4.0 ENVIRONMENTAL CONSEQUENCES

4.1 INTRODUCTION

Chapter 4, Environmental Consequences, describes the potential impacts on the environmental resources addressed in Chapter 3, Affected Environment, that would occur under the No Action Alternative and the three action alternatives.

Chapter 4 sections discuss direct, indirect, and cumulative effects[1] for each resource described in Chapter 3, and for spills in Section 4.27, Spill Risk[2], for each alternative.

4.1.1 Impact Characterization

4.1.1.1 Scope of Analysis

The Environmental Impact Statement (EIS) analysis area refers to the entire area of resource analysis that is specific to each resource discussed in Section 3.2 to Section 3.26[3]. Although the EIS analysis area can be delineated based on the physical footprint of the action alternatives, potential resource impacts are considered in a spatial context appropriate to each resource. The EIS analysis area is defined in each Chapter 3 and Chapter 4 section. See Section 3.1, Introduction to Affected Environment, for a detailed description of the scope of analysis for this EIS.

The project area refers to the exact project footprint for each action alternative.

4.1.1.2 Factors of Analysis

Adverse and beneficial effects of the project were evaluated and described for each of the resources. Each resource characterizes impacts in relation to four factors:

- **Magnitude or Intensity:** The intensity the impact would have, measured in terms of change or degree of change in a resource condition. Common characterizations are acres of impact, number of units of change, differences in levels of use, etc.
- **Duration:** How long the impact would be expected to occur or last, measured in length of time. Common characterizations are short-term, long-term, for the life of the project, etc.
- **Geographic extent:** Where the impact would be expected to occur geographically in the EIS analysis area.

[1] Note that in this document, the terms “effect” and “impact” have the same meaning and are used interchangeably.
[2] As noted in Section 3.1, Introduction to Affected Environment, there is no corresponding spill risk section in Chapter 3 as spill risk would be considered an environmental consequence to the resources discussed in Section 3.2 through Section 3.26.
[3] Note that in Chapter 3 and Chapter 4, waters of the US (abbreviated as WOUS) as defined under the Clean Water Act (CWA) and determined to be jurisdictional under US Army Corps of Engineers (USACE) authority (see Appendix J for the Preliminary Jurisdictional Determination from USACE) are discussed collectively with wetlands and other waters; all WOUS, wetlands, or other waters are together termed “wetlands and other waters.” The term WOUS may appear in Chapter 3 and Chapter 4 under specific regulatory context.

- **Potential to occur (likelihood):** How probable or likely the impact would be. Common characterizations include likelihood of the impact were the project to be permitted, or probability of occurrence based on the results of analysis or modeling.

Each section in Chapter 4 describes analysis methodology, and includes explanations of how each factor applies to that resource. Note that analysis assumes normal operating conditions for the proposed project.

Project component values, such as road lengths and pad acreage, are approximations based on best available data. Due to differences in data processing systems (e.g., Geographic Information System [GIS]) and methodologies (e.g., number rounding), the values presented in the EIS may differ slightly from values presented in other project-related documents, such as permit drawings. These differences have been reviewed, and were determined to have no material consequence to the analysis, or to the overall permitting process.

Project components - The project is discussed in Chapter 3 and Chapter 4 by its four major components (mine site, transportation corridor, ports, and natural gas pipeline corridor for each alternative. See Section 3.1, Introduction to Affected Environment, for a brief description of project components. See Chapter 2, Alternatives, for detailed description of components.

Project alternatives - See Chapter 2, Alternatives, for detailed description of alternatives. Note that the three action alternatives in Chapter 3 and Chapter 4 are referred to as "Alternative 1," Alternative 2," and "Alternative 3" without including the word "Action" in front of the alternative name as is done in Chapter 2, Appendix K2, and Appendix B.

Project phases - Impacts on some resources may vary depending on the phase of the proposed project. See Chapter 2, Alternatives, for detailed description of the proposed project phases. Chapter 4 includes analysis in the following phases:

- **Construction phase -** The period of construction of mine infrastructure prior to operations (4 years).
- **Operations phase -** The 20-year period of mine operations. Mining and milling operations would continue for the full 20-year operating life of the project.
- **Closure phase -** Activities occurring in the 20 years following the end of operations (for example, at closure year 15, pit backfilling would be completed; at closure year 20, the pyritic tailings storage facility (TSF) and water management ponds (WMPs) reclamation would be completed, and the pit lake would be at maximum level).
- **Post-closure phase -** The period of time after the 20-year closure phase (for example, at closure year 50, maximum tailings consolidation would be expected).

4.1.1.3 Types of Effects Considered

The National Environmental Policy Act (NEPA) requires three types of impacts to be evaluated: direct, indirect, and cumulative effects.

Direct, indirect, and cumulative effects are analyzed in each of the Chapter 4 sections by the four factors of analysis.

Direct and Indirect Effects

Direct and indirect effects are defined as:

Direct Effects – Effects caused by the action and occurring at the same time and place (40 Code of Federal Regulations [CFR] Part 1508.8).

Indirect Effects – Effects that are "caused by an action and are later in time or farther removed, but are still reasonably likely. Indirect impacts may include growth-inducing effects and other effects related to induced changes in the pattern of land use, population density or growth rate, and related effects on air and water and other natural systems, including ecosystems" (40 CFR Part 1508.8). Indirect effects are caused by the project, but do not occur at the same time or place as the direct effects.

Cumulative Effects

Cumulative effects are described in each Chapter 4 section under a separate subheading near the end of each section.

Cumulative effects are interactive, synergistic, or additive effects that would result from the incremental impact of the proposed action when added to other past, present, and reasonably foreseeable future actions (RFFAs) regardless of what agency (federal or non-federal) or person undertakes such other actions (40 CFR Part 1508.7). This includes incremental impacts of the proposed action or alternatives when added to other past, present, and RFFAs. Interactive effects may be either greater or less than the sum of the individual effects; therefore, the action's contribution to the cumulative case could increase or decrease the net effects. Assessing the cumulative impacts from multiple projects/activities requires considering the impacts of their combined potential affected area and associated actions. It also requires a logical nexus with the potential effects of the proposed action. This means that the specific past, present or RFFA must have potential interactive, synergistic, and/or additive effects with direct and indirect impacts on a specific resource resulting from a proposed action and its alternatives.

Past actions – Past actions include activities that may have been initiated in the past, but could also involve present operations such as infrastructure development and non-mining–related actions. They may have lingering effects in degrading the environment, or may influence trends in the physical, biological, or social environment.

Present actions – Present actions include mining projects and related activities that may have just come online, or are currently under way and are causing impacts. They may also include other non-mining–related projects, such as transportation, oil and gas development, or community development that are currently in progress.

Reasonably foreseeable future actions – For this analysis, RFFAs are existing plans, permit applications, and fiscal appropriations that are external to the proposed action, and likely (or reasonably certain) to occur.

Past and Present Actions in the EIS Analysis Area

Past and present actions that have an interactive, synergistic, and/or additive effect (per 40 CFR Part 1508.7) with a specific resource (such as lingering effects or influencing trends) in the project are relatively limited, and are described below:

- **Commercial and Subsistence Harvest of Fish and Wildlife –** Past and present harvest of fish and wildlife for commercial and subsistence purposes put some degree of pressure on those resources. Although commercial fishing in the Bristol Watershed and Cook Inlet started in the 1880s, the period from the turn of that century through the adoption of Alaska Limited Entry Act by the State of Alaska in 1972 saw incremental changes in both fishing technology and the understanding of the salmon fishery resource. It was likely that there were historic instances of overharvest, with implications for the overall salmon resource. As shown in Section 3.6, Recreational and Commercial Fisheries, the commercial harvest of

salmon in Bristol Bay fisheries districts over the last 20 years has fluctuated significantly; in 2018, Bristol Bay saw record returns, even though Cook Inlet and others areas of the state saw declining returns. Factors influencing returns are complex, and there are no clear long-term trends with commercial harvests. However, Fall et al. 2009 noted that subsistence harvest of salmon in the Kvichak and Nushagak rivers declined from long-term averages, even though the number of Bristol Bay subsistence salmon permits has been stable. Similarly, local and non-local residents have historically harvested fish and wildlife in pursuit of traditional subsistence activities, and may affect such resources. For example, the subsistence harvest of Cook Inlet beluga whale is thought to have depleted its population, and contributed to its listing as an endangered species. There have been natural variability and changes in the historic distribution of some species harvested for subsistence and recreational purposes, such as returning salmon and caribou, although there is no clear agreement as to why. Regardless, fish and wildlife resources are managed by the Alaska Department of Fish and Game (ADF&G) and federal agencies to maintain sustainable populations, and to optimize public uses and economic benefits (ADF&G 2018p). Managers use management tools such as harvest limits and areas open and closed to sport and commercial harvest of fish and wildlife to maintain sustainable resources and allocate harvest. Section 4.23, Wildlife Values (non-TES), and Section 4.24, Fish Values, discuss historic trends for area wildlife and fish populations where appropriate.

- **Commercial Recreation and Tourism –** Southwest Alaska, including the Bristol Bay region and the area around the project, is renowned for sport fishing, hunting, boating, and wildlife viewing opportunities; and there is a long history of these activities in area. Similar to commercial fishing, the sport harvest of fish and game is managed by ADF&G and federal land managers to maintain sustainable populations. These activities take place primarily from late spring to early fall, and there may be small plane, helicopter, and boat traffic associated with access that contribute to the disturbance of wildlife, as well as recreational and subsistence activity experience.
- **Community Development and Infrastructure –** The transition from seasonal communities to fixed locations with housing, public facilities, and transportation infrastructure has resulted in wetlands fill and loss of habitat. These communities also generate sewage and solid waste, and use fossil fuels for energy and heat generation. The limited number of communities, their relatively small footprint and population size, and the distance between communities have resulted in little past and present cumulative effects on a regional basis. Some transportation infrastructure such as airports, boat docks and connecting roads have increased accessibility to the region; reducing costs for communities, but facilitating visitation to the region, including airport facilities in King Salmon and Iliamna.
- **Mining Exploration Activities –** There are a number of mineral claims and resources in the Bristol Bay watershed that have been subject to mineral exploration activities. Exploration activities have been intermittent, depending on the specific claim or resources, and there has been small plane, helicopter, and boat traffic associated with exploration that contribute to the disturbance of wildlife, as well as recreational and subsistence activity experience. There have also been areas of ground disturbance associated with exploration drilling and support facilities, including at the site of the Pebble Project. In the immediate area of the project, there has been no past or present mineral production activity. It is fairly common in Alaska, where infrastructure is limited and there are long distances to market, for deposits to

undergo exploratory activity, but not progress to a stage where the nature of the mineral reserves, costs of development, and market price for minerals makes development feasible.

- **Williamsport-Pile Bay Road –** The Williamsport-Pile Bay Road, constructed in the 1930s, provides access between Cook Inlet and the Bristol Bay via a 15.5-mile road to Iliamna Lake and down the Kvichak River. The road allows transportation of fishing vessels bound for Bristol Bay commercial fisheries, as well as some goods and supplies for lake and river communities, contributing to road and lake traffic during the summer season. This results in noise disturbance and dust during the summer months along the road; and noise from waterborne activities at Williamsport, Pile Bay, and along Iliamna Lake. The road is owned and maintained by the State of Alaska.

Reasonably Foreseeable Future Actions in the EIS Analysis Area

For this analysis, RFFAs are existing plans, permit applications, and fiscal appropriations that are external to the proposed action, and likely (or reasonably certain) to occur. Actions are considered reasonably foreseeable if they would occur or have potential impacts in the area analyzed for direct and indirect effects on a specific resource. In addition, the likelihood that a specific RFFA would occur must also be assessed. This is not based on speculation, but must be anticipated to enter the permitting process based on project documentation; identified in public or private planning documents as scheduled for development; have identified indicated resources/reserves sufficient to develop a project; or have advanced exploration activities under way within the timeframe being used for assessment.

The following categories of RFFAs were considered for the cumulative effects analysis:

- Mineral Exploration and Mining
- Oil and Gas Exploration and Development
- Transportation and Infrastructure
- Energy and Utilities
- Commercial Fishing
- Subsistence
- Tourism, Recreation, and Hunting and Fishing
- Scientific Research and Surveys
- Contaminated Sites and Industrial Pollutants
- Residential/Community Development

With regard to mineral and oil and gas resources, a distinction was made between exploration and development activities. Many of the mineral projects assessed are on lands open to mineral entry and have been the subject of exploration activities for over 30 years, but have not been developed. Detailed knowledge of amount and grade of mineral reserves, along with ore price and the cost to develop, mine, and transport the ore to market is generally needed to make a development decision. For example, the Red Dog Project was originally developed in 1989, and the State of Alaska constructed the Delong Mountain Transportation System to provide a public road and port system to serve the mine, and potentially other mineral deposits in the region. Since that time, the mine has expanded to develop an adjacent deposit under the same ownership, but none of the nearby deposits (notably Lik) have been developed in nearly 30 years, despite the availability of the transportation system.

There are similar patterns of mine expansion in Alaska, developing adjacent, commonly owned, and measured/indicated reserves, including Greens Creek, Usibelli, and Fort Knox. In none of these cases has the presence of existing mine/transportation infrastructure resulted in the development of a new mine. Similarly, oil and gas lease sales have been regularly held in waters of Cook Inlet for over 50 years, but although exploration continues to occur, not all exploration activities have led to oil and gas development. Mineral and oil and gas exploration and development activities can have a variety of impacts on the physical, biological, and social environments.

Table 4.1-1 presents the potential projects considered for analysis of cumulative effects, and the conclusions with regard to whether they are reasonably foreseeable. Figure 4.1-1 illustrates the location of RFFAs. Development of any of these projects would require some level of federal, state, and local permits and approvals; and in many cases, would be subject to a separate environmental assessment or EIS as part of the review and approval process. As discussed under past and present actions, activities associated with commercial, recreational, and subsistence harvest, and scientific study of fish and wildlife will continue to occur and have the potential to impact fish and wildlife populations. Although taken into consideration by federal and state management programs, these activities can contribute to cumulative effects of developing the project. Effects can include mortality and injury on an individual and population level, and disturbance and changes in distribution and migration, which can affect availability to various users. Climate change and other changes in the natural environment can contribute to cumulative effects through past, present, and RFFAs. Climate trends can affect water balance and stream flow, fish and wildlife habitat and distribution, and affect access for pursuit of subsistence activities and community travel. Climate change analysis framework for this EIS is included Section 3.1, Introduction to Affected Environment.

The following parameters were used to evaluate the categories of RFFAs listed above and identify specific RFFAs for the cumulative effects analysis in the EIS:

- **Timeframe –** Typically, only projects with dedicated funding, currently in or scheduled to undergo federal, state, or local permitting, and with a medium to high probability of occurring, are included. However, the US Army Corps of Engineers (USACE) has determined that expansion of the Pebble Project, as originally discussed in the Wardrop 2011 Preliminary Assessment Technical Report, (commissioned by Northern Dynasty Minerals to independently review and analyze project economics, current mineral resources, and valuation estimates in compliance with National Instrument 43-101, Standards of Disclosure for Mineral Projects in Canada) and refined in the response to RFI 062 (PLP 2018-RFI 062), will be analyzed under the cumulative effects analysis (see details in Table 4.1-1, and a list of assumptions in Table 4.1-2). As presented in the response to RFI 062 (PLP 2018-RFI 062), Pebble Project expansion would begin in year 20 of the proposed Pebble Project operations. Other reasonably foreseeable future activities that may occur during construction and operation of the proposed project will also be considered. However, to be considered reasonably foreseeable, potential RFFAs need to meet additional criteria.
- **Land status subject to mining –** Mineral projects must be on State lands designated as open to mineral entry or development, or on Alaska Native Claims Settlement Act lands where previous mining exploration or development activity have been allowed. When lands are classified as open to mineral development, it facilitates obtaining permits and other approvals for exploration and development activities.

- **Development projects with dedicated funding, currently in a federal, state, and/or local permitting process, undergoing a state or federal environmental assessment, or listed in a government planning document with a specific time-frame for development –** Projects may also be considered reasonably foreseeable for development if they have dedicated funding and a schedule for development; have federal, state, or local permit applications under review or approved; are currently being evaluated through a federal NEPA compliance effort or State Best Interest Finding document (a state decision-making document that determines if granting a permit is in the best interest of the state); or are identified in a published federal, state, or local planning document (such as scheduled lease sales and community capital projects) with a specific project description and timeframe for development.
- **Information to support the viability of development has been documented in a published or online report –** Projects that have conducted extensive exploratory drilling and analysis to compile information on mineral reserves in terms of measured, indicated, and inferred resources, along with characterization of the grades of ore in the deposit are included. The potential feasibility for development is evaluated based on the published information on results of drilling and delineation of measured, indicated, inferred, and grade of reserves. To the extent they are available, estimated costs associated with development are also assessed.
- **Proximity to the project infrastructure and factors affecting co-use by other parties –** The question of whether development of the proposed project would facilitate development of other nearby mineral deposits depends in part on proximity of a potential RFFA to the proposed project and ability to use project infrastructure. Construction of access to project transportation infrastructure is expensive, and also depends on land ownership access and sensitivity of environmental resources along the access route. Project infrastructure would be privately funded, and co-use of mining and port facilities dependent on permission from Pebble Limited Partnership (PLP). Although the access road would be privately funded on State land, the State of Alaska would likely require allowing access to other mineral deposit owners if an agreement could be reached with PLP regarding operation and maintenance costs, based on the precedent set in state permit conditions for granting Pogo Mine access (S. Buckley, personal communication 2018).
- **Geographic nexus with the direct and indirect effects of project development on specific resources evaluated in the EIS –** Along with the factors previously described, there would need to be interactive and synergistic effects of an RFFA (per 40 CFR Part 1508.7) on resources directly and indirectly affected by development of the project in a specific geographic range that varies by resource.

Table 4.1-1: Potential Reasonably Foreseeable Future Actions Evaluated for Cumulative Effects

Prospect, Project, or Activity	Description	Status	References	Reasonably Foreseeable?
Potential Mineral Deposits in Southwest and Southcentral Alaska				
Pebble Project Expansion – develop 55% of delineated resources	Expansion of the Pebble Project to develop 55% of its reserves over an additional 58 years of mining, and 20 to 40 years of post-mining processing low-grade ore and pyritic material, as outlined in response to RFI 062 (Pebble Limited Partnership [PLP] 2018-RFI 062) and summarized in Table 4.1-2. It would use the same transportation facilities, power plant, and natural gas pipeline facilities. It would need additional tailing storage, additional water storage, new waste rock storage facilities, additional processing facilities, a concentrate pipeline and a deepwater loading facility. It is not part of the proposed action, and would require additional permits and separate NEPA compliance. Table 4.1-2 presents assumptions for Pebble Project expansion development.	Potential project expansion. Expansion identified as an option in the Wardrop 2011 report, and refined in the response to RFI 062 (PLP 2018-RFI 062). A similar expansion concept was analyzed as Pebble 6.5 in the US Environmental Protection Agency (EPA) Watershed Assessment (EPA 2014) on the basis of lands being classified as open for mineral exploration and development, and assuming access to Pebble Project infrastructure.	Wardrop 2011, EPA 2014, response to RFI 062 (PLP 2018-RFI 062)	Yes – for continued exploration and development. Project expansion would begin within the timeframe of the proposed Pebble Project, in year 20 of the proposed project operations. The state lands on which expansion would occur are subject to PLP mining claims and open to mineral development. PLP has existing permits for resource exploration, but has not submitted permit applications for expanded development; expansion is not part of a current NEPA compliance or Best Interest Finding effort, and is not described as reasonably foreseeable in a government planning document. PLP has conducted extensive exploratory drilling and analysis to compile a 43-101 feasibility assessment level of information on mineral reserves in terms of measured, indicated, and inferred resources, along with characterization of the grades of component ore in the deposit and estimated costs of development of mine expansion (Wardrop 2011). If the Pebble Project was permitted, Pebble expansion could use and expand on the project mine site and

Table 4.1-1: Potential Reasonably Foreseeable Future Actions Evaluated for Cumulative Effects

Prospect, Project, or Activity	Description	Status	References	Reasonably Foreseeable?
				transportation infrastructure that would be in place, similar to what has happened with other Alaskan mines where adjacent reserves are commonly owned.
Pebble South	A 54-square mile (mi^2) porphyry copper deposit/claim ~9 miles southwest of Pebble deposit. Prospect is part of the PLP/Northern Dynasty Minerals (NDM) Limited (Ltd.) claim block.	Subject to further exploration. Analyzed for cumulative effects in the EPA Watershed Assessment based on land classification of the deposit and assuming access to Pebble Project infrastructure.	EPA 2014	Yes – for further exploration. No – for development. There is no indication that development of Pebble South would occur within the operations timeframe of the proposed Pebble Project. The state lands on which expansion would occur are subject to PLP mining claims and open to mineral development. Resource delineation has not progressed sufficiently to forecast development with regard to identifying measured or indicated resources; and a project is not subject to development permitting or in a planning document. Because the Pebble South claims are currently owned by NDM Ltd., if future drilling and resource delineation indicate that it is feasible to develop the project, it is possible that construction and operations could access and use the Pebble Project transportation system. However, additional access would need to be constructed to connect to the project transportation infrastructure.

Table 4.1-1: Potential Reasonably Foreseeable Future Actions Evaluated for Cumulative Effects

Prospect, Project, or Activity	Description	Status	References	Reasonably Foreseeable?
Big Chunk South	A 73-square-mile (mi^2) porphyry copper deposit/claim ~12 miles north of the Pebble project area. The claim block is entirely in the Chulitna River drainage, which flows into Lake Clark National Park and Preserve.	Undergone some airborne surveys and limited drilling to delineate the resource. Mineral Claims transferred by Liberty Star to NDM Ltd. in 2014, Liberty Star to NDM Ltd. in 2014, which is when the last state exploration permit expired. Analyzed for cumulative effects in the EPA Watershed Assessment (EPA 2014) based on land classification of the deposit and assuming access to Pebble Project infrastructure.	EPA 2014	Yes – for further exploration. No – for development. There is no indication that development of Big Chunk North would occur within the operations timeframe of the proposed Pebble Project. The state lands on which expansion would occur are subject to NDM mining claims and open to mineral development. Resource delineation has not progressed sufficiently to forecast development with regard to identifying measured or indicated resources, and a project is not subject to development permitting or in a planning. Because Big Chunk South claims are currently owned by NDM Ltd., if future drilling and resource delineation indicate that it is feasible to develop the project, it is possible that construction and operations could access and use the Pebble Project transportation system. However, additional access would need to be constructed to connect to the project transportation infrastructure.
Big Chunk North	Porphyry copper deposit ~21 miles northwest of the Pebble project area. The claim block straddles the drainage divide between the Nushagak and	Mineral claims transferred by Liberty Star to NDM Ltd. in 2014, Liberty Star to NDM Ltd. in 2014, which is when the last state exploration	EPA 2014	Yes – for further exploration. No – for development. There is no indication that development of Big Chunk North

Table 4.1-1: Potential Reasonably Foreseeable Future Actions Evaluated for Cumulative Effects

Prospect, Project, or Activity	Description	Status	References	Reasonably Foreseeable?
	Kvichak River watersheds.	permit expired. Analyzed for cumulative effects of development in the EPA Watershed Assessment based on land classification of the deposit and assuming access to Pebble Project infrastructure.		would occur within the operations timeframe of the proposed Pebble Project. The state lands on which expansion would occur are subject to NDM mining claims and open to mineral development. Resource delineation has not progressed sufficiently to forecast development with regard to identifying measured or indicated resources, and a project is not subject to development permitting or in a planning document. Because claims are currently owned by NDM Ltd., if future drilling and resource delineation indicate that it is feasible to develop the project, it is possible that construction and operations could access and use the Pebble Project transportation system. However, additional access would need to be constructed to connect to the Project transportation infrastructure.
Fog Lake	Gold, copper in volcanic rocks located ~46 miles southeast of the Pebble Project and south of Iliamna Lake, and roughly 10 miles north of the transportation corridor to Amakdedori port.	As of 2008, exploration was occurring, but drilling had not been initiated; the exploration permit expired at the end of 2008. Analyzed for cumulative effects of development in the EPA Watershed Assessment (EPA 2014) based on land classification of the deposit and assuming access to	EPA 2014	Yes – for further exploration. No – for development. There is no indication that development of Fog Lake would occur within the operations timeframe of the proposed Pebble Project. The lands on which the deposit is located have had mining claims, and are open to mineral

Table 4.1-1: Potential Reasonably Foreseeable Future Actions Evaluated for Cumulative Effects

Prospect, Project, or Activity	Description	Status	References	Reasonably Foreseeable?
		Pebble Project infrastructure.		development. Resource delineation has not progressed sufficiently with regard to identifying measured or indicated resources, and a project is not subject to development permitting or in a planning document. Given the proximity to the proposed Pebble Project transportation corridor, if future drilling and resource delineation indicate that it is feasible to develop the project, it is possible that construction and operations could access and use the Pebble Project transportation system if an arrangement could be reached with PLP. However, additional access would need to be constructed to connect to the project transportation infrastructure.
Groundhog	196 mi^2 porphyry copper claim ~3 miles east from the Pebble project area.	Exploration drilling under way. Hard rock exploration permit issued by Alaska Department of Natural Resources (ADNR) in 2017. Analyzed for cumulative effects of development in the EPA Watershed Assessment (EPA 2014) based on land classification of the deposit and assuming access to Pebble Project infrastructure.	EPA 2014	Yes – for further exploration. No – for development. There is no indication that development of Groundhog would occur within the operations timeframe of the proposed Pebble Project. Resource delineation has not progressed sufficiently with regard to identifying measured or indicated resources, and a project is not subject to development permitting or in a planning document. Resource delineation has not

Table 4.1-1: Potential Reasonably Foreseeable Future Actions Evaluated for Cumulative Effects

Prospect, Project, or Activity	Description	Status	References	Reasonably Foreseeable?
				progressed sufficiently with regard to identifying measured or indicated resources, and a project is not subject to development permitting or in a planning document. Given the proximity to the proposed Pebble Project transportation corridor, if future drilling and resource delineation indicate that it is feasible to develop the project, it is possible that construction and operations could access and use the Pebble Project transportation system if an arrangement could be reached with PLP. However, additional access would need to be constructed to connect to the Project transportation infrastructure.
Humble	Also known as Kemuk, a 173-mi² gold and porphyry copper deposit/claim considered geologically similar to Pebble deposit. Deposit is ~83 miles southwest of the Pebble Project area.	This project has been removed from the Millrock Resources website and no longer appears to be active; the exploration permit expired in 2017. Analyzed for cumulative effects of development in the EPA Watershed Assessment (EPA 2014) based on land classification of the deposit, and assuming access to Pebble Project infrastructure.	EPA 2014, Millrock Resources, Inc. 2018	No – for further exploration. No – for development. There is no indication that development of Humble would occur within the operations timeframe of the proposed Pebble Project. The state lands on which the deposit is located have had mining claims and are open to mineral development. Resource delineation has not progressed sufficiently with regard to identifying measured or indicated resources, and a project is not subject to development permitting or in a

Table 4.1-1: Potential Reasonably Foreseeable Future Actions Evaluated for Cumulative Effects

Prospect, Project, or Activity	Description	Status	References	Reasonably Foreseeable?
				planning document. The project is closer to tidewater at Dillingham than the Pebble Project, and would not likely use the project transportation system.
AUDN/Iliamna	113-mi² porphyry copper claim block ~55 miles southwest of the Pebble project area in the Kvichak River watershed.	Millrock Resources began exploration in 2012, but the project has been removed from the Millrock Resources and TNR Gold Corp websites and no longer appears to be active. Analyzed for cumulative effects of development in the EPA Watershed Assessment (EPA 2014) based on land classification of the deposit.	EPA 2014; Bristol Exploration Co., Inc. 2011	No – for further exploration. No – for development. There is no indication that development of Humble would occur within the operations timeframe of the proposed Pebble Project. The state lands on which the deposit is located have had mining claims and are open to mineral development. Resource delineation has not progressed sufficiently with regard to identifying measured or indicated resources, and a project is not subject to development permitting or in a planning document. The project is closer to tidewater at Naknek than the Pebble Project, and would not likely use the project transportation system.
Kamishak	Porphyry copper in a breccia pipe roughly 49 miles southeast of the Pebble Project area, and roughly 10 miles south of the transportation corridor to Amakdedori port.	There were 18 holes drilled between 1990 and 1991, and an additional 5 holes were drilled in 2006. As of 2008, reserves had not been identified, and the exploration permit expired.	AERI 2008	No – for further exploration. No – for development. There is no indication that development of Kamishak would occur within the operations timeframe of the proposed Pebble Project.

Table 4.1-1: Potential Reasonably Foreseeable Future Actions Evaluated for Cumulative Effects

Prospect, Project, or Activity	Description	Status	References	Reasonably Foreseeable?
				The lands on which the deposit is located have had mining claims, and are open to mineral development. Resource delineation has not progressed sufficiently with regard to identifying measured or indicated resources, and a project is not subject to development permitting or in a planning document. Given the proximity to the proposed Pebble Project transportation corridor, if future drilling and resource delineation indicate that it is feasible to develop the project, it is possible that construction and operations could access and use the Pebble Project transportation system if an arrangement could be reached with PLP. However, additional access would need to be constructed to connect to the project transportation infrastructure.
Shotgun	Quartz-feldspar porphyry deposit with gold as the primary interest, located roughly 99 miles northwest of the Pebble Project, 90% owned by TNR Gold Corporation. If developed, Shotgun could access tide water via barge transport from Dillingham (93 miles away) up the Nushagak River to Koliganek, New Stuyahok, or Ekwok (49, 68, and 74 miles away, respectively).	There have been extensive drilling programs since the late 1980s through 2012; and as of 2013, inferred mineral resources were estimated at 20.7 million tons, with a grade of 1.06 gram of gold per ton, with a cut-off grade of 0.50 gram per ton of gold. 34 exploration holes have been drilled onsite.	TNR Gold Corp. 2011, 2012, 2018; ADNR 2012	Yes – for further exploration. No – for development. There is no indication that development of Shotgun would occur within the operations timeframe of the proposed Pebble Project. The lands on which the deposit is located have had mining claims and open to mineral development. Mineral exploration has

Table 4.1-1: Potential Reasonably Foreseeable Future Actions Evaluated for Cumulative Effects

Prospect, Project, or Activity	Description	Status	References	Reasonably Foreseeable?
				delineated inferred mineral resources, but to date have not been identified as measured or indicated. The project is not currently subject to development permitting or in a planning document. The project is closer to tidewater at Dillingham than the Pebble Project, and would not likely use the project transportation system.
Johnson Tract	Gold-rich poly-metallic deposit located roughly 80 miles east of the Pebble Project, owned by Cook Inlet Region, Incorporation (CIRI) and subject to an exploration agreement with Constantine Metals Resources Ltd. CIRI has access rights through Lake Clark National Park and Preserve to a port site at Tuxedni Bay on Cook Inlet.	Discovered by Anaconda in 1982, 90 holes have been drilled but no exploration has occurred in more than 20 years. In 2018, Constantine Metals agreed to resume exploration and take the project to the point of evaluating feasibility of developing the mine.		Yes – for further exploration. No – for development. There is no indication that development of Johnson Tract would occur within the operations timeframe of the proposed Pebble Project. The private lands on which the deposit is located have had mining claims, and are open to mineral development. Resource delineation has not progressed sufficiently with regard to identifying measured or indicated resources, and a project is not subject to development permitting or in a planning document. The project is closer to tidewater at Cook Inlet than the Pebble Project, and would not likely use the project transportation system.

Table 4.1-1: Potential Reasonably Foreseeable Future Actions Evaluated for Cumulative Effects

Prospect, Project, or Activity	Description	Status	References	Reasonably Foreseeable?
Proposed Mining and Mineral Projects in Southwestern and Southcentral Alaska				
Donlin Gold	Open-pit hard rock mine in the Kuskokwim River watershed, 277 miles west of Anchorage. The proposed mine would have a total footprint of approximately 16,300 acres. Includes a 315-mile-long pipeline to carry natural gas from Cook Inlet to the mine site.	Final EIS (FEIS) issued in April 2018. USACE and Bureau of Land Management (BLM) have issued a Joint Record of Decision (JROD) granting major federal permits.	USACE 2018	Yes – for further exploration. Yes – for development. FEIS on the project has been completed, and the JROD was signed in August 2018. The project is considered reasonably foreseeable in the 78-year timeframe.
Diamond Point Rock Quarry	Granite quarry project near the convergence of Cottonwood and Iliamna bays on the western side of Cook Inlet. Project involves modification of shoreline to construct an access road, breakwater, barge landing, and solid fill dock. Dredging would be required in Iliamna Bay.	The project has been developed as the first phase of a larger facility. Coastal infrastructure includes discharging fill material into 11.42 acres below the high tide line fill for staging equipment, stockpiling aggregate, and barge-loading facilities.	USACE 2010	Yes – for development expansion. Reserves of quarry rock have been estimated and a permit was issued. Construction has begun.
Potential Oil and Gas Exploration and Development				
Alaska Stand Alone Pipeline Project	Proposed 737-mile natural gas pipeline from Prudhoe Bay to Point McKenzie, Alaska. The project involves the construction of a liquefied natural gas (LNG) extraction plant on the western side of Cook Inlet at Point McKenzie.	A FEIS was completed in 2018. A ROD is expected soon. If developed, the project would generate additional construction and potentially LNG shipment vessel traffic in Cook Inlet.	Alaska Stand Alone Pipeline (ASAP) 2018	Yes – Because the project has a permit application and is near completion of an EIS, it is considered foreseeable for development. However, it would not be built if the Alaska LNG project is funded for development.
Alaska Liquefied Natural Gas Project (Alaska LNG)	Proposed 800-mile natural gas line from Prudhoe Bay to Nikiski, where the gas will be liquefied and shipped to foreign markets. Involves a natural gas pipeline crossing Cook Inlet and will result in increased marine traffic in Cook Inlet.	Federal Regulatory Energy Commission application filed. A Draft EIS (DEIS) will be released in 2019; a FEIS would be released in 2020. Construction would begin after 2020. The project does not have funding to proceed.	Alaska LNG 2018	Yes – Because the project has a permit application and is near completion of an EIS, it is considered foreseeable for development.

Table 4.1-1: Potential Reasonably Foreseeable Future Actions Evaluated for Cumulative Effects

Prospect, Project, or Activity	Description	Status	References	Reasonably Foreseeable?
Drift River Decommissioning/Oil Pipeline Transportation Project	Proposes to repurpose an existing natural gas pipeline crossing Cook Inlet to an oil pipeline. Involves the installation of 9 miles of new cross-inlet pipeline between Beluga and Nikiski.	Decommissioning of the Drift River Terminal was initiated in 2017, and construction has begun. The project would result in gas pipeline construction in middle Cook Inlet, and generate additional vessel traffic in Cook Inlet to remove decommissioned materials.	Regulatory Commission of Alaska 2018; KDLL, Public Radio for Central Kenai 2018	Yes – for development. The project is in the permitting phase and scheduled for execution. It is considered reasonably foreseeable in the 78-year timeframe.
Cook Inlet Oil and Gas Lease Sales	State: ADNR is responsible for leasing oil and gas in state waters. Federal: The Bureau of Ocean and Energy Management is responsible for leasing oil and gas in federal waters. Recent assessments by the US Geological Survey (USGS) estimate that the Cook Inlet region (excluding the Outer Continental Shelf) contains mean values of 637 billion cubic feet of natural gas, 600 million barrels of oil, and 46 million barrels of natural gas liquids (from BOEM 2016). There are 17 offshore production platforms located in Cook Inlet state waters (ADNR 2018e; BOEM 2016). Exploration activities continue with future development anticipated.	State: ADNR released a preliminary best interest finding on the Cook Inlet Area-wide Oil and Gas Lease Sale in June 2018. Federal: In 2017, Federal Lease 244 resulted in bids for 14 tracts in Cook Inlet. Federal Lease Sale 258 for Cook Inlet is scheduled for 2021. Oil and gas exploration and development activities in Cook Inlet are ongoing and likely to continue.	ADNR 2018e BOEM 2016	Yes – for exploration; oil and gas exploration has been subject to a 2016 EIS (federal waters) and a 2018 preliminary best interest finding (state waters). Yes – for development. Although no new offshore platforms are currently scheduled, work on and drilling from existing offshore platforms is likely to continue.
Hydrocarbon Exploration Licensing and Leasing Program	ADNR, Lake and Peninsula Borough (LPB), Bristol Bay Borough, and Aleutians East Borough have signed a	Exploration has historically occurred, but not resulted in development.	Bristol Bay Area Plan for State Lands 2015	Yes – for exploration. The State of Alaska has held lease sales, and additional exploration is considered reasonably

Table 4.1-1: Potential Reasonably Foreseeable Future Actions Evaluated for Cumulative Effects

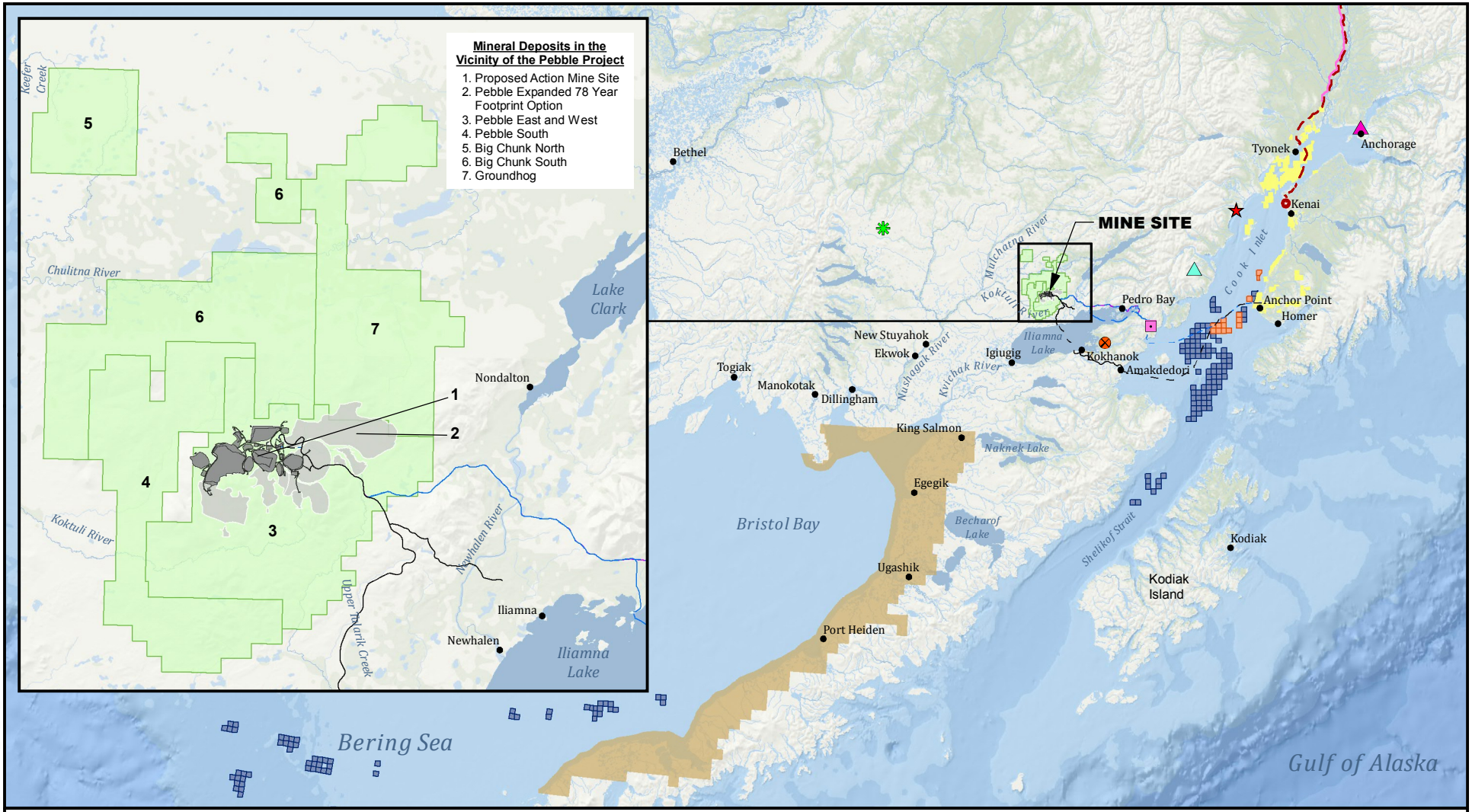
Prospect, Project, or Activity	Description	Status	References	Reasonably Foreseeable?
	Memorandum of Understanding (MOU) in support of oil and gas lease sales and licensing on State land in the analysis area. Similar MOUs exist between ADNR and the Aleut Regional Native Corporation and Bristol Bay Native Corporation.			foreseeable. No – for development. Given the lack of previous oil and development in the region, development and production are not reasonably foreseeable.
Transportation and Infrastructure				
LPB Transportation Projects	Several road improvement and new transportation corridors currently being studied. Studies include the Williamsport-Pile Bay Road upgrade, Nondalton–Iliamna River Road Corridor and Bridge, and Kaskanak Road /Cook Inlet to Bristol Bay (Igiugig).	Ongoing.	LPB Comprehensive Plan 2017	Yes – for development. These projects are in a published Borough planning document.
LPB Community Development and Capital Improvement Projects	Village infrastructure development projects, including power plant upgrades, sewer and water improvement projects, transmission upgrades, and energy efficiency initiatives.	Ongoing. List of projects from LPB 2017 capital improvement projects.	LPB Comprehensive Plan 2017	Yes – for development. These projects are in a published Borough planning document.
Rural Alaska Village Grant Program	US Department of Agriculture Rural Development program to improve rural sanitization. Grant money used to improve water and sanitation services.	Ongoing	USDA Rural Development 2018	Yes – for development. These projects are considered small-scale community improvements, and could be approved for communities in the area of analysis.
Energy and Utilities				
Lake and Peninsula Borough (LPB) and other regional Renewable Energy Initiatives	LPB and other communities and electrical generation cooperatives are studying renewable energy projects to	Studies ongoing. Igiugig has been installing its pontoon-mounted power generator annually in the Kvichak River.	LPB Comprehensive Plan 2017	Yes – for development. These projects are in a published LPB planning document.

Table 4.1-1: Potential Reasonably Foreseeable Future Actions Evaluated for Cumulative Effects

Prospect, Project, or Activity	Description	Status	References	Reasonably Foreseeable?
	help combat high fuel costs. Studies include wind, hydroelectric, river, and tidal energy alternatives. Igiugig has a permit for a removable in-river power generation facility in the Kvichak River.	The Tazimina Run of River Hydro Project upgrade has been completed, 12 miles northeast of the village of Iliamna. The village of Kokhanok has received funding to refurbish its existing wind diesel power plant.		
Nushagak Electric Cooperative Village Intertie Project	The Nuyakuk Run of River Hydro Project would connect the communities of Dillingham, Levelok, New Stuyahok, Koliganek, Aleknagik, and Ekwok with power and fiber optics with operation projected for 2024.	Nushagak Cooperative has submitted a preliminary permit application to Federal Energy Regulatory Commission (FERC) for their hydro project on the Nuyakuk River in Wood Tikchik State Park.	US Department of Energy FERC 2018 (83 FR 15826)	Yes - for development. These projects have submitted, or are in the process of submitting, permits for development.
Commercial Fishing				
Bristol Bay – Nushagak and Naknek/Kvichak State Management Districts – Salmon Lower Cook Inlet Management Area – Salmon and Herring	Continued stock assessment and allocation decisions under existing management plans.	Ongoing. Anticipate a continuation of commercial fishing in the EIS analysis area.	ADF&G Commercial Fishing Management Reports 2018	These actions will occur in response to annual stock assessments and direction from management plans.
Subsistence Activities				
Villages of Iliamna, Newhalen, Pedro Bay, Port Alsworth, Nondalton, Igiugig, Kokhanok, Koliganek, Levelock, New Stuyahok, King Salmon, Naknek, Aleknagik, Clarks Point, Manokotak, Dillingham, Ninilchik, and Seldovia	Past, present, and foreseeable subsistence activities are described in Section 3.9, Subsistence.	Ongoing. Anticipate a continuation of subsistence practices in the EIS analysis area.	See Section 3.9, Subsistence.	Subsistence harvest of fish, wildlife, and plants will continue for the foreseeable future.

Table 4.1-1: Potential Reasonably Foreseeable Future Actions Evaluated for Cumulative Effects

Prospect, Project, or Activity	Description	Status	References	Reasonably Foreseeable?
Tourism, Recreation, Hunting, and Fishing				
National Parks and Preserves Wildlife Refuges State of Alaska Special Management Areas Alaska Native Corporation Lands	Hiking, camping, wildlife viewing, and photography. Sport fishing is the primary recreational activity that occurs in the EIS analysis area. Hunting, primarily for moose, caribou, and bear, is a major recreational activity in the region.	Activities are expected to continue in the EIS analysis area.	See Section 3.5, Recreation.	Tourism, recreation, hunting, and fishing will continue for the foreseeable future.
Industrial Pollutants and Contaminated Sites				
Communities in project area	Identified sites with low levels of contamination have been identified in many Alaskan communities. Communities with site entries in the immediate vicinity of the project include Nondalton, Iliamna, Pedro Bay, Newhalen, and New Stuyahok. Many of the sites are associated with fuel storage tanks/power generation.	Many of the sites in the ADEC database have been cleaned up. The primary potential nexus with activities proposed by the project would be in communities where PLP proposes construction and operations support activities.	ADEC 2018	Yes – these projects would result in additional activities associated with clean-up of contaminated sites in communities in the EIS analysis area.
Scientific Surveys and Research				
Federal, state, institutional, and private surveys and research	Scientific surveys and research conducted by government, institutional, and private parties have the potential to disturb wildlife, as well as interfere with subsistence and recreational activities and experience. Activities conducted by aircraft typically have created the most potential for conflict.	Although some agencies and organizations conduct annual surveys, others are difficult to forecast.	See Section 3.23, Wildlife Values and Section 3.24, Fish Values.	There is a potential for airplane and helicopter traffic to disturb wildlife, and for interaction with subsistence and recreational activities and experience.



Sources: ADNR 2010, 2018; BOEM 2018

US Army Corps of Engineers

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Miles

- Fog Lake Mineral Deposit
- Shotgun Mineral Deposit
- Johnson Tract Mineral Deposit
- Diamond Point Granite Quarry
- Drift River Oil Terminal Removal Pipeline Project
- Nikiski (Proposed Alaska Liquified Natural Gas Project Terminal)
- Alaska Liquefied Natual Gas Project
- Point McKenzie (Alaska Stand Alone Pipeline Construction Port)
- Alaska Stand Alone Pipeline
- Pebble Expanded 78 Year Footprint Option
- Mineral Deposits in Vicinity of Pebble Project (See Inset Map)
- Alaska Peninsula Onshore Oil and Gas Exploration
- State Cook Inlet Oil & Gas Exploration & Lease Sales
- Federal Oil & Gas Active Leases
- Federal Historical Oil & Gas Leases

Alternative 1
- Mine Site
- Transportation Corridor
- Natural Gas Pipeline

Kokhanok East Ferry Terminal Variant
- Transportation Corridor

Alternative 2
- Transportation Corridor
- Ferry Route

Alternative 2/3
- Natural Gas Pipeline

Alternative 3
- Transportation Corridor

LOCATION OF REASONABLY FORESEEABLE FUTURE ACTIONS

PEBBLE PROJECT EIS

FIGURE 4.1-1

Table 4.1-2: Assumptions for Pebble Project Expansion

Component	Assumptions
Assumptions/Facilities Common to All Alternatives	
General Project	• The current proposed project proceeds as outlined by EIS alternative for the first 20 years. • After 20 years, mining continues for 58 years and mill throughput is expanded to 250,000 tons per day. • After mining stops (year 78), milling continues for an additional 20 to 40 years to process low-grade ore and potentially acid-generating (PAG) waste that is not backhauled to the pit. Bulk and pyritic tailing would be deposited directly into the pit. • Concurrent reclamation would occur during mining, with the northern bulk TSF closed and reclaimed as soon as it is full, along with non-trafficked areas of waste rock facilities. • Concurrent reclamation would occur during milling of low-grade ore/PAG material, with a dry closure of the southern bulk tails TSF, and final closure of non-acid-generating (NAG) waste rock facilities (WRF). • After milling stops (year 98-118), removal of all facilities and infrastructure not required post-closure. • Post-closure monitoring and water treatment would occur as proposed, but involving an expanded mine site.
Mine Site (See response to RFI 062 [PLP 2018-RFI 062] for mine layout)	• The mine pit would be expanded starting in year 20. • Reclamation of the pyritic TSF and placement of pyritic tailings and PAG rock from the first 20 years of mining would be postponed until year 78. • Additional bulk tails would be stored separately in a new southern bulk tail TSF with a flow-through embankment; additional pyritic tails would be stored in a new lined southern PAG TSF. • With mine expansion, waste rock would increase and be stored in new northern and southern NAG WRFs. Low-grade ore and PAG waste rock would be stored on the western side of the northern WRF, which drains towards the pit. All runoff and seepage from the waste rock storage facilities would be captured and used in the process, or treated for release. • An additional train would be added to the mill, and the power plant would be expanded to 375 megawatts, requiring 70 million standard cubic feet per day (commonly abbreviated as mmscfd) of natural gas. Water treatment plants would have throughput increased, or additional treatment plants would be brought on line. • The natural gas pipeline would remain the same size and route for each alternative (see additional compression at port sites under individual alternatives below).
Additional Concentrate Export Port Site	• A deepwater port facility would be constructed in Iniskin Bay for transport of copper concentrate via the concentrate pipeline. • The concentrate handling, dewatering, and treatment facilities would be similar to those discussed at the Diamond Point port under the Alternative 3 Concentrate Pipeline Variant.

Table 4.1-2: Assumptions for Pebble Project Expansion

Component	Assumptions
Additional Pipelines	• A concentrate pipeline would be constructed from the mine site to the deepwater loading facility in Iniskin Bay, and would be buried in the same trench as the natural gas pipeline from the mine site to the vicinity of Williamsport, at which point it would head east to Iniskin Bay. • A small service road would be built along the pipeline extension from Williamsport to Iniskin Bay. • A diesel pipeline would be constructed between the deepwater port in Iniskin Bay and the mine site, capable of carrying 100 million gallons annually, and parallel the concentrate pipeline.
Assumptions Differing by Alternative	
Alternative 1 – Applicant's Proposed Alternative	• The Amakdedori port and transportation system would continue to operate as proposed for the first 20 years. • After 20 years, an additional natural gas compressor station would be constructed at Amakdedori; the port and transportation system, including the ferry, would continue to be used for transport of supplies and consumables, and bags of molybdenum concentrate. • There would be less truck traffic with copper concentrate and diesel being transported via pipeline to/from Iniskin Bay. • A road would be constructed along the concentrate pipeline to provide access for servicing the pipeline, but would not be used for regular traffic.
Alternative 2 – North Road and Ferry with Downstream Dams	• The Diamond Point access road and north road would continue to operate as proposed for the first 20 years. • After 20 years, an additional natural gas compressor station would be constructed at Diamond Point. A road would be constructed to connect the two ferry terminals, and the ferry would be discontinued. • Diamond Point would continue to be used for transport of supplies and consumables, and bags of molybdenum concentrate. • There would be less truck traffic with copper concentrate and diesel being transported via pipeline to/from Iniskin Bay.
Alternative 3 – North Road Only, Concentrate Pipeline Variant	• The Diamond Point access road and north road would continue to operate as proposed for the first 20 years. • After 20 years, an additional compressor station would be constructed at Diamond Point. • Diamond Point would continue to be used for transport of supplies and consumables, and bags of molybdenum concentrate. • There would be less truck traffic with copper concentrate and diesel being transported via pipeline to/from Iniskin Bay.

4.1.2 Issues Selected for Analysis

The USACE and cooperating agencies identified topics for further analysis, and eliminated others from evaluation, based on independent evaluation of topics and through scoping comments. Issues raised during scoping are documented as Statements of Concern in the Scoping Report (Appendix A). Issues selected for analysis include:

Social science topics:

- Socioeconomics
- Subsistence
- Traditional way of life
- Archaeological and cultural resources
- Land ownership, management, and use
- Transportation and navigation
- Recreation
- Environmental justice
- Public health and safety
- Visual resources
- Wilderness characteristics
- Food and fiber production

Physical science topics:

- Air quality
- Geology and seismic activity
- Surface and groundwater hydrology impacts
- Noise impacts
- Water quality and quantity

Biological science topics:

- Vegetation and ecosystems
- Fish and aquatic resources
- Wetlands and special aquatic sites
- Wildlife, birds, and mammals
- Endangered Species Act listed threatened and endangered species
- Invasive species

Other topics:

- Hazardous materials stored and transported to and from the mine site
- Tailings dams
- Climate change
- Fuel spill risks and releases
- Natural gas supply
- Pipeline safety

4.1.3 Other Resources

The NEPA provides the lead agency with discretion to determine, based upon the scoping process, which categories of resources merit detailed analysis, and which categories do not. This determination and impacts to resources that did not warrant detailed analysis are briefly addressed in this section. This is particularly the case where the resource has relevance to USACE public interest review under Section 404 of the CWA (see Table 3.1-1 in Section 3.1, Introduction to Affected Environment, for a detailed list of resource categories, and in which section of the EIS they are discussed). Note that affected environment for resources not specifically discussed in Section 3.2 to Section 3.26 is discussed in this section, along with environmental consequences.

4.1.3.1 Conservation

Conservation is assessed in a regional context (USACE 2017). Beneficial or adverse impacts in terms of conservation for the proposed project are included in various sections of Chapter 4 in this context. Supporting discussions regarding impacts on the conservation of water supply, wetlands, wildlife, fish, aquatic resources, vegetation are provided in appropriate sections of this EIS (see Section 3.1, Introduction to Affected Environment, for details on where each resource is discussed in this document).

4.1.3.2 General Environmental Concerns

General environmental concerns are assessed in a local, regional, state, national, and global context (USACE 2017). Beneficial or adverse impacts in terms of conservation for the proposed project are included in various sections of Chapter 4 in this context. Concerns with a large mineral resource extraction project are varied, interrelated, and complex. During the scoping period, concerns that did not fall into a specific social, physical, or biological science topic included hazardous materials storage and transportation, climate change, tailings dams concerns, fuel spill risks and releases, natural gas supply, and pipeline safety.

Climate change trends are discussed Chapter 3 sections, and climate change impacts are discussed in Chapter 4 sections (effects of the project on climate change per GHG emissions; effects of climate change on the project infrastructure). See the “Climate Change” subsection below. The framework for discussing climate change in this document is found in Section 3.1, Introduction to Affected Environment.

The probabilities and potential impacts of spills (unintended releases) from the project are analyzed for diesel fuel, natural gas, copper-gold ore concentrate, chemical reagents, bulk and pyritic tailings, and untreated contact water in Section 4.27, Spill Risk. Pipeline safety is also discussed in Section 4.27, Spill Risk.

Natural gas supply is addressed below under “Energy Needs.”

4.1.3.3 Energy Needs

Energy needs are assessed in terms of power supplies to the mine site and port facilities, from a local and regional context (USACE 2017). There would not be expected to be beneficial or adverse impacts in terms of energy needs for the proposed project in this context.

The project purpose is not to generate energy. The purpose of the natural gas pipeline from the Kenai Peninsula is to provide a long-term stable supply of natural gas to meet the energy needs of the project by connecting to the existing regional gas supply network. See Chapter 1, Purpose and Need, for an expanded discussion on project purpose and need.

Due to the remote location and lack of current infrastructure, the project would be required to provide basic infrastructure in addition to support facilities typically associated with mining operations. The project would generate its own electricity using natural gas from the region and diesel fuel in back-up generators. The electricity would be used for ore extraction and processing. The peak electrical load for the project would be approximately 270 megawatts (MW). Various mine load centers would be serviced by a 69 kilovolt distribution system using a gas-insulated switchgear system located at the power plant. Waste heat from the power plant would be used to heat buildings and supply process heating to the water treatment plant, resulting in conservation of energy and reducing the amount of natural gas required to power ancillary facilities. The port site would include two 2 MW natural gas power generators with an emergency diesel generator. Natural gas would be fed to the port site power station to be used for heating. Natural gas pipeline infrastructure would include a compressor station on the Kenai

Peninsula side, and a second compressor station located at a Cook Inlet port site. The ferry mooring system design would allow engines to be turned off while parked conserving diesel fuel.

While natural gas supply was raised as a concern during the scoping period, the source of and production methods of natural gas are beyond the scope of this EIS because they are not a component of any federal permit required for this project. Additionally, the project proposes to purchase natural gas on the open market by linking with the existing pipeline system near Anchor Point, Alaska. Gas for the project would not be from a specific source. Potential sources at this time include any natural gas producer in Cook Inlet, Alaska.

4.1.3.4 Mineral Needs

Mineral needs are assessed in terms of precious metals resource extraction in an international market and global context (USACE 2017). The proposed project would result in a 20 year beneficial effect on the public's mineral needs in this context.

The proposed project would ultimately result in production of 7.4 billion pounds of copper, 36 million ounces of gold, and 398 pounds of molybdenum to meet global demand (see further details in the project description, Appendix N).

Copper is used for the production of electrical equipment (such as wiring and motors), official coins, construction (such as roofing and plumbing parts), industrial machinery (such as heat exchangers), and other uses. From the broad, macroeconomic scale, the project need is reflected in the worldwide demand for copper. In 2018, the International Copper Study Group projected a small surplus of projected available copper; however, worldwide demand for copper is projected to exceed the available supply in 2019 (ICSG 2018).

Gold is used for the production of jewelry, electronics and electrical components, official coins, and other uses. In the first 9 months of 2017, domestic consumption of gold used in the production of coins and bars decreased by more than 50 percent; however, gold consumption for jewelry increased slightly, and demand for gold coins and bars increased by 13 percent in comparison to the first 9 months of 2016 (USGS 2018d).

Molybdenum is used for the production of ferromolybdenum, metal powder, and various chemical products. Metallurgical application accounted for 87 percent of the total molybdenum consumed. In 2017, US imports for consumption of molybdenum increased by 68 percent from 2016; US exports increased by 37 percent from 2016, mainly owing to an increase in export of molybdenum ores and concentrates and molybdates. Apparent consumption increased by 26 percent in comparison to 2016 (USGS 2018d).

Project purpose and need is discussed in Chapter 1, Project Purpose and Need.

4.1.4 Traditional Ecological Knowledge

Information about traditional ecological knowledge (TEK) and the approach taken by the USACE to collect TEK is outlined in Section 3.1, Introduction to Affected Environment. The information collected is included in Appendix K3.1, Traditional Ecological Knowledge. Section 3.9, Subsistence, includes a discussion of TEK.

4.1.5 Climate Change

Chapter 3, Affected Environment, discusses climate change trends. Discussions are as follows:

- Section 3.1, Introduction to Affected Environment, provides a framework for discussion of climate change in the EIS, and the location of discussion of climate change.
- Section 3.9, Subsistence, discusses climate change in the context of traditional use change.
- Section 3.16, Surface Water Hydrology, discusses groundwater modeling incorporating cyclical and predicted climate data to account for changes in climate.
- Section 3.17, Groundwater Hydrology, provides baseline details of water balance models to discuss trends and potential changes, including how climate variability is incorporated into recalibrated modeling.
- Section 3.18, Water and Sediment Quality, discusses climate trends, and oscillations for temperature specifically.
- Section 3.20, Air Quality, provides detailed information about air quality and climate change in the context of estimated predicted future temperature and precipitation values.
- Section 3.22, Wetlands, includes discussion of the potential impacts on wetlands and other waters in a changing climate. Section 3.26, Vegetation, provides similar discussion on trends, such as changes in phenology that may affect vegetation.
- Section 3.23, Wildlife, includes detailed analysis of potential impacts of climate change on terrestrial wildlife, birds, and marine mammals, including Threatened and Endangered Species. Section 3.25, Threatened and Endangered Species, also includes discussion of climate change trends for Steller's eider.
- Section 3.24, Fish Values, discusses climate change in the context of hydrological changes and potential large-scale shifts in populations.

Chapter 4, Environmental Consequences of Action, discusses impacts of climate change from the proposed project, or contributions of the project to greenhouse gas (GHG) emissions. These impacts are primarily discussed in the physical science sections. Discussions are as follows:

- Section 4.16, Surface Water Hydrology, provides analysis of water balance models specific to the project components and operations that incorporate climate variability.
- Section 4.17, Groundwater Hydrology, also discusses climate variability in the context of analyzing water flow and balance in project components such as the pit lake.
- Section 4.20, Air Quality, includes a detailed analysis of project-related GHG emissions.

4.1.6 Unavoidable Adverse Effects

The Council on Environmental Quality (CEQ) guidelines require agencies to evaluate "any adverse environmental effects which cannot be avoided should the proposal be implemented" (40 CFR 1502.16). Unavoidable adverse effects are those remaining after the project has complied with applicable stipulations and mitigation measures. A detailed discussion of beneficial and adverse effects is presented for each resource in Section 4.2 through Section 4.26. A summary impacts subsection is presented at the end of each section.

4.1.7 Irreversible and Irretrievable Commitment of Resources

CEQ guidelines require an evaluation of "any irreversible or irretrievable commitments of resources which would be involved in the proposal should it be implemented" (40 CFR Part

1502.16). An irreversible or irretrievable commitment of resources refers to impacts on or losses to resources that cannot be recovered or reversed.

An irreversible resource commitment of a resource represents a loss of future options. This term applies primarily to the use of non-renewable resources, such as minerals, fossil fuels, or cultural resources, and to factors that are renewable only over long periods of time, such as soil productivity.

An irretrievable commitment of a resource represents opportunities that are foregone for the period of the proposed activities. This term applies primarily to the use of renewable resources, such as timber or human effort, or other utilization opportunities that are foregone in favor of the proposed activities.

Resources that would be irreversibly and irretrievable committed to the alternatives analyzed in this EIS include:

- **Cultural Resources and Historic Properties –** Any inadvertent effects to cultural resources or historic property would result in an irreversible commitment of resources.
- **Vegetation and Wetlands –** Ground disturbance, particularly due to project construction and operations, would cause irreversible impacts, including land to be permanently altered, soils and bedrock to be permanently displaced, vegetation to be permanently removed, and wetlands and other waters to be permanently altered or filled.
- **Aquatic Resources –** Irreversible changes to streamflows from permanent watershed alterations would eliminate aquatic habitat.
- **Aesthetics –** Development of infrastructure would create a visual contrast resulting in an irreversible commitment of resources in permanent fill areas, and an irretrievable commitment in areas subject to reclamation.
- **Resource consumption –** Irreversible consumption of renewable and non-renewable resources would be required for infrastructure development, including metals, aggregate, cement, wood, and other materials.
- **Soils and Geology –** Irretrievable and irreversible commitment of the use of copper, gold, and molybdenum ore resources.
- **Resource committal –** Non-renewable resources (e.g., gasoline, diesel, natural gas, and electrical power generated from these fuels) would be irreversibly committed for project construction, operations, and closure. Fuels would be required to operate aircraft, motor vehicles, barges, vessels, machinery, and mining equipment.
- **Funds and labor –** Funds and labor would be irretrievably committed for project permitting and development.
- **Water –** Water would be irretrievably committed for milling and processing.

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