APPENDIX S

Pit Lake Ecological Risk Assessment

- Ecological Risk Assessment for the Proposed Future ACMA Pit Lake, ARCADIS, January 15, 2013.
- Technical Memorandum: Addendum to Ecological Risk Assessment for the Proposed Donlin Pit Lake, ERM, August 31, 2015.
- Ecological Risk Assessment for the Proposed Future ACMA Pit Lake, Critique and Additional Information, AECOM, 2015.

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Ecological Risk Assessment for the Proposed Future ACMA Pit Lake, ARCADIS, January 15, 2013.

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Ecological Risk Assessment for the Proposed Future ACMA Pit Lake

Donlin Gold LLC

January 15, 2013

ARCADIS

Penny Hunter
Principal Scientist

Donlin Creek Mine Project

Pit Lake ERA

Prepared for:
Donlin Gold LLC

Prepared by:
ARCADIS U.S., Inc.
420 L Street
Suite 100
Anchorage
Alaska 99501
Tel 907.277.3770
Fax 907.277.3776

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Executive Summary

This document reports the results of the Pit Lake Ecological Risk Assessment (ERA) for the proposed future ACMA pike lake. The ACMA pit lake is proposed as part of the Donlin Gold Project (Donlin Project) near Bethel Alaska. Donlin Gold LLC (Donlin) is proposing to develop open pits associated with proposed mining for the Donlin Project. Subsequent to mine closure, the remaining open pit is expected to fill with water, creating a pit lake. An ERA was completed to determine the potential for chemical risk to wildlife from the proposed future pit lake.

Since the pit lake does not yet exist, this ERA relies upon a combination of water quality predictions, the general literature, and studies of pit lakes elsewhere to predict exposure and effects of pit lake constituents to wildlife receptors. The ERA followed US Environmental Protection Agency (USEPA), Alaska Department of Environmental Conservation (ADEC), and applicable Bureau of Land Management (BLM) guidance regarding risk assessment approach and methods.

The basic steps in an ERA include problem formulation, analysis, and risk characterization. The analysis phase of the ERA can be broken into two components: exposure assessment and effects assessment. The sections below summarize each of these steps and describe the results of the assessment.

Problem Formulation

Biological development in the future pit lake will depend on physical pit characteristics, water chemistry, nutrient availability, and the environment in which the lake is situated. During the period of infilling (year 2 to approximately 52 years after cessation of dewatering), rapidly rising water levels, pit wall erosion and sloughing, and the high, steep walls surrounding the water will limit access to the pit lake by wildlife. Exposure to the pit lake environment during this pit filling stage of development is expected to be limited to just the pit water itself. Once the pit lake has reached maturity (year 53 and beyond), the pit lake level will stabilize, and littoral and riparian areas along the edge of the pit lake could develop. This “mature” pit lake environment can attract a larger variety of wildlife for longer durations of time.

In the problem formulation step of an ERA, assessment endpoints (AEs), measurement endpoints (MEs), and an analysis plan is confirmed which provides the basic structure for the remaining steps of the ERA. AEs are designed to identify the ecological values that should be protected (USEPA 1997). The MEs are developed as a means of measuring potential ecological effects to AEs and determining whether any of the COPCs pose potential risk to ecological receptors. The general AE identified for this ERA is protection of wildlife survival, growth and reproduction of wildlife species that may utilize the pit lake as a drinking water source. The MEs selected for the draft BERA are therefore comparisons of modeled dietary COPC exposure of an indicator species to applicable and relevant effects concentrations. These measures constitute the analysis plan, and are used to evaluate whether the future pit lake habitat will be suitable for the wildlife receptors that may use the pit lake.

Because not all individual species or wildlife trophic components of an ecological system are practical to evaluate quantitatively (USEPA 1998a,b), several representative species were chosen in association with the assessment endpoints. Selection of these indicator species was based on consideration of all functional groups, their potential for exposure by direct and indirect pathways (i.e., exposure through food web interactions), regulatory guidance, and other stakeholder considerations, including subsistence use. Representative wildlife receptors chosen for quantitative evaluation in the ERA included:

- Black bear
- Gray wolf
- Mink
- Snowshoe hare
- Tundra vole
- American dipper
- Dark-eyed junco
- Mallard duck
- Northern shrike

Chemicals of potential concern (COPCs) were identified for pit lake water by comparing concentrations at the pit filling and mature pit lake stages to screening level benchmarks, including ADEC water quality criteria. Predicted concentrations of metals in surface water were obtained from Lorax (2012) and are summarized below. The “base case” predictions from Lorax (2012) were assessed in the ERA as this scenario represents the expected water quality for the pit lake. Predicted concentrations compared to screening benchmarks are shown in Table 1.

COPCs identified for the pit filling pit lake scenario included:

- Antimony
- Arsenic

- Cadmium
- Chromium
- Cobalt
- Copper
- Lead
- Nickel
- Selenium
- Zinc

COPCs identified for the mature pit lake scenario included:

- Antimony
- Arsenic
- Selenium

Methods

In the exposure analysis, exposure for wildlife was calculated based on a deterministic dose model developed by USEPA (1993). COPC concentrations were estimated directly for water and sediment and indirectly for food through the use of bioaccumulation factors (BAFs). Literature-based values and some site-specific data was used to determine BAFs.

In the effects analysis, toxicity reference values (TRVs) were derived for wildlife with which to compare the estimated dose. A range of TRVs was identified, corresponding to no adverse effect levels (NOAELs) and low adverse effect levels (LOAELs). Detailed review of toxicological databases identified studies from which to derive TRVs that were based on similar species, exposed via similar routes of exposure, and that measured toxicological endpoints comparable to the assessment endpoints identified in the ERA.

For each receptor-COPC combination, hazard quotients (HQs) were calculated to estimate the likelihood of ecological risk. The HQ calculations are not measurements of risk; they serve as a “cautionary signal” that potential hazards are present and are indicators of whether further evaluation or natural resource management is needed. A lower-bound and an upper-bound HQ (HQ_{NOAEL} and $HQ_{LOAEL,}$ respectively), corresponding to ratios of dose to NOAEL-based TRVs and LOAEL-based TRVs, were calculated to characterize the potential range of effects.

Results

For the pit lake filling scenario, results showed that HQs were much less than 1 for all receptor-COPC combinations, indicating risk is unlikely to wildlife exposed to the proposed pit lake during the pit lake development stage. For the mature pit lake scenario, results showed that selenium HQ_{NOAEL}s were ≤1 for all receptors, while for antimony and arsenic, HQ_{NOAELS} were >1, but <10, for the following receptors:

- Arsenic HQ_{NOAEL} > 1: American dipper, mallard duck, mink and tundra vole.
- Antimony HQ_{NOAEL} > 1: American dipper, tundra vole, wolf and black bear.

HQ_{LOAELs}, however, were <1 for all receptors for all COPCs. These results indicate that risk to wildlife from exposure to COPCs associated with the ACMA pit lake is not confirmed. In these cases, a review of assumptions and uncertainties is conducted to help guide further interpretation of results.

There were a number of conservative assumptions inherent in the risk assessment, including the use of whole rock concentration data from boreholes to estimate future sediment concentrations, over-estimates of receptor exposure durations, conservative assumptions regarding dietary fractions of pit lake items, and the assumption of 100% bioavailability of ingested sediments and food. These assumptions contributed to overestimates of exposure and risk in the ERA.

A sensitivity analysis on some of the driving exposure assumptions was conducted to help guide interpretation of results. Adjustments in pit lake use frequencies, and estimated sediment concentrations, resulted in the largest reductions in HQs, reducing them proportionally to the percent reduction in both exposure parameter inputs. For this ERA, area use was assumed to be equal to 1 (meaning that receptors spend all their time at the pit lake and do not obtain food or water elsewhere). However, it is more likely that area use of the pit lake will be much less than 1, given the number of other water bodies in the area, some of which could be more biologically productive than the pit lake. Sediment concentrations will also likely be less than the concentrations assumed here, as erosion and deposition of unmineralized surface soil along the pit rim is expected. Sediment concentrations were used to estimate uptake into aquatic plans and invertebrates, which were then assumed to be eaten by some of the wildlife receptors. Therefore, the overly conservative assumptions regarding sediment concentrations also resulted in over-estimates of exposure via food ingestion.

Despite these highly conservative assumptions used for the risk characterization of the mature pit lake, HQ_{NOAELs} were below 1 for most receptors and just above 1 for others, and HQ_{LOAELs} were less than 1 for all receptor-COPC combinations. Sensitivity analysis shows that reductions in sediment concentrations and area uses, which are expected, would result in reductions in HQs below 1 for wildlife receptors. Thus, the interpretation of the HQ results for the mature pit lake scenario is that wildlife risk from chemical exposure in the ACMA pit lake water is unlikely.

Figures

Tables

Appendices

Abbreviations and Acronyms

ADEC	Alaska Department of Environmental Conservation
amsl	above mean sea level
AWQC	ambient water quality criteria
BAF	bioaccumulation factor
BSAF	biota sediment accumulation factor
COPC	chemical of potential concern
Donlin	Donlin Gold LLC
EC	effects concentration
EPC	exposure point concentration
ERA	ecological risk assessment
˚F	degrees Fahrenheit
F	fluoride
ft	feet
HQ	hazard quotient
kcal	kilocalorie
LC_{50}	lethal concentration in 50% of the population
LOAEL	lowest observed adverse effect level
mg/kg	milligrams per kilogram
mg/kg-bw day	milligrams per kilogram body weight per day
mg/L	milligrams per liter
NAS	National Academy of Science
NOAEL	no observed adverse effect level
TRV	toxicity reference value
UF	uncertainty factor
µg/g	micrograms per gram
USEPA	United States Environmental Protection Agency

1. Introduction

Donlin Gold LLC (Donlin) is proposing to develop open pits associated with proposed mining for the Donlin Creek Gold Project (Donlin Project). Subsequent to mine closure, the remaining open pit is expected to fill with water, creating a pit lake. An ecological risk assessment (ERA) was completed to determine the potential for chemical risk to wildlife from the proposed future pit lake.

Because the pit lake does not yet exist, the ERA relies upon a combination of water quality predictions, the general literature, and studies of pit lakes elsewhere to predict exposure to and effects of metal constituents for ecological receptors. The ERA followed US Environmental Protection Agency (EPA) guidance and relevant Alaska Department of Environmental Conservation (ADEC) guidance regarding risk assessment approach and methods.

The basic steps in an ERA include problem formulation, analysis, and risk characterization. The analysis phase of the ERA can be broken into two components: exposure assessment and effects assessment. This report subsequently addresses each of these steps.

1.1 Relevant Guidance

This risk assessment considered relevant USEPA, ADEC and other guidance. Primary USEPA guidance includes:

- *Ecological Risk Assessment Guidance for Superfund* (USEPA 1998a)
- *Guidelines for Ecological Risk Assessment* (US EPA 1998b)
- *Region 10 Supplemental Guidance for Ecological Risk Assessment* (USEPA 1997)

Relevant ADEC risk assessment guidance includes:

- *Draft Risk Assessment Procedures Manual* (ADEC 2011)
- *Risk Assessment Procedures Manual* (ADEC 2010a)
- *Ecoscoping Guidance* (ADEC 2009a)

- *User's Guide for Selection and Application of Default Assessment Endpoints and Indicator Species in Alaskan Ecoregions* (ADEC 1999)

- *Policy Guidance on Developing Conceptual Site Models* (ADEC 2010b)

- *Cumulative Risk Guidance* (ADEC 2008a)

Other relevant and supplementary guidance documents that were considered and included where appropriate include, but not necessarily limited to:

- BLM *Criteria for Risk Management for Metals at Mining Sites* (Ford 2004);

- USEPA *Role of Screening-level Risk Assessments and Refining Contaminants of Concern in Baseline Ecological Risk Assessments* (USEPA 2001),

- USEPA *Guidelines for Exposure Assessment* (USEPA 1992),

- USEPA *Wildlife Exposure Factors Handbook* (USEPA 1993),

- USEPA *Generic Assessment Endpoints for Ecological Risk Assessments* (USEPA 2002),

- USEPA *Framework for Inorganic Metals Risk Assessment* (USEPA 2004)

- ADEC *Environmental Laboratory Data and Quality Assurance Requirements* (ADEC 2009b)

- ADEC *Guidelines for data reporting, data reduction, and treatment of non-detect values* (ADEC 2008b)

1.2 Approach

With the goal of improving the quality and consistency of its own ecological risk assessments and addressing the unique nature of the ecological regime in Alaska compared to the continental U.S., ADEC published a set of guidelines (ADEC 2011, 2010a) to describe the process, which is largely consistent with the overall format presented in USEPA (1998a,b).

The guidelines incorporate the elements needed to assess the likelihood that adverse ecological effects may occur as a result of exposure to one or more stressors. As outlined in both USEPA and ADEC guidance, the basic steps in an ecological risk assessment include problem formulation, analysis (consisting of an exposure assessment and an effects assessment), and risk characterization. This report subsequently addresses each of these steps. This risk assessment followed the ADEC risk assessment format as closely as possible and where appropriate.

2. Problem Formulation

The problem formulation stage of the ERA integrates information about site characteristics, exposure opportunities, and chemical and biological information to generate a set of assessment endpoints (explicit statements of an environmental value that is to be protected), an ecological conceptual model, and an analysis plan. Designed to establish the framework to evaluate hypotheses about what ecological effects can occur from the environmental conditions at the site, the problem formulation process is the foundation of the ecological risk assessment.

The proposed project is conceptual in nature, as mining has not begun in the area. Thus, an understanding of the general configuration and chemical elements of the future pit lake is based on descriptions and analyses provided in several supporting documents, which are identified below as elements of the future pit lake are described.

Following a conceptual description of the future ACMA pit lake, expected habitats are described and chemicals of potential concern (COPCs) are identified. This information was used to formulate a set of assessment endpoints and an ecological conceptual model. A set of measurement endpoints (the analysis plan) is then described in order to characterize ecological risk.

2.1 General Site Description

The proposed Donlin Project is located approximately 277 air miles west of Anchorage, and 145 miles northeast of Bethel, Alaska (Figure 2-1). Open pit mining is proposed to occur over a 20 year period at the site using a conventional truck-and-shovel operation. The proposed facilities study area (FSA) associated with the mine lies within the interior forested lowlands and uplands ecoregions, characterized by rolling lowlands, dissected plateaus and rounded low to high hills (Griffin 2010, Markon 1995). The proposed site will result in the development of 2 pits that would eventually converge as mining progresses. Upon cessation of dewatering activities, a pit lake is expected to form in the ultimate pit. The pit lake will fill to the overflow elevation of 110 meters over a period of approximately 53 years, at which point it will require a controlled discharge to the receiving environment.

2.2 Climate

The continental climate of interior southwestern Alaska is relatively dry, with precipitation averaging ~20 inches per year, with the majority of precipitation falling in July, August and September. Meteorological stations were installed by Donlin within the FSA in 2003, and temperature data collected between 2003 and 2008 show an average mean annual temperature of about 28.9°F (hourly maximums and minimums were 80.6 and -36.6°F, respectively). Predominant wind direction at the FSA is to the southeast, as measured from these meteorological stations.

2.3 Environmental Setting

2.3.1 Vegetation Communities

The proposed mine is located within the interior ecoregion, characterized as having vegetation communities that include needleleaf, broadleaf and mixed forests, with variable vegetation communities including white spruce and black spruce forests, tamarack in the bottom areas, broadleaf forests of balsam poplar and quaking aspen on floodplains, and a variety of willow scrub communities. Wildlife known to be associated with the interior forested lowlands and uplands sub-ecoregions include moose, brown bear, caribou, beaver, arctic fox, Alaska hare, ptarmigan, raven, and golden eagle.

A vegetation survey in areas surrounding the FSA was completed in 2006 (MSES 2006). Six vegetation types, corresponding to Alaska Vegetation Classification system Viereck Level 1 types (Viereck et al. 1992), were identified; these were further classified into 29 communities (Viereck Level 3 or 4), all of which are common and widespread throughout the region. Table 2-1 summarizes the vegetation types and communities identified.

2.3.2 Wildlife

The kinds of wildlife that are, or could be, present at the site and/or were considered for evaluation in the ecological risk assessment were derived from several sources:

- Alaska Department of Environmental Conservation (ADEC)
- US Fish and Wildlife Service (USFWS)
- Alaska Division of Fish and Game (ADF&G)
- Site-specific survey data
- Tribal subsistence surveys

These sources of information were researched to obtain lists of wildlife that could potentially be present in the vicinity of the proposed pit lake. Below are descriptions of various groups of species:

2.3.2.1 Threatened, endangered and candidate species

The USFWS provides lists of federally listed threatened and endangered (T&E) species for Alaska. Table 2-2 summarizes these species and their potential presence in the region. Many of the T&E species listed are marine mammals. Of the T&E species listed in Table 2-2, ten species are listed as endangered and 5 species are listed as threatened within Alaska. None of the listed populations are known to occur within the FSA.

Kittlitz's murrelet (*Brachyramphus brevirostris*) is the only candidate species in the state of Alaska. There is no confirmed identification of a Kittlitz's murrelet within the project in its entirety. During a wildlife observation study in 2007, a single unidentified murrelet was sighted in the far distance resting on the water of the Kuskokwim River near Tuntutuliak. This was the only murrelet sighting during the observation period (RWJ 2008).

2.3.2.2 Comprehensive Wildlife Conservation Strategy Species

The ADF&G prepared a Comprehensive Wildlife Conservation Strategy (CWCS) in a planning effort to secure funding directed at conserving the diversity of Alaska's wildlife resources, focusing on those species with the greatest conservation need (ADF&G 2006). Objectives of the document's development include the need to further responsible development and address other needs of a growing human population. In preparation of this document, the department prepared a list of CWCS nominee species, i.e., Alaska's species of greatest conservation need. The appendix of this plan, which contains a comprehensive list of candidate species, is included in Appendix A.

The candidate list of CWCS species replaces the previous program that included a list of species of special concern (SSC). SSC species are defined by the state of Alaska as any species or subspecies of wildlife or population of mammal or bird native to Alaska that has entered a long-term decline in abundance or is vulnerable to a significant decline due to low numbers, restricted distribution, dependence on limited habitat resources, or sensitivity to environmental disturbance.

2.3.2.3 PSFC Species

The U.S. Geological Survey Boreal Partners in Flight (an Alaska working group of over 100 state, federal and private organizations) designated some wildlife as Priority Species for Conservation (PSFC). This designation is for species with downward trending populations in the major biogeographic regions in Alaska. There are eight species listed as PSFC within southwestern Alaska (Table 2-3), of which four were detected within the area surrounding the entire proposed project (not including the proposed pipeline). These include the Gray-cheeked Thrush (*Catharus minimus*), Varied Thrush, Rusty Blackbird, and Gyrfalcon (*Falco rusticolus*).

2.3.2.4 Wildlife Data from Parks and Refuges

The nearest refuge to the FSA is the Yukon Delta National Wildlife Refuge, below Aniak, through which the Kuskokwim River flows. The Yukon Delta National Wildlife Refuge supports breeding populations many waterfowl, shorebird and raptor species. The USFWS manages Yukon Delta National Wildlife Refuge species lists. The species presented in these lists is shown in Appendix B. Few species observed in the Yukon Delta National Wildlife Refuge would be expected to occur in the FSA because the habitats in the FSA area are markedly different than the Refuge area. The FSA lies in a different ecoregion than the Refuge.

2.3.2.5 Other Published Studies

A list of potential bird species in the area was put together from distribution maps provided by Armstrong (1995) and Sibley (2003). This list is provided in Table 2-4.

2.3.2.6 ADF&G Game Species Monitoring Programs

ADF&G monitors many of the highly valued game populations in the state. Many of the game populations monitored by ADF&G could potentially be in the area at or adjacent to the FSA. The following descriptions below summarize the information provided by ADF&G on the populations and dynamics of game species potentially in the area:

Black Bears. Of the large mammals in the area, black bears appear to be the most abundant. Bag limits on black bear are liberal in the area in part to decrease black bear predation on moose calves and thereby assist moose population growth (ADF&G 2004).

Caribou. Caribou tend to be infrequent migrants through the FSA. The proposed project is located between what the ADF&G considers to be the home range of two distinct large caribou herds: 1) The Western Arctic Caribou Herd, located to the north of the FSA; and 2) The Mulchatna Caribou Herd, located to the south and west of the FSA. There is also a Beaver Mountain Caribou herd, which is a small herd located north and east of the FSA (ADF&G 2008a). The FSA area does appear to support lichen species and habitats that could be utilized by caribou.

Moose. In the boreal forests of interior Alaska, moose densities typically remain well below levels that their habitat can support (ADF&G 2008b). Moose occur in relatively low densities throughout the area in which the proposed FSA is situated (Post 2004). ADF&G considers moose abundance in the region to be in a Low Density Dynamic Equilibrium, meaning the number of moose fluctuates, but remains well below the density that the habitat can support (ADF&G 2008b).

Wolves. Wolf populations are considered to be increasing or stable within the game management units in the region (ADF&G 2003). Since 2004, programs have been in place to deliberately reduce the wolf populations in GMU 19A (in the vicinity of the proposed mine) to encourage moose population recovery (ADF&G 2004).

Wolverines. Wolverines are presently expected to be more numerous in the southwestern portion of the project in its entirety, where prey species are more abundant. Wolverines are known to travel up to 40 miles a day looking for food (ADF&G 1994b). Because of the very large home ranges that these animals exhibit, it is likely that wolverines utilize habitats in and around the proposed FSA area.

2.3.2.7 Subsistence surveys

Published data from the ADF&G Subsistence Division, including the recent technical paper on subsistence harvests in 8 communities in the central Kuskokwim River drainage (Brown et al. 2012), provided information on subsistence use in the area. Data are generally compiled for each community, including both Native and non-Native harvesters. These data were used to generally summarize past subsistence activities, identify harvest areas and note recent harvest levels for certain key species. A summary of the species of animals and plants obtained through these reports is shown in Table 2-5.

2.3.2.8 Site Survey Data

Wildlife surveys have been conducted around the site since 2004. The following summarizes wildlife survey activity that included surveys within the proposed FSA:

Type of Survey	Year Performed	Scope of the Survey
Avian Survey - Initial	2005	Initial baseline study to determine what avian species are in the vicinity of the FSA
Avian Survey - Baseline	2007-2010	Habitat-based point-count surveys and raptor nest surveys throughout the FSA area, along the Kuskokwim River, at a reference area 5 miles beyond the FSA footprint and in the proposed wind farm site to identify potential conflicts that a wind farm may have on wildlife and wildlife habitat
Wildlife Survey - Initial	2006	Initial baseline study to identify habitat types and wildlife-habitat linkages
Spring Wildlife Study - Furbearer	2006-2010	Furbearer tracking survey throughout the FSA and along the Kuskokwim River Corridor
Spring Wildlife Study - Owl	2004, 2007 and 2008	Nocturnal owl survey
Wildlife Survey - Water Transportation Corridor	2006-2008	Wildlife observations along the Kuskokwim River
Fall Moose Survey	2007, 2008, 2010	Aerial moose population survey throughout the FSA and along the Kuskokwim River Corridor
Spring Moose Survey	2007-2009	Aerial moose population survey throughout the FSA and Kuskokwim River Corridor

A summary of birds observed within study boundaries, which includes areas within and near the FSA and along the Kuskokwim River, is shown in Table 2-6; mammals observed within survey boundaries are shown in Table 2-7.

2.4 Habitats Expected in the Pit Lake

Biological development in the future pit lake, including the potential for littoral zone development, will depend on the pit lake's physical characteristics, its water chemistry and nutrient availability, and the environment in which it is situated. The pit itself is deep and surrounded by steep, high walls. During the period of infilling, water levels are expected to rise rapidly, which will prohibit development of substantial biological activity. The surface water level will also be low relative to the surrounding, steep pit walls. For these reasons, the habitat during this pit filling stage of development is expected to be limited to just the lake water. Once the pit lake has reached hydraulic equilibrium (~year 53), small littoral and riparian areas may begin to develop based on the pit geometry and expected surface water levels relative to the rim of the pits. Thus, the expected habitat of the mature pit lake will include the lake itself and potentially some development of riparian and littoral zones.

Exposure to the pit lake environment during the pit lake filling stage is expected to be limited largely to flying individuals that can access the water at the bottom of the pit. Thus, the pit lake at this stage could provide a drinking source for birds, and resting substrate for waterfowl. The mature pit lake environment will allow for greater access and resource use by wildlife, and therefore can provide a drinking source to birds and mammals, resting substrate for waterfowl, and foraging and nesting habitats and a food source for wildlife in the form of aquatic species.

2.5 Ecological Conceptual Site Models

An ecological conceptual model describes the relationship between the primary media of interest and ecological components of an environment. Such models were developed for the pit filling (Figure 2-2) and mature pit lake (Figure 2-3) scenarios based on the life history characteristics of ecological receptors; environmental fate, transport, and toxicological properties of stressors; and ecological conditions of the pit lake. Based on the conceptual models, the major groups of ecological receptors expected at the mature pit lake include waterfowl, omnivorous and insectivorous birds and mammals, predatory birds and mammals, and large game species. Ecological receptors expected at the pit lake during pit filling include waterfowl and other migratory bird species.

Fish were not included in this ecological risk assessment because persistent fish populations are not proposed to be added, nor expected to be present in the pit lake given the proposed barrier (i.e., a water treatment facility) to fish migration from the Crooked Creek drainage to the pit lake. Access barriers to prevent human access are also planned around the pit rim. The mine's current closure plan does not incorporate human recreation as a post-mine pit lake land use, nor does it include a plan to stock the pit lake with fish.

2.6 Assessment Endpoints

Assessment endpoints are explicit statements of an environmental value that is to be protected (USEPA 1998a). For this ERA, the endpoints were developed following consideration of the structure and function of the future pit lakes ecosystem, susceptibility to COPCs, policy goals, ADEC guidance (ADEC 1999), and other societal values, including consideration of threatened and endangered species.

The primary assessment endpoint identified for this ERA is protection against the potential for significant adverse effects on wildlife species abundance and diversity due to chemical concentrations in the proposed future pit lake. Following this primary assessment endpoint, specific assessment endpoints include:

- protection against the potential for significant adverse effects on abundance and diversity of waterfowl due to chemical concentrations in the future pit lake.
- protection against the potential for significant adverse effects on abundance and diversity of herbivorous birds and mammals due to chemical concentrations in the future pit lake.
- protection against the potential for significant adverse effects on abundance and diversity of omnivorous birds and mammals due to chemical concentrations in the future pit lake.
- protection against the potential for significant adverse effects on abundance and diversity of insectivorous birds and mammals due to chemical concentrations in the future pit lake.
- protection against the potential for significant adverse effects on individual threatened, endangered or special status species due to chemical concentrations in the future pit lake.

- protection against the potential for significant adverse effects on abundance and diversity on predatory birds and mammals due to chemical concentrations in the future pit lake.

2.7 Measurement Endpoints and Analysis Plan

The analysis plan includes identifying a set of measurement endpoints with which to characterize ecological risk. Measurement endpoints are defined as measurable environmental characteristics that are related to the valued characteristics that are to be protected (USEPA 1992). However, the USEPA (1998a) replaced the term “measurement endpoints,” which addressed the response of an assessment endpoint to a stressor, with more inclusive “measures,” and identified three categories of measures: effect, exposure, and ecosystem characteristics. They are defined as:

Measures of ecosystem and receptor characteristics – measures of ecosystem attributes (e.g., amount of cover, abundance of prey) that influence the behavior and location of entities selected as assessment endpoints, the distribution of a stressor, and life history characteristics for the assessment endpoints or their surrogates that may affect exposure or response to the stressor (e.g., nesting behavior, food selection, area use, etc.).

These measures describe the components of the problem formulation stage, including the expected future habitat of the pit lake and the ecology of selected receptors. The measures of ecosystem and receptor characteristics are then extrapolated to estimates of exposure and dose.

Measures of exposure – measures of stressor existence and movement in the environment and their contact or concurrence with the assessment endpoint. The measure of exposure used to characterize risk in this ERA is the estimation of COPC dose to each type of receptor identified in the problem formulation stage. The total daily rate of COPC dose for each wildlife receptor-COPC combination was estimated using the exposure model derived from the USEPA (1993).

Measures of effect – measurable changes in an attribute of an assessment endpoint in response to a stressor to which it is exposed (also referred to as “measurement endpoints”). Measures of effect measure a response of an environmental receptor to a stressor (e.g., reproductive success in response to ingestion of a chemical). The measures of effect used to characterize wildlife risk in the ERA included calculation of toxicity reference values, derived from literature studies that measured effects from exposure of similar species to chemicals.

These measures constitute the analysis plan, and are used to evaluate whether the future pit lake habitat will be suitable for the ecological receptors that may use the lake.

2.8 Receptor Identification

Specific species receptors ("receptors of interest", or ROI) were identified for both the pit filling and mature pit lake environments because in ecological risk assessments, the quantitative evaluation of wildlife exposure and risk requires that specific numerical information about the organism under consideration be measured, such as food and water intake rates and body weights.

Because not all individual species or wildlife trophic components of an ecological system are practical to evaluate quantitatively (USEPA 1998a,b), several representative species were chosen in association with the assessment endpoints. Selection of these indicator species was based on consideration of all functional groups, their potential for exposure by direct and indirect pathways (i.e., exposure through food web interactions), regulatory guidance, and other stakeholder considerations, including subsistence use.

The species identified to be potentially present in the area of the FSA were considered for receptor selection. In addition, ADEC published specific guidance on the selection of ROIs. The guidance can be found in the following publications:

- *Draft Risk Assessment Procedures Manual* (ADEC 2011)
- *Risk Assessment Procedures Manual* (ADEC 2010a).
- *User's Guide for Selection and Application of Default Assessment Endpoints and Indicator Species in Alaskan Ecoregions* (ADEC 1999).

Additionally, Shannon and Wilson (1999) identified groups of cultural value, functional and sensitive species potentially present in the Interior ecoregion (Tables 2-8 and 2-9).

Some key ADEC-specific considerations in the selection of ROIs are as follows:

1. ADEC recommends that, where applicable, threatened and endangered species

are be used as assessment endpoints, but not as measures. An indicator species from the same trophic level should be selected as a surrogate to assess ecological risk to the endangered species.

2. ADEC provided lists of default ROIs to consider using in ecological risk assessments, based on the ecoregion(s) in which the site is situated.

3. Assessment endpoints should be identified before selecting ROIs.

Final selection of ROIs for the pit lake ERA is shown in Table 2-10. This table summarizes the representative nature of each species according to different considerations for the project as a whole. In sum, the ROIs include:

- Black bear
- Gray wolf
- Mink
- Snowshoe hare
- Tundra vole
- American dipper
- Dark-eyed junco
- Mallard duck
- Northern shrike

All species shown above were assessed for the mature pit lake scenario. The species selected to assess for the pit filling stage of development include the avian species listed. It is assumed that access the pit during filling is restricted such that only flying species are likely to be attracted to such a water body and be able to access it.

Summaries of each ROI ecology are provided in Tables 2-11 through 2-19.

2.9 Identification of COPCs

The primary media of potential concern in the future pit lake is surface water. COPCs were therefore identified for surface water, and exposure of ecological receptors to these COPCs was evaluated. Predicted concentrations of constituents in surface water from Lorax (2012) were used to obtain surface water concentrations for the pit lake. COPCs were identified for the pit filling stage of development and the mature pit lake stage.

2.9.1 General COPC Identification Procedure

Although some criteria have been developed by ADEC and USEPA to determine potential risks to livestock, a comprehensive set of screening-level ecological benchmarks have not yet been developed to relate potential exposure of all types of higher-trophic-level organisms (mammals, birds) to surface water concentrations. Thus, chemicals were compared to livestock criteria and alternative screening benchmarks such as ambient water quality criteria (AWQCs). The AWQCs are conservative estimates of surface water concentrations that will not cause adverse effects on even the most sensitive aquatic species that could be found in surface waters throughout the United States. They are necessarily conservative to account for the variability in pH, water hardness, other geochemical differences that control toxicity, and the diversity of aquatic species present in surface waters in the U.S. Concentrations below AWQCs are generally thought to be protective of all ecological organisms, regardless of trophic level, and therefore are considered a conservative screening benchmark with which to identify constituents needing further evaluation in this risk assessment. Maximum surface water concentrations predicted for each scenario were compared to screening benchmarks. Constituent concentrations that exceeded screening benchmarks were carried through into the risk assessment.

The COPC screening process was conducted in the following steps described below. All benchmarks described below, and the pit lakes water quality results, are summarized in Table 2-20. Where chemistry predictions concluded that concentrations would be less than detection limits, one-half the detection limit was compared to the benchmark.

Step 1. Nutritive chemicals were compared to livestock criteria in 18 AAC 70 or, if criteria were not available from this source, then nutritive chemicals were compared to livestock maximum contaminant concentrations in NRC (2005). None of the nutritive chemical concentrations are predicted to occur above normal nutritional levels, and where therefore not evaluated further.

Step 2. Non-nutritive chemicals were compared to ADEC water quality criteria (18 AAC 70) for livestock. Chemicals above these criteria were retained for the risk assessment.

Step 3. Non-nutritive chemicals were compared to ADEC aquatic life chronic criteria for freshwater organisms. Chemicals above these criteria were retained for the risk assessment, following considerations as outlined in Step 5.

Step 4. If no criteria were available from sources in the above steps, then alternative available ecological screening-level benchmarks were developed. Sources of screening benchmarks were consulted in the following order: 1) USEPA chronic criteria for freshwater aquatic life, 2) secondary chronic values or alternative benchmarks in Suter and Tsao (1996), 3) ADEC criteria for irrigation water, 4) other applicable benchmark values published in the literature.

Step 5. Other benchmark considerations were considered in the screening process.

2.9.2 COPC Screening for Pit Filling Stage

Lorax (2012) provided time trends for each constituent modeled. The modeled constituents showed a decreasing trend in concentrations as the pit fills. Although exposure of wildlife to the pit lake during development (years 1-52) will be lower given the limited access and habitat development during this time, a screening and assessment was conducted for this pit lake stage to address the higher constituent concentrations during this time period.

Maximum constituent concentrations during the pit lake development stage were screened to identify COPCs following methods described in the previous section. Comparison of surface water concentrations to screening benchmarks is shown in Table 2-20. The following constituents were retained as COPCs for a pit filling stage assessment:

- Antimony
- Arsenic
- Cadmium
- Chromium
- Cobalt
- Copper
- Lead
- Nickel
- Selenium
- Zinc

2.9.3 COPC Screening for Mature Pit Lake Environment

In the mature pit lake scenario, maximum chemical concentrations predicted for years 52 through 99 were chosen to evaluate ecological risk. The following constituents were retained as COPCs for a mature pit lake assessment:

- Antimony
- Arsenic
- Selenium

3. Exposure Assessment

3.1 Exposure Model

Ingestion is assumed to be the primary exposure pathway for wildlife. Ecological risk from exposure to surface water COPCs is the primary assessment goal of the ERA. However, the COPCs identified in the problem formulation section also naturally occur in the sediments associated with the pit lake environment. In addition, bioaccumulation or bioconcentration of the COPCs in plants and insects can occur in the mature pit lake scenario, creating a secondary exposure to wildlife from ingestion of prey.

The exposure pathways considered for the ROIs included ingestion of pit lake water, and for the mature pit lakes scenario, ingestion of food and incidental ingestion of sediment (while consuming food). Maximum concentrations of COPCs predicted in surface water for the pit lake (pit filling and mature scenario) were used to calculate dose for wildlife. For the mature pit lake scenario, ingestion of sediment was assumed for birds or mammals whose prey items include sediment-dwelling aquatic invertebrates or aquatic plants. Total daily rate of COPC ingestion for each receptor-COPC combination was estimated using the following exposure model, derived from the USEPA (1993).

$$Dose = \frac{SUF \times [(IR_{food} \times C_{food}) + (IR_{soil} \times C_{soil}) + (IR_{water} \times C_{water})]}{BW} \quad \textbf{(1)}$$

Where:

Dose	=	estimated daily dose of COPC from ingestion (mg/kg BW/day)
SUF	=	site use factor (unitless)
IR_{food}	=	amount of food ingested per day (kg wet/day)
C_{food}	=	EPC of COPC in food items (mg/kg wet weight)
IR_{soil}	=	amount of sediment incidentally ingested (kg wet/day)
C_{soil}	=	EPC of COPC in soil or sediment (mg/kg wet weight)
IR_{water}	=	amount of water ingested per day (L /day)
C_{water}	=	EPC of COPC in water (mg/L)
BW	=	body weight (kg wet)

Most input parameters were obtained directly from empirical data presented in the literature. Remaining parameters were calculated as described in the sections below. A summary of ingestion rates and other exposure profile information for each species are presented in Tables 2-12 through 2-19.

3.1.1.1 Ingestion Rates

Where empirical food ingestion rates were available in the literature, these were preferred over methods to estimate ingestion rates. Where literature data was not available, free-living metabolic rate models developed by Nagy (1987) and used by the USEPA (1993) to estimate food ingestion rates was utilized for the remaining wildlife receptors. The model is:

$$NIR_{total} = \frac{NFMR}{ME_{avg}} \qquad \textbf{(2)}$$

Where:

NIR_{total} = Total normalized ingestion rate (g/g/day)

NFMR = Free-living metabolic rate normalized to body weight (kcal/g/day)

ME_{avg} = Metabolizable energy of the kth food type (kcal/g wet weight)

This model is most appropriate for calculating the food intake rates of species since intake rates vary depending on metabolic rates and composition of the diet (USEPA 1993). Most ROIs consume a variety of prey items, and each type of prey item has a specific metabolizable energy. Thus, in order for the predator (or receptor) to meet its daily energy needs, food intake rates will vary depending on the kinds of prey items consumed.

The average metabolizable energy (MEavg) of prey items is determined by:

(3)

$$ME_{avg} = \sum (P_k \times ME_k)$$

Where:

P_k = proportion of the total number of prey (fraction)

and

(4)

$$ME_k = GE_k \times AE_k$$

Where:

GE_k = Gross energy content of the kth food type (kcal/g wet weight)

AE_k = Assimilation efficiency for the species in the kth food type (unitless)

The free-living metabolic rate normalized to body weight is determined by:

(5)

$$NFMR = \frac{FMR}{BW}$$

Where:

FMR = Free-living metabolic rate (kcal/day)

BW = body weight (g)

Equations to estimate FMR were obtained from Nagy (1987). Information about the gross energy, water compositions and assimilation efficiencies was obtained in USEPA (1993).

Water intake rates are also dependent on metabolism and were determined for birds and some mammals using equations developed by Calder and Braun (1983) and USEPA (1993), where:

(6)

$IR_{water} = 0.059(BW)^{0.67}$ (for birds)

and

(7)

$IR_{water} = 0.099(BW)^{0.90}$ (for mammals)

Where:

IR_{water} = Ingestion rate of water (L/day)

BW = Body weight of the species (kg).

Sediment ingestion rates were calculated for all species using the equation:

(8)

$IR_{soil} = IR_{food} \times CF \times SI$

Where:

IR_{soil} = Ingestion rate of sediment (kg dry weight/day)

IR_{food} = Ingestion rate of food (wet kg/day)

CF = Wet weight to dry weight conversion factor

SI = Fraction of sediment in diet.

The fraction of sediment in species' diets was obtained from literature where available. For cliff swallows, the fraction of sediment consumed is not precisely known. During breeding season, cliff swallows build nests out of local grass and mud. Sediment ingestion was calculated by assuming an ingestion rate of 2% of their daily diet during nest building period (Beyer et al. 1994), which covers up to 3 weeks, or 11% of their six-month exposure duration.

3.1.2 Exposure Point Concentrations

3.1.2.1 Water

The procedure used to predict pit lake chemistry for the future ACMA pit lake has been described elsewhere (Lorax 2011). The maximum concentration of COPCs in the pit lake between year 2 and year 52 was used for the pit filling stage surface water EPC, and the maximum concentration of all at the mature pit lake stage (100-year prediction) was used as the mature pit lake surface water EPC. Water EPCs are shown in Table 3-1.

3.1.2.2 Sediment

Ingestion of sediment by wildlife in a mature pit lake environment could potentially occur in the shallow littoral or riparian zones of the pit lake. Sediment EPCs along the pit rims were estimated from representative whole rock samples (SRK 2007). Sediment EPCs are shown in Table 3-2.

The use of bulk sediment chemistry to estimate wildlife exposure from incidental sediment ingestion will overpredict risk to ecological receptors, because the concentrations represent only the unweathered whole rock data fraction, which will have the largest sediment metal mass. Sediment that accumulates along the pit rim will be a mixture of the pit shell rock types as well as surrounding alluvial soil (containing lower concentrations of metals), that is transported by wind or water erosion into the shallow littoral zone of the pit lake. Additionally, the bioavailable fraction of metals from the bulk sediment matrix is expected to be limited by the rate of kinetic dissolution of the ingested particles, which is a function of animal physiology (e.g., stomach pH, residence time), particle size of the sediment, and sediment mineralogy. Studies have found that solubility of some metals from soils, mine wastes, and sediments was site-specific but generally accounted for <50% of the total metal mass (e.g., USEPA 2007a, Davis et al. 1996, etc).

3.1.2.3 Food

Because the pit lake does not yet exist, concentrations of COPCs in food (prey items) for the mature pit lake scenario have to be estimated using a set of bioaccumulation factors (BAFs). BAFs describe the relationship between COPCs environment and uptake into the prey items considered. The use of BAFs to estimate concentrations of metals in food items is highly conservative because this method assumes that all metals accumulated in invertebrates or plants are 100% bioavailable to the predator. In fact, once absorbed into the organism, many heavy metals are typically sequestered into nonbioavailable forms such high-molecular-weight ligands, inert granules, or chelatins. These nonbioavailable forms are nontoxic both to the aquatic organism (Fisher and Hook 2002, Chen and Folt 2000), and its predators (Lakso and Peoples 1975, Selby et al. 1985, Suedel et al. 1994, Dietz et al. 2000).

The kinds of food items associated with the mature future ACMA pit lake could include aquatic plants and invertebrates. BAFs were obtained from studies that measured plant and invertebrate bioaccumulation from other lentic or lotic environments, including other pit lakes. BAFs for aquatic plants and invertebrates were developed based on the presumed relationship between sediments and the aquatic biota. Since the types of plants and invertebrates expected in the future pit lake would be sediment-rooted or sediment-dwelling species, it is appropriate to derive BAFs from sediment-to-tissue relationships. Aquatic BAFs used in the ERA are presented in Table 3-3.

BAFs were used to estimate wildlife dose from food consumption using the following equation:

(9)

$$Dose_{food} = \sum IR_{food_k} \times (C_{media} \times BAF_k)$$

Where:

IR_{food-k} = ingestion rate of the kth food item

C_{media} = concentration in the exposure media (sediment or soil)

BAF_k = bioaccumulation factor for the kth food item

4. Effects Analysis

Toxicity reference values (TRVs) are estimates of exposure levels below which unacceptable adverse effects are not expected to occur. TRVs were derived for each individual receptor and chemical combination, and are used as ecotoxicity screening values against which receptor-specific exposure estimates are compared.

TRVs used in this ERA were derived from studies best suited to each receptor and the assessment endpoints relevant to this study. This included screening the toxicity databases for studies that assessed chronic exposure of physiologically similar species and measured endpoints consistent with the objectives and goals of this ERA, which are to protect reproduction, growth and development in wildlife.

To derive TRVs based on phylogenically similar species, exposed via similar routes of exposure (i.e., through the diet), which measured toxicological endpoints comparable to the assessment endpoints, several steps were taken:

Step 1. Assemble toxicological databases. Literature databases were assembled that contained all available chronic and subchronic studies on birds and mammals. Since it is not appropriate to derive TRVs for birds from studies on mammals, and vice versa, separate databases for birds and mammals were assembled. Acute studies were excluded from the database since these studies do not assess long-term effects on animals and therefore do not accurately represent potential adverse risks associated with growth, reproduction, and development of species. TRV information was obtained by review of several sources, including:

- USEPA EcoSSLs,
- Sample et al. 1996,
- Eisler 2000,
- EPA IRIS, and EcoTox databases, and
- the general literature.

Step 2. Select appropriate studies from the databases. The availability of toxicity studies varies widely by COPC and by species. For some COPCs, such as selenium and zinc, as many as 10 or more toxicity studies have been published. Selection of appropriate studies from these databases necessarily involves a detailed assessment of the differences between one study and the next, with an objective selection process required to make decisions.

Selection of appropriate studies was based primarily on five principal decision factors:

- biological effects,
- technical quality of study,
- method of administration,
- duration of study / identification of a toxicological endpoint, and
- biological parameters.

Biological effects describe the effects that were measured in each study. They can be broadly classified into effects on reproduction, growth, development, or mortality. Effects on reproduction include eggshell thinning, low birth weights, reduced litter sizes, and decreased hatchability. Reproductive effects are considered one of the most sensitive measurement endpoints for a species, and therefore a key response in assessing long-term chronic impacts on animals. Reproductive effects are also part of the assessment endpoints identified in this ERA and are therefore considered a crucial measurement endpoint for studies selected for derivation of TRVs. Growth effects include weight loss or gain, and physiological impairment. Growth effects were considered acceptable but less desirable, because the relationship between growth and population-level effects is uncertain. For example, weight gain is typical during early life stages and is usually considered a positive measure of health, but it has been shown (NRC 2005) that calves exposed to low doses of arsenic gain more weight than unexposed groups.

Developmental effects include decreased food consumption and other individual responses such as histopathological changes and behavioral effects. However, developmental effects are not obviously linked to other assessment endpoints. Therefore, they were considered as a relevant factor in the selection of studies to derive TRVs but unless multiple developmental effects were evaluated in the study, the study was weighted less so than other studies on growth or reproduction.

Mortality is not a preferred endpoint for study selection because its effects are final and it is usually the cumulative result of other, sublethal, effects detected at lower exposures. However, for some COPCs, effects on mortality rates were the only category of studies available and were therefore considered in deriving appropriate TRVs.

Technical quality of study includes assessment of critical parameters such as whether a chemical is isolated or in combination with other chemicals, and whether a normal nutritional level was maintained during the exposure period. It is important in this ERA to derive TRVs from studies involving exposure to isolated chemicals because many effects of one chemical can be masked by the addition of another chemical. Further, while it is recognized that exposure to a combination of COPCs may sometimes reflect conditions in the wild, the long term additive effects of multiple COPCs are not known. It is the approach of this ERA to screen individual COPCs for further consideration by applying safety factors (i.e., uncertainty factors) and other conservative assumptions to the risk characterization process.

Normal nutritional levels are a second critical parameter for each study selected because malnourishment can interfere with chemical assimilation and metabolic functions, and can result in exacerbated or subdued effects from exposure (Newman 1998). Finally, the number of test organisms is an important consideration in the selection of studies because individual effects of chemicals can vary; statistically significant numbers of test individuals are important in order to assess population-level effects of COPCs on receptors.

Method of administration describes the route of exposure. Because wildlife populations are assumed to be exposed to chemicals in the environment primarily through diet, studies that administered chemicals orally in the diet were considered more desirable than administration by capsule or gavage. Direct injection of chemicals or drenching was not considered acceptable because the route of exposure is significantly different.

Duration of study and identification of a toxicological endpoint identifies the exposure time of the test group to the COPC, and whether a no adverse effect level (NOAEL) or low adverse effect level (LOAEL) was identified. Chronic exposure for mammals is defined as more than one year, and/or over a critical life stage, and greater than 10 weeks for birds (Sample et al. 1996). Acute studies were not considered appropriate for TRV derivation.

Biological parameters are receptor-specific and consider the similarity in phylogeny between the test organism and the wildlife receptor. Although it was considered most desirable to match the test species to the wildlife receptor, toxicological studies are typically limited to a few species. If the test organism had the same phylogenic characteristics of the wildlife receptor, this aspect of the study was preferred over a study for which the test organism had only a similar diet or physical traits as the wildlife receptor. Distinctions between bird species used in test studies were less variable, although some studies were selected based on phylogenic distinctions.

An example of the categories and point system for cadmium in birds is shown in Table 4-1. Each study listed under the same COPC category was assigned points for each receptor. Some attributes of categories were weighted based on the relevance of these parameters to assessment endpoints, and the sensitivity of the parameter to toxicological effects. For example, reproductive and/or developmental study endpoints were weighted above other kinds of endpoints because these study endpoints coincided with the ecological assessment endpoints, and are sensitive indicators of toxicological effects. Appropriate studies were selected for each COPC-species combination based on the total number of points.

Step 3. Derive NOAELs and LOAELs. Once appropriate studies were selected, study NOAELs and LOAELs were derived. NOAELs and LOAELs are expressed as mg constituent/kg body weight per day (mg/kg-bw day). If not available in the study, ingestion rates were calculated using empirically based ingestion models as described in the exposure assessment section above. Other missing information needed to calculate NOAELs and LOAELs, such as body weights, was obtained either from standard EPA information on laboratory animals or from a paired study published separately. Following USEPA methodology (USEPA 1995), if a NOAEL was not identified in the study, the LOAEL was divided by a factor of 10 to derive the NOAEL. If a LOAEL was not identified in the study, the NOAEL was multiplied by a factor of 10 to derive the LOAEL. Both NOAELs and LOAELs were derived to represent the upper and lower bounds of potential COPC risks to receptors.

Step 4. Apply uncertainty factors. Once study NOAELs and LOAELs were calculated, uncertainty factors were applied to extrapolate the study NOAELs and LOAELs to TRV_{NOAELs} and TRV_{LOAELs}. Application of uncertainty factors helps to ensure that the TRVs are appropriate for the exposure conditions and specific receptors being evaluated for the ERA. However, extrapolations must have a clear relationship to the field effect of concern (Chapman et al. 1998). Uncertainty factors applied to study NOAELs and LOAELs used the UF application matrix shown in ADEC (2010a, 2011).

Uncertainty factors (UFs) are multiplicative. The total uncertainty factor is used in the denominator of the following equation, to adjust the study NOAEL or LOAEL to a TRV:

(10)

$$TRV = \frac{Study\ Dose}{Total\ UF}$$

Wildlife TRVs derived for the ERA are shown in Table 4-2.

5. Risk Characterization

Risk characterization is the process of integrating exposure and effects data and evaluating any uncertainties. In this section, exposure concentrations described in Section 3 and chemical effects data described in Section 4 are compared to determine the potential for ecological risk.

5.1 Risk Characterization Methods

For each receptor-COPC combination, upper and lower bound hazard quotients (HQs) were calculated to estimate the likelihood of ecological risk. The HQ calculations are not measures of risk; they serve as a “cautionary signal” that potential hazards are present and are indicators of whether further evaluation or natural resource management is needed. An HQ is the ratio of the exposure concentration to the effects concentration. A lower-bound and an upper-bound HQ were calculated to characterize the potential range of effects. HQs are calculated as:

(11)

$$HQ_{lower} = \frac{Dose}{TRV_{NOAEL}}$$

(12)

$$HQ_{upper} = \frac{Dose}{TRV_{LOAEL}}$$

Where:

HQ_{lower} = lower-bound hazard quotient

HQ_{upper} = upper-bound hazard quotient

TRV_{NOAEL} = TRV derived from the measured NOAEL (mg/kg-bw day)

TRV_{LOAEL} = TRV derived from the measured LOAEL (mg/kg-bw day)

Lower and upper bound TRVs were derived for each individual receptor and chemical combination. The lower bound TRV (TRV_{NOAEL}) represents the value below which ecologically significant effects are not expected to occur. The upper bound TRV (TRV_{LOAEL}) represents the value above which ecologically significant effects are expected to occur. Therefore, an HQ_{lower}<1 indicates that risks are not likely; whereas, an HQ_{upper} >1 indicates that risks are likely. If a receptor-COPC combination results in an HQ_{lower} >1 but an HQ_{upper} <1, risks to the receptor from exposure to predicted COPC concentrations are uncertain. In such cases, an uncertainty analysis is performed to help guide risk management decisions.

5.2 Wildlife Risk Characterization Results – Pit Filling Stage

The results of the pit filling stage HQ calculations for each COPC and wildlife receptor are summarized in Table 5-1.

For the pit filling stage, HQs were much less than 1 for all receptor-COPC combinations, indicating risk is unlikely to wildlife exposed to the proposed pit lake during the pit lake development stage.

5.3 Wildlife Risk Characterization Results – Mature Pit Lake Stage

The results of the mature pit lake stage HQ calculations for each COPC and wildlife receptor are summarized in Table 5-2.

For the mature pit lake scenario, results showed that selenium HQ_{NOAEL}s were ≤1 for all receptors, while for antimony and arsenic, HQ_{NOAELS} were >1, but <10, for the following receptors:

- Arsenic HQ_{NOAEL} > 1: American dipper, mallard duck, mink and tundra vole.
- Antimony HQ_{NOAEL} > 1: American dipper, tundra vole, wolf and black bear.

These results indicate that risk to wildlife from exposure to COPCs associated with the ACMA pit lake is not confirmed. In these cases, a review of assumptions and uncertainties is conducted to help guide further interpretation of results.

There were a number of conservative assumptions inherent in the risk assessment, including the use of whole rock concentration data from boreholes to estimate future sediment concentrations, over-estimates of receptor exposure durations, conservative assumptions regarding dietary fractions of pit lake items, and the assumption of 100% bioavailability of ingested sediments and food. These assumptions contributed to overestimates of exposure and risk in the ERA.

A sensitivity analysis on some of the driving exposure assumptions was conducted to help guide interpretation of results. Adjustments in pit lake use frequencies, and estimated sediment concentrations, resulted in the largest reductions in HQs, reducing them proportionally to the percent reduction in both exposure parameter inputs. For this ERA, area use was assumed to be equal to 1 (meaning that receptors spend all their time at the pit lake and do not obtain food or water elsewhere). However, it is more likely that area use of the pit lake will be much less than 1, given the number of other water bodies in the area, some of which could be more biologically productive than the pit lake. Sediment concentrations will also likely be less than the concentrations assumed here, as erosion and deposition of unmineralized surface soil along the pit rim is expected. Sediment concentrations were used to estimate uptake into aquatic plans and invertebrates, which were then assumed to be eaten by some of the wildlife receptors. Therefore, the overly conservative assumptions regarding sediment concentrations also resulted in over-estimates of exposure via food ingestion.

Despite these highly conservative assumptions used for the risk characterization of the mature pit lake, HQ_{NOAELs} were below 1 for most receptors and just above 1 for others, and HQ_{LOAELs} were less than 1 for all receptor-COPC combinations. Sensitivity analysis shows that reductions in sediment concentrations and area uses, which are expected, would result in reductions in HQs below 1 for wildlife receptors. Thus, the interpretation of the HQ results for the mature pit lake scenario is that wildlife risk from chemical exposure in the ACMA pit lake water is unlikely.

5.4 Uncertainty Analysis

This section summarizes the uncertainties associated with each step of the ERA. Quantitative estimates of the potential for adverse effects from exposure to COPCs inherently contain artifacts of uncertainty due to chemical, environmental, and biological variability. The uncertainty analysis summarizes assumptions made for each element of the assessment and evaluates their validity, strengths, and weaknesses. Uncertainties about the assumptions, methods, and parameters used in the problem formulation, analysis, and risk characterization stages were also addressed throughout this document.

5.4.1 Site Ecology

The effects of physical or environmental conditions on wildlife or aquatic community components were not examined in depth in this ERA. Both factors can affect the kind of species present and the duration of exposure to the pit lake. For wildlife receptors, recent, site-specific biological and subsistence survey data collected was used to identify the kinds of species that are currently present in the area and from these considerations as well as risk guidance, a list of ROIs was derived. However, the post-mining landscape, regional or global factors such as global warming could affect the overall site ecology, leading to differences in species distributions or presence in the area than what was assumed in the risk assessment.

For aquatic components, it was assumed that conditions would be suitable for aquatic invertebrate and plant proliferation, and that the productivity and abundance of this prey base would be suitable to support populations of wildlife that might inhabit the pit lake area. Fish were not included in this ecological risk assessment because persistent fish populations are not proposed to be added, nor expected to be present in the pit lake given the proposed barriers to fish entry into the pit lake.

It was also assumed that riparian and littoral habitats could develop in the pit lake, with implications both for site use by wildlife receptors. However, observations of analog pit lakes and the general literature indicate that riparian and littoral zones in pit lakes are often ephemeral and/or minimal. Therefore, the assumptions about exposure to littoral zone ecology may be overestimated.

5.4.2 Exposure Assessment

Intake rates of COPCs by wildlife receptors were derived from the literature or through empirically derived intake rate models, because site-specific data cannot be measured for yet-unrealized future conditions. Exposure durations were assumed to be year-round, although the durations of many receptors will likely be limited based on winter weather conditions, literature-reported migration or hibernation patterns or anecdotal observations of wildlife in the region. Even within a season, wildlife may forage at different water bodies in the area, utilizing the pit lake for only a fraction of the time. These conservative assumptions regarding receptor ingestion of pit lake dietary fractions was assumed in the dose calculations, leading to overpredicted exposures for these receptors, particularly for the mature pit lake scenario. Because many of the exposure assumptions were conservative, a sensitivity analysis was performed for some of the driving exposure assumptions, including sediment concentrations and area use. Results are shown in Figures 5-1 through 5-6. At reduced exposure rate assumptions, HQs were proportionally lower.

Some of the receptors evaluated in this ERA also receive a portion of dietary requirements through ingestion of terrestrial-based food items. “Background” exposures, including incidental soil ingestion and ingestion of terrestrial-based prey were not considered in the risk calculations shown above. This exclusion was based on the premise that exposure of receptors to the COPCs in this area will be minimal, given the unimpacted nature of the surrounding environment and the post-mining reclamation plans which should include covering mineralized components. However, to address the possible uncertainty regarding the incremental risk of pit lake exposure in addition to “background,” ingestion of terrestrial-based items was incorporated in an alternative risk computation scenario. Soil concentrations used for the evaluation are shown in Table 5-3. Terrestrial-based BAFs are shown in Table 5-4.

For the mature pit lake, incorporation of terrestrial-based items into the dietary exposure calculations resulted in increased HQ_{NOAELs} for some receptors, but HQ_{LOAELs} remained <1 (Table 5-5).

For the pit lake filling stage, calculation of only the “background”-based risks resulted in HQs much greater than 1 for many constituents, with the implication being that pre-mining conditions already cause adverse impacts to wildlife (Table 5-6). However, these calculations should be interpreted as an artifact of simplistic, soil-based bioaccumulation models largely derived from USEPA that were developed for highly contaminated systems. Highly contaminated systems will have different bioavailability and bioaccumulation properties than what would be expected in an uncontaminated area. Further, the bioaccumulation factors used regionally-derived soil data, which may over or underpredict site soil concentrations. For the purposes of evaluating incremental risk, however, the addition of pit lake water ingestion to receptors during the pit filling stage indicates that the incremental risk of chemical exposure from the pit lake is negligible (Figures 5-7 through 5-19), resulting in no increased risk to these receptors from the pit lake during this stage of development.

Other uncertainties associated with the exposure assessment include the following:

Bioavailability of COPCs was assumed to be 100% for all media considered. In nature, bioavailability of COPCs in water is heavily influenced by geochemical and environmental constraints including pH, redox conditions, water hardness, and organic matter content. Sediment bioavailability is constrained by the dominant chemical form(s) of the COPC and by the exposure route to the receptor. These bioavailability considerations were not incorporated into the ERA. Since bioavailability of COPCs in prey items affects the effective dose to the predator, the assumption that COPCs are completely bioavailable to the receptor can result in significant overestimation of risks.

Biota accumulation was determined by review of literature which conducted laboratory exposure of representative species to water or sediment for a designated period of time. Bioaccumulation factors were thus obtained and applied to this risk assessment to estimate concentrations in the prey base. BAFs can be strongly site-specific; hence, BAFs obtained from literature can either over or underestimate these media concentrations. Bioaccumulation data was obtained from studies conducted in analog pit lakes and in other lentic environments, representing a range of environmental conditions and potential bioaccumulation patterns.

5.4.3 Effects Concentrations

A source of uncertainty in this kind of risk assessment is the use of TRVs. Toxicological data are, in many cases, absent for each representative species, and extrapolation from the available toxicity data to the receptor of interest is needed. Further, the conditions in which COPCs are introduced to the test species do not represent chemical forms that would likely be encountered in the pit lake. Because of toxicokinetic and physiological differences between species, and between laboratory studies extrapolated to site receptors, effects concentration estimates introduces a source of uncertainty to the risk estimates.

Considerable care was taken to derive effects concentrations from studies most appropriate to the receptors under consideration, the duration and routes of exposure these receptors might experience, and measurable effects that are consistent with assessment endpoints in the ERA. Additional uncertainty factors were applied to studies where these criteria were not met. There is little consensus on the appropriate use and magnitude of uncertainty factors in the derivation of TRVs, hence even the uncertainty factors are a source of uncertainty themselves. The use of uncertainty factors are inherently conservative and therefore are more likely to overestimate rather than underestimate risk.

5.4.4 Risk Characterization

The risk characterization process should combine as many lines of evidence as possible to provide a weight of evidence estimation of the risks to ecological receptors from exposure to COPCs. In this ERA, single point estimates were used to screen COPCs for further evaluation. This primary evaluation method was formulated in the context of other lines of evidence, including uncertainties involved with the derivation of exposure estimates and effect levels.

6. Summary and Conclusions

Ecological risk from exposure of wildlife to the future ACMA pit lake chemical environment was evaluated in this ERA. Wildlife species, including waterfowl, insectivorous, herbivorous, omnivorous and carnivorous birds and mammals could make use of the future pit lake. The assessment endpoints identified during problem formulation included the protection of growth, development, reproduction, and survival of these populations against adverse impacts due to chemical concentrations in the surface water of the pit lake.

Exposure of receptors to COPCs was considered for both a pit filling and a mature pit lake stage, and ingestion was considered the primary exposure pathway for wildlife. COPC concentrations were estimated for water based on the geochemical pit lake model (Lorax 2012), and through available site data (SRK 2007) thought to represent potential future sediment sources. Concentrations of COPCs were estimated indirectly for food through the use of BAFs.

In the effects analysis, TRVs were derived for wildlife with which to compare the estimated dose of each of these receptor types. Upper and lower bound TRVs were derived for each receptor-COPC combination using NOAELs, representing lower-bound effects concentrations, and LOAELs, representing upper-bound effects concentrations.

Risks were characterized by computing lower-bound and upper-bound HQs for each receptor of interest. For the pit filling scenario, HQs were much less than 1 for all receptor-COPC combinations, indicating risk is unlikely to wildlife exposed to the proposed pit lake during development. In the mature pit lake scenario, selenium HQ_{NOAELs} were ≤1 for all receptors, while for antimony and arsenic, HQ_{NOAELS} were <1 for most receptors but > 1 and <10 for a few receptors. All HQ_{LOAELs} for antimony, arsenic and selenium were < 1 for all receptors. These results indicate that risk to wildlife from exposure to COPCs associated with the ACMA pit lake is not confirmed. In these cases, a review of assumptions and uncertainties is conducted to help guide further interpretation of results.

There are a number of conservative assumptions inherent in the risk assessment, including the use of maximum COPC concentrations in surface water and sediment, estimates of receptor exposure durations, conservative assumptions regarding dietary fractions of pit lake items, and 100% bioavailability of ingested sediments and food. These assumptions contributed to overestimates of exposure and risk in the ERA.

However, even with the highly conservative assumptions used for risk characterization of the mature pit lake, all HQ_{LOAELs} were <1 for the receptors, and HQ_{NOAELS} were above 1, but <10, for a few receptors. Thus the conclusion of this ERA is that chemical risk is unlikely to wildlife from exposure to predicted chemical concentrations in the future ACMA pit lake.

7. References

Aars, J. and R. Ims. 2002. Intrinsic and climatic determinants of population demography: the winter dynamics of tundra voles. Ecology, 83: 3449–3456.

ADEC. 2008a. Cumulative Risk Guidance. Division of Spill Prevention and Response Contaminated Sites Program. June.

ADEC. 2008b. ADEC Guidelines for data reporting, data reduction, and treatment of non-detect values. Division of Spill Prevention and Response Contaminated Sites Program.

ADEC. 2008c. Alaska Water Quality Criteria Manual for Toxic and Other Deleterious Organic and Inorganic Substances. As amended through December 12, 2008.

ADEC. 2009a. Ecoscoping Guidance. Division of Spill Prevention and Response Contaminated Sites Program. March.

ADEC. 2009b. ADEC Environmental Laboratory Data and Quality Assurance Requirements. Division of Spill Prevention and Response Contaminated Sites Program.

ADEC. 2009c. 18 AAC 70, Water Quality Standards, Amended as of September 19, 2009.

ADEC. 2010a. Risk Assessment Procedures Manual. Division of Spill Prevention and Response Contaminated Sites Program.

ADEC. 2010b. Policy Guidance on Developing Conceptual Site Models. Division of Spill Prevention and Response Contaminated Sites Program. October.

ADEC. 2011. DRAFT Risk Assessment Procedures Manual. Updated and Recommended for Use. Division of Spill Prevention and Response Contaminated Sites Program. November.

ADEC.1999. User’s Guide for Selection and Application of Default Assessment Endpoints and Indicator Species in Alaskan Ecoregions. Division of Spill Prevention and Response Contaminated Sites Program. June.

ADF&G. 1994a. Information on Alaska Hare. Alaska Department of Fish and Game. Located at: http://www.adfg.state.ak.us/pubs/notebook/smgame/hares.php

ADF&G. 1994b. Wolverine (Gulo gulo) Species Profile. Alaska Department of Fish and Game. http://www.adfg.alaska.gov/index.cfm?adfg=wolverine.main Accessed March 24.

ADF&G. 1994c. Information on Wolf. Alaska Department of Fish & Game. Located at: http://www.adfg.state.ak.us/pubs/notebook/furbear/wolf.php.

ADF&G. 1994d. Information on Lynx. Alaska Department of Fish & Game. Located at: http://www.adfg.state.ak.us/pubs/notebook/furbear/lynx.php.

ADF&G. 2006. Our wealth maintained: a strategy for conserving Alaska's diverse wildlife and fish resources. April.

ADF&G. 2007. Caribou Management Report of survey-inventory activities 1 July 2004-30 June 2006. Alaska Department of Fish and Game. P. Harper, editor. Juneau, Alaska. Located at: http://www.wildlife.alaska.gov/pubs/techpubs/mgt_rpts/07_caribou.pdf

ADF&G. 2008a. Moose Management Report of survey-inventory activities 1 July 2005-30 June 2007. Alaska Department of Fish and Game. P. Harper, editor. Juneau, Alaska. Located at: http://www.wc.adfg.state.ak.us/pubs/techpubs/mgt_rpts/08_moose.pdf

ADF&G. 2008b. Information on Caribou. Alaska Department of Fish & Game. Located at: http://www.adfg.state.ak.us/pubs/notebook/biggame/caribou.php.

Ambrose, P., P.S. Larson, J.F. Borzelleca and G.R. Hennigar Jr. 1976. Longterm toxicologic assessment of nickel in rats and dogs. Journal of Food Science and Technology 13:181.

Anderson, A.E. and O.C. Wallmo. 1984. Odocoileus hemionus. In Mammalian Species. No. 219. American Society of Mammalogists.

ARCADIS. 2007. Donlin Creek 2007 Avian Study. Prepared for Donlin Creek Joint Venture, Anchorage, Alaska.

ARCADIS. 2008a. Donlin Creek 2008 Avian Study. Prepared for the Donlin Creek Joint Venture, Anchorage, Alaska.

ARCADIS. 2008b. 2007 Spring Wildlife Study, Donlin Creek Project. Anchorage, Alaska.

ARCADIS. 2008c. Spring Wildlife Study, Donlin Creek Project. Prepared for the Donlin Creek Joint Venture, Anchorage, Alaska.

ARCADIS. 2009. Donlin Creek Draft 2009 Avian Survey, Donlin Creek Project. ARCADIS Alaska, Anchorage, Alaska.

ARCADIS. 2010. Donlin Creek Final 2010 Avian Survey Report, Donlin Creek Project. ARCADIS Alaska, Anchorage, Alaska.

ARCADIS. 2011a. 2010 Final Moose Survey Report. Anchorage, Alaska.

ARCADIS. 2011b. 2011 Donlin Creek Furbearer Track Survey Report. Anchorage, Alaska.

Armstrong, R.H. 1995. Guide to the Birds of Alaska. Alaska Northwest Books, Anchorage USA.

Aulerich, R.J., R.K. Ringer and J. Iwamoto. 1974. Effects of dietary mercury on mink. Archives of Environmental Toxicology 2:43-51.

Baes, C.F., R. Sharp, A. Sjoreen and R. Shor. 1984. A Review and Analysis of Parameters for Assessing Transport of Environmentally Released Radionuclides through Agriculture. Prepared by Oak Ridge National Laboratory for U.S. Dept. of Energy. 150 pp.

Batzli, G.O. and Lesieutre, C., 1991: The influence of high quality food on habitat use by arctic microtine rodents. Oikos, 60: 299-306

Bechtel Jacobs Company LLC. 1998. Empirical Models for the Uptake of Inorganic Chemicals from Soil by Plants. Bechtel Jacobs Company LLC, Oak Ridge, Tennessee. BJC/OR-133.

Belovsky, G.E. 1984. Snowshoe hare optimal foraging and its implicatiosn for population dynamics. Theoretical Population Biology 25:235-264.

Bent, A. C. 1950. Life histories of North American wagtails, shrikes, vireos, and their allies. U.S. Natl. Mus. Bull. 197. 411pp.

Bergman, K.M and C.J. Krebs 1993. Diet overlap of collared lemmings and tundra voles at Pearce Point, Northwest Territories. Canadian Journal of Zoology 71: 1703-1709.

Bertram, M.R. and M.T. Vivion. 2002. Black Bear Monitoring in Eastern Interior Alaska. Ursus 13:69-77.

Beyer, W.N., Connor, E.E., Gerould, S. 1994. Estimates of soil ingestion by wildlife. Journal of Wildlife Management 58:375-382.

Bindra K., and K. Hall.1977. Geochemical partitioning of trace metals in sediments and factors affecting bioaccumulation in benthic organisms. Univ. of B.C., Vancouver, B.C., Canada (unpubl report)

Cade, T. J. 1967. Ecological and behavioral aspects of predation by the northern shrike. Living Bird 6:43-86.

Cain, B.W. and E.A. Pafford. 1981. Effects of dietary nickel on survival and growth of mallard ducklings. Archives of Environmental Contamination and Toxicology 10:737-745.

Calder, W.A., Braun, E.J. 1983. Scaling of osmotic regulation in mammals and birds. American Journal of Physiology 224:R601-R606.

Chapman, P.M. 1985. Effects of gut sediment contents on measurements of metal levels in benthic invertebrates—a Cautionary Note. Bulletin of Environmental Contamination and Toxicology 35:345-347.

Chen, C.Y., Folt, C.L. 2000. Bioaccumulation and diminution of arsenic and lead in a freshwater food web. Environmental Science & Technology 34:3878-3884.

Coutts, R.A., Fenton, M.B., Glen., E. 1973. Food intake by captive Myotis lucifugus and Eptesicus fuscus. Journal of Mammalogy 54:985-990.

Crock, J.G., R.C. Severson and L.P. Gough. 1992. Determining baselines and variability in elements in plants and soils near the Kenai National Wildlife Refuge, Alaska. Water, Air and Soil Pollution 63:253-271

Damron, B.L. and H.R. Wilson. 1975. Lead toxicity of Bobwhite Quail. Bulletin of Environmental Contamination and Toxicology 14:489-496/

Davis, A., Sellstone, C., Clough, S., Barrick, R., Yare, B. 1996. Bioaccumulation of arsenic, chromium and lead in fish: constraints imposed by sediment geochemistry. Applied Geochemistry 11:409-423.

Dietz, R., Riget, F., Cleemann, M., Aarkrog, A., Johansen, P., Hansen, J.C. 2000. Comparison of contaminants from different trophic levels and ecosystems. The Science of the Total Environment 245:221-231.

Dunning Jr., J.B. 1993. CRC Handbook of Avian Body Masses. Boca Raton, FL: CRC Press.

Ecology & Environment. 2011. Work plan remedial investigation/feasibility study, Red Devil Mine, Alaska. Prepared for U.S. DEPARTMENT OF INTERIOR BUREAU OF LAND MANAGEMENT. March.

Edens, F.W., and J.D. Garlich. 1983. Lead-induced egg production decrease in leghorn and Japanese quail hens. Poultry Sci. 62:1757-1763

Eisler, R. 2000. Handbook of Chemical Risk Assessment. Boca Raton, FL: Lewis Publishers.

Engle, T.E. and J.W. Spears. 2000. Effects of dietary copper concentration and source on performance and copper status of growing and finishing steers. J. Anim. Sci. 78:2446-2451.

EVS. 1998. South Pipeline project ecological risk assessment for pit lake. Prepared for the US Bureau of Land Management. Seattle: EVS Environmental Consultants.

Fisher, N.S., Hook, S.E. 2002. Toxicology tests with aquatic animals need to consider to trophic transfer of metals. Toxicology 181-182:531-536.

Ford, K. 2004. Risk management criteria for metals at BLM mining sites. Denver: Bureau of Land Management.

Gasaway, W.C. and I.O. Buss. 1972. Zinc Toxicity in the Mallard Duck. Journal of Wildlife Management 36(4):1107-1117.

Griffith. 2010. Level III North American Terrestrial Ecoregions: United States Descriptions. Prepared for North American Commission for Environmental Cooperation --- www.cec.org. May 11.

Hagler Bailly Consulting. 1995. Riparian Resources Injury Assessment: Data Report. Prepared for the Natural Resource Trustees: Coeur d'Alene Tribe, U.S. Department of Agriculture, U.S. Department of the Interior by Hagler Bailly Consulting, Inc., Boulder, CO.

Haseltine, S.D., L. Sileo, D.J. Hoffman and B.D. Mulhern. 1985. Effects of chromium on reproduction and growth of black ducks. Unpublished manuscript (cited in Eisler 1986).

Heinz, G. H., D. J. Hoffman, and L. G. Gold. 1989. Impaired reproduction of mallards fed an organic form of selenium. J. Wildl. Mgmt. 53: 418-428.

Heinz, G. H., Hoffman, D. J., and LeCaptain, L. J. 1996. toxicity of seleno-l-methionine, seleno-dl-methionine, high selenium wheat, and selenized yeast to mallard ducklings. Arch Environ Contam Toxicol. 30(1): 93-9.

Heinz, G.H, D.J. Hoffman, A.J. Krynitsky and D.M.G. Weller. 1988. Toxicity of organic and inorganic selenium to mallard ducklings. Environ. Toxicol. Chem

Heinz, G.H. and M.A. Fitzgerald. 1993. Reproduction of mallards following overwinter exposure to selenium. Environmental Pollution 81:117-122.

Heinz, G.H., D.J. Hoffman, A.J. Krynitsky and D.M.G. Weller. 1987. Reproduction in mallards fed selenium.

Environmental Toxicology and Chemistry 6:423-433.

Hill, R. 1979. A review of the 'toxic' effects of rapeseed meals with observations on meal from improved varieties. Br. Vet. J. 135.

Hoffman D.J. and G.H. Heinz. 1988. Embryotoxic and teratogenic effects of. selenium in the diet of mallards. J Toxicol Environ Health 24:477-483.

Hoffman, D. J., Sanderson, C. J., LeCaptain, L. J., Cromartie, E., and Pendleton, G. W. 1991. Interactive effects of boron, selenium, and dietary protein on survival, growth, and physiology in mallard ducklings. Arch Environ Contam Toxicol. 20(2): 288-94.

Hoffman, D. J., Sanderson, C. J., LeCaptain, L. J., Cromartie, E., and Pendleton, G. W. 1992. Interactive effects of selenium, methionine, and dietary protein on survival, growth, and physiology in mallard ducklings. Arch Environ Contam Toxicol. 23(2): 163-71.

Irving, L. 1960. Birds of Anaktuvuk Pass, Kobuk, and Old Crow. A study in arctic adaptation. U.S. National Museum Bulletin 217. Smithsonian Institution, Washington, DC. 409 pp.

Jackson, N. and Stevenson, M. H. 1981. identification of the component responsible for the effects of added dietary copper sulphate in the female domestic fowl. J Sci Food Agric. 32(11): 1047-56.

James, L.F., M.S. James, V.A. Lazar, W. Binns. 1966. Effects of sublethal doses of certain minerals on pregnant ewes and fetal development. American Journal of Veteranary Research 27(116): 132-135.

Jenkins, K. J. and M. Hidiroglou. 1986. Tolerance of. the preruminant calf for selenium in milk replacer. J. Dairy Sci. 69:1865.

Judd, S. D. 1898. Food of shrikes: Cuckoos and shrikes in their relation to agriculture. U.S. Dep. Agric., Div. Biol. Surv. Bull. 9:15-26.

Kessler, W. B. and T. E. Kogut. 1985. Habitat orientations of forest birds in southeastern Alaska. Northwest Science 59:58-65.

Lakso, J.V., Peoples, S.A. 1975. Methylation of inorganic arsenic by mammals. Journal of Agricultural and Food Chemistry 23 (4):671-676.

Logner, K.R., M.W. Neathery, W.J. Miller, R.P. Gentry, D.M. Blackmon and F.D. White. 1984. Lead toxicity and metabolism from lead sulfate fed to holstein calves. J. Dairy Sci. 67:1007-1013.

Lorax Environmental (Lorax). 2012. Pit Lake Modeling Assessment in Support of Project Permitting. Final Report, October.

Markon, C.J. Seven-year phenological record of Alaskan ecoregions derived from advanced very high resolution radiometer normalized difference vegetation index data. Open-File Rpeort 01-11. US Department of the Interior, US Geological Survey.

Maro, J. K., Kategile, J. A., and Hvidsten, H. 1980. Studies on copper and cobalt in dairy calves. British Journal of Nutrition. 44(1): 25-31.

MacHutchon, A.G. 1989. Spring and Summer Food Habits of Black Bears in the Pelly River Valley, Yukon. Northwest Science, Vol. 63, No. 3: 116-118.

Mills, C.F. and A.C. Dalgarno. 1972. Copper and zinc status of ewes and lambs receiving increased dietary concentrations of cadmium. Nature 239:171-173.

Mollenhauer, H. H., Corrier, D. E., Clark, D. E., Hare, M. F., and Elissalde, M. H. 1985. Effects of dietary cobalt on testicular structure Virchow Arch [Cell Pathol]. 49(3): 241-248.

MSES. 2006. 2004-2005 Wildlife Technical Report (DRAFT B). Calgary, Canada. Prepared for Placer Dome U.S.

Nagy, K.A. 1987. Field metabolic rate and food requirement scaling in mammals and birds. Ecological Monographs 57:111-128.

Nagy, K.A. 2001. Food requirements of wild animals: predictive equations for free-living mammals, reptiles, and birds. Nutrition Abstracts and Reviews, Series B. 71:21R-31R.

Nolan, Jr., V., E. D. Ketterson, D. A. Cristol, C. M. Rogers, E. D. Clotfelter, R. C. Titus, S. J. Schoech and E. Snajdr. 2002. Dark-eyed Junco (Junco hyemalis), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/716

Nowak, R.M. 1991. Walker's Mammals of the World. Johns Hopkins University Press.

NRC (National Research Council). 2005. Mineral Tolerances of Animals. National Academy of Sciences, Washington, D.C.

ORNL. 1998. Biota sediment accumulation factors for invertebrates: review and recommendations for the Oak Ridge Reservation. BJC/OR-112. Oak Ridge, TN: Oak Ridge National Laboratory.

Ott, E.A., W.H. Smith, R.B. Harrington and W.M. Beeson. 1966a. Zinc Toxicity in Ruminants II. Effect of High Levels of Dietary Zinc on Gains, Feed Consumption and Feed Efficiency of Beef Cattle.

Peacock, E. 2001. Kuiu Island black bear pilot study: Population estimation and sexual segregation. Alaska Department of Fish and Game. Federal aid in wildlife restoration research final report, 1 July 2000-30 June 2001, grant W-27-4, study 17.60. Juneau, Alaska. Located at: http://www.adfg.alaska.gov/static/home/library/pdfs/wildlife/research_pdfs/01-1760.pdf

Post, R. 2004. Winter Wildlife Studies Report. Prepared by Lynx Enterprises, Inc., for Placer Dome U.S., Anchorage.

PTI. 1996. Chemical Composition, Limnology, and Ecology of Three Existing Nevada Mine Pit Lakes. Interim Report. April 1996.

Rosenfeld, Irene and O.A. Beath. 1954. Effect of Selenium on Reproduction in Rats. Proc. Soc. Exp. Biol. Med. 87:295-297.

RWJ Consulting. 2008. 2007 Wildlife Observations on the Kuskokwim River. Prepared for Donlin Creek LLC. Chugiak, Alaska.

Sample, B., J.J. Beauchamp, R. Efroymson, and G.W. Suter, II. 1999. Literature-derived Bioaccumulation Models for Earthworms: Development and Validation. Environmental Toxicology and Chemistry. 18: 2110-2120.

Sample, B., J.J. Beauchamp, R. Efroymson, G.W. Suter, II, and T. Ashwood. 1998b. Development and Validation of Bioaccumulation Models for Earthworms. Oak Ridge National Laboratory. ES/ER/TM-220.

Sample, B.E., Aplin, M.S., Efroymson, R.A., Suter, G.W., II, Welsh, C.J.E. 1997. Methods and tools for estimation of the exposure of terrestrial wildlife to contaminants. ORNL/TM-13391. Oak Ridge, TN: Oak Ridge National Laboratory.

Sample, B.E., Opresko, D.M., Suter, G.W., II. 1996. Toxicological benchmarks for wildlife: 1996 revision. Oak Ridge, TN: Oak Ridge National Laboratory.

Schlicker, Sandra A. and Dennis H. Cox. 1968. Maternal Dietary Zinc and Development and Zinc, Iron, and Copper Content of the Rat Fetus. Journal of Nutrition 95: 287-294.

Schroeder, H.A. and M. Mitchner. 1971. Toxic effects of trace elements on the reproduction of mice and rats. Archives of Environmental Health 23:102-106.

Schroeder, H.A., M. Mitchener, J.J. Balassa, M. Kanisawa and A.P. Nason. 1968. Zirconium, niobium, antimony and fluorine in mice: Effects on growth, survival and tissue levels. Journal of Nutrition 95:95-101.

Selby, D.A., Ihnat, J.M., Messer., J.J. 1985. Effects of subacute cadmium exposure on a hardwater mountain stream microcosm. Water Research 19:645-655.

Shannon and Wilson. 1999. Ecoregions/assessment endpoint project technical background document for selection and application of default assessment endpoints and indicator species in Alaskan ecoregions. June.

Sibley, D. A. (2003). The Sibley Guide to the Birds of Western North America. New York, NY, Knopf Publishing Group.

Solà, C., M Burgos, A. Plazuelo, J. Toja, M. Plans and N. Prat. 2004. Heavy metal bioaccumulation and macroinvertebrate community changes in a Mediterranean stream affected by acid mine drainage and an accidental spill (Guadiamar River, SW Spain). Science of the Total Environment 333:109-126.

SRK Consulting (SRK). 2007. Waste Rock Metal Leaching and Acid Rock Drainage Assessment for Feasibility Study - Donlin Creek Project

Stahl, J.L., J.L. Greger and M.E. Cook. 1990. Breeding Hen and Progeny Performance When Hens are Fed Excessive Dietary Zinc. Metabolism and Nutrition. 259-263.

Stahler, D.R., D.W. Smith, and D.S. Guernsey. 2006. Foraging and feeding ecology of the gray wolf (Canis lupus): lessons from Yellowstone National Park, Wyoming, USA. Journal of Nutrition 24: 1923s-1926s.

Stanley Jr., T.R., J.W. Spann, G.J. Smith and R. Rosscoe. 1994. Main and interactive effects of arsenic and selenium on mallard reproduction and duckling growth and survival. Archives of Environmental Contamination and Toxicology 26:444-451.

Suedel, B.C., Boraczek, J.A., Peddicord, R.K., Clifford, P.A., Dillon, T.M. 1994. Trophic transfer and biomagnification potential of contaminants in aquatic ecosystems. Reviews of Environmental Contamination and Toxicology 136:21.

Suter, G.W., II, Tsao, C.L. 1996. Toxicological benchmarks for screening contaminants of potential concern for effects on aquatic biota: 1996 revision. ES/ER/TM-96/R2. Oak Ridge, TN: Oak Ridge National Laboratory.

Sutou, S., K. Yamamoto, H. Sendota and M. Sugiyama. 1980. Toxicity, fertility, teratogenicity, and dominant lethal tests in rats administered cadmium subchronically. II. Fertility, teratogenicity, and dominant lethal tests. Ecotoxicology and Environmental Safety 4:51-56.

Terres, J.K. 1980. The Audubon Society Encyclopedia of North American Birds. New York: Wings Books.

US EPA. 2001. ECO Update: The role of screening level risk assessments and refining contaminants of potential concern in baseline ecological risk assessments. EPA-540-F-01-014. Office of Solid Waste and Emergency Response. Washington, DC: US Environmental Protection Agency.

USEPA. 1976. Quality criteria for water (The Red Book). Office of Water and Hazardous Materials, Washington, D.C. July.

USEPA. 1992. Guidelines for exposure assessment. 600Z-92/001. Risk Assessment Forum. Washington, DC: US Environmental Protection Agency.

USEPA. 1993. Wildlife exposure factors handbook. Volume 1 and 2. EPA/600/R-93/187a and b. Office of Research and Development. Washington, DC: US Environmental Protection Agency.

USEPA. 1995. Great Lakes water quality initiative technical support document for wildlife criteria. Office of Water Regulations and Standards Criteria and Standards Division. Washington, DC: US Environmental Protection Agency.

USEPA. 1997. EPA Region 10 Supplemental Ecological Risk Assessment Guidance for Superfund. EPA 910-R-97-005. U.S. Environmental Protection Agency

USEPA. 1998a. Ecological Risk Assessment Guidance for Superfund (ERAGS): Process for Designing and Conducting Ecological Risk Assessments. Final. EPA/540/R-97/006. U.S. Environmental Protection Agency.

USEPA. 1998b. Guidelines for Ecological Risk Assessment. EPA/630/R095/002F. U.S. Environmental Protection Agency, Risk Assessment Forum, Washington, DC.

USEPA. 2002. Generic assessment endpoints for ecological risk assessments (external review draft). EPA/630/P-02/004A. Risk Assessment Forum. Washington, DC: US Environmental Protection Agency.

USEPA. 2004. Framework for Inorganic Metals Risk Assessment (External Review Draft). U.S. Environmental Protection Agency, Washington, D.C., EPA/630/P-04/068B.

USEPA. 2007a. Estimation of Relative Bioavailability of Lead in Soil and Soil-Like Materials by In Vivo and In Vitro Methods. U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response. Washington, DC 20460. OSWER 9285.7-77.

USEPA. 2007b. Guidance for Developing Ecological Soil Screening Levels (Eco SSLs). OSWER Directive 9285.7-55. Revised April 2007.

USEPA. 2009. National recommended water quality criteria. Office of Water and Office of Science and Technology. Online at: http://www.epa.gov/waterscience/criteria/wqctable/index.html

Viereck, L.A., C.T. Dyrness, A.R. Batten and K.J.Wenzlick. 1992. The Alaska Vegetation Classification. Gen. Tech. Rep. PNW-GTR-286. US Department of Agriculture, Forest Service, Pacific Northwest Research Station, Portland, OR. 278 p.

White, D.H. and M.T. Finley. 1978. Uptake and retention of dietary cadmium in mallard ducks. Environmental Research 17:53-59.

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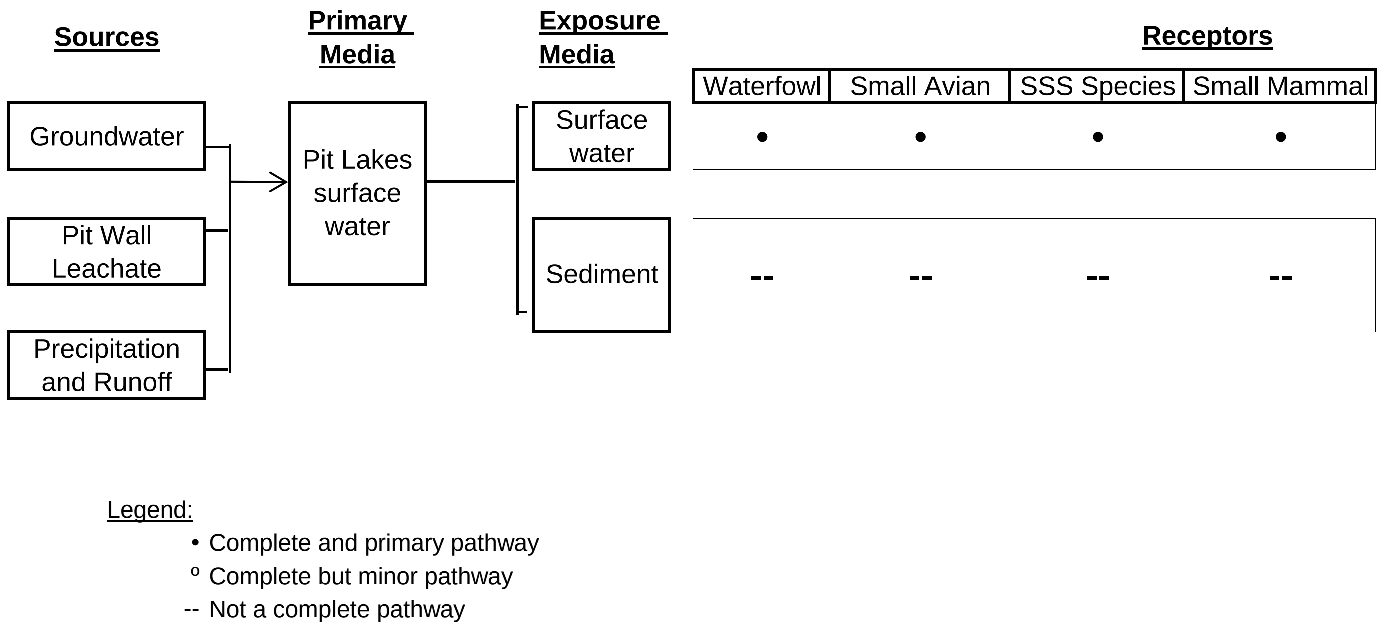
Pit Lake ERA

Figures

● Populated Places Proposed Natural Gas Pipeline Alignment Proposed Infrastructure Layout Federal Administrative Boundaries State Administrative Boundaries Seward Meridian, UTM Zone 4, NAD83	SCALE: 0 12.5 25 50 Mi 0 15 30 60 Km	DONLIN GOLD	**MINE SITE LOCATION** DONLIN GOLD PROJECT	FIGURE: **2-1**

DG: PER0236.mxd, 11/23/11, R00



Ecological Conceptual Site Model for the Proposed ACMA Pit Lake, Pit Filling Stage.

Donlin Gold LLC
Bethel, Alaska
ACMA Pit Lake Ecological Risk Assessment

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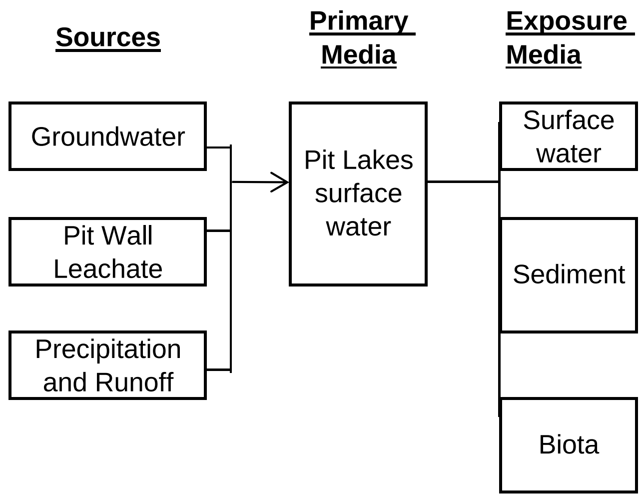
Figure 2-2



Receptors

Exposure Media	Waterfowl	Subsistence	Small Avian	SSS Species	Small Mammal	Game
Surface water	•	•	•	•	•	•
Sediment	•	•	o	o	o	o
Biota	•	•	--	--	•	--

Legend:

- • Complete and primary pathway
- o Complete but minor pathway
- -- Not a complete pathway

Ecological Conceptual Site Model for the Proposed ACMA Pit Lake, Mature Pit Lake.

Donlin Gold LLC
Bethel, Alaska
ACMA Pit Lake Ecological Risk Assessment

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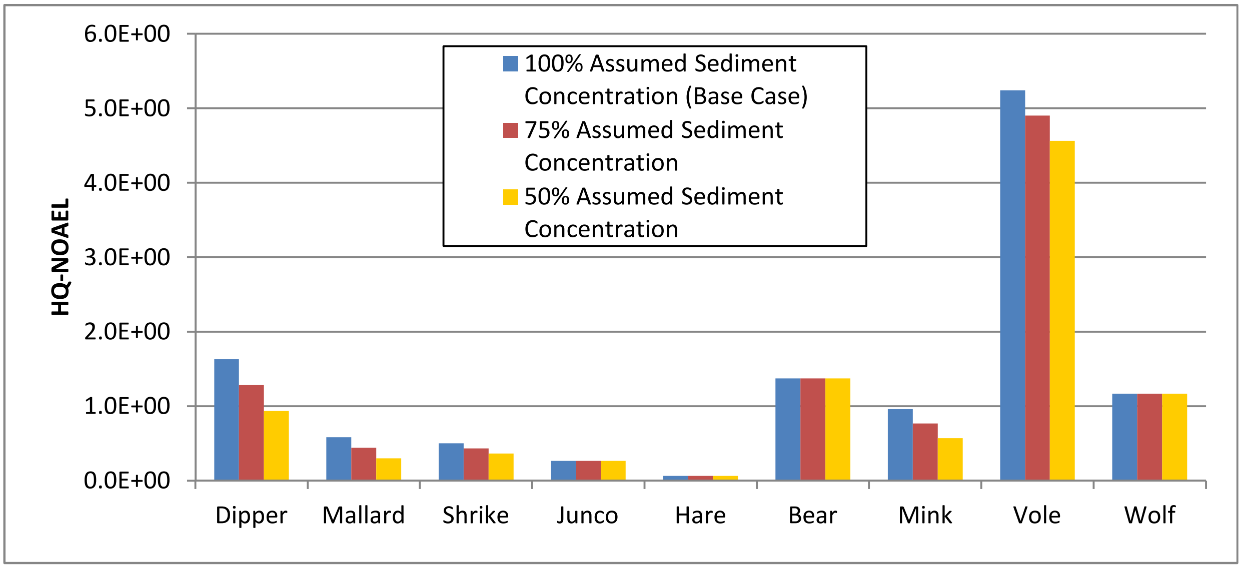
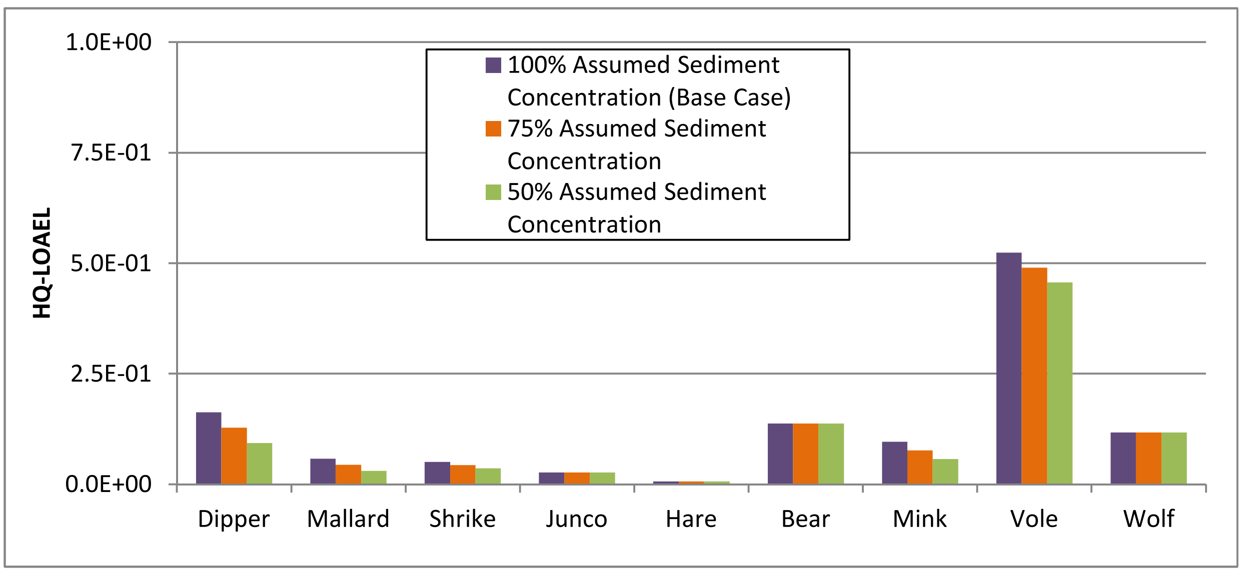
Figure 2-3





Uncertainty Evaluation - Impact of Reduced Sediment Concentration Estimates on Antimony HQ for the Mature Pit Lake

Donlin Gold LLC
Bethel, Alaska
ACMA Pit Lake Ecological Risk Assessment

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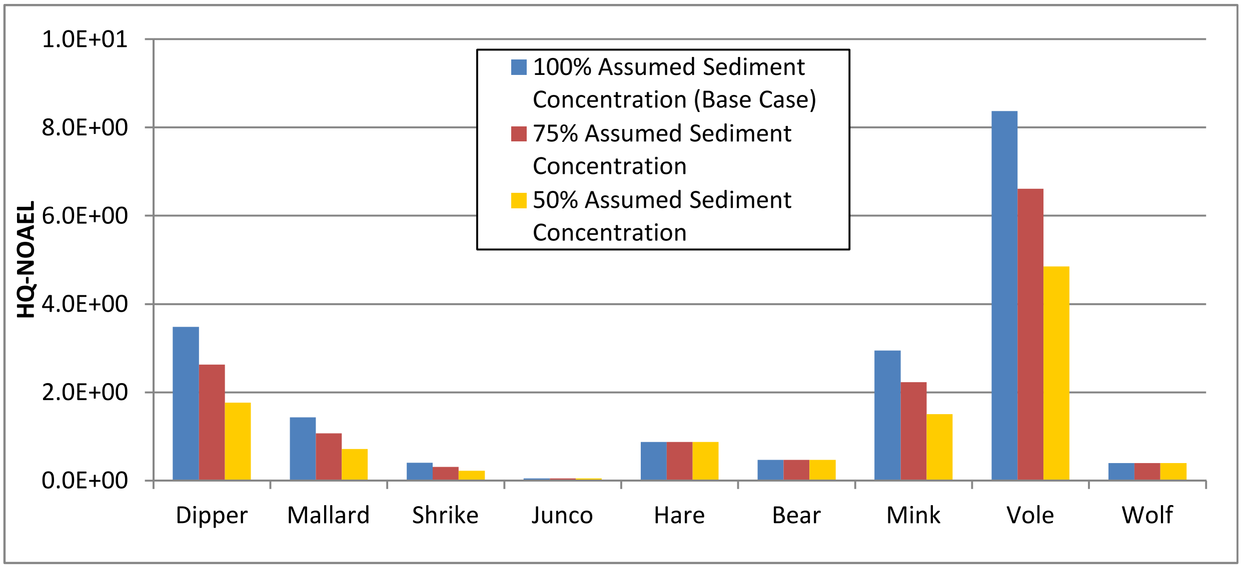
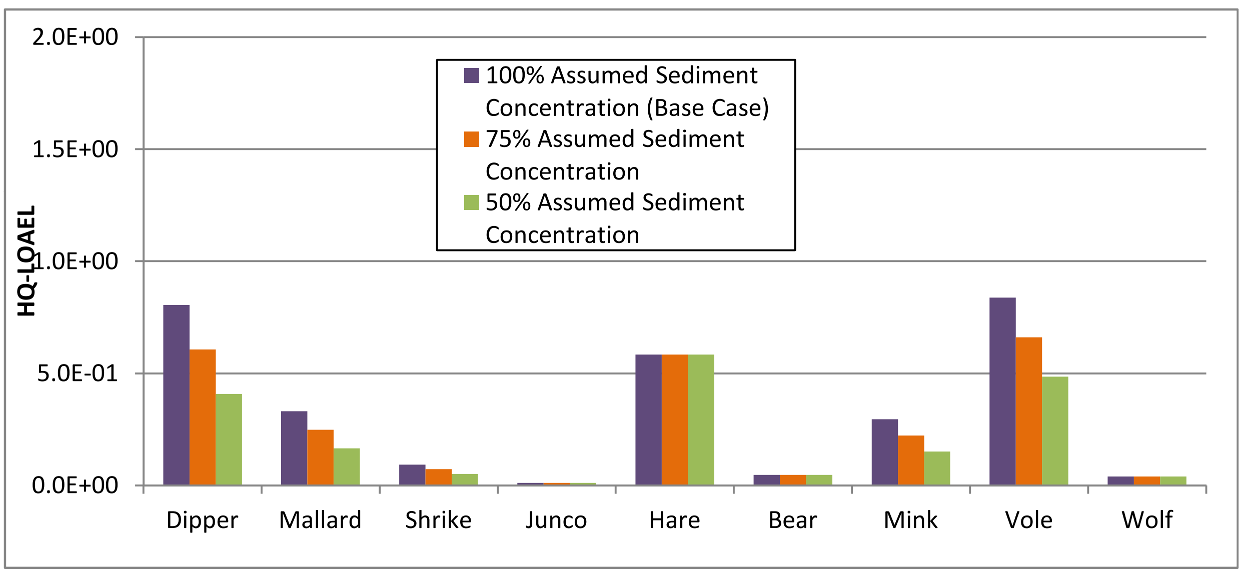
Figure 5-1





Uncertainty Evaluation - Impact of Reduced Sediment Concentration Estimates on Arsenic HQ for the Mature Pit Lake

Donlin Gold LLC
Bethel, Alaska
ACMA Pit Lake Ecological Risk Assessment

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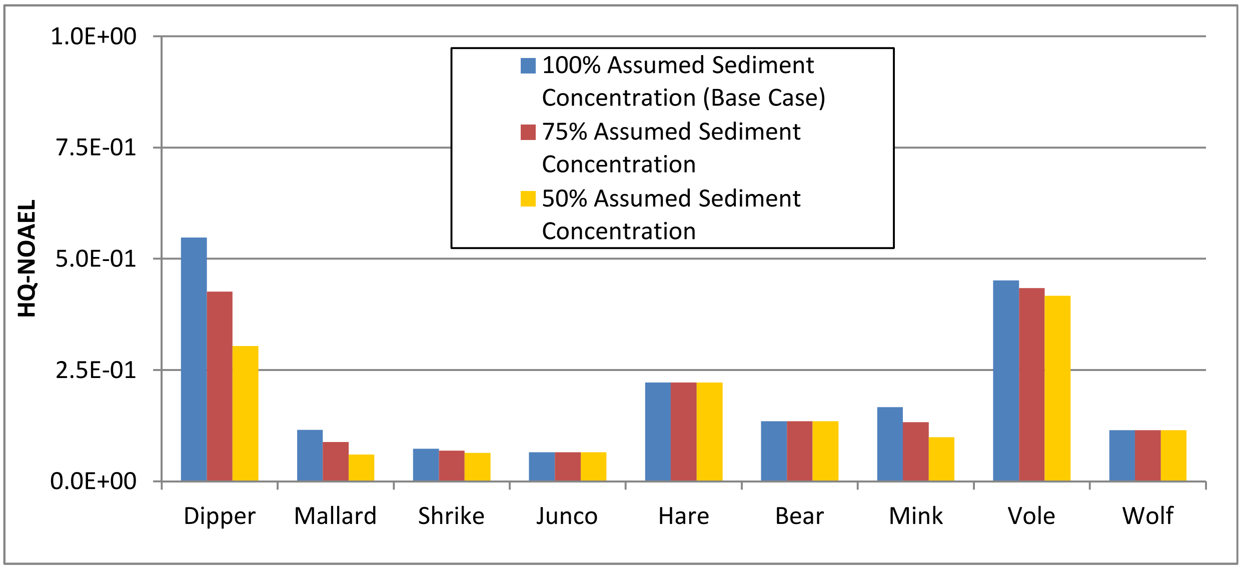
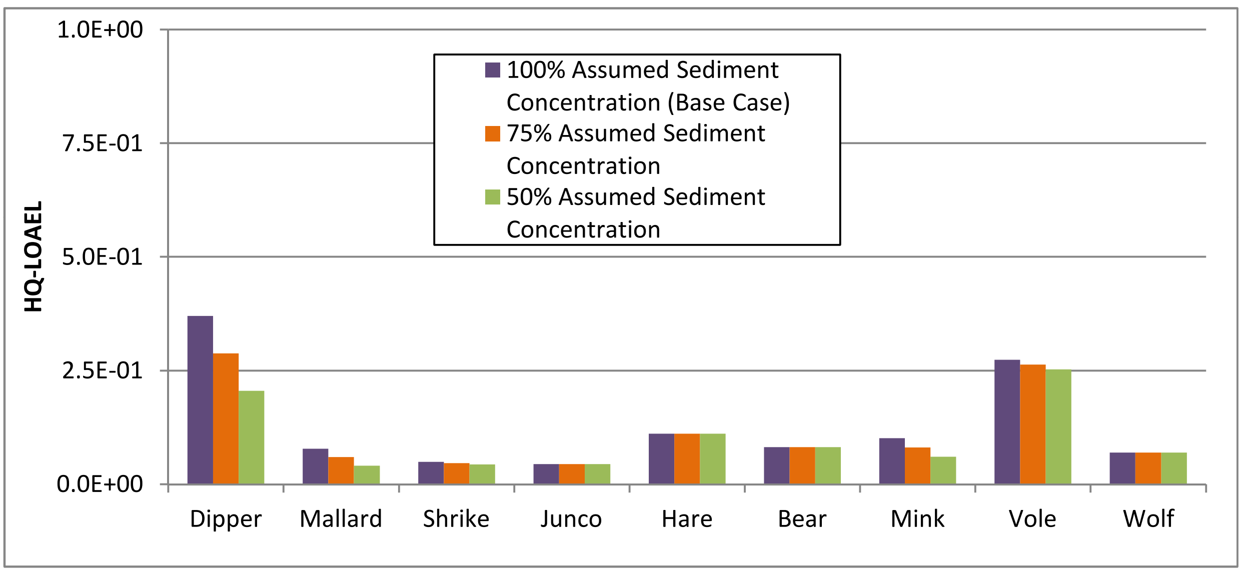
Figure 5-2





Uncertainty Evaluation - Impact of Reduced Sediment Concentration Estimates on Selenium HQ for the Mature Pit Lake

Donlin Gold LLC
Bethel, Alaska
ACMA Pit Lake Ecological Risk Assessment

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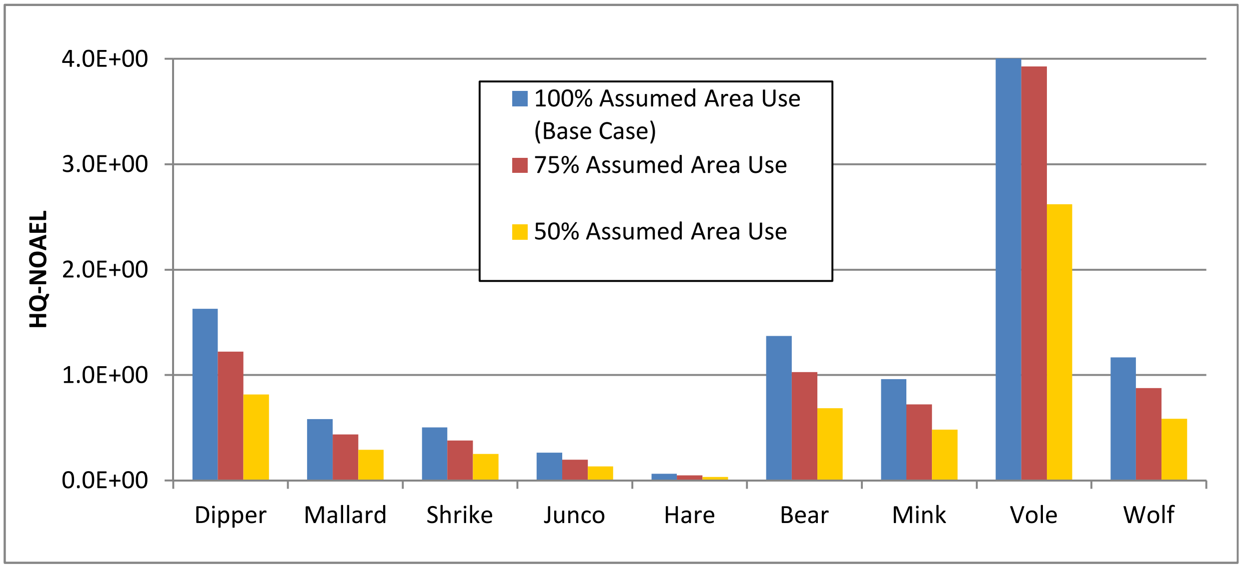
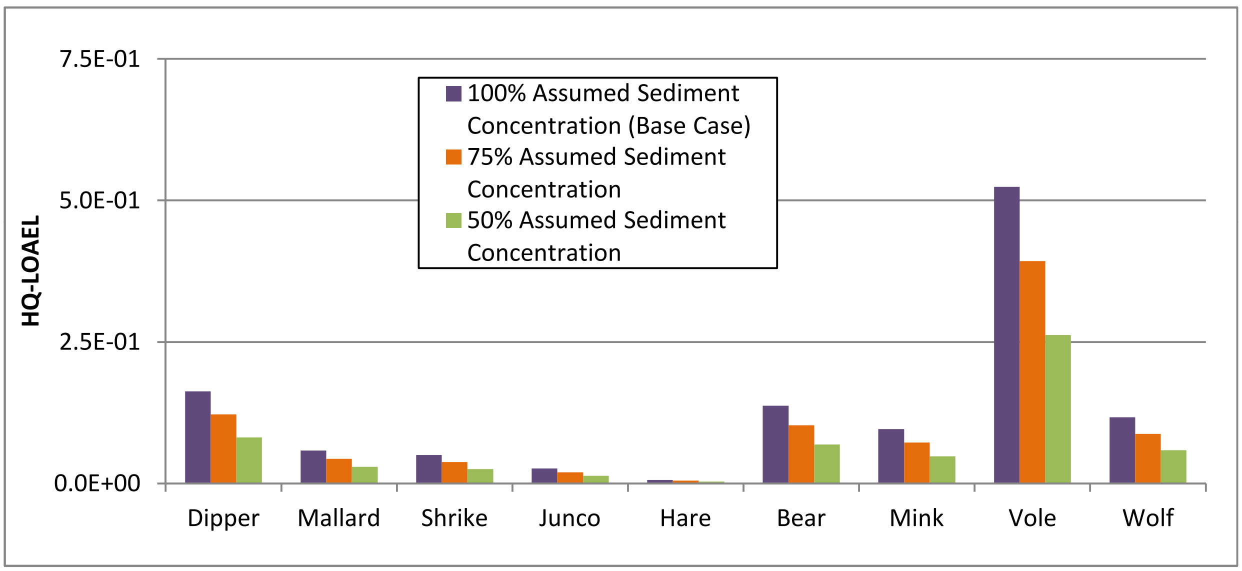
Figure 5-3





Uncertainty Evaluation - Impact of Reduced Area Use Estimates on Antimony HQ for the Mature Pit Lake

Donlin Gold LLC
Bethel, Alaska
ACMA Pit Lake Ecological Risk Assessment

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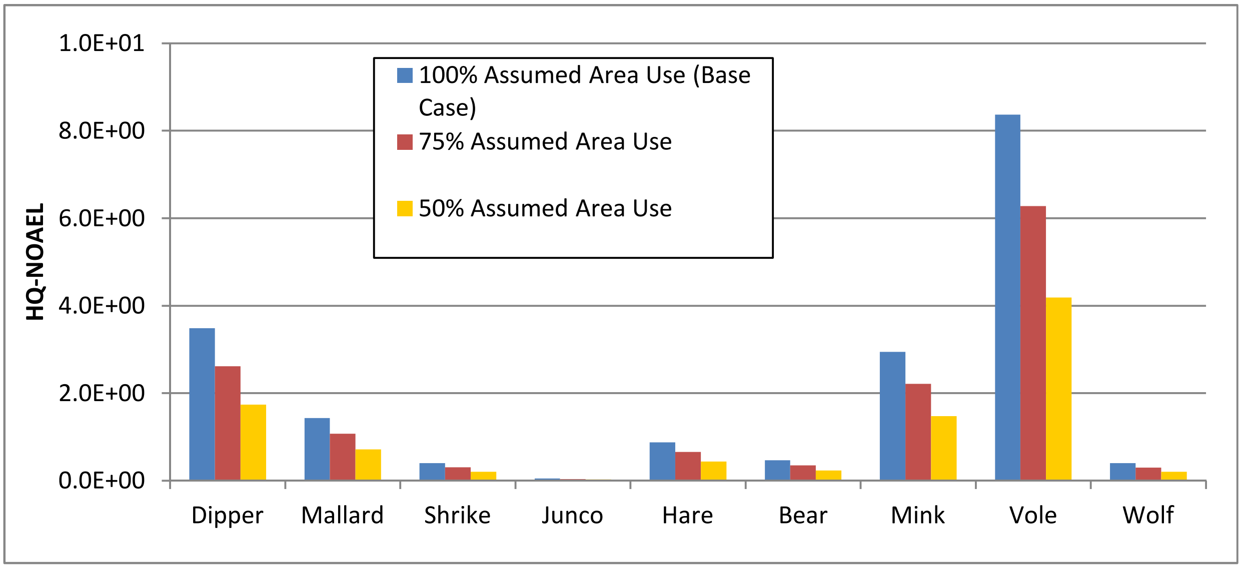
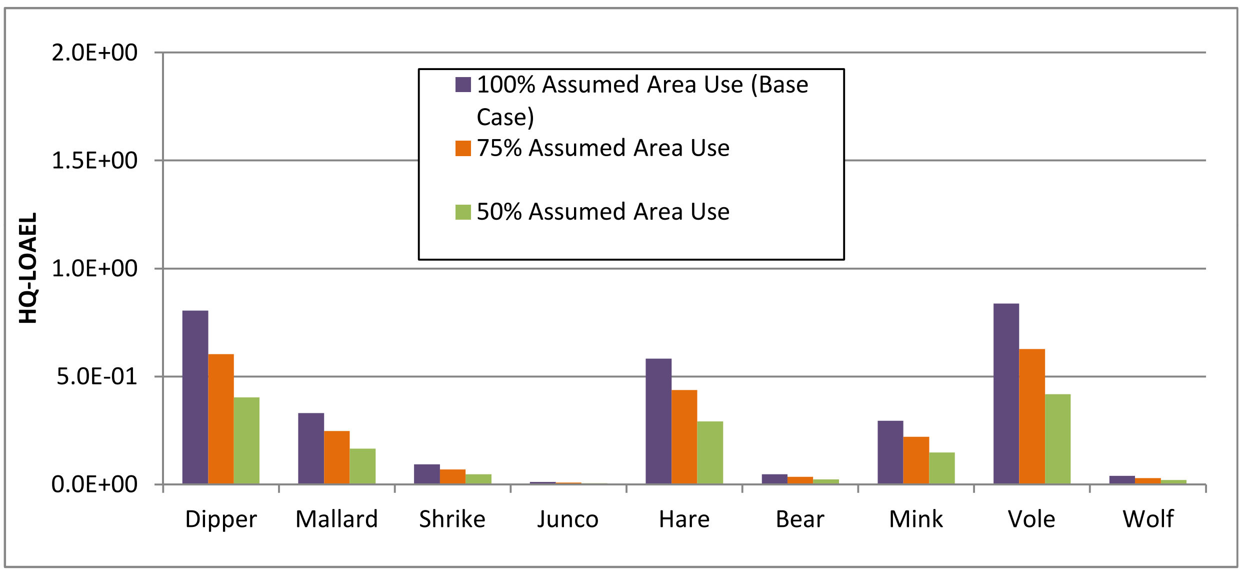
Figure 5-4





Uncertainty Evaluation - Impact of Reduced Area Use Estimates on Arsenic HQ for the Mature Pit Lake

Donlin Gold LLC
Bethel, Alaska
ACMA Pit Lake Ecological Risk Assessment

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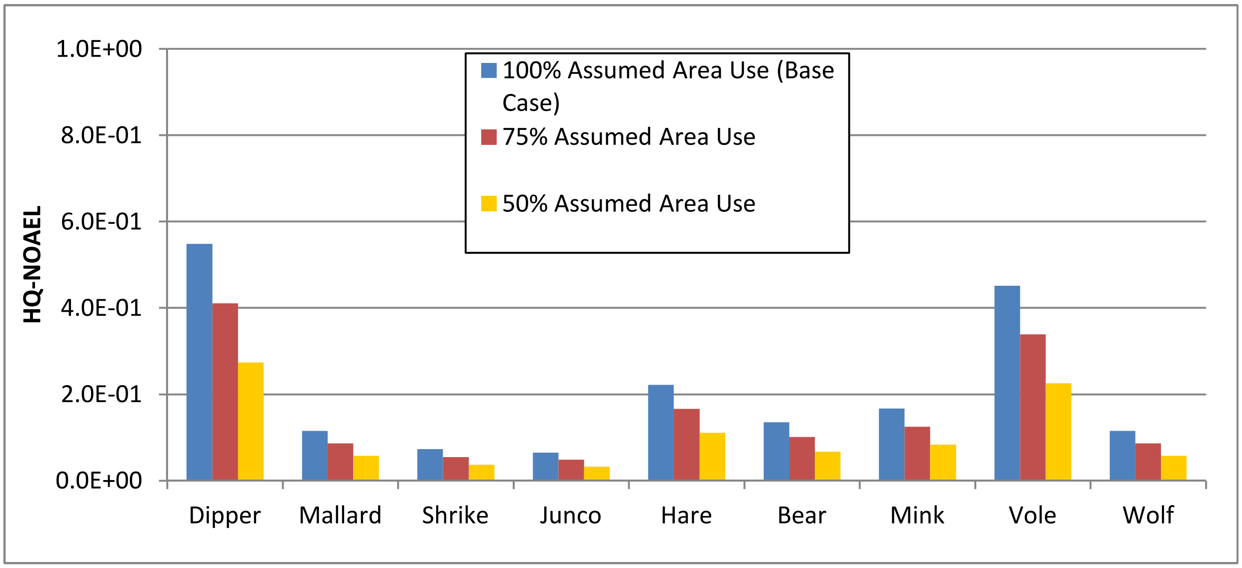
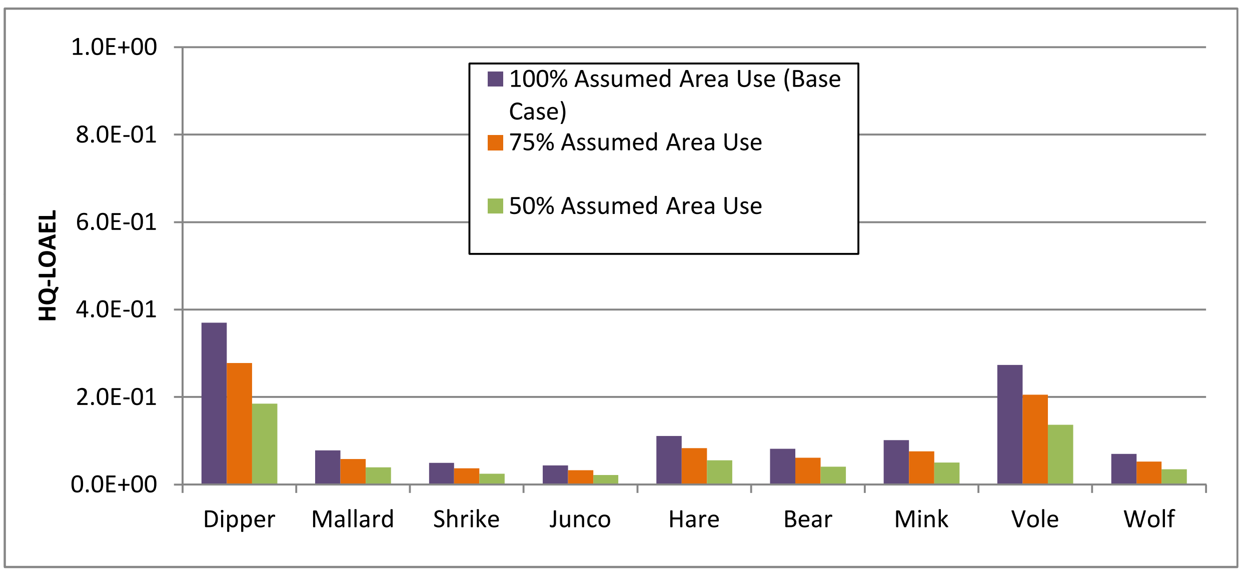
Figure 5-5





Uncertainty Evaluation - Impact of Reduced Area Use Estimates on Selenium HQ for the Mature Pit Lake

Donlin Gold LLC
Bethel, Alaska
ACMA Pit Lake Ecological Risk Assessment

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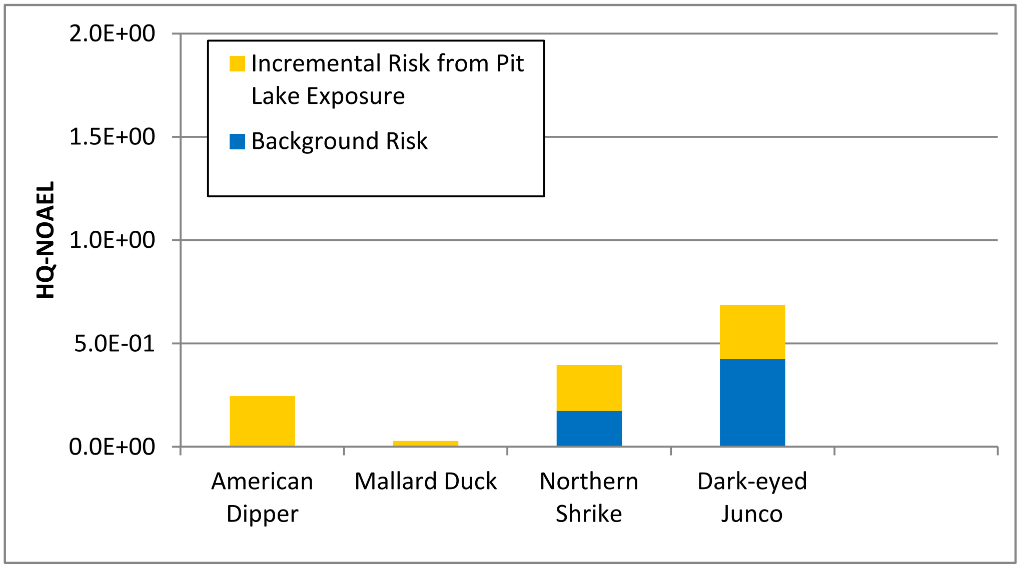
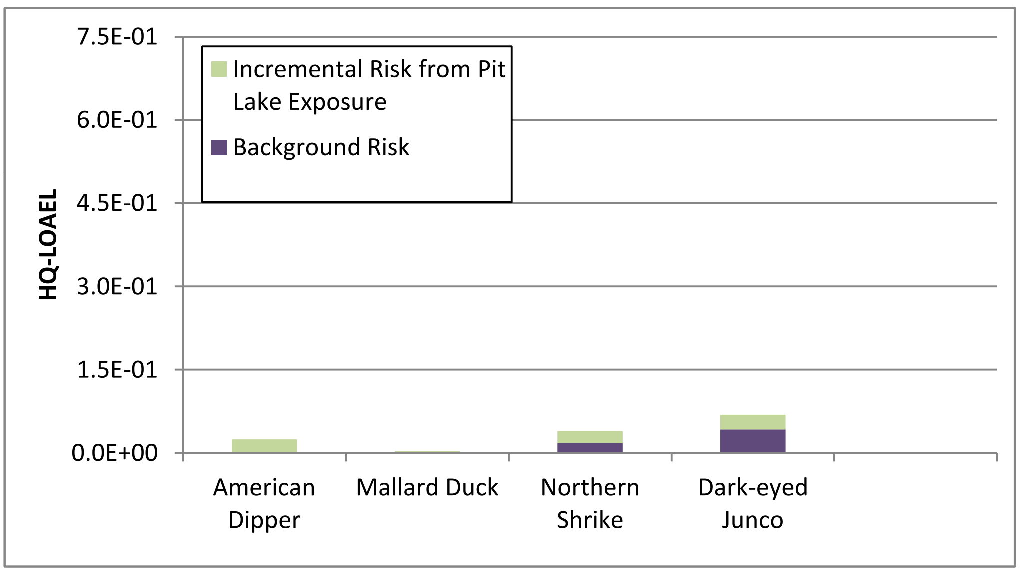
Figure 5-6





Uncertainty Evaluation - Incremental Risk Increase from Antimony Exposure to the Juvenile Pit Lake in Addition to Background Exposure

Donlin Gold LLC
Bethel, Alaska
ACMA Pit Lake Ecological Risk Assessment

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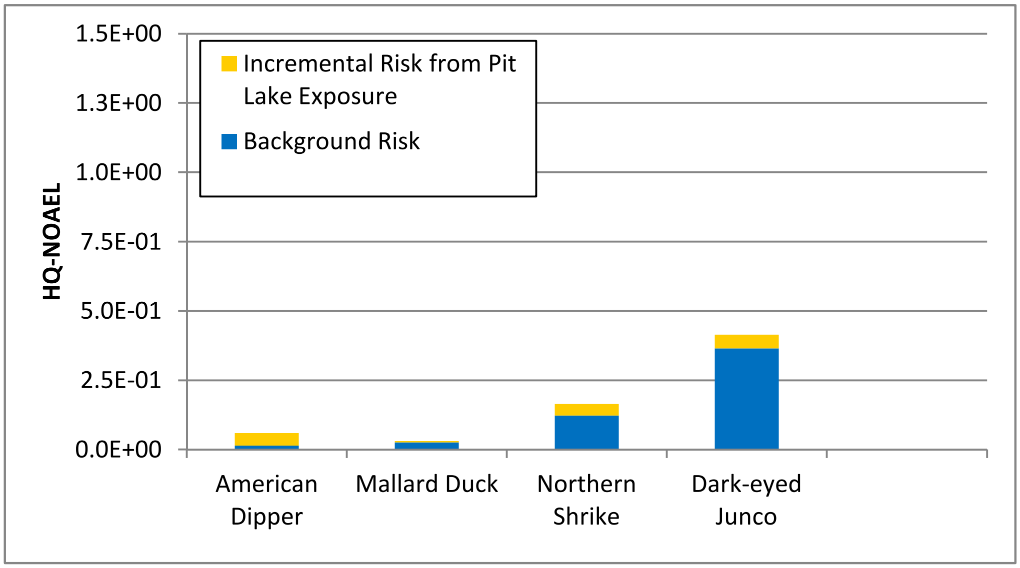
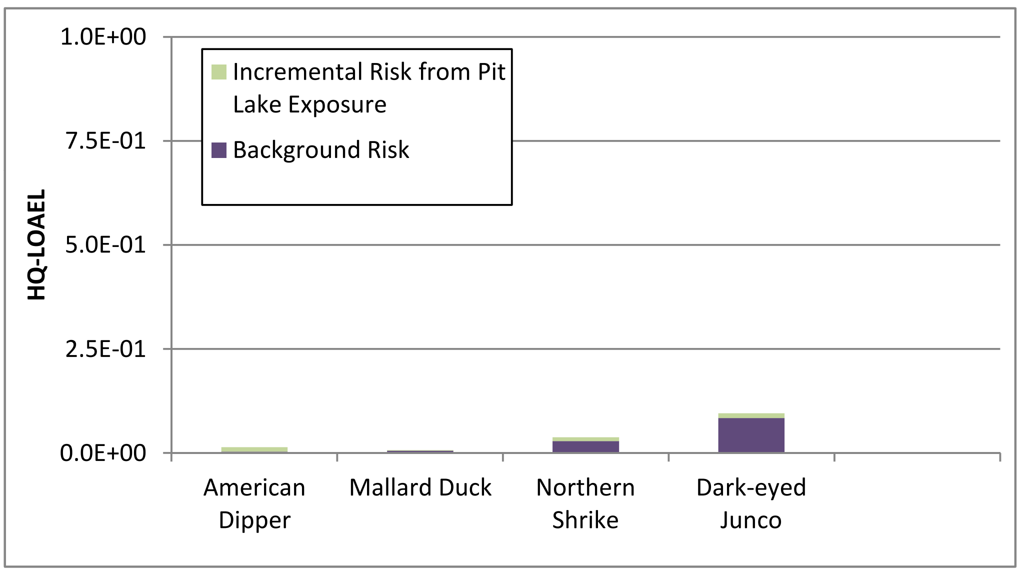
Figure 5-7





Uncertainty Evaluation - Incremental Risk Increase from Arsenic Exposure to the Juvenile Pit Lake in Addition to Background Exposure

Donlin Gold LLC
Bethel, Alaska
ACMA Pit Lake Ecological Risk Assessment

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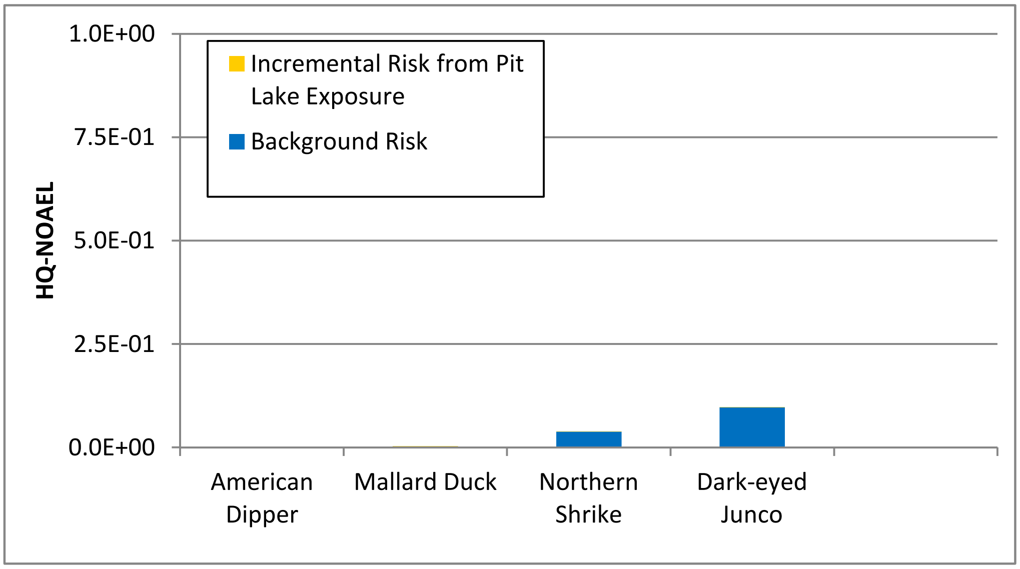
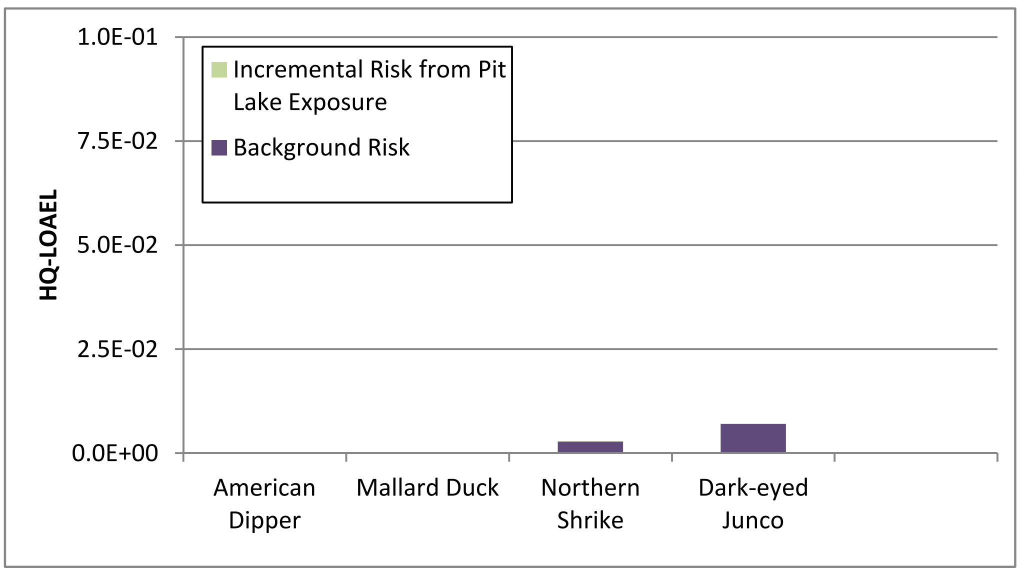
Figure 5-8





Uncertainty Evaluation - Incremental Risk Increase from Cadmium Exposure to the Juvenile Pit Lake in Addition to Background Exposure

Donlin Gold LLC
Bethel, Alaska
ACMA Pit Lake Ecological Risk Assessment

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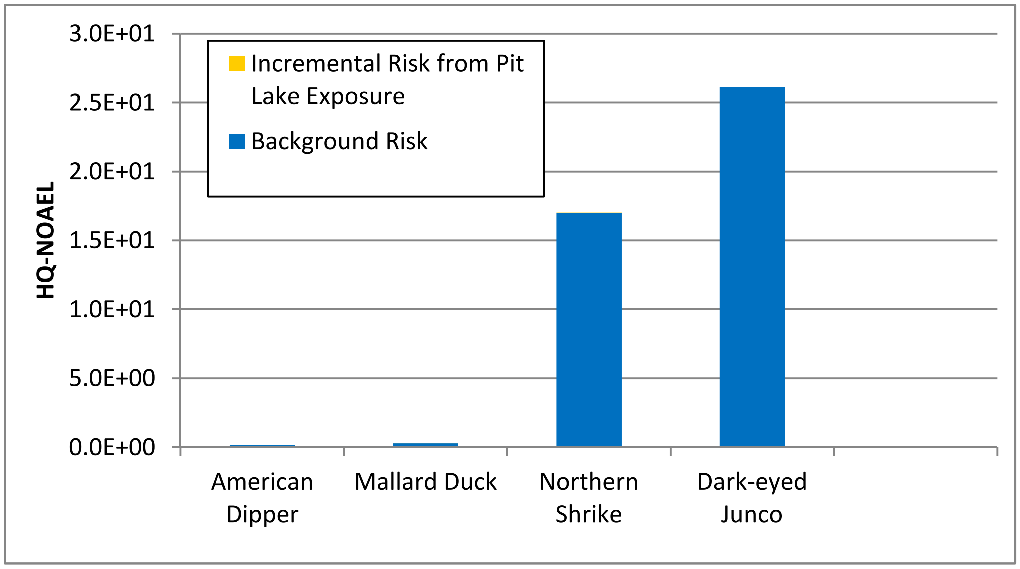
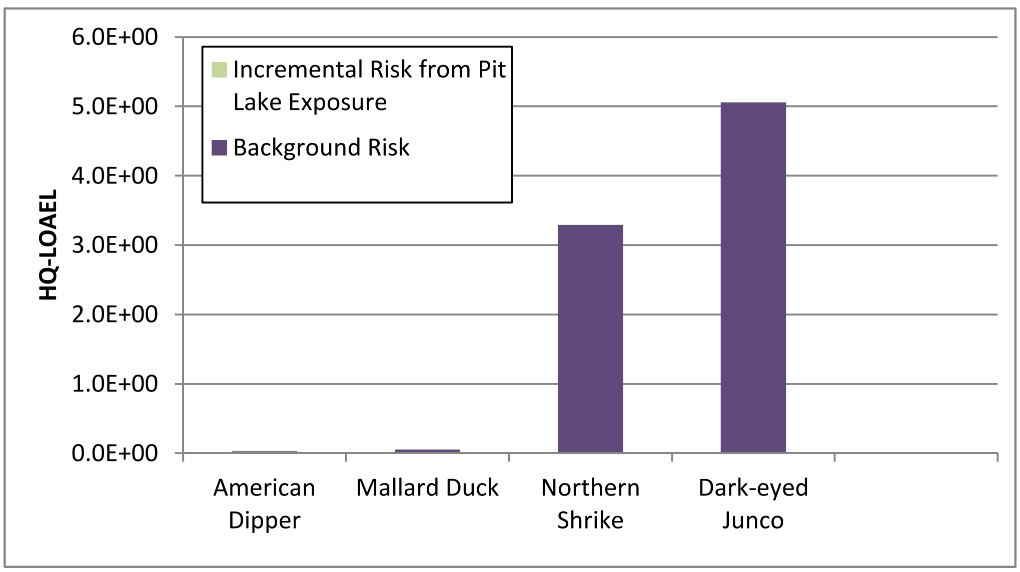
Figure 5-9





Uncertainty Evaluation - Incremental Risk Increase from Chromium Exposure to the Juvenile Pit Lake in Addition to Background Exposure

Donlin Gold LLC
Bethel, Alaska
ACMA Pit Lake Ecological Risk Assessment

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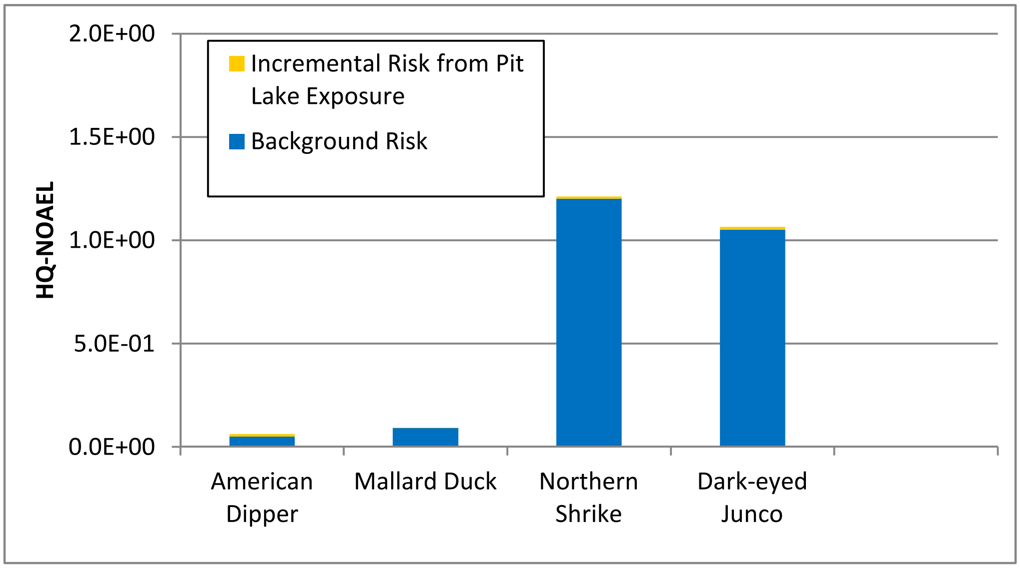
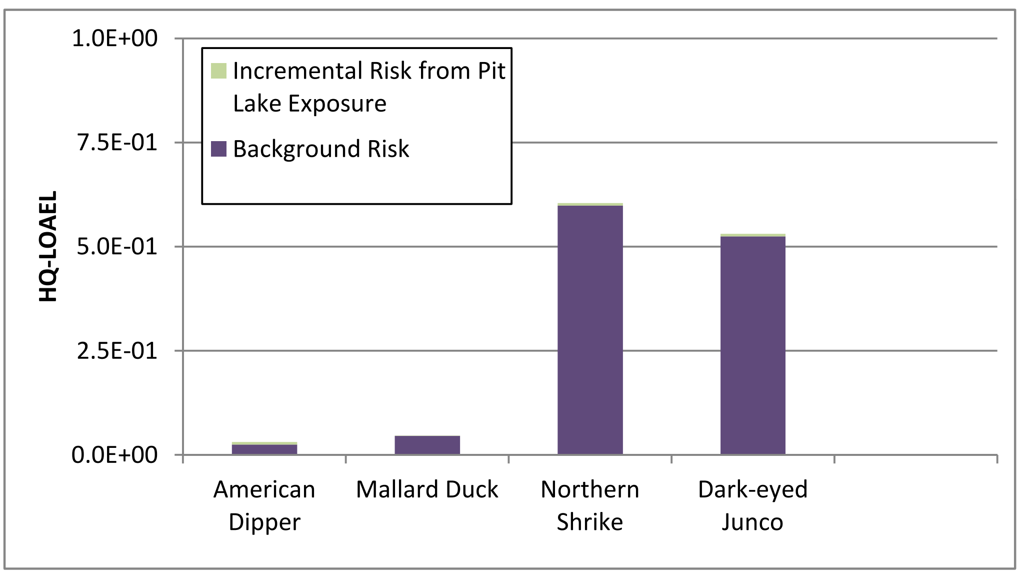
Figure 5-10





Uncertainty Evaluation - Incremental Risk Increase from Cobalt Exposure to the Juvenile Pit Lake in Addition to Background Exposure

Donlin Gold LLC
Bethel, Alaska
ACMA Pit Lake Ecological Risk Assessment

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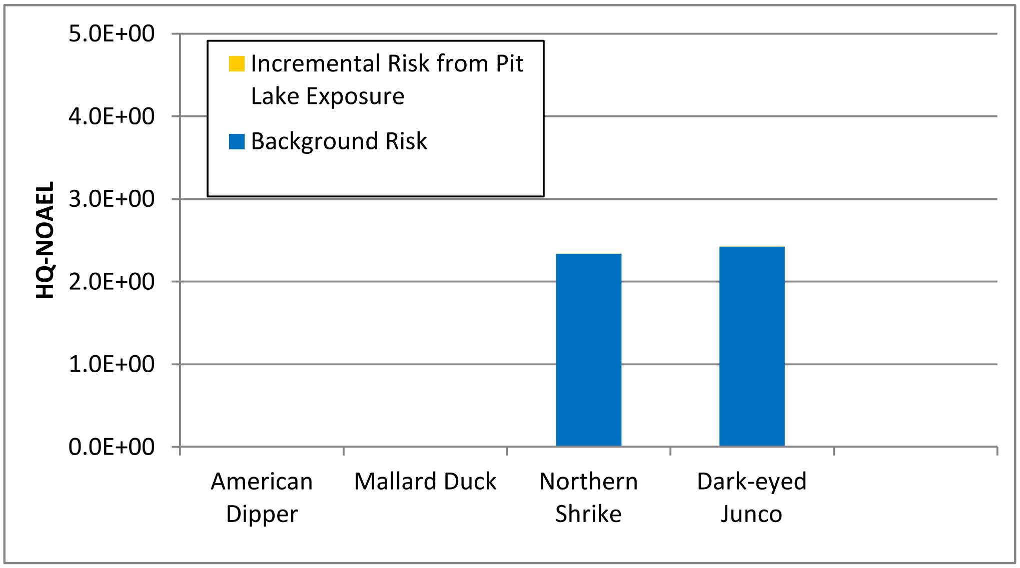
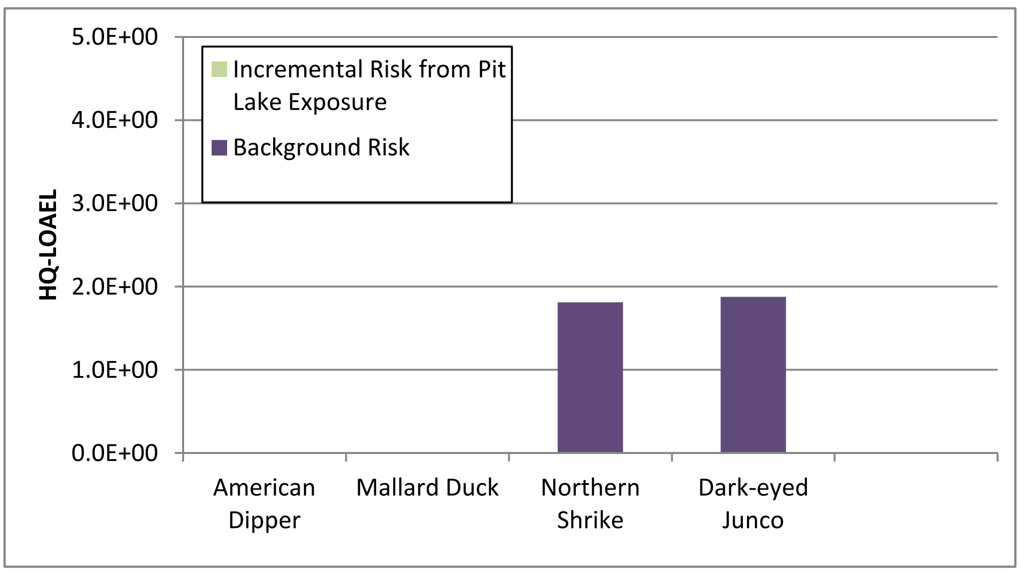
Figure 5-11





Uncertainty Evaluation - Incremental Risk Increase from Copper Exposure to the Juvenile Pit Lake in Addition to Background Exposure

Donlin Gold LLC
Bethel, Alaska
ACMA Pit Lake Ecological Risk Assessment

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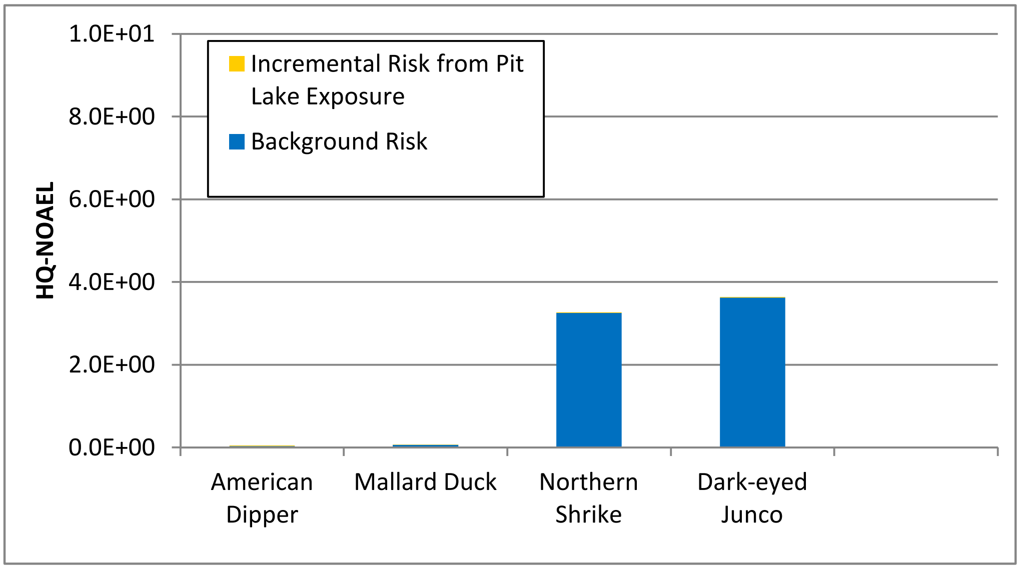
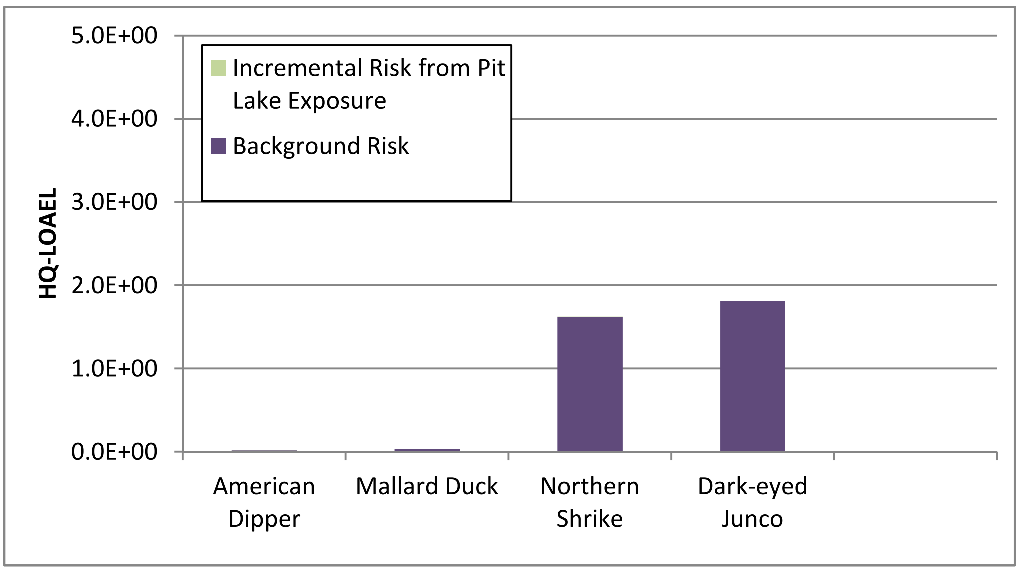
Figure 5-12





Uncertainty Evaluation - Incremental Risk Increase from Lead Exposure to the Juvenile Pit Lake in Addition to Background Exposure

Donlin Gold LLC
Bethel, Alaska
ACMA Pit Lake Ecological Risk Assessment

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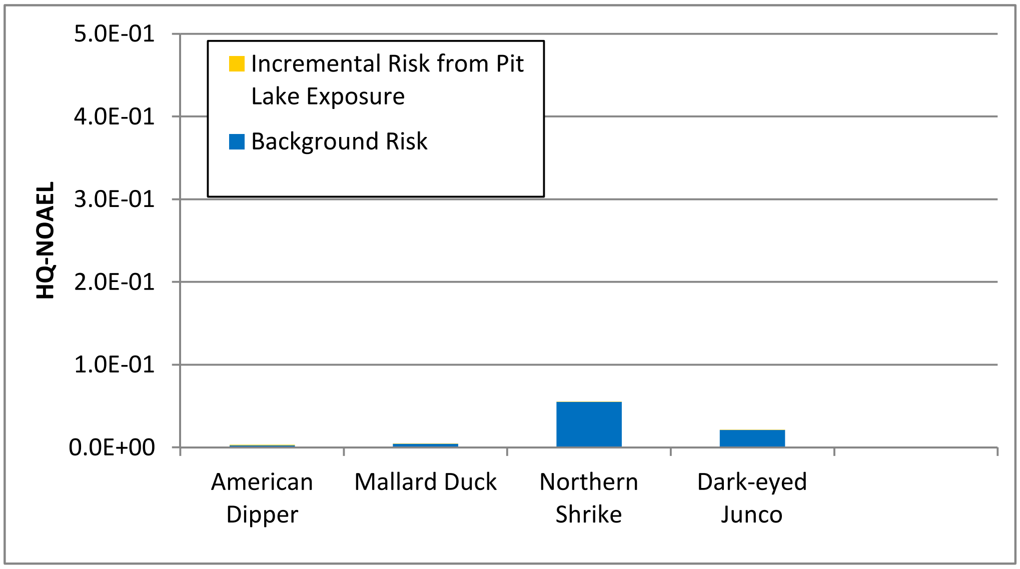
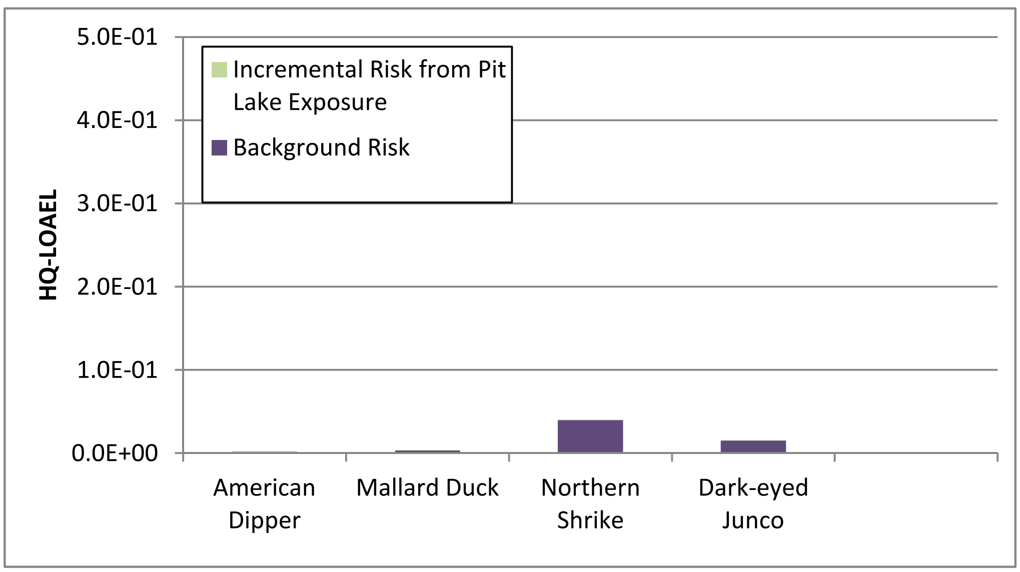
Figure 5-13





Uncertainty Evaluation - Incremental Risk Increase from Nickel Exposure to the Juvenile Pit Lake in Addition to Background Exposure

Donlin Gold LLC
Bethel, Alaska
ACMA Pit Lake Ecological Risk Assessment

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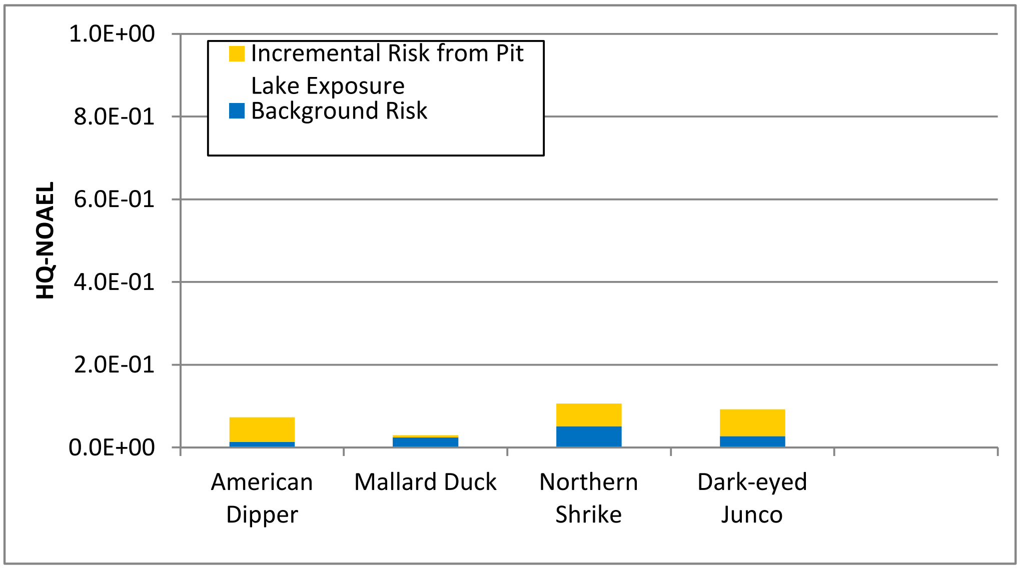
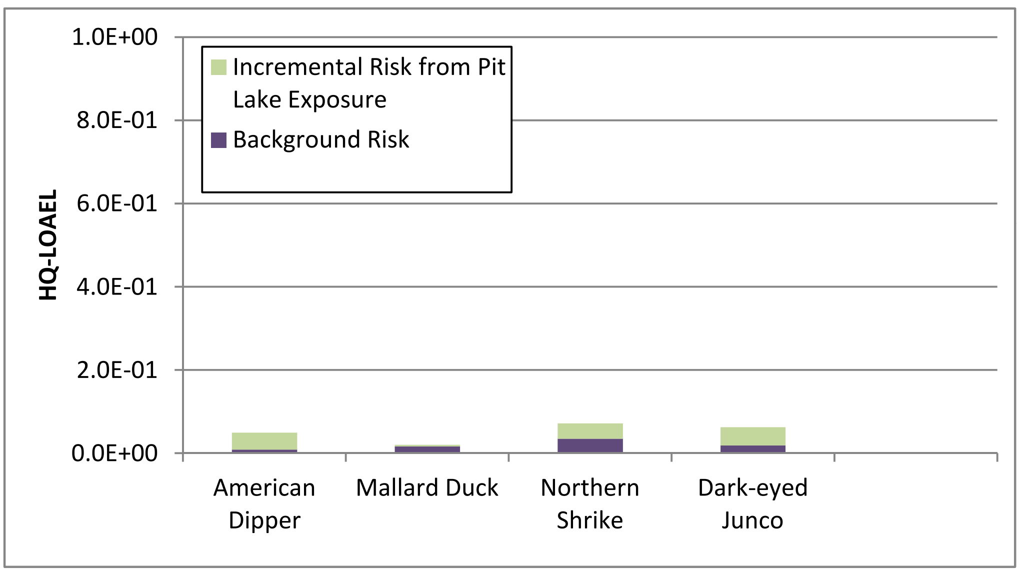
Figure 5-14





Uncertainty Evaluation - Incremental Risk Increase from Selenium Exposure to the Juvenile Pit Lake in Addition to Background Exposure

Donlin Gold LLC
Bethel, Alaska
ACMA Pit Lake Ecological Risk Assessment

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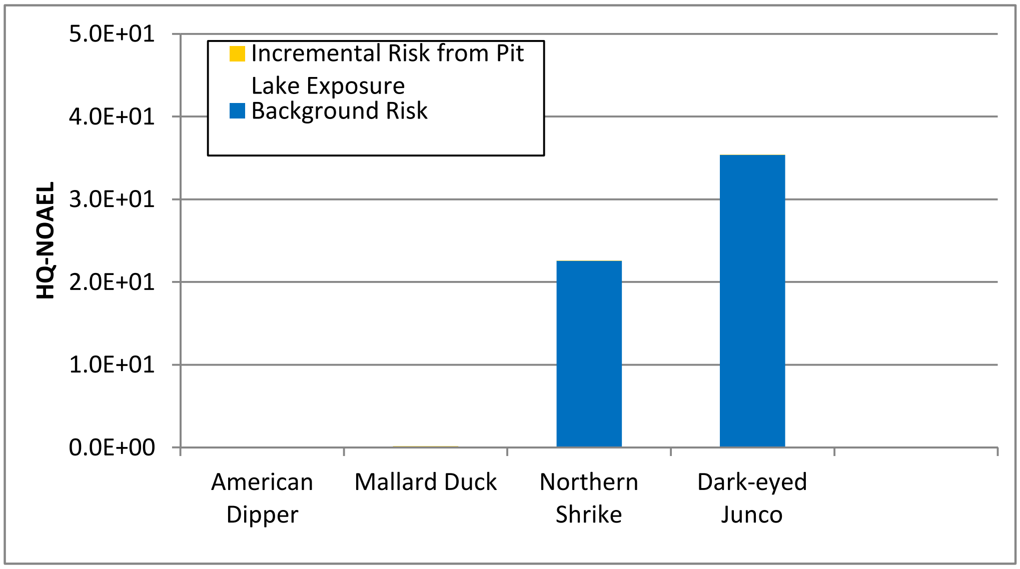
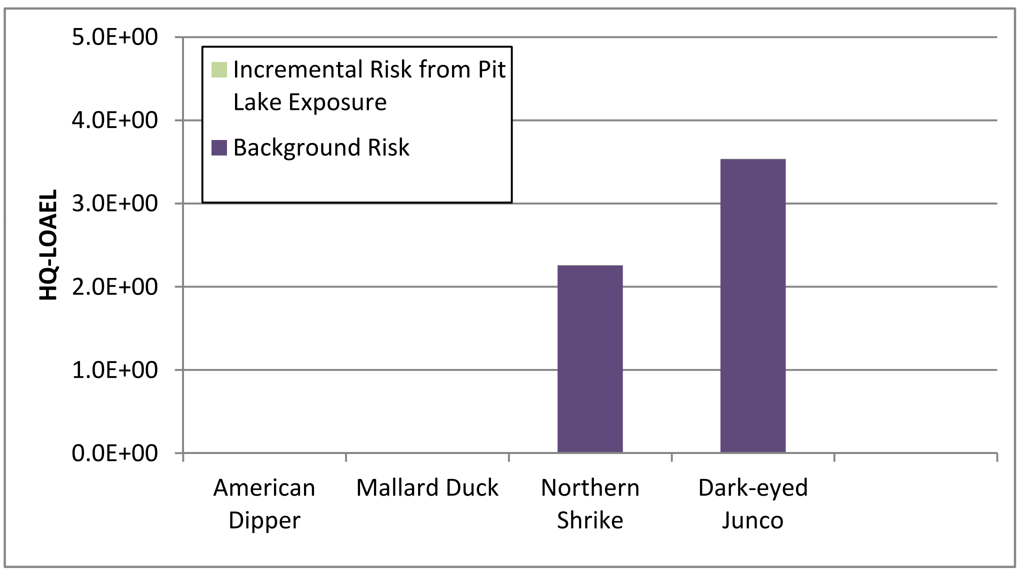
Figure 5-15





Uncertainty Evaluation - Incremental Risk Increase from Zinc Exposure to the Juvenile Pit Lake in Addition to Background Exposure

Donlin Gold LLC
Bethel, Alaska
ACMA Pit Lake Ecological Risk Assessment

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Figure 5-16

Donlin Gold LLC

Pit Lake ERA

Tables

Table 2-1
Terrestrial Vegetation Classifications and Occurrence at the FSA.

Donlin Gold LLC
Bethel, Alaska
ACMA Pit Lake Ecological Risk Assessment

Vegetation Type	Total Acres Mapped (Hectares)	Percent of Total
Broadleaf Forests	6,131 (2,483)	4.9
Closed Deciduous Forest		
Open Deciduous Forest		
Woodland Deciduous Forest		
Needleleaf Forests	74,070 (29,998)	59.1
Closed Spruce Forest		
Black Spruce Forest		
Open Spruce Forest Lichen-Moss		
Spruce Woodland Lichen-Moss		
Open Spruce Forest Moss-Lichen		
Spruce Woodland Moss-Lichen		
Mixed Forests	9,382 (3,799)	7.5
Closed Mixed Forest		
Open Mixed Forest		
Woodland Mixed Forest		
Alluvial Forest (Terrace, Lowland)		
Shrub Communities	26,646 (10,792)	21.2
Alpine Shrub Tundra		
Dwarf Birch Low Shrub		
Closed Alder Shrub		
Open Alder Shrub		
Closed Willow Shrub		
Open Willow Shrub		
Closed Alder Willow Shrub		
Open Alder Willow Shrub		
Herbaceous Communities	4,972 (2,014)	4
Bluejoint Tall Grass		
Emergent Aquatic		
Tussock Sedge		
Other Types	4,237 (1,716)	3.4
Partially Vegetated		
Lichen Mat		
Bareground, Talus, Gravel Bars		
Developed		
Totals	***125,438 (50,802)***	***100***

Notes:

Data from MSES (2006)

Table 2-2
Federally Listed Threatened or Endangered Species in Alaska.

Donlin Gold LLC
Bethel, Alaska
ACMA Pit Lake Ecological Risk Assessment

Status	Species
Plant and animal species listed in this state and that occur in this state (15 species)	
E	Albatross, short-tailed (*Phoebastria (=Diomedea) albatrus)*
E	Curlew, Eskimo (*Numenius borealis*)
E	Sea turtle, leatherback (*Dermochelys coriacea*)
E	Sea-lion, Steller western pop. (*Eumetopias jubatus*)
E	Whale, blue (*Balaenoptera musculus*)
E	Whale, bowhead (*Balaena mysticetus*)
E	Whale, finback (*Balaenoptera physalus*)
E	Whale, humpback (*Megaptera novaeangliae*)
E	Whale, sperm (*Physeter catodon* (=*macrocephalus*))
T	Bear, polar (*Ursus maritimu* s)
T	Eider, spectacled (*Somateria fischeri*)
T	Eider, Steller's AK breeding pop. (*Polysticta stelleri*)
T	Otter, Northern Sea southwest Alaska DPS (*Enhydra lutris kenyoni*)
T	Sea-lion, Steller eastern pop. (*Eumetopias jubatus*)
E	Fern, Aleutian shield (*Polystichum aleuticum*)
Species occurring in this state that are not listed in this state (2 species)	
E	Bison, wood Canada (*Bison bison athabascae*)
T	Sturgeon, North American green U.S.A. (CA) Southern Distinct Population Segment (*Acipenser medirostris*)

Notes:

Last updated: November 13, 2011

http://www.fws.gov/endangered/

T = threatened

E = endangered

Table 2-3
USGS Boreal Partners in Flight listed Priority Species for Conservation (PSFC) in the Western/Southwestern Alaska Region

Donlin Gold LLC
Bethel, Alaska
ACMA Pit Lake Ecological Risk Assessment

Species Name
Gyrfalcon
Gray-cheeked Thrush
Varied Thrush
Blackpoll Warbler
Golden-crowned Sparrow
McKay's Bunting
Rusty Blackbird
Hoary Redpoll

Notes:

Species listed as PSFC in the Western/Southwestern Alaska Region
accessed online December 9, 2010
http://alaska.usgs.gov/science/biology/bpif/priority_spp.php

Table 2-4
Potential Bird Species Near the FSA - from Armstrong (1995) and Sibley (2003)

Donlin Gold LLC
Bethel, Alaska
ACMA Pit Lake Ecological Risk Assessment

Common Name	Scientific name
Alder flycatcher	*Empidonax alnorum*
American golden-plover	*Pluvialis dominica*
American pipit	*Anthus rubescens*
American robin	*Turdus migratorius*
American tree sparrow	*Spizella arborea*
American widgeon	*Anas penelope*
Arctic warbler	*Phylloscopus borealis*
Bald eagle	*Haliaeetus leucocephalus*
Bank swallow	*Riparia riparia*
Black-capped chickadee	*Poecile atricapillus*
Blackpoll warbler	*Dendroica striata*
Blue-winged teal	*Anas discors*
Bohemian waxwing	*Bombyeilla garrulous*
Boreal chickadee	*Poecile hudsonicus*
Bristle-thighed Curlew	*Numenius tahitiensis*
Bufflehead	*Bucephala albeola*
Canada goose	*Branta canadensis*
Chipping sparrow	*Spizella passerina*
Cliff swallow	*Petrochelidon pyrrhonota*
Commom merganser	*Mergus merganser*
Common raven	*Corvus corax*
Common redpoll	*Carduelis flammea*
Common snipe	*Gallinago gallinao*
Dark-eyed junco	*Junco hyemalils*
Fox sparrow	*Passerella iliaca*
Glaucous-winged gull	*Larus glaucescens*
Golden eagle	*Aquila chrysaetos*
Golden-crowned kinglet	*Regulus satrapa*
Golden-crowned sparrow	*Zonotrichia atricapilla*
Gray jay	*Perisoreus canadensis*
Gray-cheeked thrush	*Catharus minimus*
Great gray owl	*Strix nebulosa*
Great horned owl	*Bubo virginianus*
Greater scaup	*Aythya marila*
Greater-white fronted goose	*Anser albifrons*
Green-winged teal	*Anas crecccas*
Gyrfalcon	*Falco rusticolus*
Hermit thrush	*Catharus guttatus*
Horned lark	*Eremophila alpestris*
Lapland longspur	*Calcarius lapponicus*
Long-tailed jaeger	*Stercorarius longicaudus*
Mallard	*Anas platyrhynchos*
Merlin	*Falco columbarius*
Northern harrier	*Circus cyaneus*

Common Name	Scientific name
Northern Hawk Owl	*Surnia ulula*
Northern pintail	*Anas acuta*
Northern shoveler	*Anas clypeata*
Northern waterthrush	*Seiurus noveboracensis*
Olive-sided flycatcher	*Contopus borealis*
Orange-crowned warbler	*Vermivora celata*
Osprey	*Pandion haliaetus*
Pacific golden-plover	*Pluvialis fulva*
Pacific loon	*Gavia pacifica*
Parasitic jaeger	*Stercorarius parasiticus*
Peregrine falcon	*Falco peregrinus*
Pine grosbeak	*Pinicola enucleator*
Pine siskin	*Carduelis pinus*
Red-breasted nuthatch	*Sitta canadensis*
Red-tailed hawk	*Buteo jamaicensis*
Rock ptarmigan	*Lagopus mutus*
Rough-legged hawk	*Buteo lagopus*
Ruby-crowned kinglet	*Regulus calendula*
Rusty blackbird	*Euphagus cyanocephalus*
Savannah sparrow	*Passerculus sandwhichensis*
Short-billed dowitcher	*Limnodromus griseus*
Short-eared owl	*Asio flammeus*
Spruce grouse	*Dendragapus canadensis*
Swainson's hawk	*Buteo swainsoni*
Swainson's thrush	*Catharus ustulatus*
Three-toed woodpecker	*Picoides dorsalis*
Townsend warbler	*Drendroica townsendi*
Townsend's solitaire	*Myadestes townsendi*
Tree swallow	*Tachcineta bicolor*
Tundra swan	*Cygnus columbianus*
Varied thrush	*Ixoreus naevius*
Violet-green swallow	*Tachycineta thalassina*
Whimbrel	*Numenius phaeopus*
White-crowned sparrow	*Zonotrichia leucophrys*
White-winged crossbill	*Loxia leucoptera*
Wilson's warbler	*Wilsonia pusilla*
Yellow wagtail	*Motacilla tschutschensis*
Yellow warbler	*Dendroica petechia*
Yellow-rumped warbler	*Dendroica coronata*

Notes:
Based on species distribution maps published in Armstrong (1995) and Sibley (2003).

Table 2-5
Subsistence Harvests of Wildlife Species Recorded Throughout the Project Area

Donlin Gold LLC
Bethel, Alaska
ACMA Pit Lake Ecological Risk Assessment

Species
Large land mammals
Black bear
Brown bear
Caribou
Deer
Moose
Muskox
Dall sheep
Small land mammals
Beaver
Red fox
Snowshoe hare
Alaska hare
River otter
Lynx
Marmot
Marten
Mink
Muskrat
Porcupine
Arctic ground squirrel
Red squirrel
Weasel
Gray wolf
Woverine
Feral mammals
Reindeer
Migratory birds - Ducks
Bufflehead
Canvasback
Common edier
Unknown edier
Goldeneye
Harlequin
Mallard
Common merganser
Red-breasted merganser
Long-tailed duck
Northern pintail
Scaup
Black scoter
Surf scoter
White-winged scoter
Northern shoveler
Green-winged teal

Table 2-5
Subsistence Harvests of Wildlife Species Recorded Throughout the Project Area

Donlin Gold LLC
Bethel, Alaska
ACMA Pit Lake Ecological Risk Assessment

Species
Unknown wigeon
Unknown ducks
Migratory birds - Geese
Brant
Cackling Canada goose
Lesser Canada goose
Unknown Canada goose
Emperor goose
Snow goose
Greater white-fronted goose
Uknown goose
Other Migratory and Other Birds
Tundra swan
Sandhill crane
Common loon
Spruce grouse
Ruffed grouse
Ptarmigan
Willow ptarmigan
Great horned owl
Unknown other birds

Table 2-6
Birds Observed at FSA and Kuskokwim Corridor -
from Donlin Wildlife Baseline Studies.

Donlin Gold LLC
Bethel, Alaska
ACMA Pit Lake Ecological Risk Assessment

Species Name
Alder Flycatcher
American Golden-plover
American Pipit
American Robin
American Tree Sparrow
Arctic Warbler
Bald Eagle
Bank Swallow
Black-capped Chickadee
Blackpoll Warbler
Bohemian Waxwing
Boreal Chickadee
Canada Goose
Chipping Sparrow
Cliff Swallow
Common Raven
Common Redpoll
Common Snipe
Dark-eyed Junco
Fox Sparrow
Glaucous-winged Gull
Golden Eagle
Golden Eagle
Golden-crowned Kinglet
Golden-crowned Sparrow
Goshawk
Gray Jay
Gray-cheeked Thrush
Great Gray Owl
Great Horned Owl
Gyrfalcon
Harlans Red-tailed Hawk
Hermit Thrush
Horned Lark
Lapland Longspur
Merlin
Merlin
Northern Goshawk
Northern Harrier
Northern Waterthrush
Olive-sided Flycatcher
Orange-crowned Warbler
Osprey
Ovenbird

Species Name
Pacific Golden-plover
Pacific Loon
Parasitic Jaeger
Peregrine Falcon
Pine Grosbeak
Pine Siskin
Red-breasted Nuthatch
Red-tailed Hawk
Rock Ptarmigan
Rough-legged Hawk
Ruby-crowned Kinglet
Rusty Blackbird
Savannah Sparrow
Short-billed Dowitcher
Song Sparrow
Spruce Grouse
Swainson's Hawk
Swainson's Thrush
Three-toed Woodpercker
Townsend Warbler
Townsend's Solitaire
Tree Swallow
Unknown Buteo
Varied Thrush
Violet-green Swallow
Whimbrel
White-crowned Sparrow
White-winged Crossbill
Wilson Snipe
Wilson's Warbler
Woodpecker
Yellow Warbler
Yellow-rumped Warbler
Ptarmigan

Notes:

Species recorded between 2007 and 2009 throughout FSA, Kuskokwim corridor and reference area. (ARCADIS 2007, 2008a, 2009, 2010)

Table 2-7
Mammals Observed at FSA and Kuskokwim Corridor - from Donlin Wildlife Baseline Studies.

Donlin Gold LLC
Bethel, Alaska
ACMA Pit Lake Ecological Risk Assessment

Species Name
American Marten (*Martes americana*)
Wolverine (*Gulo gulo*)
Wolf (*Canis lupus*)
Red Fox (*Vulpes vulpes*)
Snowshoe Hare (*Lepus americanus*)
Moose (*Alces alces*)
North American River Otter (*Lontra canadensis*)
Rodent
Weasels (*Mustela spp*)
Red Squirrel (*Tamiasciurus hudsonicus*)

Notes:
Species recorded between 2007 and 2009 throughout FSA, Kuskokwim corridor and reference area. (ARCADIS 2008b, 2008c, 2011a, 2011b)

Table 2-8
Functional Wildlife Species Groups in the Interior Ecoregion - from Shannon and Wilson (1999)

Donlin Gold LLC
Bethel, Alaska
ACMA Pit Lake Ecological Risk Assessment

Functional Group	Common Name	Latin Name
Freshwater avian invertevore	American dipper	*Cinclus mexicanus*
Freshwater avian invertevore	Barrow's goldeneye	*Bucephala islandica*
Freshwater avian invertevore	bufflehead	*Bucephala albeola*
Freshwater avian invertevore	canvasback	*Aythya valisineria*
Freshwater avian invertevore	common goldeneye	*Bucephala clangula*
Freshwater avian invertevore	greater scaup	*Aythya marila*
Freshwater avian invertevore	harlequine	*Histrionicus histrionicus*
Freshwater avian invertevore	horned grebe	*Podiceps auritus*
Freshwater avian invertevore	lesser scaup	*Aythya affinis*
Freshwater avian invertevore	oldsquaw	*Clangula hyemalis*
Freshwater avian invertevore	redhead	*Aythya americana*
Freshwater avian invertevore	red-necked phalarope	*Phalaropus lobatus*
Freshwater avian invertevore	ring-necked duck	*Aythya collaris*
Freshwater avian invertevore	surf scoter	*Melanitha perspicillata*
Freshwater avian invertevore	wandering tattler	*Heteroscelus incanus*
Freshwater avian invertevore	white-winged scoter	*Melanitta fusca*
Freshwater avian piscivore	bald eagle	*Haliaeetus leucocephalus*
Freshwater avian piscivore	belted kingfisher	*Ceryle alcyon*
Freshwater avian piscivore	common loon	*Gavia immer*
Freshwater avian piscivore	ospreye	*Pandion haliaetus*
Freshwater avian piscivore	Pacific loon	*Garvia pacifica*
Freshwater avian piscivore	red-necked grebe	*Podiceps grisegena*
Freshwater mammalian piscivore	brown bear	*Ursus arctos*
Freshwater mammalian piscivore	river otter	*Lutra canadensis*
Freshwater semi-aquatic avian herbivore	American wigeon	*Anas americana*
Freshwater semi-aquatic avian herbivore	blue-winged teal	*Anas discors*
Freshwater semi-aquatic avian herbivore	Canada goose	*Branta canadensis*
Freshwater semi-aquatic avian herbivore	green-winged teal	*Anas crecca*
Freshwater semi-aquatic avian herbivore	mallard	*Anas platyrhynchos*
Freshwater semi-aquatic avian herbivore	northern pintail	*Anas acuta*
Freshwater semi-aquatic avian herbivore	northern shoveler	*Anas clypeata*
Freshwater semi-aquatic avian herbivore	snow goose	*Chen caeruliscens*
Freshwater semi-aquatic avian herbivore	trumpeter swane	*Cygnus buccinator*
Freshwater semi-aquatic avian herbivore	tundra swan	*Cygnus coumbianus*
Freshwater semi-aquatic avian herbivore	white-fronted goose	*Anser albifrons*
Freshwater semi-aquatic avian invertevore	Baird's sandpiper	*Calidris bairdii*
Freshwater semi-aquatic avian invertevore	common snipe	*Gallinago gallinago*
Freshwater semi-aquatic avian invertevore	least sandpiper	*Calidris minutilla*
Freshwater semi-aquatic avian invertevore	lesser golden-plover	*Pluvialis dominica*
Freshwater semi-aquatic avian invertevore	lesser yellowlegs	*Tringa flavipes*
Freshwater semi-aquatic avian invertevore	long-billed dowitcher	*Limnodromus scolopaceus*
Freshwater semi-aquatic avian invertevore	northern waterthrush	*Seiurus noveboracensis*
Freshwater semi-aquatic avian invertevore	northern wheatear	*Oenanthe oenanthe*
Freshwater semi-aquatic avian invertevore	pectoral sandpiper	*Calidris melanotos*

Functional Group	Common Name	Latin Name
Freshwater semi-aquatic avian invertevore	sandhill crane	*Grus canadensis*
Freshwater semi-aquatic avian invertevore	semipalmated plover	*Charadrius semipalmatus*
Freshwater semi-aquatic avian invertevore	semipalmated sandpiper	*Calidris pusilla*
Freshwater semi-aquatic avian invertevore	solitary sandpiper	*Tringa solitaria*
Freshwater semi-aquatic avian invertevore	spotted sandpiper	*Actitis manuclria*
Freshwater semi-aquatic avian invertevore	surfbird	*Aphriza virgata*
Freshwater semi-aquatic avian invertevore	upland sandpiper	*Bartramia longicauda*
Freshwater semi-aquatic avian invertevore	whimbrel	*Numenius phaeopus*
Freshwater semi-aquatic mammalian carnivore	mink	*Mustela vison*
Freshwater semi-aquatic mammalian herbivore	moose	*Alces alces*
Freshwater semi-aquatic mammalian herbivore	muskrat	*Ondatra zibethicus*
Freshwater semi-aquatic mammalian herbivore	northern bog lemming	*Synaptomys borealis*
Terrestrial avian carnivore	black-billed magpie	*Pica pica*
Terrestrial avian carnivore	boreal owl	*Aegolius funereus*
Terrestrial avian carnivore	common raven	*Corvus corax*
Terrestrial avian carnivore	golden eagle	*Aquila chrysaetos*
Terrestrial avian carnivore	great horned owl	*Bubo virginianus*
Terrestrial avian carnivore	gyrfalcon	*Falco rusticolus*
Terrestrial avian carnivore	long-tailed jaeger	*Stercorarius longicaudus*
Terrestrial avian carnivore	merlin	*Falco columbarius*
Terrestrial avian carnivore	northern goshawk	*Accipiter gentilis*
Terrestrial avian carnivore	northern harrier	*Circus cyaneus*
Terrestrial avian carnivore	northern hawk owl	*Surnia ulula*
Terrestrial avian carnivore	northern shrike	*Lanius excubitor*
Terrestrial avian carnivore	red-tailed hawk	*Buteo jamaicensis*
Terrestrial avian carnivore	rough-legged hawk	*Buteo lagopus*
Terrestrial avian carnivore	sharp-skinned hawk	*Accipiter striatus*
Terrestrial avian carnivore	short-eared owl	*Asio flammens*
Terrestrial avian herbivore	bohemian waxwing	*Bombycilla garrulus*
Terrestrial avian herbivore	common redpoll	*Carduelis flammea*
Terrestrial avian herbivore	dark-eyed junco	*Junco hyemalis*
Terrestrial avian herbivore	Evermann's rock ptarmigane	*Lagopus mutus*
Terrestrial avian herbivore	pine grosbeak	*Pinocola enucleator*
Terrestrial avian herbivore	rock ptarmigan	*Lagopus mutus*
Terrestrial avian herbivore	rosy finch	*Leucosticte arctoa*
Terrestrial avian herbivore	ruffed grouse	*Bonasa umbellus*
Terrestrial avian herbivore	sharp-tailed grouse	*Tympanuchus phasianellus*
Terrestrial avian herbivore	spruce grouse	*Dendragapus canadensis*
Terrestrial avian herbivore	white-tailed ptarmigan	*Lagopus leucurus*
Terrestrial avian herbivore	white-winged crossbill	*Loxia leucoptera*
Terrestrial avian herbivore	willow ptarmigan	*Lagopus lagopus*
Terrestrial avian invertevore	alder flycatcher	*Empidonax alnorum*
Terrestrial avian invertevore	American kestrel	*Falco sparverius*
Terrestrial avian invertevore	American robin	*Turdus migratorius*
Terrestrial avian invertevore	American tree sparrow	*Spizella arborea*
Terrestrial avian invertevore	Arctic warbler	*Phylloscopus borealis*
Terrestrial avian invertevore	bank swallow	*Riparia riparia*
Terrestrial avian invertevore	black-capped chickadee	*Parus atricapillus*
Terrestrial avian invertevore	blackpoll warblere	*Dendroica straita*
Terrestrial avian invertevore	boreal chickadee	*Parus hudsonicus*
Terrestrial avian invertevore	chipping sparrow	*Spizella passerina*
Terrestrial avian invertevore	cliff swallow	*Hirundo pyrrhonota*
Terrestrial avian invertevore	downy woodpecker	*Picoides pubescens*

Functional Group	Common Name	Latin Name
Terrestrial avian invertevore	Eskimo curlewe	*Numenius borealis*
Terrestrial avian invertevore	fox sparrow	*Passerculus iliaca*
Terrestrial avian invertevore	golden-crowned sparrow	*Zonotrichia atricapilla*
Terrestrial avian invertevore	gray jay	*Perisoreus canadensis*
Terrestrial avian invertevore	gray-cheeked thrushe	*Catharus minimus*
Terrestrial avian invertevore	hairy woodpecker	*Picoides villosus*
Terrestrial avian invertevore	hermit thrush	*Catharus guttatus*
Terrestrial avian invertevore	hoary redpoll	*Carduelis hornemanni*
Terrestrial avian invertevore	horned lark	*Eremophila alpestris*
Terrestrial avian invertevore	Lapland longspur	*Calcarius lapponicus*
Terrestrial avian invertevore	Lincoln's sparrow	*Melospiza lincolnii*
Terrestrial avian invertevore	northern flicker	*Colaptes auratus*
Terrestrial avian invertevore	olive-sided flycatchere	*Contopus borealis*
Terrestrial avian invertevore	red-winged blackbird	*Agelaius phoeniceus*
Terrestrial avian invertevore	ruby-crowned kinglet	*Regulus calendula*
Terrestrial avian invertevore	rusty blackird	*Euphagus carolinus*
Terrestrial avian invertevore	Savannah sparrow	*Passerculus sandwichensis*
Terrestrial avian invertevore	Say's phoebe	*Sayornis saya*
Terrestrial avian invertevore	snow bunting	*Plectrophenax nivalis*
Terrestrial avian invertevore	Swainson's thrush	*Catharus ustulatus*
Terrestrial avian invertevore	three-toed woodpecker	*Picoides tridactylus*
Terrestrial avian invertevore	Townsend's warblere	*Dendroica townsendi*
Terrestrial avian invertevore	tree swallow	*Tachycineta bicolor*
Terrestrial avian invertevore	varied thrush	*Ixoreus naevius*
Terrestrial avian invertevore	violet-green swallow	*Tachycineta thalassina*
Terrestrial avian invertevore	water pipit	*Anthus spinoletta*
Terrestrial avian invertevore	western wood-pewee	*Contopus sordidulus*
Terrestrial avian invertevore	white-crowned sparrow	*Zonotrichia leucophrys*
Terrestrial avian invertevore	Wilson's warbler	*Wilsonia pusilla*
Terrestrial avian invertevore	yellow-rumped warbler	*Dendroica coronata*
Terrestrial invertebrate detritivore	beetles	various spp.
Terrestrial invertebrate detritivores	flies	*Tipula spp.*
Terrestrial invertebrate detritivores	snails	*gastropoda spp.*
Terrestrial invertebrate invertevore	spiders	*Arachnidae*
Terrestrial mammalian carnivore	coyote	*Canis latrans*
Terrestrial mammalian carnivore	gray wolf	*Canis lupis*
Terrestrial mammalian carnivore	least weasel	*Mustela rixosa*
Terrestrial mammalian carnivore	lynxe	*Lynx canadensis*
Terrestrial mammalian carnivore	marten	*Martes americana*
Terrestrial mammalian carnivore	red fox	*Vulpes fulva*
Terrestrial mammalian carnivore	shorttail weasel (ermine)	*Mustela erminea*
Terrestrial mammalian carnivore	wolverine	*Gulo gulo*
Terrestrial mammalian herbivore	Alaska vole	*Microtus miurus*
Terrestrial mammalian herbivore	beaver	*Castor canadensis*
Terrestrial mammalian herbivore	black bear	*Ursus americanus*
Terrestrial mammalian herbivore	brown lemming	*Lemmus trimucronatus*
Terrestrial mammalian herbivore	caribou	*Rangifer tarandus*
Terrestrial mammalian herbivore	dall sheep	*Ovis dalli*
Terrestrial mammalian herbivore	deer mouse	*Peromyscus maniculatus*
Terrestrial mammalian herbivore	Douglas squirrel	*Tamiasciurus douglasi*
Terrestrial mammalian herbivore	marmot	*Marmota broweri*
Terrestrial mammalian herbivore	meadow vole	*Microtus pennsylvanicus*
Terrestrial mammalian herbivore	muskox	*Orvibos moschatus*

Functional Group	Common Name	Latin Name
Terrestrial mammalian herbivore	pika	*Ochatna collaris*
Terrestrial mammalian herbivore	porcupine	*Erethizon dorsatum*
Terrestrial mammalian herbivore	red squirrel	*Tamiasciurus hudsonicus*
Terrestrial mammalian herbivore	snowshoe hare	*Lepus americanus*
Terrestrial mammalian herbivore	squirrel	*Citellus parryi*
Terrestrial mammalian herbivore	tundra redback vole	*Clethrionomys dawsoni*
Terrestrial mammalian herbivore	tundra vole	*Microtus oeconomus*
Terrestrial mammalian herbivore	yellow-cheeked vole	*Microtus xanthognathus*
Terrestrial mammalian invertevore	dusky shrew	*Sorex obscurus*
Terrestrial mammalian invertevore	masked shrew	*Sorex cinereus*
Terrestrial mammalian invertevore	northern flying squirrel	*Glaucomys sabrinus*
Terrestrial mammalian invertevore	Norway rat	*Rattus norvegicus*
Terrestrial mammalian invertevore	pygmy shrew	*Microsorex hoyi*
Terrestrial mammalian invertevore	tundra shrew	*Sorex tundrensis*

Notes:

Semi-aquatic infers that sustenance is obtained from sediment or sediment pore water, or the species resides in sediment.

Table includes bird and mammal species identified in Shannon & Wilson (1999) for this group

Table 2-9
Sensitive and High Value Wildlife Species of the Interior Ecoregion- from Shannon and Wilson (1999)

Donlin Gold LLC
Bethel, Alaska
ACMA Pit Lake Ecological Risk Assessment

Species group	Common Name	Category	Uses	Subregion	Preferred Habitat	Occurrence
bear	black bear	Subsistence	food, clothing, gloves, matresses	---	not stated	not stated
bear	brown bear	Subsistence	food, clothing, glvoes, matresses	---	not stated	not stated
beaver	not stated	Commercial	clothing	---	not stated	not stated
bird	pintail	Subsistence	food	---	not stated	not stated
bufflehead	not stated	Subsistence	food	---	not stated	not stated
caribou	not stated	Commercial, Recreational, Subsistence	clothing, wildlife viewing, bird watching, sport hunting, food, rope, matresses, sleds	---	not stated	not stated
coyote	not stated	Commercial	clothing	---	not stated	not stated
fox	not stated	Ceremonial, Commercial	ceremonial decoration, clothing	---	not stated	not stated
grouse	not stated	Ceremonial	ceremonial decoration	---	not stated	not stated
hare	not stated	Commercial	clothing, blankets	---	not stated	not stated
large game	musk ox	Subsistence	food, clothing	---	not stated	not stated
lynx	not stated	Commercial	clothing	---	not stated	not stated
marmot	not stated	Commercial	clothing	---	not stated	not stated
marten	not stated	Ceremonial, Commercial	ceremonial decoration, clothing	---	not stated	not stated
migrating waterfowl	not stated	Commercial, Recreational	wildlife viewing, bird watching, sport fishing, sport hunting	---	not stated	not stated
mink	not stated	Commercial	clothing	---	not stated	not stated
moose	not stated	Commercial, Subsistence	wildlife viewing, bird watching, sport fishing, sport hunting, clothing, food	---	not stated	not stated
muskrat	not stated	Commercial	clothing	---	not stated	not stated
otter	not stated	Commercial	clothing	---	not stated	not stated
protected species	blackpoll warbler	Regulatory	---	Forested lowlands and uplands	Coniferous and broadleaf forests	SU
protected species	Eskimo curlew	Regulatory	---	Yukon Flats, and along Yukon River	Grassy meadow	SU

Species group	Common Name	Category	Uses	Subregion	Preferred Habitat	Occurrence
protected species	Evermann's rock ptarmigan	Regulatory	---	Foothills	Tall and dwarf scrub/shrub, and grassy meadows	RU
protected species	gray-cheeked thrush	Regulatory	---	Forested bottomlands, lowlands, uplands, and highlands and the Yukon Flats	Coniferous and broadleaf forests and tall scrub/shrub	SU
protected species	harlequin duck	Regulatory	---	Yukon Flats and bottomlands	Ponds, lakes, rivers, and wet meadow	SC
protected species	North American lynx	Regulatory	---	Forested uplands and highlands, and foothills	Coniferous and broadleaf forests	RU
protected species	olive-sided flycatcher	Regulatory	---	Forested lowlands, uplands, and highlands	Coniferous forests	SU
protected species	osprey	Regulatory	---	Forested bottomlands and Yukon Flats	Near lakes, rivers, and coast	SU
protected species	Townsend's warbler	Regulatory	---	Forested bottomlands, lowlands, uplands, and highlands and the Yukon Flats	Coniferous and broadleaf forests	SC
protected species	trumpeter swan	Regulatory	---	Yukon Flats and bottomlands	Wet meadow, lakes, ponds, and rivers	SC
ptarmigan	not stated	Ceremonial, Recreational, Subsistence	bird watching, sport hunting, ceremonial decoration, clothing, food	---	not stated	not stated
raven	not stated	Ceremonial	central theme of cultural beliefs	---	not stated	not stated
scoter	not stated	Subsistence	food	---	not stated	not stated
sheep	Dall sheep	Commercial, Subsistence	food, clothing	---	not stated	not stated
shoveler	not stated	Subsistence	food	---	not stated	not stated
swan	not stated	Subsistence	food	---	not stated	not stated
teal	not stated	Subsistence	food	---	not stated	not stated
waterfowl	Canada goose	Subsistence	food	---	not stated	not stated
waterfowl	sandhill crane	Subsistence	food	---	not stated	not stated
weasel	not stated	Commercial	clothing	---	not stated	not stated
wolf	not stated	Ceremonial, Commercial	potlatches, clothing	---	not stated	not stated
wolverine	not stated	Commercial	potlatches, clothing	---	not stated	not stated

Notes:

Table includes bird and mammal species identified in Shannon & Wilson (1999), Tables D.1-3 and D.2-3

RC -Resident, Common

RU - Resident, Uncommon

SC - Seasonal, Common

SU - Seasonal, Uncommon

NR - Not Reported

Table 2-10
Receptors of Interest (ROI) Used in the Ecological Risk Assessment

Donlin Gold LLC
Bethel, Alaska
ACMA Pit Lake Ecological Risk Assessment

Animal Class	ROI	Scenario Evaluated	Trophic Level	Baseline Study Considerations	Subsistence Considerations	Agency Priority Considerations	Risk Guidance Considerations
Mammal	Tundra Vole	Mature	Mammal Herbivore (aquatic-based)	Likely presence at the site.		F&G candidate target species.	ADEC "Default" recommended indicator species.
	Snowshoe Hare	Mature	Mammal Herbivore (terrestrial-based)	Known presence at site.	Recognized subsistence source in the area		Listed indicator species.
	Black Bear	Mature	Mammal Omnivore (terrestrial-based)	Potential presence at the site.	Recognized subsistence source in the area		
	Mink	Mature	Mammal Carnivore (semi-aquatic)	Known presence at the site.	Recognized subsistence source in the area	A valued subsistence species.	ADEC "Default" recommended indicator species.
	Gray Wolf	Mature	Mammal Carnivore (terrestrial-based)	Known presence at site.	Recognized subsistence source in the area	F&G candidate target species.	Listed indicator species.
Bird	Mallard	Juvenile & Mature	Avian Herbivore (semi-aquatic)	Known presence at the site.	Recognized subsistence source in the area	Protected via migratory bird treaty act.	ADEC "Default" recommended indicator species.
	American Dipper	Juvenile & Mature	Avian Invertivore (aquatic-based)	Likely presence at the site.		F&G candidate target species.	ADEC "Default" recommended indicator species.
	Dark-eyed Junco	Juvenile & Mature	Avian Invertivore (terrestrial-based)	Known presence at the site		F&G candidate target species.	ADEC "Default" recommended indicator species.
	Northern Shrike	Juvenile & Mature	Avian Carnivore (terrestrial-based)	Potential presence at the site.		Protected via migratory bird treaty act.	ADEC "Default" recommended indicator species.

Table 2-11
Ecological Exposure Profile of the Black Bear (*Ursus americanus*).

Donlin Gold LLC
Bethel, Alaska
ACMA Pit Lake Ecological Risk Assessment

Parameter	Symbol	Reported Values	References	Values Identified for ERA
Habitat				
Body Weight (kg wet weight)	BW	Average male: 87.3 kg (range 59.1-117 kg) Average female: 63.4 kg (43.2-76.4 kg) Average from USEPA: 128.87 kg	Bertram and Vivion 2002; USEPA 1999	128.87
Food Ingestion Rate (kg wet weight/day)	IR_{food}	Estimated using field metabolic rates and dietary composition approach: IR_{food} = NFMR/MEavg	USEPA 1999	12.48
Water Ingestion Rate (L/day)	IR_{water}	Estimated using the equation: $IR_{water} = 0.099\ BW^{0.90}$	USEPA 1999	7.85
Sediment or Soil Ingestion Rate (kg dry weight/day)	IR_{sed}	Soil ingestion rate estimated at 2.8% of dietary intake rate.	USEPA 1999	0.35
Dietary Composition (fraction wet volume)	df	In presence of salmon food source – salmon could account for up to 56 +/-25% of the diet Yukon black bears – 95% vegetation and berries, 2% insects, 3% misc.	Peacock 2001; MacHutchon 1989	df_{fish} = 0.25 $df_{terrplant}$ = 0.75

Table 2-12
Ecological Exposure Profile of the mink (*Mustela vison*).

Donlin Gold LLC
Bethel, Alaska
ACMA Pit Lake Ecological Risk Assessment

Parameter	Symbol	Reported Values	References	Values Identified for ERA
Habitat		Mink are associated with aquatic habitats inc	USEPA 1993	
Body Weight (kg wet weight)	BW	0.568 - Female (Montana) 1.14 - Male (Montana) Mean of reported means for both sexes: 0.852	USEPA 1993	0.852
Food Ingestion Rate (kg wet weight/day)	IR_{food}	Measured values of captive minks reported at an average of 0.13 g/g-day.	USEPA 1993	0.111
Water Ingestion Rate (L/day)	IR_{water}	Measured values of captive minks reported at 0.028 g/g-day.	USEPA 1993	0.024
Sediment or Soil Ingestion Rate (kg dry weight/day)	IR_{sed}	Ingestion of sediment (IRsed) as percentage of food intake (kg dry weight/kg food dry weight) is assumed to be equal to 1%. A 75% wet weight to dry weight ratio used to calculate IRsed.	Beyer 1994	0.00083
Dietary Composition (fraction wet volume)	df	Mink are opportunistic feeders. In many parts of its range, mammals are the most important prey but mink hunt aquatic prey as well depending on the season. In Montana, frequency of occurrence of prey items for mink were 62% fish, 19% mammals and 27% aquatic invertebrates.	USEPA 1993; Hagler Bailly 1995	df_{fish} = 0.60 df_{aqinv} = 0.25 df_{mamm} = 0.15

Table 2-13
Ecological Exposure Profile of the Snowshoe Hare (*Lepus americanus*)

Donlin Gold LLC
Bethel, Alaska
ACMA Pit Lake Ecological Risk Assessment

Parameter	Symbol	Reported Values	References	Values Identified for ERA
Habitat		Found in mixed spruce forests, wooded swamps, and brushy areas.	ADF&G (1994a)	
Body Weight (kg wet weight)	BW	1.4 - 1.8 - Adults in Alaska.	ADF&G (1994a)	1.60
Food Ingestion Rate (kg wet weight/day)	IR_{food}	Estimated using field metabolic rates and dietary composition approach: IR_{food} = NFMR/Meavg; kcal daily requirements for snowshoe hare cited by Belovsky (1982) used for equation.	USEPA 1993, Belovsky 1984	0.253
Water Ingestion Rate (L/day)	IR_{water}	Estimated using the equation: $IR_{water} = 0.099\ BW^{0.90}$	USEPA 1993	1.51
Sediment or Soil Ingestion Rate (kg dry weight/day)	IR_{sed}	No sediment ingestion expected as all food items are upland terrestrial items. Soil ingestion rate estimated at 6.3% of total dry matter intake, assumed to be similar to the jackrabbit as reported by Sample et al. (1997).	Sample et al. 1997	0.0076
Dietary Composition (fraction wet volume)	df	Feeds on a variety of plants, including grasses, buds, twigs, leaves, needles and bark.	ADF&G (1994a)	$df_{terrveg} = 1$

Table 2-14
Ecological Exposure Profile of the Tundra Vole (*Microtus oeconomus*).

Donlin Gold LLC
Bethel, Alaska
ACMA Pit Lake Ecological Risk Assessment

Parameter	Symbol	Reported Values	References	Values Identified for ERA
Habitat		Inhabits the tundra and taiga. Commonly found along the edges of lakes and streams where this and similar habitats occur.	Bergman and Krebs 1993	
Body Weight (kg wet weight)	BW	0.029 - Mean - Adult Female - Norway 0.030 - Mean - Adult Male - Norway	Aars and Ims 2002	0.03
Food Ingestion Rate (kg wet weight/day)	IR_{food}	Estimated using field metabolic rates and dietary composition approach: $IR_{food} = NFMR/ME_{avg}$	USEPA 1993	0.013
Water Ingestion Rate (L/day)	IR_{water}	Estimated using the equation: $IRwater = 0.099\ BW^{0.90}$	USEPA 1993	0.042
Sediment or Soil Ingestion Rate (kg dry weight/day)	IR_{sed}	Sediment ingestion rate assumed to be similar to meadow vole, reported at 2.4% of prey ingestion rate. A wet weight to dry weight ratio of 75% used to calculate sediment ingestion rate.	Beyer 1994	0.00023
Dietary Composition (fraction wet volume)	df	Plants; estimated 70 to 80% sedges, with the remainder comprising herbs, mosses, lichen, and small woody shrubs.	Batzli and Lesieutre 1991	$df_{aqplant} = 0.5$ $df_{terrplant} = 0.5$

Table 2-15
Exposure Exposure Profile of the Gray Wolf (*Canis lupus*)

Donlin Gold LLC
Bethel, Alaska
ACMA Pit Lake Ecological Risk Assessment

Parameter	Symbol	Reported Values	References	Values Identified for ERA
Habitat		Occurs throughout mainland Alaska in a vari	ADF&G (1994c)	
Body Weight (kg wet weight)	BW	38.6 - 52.3, up to 65.3 kg - Adult Male - Alaska Adult females average 2-5 kg lighter than males.	ADF&G (1994c)	45.5
Food Ingestion Rate (kg wet weight/day)	IR_{food}	A minimum daily energy requirement of 3.25 kg per day (5 x daily basal metabolic rate) has been estimated for a 35 kg wolf. For wolves in Yellowstone National Park, (mean BW 45 kg), estimated mean food consumption rates based on early and later winter kill rates is 5.7 kg per day and 10.4 kg per day, respectively.	Stahler et al. (2006)	5.7
Water Ingestion Rate (L/day)	IR_{water}	Estimated using the following equation: IR_{water} =0.099*$BW^{0.90}$	USEPA 1993	3.07
Sediment or Soil Ingestion Rate (kg dry weight/day)	IR_{sed}	No sediment ingestion expected as all food items are upland terrestrial items. A soil ingestion rate was estimated at <2% of food ingestion rate. A 50% wet weight to dry weight ratio used to calculate soil ingestion rate.	Beyer 1994	0.06
Dietary Composition (fraction wet volume)	df	Wolves are carnivores, consuming primarily moose and/or caribou in Alaska. Also consumes Dall sheep, squirresl, snowshoe hares, beaver and occasionally birds.	ADF&G (1994c)	df_{mammal} = 1.0

Table 2-16
Ecological Exposure Profile of the American Dipper (*Cinclus mexicanus*)

Donlin Gold LLC
Bethel, Alaska
ACMA Pit Lake Ecological Risk Assessment

Parameter	Symbol	Reported Values	References	Values Identified for ERA
Habitat		Found near swift mountain streams.	Birds of North America Online (http://bna.birds.cornell.edu/bna)	
Body Weight (kg wet weight)	BW	0.0546 - 0.061kg - Adults Mean of reported values: 0.058	Dunning 1993	0.058
Food Ingestion Rate (kg wet weight/day)	IR_{food}	Estimated using field metabolic rates and dietary composition approach: $IR_{food} = NFMR/ME_{avg}$	USEPA 1993	0.022
Water Ingestion Rate (L/day)	IR_{water}	Estimated from equation: IR_{water} (L/day) = $0.059*BW^{0.67}$	USEPA 1993	0.009
Sediment or Soil Ingestion Rate (kg dry weight/day)	IR_{sed}	Ingestion of sediment (IRsed) as percentage of food intake (kg dry weight/kg food dry weight) is not available. IRsed is assumed to be 2% of the diet. A wet weight to dry weight ratio of 75% used to calculate IRsed.	Beyer 1994	0.0003
Dietary Composition (fraction wet volume)	df	Diet consists primarily of aquatic insects; also can include worms, and beetles.	Terres 1991	$df_{aqinv} = 1$

Table 2-17
Ecological Exposure Profile of the Dark-eyed Junco (*Junco hyemalis*)

Donlin Gold LLC
Bethel, Alaska
ACMA Pit Lake Ecological Risk Assessment

Parameter	Symbol	Reported Values	References	Values Identified for ERA
Habitat		Found in Alaskan forests ranging from old growth (both riparian and nonriparian) to various earlier stages; breeding range is most abundant in shrub/forb, sapling/shrub, lakeshore old growth, and muskeg habitats. Forages on forest floors.	Kessler and Kogut 1985	
Body Weight (kg wet weight)	BW	0.02 ± 0.012 - Male - Pennsylvania 0.019 ± 0.0078 - Female - Pennsylvania Mean of reported values: 0.0195	Dunning 1993	0.0195
Food Ingestion Rate (kg wet weight/day)	IR_{food}	Estimated fresh matter ingestion rate is 17.1 g/day	Nagy 2001	0.0171
Water Ingestion Rate (L/day)	IR_{water}	Estimated from equation: IR_{water} (L/day) = $0.059*BW^{0.67}$	USEPA 1993	0.004
Sediment or Soil Ingestion Rate (kg dry weight/day)	IR_{sed}	No sediment ingestion expected as all food items are upland terrestrial items. Soil ingestion rate estimated at <2% of food ingestion rate. A 50% wet weight to dry weight ratio used to calculate soil ingestion rate.	Beyer 1994	0.000086
Dietary Composition (fraction wet volume)	df	Seeds, plants and arthropods; occasionally fruit and waste grain in agricultural fields.	Nolan et al. 2002	$df_{terrplant}$ = 0.5 $df_{terrinv}$ = 0.5

Table 2-18
Ecological Exposure Profile of the Mallard (*Anas platyrhynchos*)

Donlin Gold LLC
Bethel, Alaska
ACMA Pit Lake Ecological Risk Assessment

Parameter	Symbol	Reported Values	References	Values Identified for ERA
Habitat		Bottomland wetlands, rivers, reservoirs and ponds in winter. Dense grassy vegetation at least one-half meter, usually within a few kilometers of water, for nesting.	USEPA 1993	
Body Weight (kg wet weight)	BW	1.225 - Mean - Adult Male 1.043 - Mean - Adult Female 1.043 to 1.814 - Range	USEPA 1993	1.13
Food Ingestion Rate (kg wet weight/day)	IR_{food}	Estimated using field metabolic rates and dietary composition approach: $IR_{food} = NFMR/ME_{avg}$	USEPA 1993	0.627
Water Ingestion Rate (L/day)	IR_{water}	Estimated using the Equation: $IR_{water} = 0.059\ BW^{0.67}$	USEPA 1993	0.064
Sediment or Soil Ingestion Rate (kg dry weight/day)	IR_{sed}	Sediment ingestion estimated at 3.3% of food ingestion rate. A 75% wet weight to dry weight ratio is used to calculate IRsed.	Beyer 1994	0.0156
Dietary Composition (fraction wet volume)	df	Spring/Summer: 75% insects (aquatic), 25% plants (aquatic); Fall/Winter: 100% plants (assume aquatic);	USEPA 1993	$df_{aqinv} = 0.375$ $df_{aqveg} = 0.625$;

Table 2-19
Ecological Exposure Profile of the Northern Shrike (Lanius excubitor).

Donlin Gold LLC
Bethel, Alaska
ACMA Pit Lake Ecological Risk Assessment

Parameter	Symbol	Reported Values	References	Values Identified for ERA
Habitat		Prefers open or semi-open landscapes including tundra, muskeg mat, and grass-sedge meadows.	Bent 1950	
Body Weight (kg wet weight)	BW	0.071 - Adult Males - Alaska 0.068 - Female - Adult	Irving 1960	0.07
Food Ingestion Rate (kg wet weight/day)	IR_{food}	Minimum food requirements for wild adults is 30g/day; estimated metabolic requirements for nestlings is 23g/day. 2 adults and 7 young consumed 9kg of food over a 60 day period .	Cade 1967	0.03
Water Ingestion Rate (L/day)	IR_{water}	Estimated following the equation: $IR_{water} = 0.059\ BW^{0.67}$	Estimated from USEPA 1993	0.010
Sediment or Soil Ingestion Rate (kg dry weight/day)	IR_{sed}	Sediment ingestion rate estimated at 1% of prey ingestion rate. A wet weight to dry weight ratio of 75% used to calculate sediment ingestion rate.	Beyer 1994	0.00023
Dietary Composition (fraction wet volume)	df	Small mammals and birds make up the bulk of the diet (60% measured in stomach contents); also consumes arthropods and other terrestrial invertebrates (40% stomach content).	Bent 1950, Judd 1898	$df_{bird} = 0.6$ $df_{terrinvert} = 0.4$

Table 2-20
Pit Lake Water Quality Summary and Preliminary Screening Evaluation for the ACMA Pit Lake.

Donlin Gold LLC
Bethel, Alaska
ACMA Pit Lake Ecological Risk Assessment

Analyte		Screening Criteria: Alaska Stock Watering Criteria (18 AAC 70)		Screening Criteria: USEPA or other AWQC		Screening Criteria: Alaska CCC Standard		Pit Lake Predictions: Pit Filling (yr 2 - 52)	Pit Lake Predictions: Year 53	Pit Lake Predictions: Year 99	Conclusion
Aluminum	Total Recoverable	---		---		0.750	u	0.57	0.337	0.31	Not a COPC.
	Dissolved	---		0.087	b	---					
Antimony	Total Recoverable	---		---		---		**0.347**	**0.067**	**0.067**	Retained as COPC for pit filling & mature assessments.
	Dissolved	---		0.03	b	---					
Arsenic	Total Recoverable	0.05	s	---		---		**1.196**	**0.11**	**0.112**	Retained as COPC for pit filling & mature assessments.
	Dissolved			0.15	d	0.15					
Boron	Total Recoverable	0.75	t	---		---		1.669	0.204	0.202	Not a COPC.
	Dissolved	---		0.4	m	---					
Cadmium	Total Recoverable	0.01	s	---		---		**0.00075**	0.00024	0.00024	Retained as COPC for pit filling assessment.
	Dissolved			0.00025	c,d	0.00016	v				
Chloride	Total Recoverable	---		---		---		---	15	14	Not a COPC.
	Dissolved	---		230	j	230	j				
Chromium III	Total Recoverable	---		---		---		0.0158	0.0041	0.004	Not a COPC.
	Dissolved	---		0.074	c,d	0.048	v				
Chromium VI	Total Recoverable	0.05	s	---		---		**0.0158**	0.0041	0.004	Retained as COPC for pit filling assessment.
	Dissolved			0.011	d	0.011					
Cobalt	Total Recoverable	0.05	t	---		---		**0.038**	0.002	0.002	Retained as COPC for pit filling assessment.
	Dissolved	---		0.009	c,d	0.005	v				
Copper	Total Recoverable	---		---		---		**0.0256**	0.0015	0.0014	Retained as COPC for pit filling assessment.
	Dissolved	---		0.009	c,d	0.005	v				
Fluoride	Total Recoverable	1	t	---		---		0.047	0.08	0.071	Not a COPC.
	Dissolved	---		2	h	---					
Iron	Total Recoverable	---		---		1	p	---	<0.03	<0.03	Not a COPC.
	Dissolved	---		1	h	---					
Lead	Total Recoverable	0.05	s	---		---		**0.032**	0.0023	0.0023	Retained as COPC for pit filling assessment.
	Dissolved			0.0025	c,d	0.0012	v				
Manganese	Total Recoverable	---				---		3.48	0.129	0.128	Not a COPC.
	Dissolved	---		120	b	---					
Mercury	Total Recoverable	---		---		---		0.000127	0.000026	0.000025	Not a COPC.
	Dissolved	---		0.00077	d	0.00077					
Molybdenum	Total Recoverable	---		---		---		0.094	0.013	0.012	Not a COPC.
	Dissolved	---		0.370	b	---					
Nickel	Total Recoverable	---		---		---		**0.093**	0.011	0.011	Retained as COPC for pit filling assessment.
	Dissolved	---		0.052	c,d	0.029	v				
Nitrate+Nitrite (as N)	Total Recoverable	---		500	h	---		0.409	0.648	0.62	Not a COPC.
pH	Total Recoverable	6.5 - 8.5	z	6.5 - 9.0	d,e	6.5 - 8.5		6.70	7.05	7.14	Not a COPC.
Selenium	Total Recoverable	0.01	s	---		0.005		**0.101**	**0.02**	**0.02**	Retained as COPC for pit filling & mature assessments.
	Dissolved			0.005	d	---					
Sulfate	Total Recoverable			2000	h	---		884	31	31	Not a COPC.
Zinc	Total Recoverable	---		---		---		**0.258**	0.013	0.013	Retained as COPC for pit filling assessment.
	Dissolved	---		0.12	c,d	0.066	v				

Notes:
Bolded values indicate value > screening benchmark.
b Secondary chronic value or alternative benchmark (Suter and Tsao 1996)
c Hardness dependent. Computed from hardness of 100 mg/L per 'default' guidance in USEPA
d USEPA AWQC 2009, online at http://www.epa.gov/waterscience/criteria/wqctable/index.html
h USEPA (1976). The Red Book.
j USEPA (1988). Ambient water quality criteria for chloride.
m Lowest chronic value for all aquatic organisms (Suter and Tsao 1996)
r As amended through November 9th, 2006 in 18 AAC 80.300(b), summarized in ADEC 2008
s ADEC 2008c - Alaska Water Quality Criteria Manual for Toxic and Other Deleterious Organic and Inorganic Substances. As amended through December 12, 2008.
t criteria shown for irrigation waters. This criteria was used for screening purposes of no other criteria were available. See text for details.
u ADEC 2008c states: Where the pH is greater than or equal to 7.0 and the hardness is greater than or equal to 50 ppmas CaCO3, the chronic aluminum standard will then be equal to the acute aluminum standard,750 µg/L as total recoverable aluminum.
v hardness-dependent. An estimated hardness of 50 mg/L as CaCO3 was used to calculate Alaska CCC.
z ADEC 2009c - 18 AAC 70, Water Quality Standards, Amended as of September 19, 2009.

Table 3-1
Surface Water Exposure Point Concentrations for the Future ACMA Pit Lake ERA.

Donlin Gold LLC
Bethel, Alaska
ACMA Pit Lake Ecological Risk Assessment

Constituent	Pit Filling Stage (yrs 2-52)	Mature Stage (yrs 53-99)
Antimony	0.347	0.067
Arsenic	1.196	0.112
Cadmium	0.00075	0.00024
Chromium	0.0158	0.0041
Cobalt	0.038	0.002
Copper	0.0256	0.0015
Lead	0.032	0.0023
Nickel	0.093	0.011
Selenium	0.101	0.02
Zinc	0.258	0.013

Notes:

all results in mg/L.

--- = no concentration data available for this constituent.

< = less than

Maximum concentrations predicted by Lorax (2012) for the top 33ft of the pit lake.

Table 3-2
Sediment Exposure Point Concentrations for the Future ACMA Pit Lake ERA.

Donlin Gold LLC
Bethel, Alaska
ACMA Pit Lake Ecological Risk Assessment

Constituent	Estimated Sediment Concentration (mg/kg)
Antimony	19.5
Arsenic	458
Cadmium	0.49
Chromium	17
Cobalt	17.5
Copper	49
Lead	11.5
Nickel	64.5
Selenium	1.5
Zinc	129

Notes:

--- = no concentration data available for this constituent.

Average of Shale and Graywacke rock types from SRK (2007), Table 2-10.
No cobalt sediment data available; assumed sediment concentrations were same as soil concentrations reported in (Crock et al. 1992).

Table 3-3
Aquatic Bioaccumulation Factors for the Future ACMA Pit Lake ERA.

Donlin Gold LLC
Bethel, Alaska
ACMA Pit Lake Ecological Risk Assessment

Constituent	Aquatic Bioaccumulation Factors	
	Sediment to Aquatic Invertebrate[a]	Sediment to Aquatic Plant[b]
Antimony	0.204	0.090
Arsenic	0.420	0.470
Cadmium	2.358	0.212
Chromium	0.430	0.731
Cobalt	0.500	0.500
Copper	2.797	0.319
Lead	0.465	0.345
Nickel	0.670	0.496
Selenium	1.220	0.386
Zinc	1.753	1.223

Notes:

a Average BAF from ORNL 1998, PTI 1996, EVS 1998, Sola et al. 2004 and Bindra and Hall 1977 as cited in Chapman 1985.

b Average BAF from PTI 1996, EVS 1998

Table 4-1
Selection Matrix for Avian and Mammalian Toxicity Studies.

Donlin Gold LLC
Bethel, Alaska
ACMA Pit Lake Ecological Risk Assessment

Category	Basis for Decision:	Points	Avian - As Study Considered:	Points	Avian - As Study Considered:	Points	Avian - As Study Considered:	Points
			Stanley et al. 1994		Camardese et al. 1990		USFWS 1969	
A	**Biological Effects:**							
	Developmental Endpoint Measured.	**4**		4				
	Growth	**2**				2		
	Mortality	**1**						1
B	**Technical Quality of Study**							
	> 10 Test organisms	**3**		3		3	(assumed, unknown)	3
	4 - 9	**2**						
	1 - 3	**1**						
	Normal Nutritional level in Diet (required)			x		x		x
	Isolated Contanimant (required)			x		x		x
C	**Method of Administration**							
	Oral in diet	**2**		2		2		2
	Oral by capsule	**1**						
	Injection - not acceptable							
D	**Duration of Study / Tox Endpoint ID'd**							
	Chronic NOAEL	**5**		5				5
	Subchronic NOAEL	**3**						
	Chronic LOAEL	**2**				2		
	Subchronic LOAEL	**1**						
	LD50	**0**						
E	**Biological Parameter**							
	ROCw = ROCt	**3**	3 - for mallard	3	3 - for mallard	3		
	ROCw = same phylogeny as ROCt	**2**						
	ROCw = same diet/physical traits as ROCt	**1**	1 - for other birds	1	1 - for other birds	1		1
Total Points = A + B + C + D			Mallard:	17	Mallard:	12	Mallard:	12
			Junco:	15	Junco:	10	Junco:	12
			Shrike:	15	Shrike:	10	Shrike:	12

Table 4-2
Wildlife NOAEL-Based Toxicity Reference Values Used for the Future ACMA Pit Lake ERA.

Donlin Gold LLC
Bethel, Alaska
ACMA Pit Lake Ecological Risk Assessment

TRV_{NOAEL}	American Dipper	Dark-eyed Junco	Northern Shrike	Mallard Duck	Snowshoe Hare	Black Bear	Mink	Tundra Vole	Gray Wolf
Arsenic	4.08 Stanley et al. 1994	4.08 Stanley et al. 1994	4.08 Stanley et al. 1994	16.30 Stanley et al. 1994	1.29 James et al. 1966	0.16 Schroeder and Michner 1971	0.55 Schroeder and Michner 1971	1.26 Schroeder and Michner 1971	0.20 Schroeder and Michner 1971
Antimony	0.22 Damron and Wilson 1975	0.22 Damron and Wilson 1975	0.22 Damron and Wilson 1975	0.89 Damron and Wilson 1975	5.16 James et al. 1966	0.02 Schroeder et al. 1968	0.05 Schroeder et al. 1968	0.13 Schroeder et al. 1968	0.02 Schroeder et al. 1968
Cadmium	0.41 White and Finley 1978	0.41 White and Finley 1978	0.41 White and Finley 1978	1.65 White and Finley 1978	0.95 Mills and Dalgarno 1972	0.23 Sutou et al. 1980	0.45 Sutou et al. 1980	1.85 Sutou et al. 1980	0.30 Sutou et al. 1980
Chromium	0.30 Haseltine et al. 1985	0.30 Haseltine et al. 1985	0.30 Haseltine et al. 1985	1.20 Haseltine et al. 1985	2.18 Trivedi et al. 1989	0.72 Trivedi et al. 1989	2.55 Trivedi et al. 1989	5.88 Trivedi et al. 1989	0.94 Trivedi et al. 1989
Cobalt	0.49 Hill 1979	0.49 Hill 1979	0.49 Hill 1979	1.95 Hill 1979	1.14 Maro et al. 1980	0.46 Mollenhauer et al 1985	0.90 Mollenhauer et al 1985	3.70 Mollenhauer et al 1985	0.59 Mollenhauer et al 1985
Copper	5.55 Jackson and Stevenson 1981	5.55 Jackson and Stevenson 1981	5.55 Jackson and Stevenson 1981	22.21 Jackson and Stevenson 1981	0.59 Engle and Spears 2000	5.24 Aulerich et al. 1982	17.70 Aulerich et al. 1982	37.59 Aulerich et al. 1982	6.82 Aulerich et al. 1982
Lead	0.41 Edens and Garlich 1983	0.41 Edens and Garlich 1983	0.41 Edens and Garlich 1983	1.64 Edens and Garlich 1983	1495.01 Logner et al. 1984	0.08 Schroeder et al. 1971	0.27 Schroeder et al. 1971	0.63 Schroeder et al. 1971	0.10 Schroeder et al. 1971
Nickel	21.99 Cain and Pafford 1981	21.99 Cain and Pafford 1981	21.99 Cain and Pafford 1981	87.96 Cain and Pafford 1981	27.36 Ambrose et al. 1976	9.11 Ambrose et al. 1976	18.02 Ambrose et al. 1976	73.93 Ambrose et al. 1976	11.85 Ambrose et al. 1976
Selenium	0.26 Heinz and Hoffman1	0.26 Heinz and Hoffman1	0.26 Heinz and Hoffman1	1.05 Heinz and Hoffman1	0.43 Jenkins and Hidiroglou 1986	0.05 Rosenfeld and Beath 1954	0.09 Rosenfeld and Beath 1954	0.37 Rosenfeld and Beath 1954	0.06 Rosenfeld and Beath 1954
Zinc	32.28 Stahl et al. 1990	32.28 Stahl et al. 1990	32.28 Stahl et al. 1990	7.70 Gassaway and Buss 1972	41.44 Ott et al. 1966a	45.56 Schlicker and Cox 1968	90.09 Schlicker and Cox 1968	369.63 Schlicker and Cox 1968	59.23 Schlicker and Cox 1968

Notes:
Units in mg/kg-bw day
TRV_{NOAEL} = lower bound TRV, corresponding to the no adverse effects level (NOAEL)
1 The geometric mean of a series of studies on the mallard duck was calculated to obtain this TRV. Studies included Heinz and Fitzgerald (1993), Heinz et al. (1987, 1988, 1989, 1996), Heinz and Hoffman (1988), Hoffman et al. (1991, 1992).

Table 4-3
Wildlife LOAEL-Based Toxicity Reference Values Used for the Future ACMA Pit Lake ERA.

Donlin Gold LLC
Bethel, Alaska
ACMA Pit Lake Ecological Risk Assessment

TRV_{LOAEL}	American Dipper	Dark-eyed Junco	Northern Shrike	Mallard Duck	Snowshoe Hare	Black Bear	Mink	Tundra Vole	Gray Wolf
Arsenic	17.6 Stanley et al. 1994	17.6 Stanley et al. 1994	17.6 Stanley et al. 1994	70.5 Stanley et al. 1994	1.9 James et al. 1966	1.6 Schroeder and Michner 1971	5.5 Schroeder and Michner 1971	12.6 Schroeder and Michner 1971	2.0 Schroeder and Michner 1971
Antimony	2.2 Damron and Wilson 1975	2.2 Damron and Wilson 1975	2.2 Damron and Wilson 1975	8.9 Damron and Wilson 1975	51.6 James et al. 1966	0.2 Schroeder et al. 1968	0.5 Schroeder et al. 1968	1.3 Schroeder et al. 1968	0.2 Schroeder et al. 1968
Cadmium	5.7 White and Finley 1978	5.7 White and Finley 1978	5.7 White and Finley 1978	22.8 White and Finley 1978	9.5 Mills and Dalgarno 1972	2.3 Sutou et al. 1980	4.5 Sutou et al. 1980	18.5 Sutou et al. 1980	3.0 Sutou et al. 1980
Chromium	1.6 Haseltine et al. 1985	1.6 Haseltine et al. 1985	1.6 Haseltine et al. 1985	6.2 Haseltine et al. 1985	21.7 Trivedi et al. 1989	7.2 Trivedi et al. 1989	25.5 Trivedi et al. 1989	58.8 Trivedi et al. 1989	9.4 Trivedi et al. 1989
Cobalt	1.0 Hill 1979	1.0 Hill 1979	1.0 Hill 1979	3.9 Hill 1979	0.0 Maro et al. 1980	4.6 Mollenhauer et al 1985	9.0 Mollenhauer et al 1985	37.0 Mollenhauer et al 1985	5.9 Mollenhauer et al 1985
Copper	7.2 Jackson and Stevenson 1981	7.2 Jackson and Stevenson 1981	7.2 Jackson and Stevenson 1981	28.7 Jackson and Stevenson 1981	2.1 Engle and Spears 2000	7.6 Aulerich et al. 1982	25.7 Aulerich et al. 1982	54.6 Aulerich et al. 1982	9.9 Aulerich et al. 1982
Lead	0.8 Edens and Garlich 1983	0.8 Edens and Garlich 1983	0.8 Edens and Garlich 1983	3.3 Edens and Garlich 1983	3958.3 Logner et al. 1984	0.8 Schroeder et al. 1971	2.7 Schroeder et al. 1971	6.3 Schroeder et al. 1971	1.0 Schroeder et al. 1971
Nickel	30.4 Cain and Pafford 1981	30.4 Cain and Pafford 1981	30.4 Cain and Pafford 1981	121.5 Cain and Pafford 1981	54.7 Ambrose et al. 1976	18.2 Ambrose et al. 1976	36.0 Ambrose et al. 1976	147.9 Ambrose et al. 1976	23.7 Ambrose et al. 1976
Selenium	0.4 Heinz and Hoffman1	0.4 Heinz and Hoffman1	0.4 Heinz and Hoffman1	1.6 Heinz and Hoffman1	0.9 Jenkins and Hidiroglou 1986	0.1 Rosenfeld and Beath 1954	0.1 Rosenfeld and Beath 1954	0.6 Rosenfeld and Beath 1954	0.1 Rosenfeld and Beath 1954
Zinc	322.8 Stahl et al. 1990	322.8 Stahl et al. 1990	322.8 Stahl et al. 1990	103.2 Gassaway and Buss 1972	82.9 Ott et al. 1966a	91.1 Schlicker and Cox 1968	180.2 Schlicker and Cox 1968	739.3 Schlicker and Cox 1968	118.5 Schlicker and Cox 1968

Notes:
Units in mg/kg-bw day
TRV_{LOAEL} = upper bound TRV, corresponding to the low adverse effects level (LOAEL)
1 The geometric mean of a series of studies on the mallard duck was calculated to obtain this TRV. Studies included Heinz and Fitzgerald (1993), Heinz et al. (1987, 1988, 1989, 1996), Heinz and Hoffman (1988), Hoffman et al. (1991, 1992).

Table 5-1
Hazard Quotients for Wildlife Associated with the Future ACMA Pit Lake During Lake Filling Stage.

Donlin Gold LLC
Bethel, Alaska
ACMA Pit Lake Ecological Risk Assessment

NOAEL-HQ	American Dipper	Mallard Duck	Northern Shrike	Dark-eyed Junco
Antimony	2.4E-01	2.2E-02	2.2E-01	2.6E-01
Arsenic	4.6E-02	4.2E-03	4.2E-02	5.0E-02
Cobalt	1.2E-02	1.1E-03	1.1E-02	1.3E-02
Cadmium	2.8E-04	2.6E-05	2.6E-04	3.1E-04
Chromium	8.2E-03	7.5E-04	7.5E-03	8.9E-03
Copper	7.2E-04	6.6E-05	6.5E-04	7.8E-04
Lead	1.2E-02	1.1E-03	1.1E-02	1.3E-02
Nickel	6.6E-04	6.0E-05	6.0E-04	7.2E-04
Selenium	6.0E-02	5.5E-03	5.5E-02	6.5E-02
Zinc	1.2E-03	1.9E-03	1.1E-03	1.4E-03

LOAEL -HQ	American Dipper	Mallard Duck	Northern Shrike	Dark-eyed Junco
Antimony	2.4E-02	2.2E-03	2.2E-02	2.6E-02
Arsenic	1.1E-02	9.7E-04	9.6E-03	1.1E-02
Cobalt	6.0E-03	5.6E-04	5.5E-03	6.6E-03
Cadmium	2.0E-05	1.9E-06	1.9E-05	2.2E-05
Chromium	1.6E-03	1.5E-04	1.4E-03	1.7E-03
Copper	5.5E-04	5.1E-05	5.1E-04	6.0E-04
Lead	6.0E-03	5.5E-04	5.5E-03	6.6E-03
Nickel	4.8E-04	4.4E-05	4.3E-04	5.2E-04
Selenium	4.0E-02	3.7E-03	3.7E-02	4.4E-02
Zinc	1.2E-04	1.4E-04	1.1E-04	1.4E-04

Notes:
Bolded Values indicate HQ >1

Table 5-2
Hazard Quotients for Wildlife Associated with the Mature Future ACMA Pit Lake.

Donlin Gold LLC
Bethel, Alaska
ACMA Pit Lake Ecological Risk Assessment

NOAEL-HQ	American Dipper	Mallard Duck	Northern Shrike	Dark-eyed Junco	Snowshoe Hare	Black Bear	Mink	Tundra vole	Gray Wolf
Antimony	**1.6E+00**	5.8E-01	5.0E-01	2.6E-01	6.3E-02	**1.4E+00**	9.6E-01	**5.2E+00**	**1.2E+00**
Arsenic	**3.5E+00**	**1.4E+00**	4.0E-01	5.0E-02	8.7E-01	4.7E-01	**2.9E+00**	**8.4E+00**	4.0E-01
Selenium	5.5E-01	1.2E-01	7.3E-02	6.5E-02	2.2E-01	1.4E-01	1.7E-01	4.5E-01	1.2E-01

LOAEL -HQ	American Dipper	Mallard Duck	Northern Shrike	Dark-eyed Junco	Snowshoe Hare	Black Bear	Mink	Tundra vole	Gray Wolf
Antimony	1.6E-01	5.8E-02	5.0E-02	2.6E-02	6.3E-03	1.4E-01	9.6E-02	5.2E-01	1.2E-01
Arsenic	8.1E-01	3.3E-01	9.3E-02	1.1E-02	5.8E-01	4.7E-02	2.9E-01	8.4E-01	4.0E-02
Selenium	3.7E-01	7.8E-02	4.9E-02	4.4E-02	1.1E-01	8.2E-02	1.0E-01	2.7E-01	7.0E-02

Notes:
Bolded Values indicate HQ >1

Table 5-3
Soil Concentrations for the Future ACMA Pit Lake ERA.

Donlin Gold LLC
Bethel, Alaska
ACMA Pit Lake Ecological Risk Assessment

Constituent	Soil concentration (mg/kg)	Reference
Antimony	1.09	b
Arsenic	10.35	a,c
Cadmium	0.2	b
Chromium	17	a
Cobalt	4	a
Copper	12	a
Lead	5	a
Nickel	7	a
Selenium	0.2	a
Zinc	44	a

Notes:

a = Crock et al. (1992)

b = USEPA (2007), background concentration average of West+East

c = Ecology & Environment (2011); background concentrations only.

Table 5-4
Terrestrial Bioaccumulation Factors for the Future ACMA Pit Lake ERA.

Donlin Gold LLC
Bethel, Alaska
ACMA Pit Lake Ecological Risk Assessment

CONSTITUENT	Terrestrial Bioaccumulation Factors					
	Soil to Terrestrial Invertebrate		Soil to Terrestrial Plant		Soil to Mammal	
Antimony	1.00	a	ln(Cp) = 0.938 * ln(Cs) - 3.233	d	0.05	c
Arsenic	ln(Ci) = 0.706 * ln(Cs) - 1.421	b	0.03752	e	ln(Cm) = 0.8188 * ln(Cs) -4.8471	f
Cadmium	ln(Ci) = 0.795 * ln(Cs) + 2.114	b	ln(Cp) = 0.546 * ln(Cs) - 0.475	e	ln(Cm) = 0.4723 * ln(Cs) - 1.2571	f
Chromium	0.306	b	0.041	d	ln(Cm) = 0.7338 * ln(Cs) - 1.4599	f
Cobalt	0.122	b	0.0075	e	ln(Cm) = 1.307 * ln(Cs) - 4.4669	f
Copper	0.515	b	ln(Cp) = 0.394 * ln(Cs) + 0.668	e	ln(Cm) = 0.1444 * ln(Cs) + 2.042	f
Lead	ln(Ci) = 0.807 * ln(Cs) - 0.218	b	ln(Cp) = 0.561 * ln(Cs) - 1.328	e	ln(Cm) = 0.4422 * ln(Cs) + 0.0761	f
Nickel	1.059	b	ln(Cp) = 0.748 * ln(Cs) - 2.223	e	ln(Cm) = 0.4658 * ln(Cs) - 0.2462	f
Selenium	ln(Ci) = 0.733 * ln(Cs) - 0.075	b	ln(Cp) = 1.104 * ln(Cs) - 0.677	e	ln(Cm) = 0.3764 * ln(Cs) - 0.4158	f
Zinc	ln(Ci) = 0.328 * ln(Cs) + 4.449	b	ln(Cp) = 0.554 * ln(Cs) + 1.575	e	ln(Cm) = 0.0706 * ln(Cs) + 4.3632	f

Notes:

Ci Invertebrate tissue concentration (mg/kg)

Cp Plant tissue concentration (mg/kg)

Cm Small mammal tissue concentration (mg/kg)

NA = not applicable. No BAF available for this constituent.

a Assumed; cited in USEPA 2007

b Sample 1999 as cited in USEPA 2007

c Baes et al 1984 as cited in USEPA 2007

d USEPA 2007

e From Bechtel Jacobs, 1998a; median values used. As cited in USEPA 2007

f Sample 1998b as cited in USEPA 2007

Table 5-5
Hazard Quotients for the Mature Pit Lake, Incorporating "Background" Exposure.

Donlin Gold LLC
Bethel, Alaska
ACMA Pit Lake Ecological Risk Assessment

NOAEL-HQ	American Dipper	Mallard Duck	Northern Shrike	Dark-eyed Junco	Snowshoe Hare	Black Bear	Mink	Tundra vole	Gray Wolf
Antimony	**1.6E+00**	5.8E-01	6.7E-01	6.9E-01	6.5E-02	**1.6E+00**	9.7E-01	**5.3E+00**	**1.4E+00**
Arsenic	**3.5E+00**	**1.4E+00**	5.0E-01	4.1E-01	**1.1E+00**	**1.2E+00**	**3.0E+00**	**8.6E+00**	5.8E-01
Selenium	5.5E-01	1.2E-01	1.0E-01	9.3E-02	2.3E-01	1.6E-01	1.7E-01	4.6E-01	1.7E-01

LOAEL -HQ	American Dipper	Mallard Duck	Northern Shrike	Dark-eyed Junco	Snowshoe Hare	Black Bear	Mink	Tundra vole	Gray Wolf
Antimony	1.6E-01	5.8E-02	6.7E-02	6.9E-02	6.5E-03	1.6E-01	9.7E-02	5.3E-01	1.4E-01
Arsenic	8.1E-01	3.3E-01	1.2E-01	9.6E-02	7.1E-01	1.2E-01	3.0E-01	8.6E-01	5.8E-02
Selenium	3.7E-01	7.8E-02	6.9E-02	6.3E-02	1.1E-01	9.4E-02	1.0E-01	2.8E-01	1.0E-01

Notes:

Bolded Values indicate HQ >1

Table 5-6
Hazard Quotients for an Assumed "Background" Exposure Only.

Donlin Gold LLC
Bethel, Alaska
ACMA Pit Lake Ecological Risk Assessment

NOAEL-HQ	American Dipper	Mallard Duck	Northern Shrike	Dark-eyed Junco
Antimony	0.0E+00	0.0E+00	1.7E-01	4.2E-01
Arsenic	0.0E+00	0.0E+00	9.9E-02	3.6E-01
Cobalt	0.0E+00	0.0E+00	**1.1E+00**	**1.1E+00**
Cadmium	0.0E+00	0.0E+00	3.6E-02	9.7E-02
Chromium	0.0E+00	0.0E+00	**1.7E+01**	**2.6E+01**
Copper	0.0E+00	0.0E+00	**2.3E+00**	**2.4E+00**
Lead	0.0E+00	0.0E+00	**3.2E+00**	**3.6E+00**
Nickel	0.0E+00	0.0E+00	5.1E-02	2.1E-02
Selenium	0.0E+00	0.0E+00	2.9E-02	2.7E-02
Zinc	0.0E+00	0.0E+00	**2.3E+01**	**3.5E+01**

LOAEL -HQ	American Dipper	Mallard Duck	Northern Shrike	Dark-eyed Junco
Antimony	0.0E+00	0.0E+00	1.7E-02	4.2E-02
Arsenic	0.0E+00	0.0E+00	2.3E-02	8.4E-02
Cobalt	0.0E+00	0.0E+00	5.6E-01	5.2E-01
Cadmium	0.0E+00	0.0E+00	2.6E-03	7.0E-03
Chromium	0.0E+00	0.0E+00	**3.2E+00**	**5.1E+00**
Copper	0.0E+00	0.0E+00	**1.8E+00**	**1.9E+00**
Lead	0.0E+00	0.0E+00	**1.6E+00**	**1.8E+00**
Nickel	0.0E+00	0.0E+00	3.7E-02	1.5E-02
Selenium	0.0E+00	0.0E+00	1.9E-02	1.8E-02
Zinc	0.0E+00	0.0E+00	**2.3E+00**	**3.5E+00**

Notes:

Bolded Values indicate HQ >1

Donlin Gold LLC

Pit Lake ERA

Appendix A – Candidate Species for the Comprehensive Wildlife Conservation Strategy Plan

Appendix 7. Nominee Species List

This list of species nominated for consideration as potential planning targets was derived from various conservation plans, lists, and organizations, as well as expert and public comments. For the purposes of developing a Comprehensive Wildlife Conservation Strategy for the State of Alaska, we consider this list to represent our species of greatest conservation need. We will consider adding and deleting species as plans and lists of other organizations are updated.

Conservation Status:

A Key to Abbreviations (with organizations listed in alphabetical order)

AA WATCH LIST. Audubon's Alaska WatchList.

PT – population trend
RA – relative abundance
BD – breeding distribution
TB – threats during breeding season
ND – nonbreeding distribution (migration & winter)
(ND) – nonbreeding distribution primarily outside Alaska
TN – threats during nonbreeding season
(TN) – threats during nonbreeding season are outside Alaska
* – species also recognized by National Audubon Society

ABC GREEN LIST. American Bird Conservancy.
Green List species are those with scoring sums (i.e., Population Trend + Population Size + Maximum Threat score [breeding or nonbreeding) + Maximum Distribution score (breeding or nonbreeding]) > 14, or those with a sum of 13 with a Trend score of 5. Details of scoring can be found in the Species Assessment Handbook by Arvind Panjabi, located on the Rocky Mountain Bird Observatory web site (http://www.rmbo.org/)

Across-the-board high scores put birds in the highest concern category. High trend and threat scores with low size and distribution scores put birds into the widespread but vulnerable list, while the opposite, high size and distribution and low (or unknown) trend and threats, constitute the third category. The "rules" that govern what is or is not "high" are not set in stone, but were open to interpretation by knowledgeable ornithologists. American Bird Conservancy took these rules developed by Partners in Flight for landbirds and applied them to the entire North American avifauna (D. Pashley, pers. comm.).

Green List species are shown with codes indicating the factor(s) that contribute(s) to their need for conservation action:

D – declines
HCC – highest continental concern
HT – high threats
LPS – low population size
MA – moderately abundant
RD – restricted distribution

AFS. American Fisheries Society.

Conservation Dependent – reduced but stabilized or recovering under a continuing conservation plan

Endangered – high risk of extinction in the wild in the immediate future (years)

Vulnerable – a decline in productivity over the longer of 10 years or 3 generations—with the percent decline that triggers the vulnerable status calibrated to the productivity of the species

ASCP. Alaska Shorebird Conservation Plan (March 2000).

SOHC – Species of High Concern: Populations of these species are known or thought to be declining, and have some other known or potential threat as well. Species are identified as SOHC using the following criteria:

PT = 4 or 5 and either RA, BD, TB, or TN = 4 or 5

RA = 4 or 5 and either TB or TN = 4 or 5

AI = 5 and RA >3 for regional lists only

PT = Population trend and population trend uncertainty; a measure of the component of vulnerability reflected by the direction and magnitude of changes in population size over the past 30 years. 4 = Apparent population decline, or significance test has medium or low power (<0.8) and comprehensiveness is low; or, no date but informed estimates about population trend possible; 5 = Significant population decline (p<0.10), or no information about population trend.

RA = Relative abundance; a measure of the component of vulnerability that reflects the abundance of breeding individuals of a species, within its range, relative to other species. 4 = 25,000 - < 150,000 individuals; 5 = < 25,000 individuals.

BD = Breeding distribution; a measure of the component of vulnerability that reflects the global distribution of breeding individuals of a species during the breeding season. 4 = 2.5-4.9% of North America; 5 = <2.5% of North America (212,880 square miles).

TB = Threats during breeding season; an evaluation of the component of vulnerability that reflects the effects of current and future extrinsic conditions on the ability of a species to maintain healthy populations through successful reproduction. 4 = Significant potential threats exist (e.g., oil spills) but have not actually occurred; 5 = Known threats are actually occurring (e.g., significant loss of critical habitat), and can be documented.

TN = Threats during nonbreeding season; an evaluation of the component of vulnerability that reflects the effects of current and future extrinsic conditions on the ability of a species to maintain healthy populations through successful survival over the nonbreeding season. 4 = Significant potential threats exist (e.g., oil spills) but have not actually occurred. Concentration results in high potential risk. 5 = Known threats are actually occurring (e.g., significant loss of critical habitat) and can be documented. Concentration results in actual risk.

AI = Area importance; scores are based on knowledge of distributions, expert opinion, and data on distributions for species where they are available. Species are ranked on a relative scale within each Bird Conservation Region. The regional prioritization system uses the same criteria as for national priorities, with the additional rule that species can be assigned to a different category based on their area importance within the region. Species that are highly imperiled are included wherever they occur.

BC. British Columbia, Provincial Red and Blue List (2002)

RED – extirpated, endangered, or threatened
BLUE – vulnerable
YELLOW – not at risk
ACC – accidental

BPIF. Boreal Partners in Flight

Species of conservation priority are those species ranking > 17 using the species prioritization process found in Landbird Conservation Plan for Alaska Biogeographic Regions, Version 1.0 (October 1999), pp. 10–13. Species of conservation priority are shown with a letter indicating the factor(s) that contribute(s) to their need for conservation action:

B – boreal North America monitoring responsibility
F – potential negative response to loss of forest cover
G – global monitoring responsibility
T – decreasing population trend
W – nonbreeding habitat threats

BLM. Bureau of Land Management, U.S. Department of Interior

S–Sensitive: BLM Manual Section 6840 defines sensitive species as ". . . those species that are: (1) under status review by the FWS/NMFS; or (2) whose numbers are declining so rapidly that Federal listing may become necessary; or (3) with typically small and widely dispersed populations; or (4) those inhabiting ecological refugia or other specialized or unique habitat."

CITES. Convention on International Trade in Endangered Species of Wild Fauna and Flora (as of July 2002)

Protection Status: Value assigned to the species from the Protective Appendix according to the Convention on International Trade in Endangerment of Species (CITES). Values include: A1 = Appendix I (species that are most endangered, threatened with extinction, and for which commercial international trade is generally prohibited), A2 = Appendix II (species that are not necessarily threatened with extinction at this time, but that may become threatened unless commercial international trade is controlled), A3 = Appendix III (species included by request of a country that regulates its trade, and for which cooperation of other countries is needed to prevent exploitation).

COSEWIC. Committee on the Status of Endangered Wildlife in Canada (as of November 2002)

(for definitions, see www.cosewic.gc.ca/eng/sct0/Assessment_process_tbl2_e.cfm)

XT – extirpated; a species no longer existing in the wild in Canada, but occurring elsewhere

E – endangered; a species facing imminent extirpation or extinction

T – threatened; a species likely to become endangered if limiting factors are not reversed

SC – special concern; a species that is sensitive to human activity or natural events

NAR –not at risk

DD – data deficient

C – candidate; a species that is suspected of being in some COSEWIC category of risk of extinction or extirpation at the national level, before being examined through the status assessment process

PS – partial status (applies only to portion of species' range)

GRANK. NatureServe, a network of natural heritage programs, and The Nature Conservancy (as of November 2001) Global Status (throughout its range)

GX - presumed extinct - not located despite intensive searches and virtually no likelihood of rediscovery

GH - possibly extinct - missing; known from only historical occurrences but still some hope of rediscovery

G1 – critically imperiled - at very high risk of extinction due to extreme rarity (often 5 or fewer populations), very steep declines, or other factors

G2 – imperiled - at high risk of extinction due to very restricted range, very few populations (often 20 or fewer), steep declines, or other factors

G3 – vulnerable - at moderate risk of extinction due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors

G4 – apparently secure - uncommon but not rare; some cause for long-term concern due to declines or other factors

G5 – secure - common; widespread and abundant

GNR – unranked - global rank not yet assessed

GU – unrankable - currently unrankable due to lack of information or due to substantially conflicting information about status or trends. Whenever possible, the most likely rank is assigned and the question mark qualifier is added (e.g., G2?) to express uncertainty, or a range rank (e.g., G2G3) is used to delineate the limits (range) of uncertainty.

G#G# - range rank - A numeric range rank (e.g., G2G3) is used to indicate the range of uncertainty in the status of a species or community. Ranges cannot skip more than one rank (e.g., GU should be used rather than G1G4).

G#? – inexact numeric rank—denotes inexact numeric rank (e.g., G2?)

G#Q - questionable taxonomy - taxonomic distinctiveness of this entity at the current level is questionable; resolution of this uncertainty may result in change from a species to a subspecies or hybrid, or the inclusion of this taxon in another taxon, with the resulting taxon having a lower-priority conservation priority

G#T# - infraspecific taxon (trinomial) - The status of infraspecific taxa (subspecies or varieties) are indicated by a "T-rank" following the species' global rank. Rules for assigning T-ranks follow the same principles outlined above for global conservation status ranks. For example, the global rank of a critically imperiled subspecies of an otherwise widespread and common species would be G5T1. A T-rank cannot imply the subspecies or variety is more abundant than the species as a whole-for example, a G1T2 cannot occur. A vertebrate animal population, such as those listed as distinct population segments under the U.S. Endangered Species Act, may be considered an infraspecific taxon and assigned a T-rank; in such cases a Q is used after the T-rank to denote the taxon's informal taxonomic status. At this time, the T rank is not used for ecological communities.

IUCN. International Union for Conservation of Nature and Natural Resources (as of 2002)

IUCN Conservation Status: EX = extinct, EW = extinct in wild, CE = critically endangered, E = endangered, VU = vulnerable, LR = lower risk, DD = data deficient, NE = not evaluated, CD = conservation dependent, NT = near threatened, LC = least concern. According to the IUCN Red List Categories and Criteria, Version 3.1 (found at http://www.iucn.org/themes/ssc/redlists/RLcats2001booklet.html), a taxon is Critically Endangered "when the best available evidence indicates that it meets any of the criteria A to E for Critically Endangered (see Section V), and it is therefore considered to be facing an extremely high risk of extinction in the wild." Similarly a taxon is Endangered "when the best available evidence indicates that it meets any of the criteria A to E for Endangered (see Section V), and it is therefore considered to be facing a very high risk of extinction in the wild. A taxon is Near Threatened when it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for, or is likely to qualify for, a threatened category in the near future."

NAWCP. Waterbird Conservation for the Americas: The North American Waterbird Conservation Plan, Version 1 (2002).

Highly Imperiled – This includes all species with significant population declines and either low populations or some other high risk factor. Species are identified as Highly Imperiled using the following criteria:

PT = 5 and either PS, TB, TN, or BD = 5.

High Concern – Species that are not Highly Imperiled. Populations of these species are known or thought to be declining, and have some other known or potential threat as well. Species are identified as of High Concern using the following criteria: PT = 4 or 5 and either PS, TB, TN, or BD = 4 or 5; or PS = 4 or 5 and either TB or TN = 4 or 5

PT = Population trend. 4 = apparent population decline; 5 = biologically significant population decline.

PS = Population size. 4 = 480–5800 individuals; 5 = up to 480 individuals.

TB = Threats to Breeding. 4 = Significant potential threats exist, but have not actually occurred; concentration not a risk; 5 = Known threats are actually occurring and can be documented; concentration results in actual risk.

TN = Threats to Nonbreeding. This factor rates the threats know to exist for each species during their nonbreeding season. The scores are the same as for the Threats to Breeding factor, but without the additional risk due to concentration during breeding.

BD = Breeding Distribution. 4 = local (450,000 km^2 - 1,500,000 km^2); 5 = highly restricted (up to 450,000 km^2)

NOAA. National Oceanic Atmospheric Administration – Fisheries (Formerly called National Marine Fisheries Service).

Same as USFWS (below) Under the Endangered Species Act of 1973, as amended, NOAA – Fisheries is responsible for listed anadromous and marine fishes and marine mammals other than sea otter, manatees, and dugongs.

SOA. State of Alaska.

E = Endangered. A species or subspecies of fish or wildlife is considered endangered when the Commissioner of the Department of Fish and Game determines that its numbers have decreased to such an extent as to indicate that its continued existence is threatened. In making this determination the commissioner shall consider:

1–the destruction, drastic modification, or severe curtailment of its habitat;
2–its overutilization for commercial or sporting purposes;
3–the effect on it of disease or predation;
4–other natural or man-made factors affecting its continued existence.

SSOC = State Species of Concern. On May 25, 1993, the commissioner of the Alaska Department of Fish and Game established a new administrative list of Species of Concern to complement the Alaska Endangered Species List. A State Species of Concern is defined as any species or subspecies of fish and wildlife native to the State of Alaska that has entered a long term decline in abundance or is vulnerable to a significant decline due to low numbers, restricted distribution, dependence on limited habitat resources, or sensitivity to environmental disturbance.

SRANK. NatureServe, a network of natural heritage programs, and The Nature Conservancy (as of November 2001) subnational/state status (status in Alaska)

SX – presumed extirpated; not located despite intensive searches of historical sites and other appropriate habitat, and virtually no likelihood that species will be rediscovered

SH – possibly extirpated; some possibility that species may be rediscovered, but its presence may not have been verified in the past 20–40 years

S1 – critically imperiled; extreme rarity (often 5 or fewer occurrences) or because of some factor(s) such as very steep declines making species especially vulnerable to extirpation

S2 – imperiled; rarity due to very restricted range, very few populations (often 20 or fewer), steep declines, or other factors making species very vulnerable to extirpation

S3 – rare or uncommon; restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors making species vulnerable to extirpation

S4 – not rare, long-term concern; uncommon but not rare; some cause for long-term concern due to declines or other factors

S5 – widespread, abundant, secure

SNR - species not ranked; conservation status not yet assessed

SU - unrankable due to lack of information or due to substantially conflicting information about status or trends

S#S# - a numeric range rank (e.g., S2S3) is used to indicate any range of uncertainty about the status of the species

S#B - conservation status refers to the breeding population of the species

S#N – conservation status refers to the breeding population of the species

Note: A breeding status is only used for species that have distinct breeding and/or nonbreeding populations in the state. A breeding-status S-rank can be coupled with its complementary nonbreeding-status S-rank if the species also winters in the state.

S#? – inexact or uncertain; the ? qualifies the character immediately preceding it in the S-rank.

S#Q – questionable taxonomy that may reduce conservation priority. Distinctiveness of this entity as a taxon at the current level is questionable; resolution of this uncertainty may result in change from a species to a subspecies or hybrid, or inclusion of this taxon in another taxon, with the resulting taxon having a lower-priority (numerically higher) conservation status rank.

S#T# – infraspecific taxon (trinomial) – the status of infraspecific taxa (subspecies or varieties) are indicated by a "T-rank" following the species' state rank. Rules for assigning T-ranks follow the same principles outlined above. For example, the state rank of a critically imperiled subspecies of an otherwise widespread and common species would be S5T1. A T subrank cannot imply the subspecies or variety is more abundant than the species; for example, a S1T2 subrank should not occur. A vertebrate animal population (e.g., listed under the U.S. Endangered Species Act or assigned candidate status) may be tracked as an infraspecific taxon and given a T rank; in such cases a Q is used after the T-rank to denote the taxon's informal taxonomic status.

USFS. United States Forest Service, U.S. Department of Interior.

Sensitive – Designated due to conservation threat.

SSI – Species of Special Interest, selected due to rarity; lack of information or knowledge; suspected conservation concerns; or unique habitat characteristics, and not otherwise captured as a Management Indicator Species.

TNF – Tongass National Forest

CNF – Chugach National Forest

USFWS. U.S. Fish and Wildlife Service, U.S. Department of Interior.
[http://Alaska.fws.gov/fisheries/endangered/pdf/AK%20SPP%20List%206-04.pdf]

BCC – Bird of Conservation Concern

LE – Listed Endangered. An "endangered species" is one that is in danger of extinction throughout all or a significant portion of its range.

LT – Listed Threatened. A "threatened" species is one that is likely to become endangered in the foreseeable future.

PS – Partial Status (applies only to portion of species' range; typically indicated in a "full" species record where an intraspecific taxon or population has U.S. ESA status, but the entire species does not; see www.natureserve.org/explorer.) See associated footnotes in table below to determine if the Alaska population is included.

C – Candidate species. A "candidate species" is one for which there is sufficient information on biological vulnerability and threat(s) to support proposals to list as threatened or endangered.

PT – Proposed threatened

To help conserve genetic diversity, the ESA defines "species" broadly to include subspecies, and (for vertebrates) "distinct populations."

Fish Nominees								
Group	Common Name	Scientific Name	GRANK	SRANK	COSEWIC	IUCN	BLM	AFS
Freshwater Fish	Pacific lamprey	*Entosphenus tridentatus*	G5	S4S5				
Freshwater Fish	river lamprey	*Lampetra ayresi*	G4	S3				
Freshwater Fish	western brook lamprey	*Lampetra richardsoni*	G5	S1?			Sensitive	
Freshwater Fish	Alaskan brook lamprey	*Lampetra alaskense*	GNR	SNR				
Freshwater Fish	Siberian brook lamprey	*Lampetra kessleri*	GNR	SNR				
Freshwater Fish	Arctic lamprey	*Lampetra japonica*	G4	S4S5				
Saltwater Fish	big skate	*Raja (Dipturus) binoculata*	G4	SNR	C	LR		Vulnerable
Freshwater Fish	green sturgeon	*Acipenser medirostris*	G3	S4N				Endangered
Freshwater Fish	white sturgeon	*Acipenser transmontanus*	G4	S3S4				Not assessed
Freshwater Fish	lake chub	*Couesius plumbeus*	G5	S4S5				
Freshwater Fish	longnose sucker	*Catostomus catostomus*	G5	S5				
Freshwater Fish	Alaska blackfish	*Dallia pectoralis*	G5	S5				
Freshwater Fish	pond smelt	*Hypomesus olidus*	G5	S5				
Saltwater Fish	surf smelt	*Hypomesus pretiosus*	G5	S5				
Saltwater Fish	capelin	*Mallotus villosus*	GNR	SNR				
Saltwater Fish	rainbow smelt	*Omersus mordax*	G5	S5				
Saltwater Fish	longfin smelt	*Spirinchus thaleichthys*	G5	S4S5				
Saltwater Fish	eulachon	*Thaleichthys pacificus*	G5	S3S4				
Freshwater Fish	Bering cisco	*Coregonus laurettae*	G4	S4	SC			
Freshwater Fish	broad whitefish	*Coregonus nasus*	G5	S4S5		DD		
Freshwater Fish	humpback whitefish	*Coregonus pidschian*	G5	S5		DD		
Freshwater Fish	pygmy whitefish	*Prosopium coulteri*	G5	S4				
Freshwater Fish	round whitefish	*Prosopium cylindraceum*	G5	S4				
Freshwater Fish	trout-perch	*Percopsis omiscomaycus*	G5	S3				
Saltwater Fish	Arctic cod	*Boreogadus saida*	GNR	S4S5				
Freshwater Fish	threespine stickleback	*Gasterosteus aculeatus*	G5	S5				
Freshwater Fish	threespine stickleback, Cook Inlet	*Gasterosteus aculeatus*	G5T1Q	S1				
Freshwater Fish	ninespine stickleback	*Pungitius pungitius*	G5	S4S5				
Saltwater Fish	sharpnose sculpin	*Clinocottus acuticeps*	G5	S5				
Freshwater Fish	coastrange sculpin	*Cottus aleuticus*	G5	S5				
Freshwater Fish	prickly sculpin	*Cottus asper*	G5	S5				

Group	Common Name	Scientific Name	GRANK	SRANK	COSEWIC	IUCN	BLM	AFS
Freshwater Fish	slimy sculpin	*Cottus cognatus*	G5	S5				
Freshwater Fish	Pacific staghorn sculpin	*Leptocottus armatus*	G5	S5				
Saltwater Fish	fourhorn sculpin	*Myoxocephalus quadricornis*	G5	S5				
Freshwater Fish	shiner perch	*Cymatogaster aggregata*	G5	S4S5				
Saltwater Fish	prowfish	*Zaprora silenus*	GNR	SNR				
Saltwater Fish	Pacific sandfish	*Trichodon trichodon*	G5	S5				
Saltwater Fish	Pacific sand lance	*Ammodytes hexapturus*	GNR	SNR				
Saltwater Fish	Forage fish	Cottid Family[1]						
Saltwater Fish	Forage fish	HemipteridFamily[1]						
Saltwater Fish	Forage fish	Rhamphocottid Family[1]						
Saltwater Fish	Forage fish	Stichaeid Family[1]						
Saltwater Fish	Forage fish	Pholid Family[1]						
Saltwater Fish	Forage fish	Myctophidae[2]						

[1] See Forage Fish Occurring in Intertidal/Shallow SubtidalAreas template in Appendix 4
[2] See Nearshore Occurrence of Pelagic Forage Fish template in Appendix 4

Amphibian Nominees					
Group	Common Name	Scientific Name	GRANK	SRANK	IUCN
Amphibian	Columbia spotted frog	*Rana luteiventris*	G4	S2?	
Amphibian	Long-toed salamander	*Ambystoma macrodactylum*	G5	S2?	
Amphibian	Northwestern salamander	*Ambystoma gracile*	G5	S2?	
Amphibian	Rough-skinned newt	*Taricha granulosa*	G5	S2?	
Amphibian	Western toad	*Bufo boreas*	G4	S2?	NT
Amphibian	Wood frog	*Rana sylvatica*	G5	S3S4	

Reptile Nominees

Group	Common Name	Scientific Name	GRANK	SRANK	NOAA	COSEWIC	IUCN	CITES	BC
Sea turtle	Green seaturtle	*Chelonia mydas*	G3		LT		E	A1	
Sea turtle	Leatherback seaturtle	*Dermochelys coriacea*	G2	SAN	LE	E	CE	A1	RED
Sea turtle	Loggerhead seaturtle	*Caretta caretta*	G3	SAN	LT		E	A1	ACC
Sea turtle	Olive Ridley seaturtle	*Lepidochelys olivacea*	G3		LT		E	A1	

Bird Nominees														
Group	Common Name	Scientific Name	GRANK	SRANK	SOA	USFWS	COSEWIC	BLM	USFS	ABC Green List	AA WatchList	BPIF	NAWCP	ASCP
Loons	Red-throated Loon	*Gavia stellata*	G5	S3B, S3?N		BCC	NAR	Sensitive			PT, TN			
Loons	Arctic Loon	*Gavia arctica*	G5	S5B										
Loons	Green-throated Arctic Loon	*Gavia arctica viridigularis*	G5T2?	S3?B										
Loons	Pacific Loon	*Gavia pacifica*	G5	S?B										
Loons	Common Loon	*Gavia immer*	G5	S4			NAR							
Loons	Yellow-billed Loon	*Gavia adamsii*	G4	S3B, S3N		BCC		Sensitive			RA, TB, TN			
Grebes	Pied-billed Grebe	*Podilymbus podiceps*	G5	S3										
Grebes	Horned Grebe	*Podiceps auritus*	G5	S3						MA, D, HT				
Grebes	Red-necked Grebe	*Podiceps grisegena*	G5	S4S5B, S4?N			NAR							
Albatrosses	Laysan Albatross	*Phoebastria immutabilis*	G3	S3N									High Concern	
Albatrosses	Black-footed Albatross	*Phoebastria nigripes*	G5	S5N									Highly imperiled	
Albatrosses	Short-tailed Albatross	*Phoebastria albatrus*	G1	S1N	E	LE							High Concern	
Shearwaters and Petrels	Pink-footed Shearwater	*Puffinus creatopus*	G1G2Q	S2N									High Concern	
Shearwaters and Petrels	Buller's Shearwater	*Puffinus bulleri*	G3	S2S3N										
Storm-Petrels	Fork-tailed Storm-Petrel	*Oceanodroma furcata*	G5	S5B, S3N										
Storm-Petrels	Fork-tailed Storm-Petrel	*Oceanodroma furcata furcata*	GNR	SNR										
Storm-Petrels	Fork-tailed Storm-Petrel	*Oceanodroma furcata plumbea*	GNR	SNR										
Storm-Petrels	Leach’s Storm-Petrel	*Oceanodroma leucorhoa*	G5	S5B										
Storm-Petrels	Leach’s Storm-Petrel	*Oceanodroma leucorhoa leucorhoa*	GNR	SNR										

Group	Common Name	Scientific Name	GRANK	SRANK	SOA	USFWS	COSEWIC	BLM	USFS	ABC Green List	AA WatchList	BPIF	NAWCP	ASCP
Cormorants	Brandt's Cormorant	*Phalacrocorax penicillatus*	G5	S3B						MA, D, HT			High Concern	
Cormorants	Double-crested Cormorant	*Phalacrocorax auritus*	G5	S3B										
Cormorants	Red-faced Cormorant	*Phalacrocorax urile*	G5	S3S4B, S3S4N		BCC				RD, LPS	RA, BD, ND, *		High Concern	
Cormorants	Pelagic Cormorant	*Phalacrocorax pelagicus*	G5	S5						MA, D, HT			High Concern	
Frigatebirds	Magnificent Frigatebird	*Fregata manificens*	G5	SAN									High Concern	
Herons and Bitterns	American Bittern	*Botarus lentiginosus*	G4	S3B										
Herons and Bitterns	Pacific Great Blue Heron	*Ardea herodias fannini*	G5T4	S3?B										
Ducks, Geese and Swans	Tule White-fronted Goose	*Anser albifrons elgasi*	G5T2T3	S3?B										
Ducks, Geese and Swans	Aleutian Canada Goose	*Branta canadensis leucopareia*	G5T4	SNR	SSOC									
Ducks, Geese and Swans	Steller's Eider	*Polysticta stelleri*	G3	S2B, S3?N	SSOC	PS:LT[1]				HCC				
Ducks, Geese and Swans	Spectacled Eider	*Somateria fischeri*	G2	S2B	SSOC	LT				HCC				
Ducks, Geese and Swans	King Eider	*Somateria spectabilis*	G5	S2S3B,S2S3N										
Ducks, Geese and Swans	Pacific Common Eider	*Somateria mollissima v-nigra*	GNR	SNR										
Ducks, Geese and Swans	Surf Scoter	*Melanitta perspicillata*	G5	S2S3B,S2S3N										
Ducks, Geese and Swans	White-winged Scoter	*Melanitta fusca deglandi*	G5	S2S3B,S2S3N										
Ducks, Geese and Swans	Black Scoter	*Melanitta nigra americana*	GNR	SNR										
Ducks, Geese and Swans	Long-tailed Duck	*Clangula hyemalis*	G5	S2B,S2N										
Grouse and Ptarmigan	Prince of Wales Spruce Grouse,	*Falcipennis canadensis isleibi*	GNR	SNR										

Group	Common Name	Scientific Name	GRANK	SRANK	SOA	USFWS	COSEWIC	BLM	USFS	ABC Green List	AA WatchList	BPIF	NAWCP	ASCP
Grouse and Ptarmigan	Evermann's Rock Ptarmigan	*Lagopus mutus evermanni*	G5T2T3	S2S3										
Grouse and Ptarmigan	Townsend's Rock Ptarmigan	*Lagopus mutus townsendi*	G5T2T3	S2S3										
Grouse and Ptarmigan	Turners Rock Ptarmigan	*Lagopus mutus atkhensis*	G5T2T3	S2S3										
Grouse and Ptarmigan	Blue Grouse	*Dendragapus obscurus*	G5	S5										
Hawks and Eagles	Osprey	*Pandion haliaetus*	G5	S3B					Sensitive					
Hawks and Eagles	Osprey	*Pandion haliaetus carolinensis*	G5T2T3	S3B										
Hawks and Eagles	Bald Eagle	*Haliaeetus leucocephalus*	G4	S3B, S3N					Sensitive					
Hawks and Eagles	Northern Bald Eagle	*Haliaeetus leucocephalus alascanus*	G4T3	S3										
Hawks and Eagles	White-tailed Eagle	*Haliaeetus albicilla*	G4G5	S1B										
Hawks and Eagles	Northern Harrier	*Circus cyaneus*	G5	S4?B			NAR							
Hawks and Eagles	Sharp-shinned Hawk	*Accipiter striatus*	G5	S4B, S3N										
Hawks and Eagles	Northern Goshawk	*Accipiter gentilus*	G5	S4					Sensitive					
Hawks and Eagles	Northern Goshawk	*Accipiter gentilus atricapillus*	GNR	SNR										
Hawks and Eagles	Queen Charlotte Northern Goshawk	*Accipiter gentilus laingi*	G5T2	S2B, S2N	SSO C			Sensitive	Sensitive	RD, LPS	BD, TB, ND			
Hawks and Eagles	Swainson's Hawk	*Buteo swainsoni*	G5	S3B, SAN										
Hawks and Eagles	Red-tailed Hawk	*Buteo jamaicensis alascensis*	G5T3?	S3?										
Hawks and Eagles	Rough-legged Hawk	*Buteo lagopus*	G5	S5B			NAR							
Hawks and Eagles	Golden Eagle	*Aquila chrysaetos*	G5	S4							RA, (TN)			
Falcons	Merlin	*Falco columbarius*	G5	S3S4B										

Group	Common Name	Scientific Name	GRANK	SRANK	SOA	USFWS	COSEWIC	BLM	USFS	ABC Green List	AA WatchList	BPIF	NAWCP	ASCP
Falcons	Black Merlin	*Falco columbarius suckleyi*	G5T2?	S3?B, S3?N										
Falcons	Gyrfalcon	*Falco rusticolus*	G5	S3								B		
Falcons	Peregrine Falcon	*Falco peregrinus*	G4	S3B										
Falcons	American Peregrine Falcon	*Falco peregrinus anatum*	G4T3	S3B	SSOC	Delisted		Sensitive			RA, (TN)			
Falcons	Peale's Peregrine Falcon	*Falco peregrinus pealei*	G4T3	S3				Sensitive	Sensitive		RA, (TN)			
Falcons	Arctic Peregrine Falcon	*Falco peregrinus tundrius*	G4T3T4	S3S4B	SSOC	Delisted		Sensitive			RA, (TN)			
Rails and Coots	Sora	*Porzana carolina*	G5	S3B										
Rails and Coots	American Coot	*Fulica americana*	G5	S3N										
Plovers	Black-bellied Plover	*Pluvialis squatarola*	G5	S5B						??				
Plovers	American Golden-Plover	*Pluvialis dominica*	G5	S5B, SAN		BCC				MA, D, HT				
Plovers	Pacific Golden-Plover	*Pluvialis fulva*	G5	S5B, SAN		BCC				RD, LPS	RA, BD, ND, *			SOHC
Plovers	Mongolian Plover	*Charadrius mongolus*	G4G5	S3B										
Plovers	Eastern Mongolian Plover	*Charadrius mongolus stegmanni*	G4G5T4	S3B										
Plovers	Killdeer	*Charadrius vociferous*	G5	S3B, S3N										
Plovers	Eurasian Dotterel	*Charadrius morinellus*	G5	S3B										
Oystercatchers	Black Oystercatcher	*Haematopus bachmani*	G5	S3S4B, S3?N		BCC				RD, LPS	RA, TB, ND, *			SOHC
Sandpipers	Common Greenshank	*Tringa nebularia*	G5	S2N										
Sandpipers	Lesser Yellowlegs	*Tringa flavipes*	G5	S5B						MA, D, HT				

Group	Common Name	Scientific Name	GRANK	SRANK	SOA	USFWS	COSEWIC	BLM	USFS	ABC Green List	AA WatchList	BPIF	NAWCP	ASCP
Sandpipers	Solitary Sandpiper	*Tringa solitaria*	G5	S4B		BCC				MA, D, HT				
Sandpipers	Solitary Sandpiper	*Tringa solitaria cinnamonea*	G5	S4B										
Sandpipers	Wandering Tattler	*Heteroscelus incanus*	G5	S3S4B							RA			SOHC
Sandpipers	Gray-tailed Tattler	*Heteroscelus brevipes*	G4G5	S3N										
Sandpipers	Common Sandpiper	*Actitis hypoleucos*	G5	SAB, S3N										
Sandpipers	Upland Sandpiper	*Bartramia longicauda*	G5	S3B		BCC				MA, D, HT				
Sandpipers	Eskimo Curlew	*Numenius borealis*	G1	SH	E	LE				HCC				
Sandpipers	Whimbrel	*Numenius phaeopus*	G5	S5B		BCC				MA, D, HT				SOHC
Sandpipers	Bristle-thighed Curlew	*Numenius tahitiensis*	G2	S2B		BCC		Sensitive		RD, LPS	RA, BD, (TN), *			SOHC
Sandpipers	Black-tailed Godwit	*Limosa limosa*	G5	S2N				Sensitive						
Sandpipers	Hudsonian Godwit	*Limosa haemastica*	G4	S3B		BCC		Sensitive		RD, LPS	RA, BD, (TN), *			SOHC
Sandpipers	Bar-tailed Godwit	*Limosa lapponica*	G5	S3B		BCC				RD, LPS				
Sandpipers	Bar-tailed Godwit	*Limosa lapponica baueri*	GNR	SNR										
Sandpipers	Marbled Godwit	*Limosa fedoa*	G5	S3B		BCC		Sensitive		MA, D, HT				
Sandpipers	Beringian Marbled Godwit	*Limosa fedoa beringiae*	G5T3?	S3?B							RA, (TN)			SOHC
Sandpipers	Black Turnstone	*Arenaria melanocephala*	G5	S5B, S3N		BCC				RD, LPS	RA, BD, (TN), *			SOHC
Sandpipers	Surfbird	*Aphriza virgata*	G5	S5?B, S3?N				Sensitive		RD, LPS	RA, TN, *			SOHC
Sandpipers	Red Knot	*Calidris canutus*	G5	S2B		BCC		Sensitive		RD, LPS				
Sandpipers	Red Knot	*Calidris canutus roselaari*	GNR	SNR										

Group	Common Name	Scientific Name	GRANK	SRANK	SOA	USFWS	COSEWIC	BLM	USFS	ABC Green List	AA WatchList	BPIF	NAWCP	ASCP
Sandpipers	Sanderling	*Calidris alba*	G5	S4B, S3N						MA, D, HT				
Sandpipers	Semipalmated Sandpiper	*Calidris pusilla*	G5	S5B						MA, D, HT				
Sandpipers	Western Sandpiper	*Calidris mauri*	G5	S5B						MA, D, HT				
Sandpipers	Temminck's Stint	*Calidris temminckii*	G5	S2N										
Sandpipers	Long-toed Stint	*Calidris subminuta*	G4G5	S2N										
Sandpipers	White-rumped Sandpiper	*Calidris fuscicollis*	G5	S3B										
Sandpipers	Baird's Sandpiper	*Calidris bairdii*	G5	S3B										
Sandpipers	Sharp-tailed Sandpiper	*Calidris acuminata*	G5	S3B										
Sandpipers	Rock Sandpiper, Aleutians	*Calidris ptilocnemis couesi*	SNR	SNR										SOHC
Sandpipers	Rock Sandpiper, Pribilofs	*Calidris ptilocnemis ptilocnemis*	G5T3T4	S3S4B, S3N							RA, ND, TN, *			SOHC
Sandpipers	Rock Sandpiper, Bering Sea	*Calidris ptilocnemis tschuktschorum*	SNR	SNR										SOHC
Sandpipers	Dunlin	*Calidris alpina*	G5	S5B, S3N		BCC				MA, D, HT				
Sandpipers	Arctic Dunlin	*Calidris alpina articola*	G5	S5B, S3N							PT, BD, (TN)			SOHC
Sandpipers	Pacific Dunlin	*Calidris alpine pacifica*	GNR	SNR										
Sandpipers	Curlew sandpiper	*Califris ferruginea*	G5?	S3B										
Sandpipers	Stilt Sandpiper	*Calidris himantopus*	G5	S3B						MA, D, HT				
Sandpipers	Buff-breasted Sandpiper	*Tryngites subruficollis*	G4	S2B		BCC		Sensitive		RD, LPS	RA, PT, TB, (TN), *			SOHC
Sandpipers	Ruff	*Philomachus pugnax*	G5	S1B										

Group	Common Name	Scientific Name	GRANK	SRANK	SOA	USFWS	COSEWIC	BLM	USFS	ABC Green List	AA WatchList	BPIF	NAWCP	ASCP
Sandpipers	Short-billed Dowitcher	*Limnodromus griseus*	G5	S5B						MA, D, HT				
Sandpipers	Short-billed Dowitcher	*Limnodromus griseus caurinus*	GNR	SNR										SOHC
Sandpipers	Common Snipe	*Gallinago gallinago*	G5	S5B, S3N										
Sandpipers	Wilson's Snipe	*Gallinago delicata*	G5	SA						MA, D, HT				
Sandpipers	Red-necked Phalarope	*Phalaropus lobatus*	G5	S5B, S3N										
Sandpipers	Red Phalarope	*Phalaropus fulicarius*	G5	S5B						MA, D, HT				
Skuas, Gulls, Terns	South Polar Skua	*Stercorarius maccormicki*	G5	S3N										
Skuas, Gulls, Terns	Black-headed Gull	*Larus ridibundus*	G5	S3N										
Skuas, Gulls, Terns	California Gull	*Larus californicus*	G5	S2N										
Skuas, Gulls, Terns	Glaucous Gull	*Larus hyperboreus*	G5	S3B, S5N										
Skuas, Gulls, Terns	Ring-billed Gull	*Larus delawarensis*	G5	S3N										
Skuas, Gulls, Terns	Ross's Gull	*Rhodostethia rosea*	G3G4	S3N										
Skuas, Gulls, Terns	Slaty-backed Gull	*Larus schistisagus*	G5	S2N										
Skuas, Gulls, Terns	Black-legged Kittiwake	*Rissa tridactyla*	G5	S5B, S3N										
Skuas, Gulls, Terns	Black-legged Kittiwake	*Rissa tridactyla pollicaris*	GNR	SNR										
Skuas, Gulls, Terns	Red-legged Kittiwake	*Rissa brevirostris*	G2	S2S3B, S2N		BCC				RD, LPS	RA, BD		High Concern	
Skuas, Gulls, Terns	Aleutian Tern	*Sterna aleutica*	G4	S4B		BCC				RD, LPS	RA, TB		High Concern	
Skuas, Gulls, Terns	Arctic Tern	*Sterna paradisaea*	G5	S5		BCC							High Concern	
Skuas, Gulls, Terns	Caspian Tern	*Sterna caspia*	G5	S3B										
Skuas, Gulls, Terns	Common Tern	*Sterna hirundo*	G5	S2N										

Group	Common Name	Scientific Name	GRANK	SRANK	SOA	USFWS	COSEWIC	BLM	USFS	ABC Green List	AA WatchList	BPIF	NAWCP	ASCP
Auks, Murres, Puffins	Dovekie	*Alle alle*	G5	S1				Sensitive						
Auks, Murres, Puffins	Common Murre	*Uria aalge*	G5	S5										
Auks, Murres, Puffins	Thick-billed Murre	*Uria lomvia*	G5	S5										
Auks, Murres, Puffins	Black Guillemot	*Cepphus grylle*	G5	S2B				Sensitive						
Auks, Murres, Puffins	Pigeon Guillemot	*Cepphus columba*	G5	S5						MA, D, HT				
Auks, Murres, Puffins	Marbled Murrelet	*Brachyranphus marmoratus*	G3G4	S2S3		PS:LT[2]	T	Sensitive	SSI - CNF	HCC	PT, TB		High Concern	
Auks, Murres, Puffins	Kittlitz's Murrelet	*Brachyranphus brevirostris*	G3G4	S2B, S2N		C		Sensitive		RD, LPS			High Concern	
Auks, Murres, Puffins	Ancient Murrelet	*Synthliboramphus antiquus*	G4	S4						RD, LPS			High Concern	
Auks, Murres, Puffins	Least Auklet	*Aethia pusilla*	G5	S5										
Auks, Murres, Puffins	Whiskered Auklet	*Aethia pygmaea*	G5?	S3		BCC				RD, LPS	RA, BD, *			
Auks, Murres, Puffins	Crested Auklet	*Aethia cristatella*	G5	S5										
Pigeons	Band-tailed Pigeon	*Columba fasciata*	G5	S3B										
Owls	Western Screech-Owl	*Megascops kennicottii*	G5	S3?B										
Owls	Great Horned Owl	*Bubo virginianus*	G5	S5										
Owls	Snowy Owl	*Bubo scandiacus*	G5	S4								B		
Owls	Northern Hawk Owl	*Surnia ulula*	G5	S4										
Owls	Northern Pygmy-Owl	*Glaucidium gnoma*	G5	S3										
Owls	Barred Owl	*Strix varia*	G5	SNA										
Owls	Great Gray Owl	*Strix nebulosa*	G5	S3								B		
Owls	Short-eared Owl	*Asio flammeus*	G5	S4S5B		BCC				MA, D, HT				
Owls	Boreal Owl	*Aegolius funereus*	G5	S4								B, F		
Owls	Northern Saw-Whet	*Aegolius acadicus*	G5	S4										

Group	Common Name	Scientific Name	GRANK	SRANK	SOA	USFWS	COSEWIC	BLM	USFS	ABC Green List	AA WatchList	BPIF	NAWCP	ASCP
Owls	Western Screech-Owl	*Megascops kennicottii*	G5	S3?B								F		
Swifts	Black Swift	*Cypseloides niger*	G4	S3?B										
Swifts	Black Swift	*Cypseloides niger borealis*	G4	S3?B							RA, PT, (ND), *	T		
Swifts	Vaux's Swift	*Chaetura vauxi*	G5	S3?B								F		
Hummingbirds	Anna's Hummingbird	*Calypte anna*	G5	S3N										
Hummingbirds	Rufous Hummingbird	*Selasphorus rufus*	G5	S3B						MA, D, HT		F		
Kingfishers	Belted Kingfisher	*Ceryle alcyon*	G5	S5										
Woodpeckers	Yellow-bellied Sapsucker	*Sphyrapicus varius*	G5	S3B										
Woodpeckers	Red-breasted Sapsucker	*Sphyrapicus ruber*	G5	S3B								F		
Woodpeckers	Hairy Woodpecker	*Picoides villosus*	G5	S4										
Woodpeckers	American Three-toed Woodpecker	*Picoides dorsalis*	G5	S4										
Woodpeckers	Black-backed Woodpecker	*Picoides arcticus*	G5	S4								G		
Woodpeckers	Northern Flicker	*Colaptes auratus*	G5	S5B										
Flycatchers	Eastern Kingbird	*Tyrannus tyrannus*	G5	S2N										
Flycatchers	Hammond's Flycatcher	*Empidonax hammondii*	G5	S5B								G		
Flycatchers	Olive-sided Flycatcher	*Contopus cooperi*	G4	S3S4B	SSOC			Sensitive		MA, D, HT	RA, PT	F, T		
Flycatchers	Pacific-slope Flycatcher	*Empidonax difficilis*	G5	S5B								F		
Flycatchers	Western Wood-Pewee	*Contopus sordidulus*	G5	S3?B								T		
Shrikes	Northern Shrike	*Lanius excubitor*	G5	S4B, S4N								B		
Vireos	Cassin's Vireo	*Vireo cassinii*	G5	SNR										
Vireos	Red-eyed Vireo	*Vireo olivaceus*	G5	S3B										

Group	Common Name	Scientific Name	GRANK	SRANK	SOA	USFWS	COSEWIC	BLM	USFS	ABC Green List	AA WatchList	BPIF	NAWCP	ASCP
Jays	Steller's Jay	*Cyanocitta stelleri*	G5	S5								G		
Crows	American Crow	*Corvus brachyrhynchos*	G5	S2										
Crows	Northwestern Crow	*Corvus caurinus*	G5	S5								G		
Larks	Sky Lark	*Alauda arvensis*	G5	S1B										
Swallows	Violet-green Swallow	*Tachycineta thalassina*	G5	S5B										
Swallows	Northern Rough-winged Swallow	*Stelgidopteryx rufficollis*	G5	S3B										
Swallows	Bank Swallow	*Riparia riparia*	G5	S5B										
Swallows	Cliff Swallow	*Petrochelidon pyrrhonota*	G5	S5B										
Swallow	Barn Swallow	*Hirundo rustica*	G5	S5B										
Chickadees	Chestnut-backed Chickadee	*Poecile rufescens*	G5	S5								G		
Chickadees	Boreal Chickadee	*Poecile hudsonica*	G5	S5										
Chickadees	Gray-headed Chickadee	*Poecile cincta*	G5	S3										
Nuthatches	Red-breasted Nuthatch	*Sitta canadensis*	G5	S4										
Creepers	Brown Creeper	*Certhia americana*	G5	S4										
Wrens	Pribilof Winter Wren	*Troglodytes troglodytes alascensis*	G5T3	S3										
Wrens	Kodiak Winter Wren	*Troglodytes troglodytes helleri*	G5T3	S3										
Wrens	Kiska Winter Wren	*Troglodytes troglodytes kiskensis*	G5T3	S3										
Wrens	Attu Winter Wren	*Troglodytes troglodytes meligerus*	G5T3	S3										

Group	Common Name	Scientific Name	GRANK	SRANK	SOA	USFWS	COSEWIC	BLM	USFS	ABC Green List	AA WatchList	BPIF	NAWCP	ASCP
Wrens	Unalaska Winter Wren	*Troglodytes troglodytes petrophilus*	G5T3	S3										
Wrens	Sedimi Winter Wren	*Troglodytes troglodytes semidiensis*	G5T3	S3										
Wrens	Stevenson's Winter Wren	*Troglodytes troglodytes stevensoni*	G5T3	S3										
Wrens	Tanaga Winter Wren	*Troglodytes troglodytes tanagensis*	G5T3	S3										
Dippers	American Dipper	*Cinclus mexicanus*	G5	S5								B		
Kinglets	Golden-crowned Kinglet	*Regulus satrapa*	G5	S5								F		
Thrushes	Arctic Warbler	*Phylloscopus borealis*	G5	S5B										
Thrushes	Siberian Rubythroat	*Luscinia calliope*	G5	S2N										
Thrushes	Bluethroat	*Luscinia svecica*	G5	S3B										
Thrushes	Mountain Bluebird	*Sialia currucoides*	G5	S3B										
Thrushes	Townsend's Solitaire	*Myadestes townsendi*	G5	S3B, SAN										
Thrushes	Gray-cheeked Thrush	*Catharus minimus*	G5	S3B	SSOC			Sensitive				G		
Thrushes	Swainson's Thrush	*Catharus ustulatus*	G5	S3B										
Thrushes	Hermit Thrush	*Catharus guttatus*	G5	S4B										
Thrushes	Eyebrowed Thrush	*Turdus obscurus*	G5	S2N										
Thrushes	American Robin	*Turdus migratorius*	G5	S5B, S3N										
Thrushes	Varied Thrush	*lxoreus naevius*	G5	S5								F, G		
Wagtails, Pipits	Black-backed Wagtail	*Motacilla lugens*	G5?	SAB, S3N										
Wagtails, Pipits	White Wagtail	*Motacilla alba*	G5	S3B										

Group	Common Name	Scientific Name	GRANK	SRANK	SOA	USFWS	COSEWIC	BLM	USFS	ABC Green List	AA WatchList	BPIF	NAWCP	ASCP
Wagtails, Pipits	Eastern Yellow Wagtail	*Motacilla tschutschensis*	G5	S5B										
Waxwings	Bohemian Waxwing	*Bombycilla garrulus*	G5	S5B, S5N								B		
Wood Warblers	Blackpoll Warbler	*Dendroica striata*	G5	S3B	SSOC			Sensitive			PT, ND	G		
Wood Warblers	MacGillivray's Warbler	*Oporornis tolmiei*	G5	S4B								W		
Wood Warblers	Tennessee Warbler	*Vermivora peregrina*	G5	S3B										
Wood Warblers	Townsend's Warbler	*Dendroica townsendi*	G5	S3B	SSOC			Sensitive	SSI - CNF			F		
Wood Warblers	Wilson's Warbler	*Wilsonia pusilla*	G5	S3B										
Wood Warblers	American Redstart	*Setophaga ruticilla*	G5	S3B										
Wood Warblers	Northern Waterthrush	*Seiurus noveboracensis*	G5	S3B										
Tanagers	Western Tanager	*Piranga ludoviciana*	G5	S3B										
Sparrows	American Tree Sparrow	*Spizella arborea*	G5	S5B, S3N										
Sparrows	Fox Sparrow	*Passerella iliaca*	G5	S3N, S5N										
Sparrows	Giant Song Sparrow	*Melospiza melodia maxima*	G5T4	S4										
Sparrows	Amak Island Song Sparrow	*Melospiza melodia amaka*	G5T2	S2										
Sparrows	Harris's Sparrow	*Zonotrichia querula*	G5	S3N										
Sparrows	White-crowned Sparrow	*Zonotrichia leucophrys*	G5	S5B, S3N										
Sparrows	Golden-crowned Sparrow	*Zonotrichia atricapilla*	G5	S5B, S3N								G		
Sparrows	Dark-eyed Junco	*Junco hyemalis*	G5	S5B, S3N										
Sparrows	Smith's Longspur	*Calcarius pictus*	G5	S3S4B							RA, (ND), *	G, W		

Group	Common Name	Scientific Name	GRANK	SRANK	SOA	USFWS	COSEWIC	BLM	USFS	ABC Green List	AA WatchList	BPIF	NAWCP	ASCP
Sparrows	Rustic Bunting	*Emberiza rustica*	G5	S2N										
Sparrows	McKay's Bunting	*Plectrophenax hyperboreus*	G3	S3				Sensitive		RD, LPS	RA, BD, *	G		
Grosbeaks	Pine Grosbeak	*Pinicola enucleator*	G5	S5B,S5N										
Blackbirds	Brown-headed Cowbird	*Molothrus ater*	G5	S3B, SAN										
Blackbirds	Red-winged Blackbird	*Agelaius phoeniceus*	G5	S3B, S2N										
Blackbirds	Rusty Blackbird	*Euphagus carolinus*	G5	S4B						MA, D, HT		G, T		
Finches	Brambling	*Fringilla montifringilla*	G5	S2N										
Finches	Gray-crowned Rosy-Finch	*Leucosticte tephrocotis*	G5	S5B, S3N										
Finches	Red Crossbill	*Loxia curvirostra*	G5	S5										
Finches	White-winged Crossbill	*Loxia leucoptera*	G5	S5								B		
Finches	Hoary Redpoll	*Carduelis hornemanni*	G5	S5B, S5N								B		
Finches	Pine Siskin	*Carduelis pinus*	G5	S5		LC								

[1]Alaska's population of Steller's Eider is part of this listing.
[2]Alaska's population of Marbled Murrelet is not part of this listing.

Mammal Nominees												
Group	Common Name	Scientific Name	GRANK	SRANK	SOA	USFWS	NOAA	COSEWIC	IUCN	CITES	BLM	USFS
Shrews	dusky shrew	*Sorex monticolus*	G5	SNR								
Shrews	dusky shrew, Yakutat	*Sorex monticolus alascensis*	G5	SNR								
Shrews	dusky shrew, Queen Charlotte Islands	*Sorex monticolus ellassodon*										
Shrews	dusky shrew, Warren Island	*Sorex monticolus malitiosus*	G5T3Q	S3Q								
Shrews	Pribilof Island shrew	*Sorex pribilofensis (hydrodromus)*	G3	S3					E			
Shrews	pygmy shrew	*Sorex hoyi*	G5	SNR								
Shrews	St. Lawrence Island shrew	*Sorex jacksoni*	G3	S3					E			
Shrews	tiny shrew	*Sorex yukonicus*	GU	SNR								
Shrews	tundra shrew	*Sorex tundrensis*	G5	SNR								
Shrews	water shrew	*Sorex palustris*	G5	SNR								
Shrews	Glacier Bay water shrew	*Sorex alaskanus*	G5THQ	SH								
Bats	big brown bat	*Eptesicus fuscus*	G5	S2?								
Bats	California myotis	*Myotis californicus*	G5	S1S3B							Sensitive	
Bats	Keen's myotis	*Myotis keenii*	G2G3	S1S3				DD	LR		Sensitive	
Bats	little brown myotis	*Myotis lucifugus*	G5	S3S4								
Bats	long-legged myotis	*Myotis volans (longicrus)*	G5	S2?								
Bats	silver-haired bat	*Lasionycteris noctivagans*	G5	S1S3B							Sensitive	
Canids	gray wolf, Alexander Archipelago	*Canis lupus ligoni*	G4T2T3Q	S2S3Q						A2		
Mustelids	sea otter	*Enhydra lutris*	G4	S4	SSOC							
Mustelids	northern sea otter, Southwest Alaska population	*Enhydra lutris kenyoni*	G4T4	S2S3		PT		T				
Mustelids	river otter, Prince of Wales	*Lontra canadensis mira*	G5T3T4	S3S4						A2		
Mustelids	wolverine, Kenai	*Gulo gulo katschemakensis*	G4T3?	S3?								
Mustelids	marten, Kenai	*Martes americana kenaiensis*										

Group	Common Name	Scientific Name	GRANK	SRANK	SOA	USFWS	NOAA	COSEWIC	IUCN	CITES	BLM	USFS
Mustelids	marten	*Martes caurina caurina*										
Mustelids	ermine	*Mustela erminea alascensis*										
Mustelids	ermine, Prince of Wales	*Mustela erminea celenda*	G5T4?	S4?								
Mustelids	ermine	*Mustela erminea initis*										
Mustelids	ermine, Kodiak	*Mustela erminea kadiacensis*	G5T4?	S4?								
Mustelids	ermine	*Mustela erminea salva*										
Mustelids	ermine, Suemez Island	*Mustela erminea seclusa*	G5T2?Q	S2?Q								
Walrus	walrus	*Odobenus rosmarus*	G4	S4				NAR	LR	A3		
Seals	bearded seal	*Erigrathus barbatus*	G4G5	SNR								
Seals	elephant seal	*Mirounga angustirostris*	G5	SNR						A2		
Seals	northern fur seal	*Callorhinus ursinus*	G3	S3								
Seals	harbor seal , Pacific	*Phoca vitulina richardsi*	G5T5Q	S4S5	SSOC						Sensitive	
Seals	ribbon seal	*Phoca fasciata*	G5	SNR								
Seals	ringed seal	*Phoca hispida*	G5	SNR								
Seals	spotted seal	*Phoca largha*	G4G5	SNR								
Seals	Steller's sea lion, Western Alaska Population	*Eumetopias jubatus*	G3	SNR	SSOC		LE	NAR				
Seals	Steller's sea lion, Eastern Alaska Population	*Eumetopias jubatus*	G3	S2	SSOC		LT	NAR				
Bears	brown bear, Kenai population	*Ursus arctos kenai*			SSOC							
Bears	polar bear	*Ursus maritimus*	G4	S3				SC	LR	A2		
Whales	beluga whale, Cook Inlet	*Delphinapterus leucas*, pop. 4	G4T1	S1	SSOC		C					
Whales	blue whale, North Pacific	*Balaenoptera musculus*, pop. 2	G2	S2B	E		LE					
Whales	bowhead, Western Arctic	*Balaena mysticetus*, pop. 2	G2	S2	SSOC		LE	E				
Whales	fin whale, Northeast Pacific	*Balaenoptera physalus*, pop. 2	G3G4	S2B			LE					
Whales	gray whale, Eastern Pacific	*Eschrichtius robustus*, pop. 4	G4	S3B			Delisted	XT, NAR				
Whales	humpback whale, Western and Central North Pacific	*Megaptera novaeangliae*, pop. 1	G3	S2B	E		LE					
Whales	minke whale, Northern	*Balaenoptera acutorostrata*	G5	SNR						A1		

Group	Common Name	Scientific Name	GRANK	SRANK	SOA	USFWS	NOAA	COSEWIC	IUCN	CITES	BLM	USFS
Whales	northern right whale, North Pacific	*Eubalaena glacialis*, pop.2	G1	S1	E		LE	E				
Whales	sei whale, North Pacific	*Balaenoptera borealis*	G3	S2B			LE					
Whales	sperm whale, North Pacific	*Physeter catodon*	G3G4	S2S3			LE					
Whales	Baird's beaked whale	*Berardius bairdii*	G4	SNR								
Whales	Stejneger's beaked whale	*Mesoplodon stejnegeri*	G3	SNR								
Whales	Cuvier's beaked whale	*Ziphius cavirostris*	G4	SNR								
Whales	killer whale	*Orcinus orca*	G4	SNR								
Porpoises	harbor porpoise	*Phocoena phocoena*	G4G5	S2S3								
Deer	woodland caribou, Chisana herd	*Rangifer tarandus caribou*	G5T4	SNR		PS:LE						
Rodents	Alaska marmot	*Marmota broweri*	G4	S4								
Rodents	hoary marmot, Glacier Bay	*Marmota caligata vigilis*	G5T3?	S3?					DD			
Rodents	hoary marmot, Montague Island	*Marmota caligata sheldoni*	G5T2T3	S2S3					DD			SSI - CNF
Rodents	arctic ground squirrel	*Spermophilus parryii*	G5	SNR								
Rodents	arctic ground squirrel	*Spermophilus parryii ablusus*										
Rodent	arctic ground squirrel, Barrow	*Spermophilus parryii kennicottii*										
Rodents	arctic ground squirrel, Kodiak Island	*Spermophilus parryii kodiacensis*	G5T3	S3					DD			
Rodents	arctic ground squirrel, St. Lawrence Island	*Spermophilus parryii lyratus*	G5T3	S3					DD			
Rodents	arctic ground squirrel, Shumagin Islands	*Spermophilus parryii nebulicola*	G5T3	S3					DD			
Rodents	arctic ground squirrel, Osgood's	*Spermophilus parryii osgoodi*	G5T3?	S3?								
Rodents	red squirrel, Kupreanof	*Tamiasciurus hudsonicus picatus*	G5T3?	S3?								
Rodents	red squirrel, Kenai	*Tamiasciurus hudsonicus kenaiensis*	GNR	SNR								
Rodents	northern flying squirrel	*Glaucomys sabrinus alpinus*										

Group	Common Name	Scientific Name	GRANK	SRANK	SOA	USFWS	NOAA	COSEWIC	IUCN	CITES	BLM	USFS
Rodents	northern flying squirrel, Prince of Wales	*Glaucomys sabrinus griseifrons*	G5T2?Q	S2?Q					E			
Rodents	beaver, Admiralty	*Castor canadensis phaeus*	G5T3	S3								
Rodents	meadow jumping mouse	*Zapus hudsonius*	G5	S5?								
Rodents	southern red-backed vole	*Clethrionomys gapperi*	G5	SNR								
Rodents	southern red-backed vole	*Clethrionomys gapperi phaeus*	GNR	SNR								
Rodents	southern red-backed vole, Revillagigedo Island	*Clethrionomys gapperi solus*	G5T3Q	S3Q					DD			
Rodents	southern red-backed vole, Gapper's	*Clethrionomys gapperi stikinensis*	G5T2T3	S2S3								
Rodents	southern red-backed vole, Wrangell Island	*Clethrionomys gapperi wrangeli*	G5T2T3	S2S3								
Rodents	northern red-backed vole	*Clethrionomys rutilus*	G5	SNR								
Rodents	northern red-backed vole	*Clethrionomys rutilus insularis*	G5T3	S3								
Rodents	northern red-backed vole	*Clethrionomys rutilus orca*	G5T3	S3								
Rodents	northern red-backed vole, Glacier Bay	*Clethrionomys rutilus glacialis*	G5T3	S3								
Rodents	northern red-backed vole, St. Lawrence Island	*Clethrionomys rutilus albiventer*	G5T3	S3								
Rodents	brown lemming	*Lemmus trimucronatus*	G5	SNR								
Rodents	brown lemming, Nunivak Island	*Lemmus trimucronatus harroldi*	G5T4	S4								
Rodents	brown lemming, black-footed	*Lemmus trimucronatus nigripes*	G5T3	S3								
Rodents	northern bog lemming	*Synaptomys borealis*	G4	S4								
Rodents	collared lemming	*Dicrostonyx groenlandicus*	G3	S3								
Rodents	collared lemming, St. Lawrence Island	*Dicrostonyx groenlandicus exsul*	G5T4	S4					DD			
Rodents	collared lemming	*Dicrostonyx groenlandicus peninsulae*										
Rodents	collared lemming, Stevenson's	*Dicrostonyx groenlandicus stevensoni*	GNR	SNR								
Rodents	collared lemming, Unalaska	*Dicrostonyx groenlandicus unalascensis*	G5T3	S3					DD			

Group	Common Name	Scientific Name	GRANK	SRANK	SOA	USFWS	NOAA	COSEWIC	IUCN	CITES	BLM	USFS
Rodents	insular vole	*Microtus abbreviatus*	G3Q	S3								
Rodents	insular vole, Hall Island	*Microtus abbreviatus abbreviatus*	G3QT3	S3Q					DD			
Rodents	insular vole, St. Matthew Island	*Microtus abbreviatus fisheri*	G3QT3	S3Q					DD			
Rodents	long-tailed vole	*Microtus longicaudus*	G5	SNR								
Rodents	long-tailed vole, Coronation Island	*Microtus longicaudus coronarius*	G5T3Q	S3Q					DD			
Rodents	long-tailed vole	*Microtus longicaudus littoralis*	G5	SNR								
Rodents	singing vole	*Microtus miurus*	G4	S4								
Rodents	tundra vole	*Microtus oeconomus*	G5	SNR								
Rodents	tundra vole, Amak Island	*Microtus oeconomus amakensis*	G5T2Q	S2Q					DD			
Rodents	tundra vole, Montague Island	*Microtus oeconomus elymocetes*	G5T2	S2					DD			Sensitive - CNF
Rodents	tundra vole, Punuk Island	*Microtus oeconomus punukensis*	G5T1	S1					DD			
Rodents	tundra vole, St. Lawrence Island	*Microtus oeconomus innuitus*	G5T3	S3					DD			
Rodents	tundra vole, Shumagin Island	*Microtus oeconomus popofensis*	G5T3	S3					DD			
Rodents	tundra vole, Sitka	*Microtus oeconomus sitkensis*	G5T3	S3					DD			
Rodents	tundra vole, Unalaska	*Microtus oeconomus unalascensis*	G5T3	S3								
Rodents	tundra vole, Yakutat	*Microtus oeconomus yakutatensis*	G5T4	S4								
Rodents	meadow vole	*Microtus pennsylvanicus*	G5	SNR								
Rodents	meadow vole, Admiralty Island	*Microtus pennsylvanicus admiraltiae*	G5T3	S3								
Rodents	yellow-cheeked vole (Taiga vole)	*Microtus xanthognathus*	G5	SNR								
Rodents	forest deer mouse, Keen's mouse	*Peromyscus keeni*	G5	S3								
Rodents	forest deer mouse	*Peromyscus keeni algidus*										

Group	Common Name	Scientific Name	GRANK	SRANK	SOA	USFWS	NOAA	COSEWIC	IUCN	CITES	BLM	USFS
Rodents	forest deer mouse	*Peromyscus keeni hylaeus*										
Rodents	forest deer mouse	*Peromyscus keeni macrorhinus*										
Rodents	forest deer mouse	*Peromyscus keeni oceanicus*										
Rodents	forest deer mouse	*Peromyscus keeni sitkensis*										
Pikas	collared pika	*Ochotona collaris*	G5	S5								
Hares	tundra hare	*Lepus othus*	G3G4	S3S4Q								
Hares	tundra hare	*Lepus othus othus*										
Hares	tundra hare	*Lepus othus poadromus*										

Invertebrate Nominees					
Group	Common Name	Scientific Name	GRANK	SRANK	COSEWic
Worms	Round, whip, lung, hook, and eel[1]	Nematoda			
Worms	Leeches, earthworms, bristle worms[1]	Annelida			
Amphipod	A cave obligate amphipod	*Stygobromus quatsinensis*	G2G3	S2S3	
Arthropoda	Crustaceans, Spiders, Insects[1]	Arthropoda			
Insect	Mayflies	Ephemeroptera			
Insect	A mayfly	*Brachycercus arcticus*	G1	S?	
Insect	A mayfly	*Ephemerella lacustris*	G1	S?	
Insect	A mayfly	*Acentrella feropagus*	G3	S?	
Insect	A stonefly	*Isoperla katmaiensis*	G2	S?	
Insect	Stoneflies	Plecoptera			
Insect	A stonefly	*Mesocapnia bergi*	G1	S?	
Insect	A stonefly	*Nemoura normani*	G1	S?	
Insect	A stonefly	*Isocapnia agassizi*	G3	S?	
Insect	A stonefly	*Podmosta weberi*	G3	S?	
Insect	A stonefly	*Alaskaperla ovibovis*	G3	S?	
Insect	A stonefly	*Isoperla decolorata*	G3	S?	
Insect	A stonefly	*Isoperla sordida*	G3	S?	
Insect	A stonefly	*Pteronarcella regularis*	G3	S?	
Insect	Caddisflies	Trichoptera			
Insect	Eskimo arctic	*Oeneis alpina*	G3G4	S?	
Insect	Alaskan orange tip	*Anthocharis sara alaskensis*	G5T1T2	S?	
Insect	Bog fritillary	*Boloria eunomia denali*	G5T2T3	S?	
Insect	Uhler's arctic	*Oeneis uhleri cairnesi*	G5T2T3	S?	
Insect	Astarte fritillary	*Boloria astarte distincta*	G5T3	S?	
Insect	Field crescent	*Phyciodes pratensis totchone*	G5T3T4	S?	
Insect	Western bumblebee	*Bombus occidentalis*	GNR	SNR	
Insect	Dragonflies and Damselflies[2]	Odonata			
Insect	Water fleas	Cladocera			
Mollusc	Clams and Mussels[3]	Pelecypoda			

Group	Common Name	Scientific Name	GRANK	SRANK	COSEWic
Mollusc	Western pearl shell	*Margaritifera falcata*	G4	SNR	
Mollusc	Yukon floater	*Anodonta beringiana*	G4	S3S4	
Mollusc	Western floater	*Anodonta kennerlyi*	G4	SNR	
Mollusc	Snails, Slugs, Limpets[1, 4, 8]	Gastropoda			
Mollusc	Attenuate fossaria	*Fossaria truncatula*	G1G2Q	S?	
Mollusc	Rams-horn valvata	*Valvata mergella*	G2	S?	
Mollusc	Fringed valvata	*Valvata lewisi*	G3?	S?	
Mollusc	Frigid lymnaea	*Lymnaea atkaensis*	G3?	S?	
Mollusc	Hanna's vertigo	*Vertigo hannai*	GH	S?	
Mollusc	Undescribed snail	*Vertigo* sp. *nov*	G?	S?	
Mollusc	Black Katy chiton	*Katharina tunicata*	G5	S5	
Mollusc	Gumboot chiton	*Cryptochiton stelleri*			
Mollusc	Pinto (Northern) abalone	*Haliotis kamtschatkana*	GNR	SNR	T
Mollusc	Intertidal and shallow subtidal bivalves[4]	various			
Various	Eelgrass-associated invertebrates[4]	various			
Various	Corals, tunicates, sponges[5]	various			
Various	Salt marsh-associated invertebrates[6]	various			
Various	Zooplankton[7]	various			
Various	Benthic grazers[8]	various			
Various	Cave-dwelling species[9]	various			

[1] See Terrestrial Invertebrates Introduction in Appendix 4 for complete list of orders
[2] See Freshwater Invertebrates: Dragonflies and Damselflies template in Appendix 4 for complete list of species
[3] See Freshwater Invertebrates: Mollusca in Appendix 4
[4] See Nearshore Soft Benthic Ecosystems templates in Appendix 4
[5] See Deep Benthic Ecosystems template in Appendix 4
[6] See Salt Marsh Ecosystems template in Appendix 4
[7] See Pelagic Ecosystems template in Appendix 4
[8] See Nearshore Rocky Reef Ecosystems template in Appendix 4
[9] See Karst Cave Dwelling Aquatic Invertebrates template in Appendix 4

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Pit Lake ERA

Appendix B – Yukon Delta National Wildlife Refuge species lists

Appendix B. Yukon Delta National Wildlife Refuge species lists

Group	Subgroup	Common Name	Habitat Notes
bird	ACCENTORS	Siberian Accentor	A
bird	BLACKBIRDS	Rusty Blackbird	S*
bird	BLACKBIRDS	Brown-headed Cowbird	A
bird	CHICKADEES AND TITMICE	Black-capped Chickadee	P*
bird	CHICKADEES AND TITMICE	Boreal Chickadee	P*
bird	CHICKADEES AND TITMICE	Gray-headed Chickadee	A
bird	CORMORANTS	Double-crested Cormorant	C*
bird	CORMORANTS	Red-faced Cormorant	S*
bird	CORMORANTS	Pelagic Cormorant	S*
bird	CRANES	Sandhill Crane	S*
bird	CREEPERS	Brown Creeper	A
bird	CUCKOOS	Common Cuckoo	A
bird	DIPPERS	American Dipper	P*
bird	FALCONS	American Kestrel	C
bird	FALCONS	Merlin	S*
bird	FALCONS	Gyrfalcon	P*
bird	FALCONS	Peregrine Falcon	S*
bird	FINCHES	Brambling	A
bird	FINCHES	Gray-crowned Rosy-Finch	S*
bird	FINCHES	Pine Grosbeak	P*
bird	FINCHES	Common Rosefinch	A
bird	FINCHES	Purple Finch	A
bird	FINCHES	White-winged Crossbill	P*
bird	FINCHES	Common Redpoll	P*
bird	FINCHES	Hoary Redpoll	P*
bird	FINCHES	Pine Siskin	A
bird	FINCHES	Eurasian Bullfinch	A
bird	FLYCATCHERS	Olive-sided Flycatcher	S*
bird	FLYCATCHERS	Alder Flycatcher	S*
bird	FLYCATCHERS	Willow Flycatcher	A
bird	FLYCATCHERS	Say's Phoebe	S*
bird	FLYCATCHERS	Eastern Kingbird	A
bird	FULMARS, SHEARWATERS	Northern Fulmar	A
bird	FULMARS, SHEARWATERS	Mottled Petrel	A
bird	FULMARS, SHEARWATERS	Sooty Shearwater	A
bird	FULMARS, SHEARWATERS	Short-tailed Shearwater	M
bird	FULMARS, SHEARWATERS	Fork-tailed Storm-Petrel	M
bird	GALLINACEOUS BIRDS	Ruffed Grouse	P*
bird	GALLINACEOUS BIRDS	Spruce Grouse	P*
bird	GALLINACEOUS BIRDS	Willow Ptarmigan	P*
bird	GALLINACEOUS BIRDS	Rock Ptarmigan	P*
bird	GALLINACEOUS BIRDS	White-tailed Ptarmigan	P*
bird	GREBES	Horned Grebe	S*
bird	GREBES	Red-necked Grebe	S*
bird	HOOPOES AND KINGFISHERS	Hoopoe	A
bird	HOOPOES AND KINGFISHERS	Belted Kingfisher	S*
bird	HUMMINGBIRDS	Rufous Hummingbird	A

Group	Subgroup	Common Name	Habitat Notes
bird	JAEGERS, GULLS AND TERNS	Pomarine Jaeger	M*
bird	JAEGERS, GULLS AND TERNS	Parasitic Jaeger	S*
bird	JAEGERS, GULLS AND TERNS	Long-tailed Jaeger	S*
bird	JAEGERS, GULLS AND TERNS	Black-headed Gull	A
bird	JAEGERS, GULLS AND TERNS	Bonaparte;s Gull	S*
bird	JAEGERS, GULLS AND TERNS	Black-tailed Gull	A
bird	JAEGERS, GULLS AND TERNS	Mew Gull	S*
bird	JAEGERS, GULLS AND TERNS	Herring Gull	S
bird	JAEGERS, GULLS AND TERNS	Slaty-backed Gull	C*
bird	JAEGERS, GULLS AND TERNS	Glaucous-winged Gull	S*
bird	JAEGERS, GULLS AND TERNS	Glaucous Gull	S*
bird	JAEGERS, GULLS AND TERNS	Sabine's Gull	S*
bird	JAEGERS, GULLS AND TERNS	Black-legged Kittiwake	S*
bird	JAEGERS, GULLS AND TERNS	Red-legged Kittiwake	A
bird	JAEGERS, GULLS AND TERNS	Ross' Gull	A
bird	JAEGERS, GULLS AND TERNS	Ivory Gull	A
bird	JAEGERS, GULLS AND TERNS	Caspian Tern	C*
bird	JAEGERS, GULLS AND TERNS	Common Tern	A
bird	JAEGERS, GULLS AND TERNS	Arctic Tern	S*
bird	JAEGERS, GULLS AND TERNS	Aleutian Tern	S*
bird	JAYS, MAGPIES AND CROWS	Gray Jay	P*
bird	JAYS, MAGPIES AND CROWS	Steller’s Jay	A
bird	JAYS, MAGPIES AND CROWS	Black-billed Magpie	P*
bird	JAYS, MAGPIES AND CROWS	Common Raven	P*
bird	KINGLETS	Golden-crowned Kinglet	C
bird	KINGLETS	Ruby-crowned Kinglet	S*
bird	LARKS	Horned Lark	S*
bird	LOONS	Red-throated Loon	S*
bird	LOONS	Arctic Loon	A
bird	LOONS	Pacific Loon	S*
bird	LOONS	Common Loon	S*
bird	LOONS	Yellow-billed Loon	M
bird	Mimids	Northern Mockingbird	A

Group	Subgroup	Common Name	Habitat Notes
bird	MURRES, GUILLEMOTS AND PUFFINS	Common Murre	S*
bird	MURRES, GUILLEMOTS AND PUFFINS	Thick-billed Murre	S*
bird	MURRES, GUILLEMOTS AND PUFFINS	Black Guillemot	A
bird	MURRES, GUILLEMOTS AND PUFFINS	Pigeon Guillemot	S*
bird	MURRES, GUILLEMOTS AND PUFFINS	Marbled Murrelet	A
bird	MURRES, GUILLEMOTS AND PUFFINS	Ancient Murrelet	A
bird	MURRES, GUILLEMOTS AND PUFFINS	Parakeet Auklet	S*
bird	MURRES, GUILLEMOTS AND PUFFINS	Least Auklet	A
bird	MURRES, GUILLEMOTS AND PUFFINS	Crested Auklet	S*
bird	MURRES, GUILLEMOTS AND PUFFINS	Horned Puffin	S*
bird	MURRES, GUILLEMOTS AND PUFFINS	Tufted Puffin	S*
bird	NUTHATCHERS	Red-breasted Nuthatch	C
bird	OLD WORLD WARBLERS	Middendorff's Grasshopper Warbler	A
bird	OLD WORLD WARBLERS	Arctic Warbler	S*
bird	OSPREY, EAGLES AND HAWKS	Osprey	S*
bird	OSPREY, EAGLES AND HAWKS	Bald Eagle	S*
bird	OSPREY, EAGLES AND HAWKS	Northern Harrier	S*
bird	OSPREY, EAGLES AND HAWKS	Sharp-shinned Hawk	A
bird	OSPREY, EAGLES AND HAWKS	Northern Goshawk	P*
bird	OSPREY, EAGLES AND HAWKS	Swainson¹s Hawk	A
bird	OSPREY, EAGLES AND HAWKS	Red-tailed Hawk	S*
bird	OSPREY, EAGLES AND HAWKS	Rough-legged Hawk	S*
bird	OSPREY, EAGLES AND HAWKS	Golden Eagle	P*
bird	OWLS	Great Horned Owl	P*
bird	OWLS	Snowy Owl	P*
bird	OWLS	Northern Hawk Owl	P*
bird	OWLS	Great Gray Owl	P*
bird	OWLS	Short-eared Owl	S*
bird	OWLS	Boreal Owl	P*
bird	SHOREBIRDS	Black-bellied Plover	S*
bird	SHOREBIRDS	American Golden-Plover	S*
bird	SHOREBIRDS	Pacific Golden-Plover	S*

Group	Subgroup	Common Name	Habitat Notes
bird	SHOREBIRDS	Mongolian Plover	A
bird	SHOREBIRDS	Semipalmated Plover	S*
bird	SHOREBIRDS	Killdeer	A
bird	SHOREBIRDS	Common Greenshank	A
bird	SHOREBIRDS	Greater Yellowlegs	S*
bird	SHOREBIRDS	Lesser Yellowlegs	S*
bird	SHOREBIRDS	Solitary Sandpiper	S*
bird	SHOREBIRDS	Wandering Tattler	S*
bird	SHOREBIRDS	Gray-tailed Tattler	A
bird	SHOREBIRDS	Common Sandpiper	A
bird	SHOREBIRDS	Spotted Sandpiper	S*
bird	SHOREBIRDS	Terek Sandpiper	A
bird	SHOREBIRDS	Eskimo Curlew	M(X)
bird	SHOREBIRDS	Whimbrel	S*
bird	SHOREBIRDS	Bristle-thighed Curlew	S*
bird	SHOREBIRDS	Hudsonian Godwit	S*
bird	SHOREBIRDS	Bar-tailed Godwit	S*
bird	SHOREBIRDS	Marbled Godwit	A
bird	SHOREBIRDS	Ruddy Turnstone	S*
bird	SHOREBIRDS	Black Turnstone	S*
bird	SHOREBIRDS	Surfbird	S*
bird	SHOREBIRDS	Red Knot	M
bird	SHOREBIRDS	Sanderling	M
bird	SHOREBIRDS	Semipalmated Sandpiper	S*
bird	SHOREBIRDS	Western Sandpiper	S*
bird	SHOREBIRDS	Red-necked Stint	A
bird	SHOREBIRDS	Least Sandpiper	S*
bird	SHOREBIRDS	Baird's Sandpiper	S*
bird	SHOREBIRDS	Pectoral Sandpiper	S*
bird	SHOREBIRDS	Sharp-tailed Sandpiper	M
bird	SHOREBIRDS	Rock Sandpiper	C
bird	SHOREBIRDS	Dunlin	S*
bird	SHOREBIRDS	Curlew Sandpiper	A
bird	SHOREBIRDS	Buff-breasted Sandpiper	A
bird	SHOREBIRDS	Ruff	A
bird	SHOREBIRDS	Short-billed Dowitcher	S*
bird	SHOREBIRDS	Long-billed Dowitcher	S*
bird	SHOREBIRDS	Wilson’s Snipe	S*
bird	SHOREBIRDS	Wilson's Phalarope	A
bird	SHOREBIRDS	Red-necked Phalarope	S*
bird	SHOREBIRDS	Red Phalarope	S*
bird	SHRIKES	Northern Shrike	P*
bird	SPARROWS	American Tree Sparrow	S*
bird	SPARROWS	Savannah Sparrow	S*
bird	SPARROWS	Fox Sparrow	S*
bird	SPARROWS	Lincoln's Sparrow	S*
bird	SPARROWS	Harris' Sparrow	A
bird	SPARROWS	White-crowned Sparrow	S*
bird	SPARROWS	Golden-crowned Sparrow	S*
bird	SPARROWS	Dark-eyed Junco	S*
bird	SPARROWS	Lapland Longspur	S*
bird	SPARROWS	Rustic Bunting	A
bird	SPARROWS	Snow Bunting	P*

Group	Subgroup	Common Name	Habitat Notes
bird	SPARROWS	McKay's Bunting	W
bird	STARLINGS	European Starling	A
bird	SWALLOWS	Tree Swallow	S*
bird	SWALLOWS	Violet-green Swallow	S*
bird	SWALLOWS	Bank Swallow	S*
bird	SWALLOWS	Cliff Swallow	S*
bird	SWALLOWS	Barn Swallow	C*
bird	THRUSHES	Bluethroat	C*
bird	THRUSHES	Red-flanked Bluetail	A
bird	THRUSHES	Northern Wheatear	S*
bird	THRUSHES	Mountain Bluebird	A
bird	THRUSHES	Gray-cheeked Thrush	S*
bird	THRUSHES	Swainson's Thrush	S*
bird	THRUSHES	Hermit Thrush	S*
bird	THRUSHES	Eye-browed Thrush	A
bird	THRUSHES	American Robin	S*
bird	THRUSHES	Varied Thrush	S*
bird	WAGTAILS AND PIPITS	Yellow Wagtail	S*
bird	WAGTAILS AND PIPITS	White Wagtail	C*
bird	WAGTAILS AND PIPITS	Red-throated Pipit	C
bird	WAGTAILS AND PIPITS	American Pipit	S*
bird	WATERFOWL	Greater White-fronted Goose	S*
bird	WATERFOWL	Emperor Goose	S*
bird	WATERFOWL	Snow Goose	M
bird	WATERFOWL	Brant	S*
bird	WATERFOWL	Canada Goose	S*
bird	WATERFOWL	Trumpeter Swan	S*
bird	WATERFOWL	Tundra Swan	S*
bird	WATERFOWL	Gadwall	C*
bird	WATERFOWL	Eurasian Wigeon	C
bird	WATERFOWL	American Wigeon	S*
bird	WATERFOWL	Mallard	S*
bird	WATERFOWL	Blue-winged Teal A	A
bird	WATERFOWL	Northern Shoveler	S*
bird	WATERFOWL	Northern Pintail	S*
bird	WATERFOWL	Garganey	A
bird	WATERFOWL	Green-winged Teal	S*
bird	WATERFOWL	Canvasback	S*
bird	WATERFOWL	Redhead	S*
bird	WATERFOWL	Ring-necked Duck	A
bird	WATERFOWL	Greater Scaup	S*
bird	WATERFOWL	Lesser Scaup	S
bird	WATERFOWL	Steller's Eider	S*
bird	WATERFOWL	Spectacled Eider	S*
bird	WATERFOWL	Common Eider	S*
bird	WATERFOWL	King Eider	M*
bird	WATERFOWL	Harlequin Duck	S*
bird	WATERFOWL	Surf Scoter	S
bird	WATERFOWL	White-winged Scoter	S
bird	WATERFOWL	Black Scoter	S*
bird	WATERFOWL	Long-tailed Duck	S*
bird	WATERFOWL	Bufflehead\	S*
bird	WATERFOWL	Common Goldeneye	S*

Group	Subgroup	Common Name	Habitat Notes
bird	WATERFOWL	Barrow's Goldeneye	A
bird	WATERFOWL	Common Merganser	S*
bird	WATERFOWL	Red-breasted Merganser	S*
bird	WAXWINGS	Bohemian Waxwing	S*
bird	WOOD WARBLERS	Orange-crowned Warbler	S*
bird	WOOD WARBLERS	Yellow Warbler	S*
bird	WOOD WARBLERS	Magnolia Warbler	A
bird	WOOD WARBLERS	Yellow-rumped Warbler	S*
bird	WOOD WARBLERS	Palm Warbler	A
bird	WOOD WARBLERS	Blackpoll Warbler	S*
bird	WOOD WARBLERS	Northern Waterthrush	S*
bird	WOOD WARBLERS	Wilson's Warbler	S*
bird	WOODPECKERS	Red-breasted Sapsucker	A
bird	WOODPECKERS	Downy Woodpecker	P*
bird	WOODPECKERS	Hairy Woodpecker	P?
bird	WOODPECKERS	Three-toed Woodpecker	P*
bird	WOODPECKERS	Northern Flicker	A
bird	WRENS	Winter Wren	A
mammal	Bovids (goats and sheep)	Muskox	Tundra north of the mountains
mammal	Candis (foxes and wolves)	Coyote	Rare in open areas.
mammal	Candis (foxes and wolves)	Gray Wolf	All plant communities throughout the Refuge.
mammal	Candis (foxes and wolves)	Arctic Fox	Tundra north of the mountains.
mammal	Candis (foxes and wolves)	Red Fox	All plant communities throughout the Refuge
mammal	Cervids (deer)	Moose	Willow thickets and wet areas.
mammal	Cervids (deer)	Caribou	All plant communities throughout the Refuge.
mammal	Cetaceans (whales)	Beluga Whale	Coastal waters
mammal	Cetaceans (whales)	Minke Whale	Coastal waters
mammal	Cetaceans (whales)	Gray Whale	Rare in coastal waters.
mammal	Cetaceans (whales)	Bowhead Whale	Coastal waters
mammal	Cetaceans (whales)	Killer Whale	Coastal waters
mammal	Chiroptera (bats)	Little Brown Bat	Along watercourses and in open forests at dusk and night. In caves, hollow trees, or buildings
mammal	Fields (cats)	Lynx	Forests throughout the Refuge.
mammal	Insectivores (shrews)	Masked (*Common*) Shrew	Moist tundra, bogs, and forests.
mammal	Insectivores (shrews)	Tundra Shrew	Wet or dry tundra.
mammal	Insectivores (shrews)	Dusky Shrew	Wet meadows and moist, shaded areas.

Group	Subgroup	Common Name	Habitat Notes
mammal	Lagomorphs (hares and rabbits)	Collared Pika	Rock piles and talus slopes, usually at higher elevations. This species is believed to occur on the refuge in the Kuskokwim Mountains.
mammal	Lagomorphs (hares and rabbits)	Snowshoe Hare	Forests, shrub thickets, and brushy areas.
mammal	Lagomorphs (hares and rabbits)	Tundra Hare	Brushy tundra areas
mammal	Mustelids (weasels)	Marten	Spruce forests.
mammal	Mustelids (weasels)	Short-tailed Weasel	Open forests and tundra.
mammal	Mustelids (weasels)	Least Weasel	Open, wet areas.
mammal	Mustelids (weasels)	Mink	Near wet areas south of the mountains
mammal	Mustelids (weasels)	Wolverine	Forests and tundra.
mammal	Mustelids (weasels)	Canadian (River) Otter	Rivers and lakes mainly south of the mountains.
mammal	Pinnipeds (seals, sea lions, and walrus)	Walrus	Rare along the coast
mammal	Pinnipeds (seals, sea lions, and walrus)	Spotted Seal	Coastal waters and on drifting ice
mammal	Pinnipeds (seals, sea lions, and walrus)	Harbor Seal	Coastal waters and on drifting ice
mammal	Pinnipeds (seals, sea lions, and walrus)	Ringed Seal	Ice along the coast
mammal	Pinnipeds (seals, sea lions, and walrus)	Bearded Seal	Coastal waters and on drifting ice
mammal	Pinnipeds (seals, sea lions, and walrus)	Ribbon Seal	Coastal waters and on drifting ice
mammal	Pinnipeds (seals, sea lions, and walrus)	Northern Fur Seal	Coastal waters and on drifting ice
mammal	Pinnipeds (seals, sea lions, and walrus)	Steller's Sea Lion	Coastal waters and on drifting ice
mammal	Rodents (squirrels, mice, porcupines, etc.)	Hoary Marmot	Rocky, mountainous areas.
mammal	Rodents (squirrels, mice, porcupines, etc.)	Arctic Ground Squirrel	Dry, sandy, and rocky areas
mammal	Rodents (squirrels, mice, porcupines, etc.)	Red Squirrel	Spruce forests
mammal	Rodents (squirrels, mice, porcupines, etc.)	Muskrat	Ponds and marshes.
mammal	Rodents (squirrels, mice, porcupines, etc.)	Beaver	Streams with woody vegetation.
mammal	Rodents (squirrels, mice, porcupines, etc.)	Meadow Vole	Grassy meadows and open forests.
mammal	Rodents (squirrels, mice, porcupines, etc.)	Tundra Vole	Tundra, grassy, or moist sedge areas.
mammal	Rodents (squirrels, mice, porcupines, etc.)	Northern Red-backed Vole	Moist soils in both tundra and forest areas.

Group	Subgroup	Common Name	Habitat Notes
mammal	Rodents (squirrels, mice, porcupines, etc.)	Brown Lemming	Wet tundra areas.
mammal	Rodents (squirrels, mice, porcupines, etc.)	Northern Bog Lemming	Wet tundra and sphagnum bogs, also in moist meadows.
mammal	Rodents (squirrels, mice, porcupines, etc.)	Collared Lemming	Sedge tundra
mammal	Rodents (squirrels, mice, porcupines, etc.)	Meadow Jumping Mouse	Moist meadows and open forests.
mammal	Rodents (squirrels, mice, porcupines, etc.)	Porcupine	Forests, shrub thickets, and tundra
mammal	Ursids (bears)	Black Bear	Forests throughout the Refuge.
mammal	Ursids (bears)	Brown Bear	Open areas throughout the Refuge
mammal	Ursids (bears)	Polar Bear	Along the coast and on ocean ice.

Notes
Lists were accessed on website on December 20, 2010. Lists were last updated by USFW
http://yukondelta.fws.gov/wildlife.htm
P - permanent resident
S - summer resident
W - winter resident
M - migrant (species that occur on the refuge only as migrants en route to other destinatio
C - casual (species that have been reported 5 or more times, but are not expected on an a
A - accidental (species which have been reported fewer than 5 times on the refuge).
X - extinct (no longer occurs on the refuge)
* Known to have bred in the past and/or currently br

Technical Memorandum: Addendum to Ecological Risk Assessment for the Proposed Donlin Pit Lake, ERM, August 31, 2015.

Memorandum

Environmental
Resources
Management

555 17th Street
Suite 1700
Denver, Colorado 80202
(303) 741-5050
(303) 773-2624 (fax)
www.erm.com

To: Nick Enos

From: Penny Hunter

Date: August 31, 2015

Subject: Addendum to Ecological Risk Assessment for the Proposed Donlin Pit Lake, for the Revised Water Management Advanced Water Treatment

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Donlin Gold LLC (Donlin Gold) has proposed the development of an open pit, hardrock gold mine (Project) located 277 miles (mi) (446 kilometers [km]) west of Anchorage, 145 mi (233 km) northeast of Bethel, and 10 mi (16 km) north of the village of Crooked Creek. The mine closure plan for the open pit includes the formation of a pit lake. In 2013, ARCADIS conducted an Ecological Risk Assessment (ERA) for the proposed pit lake (ARCADIS 2013; henceforth referred to as the "2013 ERA"). The 2013 ERA relied upon predicted surface water quality for the proposed pit lake (Lorax 2012). In 2015, Donlin Gold evaluated a water management scenario for the treatment and discharge of excess water. This scenario is referred as Advanced Water Treatment (AWT). As a consequence of the AWT, the surface water quality predictions were revised (Lorax 2015). The updated surface water quality predictions for year 99 shows that two additional constituents, aluminum and copper, are predicted to occur in concentrations above ecological water quality criteria. These constituents were not addressed in the 2013 ERA. Other constituent concentration changes were small enough that the updated values would not affect the conclusions of the 2013 ERA for these constituents, which showed no risk to wildlife. The purpose of this memorandum is to provide an addendum to the 2013 ERA with an analysis of the potential risk to wildlife from exposure to aluminum and copper constituents in the proposed pit lake at year 99.

Methods

This ERA analysis tiered off of the 2013 ERA for the proposed pit lake. The approach, steps of the ERA, and many of the input parameters that are provided in detail in the 2013 ERA were retained for this analysis. The following summarizes the approach and inputs used for this ERA analysis:

- All applicable guidance and ERA protocols as described in detail in the 2013 ERA were followed in this ERA.

- The conceptual site model described in the 2013 ERA for the proposed mature pit lake was used for this analysis, including assumptions about predicted habitats, bioaccumulation pathways, and wildlife frequency of exposure.

- The assessment endpoints, measurement endpoints, and analysis plan were retained in this ERA.

- Receptors evaluated in this ERA continued to include:

    - Black bear
    - Gray wolf
    - Mink
    - Snowshoe hare
    - Tundra vole
    - American dipper
    - Dark-eyed junco
    - Mallard duck
    - Northern shrike

- All of the ecological profile characteristics of these receptors (e.g., body weights, ingestion rates), as shown in Tables 2-11 through Table 2-19 of the 2013 ERA, were retained in this analysis. The water ingestion rate for the tundra vole was corrected to 0.0042 L/day per note provided in a technical memorandum by ERM on May 28, 2015.

- Constituents of potential concern (COPCs) evaluated in this ERA analysis included aluminum and copper. Media concentrations and bioaccumulation factors for these constituents are summarized in Table 1. Sediment data collected throughout the watershed (ARCADIS 2008) was used to represent the approximate sediment concentrations nearest the surface of the pit lake. Bioaccumulation factors for were determined from the same sources of data as presented in the 2013 ERA.

Table 1
Exposure Point Concentrations and Bioaccumulation Factors for Aluminum and Copper

Donlin Gold LLC
Crooked Creek, Alaska
Pit Lake Ecological Risk Assessment Update

Factor:	Aluminum		Copper	
	value	citation	value	citation
Surface Water (mg/L)	1.57	1	0.0105	1
Sediment (mg/kg)	14867	2	16.3	2
BAF: Sediment to Aquatic Invertebrate	0.014	3	2.80	3
BAF: Sediment to Aquatic Plant	0.036	3	0.319	3

Notes:
1 Lorax Environmental (2015)
2 ARCADIS (2008)
3 Average of BAFs provided in PTI (1996) and EVS (1998)

- The same dose equation used in the 2013 ERA (equation 1) was used for this ERA analysis.

- Toxicity reference values (TRVs) were derived for aluminum and copper following the same approach as was described in the 2013 ERA. For each receptor-COPC combination, a no adverse effect level (NOAEL) and a low adverse effect level (LOAEL) TRV was derived to characterize the potential range of effects. TRVs are receptor and constituent specific. The TRVs used in this ERA are shown in Table 2.

Table 2
Toxicity Reference Values for Aluminum and Copper

Donlin Gold LLC
Crooked Creek, Alaska
Pit Lake Ecological Risk Assessment Update

Receptor	TRV_{NOAEL}				TRV_{LOAEL}			
	Aluminum		Copper		Aluminum		Copper	
	value	citation	value	citation	value	citation	value	citation
American Dipper	210	1	5.55	4	1052	1	7.2	4
Dark-eyed Junco	1037	2	5.55	4	10367	2	7.2	4
Northern Shrike	1037	2	5.55	4	10367	2	7.2	4
Mallard Duck	210	1	22.21	4	1052	1	28.7	4
Snowshoe Hare	18.3	3	0.59	5	91.6	3	2.1	5
Black Bear	18.3	3	5.24	6	91.6	3	7.6	6
Mink	18.3	3	17.70	6	91.6	3	25.7	6
Tundra Vole	18.3	3	37.59	6	91.6	3	54.6	6
Gray Wolf	18.3	3	6.82	6	91.6	3	9.9	6

Notes:
Units in mg/kg-bw day
TRV_{NOAEL} = lower bound TRV, corresponding to the no adverse effects level (NOAEL)
TRV_{LOAEL} = upper bound TRV, corresponding to the low adverse effects level (LOAEL)
1 Capdevielle and Scanes 1995
2 Miles et al. 1993
3 Golub et al. 1985
4 Jackson and Stevenson 1981
5 Engle and Spears 2000
6 Aulerich et al. 1982

- Risk characterization methods described in the 2013 ERA were used for this ERA. For each receptor-COPC combination, upper and lower bound hazard quotients (HQs) were calculated to estimate the likelihood of ecological risk. The HQ calculations are not measures of risk; they serve as a "cautionary signal" that potential hazards are present and are indicators of whether further evaluation or natural resource management could be needed. An HQ is the ratio of the exposure concentration to the effects concentration. A lower-bound and an upper-bound HQ were calculated to characterize the potential range of effects.

Results and Discussion

HQs for each receptor-COPC combination are provided in Table 3. All upper bound HQs (i.e., LOAEL-HQs) are less than 1, indicating no adverse effects to wildlife receptors are predicted. Two lower bound HQs (NOAEL-HQs) were slightly greater than 1 for the mallard duck and tundra vole risk characterization of aluminum, indicating some uncertainty exists in no effect predictions for these receptors' exposure to aluminum. Upper bound HQs were less than 1 for these receptors, however, indicating no prediction of adverse risk to mallards or voles. The ERA was designed to be a conservative prediction of potential risk; as such, many assumptions were built into the ERA that assume greater exposure of wildlife receptors than are likely to be the case. The reason for incorporating conservative assumptions is to increase confidence that the risk predictions are not underpredicting risk to wildlife. Even with the inherently conservative predictions, upper bound HQs are all less than 1, and lower bound HQs were only slightly greater than 1. Thus, the potential risk to wildlife from exposure to aluminum and copper concentrations in the proposed pit lake is regarded as low.

Table 3
Aluminum and Copper Hazard Quotients for Wildlife

Donlin Gold LLC
Crooked Creek, Alaska
Pit Lake Ecological Risk Assessment Update

NOAEL-HQ	American Dipper	Mallard Duck	Northern Shrike	Dark-eyed Junco	Snowshoe Hare	Black Bear	Mink	Tundra vole	Gray Wolf
Aluminum	4.4E-01	**1.1E+00**	4.6E-02	3.1E-04	8.1E-02	5.2E-03	8.6E-01	**3.9E+00**	5.8E-03
Copper	5.8E-01	9.8E-02	9.7E-03	3.9E-04	1.7E-02	1.2E-04	1.6E-02	5.6E-03	1.0E-04

LOAEL -HQ	American Dipper	Mallard Duck	Northern Shrike	Dark-eyed Junco	Snowshoe Hare	Black Bear	Mink	Tundra vole	Gray Wolf
Aluminum	8.7E-02	2.3E-01	4.6E-03	3.1E-05	1.6E-02	1.0E-03	1.7E-01	7.9E-01	1.2E-03
Copper	4.4E-01	7.6E-02	7.5E-03	3.0E-04	4.7E-03	8.4E-05	1.1E-02	3.9E-03	7.2E-05

Notes:
Bolded Values indicate HQ >1

References

ARCADIS. 2008. DRAFT - Mercury / Metals Sediment 2008 Report. Donlin Creek Project, Alaska.

ARCADIS. 2013. Ecological Risk Assessment for the Proposed Donlin Pit Lake. January 27.

Aulerich, R.J., R.K. Ringer and J. Iwamoto. 1974. Effects of dietary mercury on mink. Archives of Environmental Toxicology 2:43-51.

Capdeville, M.C. and C.G. Scanes. 1995. Effect of dietary acid or aluminum on growth and growth-related hormones in mallard ducklings (Anas platyrhynchos). Archives of Environmental Contamination and Toxicology 29(4):462-468.

Engle, T.E. and J.W. Spears. 2000. Effects of dietary copper concentration and source on performance and copper status of growing and finishing steers. J. Anim. Sci. 78:2446-2451.

EVS. 1998. South Pipeline project ecological risk assessment for pit lake. Prepared for the US Bureau of Land Management. Seattle: EVS Environmental Consultants.

Golub, M.S., S.R. Negri, C.L. Keen, and M.E. Gershwin. 1985. Developmental toxicity of chronic oral aluminum exposure in mice. Teratology 31(3): 64A.

Jackson, N. and Stevenson, M. H. 1981. identification of the component responsible for the effects of added dietary copper sulphate in the female domestic fowl. J Sci Food Agric. 32(11): 1047-56.

Lorax Environmental (Lorax). 2012. Pit Lake Modeling Assessment in Support of Project Permitting. Final Report, October.

Lorax. 2015. Pit Lake Modeling of Revised Water Management Advanced Water Treatment Option for Donlin Gold. Technical Memorandum, issued August 11.

Mills, C.F. and A.C. Dalgarno. 1972. Copper and zinc status of ewes and lambs receiving increased dietary concentrations of cadmium. Nature 239:171-173.

PTI. 1996. Chemical Composition, Limnology, and Ecology of Three Existing Nevada Mine Pit Lakes. Interim Report. April 1996.

Ecological Risk Assessment for the Proposed Future ACMA Pit Lake, Critique and Additional Information by AECOM, 2015 (performed on Arcadis 2013 Ecological Risk Assessment).

Ecological Risk Assessment for the Proposed Future ACMA Pit Lake (Arcadis 2013)

Critique and additional information by Tom Campbell, Leader-Denver Risk Assessment Team, AECOM

The following is a critique of the ecological risk assessment (ERA) prepared by Arcadis U.S. Inc. (Arcadis) for Donlin Gold LLC (Arcadis 2013) that considers the methods used, more recent water quality estimates, and other relevant information.

The ERA prepared by Arcadis for Donlin Gold LLC evaluated the potential for risk to terrestrial ecological receptors exposed to water accumulated in the open pit after mining is completed when water will be allowed to accumulate in the open pit. The ERA evaluated potential risk for two stages: filling stage of the open pit lake (years 2-52) and after the pit is filled to capacity (the mature stage [year 53]). The ERA did not evaluate potential risk to ecological receptors (terrestrial or aquatic) from exposure to the operational water bodies described as the tailings storage facility (TSF) or the two contact water dam ponds (CWDs).

The ERA for the open pit lake followed Alaska Department of Environmental Conservation (ADEC 2010, 2011) and U.S. Environmental Protection Agency (USEPA 1998) format for ERAs and included three stages: problem formulation, analysis, and risk characterization. The ERA was conservative in the assumptions used where data were not available.

In the problem formulation phase of the ERA, chemicals of potential concern (COPCs) were selected by comparing modeled concentrations of surface water (Base Case) from Lorax (2012) against chronic water quality criteria from ADEC (2008), USEPA (2013a), or other sources. Although mixing of waters in the open pit lake and resulting higher concentrations is possible, it is unknown how frequently that may happen. Hardness-dependent criteria from ADEC (2008) were based on a default hardness of 50 milligrams per liter (mg/L) as $CaCO_3$, and criteria from USEPA were based on default hardness of 100 mg/L as $CaCO_3$. If the modeled concentration for either stage of the open pit lake (i.e., filling or mature stage) exceeded its criterion, it was identified as a COPC. Ten metals were identified as COPCs for the filling stage of the pit, and three metals were identified for the mature stage.

Based on an estimated (not default) pit lake water hardness of 65 mg/L as $CaCO_3$ and pH (<7.0) and on the priority list of criteria prescribed in the ERA, the selection of COPCs was in error regarding aluminum and cadmium. In the ERA, aluminum was not retained for either stage, and cadmium was retained for the filling stage. However, based on the modeled concentration for pH, aluminum should be retained for both the filling and mature stages (0.57 and 0.31 mg/L, respectively) because the criterion of 0.087 mg/L applies to waters with a pH of <7.0. Conversely, the modeled concentrations of cadmium (0.00075 mg/L in filling stage and 0.00024 mg/L in mature stage) do not exceed the Alaska criterion for livestock watering (0.010 mg/L), and therefore, should not be included as a COPC for the filling stage (or the mature stage).

While the use of the ADEC water quality criterion for livestock watering criteria appears appropriate, the use of water quality criteria from ADEC (2008) or USEPA (2013a) that are intended to protect aquatic organisms is inconsistent with the objective of the ERA to assess potential risk to terrestrial biota. As an alternative to the use of Alaska or federal chronic water quality criteria for screening, it may be more appropriate to use no-effect ecological screening levels (ESLs) from Los Alamos National Laboratories (LANL 2012) that have been calculated for exposure of birds and mammals exposed to metals exclusively through ingestion of water.

Based on comparisons of projected water concentrations to the lowest no-effect water-only ESLs from LANL (0.56 mg/L for arsenic), only arsenic, at an estimated concentration of 1.196 mg/L, should be retained as a COPC in the ERA for the filling stage of the open pit, while no metals should be retained for the mature stage. No hazard quotients (HQs) for arsenic in the filling stage exceeded 1.0 as seen in Table 5-1 of Arcadis (2013), indicating no risk to birds exposed to arsenic in water. This absence of risk to birds during the fill stage is confirmed by the non-exceedance of the lowest low-effect water-only ESL for arsenic from LANL (5.60 mg/L). No other metals have NOAEL- or LOAEL-based HQs greater than 1.0 for the filling stage of the pit lake.

In the ERA prepared by Arcadis, an assumption was made that wildlife ingest water in the open pit lake 100% of the time. This assumption resulted in an area use factor (AUF) of 1.0. In other words, it was assumed that wildlife are exposed to the open pit lake every day for their entire life – they live their entire lifetime near the open pit and drink water only from the open pit lake. This assumption of 100% exposure is overly conservative in view of several factors, including (among others):

- Migratory patterns of wildlife,
- Poor habitat of very steep rock adjacent to the pit lake,
- No forage (food) along the margins of the pit lake, and
- Many other natural water bodies in the vicinity of the pit lake.

A more reasonable, yet conservative, AUF for the open pit lake may be in the range of 5 to 10% based on waterfowl migration information compiled by Owl Ridge Natural Resource Consultants (2014). In this review of migration patterns, waterfowl would be expected in the area of the proposed Donlin mine fewer than 7 days in the spring and in the fall. Other wildlife used in the ERA also would be subject to migration patterns and could use other sources of water. An AUF of 10% would reduce all of the calculated HQs for the identified COPCs and wildlife receptors in Table 5-2 of Arcadis (2013) by an order of magnitude to become less than 1.0 – indicative of no risk to wildlife. For example, the highest HQ in Table 5-2 is 8.4 for the tundra vole exposed to arsenic. This would be reduced to an HQ of 0.84 using an AUF of 10%. With all HQs (NOAEL- and LOAEL-based) less than 1.0, no risk from metals is expected to the birds and mammals assumed to be exposed to surface water in the mature stage pit lake.

Additionally, as described above, no metals have HQs greater than 1.0 for the filling stage of the pit lake.

Another conservative assumption in the ERA is bioavailability of 100% for all metals in ingested water, sediment, and food. The bioavailability of metals in soil vary with soil conditions (e.g., pH, Eh, and organic content of the soil), and are typically less than 100 percent (USEPA 2001, 2013b; Gustafsson et al. 2003). Also, as described in Arcadis (2013), once absorbed by a prey organism many metals are sequestered into nonbioavailable forms in the prey tissues.

In summary, the ERA prepared by Arcadis for Donlin Gold (Arcadis 2013) for the proposed future pit lake relied on overly conservative assumptions that are not representative of exposure conditions expected in the open pit lake. In Table 5-1 of the ERA (filling stage of the pit lake), no HQs are greater than 1.0, and in Table 5-2 (mature stage of the pit lake), practically all of the HQs are less than 1.0, even with use of the conservative assumptions described above. If more representative assumptions were used in the ERA, none of the HQs shown in Table 5-2 would be greater than 1.0 for the mature stage pit lake. As a result, no wildlife are expected to be at risk from ingestion of water during the filling stage of the pit lake or from ingestion of surface water, sediment, and food from the mature pit lake following filling.

References:

Alaska Department of Environmental Conservation (ADEC). 2008. Alaska Water Quality Criteria Manual for Toxic and Other Deleterious Organic and Inorganic Substances. As amended through December 12, 2008 (most recent as of May 2014).

ADEC. 2010. Risk Assessment Procedures Manual. Division of Spill Prevention and Response, Contaminated Sites Program. In: Arcadis (2013).

ADEC. 2011. Draft Risk Assessment Procedures manual. Updated and Recommended for Use. Division of Spill prevention and Response, Contaminated Sites Program. November. In: Arcadis (2013).

Arcadis U.S., Inc. (Arcadis). 2013. *Ecological Risk Assessment for the Proposed Future ACMA Pit Lake.* Prepared for Donlin Gold, LLC. January 15.

Gustafsson, J.P., P. Pechova, and D. Berggren. 2003. Modeling metal binding to soils: the role of natural organic matter. Environ. Sci. Technol. 37: 2767-2774.

Lorax Environmental (Lorax). 2012. Pit Lake Modeling Assessment in Support of Project Permitting. Final Report. October.

Los Alamos National Laboratory (LANL). 2012. Ecorisk Database (Release 3.1a): LA-UR-12-24548. Los Alamos, NM. Accessed at: http://www.lanl.gov/community-environment/environmental-stewardship/protection/eco-risk-assessment.php. October.

Owl Ridge Natural Resource Consultants. 2014. Waterfowl Seasonal Use Patterns in the Vicinity of the Donlin Gold Project, Alaska. Letter report prepared by G. Green (Principal Ecologist, Owl Ridge) for Donlin Gold. April 15.

U.S. Environmental Protection Agency (USEPA). 1998. *Guidelines for Ecological Risk Assessment.* Federal Register Vol. 63, No. 93. May 14.

USEPA. 2001. *The Role of Screening-Level Risk Assessments and Refining Contaminants of Concern in Baseline Ecological Risk Assessments*. ECO Update. Intermittent Bulletin. Office of Solid Waste and Emergency Response. EPA 540/F-01/014. June.

USEPA. 2013a. National Recommended Water Quality Criteria. Accessed at: http://water.epa.gov/scitech/swguidance/standards/criteria/current/index.cfm. Latest update: August 2013.

USEPA. 2013b. Bioavailability. Region 8 Recommendations for Quantifying the Bioavailability of Lead and Arsenic in Soil for Use in Human Health risk Assessments. Accessed at: http://www.epa.gov/region8/r8risk/hh_rba.html. Latest update: January 27, 2013.