the “other waters” categories of Table 4.22-1, and would not result in additional areas of impact.

Special aquatic sites that would be directly and permanently impacted under Alternative 3 include mudflats, riffle and pool complexes, vegetated shallows, and wetlands. Quantifiable categories of regionally important wetlands that would be directly and permanently impacted under Alternative 2 include fens, and estuarine, riparian, and forested wetlands (see Section 3.22, Wetlands and Other Waters/Special Aquatic Sites, for a description of these types).

The greatest magnitude of impact to special aquatic sites would be to wetlands (2,090 acres), including regionally important riparian wetlands (132 acres), fens (72 acres), forested wetlands (5 acres), estuarine wetlands (less than 1 acre), followed by riffle and pool habitat (92 acres, including 88.5 miles of upper perennial stream), mudflats (57 acres), and vegetated shallows (4 acres). The specific consequences of these losses are discussed under Alternative 1a; impacts to estuarine wetlands are discussed under Alternative 2.

Although the extent of impacts is expected to occur across all eight of the watersheds intersected by Alternative 3, 94 percent of the impact to special aquatic sites and regionally important wetlands is expected in the Headwaters Koktuli River watershed, and would be largely associated with the construction and operation of the mine site. Direct, permanent impact to special aquatic sites and regionally important wetlands would affect 6 percent of the wetlands and other waters mapped in the Headwaters Koktuli drainage. The areas presented in Table 4.22-31 are those of direct permanent impacts to special aquatic sites and regionally important wetlands for all components of Alternative 3; the variant, direct temporary, and indirect impacts are not evaluated.

A summary follows of the direct and indirect impacts to wetlands and other waters, presented by project component and variant. Areas of impact were assessed according to the analysis methodology described above. A map book showing impacts in the analysis area is provided in Appendix K4.22.

4.22.9.1 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.

<u>Direct Impacts</u>

Concentrate Pipeline Variant

This variant considers delivery of copper-gold concentrate to Diamond Point port via a pipeline, and includes an option to construct an additional pipeline to return filtrate to the mine site. This variant would slightly increase the road corridor width due to the co-location of the concentrate, optional return water, and natural gas pipelines in a single trench at the toe of the road embankment. Construction of the concentrate pipeline would increase the average width of the road corridor by less than 10 percent; construction of the concentrate and water return pipelines would increase the average width of the road corridor by less than 3 feet. There would be no change to the magnitude, duration, or extent of direct or indirect impacts to wetlands and other waters at the mine site under this variant.

Table 4.22-31: Alternative 3—Direct Impacts to Special Aquatic Sites and Regionally Important Wetlands

HGM/NWI Group	Chekok Creek	Chinitna River-Frontal Cook Inlet	Headwaters Koktuli River	Iliamna Lake	Iliamna River	Newhalen River	Pile River	Upper Talarik Creek	Combined Watershed Area (Acres)
Percent of Watershed Mapped by NWI	100	100	100	57	100	95	100	92	
Special Aquatic Sites									
Mudflats	<1	16	12	<1	<1	—	<1	29	57
Riffle and Pool Habitat	<1	<1	44	1	<1	<1	<1	46	92
Vegetated Shallows	—	—	2	—	—	—	—	2	4
Wetlands	1	<1	2,048	8	7	7	<1	18	2,090
Regionally Important Wetlands									
Estuarine Wetland	—	<1	—	—	—	—	—	—	<1
Fen	—	—	70	—	—	<1	—	1	72
Forested Wetland	—	—	—	4	1	<1	—	—	5
Riparian Wetland	<1	—	125	1	4	1	<1	1	132
Total Area of Special Aquatic Sites and Regionally Important Wetlands Impacted (Acres)	**1**	**17**	**2,302**	**14**	**13**	**8**	**1**	**97**	**2,453**
Total Area of NWI Wetlands and Other Waters (Acres)	**3,808**	**77,388**	**36,458**	**389,610**	**4,529**	**23,380**	**2,975**	**13,193**	**551,340**
Percent Total of NWI Wetlands and Other Waters	**<1**	**<1**	**6**	**<1**	**<1**	**<1**	**<1**	**1**	**<1**

Notes:

< = less than
— = not applicable
HGM = hydrogeomorphic
NWI = National Wetland Inventory

Source: Three Parameters Plus and HDR 2011b; HDR and Three Parameters Plus 2011b; HDR 2019i, j

4.22.9.2 Transportation Corridor

The Alternative 3 transportation corridor has an 82-mile north access road from the mine site to a port location north of Diamond Point in Iliamna Bay. Because Iliamna Bay is bordered by mountains that rise steeply from tidewater, a portion of the road would be constructed at the toe of the mountain slope in the intertidal zone. The Alternative 3 transportation corridor includes a southern crossing of the Newhalen River, from where the alignment largely follows the Alternative 2 transportation and natural gas pipeline corridors to Iliamna Bay. Exceptions are an approximately 2.5-mile realignment around Knutson Bay, west of the village of Pedro Bay and the exclusion of ferry access roads to the Eagle Bay and Plie Bay ferry terminals, which would not be built under Alternative 3. The transportation corridor includes the sections of the natural gas pipeline that are co-located with road alignments.

<u>Direct Impacts</u>

The magnitude and duration of direct impacts from construction of the transportation corridor are the permanent loss of 66 acres of wetlands and other waters, including 5.7 miles of streams (Table 4.22-32); and temporary impacts to 40 acres of wetlands and other waters, including 3.9 miles of streams (Table 4.22-33). Slope wetlands are the most impacted type, comprising 82 percent and 81 percent, respectively, of permanent and temporary impacts to wetlands. The majority of slope wetlands are represented by broad-leaved deciduous shrub wetlands, the loss and degradation of which are discussed under above. With respect to other waters, coastal fringe estuarine waters are the most impacted type, comprising 75 percent and 64 percent, respectively, of permanent and temporary impacts to other waters. Impacts to coastal wetlands and intertidal habitat are due to the outbuilding of approximately 1.7 miles of the access road into intertidal habitat on approach to the port (Figure 2-69); rock would be placed for fill and armor protection. Rock fill would consist of durable, coarse, free-draining material to minimize sedimentation and drainage and equalization culverts would be installed throughout the road segment. Where construction of the access road would transect inlets, modification of the flow and residence time of tidal waters in the section of the inlet bounded by the road and shoreline, would be expected.

The extent of direct impacts in the transportation corridor would affect wetlands and other waters across eight watersheds. Direct impacts are highest in the Chinitna River-Frontal Cook Inlet watershed, where they represent 33 and 25 percent, respectively, of all permanent and temporary impacts to wetlands and other waters. For all watersheds, total direct permanent or temporary impact represent 1 percent or less of all wetlands and other waters mapped by NWI. Impacts to wetlands and other waters coincident with the roadbed are considered permanent, whereas construction-related impacts occurring within 30 feet of the roadbed are considered temporary.

Newhalen River Bridge

Construction of the multi-span Newhalen River bridge would require the placement of piles below the ordinary high-water mark. The direct footprint of these pilings is 201 square feet (approximately 0.005 acre)[9] in perennial riverine habitat. Impacts to these waters would be permanent. Temporary impacts to 0.1 acre of herbaceous riverine wetlands are expected during construction. These areas are included in Table 4.22-32 and Table 4.22-33 and do not represent additional areas of impact. Impacts to wetlands and open water habitat associated with construction of bridges are discussed above.

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[9] Construction plans for the Newhalen River bridge place 16 4-foot-diameter piles in the waters of the Newhalen River.

Table 4.22-32: Alternative 3—Transportation Corridor Permanent Impacts on Wetlands and Other Waters

HGM/NWI Group	Chekok Creek	Chinitna River-Frontal Cook Inlet	Headwaters Koktuli River	Iliamna Lake	Iliamna River	Newhalen River	Pile River	Upper Talarik Creek	Combined Watershed Area	
									(Acres)	(Miles)
Percent of Watershed Mapped by NWI	100	100	100	57	100	95	100	92		
SLOPE	**1**	**<1**		**7**	**5**	**6**		**12**	**31**	
Wetlands	**1**	**<1**	—	**7**	**5**	**6**		**12**	**31**	
Herbaceous	—	—	—	1	1	<1	—	1	3	
Deciduous Shrubs	1	<1	—	3	3	5	—	11	23	
Evergreen Shrubs	—	—	—	<1	<1	<1	—	—	1	
Deciduous Forest	—	—	—	3	—	<1	—	—	4	
Evergreen Forest	—	—	—	<1	1	<1	—	—	1	
Other Waters					**<1**			**<1**	**<1**	
Ponds	—	—	—	—	<1	—	—	<1	<1	
DEPRESSIONAL			**<1**	**<1**	**1**	**<1**		**<1**	**1**	
Wetlands			**<1**	**<1**	**<1**	**<1**		**<1**	**<1**	
Herbaceous	—	—	<1	<1	<1	<1	—	<1	<1	
Other Waters			**<1**	**<1**	**1**			**<1**	**1**	
Ponds	—	—	<1	<1	1	—	—	<1	1	
FLAT						**<1**		**1**	**1**	
Wetlands						**<1**		**1**	**1**	
Herbaceous	—	—	—	—	—	—	—	1	1	
Deciduous Shrubs	—	—	—	—	—	<1	—	<1	<1	
LACUSTRINE				**<1**					**<1**	
Other Waters				**<1**					**<1**	
Lakes	—	—	—	<1	—	—	—	—	<1	
LACUSTRINE FRINGE							**<1**		**<1**	
Wetlands							**<1**		**<1**	
Herbaceous	—	—	—	—	—	—	<1	—	<1	
RIVERINE CHANNEL	**<1**	**1**	**<1**	**1**	**1**	**<1**		**<1**	**3**	
Other Waters	**<1**	**1**	**<1**	**1**	**1**	**<1**		**<1**	**3**	
Streams (Intermittent)	—	<1	—	<1	<1	—	—	<1	<1	1.4

Table 4.22-32: Alternative 3—Transportation Corridor Permanent Impacts on Wetlands and Other Waters

HGM/NWI Group	Chekok Creek	Chinitna River-Frontal Cook Inlet	Headwaters Koktuli River	Iliamna Lake	Iliamna River	Newhalen River	Pile River	Upper Talarik Creek	Combined Watershed Area	
									(Acres)	(Miles)
Streams (Perennial)	<1	<1	<1	1	1	<1	—	<1	2	4.3
RIVERINE	**<1**			**1**	**5**	**1**	**<1**	**1**	**8**	
Wetlands	**<1**			**1**	**2**	**1**	**<1**	**1**	**5**	
Herbaceous	—	—	—	1	1	—	<1	<1	2	
Deciduous Shrubs	<1	—	—	<1	1	1	<1	1	3	
Deciduous Forest	—	—	—	<1	<1	<1	—	—	<1	
Evergreen Forest	—	—	—	<1	—	—	—	—	<1	
Other Waters				**<1**	**3**			**<1**	**3**	
Ponds	—	—	—	<1	3	—	—	<1	3	
COASTAL FRINGE		**21**							**21**	
Wetlands		**<1**							**<1**	
Herbaceous	—	<1	—	—	—	—	—	—	<1	
Other Waters		**21**							**21**	
Estuarine (Intertidal)	—	16	—	—	—	—	—	—	16	
Estuarine (Subtidal)	—	5	—	—	—	—	—	—	5	
Streams (Tidal)	—	<1	—	—	—	—	—	—	<1	
Total Wetland Impacts (Acres)	**1**	**<1**	**<1**	**8**	**7**	**7**	**<1**	**14**	**38**	
Total Other Waters Impacts (Acres)	**<1**	**21**	**<1**	**1**	**4**	**<1**		**1**	**28**	**5.7**
Total Wetlands and Other Waters Impacts (Acres)	**1**	**22**	**<1**	**10**	**11**	**7**	**<1**	**15**	**66**	
Total Area of NWI Wetlands and Other Waters (Acres)	**3,808**	**77,388**	**36,458**	**389,610**	**4,529**	**23,380**	**2,975**	**13,193**	**551,340**	
Percent Total of NWI Wetlands and Other Waters	**<1**	**<1**	**<1**	**<1**	**<1**	**<1**	**<1**	**<1**	**<1**	

Notes:

< = less than
— = not applicable
HGM = hydrogeomorphic
NWI = National Wetland Inventory

Source: Three Parameters Plus and HDR 2011b; HDR and Three Parameters Plus 2011b; HDR 2019i, j

Table 4.22-33: Alternative 3—Transportation Corridor Temporary Impacts on Wetlands and Other Waters

HGM/NWI Group	Chekok Creek	Chinitna River-Frontal Cook Inlet	Headwaters Koktuli River	Iliamna Lake	Iliamna River	Newhalen River	Pile River	Upper Talarik Creek	Combined Watershed Area	
									(Acres)	(Miles)
Percent of Watershed Mapped by NWI	100	100	100	57	100	95	100	92		
SLOPE	**<1**			**6**	**5**	**4**		**5**	**21**	
Wetlands	**<1**			**6**	**5**	**4**		**5**	**21**	
Herbaceous	—	—	—	1	1	<1	—	1	3	
Deciduous Shrubs	<1	—	—	3	3	3	—	5	14	
Evergreen Shrubs	—	—	—	<1	<1	1	—	—	1	
Deciduous Forest	—	—	—	2	—	<1	—	—	2	
Evergreen Forest	—	—	—	<1	<1	<1	—	—	1	
Other Waters					**<1**				**<1**	
Ponds	—	—	—	—	<1	—	—	—	<1	
DEPRESSIONAL			**<1**	**<1**	**<1**	**<1**		**<1**	**1**	
Wetlands			**<1**	**<1**	**<1**	**<1**		**<1**	**1**	
Herbaceous	—	—	<1	<1	<1	<1	—	<1	1	
Deciduous Shrubs	—	—	—	<1	—	—	—	—	<1	
Evergreen Shrubs	—	—	—	—	—	<1	—	—	<1	
Other Waters			**<1**	**<1**	**<1**			**<1**	**<1**	
Ponds	—	—	<1	<1	<1	—	—	<1	<1	
FLAT						**<1**		**<1**	**1**	
Wetlands						**<1**		**<1**	**1**	
Herbaceous	—	—	—	—	—	—	—	<1	<1	
Deciduous Shrubs	—	—	—	—	—	<1	—	<1	<1	
LACUSTRINE				**<1**					**<1**	
Other Waters				**<1**					**<1**	
Lakes	—	—	—	<1	—	—	—	—	<1	
LACUSTRINE FRINGE							**<1**		**<1**	
Wetlands							**<1**		**<1**	
Herbaceous	—	—	—	—	—	—	<1	—	<1	

Table 4.22-33: Alternative 3—Transportation Corridor Temporary Impacts on Wetlands and Other Waters

HGM/NWI Group	Chekok Creek	Chinitna River-Frontal Cook Inlet	Headwaters Koktuli River	Iliamna Lake	Iliamna River	Newhalen River	Pile River	Upper Talarik Creek	Combined Watershed Area	
									(Acres)	(Miles)
RIVERINE CHANNEL	**<1**	**1**	**<1**	**1**	**1**	**<1**	**<1**	**<1**	**4**	
Other Waters	**<1**	**1**	**<1**	**1**	**1**	**<1**	**<1**	**<1**	**4**	
Streams (Intermittent)	—	<1	—	<1	<1	—	—	<1	<1	0.8
Streams (Perennial)	<1	1	<1	1	1	<1	<1	<1	3	3.1
RIVERINE	**<1**	**<1**		**1**	**2**	**1**	**<1**	**<1**	**4**	
Wetlands	**<1**	**<1**		**1**	**1**	**1**	**<1**	**<1**	**3**	
Herbaceous	—	—	—	<1	1	<1	<1	<1	1	
Deciduous Shrubs	<1	<1	—	<1	<1	<1	<1	<1	2	
Deciduous Forest	—	—	—	<1	<1	<1	—	—	<1	
Other Waters				**<1**	**1**			**<1**	**1**	
Ponds	—	—	—	<1	1	—	—	<1	1	
COASTAL FRINGE		**9**							**9**	
Wetlands		**<1**							**<1**	
Herbaceous	—	<1	—	—	—	—	—	—	<1	
Other Waters		**9**							**9**	
Estuarine (Intertidal)	—	5	—	—	—	—	—	—	5	
Estuarine (Subtidal)	—	4	—	—	—	—	—	—	4	
Streams (Tidal)	—	<1	—	—	—	—	—	—	<1	<0.1
Total Wetland Impacts (Acres)	**<1**	**<1**	**<1**	**7**	**6**	**5**	**<1**	**6**	**26**	
Total Other Waters Impacts (Acres)	**<1**	**10**	**<1**	**2**	**2**	**<1**	**<1**	**1**	**14**	
Total Wetlands and Other Waters Impacts (Acres)	**1**	**10**	**<1**	**9**	**8**	**5**	**1**	**7**	**40**	**3.9**
Total Area of NWI Wetlands and Other Waters (Acres)	**3,808**	**77,388**	**36,458**	**389,610**	**4,529**	**23,380**	**2,975**	**13,193**	**551,340**	
Percent Total of NWI Wetlands and Other Waters	**<1**	**<1**	**<1**	**<1**	**<1**	**<1**	**<1**	**<1**	**<1**	

Notes:

< = less than
— = not applicable
HGM = hydrogeomorphic
NWI = National Wetland Inventory

Source: Three Parameters Plus and HDR 2011b; HDR and Three Parameters Plus 2011b; HDR 2019i, j

Iliamna River Bridge

Construction of the Iliamna River bridge would not require the placement of piles; however, 1.4 acres of riverine wetlands and 0.1 acre of perennial stream would be permanently impacted along the transportation corridor on approach to the bridge. An additional 1.1 acres of riverine wetland and 0.2 acre of perennial stream could be temporarily impacted by construction of the road along this same stretch of the transportation corridor. These areas are included in Table 4.22-32 and Table 4.22-33, and do not represent additional areas of impact. Impacts to wetlands and open-water habitat associated with construction of bridges are discussed above.

Concentrate Pipeline Variant

Because the Alternative 3 base case road width is conceptually engineered to accommodate the concentrate pipeline and optional return water pipeline, change to the magnitude, duration, or extent of direct or indirect impacts to wetlands and other waters in the transportation corridor that would occur under the Concentrate Pipeline Variant would be minor, commensurate with the transportation corridor being up to 10 percent wider.

Indirect Impacts—Fugitive Dust

Under Alternative 3, the magnitude of indirect impacts in the transportation corridor would be the potential deposition of dust across 745 acres of wetlands and other waters, including 48.5 miles of streams. Slope wetlands comprise 77 percent of the wetland area exposed to fugitive dust, and are chiefly represented by broad-leaved deciduous shrub wetlands, the degradation of which is discussed above. Estuarine waters and streams represent 39 percent and 33 percent, respectively, of the other water types that would be exposed to fugitive dust (Table 4.22-34). The extent of indirect impact transects eight watersheds. Indirect impacts in the Iliamna Lake and Iliamna River watersheds represent 23 percent and 22 percent, respectively, of the total area of indirect impact. Due to the relatively small total area of the Iliamna River watershed, these impacts represent 4 percent of all wetlands and other waters mapped by NWI for this watershed. The highest severity of dust deposition to wetlands, other waters, and their functions is expected to occur proximal to the road edge, but may be detectable up to 330 feet distant. Note that the 330-foot dust zone overlaps with the 30-foot temporary construction impact zone in the transportation corridor. Dust impacts are considered an indirect yet long-term consequence of development.

Concentrate Pipeline Variant

Implementation of a concentrate and water return pipeline would reduce traffic in the transportation corridor. Although the magnitude and extent of potential dust deposition under the Concentrate Pipeline Variant would not be expected to differ from the Alternative 3 base case (Table 4.22-1), the severity of impacts would be less.

4.22.9.3 Diamond Point Port

Alternative 3 proposes a caisson dock design at a port site north of Diamond Point in Iliamna Bay. Due to the shallowness of Iliamna Bay, 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. An airport would not be built at this port location, and there would be only one lightering station in Iniskin Bay (see Figure 2-80). On-shore facilities, temporary facilities, and physical reclamation and closure of the site would be the same as Alternative 2, but would occur at this location.

Table 4.22-34: Alternative 3—Transportation Corridor Fugitive Dust Impacts on Wetlands and Other Waters

HGM/NWI Group	Chekok Creek	Chinitna River-Frontal Cook Inlet	Headwaters Koktuli River	Iliamna Lake	Iliamna River	Newhalen River	Pile River	Upper Talarik Creek	Combined Watershed Area	
									(Acres)	(Miles)
Percent of Watershed Mapped by NWI	100	100	100	57	100	95	100	92		
SLOPE	**7**		**1**	**97**	**78**	**63**	**5**	**73**	**324**	
Wetlands	**7**		<1	**96**	**78**	**63**	**5**	**73**	**323**	
Herbaceous	<1	—	<1	18	31	15	5	12	81	
Deciduous Shrubs	6	—	<1	53	40	45	<1	61	206	
Evergreen Shrubs	—	—	—	6	2	3	—	<1	11	
Deciduous Forest	1	—	—	16	—	1	—	—	17	
Evergreen Forest	—	—	—	2	4	<1	—	—	7	
Other Waters			**<1**	**1**	**<1**	**<1**		**<1**	**2**	
Ponds	—	—	<1	1	<1	<1	—	<1	2	
DEPRESSIONAL			**<1**	**14**	**5**	**11**	**5**	**19**	**53**	
Wetlands			**<1**	**5**	**3**	**5**	**1**	**1**	**15**	
Herbaceous	—	—	<1	4	2	4	1	1	12	
Deciduous Shrubs	—	—	—	1	1	1	—	<1	3	
Evergreen Shrubs	—	—	—	—	<1	<1	—	—	<1	
Other Waters			**<1**	**8**	**3**	**6**	**4**	**17**	**39**	
Aquatic Bed	—	—	—	—	—	**1**	—	—	**1**	
Ponds	—	—	<1	8	3	5	4	17	38	
FLAT						**1**		**15**	**17**	
Wetlands						**1**		**15**	**17**	
Herbaceous	—	—	—	—	—	—	—	10	10	
Deciduous Shrubs	—	—	—	—	—	1	—	6	7	

Table 4.22-34: Alternative 3—Transportation Corridor Fugitive Dust Impacts on Wetlands and Other Waters

HGM/NWI Group	Chekok Creek	Chinitna River-Frontal Cook Inlet	Headwaters Koktuli River	Iliamna Lake	Iliamna River	Newhalen River	Pile River	Upper Talarik Creek	Combined Watershed Area	
									(Acres)	(Miles)
LACUSTRINE				**29**		**6**	**7**	**7**	**48**	
Other Waters				**29**		**6**	**7**	**7**	**48**	
Lakes	—	—	—	29	—	6	7	7	48	
LACUSTRINE FRINGE				**2**		**<1**	**<1**	**<1**	**3**	
Wetlands				**2**		**<1**	**<1**	**<1**	**3**	
Herbaceous	—	—	—	2	—	<1	<1	—	2	
Deciduous Shrubs	—	—	—	—	—	—	—	<1	<1	
RIVERINE CHANNEL	**2**	**16**	**<1**	**15**	**61**	**21**	**5**	**5**	**124**	
Other Waters	**2**	**16**	**<1**	**15**	**61**	**21**	**5**	**5**	**124**	
Ponds	—	—	—	**<1**	—	—	—	—	**0**	
Streams (Intermittent)	<1	7	—	1	1	<1	—	<1	10	10.1
Streams (Perennial)	2	9	<1	13	60	21	5	5	115	38.2
RIVERINE	**1**	**<1**		**17**	**22**	**8**	**6**	**10**	**65**	
Wetlands	**1**	**<1**		**17**	**20**	**8**	**6**	**9**	**63**	
Herbaceous	—	—	—	8	11	1	4	1	25	
Deciduous Shrubs	1	<1	—	7	7	7	2	8	33	
Deciduous Forest	—	—	—	2	2	<1	<1	—	4	
Evergreen Forest	—	—	—	<1	—	—	<1	—	<1	
Other Waters				**<1**	**1**			**1**	**2**	
Aquatic Bed								**<1**	**<1**	
Ponds	—	—	—	<1	1	—	—	1	2	
COASTAL FRINGE		**111**							**111**	
Wetlands		**2**							**2**	

Table 4.22-34: Alternative 3—Transportation Corridor Fugitive Dust Impacts on Wetlands and Other Waters

HGM/NWI Group	Chekok Creek	Chinitna River-Frontal Cook Inlet	Headwaters Koktuli River	Iliamna Lake	Iliamna River	Newhalen River	Pile River	Upper Talarik Creek	Combined Watershed Area	
									(Acres)	(Miles)
Herbaceous	—	2	—	—	—	—	—	—	2	
Other Waters		**108**							**108**	
Estuarine (Intertidal)	—	47	—	—	—	—	—	—	47	
Estuarine (Subtidal)	—	60	—	—	—	—	—	—	60	
Streams (Tidal)	—	1	—	—	—	—	—	—	1	0.2
Total Wetland Impacts (Acres)	**9**	**3**	**<1**	**120**	**101**	**78**	**13**	**99**	**422**	
Total Other Waters Impacts (Acres)	**2**	**124**	**<1**	**52**	**65**	**33**	**17**	**30**	**323**	48.5
Total Wetlands and Other Waters Impacts (Acres)	**10**	**127**	**1**	**172**	**166**	**110**	**30**	**129**	**745**	
Total Area of NWI Wetlands and Other Waters (Acres)	**3,808**	**77,388**	**36,458**	**389,610**	**4,529**	**23,380**	**2,975**	**13,193**	**551,340**	
Percent Total of NWI Wetlands and Other Waters	**<1**	**<1**	**<1**	**<1**	**4**	**<1**	**1**	**1**	**<1**	

Notes:

< = less than
— = not applicable
HGM = hydrogeomorphic
NWI = National Wetland Inventory

Source: Three Parameters Plus and HDR 2011b; HDR and Three Parameters Plus 2011b; HDR 2019i, j

Direct Impacts

Compared to Amakdedori, Iliamna Bay has a more rugged topography, which transitions abruptly to a shallower and lower-energy nearshore environment. The Alternative 3 port terminal and associated shore-based facilities are sited to minimize direct impacts to wetlands. In terms of magnitude and duration, construction of the port would permanently impact less than 1 acre of estuarine wetlands and 3 acres of estuarine waters, with the sea anchors for the lightering location permanently impacting 0.1 acre of the subtidal portion of these waters (Table 4.22-35). In the immediate nearshore environment, the in-water components of the caisson dock would alter localized currents, water circulation, and likely patterns of erosion and sedimentation. Due to the intermediate footprint of the caisson dock, impacts to water movement are expected to be less than those associated with the earthen fill causeway and sheet pile jetty design, but more than those associated with the pile-supported dock design.

Table 4.22-35: Alternative 3—Port Direct Impacts on Wetlands and Other Waters

HGM/NWI Group	Permanent		Temporary	
	Chinitna River-Frontal Cook Inlet			
	(Acres)	(Miles)	(Acres)	(Miles)
Percent of Watershed Mapped by NWI	100		100	
FLAT	**<1**			
Wetlands	**<1**			
Broad Leaved Deciduous Shrubs	<1			
RIVERINE CHANNEL	**<1**		**<1**	
Other Waters	**<1**		**<1**	
Streams (Intermittent)	<1	<0.1	<1	0.1
COASTAL FRINGE	**3**		**88**	
Other Waters	**3**		**88**	
Estuarine (Intertidal)	<1		<1	
Estuarine (Subtidal)	3		88	
Total Wetland Impacts (Acres)	**<1**		**—**	
Total Other Waters Impacts (Acres)	**3**		**88**	
Total Wetlands and Other Waters Impacts (Acres)	**3**		**88**	
Total Area of NWI Wetlands and Other Waters (Acres)	**77,388**		**77,388**	
Percent Total of NWI Wetlands and Other Waters	**<1**		**<1**	

Notes:

< = less than
— = not applicable
HGM = hydrogeomorphic
NWI = National Wetland Inventory

Source: Three Parameters Plus and HDR 2011b; HDR and Three Parameters Plus 2011b; HDR 2019i, j

Initial and maintenance dredging of 76 acres of estuarine habitat in Iliamna Bay would be required for access to the dock. The material from initial dredging would either be used in construction of the causeway and dock, or disposed of onshore in a storage facility in uplands along the port access road. The frequency of maintenance dredging is unknown, but could occur every 5 years. Material from maintenance dredging would be disposed of in a storage site also located in uplands along the port access road; because this dredge material storage area would be in a former material site, the footprint is captured in the transportation corridor. Drainage from the dredge spoils would be directed through settling ponds and then into a drainage ditch before discharge to Iliamna Bay. Dredging activities are more fully described in Chapter 2, Alternatives; locations of the proposed dredge area and storage areas for dredged materials are shown in Figure 2-80. Dredging is included in the area of temporary impact for the port.

Construction-related impacts are expected to cause temporary impact to 88 acres of subtidal estuarine waters (Table 4.22-35). Increases in turbidity and changes in sedimentation pattern with subsequent disturbance to benthic fauna and bottom habitat structure would be expected. Because the port site north of Diamond Point is lower-energy than Amakdedori, disturbed substrate would likely be slower to return to natural condition, and resident organisms may be less adapted to changing water circulation and bottom conditions; see above for an expanded discussion of impacts to the nearshore environment. Relative to other dock designs, construction of a caisson-supported dock would avoid extensive pile-driving, and therefore have less noise-associated temporary impacts than a pile-supported dock. Due to its smaller footprint, a caisson dock would have a smaller magnitude of construction-related increases in turbidity and sedimentation than an earthen fill causeway with sheet pile jetty.

The extent of direct impacts at the port site would be restricted to the Chinitna River-Frontal Cook Inlet watershed, and would impact less than 1 percent of the wetlands and other waters mapped by NWI for this watershed. The Diamond Point quarry is adjacent to the proposed port site, and the Williamsport-Pile Bay Road terminates at the head of Iliamna Bay; otherwise, previous disturbance to wetlands or other waters in this area is minimal.

Concentrate Pipeline Variant

Under the Concentrate Pipeline Variant, three additional caissons to support concentrate loading would be placed in the temporary dredge area for the Alternative 3 base case. Therefore, 0.25 acre of temporary impact is transitioned to permanent impact under this variant. This change in impact type occurs in estuarine subtidal waters. There would be no change to the duration or extent of direct impacts to wetlands and other waters at the port under this variant.

Indirect Impacts – Fugitive Dust

Fugitive dust would be generated from construction of the terminal. Because the caisson dock is decked with concrete, the generation of fugitive dust during operations is expected to be minimal. The magnitude of wetlands and other waters that would potentially be affected by dust deposition at the port location north of Diamond Point port is 1.5 acres (Table 4.22-36). The extent of potential impacts is restricted to the Chinitna River-Frontal Cook Inlet watershed, and would impact less than 1 percent of the wetlands and other waters mapped by NWI for this watershed. Potential impacts due to dust are considered an indirect but long-term consequence of development.

Concentrate Pipeline Variant

There would be no change to the magnitude, duration, or extent of indirect impacts to wetlands and other waters at the port under the concentrate pipeline variant.

Table 4.22-36: Alternative 3—Port Fugitive Dust Impacts on Wetlands and Other Waters

HGM/NWI Group	Chinitna River-Frontal Cook Inlet	
	(Acres)	**(Miles)**
Percent of Watershed Mapped by NWI	100	
RIVERINE CHANNEL	**1.0**	
Other Waters	**1.0**	
Streams (Intermittent)	0.6	0.3
Streams (Perennial)	0.4	0.1
RIVERINE	**0.3**	
Wetlands	**0.3**	
Deciduous Shrubs	0.3	
COASTAL FRINGE	**0.2**	
Other Waters	**0.2**	
Estuarine (Intertidal)	0.2	
Total Wetland Impacts (Acres)	**0.3**	
Total Other Waters Impacts (Acres)	**1.2**	**0.4**
Total Wetlands and Other Waters Impacts (Acres)	**1.5**	
Total Area of NWI Wetlands and Other Waters (Acres)	**77,388**	
Percent Total of NWI Wetlands and Other Waters	**<1**	

Notes:
< = less than
HGM = hydrogeomorphic
NWI = National Wetland Inventory
Source: Three Parameters Plus and HDR 2011b; HDR and Three Parameters Plus 2011b; HDR 2019i, j

4.22.9.4 Natural Gas Pipeline Corridor

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 natural gas pipeline with the road corridor, much of the area of impacts associated with construction of the pipeline is evaluated under the transportation corridor. Impacts presented here are for the pipeline-only sections of the natural gas pipeline that are not in the transportation corridor, and include the 1-mile section from the compressor station on the Kenai Peninsula to the 75-mile crossing of Cook Inlet; the 6-mile segment overland from Ursus Cove to Cottonwood Bay; the 3-mile section across Cottonwood Bay; and the 2-mile section from the mine access road to the mine site.

Direct Impacts

No permanent impacts to wetlands and other waters are incurred along the pipeline-only sections of the Alternative 3 natural gas pipeline corridor. Temporary impacts are expected to 644 acres of wetlands and other waters, including 2.2 miles of stream (Table 4.22-37). A total of 639 acres of estuarine and marine waters would experience temporary increases in turbidity and sedimentation from installation of the natural gas pipeline across Cook Inlet. Impacts to these Cook Inlet waters represent 99 percent of the total area of temporary impact for the natural gas pipeline. The extent of direct impacts transects five watersheds; and although concentrated in the Cook Inlet watershed, impacts represent less than 1 percent of wetlands and other waters mapped by NWI. The duration of impacts from the installation of offshore sections of the pipeline is considered temporary, because sedimentation rates in the benthic environment would be expected to quickly return the seabed to its natural condition; see above for an expanded discussion of impacts.

Table 4.22-37: Alternative 3—Natural Gas Pipeline Temporary Impacts to Wetlands and Other Waters

HGM/NWI Group	Chinitna River-Frontal Cook Inlet	Cook Inlet	Headwaters Koktuli River	Stariski Creek-Frontal Cook Inlet	Upper Talarik Creek	Combined Watershed Area	
						(Acres)	(Miles)
Percent of Watershed Mapped by NWI	100	100	100	100	91		
SLOPE	**4**				**<1**	**4**	
Wetlands	**4**				**<1**	**4**	
Herbaceous	1	—	—	—	—	1	
Deciduous Shrubs	4	—	—	—	<1	4	
Other Waters	**<1**					**<1**	
Ponds	<1	—	—	—	—	<1	
DEPRESSIONAL					**<1**	**<1**	
Other Waters					**<1**	**<1**	
Ponds	—	—	—	—	<1	<1	
RIVERINE CHANNEL	**1**		**<1**		**<1**	**1**	
Other Waters	**1**		**<1**		**<1**	**1**	
Streams (Intermittent)	<1	—	<1	—	—	<1	0.4
Streams (Perennial)	1	—	—	—	<1	1	1.8
RIVERINE	**<1**				**<1**	**1**	
Wetlands	**<1**				**<1**	**1**	
Herbaceous	—	—	—	—	<1	<1	
Deciduous Shrubs	<1	—	—	—	<1	<1	
COASTAL FRINGE	**69**					**69**	
Other Waters	**69**					**69**	
Estuarine (Intertidal)	2	—	—	—	—	2	
Estuarine (Subtidal)	67	—	—	—	—	67	

Table 4.22-37: Alternative 3—Natural Gas Pipeline Temporary Impacts to Wetlands and Other Waters

HGM/NWI Group	Chinitna River-Frontal Cook Inlet	Cook Inlet	Headwaters Koktuli River	Stariski Creek-Frontal Cook Inlet	Upper Talarik Creek	Combined Watershed Area	
						(Acres)	(Miles)
MARINE	**9**	**553**		**7**		**569**	
Other Waters	**9**	**553**		**7**		**569**	
Marine (Intertidal)	<1	—	—	—	—	<1	
Marine (Subtidal)	9	553	—	7	—	569	
Total Wetland Impacts (Acres)	**5**				**<1**	**5**	
Total Other Waters Impacts (Acres)	**79**	**553**	**<1**	**7**	**<1**	**639**	**2.2**
Total Wetlands and Other Waters Impacts (Acres)	**84**	**553**	**<1**	**7**	**1**	**644**	
Total Area of NWI Wetlands and Other Waters (Acres)	**77,388**	**4,167,981**	**36,458**	**89,067**	**13,193**	**4,785,008**	
Percent Total of NWI Wetlands and Other Waters	**<1**	**<1**	**<1**	**<1**	**<1**	**<1**	

Notes:

< = less than
— = not applicable
HGM = hydrogeomorphic
NWI = National Wetland Inventory

Source: Three Parameters Plus and HDR 2011b; HDR and Three Parameters Plus 2011b; HDR 2019i, j

Concentrate Pipeline Variant

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

Indirect Impacts—Fugitive Dust

During construction, the magnitude of indirect impacts would be the potential deposition of dust over 7 acres of wetlands and other waters, including 0.8 mile of streams. Under Alternative 3, potential dust impacts in the natural gas pipeline corridor are largely associated with three material sites in the overland section between Cottonwood Bay and Ursus Cove. Although these material sites are located in uplands, their dust zone buffer extends to wetlands and other waters. Estuarine waters comprise 86 percent of the area that would be exposed to the deposition of dust (Table 4.22-38). The extent of impact is restricted to the Chinitna River-Fontal Cook Inlet watershed, and represents less than 1 percent of wetlands and other waters mapped by NWI. Dust impacts are considered an indirect but long-term consequence of development.

Table 4.22-38: Alternative 3—Natural Gas Pipeline Corridor Fugitive Dust Impacts on Wetlands and Other Waters

HGM/NWI Group	Chinitna River-Frontal Cook Inlet	
	(Acres)	(Miles)
Percent of Watershed Mapped by NWI	100	
SLOPE	**<1**	
Wetlands	**<1**	
Herbaceous	<1	
RIVERINE CHANNEL	**1**	
Other Waters	**1**	
Streams (Intermittent)	<1	0.1
Streams (Perennial)	1	0.6
RIVERINE	**<1**	
Wetlands	**<1**	
Deciduous Shrubs	<1	
COASTAL FRINGE	**6**	
Other Waters	**6**	
Estuarine (Intertidal)	6	
MARINE	**<1**	
Other Waters	**<1**	
Marine (Intertidal)	<1	
Total Wetland Impacts (Acres)	**<1**	
Total Other Waters Impacts (Acres)	**7**	**0.8**
Total Wetlands and Other Waters Impacts (Acres)	**7**	
Total Area of NWI Wetlands and Other Waters (Acres)	**77,388**	
Percent Total of NWI Wetlands and Other Waters	**<1**	

Notes:

< = less than
HGM = hydrogeomorphic
NWI = National Wetland Inventory

Source: Three Parameters Plus and HDR 2011b; HDR and Three Parameters Plus 2011b; HDR 2019i, j

4.22.10 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 wetlands and other waters are expected to result from the excavation or placement of fill, fragmentation of aquatic resources, the potential deposition of fugitive dust, and/or dewatering related to mine operations. These actions will cause the permanent loss of wetlands and other waters, altered wetland hydrology, soils, and vegetation, as well as reductions in the connectivity, ecological function, and value of aquatic resources. The magnitude, duration, extent, and likelihood of impacts are assessed following the criteria set forth above under Analysis Methodology.

The cumulative effects analysis area for wetlands and other waters 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 wetlands and other waters 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 wetlands and other waters. Offshore-based developments, including oil and gas lease sales and non-industrialized, point-source activities (e.g., tourism, recreation, fishing, and hunting) are unlikely to result in impacts to wetlands and other waters beyond a temporary basis. 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.

4.22.10.1 Past and Present Actions

Past and present actions that have affected or are currently affecting wetlands and other waters in the analysis area are minimal, because most of the area is undisturbed. Current development consists of a small number of towns and villages connected by a limited road network. Present activities include mining exploration and non-mining–related projects, such as transportation, oil and gas development, and community development actions. Human-caused disturbance at the mine site is minimal and appears to be limited to all-terrain vehicle trails or campsites. Drill pads and other temporary disturbance from project exploration were not observed to alter wetland status or characteristics (Three Parameters Plus and HDR 2011b).

Although past and present actions affect localized areas, they are additive to other wetland-degrading actions, and thereby increase the total acreage of wetlands and other waters affected. The USACE has prepared HUC estimates of the total acreages authorized to be filled for the 13 watersheds potentially affected by the project (Table 4.22-39). The current area of wetlands filled, presented by percent of wetlands and other waters mapped by NWI in the watershed, ranges from 0 percent of the Headwaters Koktuli River and several other watersheds, to 4 percent of the Stariski Creek-Frontal Cook Inlet watershed on the Kenai Peninsula.

Table 4.22-39: Current Acres of Fill in HUC Watersheds in the Project Area

HUC 10 Name	HUC 10 Number	Total Watershed Area (Acres)	Total Area of Wetlands and Other Waters (Acres)	Total ORM2[1] Impacts (Acres) through December 2016	Percentage of Wetlands and Other Waters Filled
Amakdedori Creek-Frontal Kamishak Bay	1902060212	231,105	29,739	<1	0
Chekok Creek	1903020603	42,910	3,808	<1	0
Chinitna River-Frontal Cook Inlet	1902060207	310,561	77,388	24.72	0.0319
Cook Inlet	1902080000	4,189,614	4,167,981	76.24	0.0018
Gibraltar Lake	1903020606	81,581	797	<1	0
Headwaters Koktuli River	1903030211	170,632	36,458	<1	0
Iliamna Lake	1903020609	1,201,854	389,610	1.13	0.0003
Iliamna River	1903020602	122,322	4,529	0.21	0.0046
Newhalen River	1903020514	119,708	23,381	144.61	0.6185
Paint River	1902060208	128,354	2,762	0.06	0.0022
Pile River	1903020601	101,169	2,975	<1	0
Stariski Creek-Frontal Cook Inlet	1902030108	210,190	89,067	3,313.90	3.7207
Upper Talarik Creek	1903020607	87,539	13,193	<1	0
Total	**—**	**6,997,539**	**4,841,687**	**3,561**	**0.0735**

Notes:

< = less than
HUC = hydrologic unit code

Source: USACE 2018e

4.22.10.2Reasonably Foreseeable Future Actions

RFFAs that could contribute cumulatively to known and projected impacts to wetlands and other waters in the analysis area were advanced for consideration. The following RFFAs identified in Section 4.1, Introduction to Environmental Consequences, include: 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, the continued development of the Diamond Point rock quarry, and dredging at the Williamsport port. These projects are anticipated to impact wetlands and other waters through dredging, the discharge of dredged material, the excavation or placement of fill, deposition of dust, as well as the fragmentation and dewatering of aquatic resources.

Initial and maintenance dredging for boat access to the Williamsport port has been permitted (USACE 2011b). The permit allows for side-cast dredging of approximately 9,000 cubic yards of material through intertidal estuarine habitat to create a 150- by 500-foot channel and a 100- by 50-foot boat turn area, both with 2- to 4-foot depth. Following initial dredging, maintenance dredging of approximately 2,250 cubic yards would be done once yearly. This activity is likely to directly impact coastal mudflats, a special aquatic site ("Special Aquatic Sites" subsection, above).

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 entail expansion of the mine site and construction of a transportation corridor and concentrate pipeline to a new deepwater port at Iniskin Bay; details of this expansion are provided 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 3 would have a northern access road and natural gas pipeline along the same corridor that would be used under the Pebble Project expansion, further development would only require construction of a short (8 miles) road and pipeline segment from Williamsport to Iniskin Bay. Therefore, with respect to the total area of direct disturbance (i.e., wetlands, other waters, and uplands), cumulative effects are least for Alternative 3. Alternatively, cumulative effects from the total area of direct disturbance (i.e., wetlands, other waters, and uplands) 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 miles) concentrate pipeline and transportation corridor; areas of direct disturbance are provided in Appendix K-2.

A summary of cumulative effects to wetlands and other waters under the expansion scenario is provided by alternative in Table 4.22-40. The extent of cumulative impacts to wetlands and other waters at the mine site related to expansion is shown on Figure 4.22-5. A summary of cumulative effects on wetlands and other waters is presented by project alternative for all RFFAs in Table 4.22-41. The No Action Alternative would not contribute to cumulative effects on wetlands or other waters, and therefore is not evaluated here. For the expanded mine scenario, indirect impacts due to dust, fragmentation, and dewatering were calculated following same methodology presented above. Overlap exists among the areas of indirect impact due to the deposition of fugitive dust, fragmentation of aquatic resources, and dewatering. When presented individually, the areas of impact are not corrected for overlap; when presented cumulatively, the total area of indirect impact is corrected for overlap. Therefore, individual areas of indirect impact will not sum to the cumulative area of indirect impact for a given alternative under the proposed project and/or the expanded mine development scenario.

The exact routing of the transportation corridor/concentrate pipeline and the location of the Iniskin Bay port that are proposed under the mine expansion scenario are not known, and therefore cannot be intersected with wetland mapping to derive impacts; the direct and indirect areas of impact on vegetation associated with these facilities are provided in Table 4.26-40. It is assumed that the transportation corridor/concentrate pipeline and Iniskin Bay port would avoid wetlands and other waters to the extent possible; however, due to the uncertainty surrounding these components of expanded development, the total impacts of expansion on wetlands and other waters should be considered estimates, and used for comparison purposes only.

Table 4.22-40 Summary of Cumulative Impacts to Wetlands and Other Waters under the Pebble Project Expansion Scenario

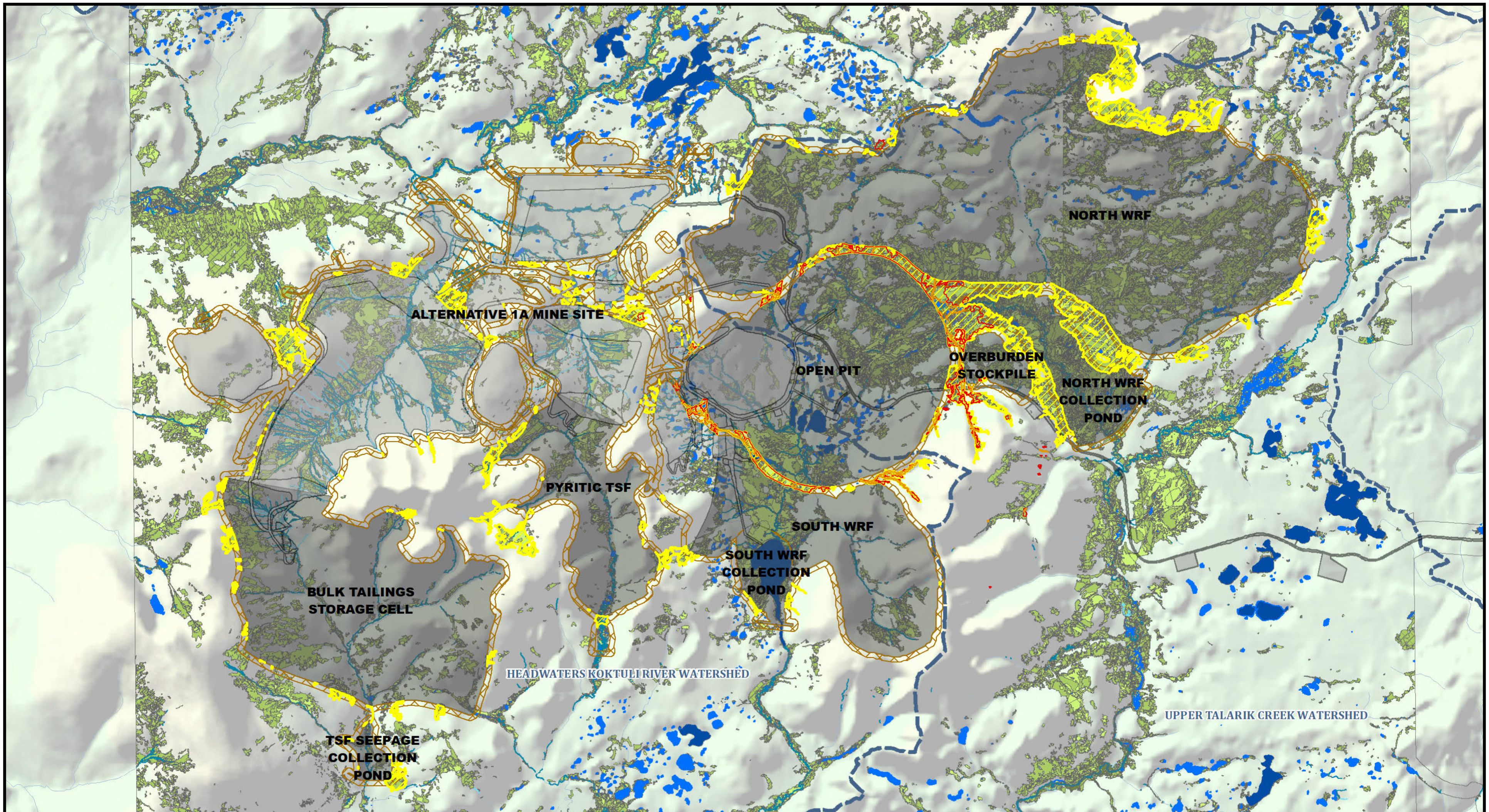
	Impact	Alternative 1a		Alternative 1		Alternative 2		Alternative 3	
All Project Components									
		Acres	**Miles**	**Acres**	**Miles**	**Acres**	**Miles**	**Acres**	**Miles**
Project	Permanent	2,226	105.4	2,226	105.8	2,261	104.1	2,231	105.4
	Temporary	858	4.6	858	3.9	781	9.0	773	6.2
	Indirect	1,662	75.3	1,642	75.2	1,602	65.8	1,609	79.5
Expansion	Permanent	8,756	330.5	8,756	330.5	8,756	330.5	8,756	330.5
	Temporary	—	—	—	—	—	—	—	—
	Indirect	1,829	17.0	1,829	17.0	1,829	17.0	1,829	17.0
Cumulative	Permanent	10,982	435.9	10,982	436.3	11,017	434.6	10,987	435.9
	Temporary	858	4.6	858	3.9	781	9.0	773	6.2
	Indirect	3,491	92.3	3,471	92.2	3,431	82.8	3,438	96.5
Mine Site									
Project	Permanent	2,162	99.7	2,162	99.7	2,184	100.3	2,162	99.7
	Temporary	<1	<0.1	<1	<0.1	<1	<0.1	<1	<0.1
	Fragmentation	257	9.2	257	9.2	260	9.3	257	9.2
	Fugitive Dust	588	24.1	588	24.1	584	23.8	588	24.1
	Dewatering	355	10.4	355	10.4	352	10.3	355	10.4
Expansion	Permanent	8,756	330.5	8,756	330.5	8,756	330.5	8,756	330.5
	Temporary	—	—	—	—	—	—	—	—
	Fragmentation	1,538	8.4	1,538	8.4	1,538	8.4	1,538	8.4
	Fugitive Dust	1,093	15.0	1,093	15.0	1,093	15.0	1,093	15.0
	Dewatering	338	3.2	338	3.2	338	3.2	338	3.2
Transportation									
Project	Permanent	60	5.7	61	6.1	62	3.3	66	5.7
	Temporary	47	3.9	44	3,7	39	2.2	40	3.9
	Fugitive Dust	791	45.3	739	45.2	612	30.6	745	48.5
Port									
Project	Permanent	2	—	11	—	14	<0.1	3	<0.1
	Temporary	5	—	4	—	72	0.1	88	0.1
	Fugitive Dust	15	0.1	47	0.1	71	0.8	1	0.4
Natural Gas Pipeline									
Project	Permanent	1	—	4	—	<1	0.5	—	—
	Temporary	807	0.6	753	0.2	670	6.6	644	2.2
	Fugitive Dust	—	—	—	—	67	4.7	7	0.8

Notes:

< = less than
— = not applicable

Source: Three Parameters Plus and HDR 2011b; HDR and Three Parameters Plus 2011b; HDR 2019i, j

Regardless of alternative, the expanded mine scenario would increase the area of wetlands and other waters lost or altered, impacts that would be additive to those of the project. Total cumulative impact to wetlands and other waters (i.e., direct and indirect) is greatest for Alternative 1a (15,331 acres) and least for Alternative 3 (15,198 acres). However, when compared by impact type, cumulative permanent impacts to wetlands and other waters are greatest under Alternative 2, whereas temporary and indirect impacts are greatest under Alternative 1a. Cumulative permanent impacts to wetlands and other waters are least under Alternative 1a and Alternative 1, whereas temporary impacts are least under Alternative 3, and indirect impacts are least under Alternative 2. Cumulative impacts to wetlands and other waters associated with the proposed alternatives and the Pebble Project expansion scenario would transect 13 watersheds (Figure 4.22-4 and Table 4.22-39). Based on NWI mapping, a total area of 4,841,687 acres of wetlands and other waters occurs in these watersheds. Assuming a maximum cumulative impact of 15,331 acres of wetlands and other waters (Alternative 1a), 0.3 percent of the combined wetland and other waters area of these watersheds would be lost or degraded with expansion of the mine. Although expansion of the mine would result in impacts to wetlands and other waters across multiple watersheds, the Headwaters Koktuli River and Upper Talarik Creek watersheds would experience the greatest magnitude of impact. In these watersheds, loss of wetlands and other waters would increase from 6 percent to 23 percent under mine expansion. A summary of cumulative effects on wetlands and other waters is presented by project alternative for all RFFAs in Table 4.22-41.



Sources: PLP 2019-RFI116; PLP 2019 RFI-153; PLP 2020-RFI082c

US Army Corps of Engineers

MINE SITE CUMULATIVE IMPACTS UNDER AN EXPANDED MINE SCENARIO

PEBBLE PROJECT EIS

FIGURE 4.22-5

Table 4.22-41: Contribution to Cumulative Effects on Wetlands

Reasonably Foreseeable Future Actions	Alternative 1a	Alternative 1 and Variants	Alternative 2 and Variants	Alternative 3 and Variant
Pebble Project Expansion Scenario	**Mine Site**: Under the expansion scenario, the mine site footprint would be larger due to a larger open pit and new facilities to store tailings and waste rock, and manage water. This expansion would increase the area of wetlands and other waters lost or altered by the excavation or placement of fill, deposition of fugitive dust, and dewatering. the Pebble Project expansion site would impact an additional 8,484 acres of wetlands and 228 miles of streams. The dominant wetlands impacted under this scenario are broad-leaved deciduous shrub and herbaceous types; streams are predominantly perennial. **Other Facilities**: Under the expansion scenario, a north access road corridor would be constructed from the Eagle Bay ferry terminal, along the Alternative 3 road alignment, and extended to Iniskin Bay; new concentrate and diesel pipelines would be constructed from the mine site to Iniskin Bay along this same alignment. Pipeline construction would have cumulative impacts on wetlands and other waters from trenching. Construction and operation of the road would have impacts to wetlands and other waters from the excavation and placement of fill, fragmentation of habitat, and generation of fugitive dust. Development of these facilities would permanently impact an additional 16 acres of wetlands and 4 miles of stream. It is assumed that the wetlands and other waters types affected would be similar to those affected by the project in the Alternative 3 transportation and natural gas pipeline corridor (broad-leaved deciduous shrub and herbaceous wetlands, and perennial streams). **Magnitude**: The expansion scenario for Alternative 1a would impact a total of 8,511 additional acres of wetlands and 232 additional miles of streams. The dominant wetlands impacted under this scenario are the broad-leaved deciduous shrub and herbaceous types; streams are predominantly perennial. **Duration:** The duration of cumulative impacts to wetlands and other waters would vary from temporary disturbance during construction to permanent loss in the footprint of the mine and	**Mine Site**: Identical to Alternative 1a. **Other Facilities**: Similar to Alternative 1a, except that the portion of the access road from the north ferry terminal to the existing Iliamna area road system would not already be constructed. The north access road would be extended from the mine site to the Pile Bay terminus of the Williamsport-Pile Bay Road. Concentrate and diesel pipelines would be constructed along the Alternative 3 road alignment and extended to a new deepwater port site at Iniskin Bay. **Magnitude**: The Pebble Project expansion scenario under Alternative 1 would impact an additional 8,552 acres of wetlands and an additional 322 miles of streams. **Duration/Extent**: The duration and extent of	**Mine Site**: Identical to Alternative 1a. **Other Facilities**: The north access road would be extended east from the Eagle Bay ferry terminal to Iniskin Bay. Concentrate and diesel pipelines would be constructed along the Alternative 3 road alignment and extended to a new deepwater port site at Iniskin Bay. **Magnitude**: The Pebble Project expansion scenario under Alternative 2 would impact an additional 8,479 acres of wetlands and an additional 230 miles of streams. **Duration/Extent**: The duration and extent of cumulative impacts to wetlands would be similar to those of Alternative 1a, although affecting fewer acres of wetlands and fewer miles of streams. **Contribution**: The contribution to cumulative effects	**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. **Magnitude**: The Pebble Project expansion scenario under Alternative 3 would impact an additional 8,495 acres of wetlands and an additional 288 miles of streams. **Duration/Extent**: The duration and extent of cumulative impacts to wetlands would be similar to those of Alternative 1a, although affecting fewer acres of wetlands and fewer miles of streams. **Contribution**: The contribution to cumulative effects would be similar to Alternative 1a, although

Table 4.22-41: Contribution to Cumulative Effects on Wetlands

Reasonably Foreseeable Future Actions	Alternative 1a	Alternative 1 and Variants	Alternative 2 and Variants	Alternative 3 and Variant
	other project facilities. The duration of impacts would be extended, because the processing of low-grade ore and potentially acid-generating waste material would continue for 20 to 40 years past the end of mining. This would delay the reclamation of wetlands and other waters affected by the low-grade ore and potentially acid-generating material storage areas, and extend the duration of impacts from fragmentation, fugitive dust, and dewatering. **Extent**: The extent of impacts would be limited to the immediate vicinity of the disturbance footprint. **Contribution**: Expansion of the project would contribute to cumulative effects on wetlands and other waters through the excavation and placement of fill, fragmentation of habitat, deposition of dust, and dewatering. These actions would be expected to contribute to the permanent loss of habitat and associated reduction in habitat connectivity, ecological function, and the perceived values of wetlands and other waters. The contribution to cumulative effects on wetlands and other waters is expected to be greatest under Alternative 1a (and Alternative 1), because it requires the construction of a 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 because it increases the magnitude, duration, and extent of indirect impacts related to fugitive dust.	cumulative impacts to wetlands would be similar to those of Alternative 1a, although affecting slightly more acres of wetlands and an additional 1 mile of stream. **Contribution**: The contribution to cumulative effects would be similar to Alternative 1a, although affecting the most acres of wetlands and miles of streams of any alternative.	would be similar to Alternative 1a, although affecting the fewest acres of wetlands of any alternative, and fewer miles of streams than Alternative 1a.	affecting the least acres of wetlands of any alternative, and fewer miles of streams than Alternative 1a.
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 wetlands and other waters; however, this added impact is expected to be limited in extent and localized to the disturbing action. **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	Similar to Alternative 1a.	Similar to Alternative 1a.	Similar to Alternative 1a.

Table 4.22-41: Contribution to Cumulative Effects on Wetlands

Reasonably Foreseeable Future Actions	Alternative 1a	Alternative 1 and Variants	Alternative 2 and Variants	Alternative 3 and Variant
	specific mineral prospect. Table 4.1-1 in Section 4.1, Introduction to Environmental Consequences, identifies seven mineral prospects where exploratory drilling is anticipated (four of which are in proximity to the Pebble Project). Because permit requirements would likely require reclamation, the duration of some portion of these actions would be considered temporary. **Contribution**: Other mineral exploration would contribute to cumulative effects on wetlands and other waters through the excavation and placement of fill, fragmentation of habitat, and deposition of dust. These actions would be expected to contribute to the permanent loss of habitat and associated reduction in habitat connectivity, and alterations to the hydrology, ecological function, and perceived values of wetlands and other waters.			
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 impacts to wetlands and other waters. Should it occur, exploratory drilling would involve the construction of temporary pads and support facilities, with permit conditions to minimize impacts to wetlands and restore drill sites after exploration activities have ceased. **Duration/Extent**: Seismic exploration and exploratory drilling are typically single-season, temporary activities. The 2013 Bristol Bay Plan Amendment 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, but based on historic activity, is not expected to be intensive. Because permit requirements typically stipulate site reclamation, the duration of some portion of these actions would be considered temporary.	Similar to Alternative 1a.	Similar to Alternative 1a.	Similar to Alternative 1a.

Table 4.22-41: Contribution to Cumulative Effects on Wetlands

Reasonably Foreseeable Future Actions	Alternative 1a	Alternative 1 and Variants	Alternative 2 and Variants	Alternative 3 and Variant
	Contribution: Onshore oil and gas exploration activities would contribute to cumulative effects on wetlands and other waters through the excavation and placement of fill, fragmentation of habitat, and deposition of dust. These actions would be expected to contribute to the permanent loss of habitat and associated reduction in habitat connectivity, and alterations to the hydrology, ecological function, and perceived values of wetlands and other waters.			
Road Improvement and Community Development Projects	**Magnitude**: Road improvement projects would take place in the vicinity of communities, and have impacts through grading, filling, and potentially, increased erosion. Communities in the vicinity of the project, such as Iliamna, Newhalen, and Kokhanok, would have the greatest contribution to cumulative effects. Limited road upgrades could occur in the vicinity of the natural gas pipeline starting point near Stariski Creek, or in support of mineral exploration as previously discussed. Road construction impacts wetlands and other waters through the direct excavation and placement of fill, and indirectly though dust deposition and fragmentation of habitat. The construction of linear features, such as gravel roads perpendicular to the predominant hydraulic gradient, has a greater potential to alter wetland hydrology and stream flow. The expansion of Diamond Point Rock Quarry would disturb 140 acres (ADNR 2014a), and has potential to adversely affect wetlands and other waters. The types of wetlands and other waters affected are expected to be similar to those documented in the Diamond Point port analysis area for Alternative 2 and Alternative 3. Dredging at the approach to Williamsport allows for side-cast dredging of approximately 9,000 cubic yards of mudflats to create a boat access channel and turning basin; following initial dredging, maintenance dredging of approximately 2,250 cubic yards is permitted annually (USACE 2011b). **Duration/Extent**: Disturbance from road construction would typically occur over a single season, whereas operation of the quarry is expected to last several years. Impacts to wetlands	Similar to Alternative 1a and Alternative 3; greater than Alternative 2.	The footprint of the Diamond Point Rock Quarry coincides with the Diamond Point port location for Alternative 2. Cumulative impacts under Alternative 2 would likely be less than all other alternatives due to overlap between the Diamond Point port and Diamond Point Rock Quarry. The quarry is permitted for the excavation and placement of fill across 23 acres of the site. This area would not require additional permitting under Alternative 2.	Similar to Alternative 1a and Alternative 1; greater than Alternative 2.

Table 4.22-41: Contribution to Cumulative Effects on Wetlands

Reasonably Foreseeable Future Actions	Alternative 1a	Alternative 1 and Variants	Alternative 2 and Variants	Alternative 3 and Variant
	and other waters 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. Extent would be limited to the vicinity of surrounding communities, Diamond Point, and Williamsport. **Contribution**: Road improvement and community development projects would contribute to cumulative effects on wetlands and other waters through dredging and discharge of dredged material, the excavation and placement of fill, fragmentation of habitat, and deposition of dust. These actions would be expected to contribute to the permanent loss of habitat and associated reduction in habitat connectivity, ecological function, and the perceived values of wetlands and other waters.			
Summary of Project contribution to Cumulative Effects	Overall, the contribution of Alternative 1a to cumulative effects on wetlands and other waters, when taking other past, present, and reasonably foreseeable future actions into account, would permanently impact an estimated 0.3 percent of wetlands in the watersheds intersecting the Pebble Project and mine expansion footprint.	Similar to Alternative 1a, although slightly more acres of wetlands and miles of streams would be affected by the Pebble Project expansion.	Similar to Alternative 1a, although fewer acres of wetlands and miles of streams would be affected by the Pebble Project expansion.	Similar to Alternative 1a, although fewer acres of wetlands and miles of streams would be affected by the Pebble Project expansion.

Note:

Percent wetlands and other waters impacted by watershed is calculated as the cumulative acres of wetland and other waters acres directly and indirectly impacted under a given alternative and mine expansion using project-specific mapping (Three Parameters Plus and HDR 2011b; HDR and Three Parameters Plus 2011b; HDR 2019i, j), relative to the combined area wetlands and other waters mapped by NWI in HUC 10 watersheds intersected by the proposed project and mine expansion.