# APPENDIX Q

## Essential Fish Habitat Assessment

- National Marine Fisheries Service conservation recommendation letter dated November 2, 2017.
- National Oceanic and Atmospheric Administration Essential Fish Habitat Assessment, V2.4, June 2017.

This page intentionally left blank.

**UNITED STATES DEPARTMENT OF COMMERCE**
**National Oceanic Atmospheric Administration**
*National Marine Fisheries Service*
*P.O. Box 21668*
*Juneau, Alaska 99802-1668*

November 2, 2017

Colonel Michael S. Brooks
U.S. Army Corps of Engineers
P.O. Box 6898
JBER, Alaska, 99506-0898

Re: POA-1995-120, Donlin Gold Project

Dear Colonel Brooks:

Section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) requires Federal agencies to consult with National Marine Fisheries Service (NMFS) on any action authorized, funded, or undertaken which may adversely affect Essential Fish Habitat (EFH). The EFH consultation process begins with a determination of adverse effect[1] by the action agency. If an action may adversely effect EFH, an EFH Assessment is required per 50 CFR 600.920(e).

NMFS has reviewed the EFH Assessment, dated September 26th, 2017, prepared the U.S. Army Corps of Engineers (ACOE) regarding the proposed Donlin Gold Project. The submission of an EFH assessment asserts the ACOE permitted action(s) may have adverse effects on EFH. Based on the cover letter submitted with the EFH Assessment, the ACOE determined the overall project will have short term and long term effects; overall activities are unlikely to have adverse effects on EFH; and any adverse effects on EFH will be minimal. Further, the mine facilities and the port at Jungjuk Point will not have any adverse effects on EFH.

**Project Description**

The proposed project footprint includes the open pit mine, processing plant, and waste rock and tailings storage facilities. The ACOE estimates the project footprint is approximately 16,300 acres. Supporting infrastructure includes 315-mile natural gas pipeline extending from Cook Inlet to the mine site, a port facility for service barges, approximately 30-miles of access roads, and several gravel mine sites to support construction.

The excavated mine pit will measure approximately 2.2 miles long, 1 mile wide, and 1,850 feet deep. The tailings storage facility will be constructed in the Anaconda Creek drainage and is estimated to cover 2,350 acres. This facility will have a capacity to store 568 million tons of tailing waste behind a 464 foot high earthen dam. A separate waste rock and overburden facility will also cover approximately 2,240 acres and hold an additional 2.46 billion tons of waste rock.

[1] Adverse effect is any impact that reduces quality and/or quantity of EFH. Adverse effects may include direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality and/or quantity of EFH. Adverse effects to EFH can result from actions occurring within or outside EFH, be site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810 (a)).

**General Comments**
NMFS is concerned the project, as proposed, may adversely affect EFH designated for salmon stocks managed under the Fishery Management Plan for the Salmon Fisheries in the EEZ Off Alaska, promulgated under the MSA.

However, based upon our meeting with the ACOE and applicants on January 18, 2017, and in review of the EFH assessment, NMFS concludes the EFH Assessment does not fully represent the scale and scope of the proposed project. Further, the EFH Assessment does not adequately represent the cumulative potential impacts to EFH supporting anadromous salmon during their freshwater phases. NMFS references the Draft Environmental Impact Statement (DEIS, ACOE 2015) and associated technical comments regarding the hydrological modeling provided by the cooperating Federal agencies, which substantiate NMFS's concerns.

NMFS recognizes Crooked Creek will not be directly mined. However, the continuous need to dewater the mine pit will impact Crooked Creek due to its close proximity. Additional information provided in the DEIS further indicates:

> *Mine pit dewatering (at a maximum planned groundwater pumping rate of 2,600 gpm) would create up to 1,600 feet of drawdown in the local groundwater flow system. The areal extent of the cone of depression would be 9,000 acres during operations and 2,000 acres during post-closure.*
>
> *After mine closure, modeling shows that the pit lake would continue to be a destination for groundwater flow, and that Crooked Creek would continue to lose water to the groundwater system flowing to the pit because of ongoing pumping and treating of lake water to keep water levels below surrounding water levels.*

Simply described, the worst case scenario of a 40 to 100 percent drawdown of Crooked Creek, regardless of the season, will have cumulative adverse effects to upstream and downstream flows and water levels. Significant decreases to instream flows will not adequately provide suitable water levels and temperatures for egg survival, growth to maturity, or allow passage of anadromous salmon to the upstream reaches of Crooked Creek and Donlin Creek. As stated in the DEIS and technical comments, increased reductions of water from tributary inflows and decreases in annual precipitation could lead to 45 to 100 percent reduction in Crooked Creek instream flows in the area near the mine site.

Water quality and quantity are fundamental EFH attributes supporting sustainable anadromous salmon in the surrounding watersheds. NMFS is concerned fresh water EFH and associated life stages of anadromous salmon found in the upper reaches of Crooked Creek and Donlin Creek, will not be conserved or protected from mining activities, such as dewatering ground and surface water regimes or reducing instream flows needed to support anadromous salmon.

If adult salmon gain access to the upper reaches of the watershed (Crooked Creek and Donlin Creek) to spawn, it is highly probable they emerged as fry from those gravel substrates. Their ability to emigrate as fry or immigrate as adults (freshwater phases) is dependent upon fish passage provided by adequate instream flows. In watersheds that historically support anadromous salmon, the species is present year round in some life stage (egg, larval, juvenile or spawning adults). Salmon larvae's ability to survive freezing over-winter conditions to emerge as fry in the spring is a direct result of adequate water levels and temperatures flowing through gravel substrates in the hyporheic zone (Casas-Mulet 2015, Cunjak and Power 1986, Cunjak 1988, 1996). The inter-dependent relationship between ground and surface water regimes supporting instream flows and salmon embryo survival and condition is well documented (Sophocleous 2002, Malcolm et al. 2003, 2004, 2005 and 2009).

**EFH Conservation Recommendations**

NMFS recommends pursuant to Section 305(b)(4)(A) of the MSA that the ACOE adopt the following EFH Conservation Recommendations for any permit issued for this project:

1. The ACOE and project proponents should address inadequacies and deficiencies identified by the cooperating agencies in the current ground water (hydrological) models (2015 Public Comments).
2. Implement measures to predict, regulate, and provide adequate instream flows of Crooked Creek to allow adequate water conditions to support migratory corridors, maintain fish passage, and provide salmon survival at all freshwater life stages in the upper reaches of Crooked Creek and Donlin Creek. The ACOE should continue to work with the State of Alaska, U.S. Fish and Wildlife Service, and Donlin Gold to establish these flow levels.
3. Design and install structures to supplement or reduce the loss of water flow underneath the reaches of Crooked Creek that are susceptible to dewatering, such as to employ technologies to limit loss of instream flows and surface waters to the influence of groundwater draw down.
4. Monitor the project, post-closure mine pit, tailings impoundments, waste rock facilities, and associated ground and surface waters in perpetuity.

Section 305(b)(4)(B) of the MSA requires the ACOE to provide NMFS with a detailed written response to these EFH Conservation Recommendations, including a description of measures adopted for avoiding, mitigating, or offsetting the impact of the project on EFH. In the case of a response that is inconsistent with NMFS' recommendations, the ACOE must explain its reasons for not following the recommendations, including the scientific justification for any disagreements with NMFS over the anticipated effects of the proposed action and the measures needed to avoid, minimize, mitigate, or offset such effects (50 CFR 600.920(j)).

If you have any questions regarding our EFH conservation recommendations for this project, please contact Doug Limpinsel or Matthew P. Eagleton of my staff, (907)271-5153.

Sincerely,

for James W. Balsiger, Ph.D.
Administrator, Alaska Region

Cc: Darden, Richard L CIV USARMY CEPOA (US) Richard.L.Darden@usace.army.mil
Kennedy, Timothy A CIV USARMY USACE (US) Timm.A.Kennedy@usace.army.mil

**Citations**


Casas-Mulet, R., Alfredsen, K., Brabrand, Å. and Saltveit, S.J., 2015. Survival of eggs of Atlantic salmon (Salmo salar) in a drawdown zone of a regulated river influenced by groundwater. Hydrobiologia, 743(1), pp.269-284.

Cunjak, R. A. and G. Power. 1986. Winter habitat utilization by stream resident brook trout (Salvelinus fontinalis) and brown trout (Salmo trutta). Canadian Journal of Fisheries and Aquatic Sciences 43:1970-1981.

Cunjak, R. A. 1988. Behavior and microhabitat of young Atlantic salmon (*Salmo salar*) during winter. Canadian Journal of Fisheries and Aquatic Sciences **45**:2156-2160.

Cunjak, R. A. 1996. Winter habitat of selected stream fishes and potential impacts from land-use activity. Canadian Journal of Fisheries and Aquatic Sciences 53:267-282.Donlin Gold Project

Malcolm, I. A., A. F. Youngson & C. Soulsby, 2003. Survival of salmonid eggs in a degraded gravel-bed stream: effects of groundwater–surface water interactions. River Research and Applications 19: 303–316.

Malcolm, I. A., C. Soulsby, A. F. Youngson, D. M. Hannah, I. S. McLaren, and A. Thorne. 2004. Hydrological influences on hyporheic water quality: implications for salmon egg survival. Hydrological Processes 18:1543-1560.

Malcolm, I. A., C. Soulsby, A. F. Youngson, and D. M. Hannah. 2005. Catchment-scale controls on groundwater–surface water interactions in the hyporheic zone: implications for salmon embryo survival. River Research and Applications 21:977-989.

Malcolm, I. A., C. Soulsby, A. F. Youngson&D. Tetzlaff, 2009. Fine scale variability of hyporheic hydrochemistry in salmon spawning gravels with contrasting groundwater–surface water interactions. Hydrogeology Journal 17: 161–173.

Sophocleous, M. 2002. Interactions between groundwater and surface water: the state of the science. Hydrogeology Journal 10:52-67.

U.S. Army Corps of Engineers (ACOE). 2015. Donlin Gold Project Draft Environmental Impact Statement. U.S. Army Corps of Engineers, Alaska District, JBER, AK, 99506-0898. November 2015. Available at http://www.donlingoldeis.com/EISDocuments.aspx

U.S. Army Corps of Engineers (ACOE). 2015. Donlin Gold Project Draft Environmental Impact Statement. Public Comments. U.S. Army Corps of Engineers, Alaska District, JBER, AK, 99506-0898. Available at http://www.donlingoldeis.com/PublicComment.aspx

# Essential Fish Habitat Assessment

## Donlin Gold Project
## Draft Version 2.4

**June 2017**

**Prepared for:**

Donlin Gold LLC
4720 Business Park Blvd., Suite G-25
Anchorage, AK 99503

**Prepared by:**

Owl Ridge Natural Resource Consultants, Inc.
6407 Brayton Drive, Suite 204
Anchorage, Alaska 99507
T: 907.344.3448
F: 907.344.3445
www.owlridgenrc.com

- Page Intentionally Left Blank -

# TABLE OF CONTENTS

## List of Tables



## List of Figures

# EXECUTIVE SUMMARY

Donlin Gold LLC (Donlin Gold) submitted a preliminary application for a federal permit pursuant to Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act to the United States Army Corps of Engineers to develop an open pit, hardrock gold mine approximately 10 miles (mi) 16 kilometers (km) north of the village of Crooked Creek, in western Alaska. The proposed Donlin Gold Project (Project) has three primary components: 1) mine site facilities, 2) a 315-mi (507-km) natural gas pipeline, and 3) transportation infrastructure. These three components define the Project Area that potentially affect Essential Fish Habitat (EFH) for the species regulated under a federal Fishery Management Plan (FMP). This document presents the findings of an EFH Assessment of the proposed Project and is intended to support EFH consultation under the Magnuson-Stevens Fishery Conservation and Management Act (MSA) of 1996.

The proposed Project would affect aquatic habitats that support different species and life stages of salmon, as summarized by Project component below:

1. Streams near the proposed mine site support spawning by Chinook, coho, and chum salmon and rearing by juvenile Chinook and coho salmon. Adult pink salmon and sockeye salmon can be present in low numbers. Site-specific Project effects to EFH and EFH species from mine facilities are judged to range from low to moderate, with an overall low level of effect to EFH and EFH species in the drainage. Impacts are expected to range from negligible to low in Crooked Creek mainstem habitats. EFH upstream from the proposed mine site (primarily in Donlin Creek) and downstream from the proposed mine site (in two major salmon tributaries downstream), would be unaffected. Crooked Creek mainstem habitats adjacent to the mine site and downstream would be adversely affected, primarily by reduced flow and associated increased sedimentation. A low level overall effect to EFH is anticipated in this reach of Crooked Creek, with most reductions in habitat occurring adjacent to the mine site. Localized moderate impacts are associated with loss of Chinook and coho rearing habitat through direct loss of two creeks and the effects of reduced flow in Crooked Creek. Rearing stages of these two species are present in low densities in streams that will be affected by Project activities. Coho spawning habitat will likely be reduced in Crooked Creek adjacent to the mine area because of the estimated stream flow reductions; however, spawning in this reach is low.

2. The natural gas pipeline will cross numerous streams containing habitat used by the five species of Pacific salmon (Chinook, chum, coho, pink, and sockeye). Potential effects of the natural gas pipeline on EFH species are judged to be low, because most construction will be conducted during winter when salmon are not present. The few streams requiring summer construction will employ best management practices (BMPs) that reduce and mitigate disturbance to streambeds; or will be crossed using horizontal directional drilling (HDD) under the stream channel.

3. Transportation infrastructure will include a port on the Kuskokwim River and a road connecting the Port to the mine facilities. Transportation operations will include increased barge activity along

the Kuskokwim River, barge-handling activities at the Port, and truck traffic from the Port to the mine facilities. The mine access road will cross six streams used by Chinook, coho and/or chum salmon, although crossings of Jungjuk Creek occur at least 1.6 mi (2.6 km) upstream from documented EFH. Five streams will be crossed with full span steel arch bridge structures while Crooked Creek will be crossed with a clear span bridge, resulting in low effect. Activities associated with Port construction, Port operation, and barge navigation between the port and Bethel, are judged to result in a low effect to EFH and EFH species. Potential impacts at the port would primarily result from pile driving and propeller strikes. Barging between approximately May and September, may result in an increased potential for stranding juvenile salmon during the end of the smolt outmigration, primarily for chum salmon. However, such impacts should be low based on results of analysis of the temporal and spatial distribution and habitat use by outmigrating salmon and predicted barge-induced wave heights.

The evaluation of impacts includes mitigation measures integrated into the facility design, construction schedule, and implementation of BMPs. Mitigation measures proposed to reduce effects of project construction include sediment control BMPs such as silt fences, sediment retention basins, cross bars and ditches, runoff interception and diversion, mulching and revegetating disturbed surfaces and soil stockpiles, and other techniques designed to reduce the intensity of surface runoff, erosion, and sediment loads in downstream drainages.

Mitigation of unavoidable habitat losses would be achieved through a series of habitat modifications including: 1) reclamation of disturbed habitats in Snow and Ruby gulches, 2) removal of an apparent migration blockage on the south fork of Getmuna Creek, and 3) reclaiming the Getmuna material site (MS-10) to provide fish-rearing and over-wintering habitat.

In addition, substrate freezedown monitoring of Crooked Creek would be implemented to determine current winter habitat availability and variability in the middle reaches of the creek. Monitoring will be initiated prior to mine construction and continued into operations to determine current conditions and quantify changes in wintering habitat that may occur during early of phases of mine operations. Results would be used to better predict and determine what mitigation may be necessary in this reach when water drawdowns reach their theoretical maximum around Year 20 of operation.

# ACRONYM LIST

%......................percent
AAC.................Alaska Administrative Code
ADEC...............Alaska Department of Environmental Conservation
ADF.................Average Daily Flow
ADF&G...........Alaska Department of Fish and Game
ADNR..............Alaska Department of Natural Resources
amsl..................above mean sea level
ANFO...............ammonium nitrate and fuel oil
ANS.................Aquatic Nuisance Species
APDES.............Alaska Pollutant Discharge Elimination System
AWC................Anadromous Waters Catalog
BC.....................British Columbia
BMP.................Best Management Practice
BPL..................Beluga Natural Gas Pipeline
Calista..............Calista Corporation
CFR...................Code of Federal Regulations
cfs.....................cubic feet per second
cm.....................centimeters
CWA................Clean Water Act
dB......................decibel
Donlin Gold.....Donlin Gold LLC
EEZ..................U.S. Exclusive Economic Zone (federal waters)
EFH..................Essential Fish Habitat
EIS...................Environmental Impact Statement
FMP.................Fishery Management Plan
FRP..................Fish Resource Permit
ft.......................foot or feet
HDD.................Horizontal Directional Drilling
HP....................horsepower
km....................kilometer(s)
$km^2$...................square kilometers
m......................meter(s)
$m^3$.....................cubic meters
$m^3$/sec...............cubic meters per second
mi.....................statue mile(s)
$mi^2$....................square mile(s)
mm...................millimeter(s)
mph.................miles per hour
MP....................Mile Post
MSA.................Magnuson-Stevens Fishery Conservation and Management Act of 1996
MS....................Material Site
NA.....................Not Applicable
NEPA...............National Environmental Policy Act
NMFS...............National Marine Fisheries Service
NOAA..............National Oceanic and Atmospheric Administration
ns.......................not surveyed
ODPCP.............Oil Discharge Prevention and Contingency Plan

Port....................Jungjuk Port
Project..............Donlin Gold Project
POL..................petroleum, oils, and lubricants
re 1 μPa............relative to 1 microPascal
RHA.................Rivers and Harbors Act
ROW................right-of-way
SEL...................sound exposure level
SFSGR.............Susitna Flats State Game Refuge
SPCC................Spill Prevention and Countermeasures
SPL....................sound pressure level
SWPPP.............Stormwater Pollution Prevention Plans
TKC.................The Kuskokwim Corporation
TSF...................Tailings Storage Facility
USACE............United States Army Corps of Engineers
USCG...............United States Coast Guard
WA...................Washington
WRF.................Waste Rock Facility

# 1. PURPOSE AND SCOPE

This document presents the findings of an Essential Fish Habitat (EFH) Assessment of the proposed Donlin Gold LLC (Donlin Gold) Mine Project (Project) in southwestern Alaska and is intended to support EFH consultation under the Magnuson-Stevens Fishery Conservation and Management Act (MSA) of 1996. The MSA, as amended by the Sustainable Fisheries Act of 1996 (Public Law 104-267), establishes procedures designated to identify, conserve, and enhance EFH for those species regulated under a federal Fishery Management Plan (FMP). Section 305(b)(2) of the MSA requires federal agencies to consult with National Marine Fisheries Service (NMFS) on all actions or proposed actions authorized, funded, or undertaken by the agencies that might adversely affect EFH.

The EFH Guidelines, 50 Code of Federal Regulations (CFR) 600.05 – 600.930, outline procedures that federal agencies must follow to satisfy MSA consultation requirements. Federal agencies must provide the NMFS with an EFH Assessment if the federal action may adversely affect EFH. An EFH Assessment is to include the following contents (50 CFR 600.920(e)): 1) a description of the action, 2) an analysis of the potential effects of the action on EFH and managed species, 3) the federal agency's view of the effects of the action, and 4) proposed mitigation, if necessary.

In July 2012, Donlin Gold submitted a preliminary permit application, pursuant to Section 10 of the Rivers and Harbors Act (RHA) and Section 404 of the Clean Water Act (CWA), to the United States Army Corps of Engineers (USACE) for the proposed Project. Updates to the permit application were submitted to the USACE in December 2014. Before making a decision on the application, the USACE is complying with the National Environmental Policy Act (NEPA) by developing an environmental impact statement (EIS) regarding the proposed Project. NMFS is not a formal cooperating agency in the NEPA process, but has been provided the same materials as cooperating agencies (e.g., preliminary versions of the EIS). Much of the information in this EFH Assessment has been drawn from the draft EIS.

The Project has the potential to adversely affect EFH, which requires the USACE to consult with NMFS under the MSA. This EFH Assessment was prepared following the MSA regulations and EFH Assessment Guidance developed by the National Oceanic and Atmospheric Administration (NOAA) (2004).

The assessment focuses on Pacific salmon (Chinook, chum, coho, pink and sockeye) as defined in the FMP for the Salmon Fisheries in the Exclusive Economic Zone (EEZ) off Alaska (NPFMC et al. 2012). Transport of Project materials to and from the mouth of the Kuskokwim River will cross areas covered by other FMPs that deal with fisheries of the Pacific Northwest, Gulf of Alaska, and Bering Sea regions. However, ocean transport of material to support Project activities is unlikely to interfere with fisheries or fish populations in these regions, because ocean transport is not identified as an activity of concern by NMFS (2011).

# 2. DEFINITION OF ESSENTIAL FISH HABITAT

EFH is defined as waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity (50 CFR Part 600). For the purposes of this definition:

- "Waters" means aquatic areas and their associated physical, chemical, and biological properties.
- "Substrate" includes sediment, hard bottom, structures underlying the water surfaces, and associated biological communities.
- "Necessary" means the habitat required to support a sustainable fishery and healthy ecosystem.
- "Spawning, feeding, and breeding" are terms used to encompass the complete life cycle of a species (50 CFR Part 600).

EFH is designated based on the best available scientific information and the levels defined by the MSA including the following levels and corresponding information (NMFS 2005):

- Level 1 – distribution
- Level 2 – density or relative abundance
- Level 3 – growth, reproduction, or survival rates
- Level 4 – production rates.

Pacific salmon EFH is designated for all species and all life stages based on Level 1 information (NMFS 2005).

# 3. PROJECT DESCRIPTION

The EFH Assessment addresses the Project description that is the basis for the CWA 404/RHA 10 preliminary permit application, which is equivalent to the proposed action in the USACE Donlin Gold Project EIS. Donlin Gold proposes to develop an open pit, hardrock gold mine on land leased from The Kuskokwim Corporation (TKC) and Calista Corporation (Calista). The proposed mine site is 277 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 (**Figure 3.0-1**). Donlin Gold would construct the mine over three to four years and anticipates an active mine life of approximately 27 years of year-round operation (SRK Consulting 2012). Reclamation and closure have been integrated into the Project design and would occur over four years. Following reclamation and closure, post-closure management and treatment of water would continue.

The Project has three primary components: 1) mine site facilities, 2) natural gas pipeline, and 3) transportation infrastructure including an airstrip, port on the Kuskokwim River at Jungjuk Creek (Jungjuk Port, or Port), and a 30-mi (48-km) gravel access road to connect the Port and the mine site.

These components are described below and in greater detail in the EIS (Section 2.3.2 Alternative 2 – Donlin Gold's Proposed Action) as well as SRK Consulting (2012) and SRK Consulting (2013).

## 3.1. Mine Site Facilities

The mine site facilities would be within the Crooked Creek drainage at elevations ranging from 500 feet (ft) above mean sea level (amsl) (152 meters [m] amsl) to 2,100 ft amsl (640 m amsl) on the western slopes of the Kuskokwim Mountains. The Crooked Creek drainage encompasses approximately 333 square mi ($mi^2$) (862 square km [$km^2$]), flowing into the Kuskokwim River at the village of Crooked Creek (**Figure 3.0-1**).

Major Project components would be constructed in American Creek, Anaconda Creek, and Snow Gulch basins. The American and Anaconda basins comprise approximately 7 $mi^2$ (18 $km^2$). The mine pit and waste rock facility (WRF) would be within the American Creek drainage. The tailings storage facility (TSF) would be in the Anaconda Creek drainage. Tailings storage would encompass 2,351 acres (951 hectares) with a 464-ft (141-m) high (above existing ground level) dam constructed at the downstream location. Snow Gulch basin, with a catchment area of approximately 2.4 $mi^2$ (6.2 $km^2$), would include a freshwater reservoir to supply freshwater needed for the Project.

Mine components would include an open pit mine, TSF, WRF, mill, power plant, bulk fuel storage (with secondary containment), material source and storage sites, freshwater reservoirs, contact water ponds, personnel camps, water treatment plant, and connecting road infrastructure. Two temporary freshwater diversion dams would be used to minimize runoff to the TSF impoundment and facilitate construction of the TSF dam.

## 3.2. Natural Gas Pipeline

To meet the energy needs of the Project, Donlin Gold has proposed a natural gas-fired power plant fed by a 315-mi (507-km) 14-inch (36-centimeters [cm]) diameter, buried, natural gas pipeline (**Figure 3.2-1**). The proposed pipeline route crosses an area with no significant pre-existing infrastructure and does not follow any existing utility right-of-way (ROW).

The pipeline would originate at a tie-in near Beluga on Cook Inlet and would terminate at the mine site. The pipeline route would begin at the Beluga Natural Gas Pipeline (BPL), designated Mile Post (MP) 0 within the Susitna Flats State Game Refuge (SFSGR) and follow the Pretty Creek public road easement through most of the pipeline route though the SFSGR. The pipeline would receive booster compression supplied by one compressor station at approximately MP 0.4, near the beginning of the pipeline, inside the boundary of the SFSGR. From the SFSGR, the proposed route proceeds northerly, traversing the east flank of Little Mount Susitna to the Skwentna River (approximately MP 50), then parallels the Skwentna River westerly to Puntilla Lake (approximately MP 102).

From approximately MP 106 the route trends northwesterly to a crossing of Happy River at approximately MP 108.5. From the Happy River crossing, the pipeline route proceeds along a low moraine ridge before turning north into the broad valley of Threemile Creek. At approximately MP 114.5, the alignment trends westerly as it approaches an unnamed pass in the Alaska Range divide. This pass has an elevation of 3,870 ft amsl (1,180 m amsl). Short, steep drainages immediately on each side of the pass are in narrow valleys with talus lobes and stabilized rock glaciers at the base of steep rock slopes. At approximately MP 120.5, the pipeline route enters a typical broad U-shaped (glacially formed) valley. As the pipeline route descends this valley it trends along the benches or terraces with moderate to little slope that border this unnamed tributary of the Tatina River.

At approximately MP 127.3, the proposed route crosses the Tatina River braided glacial outwash floodplain before it ascends to a broad open pass and then descends into the Jones River valley at approximately MP 130.5. From approximately MP 130.5 to MP 143 the pipeline route remains in the Jones River valley and roughly parallels the Jones River. The route crosses the Jones River twice, at approximately MP 136.6 and MP 137.6. The pipeline route exits the mountains to the west of the Alaska Range at approximately MP 143, then trends westerly across the south fork of the Kuskokwim River and then southwesterly toward Farewell, Alaska.

The proposed route continues southwesterly near Farewell (approximately MP 157), paralleling the Alaska Range until crossing the Kuskokwim River (between approximately MP 240 and MP 241). Beyond the Kuskokwim River, the route primarily follows ridgelines west for more than 80 mi (129 km), to the terminus at the proposed mine site about 10 mi (16 km) north of the village of Crooked Creek.

The pipeline would be buried in trenches, except for six crossings where horizontal directional drilling (HDD) will be used. At trenched crossings, a trench would be excavated using chain excavators, wheel trenchers, and/or backhoes. Trenching crews would excavate a trench deep enough to provide the design soil cover depth over the top of the pipe. Construction and water diversion methods used to excavate the trench would vary, depending on soil type and terrain characteristics. Excavators would generally be used in areas of steep slopes, high water tables, soils with cobbles and boulders, or deep trench areas such as river and stream crossings.

## 3.3. Transportation Facilities

This section describes the proposed transportation facilities and cargo/fuel transport and storage associated with the Kuskokwim River.

Transportation facilities included in the proposed Project are:

- Mine access road
- Jungjuk Port
- Airstrip near the mine site

Each of these facilities is described in Section 3.3.1 through Section 3.3.3.

### *3.3.1. Mine Access Road*

The 30-mi (48 km) mine access road (Jungjuk Road) connecting the Jungjuk Port site and the mine site would be a two-lane, all-season gravel road, designed to accommodate seasonal drainage and spring runoff and would be used to move fuel and cargo between the Port and mine site during the 110-day navigation season. The completed road would include six crossings of anadromous fish-bearing streams. Crooked Creek would be crossed with a steel girder concrete deck bridge while the remaining five crossings would be crossed using steel arch bridges designed to fully span each creek. Short spur roads off the main access road would connect to the mine site airstrip and mine camp facilities.

Construction materials for the access road and facilities would be excavated from 13 material sites. The largest of the material sites (material site [MS] 10) would be just upstream from the confluence of the north and south forks of Getmuna Creek, the largest tributary in the Crooked Creek drainage at 98.6 $mi^2$ (255 $km^2$).

### *3.3.2. Jungjuk Port Site*

The Jungjuk Port site on the Kuskokwim River, 9 mi (14.5 km) downstream of the Village of Crooked Creek, would include a container unloading and storage area with sufficient space to hold up to 1,000 containers. The Port facility would be approximately 21 acres (8.5 hectares), of which about 3.5 acres (1.4 hectares) would be constructed on State of Alaska submerged lands (below the ordinary high water mark) within the Kuskokwim River. An additional approximately 4.3 acres (1.7 ha) of State of Alaska submerged lands would be needed for operational space to allow safe docking of barges at the Port. An open-cell sheet-pile design earth-retaining system would be used for protection of the dock against ice loading. Riprap armor would be installed to protect the sheet pile transition from the river bank to uplands.

### *3.3.3. Airstrip Near Mine Site*

An airstrip would be constructed to support transport of personnel to the mine as well as some perishable and emergency re-supply cargoes. The airstrip would be approximately 9 mi (14 km) by road west of the mine site. It would be accessed by a 3-mi (4.8-km) spur road beginning at the Jungjuk Road (**Figure 3.0-1**). The airstrip would be gravel surfaced, 5,000 ft (1,524 m) long and 150 ft (46 m) wide. The airstrip would be constructed along a ridge that aligns with the prevailing winds from the southeast. The spur road route follows high terrain and does not cross any permanent streams.

### *3.3.4. Cargo and Fuel Transportation Handling*

**General**

Cargo for Project operations would be transported from terminals in Seattle, Washington (WA); Vancouver, British Columbia (BC); or Dutch Harbor, Alaska via marine barge to Bethel, 73 river miles (117 km) upstream on the Kuskokwim River. At Bethel, it is expected that cargo would be transferred to the dock for temporary storage or loaded directly onto river barges for transport up the Kuskokwim River to Jungjuk Port, approximately 177 river miles (284 km) upstream of Bethel (**Figure 3.3-1**). During the shipping season, June to early September, containerized, break-bulk, and other general cargoes would be transported from Jungjuk Port to the mine by a fleet of B-train tractor-trailer units.

Barging of cargo from the west coast ports would occur between May and September when all waters are clear of ice, and seasonal storms have abated. Barging would occur over the estimated three to four years of mine construction and 27 years of operation. During mine operation, three sets of cargo barges departing from Seattle or Vancouver would make approximately 12 round trips (24 transits) annually to Bethel, each round trip is expected to take about 32 days (**Table 3.3-1**). Each barge would have a deadweight capacity of 11,500 short tons (10,433 tonnes) and a net cargo capacity of 9,480 short tons (8,600 tonnes), and would be hawser-towed by a 4,200-horsepower (HP) oceanic tugboat. Cargo would include annual consumables and general cargo consolidated as bulk in containers, bulk in super-sacks, loose, or palletized break-bulk, small packages, and liquid in small tanks.

**Table 3.3-1: Estimated Annual Ocean and River Barge Traffic**

| Material | From | To | Number of Round Trips per Season |
|---|---|---|---|
| Cargo | Seattle, WA or Vancouver, BC | Bethel | 16 during construction<br>12 during operation |
| Fuel | Dutch Harbor | Bethel | 14 |
| Pipe and Equipment | Bethel | Kuskokwim Landing | 20 during first two years of pipeline construction |
| Pipe and Equipment | Anchorage | Beluga Landing | 20 during first year of pipeline construction |
| Cargo | Bethel | Jungjuk Port | 50 during construction[1]<br>64 during operation |
| Fuel | Bethel | Jungjuk Port | 19 during construction[2]<br>58 during operation |

[1] Total would be 200 trips over four years of construction. Exact distribution (number of round trips each year) would be determined during final design.
[2] Number is an average; the actual number would range from 9 to 29 depending on the year.

Source: SRK Consulting 2013

**Fuel**

During mine operation, fuel would be transported from Dutch Harbor to Bethel using a single double-hulled barge with capacity of up to 2.9 million U.S. gallons (11 million liters). The barge would be towed by a 3,000-HP tugboat. At Bethel, fuel would either be transferred directly to double-hulled fuel river barges for transport to Jungjuk Port, or off-loaded for temporary storage and later transported to Jungjuk Port. From Jungjuk Port, fuel would be transported to the mine site fuel storage facility via B-train tanker trucks on the Jungjuk Road (Section 3.3.1).

Fuel demand will vary over the mine life, but at the peak of operation (at approximately Year 15) a maximum of 14 barge trips per year across Kuskokwim Bay would be anticipated.

**River Transport**

From the Bering Sea, a navigation channel on Kuskokwim Bay and upstream to Bethel is marked by seasonal buoys. The marked channel is known to shift from time to time due to river currents on the sandy river bottom. Local tug and barge operators would depart Bethel for Jungjuk Port once Bethel is clear of ice and flow levels provide at least 2 ft (60 cm) of gross under the keel clearance, when factoring stream flow and barge loads (AMEC 2014).

Barge traffic from Bethel to Jungjuk Port would consist of multiple, daily, 24-hour operation, four-barge tows over the estimated 110-day shipping season from approximately May to September. River barge shipments throughout the mine life between Bethel and Jungjuk Port would range from approximately 122 to 190 cargo and fuel barge tows (round trips) per season. Diesel fuel would be transported to Jungjuk Port every four days.

For construction of the natural gas pipeline, it is estimated that up to 20 annual barge trips, over two years, will be required to transport gas line pipe and other pipeline construction supplies to the Kuskokwim barge landing site (near the Kuskokwim River and proposed natural gas pipeline intersection) (**Table 3.3-1)**. Up to 20 construction barge trips (40 transits) will run from Anchorage to Beluga (at a beach landing site). All trips would occur within one construction season with gas line pipe as the primary cargo. The beach landing site is 3.8 mi (6.1 km) south of the Beluga Airport and 7.3 mi (11.7 km) south of the mouth of the Beluga River.

# 4. EVALUATION OF POTENTIAL IMPACTS TO EFH

## 4.1. Species Evaluated

The proposed Project would be within the jurisdiction of the FMP for the Salmon Fisheries in the EEZ off Alaska (NPFMC et al. 2012), which lists five species of Pacific salmon that could occur within the Project Area: Chinook, sockeye, coho, chum, and pink salmon.

Pacific salmon populations within the Project Area are all in the West Management Area, which includes all federal waters west of Cape Suckling in the Gulf of Alaska to Demarcation Point in the Beaufort Sea; with the exception of three excluded areas in northern Gulf of Alaska. Pacific salmon EFH in Alaska is designated based on Level 1 (i.e., information based on distribution) (NMFS 2005). The Salmon FMP identifies EFH for each species' life stage and, in most cases, is based on either the general distribution of the life stage or the general distribution of the life stage in waters identified by the Alaska Department of Fish & Game (ADF&G) Catalog of Waters Important for the Spawning, Rearing, or Migration of Anadromous Fishes (Johnson and Coleman 2014a and 2014b).

Pacific salmon are the species of interest within the Project Area and any fishery based on these species could potentially be affected by Project activities. Life stages expected to be exposed to proposed Project activities include: freshwater eggs, freshwater larvae and juveniles, and freshwater adults (**Table 4.1-1**).

**Table 4.1-1: Salmon Species EFH Life Stages Present in the Project Area**

| Salmon Species | Freshwater Eggs | Freshwater Larvae and Juveniles | Estuarine Juveniles | Marine Juveniles | Marine Immature and Maturing Adults | Freshwater Adults |
|---|---|---|---|---|---|---|
| Chinook | 1 | 1 | 2 | 2 | 2 | 1 |
| Sockeye | 1 | 1 | 2 | 2 | 2 | 1 |
| Coho | 1 | 1 | 2 | 2 | 2 | 1 |
| Chum | 1 | 1 | 2 | 2 | 2 | 1 |
| Pink | 1 | 1 | 2 | 2 | 2 | 1 |

1 = life stage with defined EFH in the Project Area.
2 = life stage with defined EFH, but none in the Project Area.
Source: NMFS 2005

## 4.2. EFH within the Project Area

The EFH life stages for salmon within the Project Area include maturing and spawning adults, incubating eggs, rearing juveniles, and outmigrating juveniles. The following sections address EFH by Project components: mine site facilities, natural gas pipeline, and transportation facilities.

### *4.2.1. Mine Site Facilities*

Based on studies by OtterTail Environmental, Inc. (OtterTail) (2014a), all five Pacific salmon species are present in or near the proposed mine site area (**Table 4.2-1**) as either adult or juvenile stages. Nine of the 18 surveyed streams represent EFH. Snow Gulch is not considered to represent EFH, because only a few adult coho salmon were observed in the lower reach near the mouth of the creek; these fish were likely resting on their way to spawning areas in another stream.

**Table 4.2-1: Pacific Salmon Identified within the Crooked Creek Drainage, 2004 to 2013**

| | | | Chinook | | Coho | | Sockeye | | Chum | Pink |
|---|---|---|---|---|---|---|---|---|---|---|
| **Stream** | **EFH Stream** | **AWC Stream No.** | **Adult** | **Juvenile** | **Adult** | **Juvenile** | **Adult** | **Juvenile** | **Adult** | **Adult** |
| Donlin Creek | Yes | 335-20-16600-2671-3100 | -- | -- | -- | + | -- | -- | + | -- |
| Flat Creek | Yes | | -- | -- | -- | + | -- | -- | -- | -- |
| Dome Creek | Yes | 335-20-16600-2671-3100-4012 | -- | -- | -- | + | -- | -- | -- | -- |
| Quartz Creek | No | | -- | -- | -- | -- | -- | -- | -- | -- |
| Snow Gulch | No | | -- | -- | +[1] | -- | -- | -- | -- | -- |
| Queen Gulch | No | | -- | -- | -- | -- | -- | -- | -- | -- |
| Crooked Creek | Yes | 335-20-16600-2671 | + | + | + | + | + | + | + | + |
| Lewis Gulch | No | | -- | -- | -- | -- | -- | -- | -- | -- |
| American Creek | Yes | 335-20-16600-2671-3056 | -- | -- | -- | + | -- | -- | -- | -- |
| Grouse Creek | Yes | 335-20-16600-2671-3055 | -- | -- | + | -- | -- | -- | -- | -- |
| Omega Gulch | No | | -- | -- | -- | -- | -- | -- | -- | -- |
| Anaconda Creek | Yes | 335-20-16600-2671-3032 | -- | -- | -- | + | -- | -- | -- | -- |
| Crevice Creek | No | | -- | -- | -- | -- | -- | -- | -- | -- |
| Eagle Creek | No | | -- | -- | -- | -- | -- | -- | -- | -- |
| BC Creek | No | | -- | -- | -- | -- | -- | -- | -- | -- |
| AC Creek | No | | -- | -- | -- | -- | -- | -- | -- | -- |
| Getmuna Creek | Yes | 335-20-16600-2671-3023 | + | + | + | + | + | + | + | -- |
| Bell Creek | Yes | 335-20-16600-2671-3020 | -- | + | -- | + | -- | -- | + | -- |

+ = Present
-- = Not Detected
[1] Adult coho salmon have been observed in Snow Gulch, but all were just upstream of the stream mouth and were likely associated with Crooked Creek.

Source: OtterTail 2014a

Adult salmon are present in Crooked Creek, both downstream and upstream from the proposed mine site (**Figure 4.2-1**). Chinook, coho, and chum salmon are consistently present, with sockeye and pink salmon occurring in lower numbers (**Table 4.2-2**). Adult salmon enter the Crooked Creek drainage from late June until late September, depending on species, beginning with Chinook and ending with coho (**Figure 4.2-2**).

**Table 4.2-2: Crooked Creek Weir Salmon Escapement Summary, 2008 to 2012**

(estimated total numbers corrected for periods when weir was inoperable)

| Species | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|
| Chinook Salmon | 86 | 100 | 49 | 32 | 29 |
| Chum Salmon | 1,699 | 1,991 | 1,257 | 3,755 | 832 |
| Coho Salmon | 4,204 | 1,295 | 1,212 | 591 | 868 |
| Pink Salmon | 11 | 59 | 5 | 4 | 19 |
| Sockeye Salmon | 60 | 10 | 5 | 16 | 1 |
| | | | | | |
| Totals | 6,060 | 3,455 | 2,528 | 4,398 | 1,749 |

Source: OtterTail 2014a

Based on summer aerial surveys between 2004 and 2014, 71 percent (%) of the Chinook salmon adults within the Crooked Creek mainstem were in reaches downstream from the mine area, while 95% of the chum salmon were in downstream reaches (**Table 4.2-3**). Conversely, 10% of coho salmon adults were in downstream reaches of mainstem Crooked Creek; while 69% were in upper reaches of the drainage in Donlin Creek, upstream from the mine site. Approximately 9.5% of all mainstem Crooked Creek coho salmon adults were adjacent to the mine site (**Table 4.2-3**). Most coho spawning in the Crooked Creek drainage occurs in the mainstems of the larger tributaries, which would not be influenced by the proposed mining. On average, Getmuna, Bell, and Donlin creeks accounted for 28, 35, and 25% of coho salmon counted in fall aerial surveys, respectively. Coho salmon spawning in the areas adjacent to the mine site represent a very low number of overall spawners relative to the drainage.

On average, 170 redds are documented each year in the Crooked Creek watershed during summer redd surveys (OtterTail 2014a). Although redds were not associated with a specific salmon species, Chinook and chum salmon are the most abundant species present during summer surveys. Summer redds were most abundant in Getmuna Creek (40.5%) and lower Crooked Creek, from Eagle Creek to the mouth of the Kuskokwim River (54.2%) (**Table 4.2-4**). Summer redds tended to be more abundant in the lower watershed, with 95% of summer redds found in the mainstem of Crooked Creek occurring in the lower reaches, approximately 3 mi (4.8 km) downstream from Anaconda Creek to the Kuskokwim River (**Table 4.2-4**). A similar trend was noted in Getmuna Creek, with 93% of redds documented in Getmuna Creek occurring in the lower reach. Adult salmon aerial counts also show Chinook and chum salmon preferences toward these lower reaches.

Fall redd surveys have documented a five-year average of 288 redds in the Crooked Creek watershed (Ottertail, 2014a). Although redds were not associated with a specific salmon species, adult salmon aerial surveys showed coho salmon to be the most abundant species present during fall surveys. Fall redd surveys show the tendency of coho salmon to spawn higher in the watershed and in tributaries. On average, the Crooked Creek tributaries Donlin Creek, Getmuna Creek, and Bell Creek accounted for 21%, 24% and 17% of all fall redds, respectively (**Table 4.2-4**). Mainstem reaches of Crooked Creek adjacent to the mine area contained 10% of fall redds in the drainage. Redds have been documented as high up in the watershed as upper Donlin Creek, upper Getmuna Creek, and upper Bell Creek (**Figure 4.2-1**).

Juvenile Chinook rear in Crooked and Getmuna creeks, with some indication of rearing in Bell Creek (**Table 4.2-5**). Coho salmon juveniles were more widely distributed, being found in eight creeks and at higher densities than Chinook salmon (**Figure 4.2-3**). Sockeye salmon juveniles were occasionally encountered (**Table 4.2-5**). Juvenile chum salmon outmigrate shortly after emergence from the gravel, so were not found during studies of rearing salmon.

**Table 4.2-3: Distribution of Pacific Salmon in Crooked Creek Based on Aerial Surveys, 2004 to 2014**

| Table 4.2-3 | | | Crooked Creek Reaches[1] | | | | | | Crooked Creek Total |
|---|---|---|---|---|---|---|---|---|---|
| | | | Upstream of Mine Area | Adjacent to Mine Area | | | Downstream of Mine Area | | |
| **Season** | **Species** | **Year** | Donlin Upstream of Flat | Donlin to American | American to Anaconda | Anaconda to Eagle | Eagle to Bell | Bell to Kuskokwim | |
| **Summer** | **Chinook** | **2004** | 0 | 0 | 2 | 4 | 20 | 29 | 55 |
| | | **2005** | 0 | 6 | 2 | 0 | 6 | 1 | 15 |
| | | **2006** | 0 | 0 | 1 | 1 | 5 | 5 | 12 |
| | | **2007** | 0 | 0 | 1 | 1 | 2 | 0 | 4 |
| | | **2008** | 0 | 0 | 0 | 0 | 2 | 1 | 3 |
| | | **2009** | 0 | 0 | 3 | 3 | 6 | 10 | 22 |
| | | **2010** | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | **2011** | 0 | 0 | 0 | 0 | 1 | 5 | 6 |
| | | **2012** | 0 | 0 | 0 | 2 | 1 | 5 | 8 |
| | | **2013** | 0 | 0 | 0 | 4 | 3 | 0 | 7 |
| | | **2014** | 5 | 1 | 5 | 0 | 0 | 0 | 11 |
| | | **Mean[2]** | 0.5 | 0.7 | 1.3 | 1.4 | 4.2 | 5.1 | 13 |
| | | **Min** | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | **Max** | 5 | 6 | 3 | 4 | 20 | 29 | 55 |
| | **Chum** | **2004** | 1 | 0 | 1 | 3 | 134 | 52 | 190 |
| | | **2005** | 11 | 7 | 15 | 24 | 178 | 291 | 515 |
| | | **2006** | 0 | 0 | 0 | 1 | 146 | 280 | 427 |
| | | **2007** | 2 | 8 | 17 | 21 | 89 | 264 | 399 |
| | | **2008** | 0 | 0 | 0 | 1 | 30 | 16 | 47 |
| | | **2009** | 1 | 2 | 10 | 4 | 72 | 77 | 165 |
| | | **2010** | 0 | 0 | 2 | 3 | 37 | 66 | 108 |
| | | **2011** | 0 | 0 | 0 | 4 | 177 | 212 | 393 |
| | | **2012** | 0 | 0 | 0 | 1 | 124 | 109 | 234 |
| | | **2013** | 0 | 2 | 12 | 4 | 333 | 243 | 594 |
| | | **2014** | 0 | 1 | 5 | 0 | 0 | 0 | 6 |
| | | **Mean[2]** | 1.4 | 1.8 | 5.6 | 6 | 120 | 146.4 | 279.8 |

| Table 4.2-3 | | | Crooked Creek Reaches[1] | | | | | | Crooked Creek Total |
|---|---|---|---|---|---|---|---|---|---|
| | | | Upstream of Mine Area | Adjacent to Mine Area | | | Downstream of Mine Area | | |
| Season | Species | Year | Donlin Upstream of Flat | Donlin to American | American to Anaconda | Anaconda to Eagle | Eagle to Bell | Bell to Kuskokwim | |
| | | **Min** | 0 | 0 | 0 | 0 | 0 | 0 | 6 |
| | | **Max** | 11 | 8 | 17 | 24 | 333 | 291 | 594 |
| | **Sockeye** | **2004** | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | **2005** | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | **2006** | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | **2007** | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | **2008** | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | **2009** | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | **2010** | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | **2011** | 0 | 0 | 0 | 0 | 0 | 3 | 3 |
| | | **2012** | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | **2013** | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | **2014** | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| | | **Mean[2]** | 0 | 0 | 0 | 0 | 0 | 0.4 | 0.4 |
| | | **Min** | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | **Max** | 0 | 0 | 0 | 0 | 0 | 3 | 3 |
| | **Pink salmon** | **2004** | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | **2005** | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | **2006** | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | **2007** | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | **2008** | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | **2009** | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | **2010** | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | **2011** | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | **2012** | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | **2013** | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| | | **2014** | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | **Mean[2]** | | 0 | 0 | 0 | 0.1 | 0 | 0.1 |
| | | **Min** | | 0 | 0 | 0 | 0 | 0 | 0 |
| | | **Max** | | 0 | 0 | 0 | 1 | 0 | 1 |
| **Fall** | **Coho** | **2004** | 246 | 27 | 23 | 9 | 3 | 2 | 310 |
| | | **2005** | 1 | 1 | 0 | 0 | 0 | 0 | 2 |
| | | **2006** | 80 | 0 | 0 | 0 | 0 | 0 | 80 |
| | | **2007** | 56 | 0 | 7 | 8 | 0 | 0 | 71 |

| Table 4.2-3 | | | Crooked Creek Reaches[1] | | | | | | Crooked Creek Total |
|---|---|---|---|---|---|---|---|---|---|
| | | | Upstream of Mine Area | Adjacent to Mine Area | | | Downstream of Mine Area | | |
| Season | Species | Year | Donlin Upstream of Flat | Donlin to American | American to Anaconda | Anaconda to Eagle | Eagle to Bell | Bell to Kuskokwim | |
| | | **2008** | 102 | 24 | 38 | 25 | 18 | 14 | 221 |
| | | **2009** | 103 | 8 | 3 | 15 | 40 | 7 | 176 |
| | | **2010** | 139 | 35 | 5 | 4 | 22 | 8 | 213 |
| | | **2011** | 297 | 39 | 36 | 19 | 26 | 3 | 420 |
| | | **2012** | 15 | 1 | ns | ns | ns | ns | 16 |
| | | **2013** | 33 | 2 | 0 | 0 | 0 | 0 | 35 |
| | | **2014** | 44 | 7 | 6 | 2 | 0 | 10 | 69 |
| | | **Mean[2]** | 101.5 | 13.1 | 11.8 | 8.2 | 10.9 | 4.4 | 146.6 |
| | | **Min** | 1 | 0 | 0 | 0 | 0 | 0 | 2 |
| | | **Max** | 297 | 39 | 38 | 25 | 40 | 14 | 420 |
| | **Pink** | **2004** | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | **2005** | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | **2006** | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | **2007** | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | **2008** | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | **2009** | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | **2010** | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | **2011** | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| | | **2012** | 0 | 0 | ns | ns | ns | ns | 0 |
| | | **2013** | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | **2014** | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | **Mean[2]** | 0 | 0 | 0 | 0 | 0 | 0.1 | 0.1 |
| | | **Min** | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | **Max** | 0 | 0 | 0 | 0 | 0 | 1 | 1 |

[1] see Figure 4.2-1

[2] Mean = total fish seen/number of years surveyed

ns = not surveyed

Source: OtterTail 2014a

**Table 4.2-4: Aerial Counts of Salmon Redds within Crooked Creek Mainstem, 2009 to 2013**

| Season | Stream | Reach | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | Total | Percent |
|---|---|---|---|---|---|---|---|---|---|---|
| **Summer** | Crooked Creek | Donlin Upstream from Flat Creek | | 0 | 4 | 0 | 0 | 2 | 6 | 0.67% |
| | | Donlin to American | | | | | | | 0 | |
| | | American to Anaconda | | | 3 | | 3 | 6 | 12 | 1.33% |
| | | Anaconda to Eagle | | 6 | 2 | 1 | 3 | 0 | 12 | 1.33% |
| | | Eagle to Bell | | 20 | 43 | 21 | 97 | 101 | 282 | 31.32% |
| | | Bell to Kuskokwim | | 50 | 44 | 29 | 59 | 24 | 206 | 22.88% |
| | Getmuna | Getmuna | 0 | 67 | 111 | 14 | 100 | | 292 | 40.53% |
| | Bell | Bell | 0 | 0 | 0 | 0 | 1 | 13 | 14 | 1.94% |
| **Summer Total** | | | 0 | 143 | 207 | 65 | 263 | 146 | **824** | |
| **Fall** | Crooked Creek | Donlin Upstream from Flat Creek | 44 | 54 | 132 | | 0 | 9 | 239 | 21.05% |
| | | Donlin to American | 6 | 3 | 13 | | 0 | 2 | 24 | 1.87% |
| | | American to Anaconda | 6 | 1 | 23 | | 0 | 14 | 44 | 3.42% |
| | | Anaconda to Eagle | 29 | 2 | 18 | | 0 | 12 | 61 | 4.75% |
| | | Eagle to Bell | 97 | 19 | 10 | | 0 | 23 | 149 | 11.60% |
| | | Bell to Kuskokwim | 101 | 16 | 23 | | 0 | 34 | 174 | 13.54% |
| | Getmuna | Getmuna | 79 | 63 | 146 | | 5 | 21 | 314 | 24.44% |
| | Bell | Bell | | | 112 | | 7 | 12 | 131 | 16.99% |
| **Fall Total** | | | 362 | 158 | 477 | 0 | 12 | 127 | **1136** | |
| **Grand Total** | | | 362 | 301 | 684 | 65 | 275 | 273 | **1960** | |

Shaded reaches are adjacent to the mine area; other reaches are downstream.

Summer redds are mostly chum with some chinook; Fall redds are mostly coho salmon.

Source: OtterTail 2014a

**Table 4.2-5: Summary of Electrofishing Results by Site within Crooked Creek Drainage, 2004 to 2013**

| | | | Average # Fish Captured[1] (#/300 ft) | | |
|---|---|---|---|---|---|
| **Streams** | **Site** | ***n* (years)** | **Chinook salmon (Juvenile)** **Mean** Range | **Coho salmon (Juvenile)** **Mean** Range | **Sockeye salmon (Juvenile)** **Mean** Range |
| Donlin Creek | DO1 | 9 | -- | **36.3** (2-182) | -- |
| Flat Creek | FL1 | 6 | -- | **1.6** (0-3.1) | -- |
| Dome Creek | DM1 | 2 | -- | **28.0** (0-56.1) | -- |
| Quartz Creek | QZ1 | 1 | -- | -- | -- |
| Snow Gulch | SN1 | 1 | -- | -- | -- |
| | SN2 | 7 | -- | -- | -- |
| Queen Gulch | QU1 | 1 | -- | -- | -- |
| Crooked Creek | CR2 | 9 | **2.0** (0-7.6) | **18.3** (3-70.1) | -- |
| | CR1 | 9 | **2.1** (0-10.9) | **110.0** (1.6-831.6) | -- |
| | CR0.7 | 7 | **2.1** (0-8.5) | **35.9** (6.4-195.7) | **3.6** (0-23.4) |
| | CR0.3 | 5 | **5.5** (0-22.7) | **11.8** (1.5-45.5) | -- |
| Lewis Gulch | LE1 | 1 | -- | -- | -- |
| American Creek | AM1 | 7 | -- | **6.0** (0-18.3) | -- |
| | AM2 | 1 | -- | -- | -- |
| | AM3 | 1 | -- | -- | -- |
| | AM4 | 2 | -- | -- | -- |
| Grouse Creek | GR1 | 1 | -- | -- | -- |
| Omega Gulch | OM1 | 1 | -- | -- | -- |
| Anaconda Creek | AN1 | 7 | -- | **0.1** (0-1) | -- |
| | AN2 | 4 | -- | -- | -- |
| Crevice Creek | CV1 | 4 | -- | -- | -- |
| Eagle Creek | EG1 | 1 | -- | -- | -- |
| BC Creek | BC1 | 1 | -- | -- | -- |
| AC Creek | AC1 | 1 | -- | -- | -- |
| Getmuna Creek | GM1 | 3 | **12.0** (6-21.6) | **90.8** (15.6-231.6) | **0.8** (0-2.4) |
| | GM2 | 1 | -- | **16.0** NA | -- |
| | GM3 | 2 | -- | **20.5** (10-31) | -- |
| | GM4 | 1 | -- | **9.0** NA | -- |
| Bell Creek | BL1 | 2 | **0.5** (1-1) | **6.0** (4-8) | -- |

Refer to **Figure 4.2-3** for site locations.
Adult salmon are not included in the above counts.
[1] #/300 ft = number of fish per 300 feet. Only one pass was allowed in 2005 & 2006; therefore, one pass data were used for each year in this table to enable comparison between years.
NA = Not Applicable, no range available for 1 year of sampling
Source: OtterTail 2014a

### *4.2.2 Natural Gas Pipeline*

The proposed 315-mi (507-km) buried natural gas pipeline would cross numerous tributaries to salmon-producing drainages. OtterTail (2014b) conducted an evaluation of each stream crossing, including field sampling at sites not previously identified by ADF&G as containing anadromous fish. Drainages were surveyed on the ground if they met the following criteria: 1) the drainage was deemed to have potential for fish occurrence; 2) the crossing was not cataloged anadromous in the ADF&G (2011) Anadromous Waters Catalog (AWC) (Johnson and Blanche 2011a, b, and c); and 3) the stream crossing was not planned to be accomplished by HDD.

Between 2010 and 2014, a total of 1,053 sampling site visits to 672 sampling sites were conducted, with over 25 mi (40 km) of stream electrofished during the survey. Through 2014, 70 stream crossings within EFH were identified (**Figure 4.2-4, Table 4.2-6**). Green shading within Table 4.2-6 indicates stream crossings to be constructed during summer (7 crossings); the others will be constructed during winter. A complete list of all sampling results from proposed crossings, including maps of each crossing, is presented in the Aquatics Map Book (OtterTail 2014c).

Drainages and streams identified as particularly important to salmon and crossed by the proposed natural gas pipeline include Wolverine and Sucker creeks. Wolverine and Sucker creeks (below the confluence with Wolverine Creek) provide more than 90% of the spawning habitat for Chinook salmon in the Alexander Creek drainage. Spawning habitat in upper Wolverine Creek would be considered important and sensitive when considering method of crossing or establishment and operation of a nearby construction camp.

The Skwentna River is a corridor for anadromous fish migration for the five species of Pacific salmon. The main channel is known to provide spawning habitat for sockeye, chum, and coho salmon. The main channel likely provides some rearing habitat for juvenile salmon as well. Within the Skwentna drainage, Eightmile Creek supports a relatively small Chinook and coho salmon fishery at its confluence with the Skwentna River. Eightmile Creek provides spawning habitat for Chinook salmon. Shell Lake is one of two major sockeye salmon-producing lakes within the Yentna River drainage in the Susitna basin. Susitna River sockeye salmon are a recognized stock of concern by the Board of Fish. Though most of the sockeye salmon production occurs well upstream of the proposed pipeline crossing, lower Shell Creek provides habitat for spawning and rearing coho salmon. The Happy River drainage supports spawning and rearing sockeye salmon, most notably in Puntilla Lake from where Squaw Creek drains. Chinook salmon spawning and rearing occurs on the lower 1.5 mi (2.4 km) of Squaw and Indian creeks. Chinook salmon production in the Happy River drainage contributes to downstream fisheries on the Skwentna and Yentna rivers.

The George and Tatlawiksuk rivers have weirs that have continually collected escapement data since the late 1990s. Their operational period is between June 15 and September 20. In most years, all five species of Pacific salmon pass the weir in both rivers, with chum and coho salmon the most abundant (Brazil et al. 2013).

## Table 4.2-6: EFH Stream Crossings along the Natural Gas Pipeline Route

| Drainage | Mainstem | Tributary | Sub Trib | AWC No.[1] | Mile Post (distance to AWC extent (m)) | HDD | Crossing[2] | Sample Site[3] | Year Sampled[4] | Species | Chinook Salmon[5] | Chum Salmon | Coho Salmon | Sockeye Salmon |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cook Inlet | Theodore R. | *Mainstem* | | 247-30-10080 | 5.36 | | cTH1 | cTH1 | 2014 | CO,CH,K,P | 0 | 0 | 8 | 0 |
| | | *Tribs* | | 247-30-10080-2031 | 0.48 | | cTHT89 | cTHT89 | 2014 | CO | 0 | 0 | 20 | 0 |
| | | | | 247-30-10080-2057 | 1.65 | | cTHT91 | cTHT91_OH1 | 2013 | K,CO | 8 | 0 | 1 | 0 |
| | | | | | | | | | 2014 | CO | 0 | 0 | 51 | 0 |
| | | | | 247-30-10080-2065 | 2.08 | | cTHT91.5 | cTHT91.5 | 2014 | CO | 0 | 0 | 2 | 0 |
| | Alexander Ck | *Bear Ck* | Mainstem | 247-41-10200-2015-3117 | 32.86 | | cBE1 | cBE1 | | K,S | -- | -- | -- | -- |
| | | *U. Sucker Ck* | Trib | 247-41-10200-2015-3035-4225 | | | cSUT1 | | | CO,S | | | | |
| Skwentna | Skwentna R. | *Mainstem* | | 247-41-10200-2053-3205 | 50.21 | X | sSK1 | sSK1 | | CH,CO,K,S,P | -- | -- | -- | -- |
| | Eightmile Cr. | *Mainstem* | | 247-41-10200-2053-3205-4009-5025 | 44.81 | | sEI1 | sEI1 | | CO,K,S | -- | -- | -- | -- |
| | | *Tribs* | | 247-41-10200-2053-3205-4009-5025-6311 | 44.11 | | sEIT2 | sEIT2 | 2010 | CO | 0 | 0 | 98 | 0 |
| | | | | | | | | | 2011 | CO | 0 | 0 | 25 | 0 |
| | | | | | 44.24 | | sEIT3 | sEIT2_OH1 | 2010 | CO | 0 | 0 | 108 | 0 |
| | | | | | | | | sEIT3 | 2010 | CO | 0 | 0 | 1 | 0 |
| | Shell Cr. | *Mainstem* | | 247-41-10200-2053-3205-4052 | 53.30 | | sSL1 | sSL1 | | CO,K,S,P | -- | -- | -- | -- |
| | | *Tribs* | | 247-41-10200-2053-3205-4052-5010 | 53.25 | | sSLT1 | sSLT1 | 2010 | CO,K,S,P | 0 | 0 | 83 | 0 |
| | Happy R. | *Mainstem* | | 247-41-10200-2053-3205-4112 | 86.05 | X | sHA1 | sHA1 | | K,S | -- | -- | -- | -- |
| | | | | | 108.44 | | SHA3 | sHA3 | | K,S | -- | -- | -- | -- |
| | | *Canyon Cr.* | Mainstem | 247-41-10200-2053-3205-4112-5037 | 95.18 | | sCA1 | sCA1 | | K | -- | -- | -- | -- |
| | | *Indian Cr.* | Mainstem | 247-41-10200-2053-3205-4112-5049 | 102.69 | | sIN1 | sIN1 | | K | -- | -- | -- | -- |
| | | *Squaw Cr.* | Mainstem | 247-41-10200-2053-3205-4112-5045 | 100.71 | | sSQ2 | sSQ2 | | K,S | -- | -- | -- | -- |
| Skwentna | Tribs | | | 247-41-10200-2053-3205-4064 | 59.42 | | sSKT8 | sSKT8 | 2010 | CH,CO,S | 0 | 3 | 69 | 0 |
| | | | | | | | | | 2011 | CO | 0 | 0 | 42 | 0 |
| | | | | 247-41-10200-2053-3205-4075 | 66.28 | | sSKT13 | sSKT13 | | CO,K,CH,S | -- | -- | -- | -- |
| | | | | 247-41-10200-2053-3205-4082-5003 | 67.38 | | sSKT14 | sSKT14 | | CO,K | -- | -- | -- | -- |
| | | | | 247-41-10200-2053-3205-4082 | 68.14 | | sSKT15 | sSKT15 | | K,CO | -- | -- | -- | -- |
| | | | | 247-41-10200-2053-3205-4108 | 84.02 | | sSKT27 | sSKT27_OH1 | 2010 | K | 2 | 0 | 0 | 0 |
| | | | | 247-41-10200-2053-3205-4088 | 71.60 (1.44) | | sSKT28 | sSKT28 | 2011 | CO | 0 | 0 | 1 | 0 |
| | | | | 247-41-10200-2053-3205-4064-5105-6035 | 62.91 | | sSKT30 | sSKT30 | 2010 | CO,CH,S | 0 | 0 | 2 | 0 |
| Skwentna | Tribs | | | | | | | | 2011 | CO,CH,S | 0 | 0 | 40 | 0 |
| | | | | 247-41-10200-2053-3205-4064-5105 | 61.76 | | sSKT36 | sSKT36 | 2010 | CO,CH,S | 0 | 0 | 68 | 0 |
| | | | | | | | | | 2011 | CO,CH,S | 0 | 0 | 2 | 0 |

**Table 4.2-6**

| Drainage | Mainstem | Tributary | Sub Trib | AWC No.[1] | Mile Post (distance to AWC extent (m)) | HDD | Crossing[2] | Sample Site[3] | Year Sampled[4] | Species | Chinook Salmon[5] | Chum Salmon | Coho Salmon | Sockeye Salmon |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 247-41-10200-2053-3205-4064-5105-6035 | 64.15 | | sSKT40 | sSKT40 | 2010 | CO,CH,S | 0 | 0 | 15 | 0 |
| | | | | | | | | | 2011 | CO,CH,S | 0 | 0 | 5 | 0 |
| | | | | 247-41-10200-2053-3205-4064-5105-6035 | 64.59 | | sSKT41 | sSKT41 | 2010 | CO,CH,S | 0 | 0 | 12 | 0 |
| | | | | | 64.59 | | sSKT41 | sSKT41 | 2011 | CO,CH,S | 0 | 0 | 6 | 0 |
| | | | | 247-41-10200-2053-3205-4102 | 74.68 (0.87) | | sSKT45 | sSKT45 | 2010 | CO,K,S | 0 | 0 | 1 | 0 |
| | | | | | | | | sSKT45_OH1 | 2010 | K,CO,S | 4 | 0 | 40 | 7 |
| | | | | 247-41-10200-2053-3205-4064-5105 | 61.63 | | DR11 | DR11 | 2011 | CO, CH,S | 0 | 0 | 13 | 0 |
| **Yentna** | | ***Johnson Cr.*** | **Red Cr.A** | 247-41-10200-2053-3225-4015-5501 | 78.65 | | yRET1 | yRET1_OH1 | 2010 | CO | 0 | 0 | 24 | 0 |
| **Kuskokwim** | **S.F. Kuskokwim R.** | ***Mainstem*** | | 335-30-16600-2350 | 146.49 | | **kSF4** | kSF4 | | K,CH,CO,S | -- | -- | -- | -- |
| | | ***Side Arm*** | | 335-30-16600-2350 | 147.22 | | **kSFT60** | kSFT60 | | K,CH,CO,S | -- | -- | -- | -- |
| | | | | 335-30-16600-2350 | 146.03 | | kSFT72 | kSFT72 | 2012 | K,CH,CO,S | 0 | 0 | 0 | 0 |
| | | ***Tin Cr.*** | **Mainstem** | 335-30-16600-2350-3222 | 149.57 | | kTI2 | kTI2 | 2013 | CO | 0 | 0 | 1 | 0 |
| | | ***Sheep Cr.*** | **Tribs** | 335-30-16600-2350-3219-4208 | 145.43 | | kSFT73 | kSFT73 | 2012 | CO | 0 | 0 | 2 | 0 |
| | | | | | | | | | 2013 | CO | 0 | 0 | 2 | 0 |
| | | | | 335-30-16600-2350-3219 | 145.01 | | kSFT75 | kSFT75_OH1 | 2013 | CO,K | 0 | 0 | 1 | 0 |
| | **Windy F. Kuskokwim R.** | ***Mainstem*** | | 335-30-16600-2300-3095 | 168.06 | | kWI1 | kWI1 | 2011 | CO,CH,K | 0 | 0 | 4 | 0 |
| | | | | | | | | kWI1_OH2 | 2010 | CO,CH,K | 0 | 0 | 43 | 0 |
| | | | | | | | | kWI1_OH3 | 2010 | CO,CH,K | 0 | 0 | 3 | 0 |
| | **M.F. Kuskokwim R.** | ***Mainstem*** | | 335-30-16600-2300 | 182.73 | | kMF1 | kMF1_OH1 | 2011 | CO,CH,K | 0 | 0 | 3 | 0 |
| | **Big R.** | ***Mainstem*** | | 335-30-16600-2300-3030 | 191.16 | | **kBI1** | kBI1 | | CO,CH,K | -- | -- | -- | -- |
| | | ***Sidearm*** | | 335-30-16600-2300-3030 | 191.49 | | **KBI2** | kBI2 | | CO,CH,K | -- | -- | -- | -- |
| | | | | | 190.87 | | **kBIT11** | kBIT11 | | CO,CH,K | -- | -- | -- | -- |
| | **Tatlawiksuk R.** | ***Mainstem*** | | 335-30-16600-2080 | 217.38 | | **kTL1** | kTL1 | | CO,CH,K,S,P | -- | -- | -- | -- |
| | | ***Sidearm*** | | 335-30-16600-2080-3168 | 217.06 | | kTLT11 | kTLT11 | 2011 | CO | 0 | 0 | 15 | 0 |
| | | ***Tribs*** | | 335-30-16600-2080-3240-4023-5012 | 204.98 | | kTLT2 | kTLT2 | 2010 | CO,K | 6 | 0 | 64 | 0 |
| | | | | | | | | | 2011 | CO | 0 | 0 | 25 | 0 |
| | | | | 335-30-16600-2080-3240-4023-5012-6022 | 207.11 | | kTLT4 | kTLT4_OH1 | 2010 | CO | 0 | 0 | 11 | 0 |
| | | | | 335-30-16600-2080-3196-4010 | 211.18 (0.6) | | kTLT6 | kTLT6 | 2011 | CO,K | 0 | 0 | 1 | 0 |
| **Kuskokwim** | **Tatlawiksuk R** | ***Tribs*** | | 335-30-16600-2080-3196-4010-5020 | 211.45 | | kTLT7 | kTLT7 | 2010 | CO | 0 | 0 | 63 | 0 |
| | | | | | | | | | 2011 | CO | 0 | 0 | 29 | 0 |
| | | | | 335-30-16600-2080-3180 | 214.29 | | kTLT9 | kTLT9 | 2012 | CO | 0 | 0 | 2 | 0 |
| | | | | 335-30-16600-2080-3170 | 216.08 | | **kTLT10** | kTLT10 | | K | -- | -- | -- | -- |
| | | | | 335-30-16600-2080-3155 | 219.12 | | kTLT14 | kTLT14 | 2012 | CO,K | 0 | 0 | 4 | 0 |
| | | | | 335-30-16600-2080-3135 | 221.21 | | kTLT16 | kTLT16 | 2010 | CO,K | 0 | 0 | 4 | 0 |
| | | | | | | | | | 2011 | CO,K | 0 | 0 | 7 | 0 |
| | | | | 335-30-16600-2080-3023-4140-5010 | 227.30 | | kTLT21 | kTLT21 | 2010 | CO | 0 | 0 | 4 | 0 |

**Table 4.2-6**

| Drainage | Mainstem | Tributary | Sub Trib | AWC No.[1] | Mile Post (distance to AWC extent (m)) | HDD | Crossing[2] | Sample Site[3] | Year Sampled[4] | Species | Chinook Salmon[5] | Chum Salmon | Coho Salmon | Sockeye Salmon |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | 2011 | CO | 0 | 0 | 2 | 0 |
| | | | | 335-30-16600-2080-3023 | 231.66 | | kTLT23 | kTLT23 | | CO | -- | -- | -- | -- |
| | | | | 335-30-16600-2080-3023-4121 | 232.15 | | kTLT24 | kTLT24 | 2010 | CO | 0 | 0 | 1 | 0 |
| | | | | 335-30-16600-2080-3023-4121 | | | | kTLT24 OH1 | 2010 | CO | 0 | 0 | 2 | 0 |
| | | | | 335-30-16600-2080-3155-4020 | 218.85 | | kTLT29 | kTLT29 | 2012 | CO,K | 0 | 0 | 6 | 0 |
| | | | | 335-30-16600-2080-3023-4140-5010-6011 | 227.12 | | kTLT31 | kTLT31 | 2010 | CO | 0 | 0 | 6 | 0 |
| | | | | | | | | | 2011 | CO | 0 | 0 | 3 | 0 |
| | | | | 335-30-16600-2080-3023-4140-5010-6011 | 227.12 | | kTLT31 awes | kTLT31 awes | | CO | -- | -- | -- | -- |
| **Kuskokwim** | **Kuskokwim R.** | *Mainstem* | | 335-30-16600 | 240.64 | **X** | **kKU1** | kKu1 | | CH,CO,S,K,P | -- | -- | -- | -- |
| | | | | | | | | kKu1_OH3 | 2012 | CO,S | 0 | 0 | 1 | 2 |
| | | | | | | | | kKu1_OH6 | 2012 | CO,S | 0 | 0 | 0 | 1 |
| | | *Side Arm* | | 335-30-16600 | 240.25 | | **kKu1b** | kKu1b | | CH,CO,S,K,P | -- | -- | -- | -- |
| | **Moose Cr.** | ***Mainstem*** | | 335-30-16600-2039 | 255.99 (1.71) | | kMO1 | kMO1 | 2011 | CO,CH,K | 0 | 0 | 1 | 0 |
| | | | | | | | | kMO1_OH1 | 2010 | CO,CH,K | 0 | 0 | 5 | 0 |
| | | ***Tribs*** | | 335-30-16600-2039-3333 | 265.77 | | kMOT1 | kMOT1 | 2010 | CO | 0 | 0 | 3 | 0 |
| | | | | | | | | | 2011 | CO | 0 | 0 | 1 | 0 |
| | **George R.** | ***Mainstem*** | | 335-20-16600-2741 | 290.66 | **X** | **kGE2** | kGE2 | | CO,CH,K,P | -- | -- | -- | -- |
| | | ***E. F. George R.*** | **Mainstem** | 335-20-16600-2741-3050 | 283.14 | **X** | **kEF2** | kEF2 | | CH,CO,K | -- | -- | -- | -- |
| | | | **Tribs** | 335-20-16600-2741-3050-4150 | 269.68 | | kEFT1 | kEFT1_OH1 | 2010 | CO,K | 0 | 0 | 1 | 0 |
| | | ***N. F. George R.*** | **Mainstem** | 335-20-16600-2741-3075 | 297.80 | **X** | **kNF1** | kNF1 | | CH,CO,K | -- | -- | -- | -- |
| | | | **Tribs** | 335-20-16600-2741-3075-4054 | 297.71 | | **kNFT99** | kNFT99 | | K | -- | -- | -- | -- |
| **Kuskokwim** | **Tributaries** | | | 335-30-16600-2096 | 239.58 | | kKUT3 | kKUT3 | 2010 | CO | 0 | 0 | 1 | 0 |
| | | | **Trib To** | 335-30-16600-2096 | 239.66 (0.06) | | kKUT4 | kKUT4 | 2010 | CO | 0 | 0 | 1 | 0 |
| | | | | 335-30-16600-2101 | 245.14 | | kKUT6 | kKUT6_OH1 | 2010 | CO | 0 | 0 | 1 | 0 |
| **Kuskokwim** | **Tributaries** | | | | | | | kKUT8 | 2010 | CO | 0 | 0 | 51 | 0 |
| | | | | | | | | | 2011 | CO | 0 | 0 | 12 | 0 |
| | | | | | | | | kKUT8_OH1 | 2010 | CO | 0 | 0 | 2 | 0 |
| | | | | | | | | kKUT8_OH2 | 2010 | CO | 0 | 0 | 5 | 0 |
| | | | | | | | | kKUT13_OH1 | 2010 | CO | 0 | 0 | 6 | 0 |
| | | | | | | | | kKUT14 | 2011 | CO | 0 | 0 | 2 | 0 |

[1] Underlined entries denote that actual crossing occurs upstream from current AWC anadromous extent.

[2] Crossing is the code for the original surveyor's crossing location. Crossings shown in red are from ADF&G Anadromous Waters Catalog at the time of sampling. Green shaded area indicates summer construction.

[3] Refer to Aquatics Map Book for site locations.

[4] Crossings previously documented as anadromous by the ADF&G AWC were only sampled if specific proposed infrastructure warranted further refinement of fish species present at Kuskokwim River barge landings and upper Happy River Crossing (sHA3), or to verify anadromous fish species present (e.g., various kTLT sites).

[5] Salmon numbers represent counts of all fish captured during surveys (2010-2013)

Source: OtterTail 2014b

### *4.2.3 Transportation Facilities*

Along the proposed Jungjuk Road from Jungjuk Port to the mine site **(Figure 3.0-1**), salmon are present in Crooked, Getmuna and Jungjuk creeks (Ottertail 2014a), which defines these creeks as EFH. Adults of all five species of salmon enter Crooked Creek; however, most spawn downstream from the proposed Jungjuk Road crossing. Coho salmon are the most numerous spawners upstream from the road crossing, with Donlin Creek, approximately 4 mi (6.4 km) upstream from the road crossing, accounting for 25% of the coho observed during aerial surveys and 20% of the fall redd counts. Chinook, coho, and chum salmon spawn in Getmuna Creek, with highest densities of redds recorded downstream from the proposed Jungjuk Road (**Figure 4.2-1**). Ottertail (2014a) estimated that over 60% of the Chinook in the Crooked Creek drainage spawn in Getmuna Creek, along with almost 50% of the chum salmon entering the drainage.

Coho salmon is the only species that has been observed during aerial surveys along Jungjuk Creek (Ottertail 2014a). Annual coho salmon counts ranged from two fish in 2008 to eight fish in 2011. The uppermost extent of the salmon distribution is a "best-guess" estimate based on aerial observations by OtterTail (2014a). A large beaver dam complex appears to be limiting the upstream extent of coho salmon in Jungjuk Creek. Coho salmon were observed as far upstream in Jungjuk Creek as 1.6 miles (2.6 km) downstream from the lower road crossing.

Sampling was conducted in the Kuskokwim River in vicinity of the Jungjuk Port site in 2011 and 2012 (Ottertail 2014a). In 2011, eight sites were sampled (four upstream, three downstream, and one adjacent to the proposed Port site). In 2012, seven sites were sampled (four upstream, two downstream, and one adjacent to the proposed Port site) (**Figure 4.2-3**). Three gear types or methods were used: 1) seines, 2) fyke nets, and 3) electrofishing. Sockeye salmon were the most numerous juvenile salmon caught, comprising 89% of the captured juveniles (**Table 4.2-7**). Greatest numbers were caught by electrofishing.

The Kuskokwim River is a migration corridor for both returning adult salmon and outmigrating juveniles that access or emigrate from numerous tributaries that provide spawning and rearing habitat (**Figure 4.2-5**). However, the Kuskokwim River does not have substantial rearing habitat within the main channel during summer (Morris et al., 2015). A summary of the general run timing for adult salmon near the mouth of the river indicates that salmon migrate up the river from early June into early September (**Table 4.2-8**).

With the exception of pink salmon, these runs form the backbone of a robust in-river harvest, with subsistence harvests being especially important (**Table 4.2-9**). Chinook salmon are most important to the subsistence economy, but chum, sockeye, and coho are also harvested.

### Table 4.2-7: Results of Sampling in the Kuskokwim River near the Proposed Jungjuk Port Site, 2011 to 2012

| | | Upstream of Port | | | | | | | | Port | | Downstream of Port | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Survey | | KU25 | KU24 | KU23 | KU11 | KU12 | KU9 | | KU10 | KU8 | | KU20 | KU14 | | KU13 | KU15 | Total Fish |
| Method | Species | 2012 | 2012 | 2012 | 2011 | 2011 | 2011 | 2012 | 2011 | 2011 | 2012 | 2012 | 2011 | 2012 | 2011 | 2011 | |
| **Seine** | Chinook salmon | -- | 1 | -- | -- | -- | -- | -- | 1 | 2 | -- | -- | -- | -- | -- | -- | 4 |
| | Chum salmon | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | 1 | -- | -- | -- | 3 |
| | Coho salmon | -- | 1 | -- | -- | -- | -- | -- | -- | 1 | -- | -- | 1 | -- | 1 | -- | 4 |
| | Pink salmon | -- | -- | -- | -- | -- | -- | -- | 3 | -- | -- | -- | -- | -- | -- | -- | 3 |
| | Sockeye salmon | 16 | 22 | -- | 4 | 4 | -- | -- | 9 | -- | -- | -- | 1 | 9 | 3 | -- | 68 |
| *Total # Salmon Captured* | | 16 | 24 | -- | 4 | 4 | 0 | -- | 15 | 3 | -- | -- | 3 | 9 | 4 | 0 | 82 |
| *# Seine Tows* | | 3 | 4 | -- | 3 | 3 | 3 | -- | 3 | 3 | -- | -- | 7 | 6 | 3 | 3 | 41 |
| ***# Fish/Tow*** | | **5.3** | **6.0** | -- | **1.4** | **1.3** | **0.0** | **--** | **5.0** | **1.0** | **--** | **--** | **0.4** | **1.5** | **1.3** | **0.0** | **2.0** |
| *# Species (All Samples)* | | 1 | 3 | -- | 1 | 1 | 6 | -- | 4 | 2 | -- | -- | 3 | 1 | 2 | 6 | 44 |
| **Fyke** | Coho salmon | -- | - | -- | - | -- | -- | -- | - | - | 1 | 2 | -- | - | - | - | 3 |
| | Sockeye salmon | -- | - | -- | - | -- | -- | -- | 1 | - | - | - | -- | - | 1 | - | 2 |
| *Total # Salmon Captured* | | -- | 0 | 0 | 0 | -- | -- | -- | 1 | 0 | 1 | 2 | -- | 0 | 1 | 0 | 5 |
| *# Fyke Net Sets* | | -- | 1 | 1 | 1 | -- | -- | -- | 1 | 3 | 1 | 1 | -- | 1 | 1 | 1 | 12 |
| ***# Fish/24hr Set*** | | **--** | **0.0** | **0.0** | **0.0** | **--** | **--** | **--** | **1.0** | **0.0** | **1.0** | **2.0** | **--** | **0.0** | **1.0** | **0.0** | **0.4** |
| *# Species (All Samples)* | | -- | 0 | 0 | 0 | -- | -- | -- | 1 | 0 | 1 | 1 | -- | 0 | 1 | 0 | 2 |
| **Electrofishing** | Coho salmon | - | - | -- | -- | -- | - | - | -- | 2 | 4 | 12 | -- | -- | -- | -- | 18 |
| | Pink salmon | - | - | -- | -- | -- | - | - | -- | 1 | - | - | -- | -- | -- | -- | 1 |
| | Sockeye salmon | 70 | 14 | 35 | -- | -- | 3 | 41 | -- | 1 | 53 | 7 | -- | -- | -- | -- | 224 |
| *Total # Salmon Captured* | | 70 | 14 | 35 | -- | -- | 3 | 41 | -- | 4 | 57 | 19 | -- | -- | -- | -- | 243 |
| *# Electrofishing Passes* | | 1 | 1 | 1 | -- | -- | 1 | 1 | -- | 1 | 1 | 1 | -- | -- | -- | -- | 8 |
| ***# Fish/pass*** | | **70.0** | **14.0** | **35.0** | **--** | **--** | **3.0** | **41.0** | **--** | **4.0** | **57.0** | **19.0** | **--** | **--** | **--** | **--** | **30.4** |
| *# Species (All Samples)* | | 1 | 1 | 1 | -- | -- | 1 | 1 | -- | 3 | 2 | 2 | -- | -- | -- | -- | 3 |

Source: OtterTail 2014a

**Table 4.2-8: Summary of Kuskokwim River Salmon Run Timing based on Test Fishery at Bethel, 1984 to 2003**

| Species | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct |
|---|---|---|---|---|---|---|---|---|---|---|
| Chinook | | | | | | | | | | |
| Sockeye | | | | | | | | | | |
| Coho | | | | | | | | | | |
| Chum | | | | | | | | | | |
| Pink | | | | | | | | | | |

Dark shading indicates peak entry; light shading indicates fish present.

Source: Bue 2005

Morris et al. (2015) sampled for rearing salmon in the mainstem of the Kuskokwim River from mid-May into early September. From mid-May into late-June, outmigrating chum salmon smolt were the most abundant Pacific salmon species in the catch, with over 21,000 caught during the outmigration sampling. Coho salmon were second in abundance, with 428 caught, followed by sockeye (196), pink (81), and Chinook (45). In contrast, sampling from July into September found few juvenile salmon residing within the mainstem during summer. Sockeye salmon were the most abundant salmon species in the summer catch, with 28 caught from 350 seine hauls in mainstem habitats. Coho salmon were second in abundance with 5 caught, followed by one (1) Chinook, with no chum or pink juvenile salmon captured. The results were interpreted to indicate that there was little use of mainstem habitats by juvenile salmon outside of the smolt outmigration during spring. Rearing Chinook and coho salmon were abundant in the Holokuk and Aniak rivers, two clear water tributaries sampled in August. These results were consistent with sampling at Birch Tree Crossing reported by OtterTail (2014d), where sampling by seine, fyke net, and electrofishing in July 2009 caught 9 juvenile sockeye salmon. The lack of juvenile salmon within the mainstem was likely related to high turbidity and resulting low productivity in mainstem habitats compared to more productive clear water habitats within the many tributaries of the Kuskokwim drainage. Burril et al. (2009) determined that juvenile chum and other salmon species from the Kwethluk River (a tributary of the lower Kuskokwim River) migrate downstream from early May to mid-June. They found that seaward migrations for all Pacific salmon species were generally greatest when water levels were rising and during hours of low light. Based on 2003 and 2004 studies in Kuskokwim Bay, peak abundance of downstream migrating pink, coho, and sockeye salmon was greatest in late May, while chum and Chinook salmon had greatest peak abundance in mid- to late June (Hillgruber and Zimmerman 2009). Similar findings regarding the timing of outmigrating salmon in the Yukon Delta have been observed in other studies (Martin et al. 1986).

**Table 4.2-9: Estimated Salmon Utilization in the Kuskokwim River Management Area, 2007 to 2013**

| Species | Year | Commercial Harvest1[a] | Subsistence Harvest[b] | Test Fish Harvest | Sport Fish Harvest | Total Utilization | |
|---|---|---|---|---|---|---|---|
| Chinook | 2007 | 179 | 100,297 | 305 | 1,478 | 98,117 | |
| | 2008 | 8,865 | 92,977 | 420 | 708 | 108,096 | |
| | 2009 | 6,664 | 83,838 | 470 | 917 | 86,282 | |
| | 2010 | 2,731 | 70,576 | 292 | c | 69,079 | (w/o sport) |
| | 2011 | 49 | 65,850 | 337 | c | 59,048 | (w/o sport) |
| | 2012 | | 25,353 | | | | |
| | 2013 | | 50,708 | | | | |
| Chum | 2007 | 10,763 | 76,281 | 3,237 | 391 | 87,994 | |
| | 2008 | 30,516 | 66,275 | 2,472 | 121 | 101,742 | |
| | 2009 | 76,790 | 46,047 | 2,741 | 285 | 123,451 | |
| | 2010 | 93,148 | 46,797 | 2,872 | c | 142,168 | (w/o sport) |
| | 2011 | 118,256 | 55,990 | 2,289 | c | 169,787 | (w/o sport) |
| | 2012 | | 82,030 | | | | |
| | 2013 | | 55,828 | | | | |
| Sockeye | 2007 | 703 | 49,613 | 488 | 322 | 48,852 | |
| | 2008 | 15,601 | 56,205 | 584 | 273 | 75,187 | |
| | 2009 | 25,673 | 38,795 | 515 | 162 | 61,291 | |
| | 2010 | 22,428 | 41,722 | 495 | c | 61,026 | (w/o sport) |
| | 2011 | 13,842 | 46,290 | 380 | c | 53,562 | (w/o sport) |
| | 2012 | | 50,781 | | | | |
| | 201 | | 42,824 | | | | |
| Coho | 2007 | 141,049 | 35,802 | 1,557 | 2,355 | 180,293 | |
| | 2008 | 142,862 | 46,848 | 2,984 | 3,755 | 196,064 | |
| | 2009 | 104,546 | 32,519 | 2,394 | 3,257 | 139,758 | |
| | 2010 | 58,031 | 35,746 | 1,020 | c | 91,157 | (w/o sport) |
| | 2011 | 74,108 | 34,287 | 1,207 | c | 104,211 | (w/o sport) |
| | 2012 | | 29,971 | | | | |
| | 2013 | | 28,295 | | | | |

[a] Districts 1 and 2 only; does not include personal use.
[b] Estimated subsistence harvest expanded from villages surveyed as reported in Shelden et al. (2015)

“c” = Data unavailable at time of publication.

Note: 2011 – An additional 699 Chinook salmon were caught during commercial periods, but were retained for personal use. These fish are included in the subsistence harvest throughout the post-season subsistence harvest survey methodology.

Source: Brazil et al. 2013

## 4.3. Effects of Proposed Donlin Gold Project

Potential effects on EFH during construction, operation, closure, and reclamation of the Donlin Gold Project primarily involve activities that could remove, alter, or degrade surface water or groundwater and aquatic habitats. Mechanisms that cause direct or indirect impacts on salmon life stages include: in-stream habitat removal and disturbance, water quality degradation, wetland and riparian buffer removal, streamflow changes, stream temperature changes, and bank/streambed erosion and sedimentation (USACE 2015). Appendix G of the NMFS EFH EIS, subsequently updated in 2011, identifies potential impacts associated with mining, road building and pipeline installation, along with recommended conservation measures (NMFS 2005, 2011). A summary of potential Project impacts to Pacific salmon is provided in **Table 4.3-1**.

For this analysis, three degrees of potential impact are defined: low, moderate, and severe as described below.

- Low Degree of Impact: the effect may disturb or displace EFH species, but mortalities are unlikely and fish behavior will likely return to normal after the activity ceases, or no measurable effect on EFH species numbers would result.
- Moderate Degree of Impact: the effect may cause mortality to a limited number of individuals of EFH species, or remove habitat in areas with low densities of EFH species.
- Severe Degree of Impact: the effect may lead to mortality or loss of habitat in spawning areas or high density rearing habitats.

The terms "no impact" or "negligible" impacts are used where impacts are not expected, or are expected to be of such limited effect on EFH that measures are not necessary to ensure that the quality and quantity of EFH are not diminished.

### *4.3.1. Mine Site Facilities*

NMFS (2005, 2011) identifies potential impacts to EFH from mining to include: (1) adverse modification of hydrologic conditions so as to cause erosion of desirable habitats; (2) removal of substrates that serve as habitat for fish and invertebrates; (3) conversion of habitats; (4) release of harmful or toxic materials; and (5) creation of harmful turbidity levels.

**Direct Habitat Loss**

Construction and operation of mine site facilities within the American Creek watershed would result in a loss of 4.1 mi (6.6 km) of perennial aquatic habitat, of which approximately 0.5 mi (0.8 km) is documented as anadromous water for coho salmon rearing (Johnson and Coleman, 2014b). Juvenile coho salmon were caught in the lower reaches of American Creek (**Figure 4.2-3**). In American Creek, there would be a direct loss of stream channel habitat that may support up to 196 (SE=94) juvenile coho salmon due to construction of the mine pit and WRF (ARCADIS 2013). This estimate is considered to be high, because the calculation extrapolated a sample density measured at the downstream end of the impacted reach to the entire lost channel, although ~~though~~ juvenile coho were not found through much of the upstream area (**Table 4.2-5**). The densities of juvenile coho salmon recorded from American Creek are considered to be low within the

**Table 4.3-1: Potential Impacts to Salmon-Bearing Streams in the Mine Facilities Area of the Proposed Donlin Gold Project**

| Table 4.3-1<br>Source of Impact | Impact Duration | Type of Impact | Degree of Severity |
|---|---|---|---|
| Construction of open pit, WRF, contact water dams, and ancillary facilities | Permanent | Loss of 4.1 mi (6.6 km) of aquatic habitat in American Creek, including about 0.5 mi (0.8 km) of coho rearing habitat | Low adverse impact to overall EFH available for rearing<br><br>Moderate adverse impacts because of low coho densities |
| Construction of TSF, seepage recovery system, and ancillary facilities | Permanent | Loss of 1.5 mi (2.4 km) of aquatic habitat in Anaconda Creek, including potential to affect 865 ft (264 m) of coho rearing habitat | Low adverse impact to overall EFH available for rearing<br><br>Moderate adverse impacts to EFH in Anaconda Creek – based on low densities |
| Water flow changes/losses from American and Anaconda Creeks, and pit dewatering | Construction & Operation | Decreased stream flow for Crooked Creek between American Creek and Getmuna Creek, see **Table 4.3-2** for timing and amount of reduction | Low adverse impacts to rearing Chinook and coho salmon during summer because the change in flow results in less than 5% reduction in habitat in the areas with highest abundance of main channel rearing salmon<br><br>Low adverse impacts to rearing Chinook and coho salmon during winter because the change in flow generally results in less than 10% reduction of habitat in the areas with highest abundance of rearing salmon<br><br>Low adverse impacts to most spawning salmon because most spawning is confined to areas where flow reduction is moderated by inflows from Getmuna and Bell creeks<br><br>Negligible to low adverse impacts to spawning coho in the Crooked Creek drainage<br><br>Low to moderate adverse impacts to spawning coho between American Creek and Crevice Creek because decreased stream flow will decrease available spawning area |

| **Table 4.3-1** | | | |
|---|---|---|---|
| **Source of Impact** | **Impact Duration** | **Type of Impact** | **Degree of Severity** |
| | Construction & Operation | Loss of connectivity to off-channel habitats; loss of off-channel habitat area; see **Table 4.3-3** for amounts and locations of loss | Low to moderate adverse impacts to rearing Chinook and coho salmon because there is an overall loss of 26% of connected habitat relative to baseflow conditions |
| | Construction & Operation | Habitat modification of substrates or channel configuration that serve as habitat for fish and invertebrates | Low potential for adverse impacts in areas away from the mine facilities to potentially moderate in stream Crooked Creek reaches adjacent to mine activities between American and Crevice creeks |
| Water temperature changes from alteration to groundwater flow | Construction & Operation | Minor increases in water temperature caused by reduced groundwater inflow | Low potential for adverse impact because temperature changes are within natural range for salmonids |
| Fuel transport, refueling Handling of POL and other chemicals | Construction, Operation, Closure, and Reclamation | Potential release of harmful or toxic materials | Low; adverse effects only if there is a spill that reaches a waterbody |
| Stormwater Runoff/Waste Water Management | Construction, Operation, Closure, and Reclamation | Potential release of harmful or toxic materials | Stormwater (through BMPs) and wastewater will be managed to meet water quality standards that are protective of EFH. There should be no adverse impacts from these sources. |
| Blasting for rock removal | Construction and Operation | Pressures and vibrations have the potential to cause mortality to salmonids | Low, any blasting with potential to harm fish and eggs would be required to meet the ADF&G blasting standards for the protection of fish and eggs. to moderate depending on stream and location |
| Instream construction work | Construction and Operation | Creation of harmful turbidity levels | Low to moderate depending on stream and location |
| Instream bio-monitoring activities | Construction, Operation, Closure, and Reclamation | Introduction of aquatic invasive species | Low with adherence to state law and permitting requirements |

POL = petroleum, oils, and lubricants

BMP = Best Management Practice

Project Area because mean densities in Crooked Creek and other nearby tributaries (Donlin, Dome, and Getmuna creeks) ranged from 2 to 18 times greater (**Table 4.2-5**).

Predicted streamflow decreases also would reduce the amount of aquatic habitat available in the mainstem of Crooked Creek. As flows reduce, the water elevation (stage) would drop, thereby decreasing the wetted stream channel surface area. This would decrease aquatic habitat available for fish and benthic invertebrate production. Potential changes in water depth in Crooked Creek during proposed Project operations would vary seasonally with the particular phase of mining operations and with the distance downstream from the mine site. Using stage-discharge rating curves and stream channel contour mapping, impacts of flow decreases on aquatic habitat surface area in the mainstem of Crooked Creek were estimated for summer and winter season low flow conditions (OtterTail 2015).

Estimates of Crooked Creek habitat loss were predicted based on Year 20, monthly 10-year low flow projections. On a percentage basis, the greatest reduction in winter streamflow in Crooked Creek during Year 20 of operation was predicted to occur between American Creek and Omega Gulch in March under a 10-year low flow scenario. Year 20 of operation is when the lowest water table elevation is predicted as a result of mine dewatering, approximately -1,100 ft amsl (-335 m amsl). During such time and conditions, streamflow is predicted to be reduced by about 30% to 34% during February and March (OtterTail 2015).

*Summer Streamflow Changes*

In Crooked Creek, the lowest summer flows typically occur in June. A 10-year low flow scenario in June during Year 20 of operation is predicted to result in flow reductions between American Creek and Crevice Creek (**Table 4.3-2**). The flow reductions were estimated to reduce overall habitat by 4% to 7%, with the greatest reductions being in riffles (3% to 7% reduction). Riffles provide habitat for macroinvertebrates that are an important food source for rearing salmon. Reductions in run and pool habitat, which are important for rearing Chinook and coho, are estimated to be in the range of 2% to 4%. Reductions in habitat of this magnitude are within the natural range of variation, and impacts to rearing juvenile salmon are expected to be low.

Impacts on Crooked Creek flows downstream of Getmuna Creek during proposed Project operation would be negligible, due to the large inflows from Getmuna Creek. BGC (2014) estimated that Crooked Creek flows at Getmuna Creek would add 42 cubic feet per second (cfs) (1.9 cubic meters per second [$m^3$/sec]) to the 38.5 cfs (1.1 $m^3$/sec) estimated for Crooked Creek at Crevice Creek, while an additional 24.4 cfs (0.7 $m^3$/sec) would be added at Bell Creek, under the estimates for low flow scenarios. These creeks combined, increase the base flow of Crooked Creek by approximately 1.7 times, substantially attenuating any potential adverse effects of flow reductions to EFH and EFH species in the lower drainage.

*Winter Streamflow Changes*

For Crooked Creek, the lowest winter flows typically occur in March. A 10-year low flow scenario in March during Year 20 of proposed Project operation is also predicted to result in flow reductions in Crooked Creek during winter (**Table 4.3-2**). The predicted loss of flow during winter is estimated to cause a 3% to 9% overall loss of habitat within the defined reaches of Crooked Creek, with the greatest loss again being in riffle habitat (6% to 22%). Deeper habitats, such as pools where wintering juvenile salmon would be expected, are estimated to decease by 2% to 4%. Reductions in habitat of this magnitude are within the natural range of variation, and impacts to rearing juvenile salmon are expected to be low.

### Streamflow Changes and Off-Channel Aquatic Habitat

During construction, operation and maintenance, and closure, a reduction in Crooked Creek flow could cause geomorphic changes to the stream channel. These changes could include a slight narrowing of the bankfull width of the channel and encroachment (expanded growth) of riparian vegetation. Reduced flows also could affect the frequency with which off-channel habitat, such as isolated backwaters and oxbows, maintains connection with the main channel. Off-channel habitats along Crooked Creek are used by rearing coho salmon, which were the only EFH species found in these habitats during 2013 (OtterTail 2014a).

**Table 4.3-2: Estimated Reductions in Aquatic Habitat Surface Area for Summer and Winter, Average and Low Flow Conditions during Year 20 of Mine Operations**

| | | | | Summer | | | | Winter | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Crooked Creek Stream Section | Parameter | Habitat Type | # of Units | Undisturbed Summer Mapped Discharge Average | Undisturbed Summer (June) Low flow (10th Percentile) | Disturbed Summer (June) Low flow (10th Percentile) 20-year operations | Percent Reduction of Habitat from Low flow | Undisturbed Winter (Jan) Average | Undisturbed Winter (March) Low flow (10th Percentile) | Disturbed Winter (March) Low flow (10th Percentile) 20-year operations | Percent (%) Reduction of Habitat from Low flow |
| **Crooked Creek Below American Creek (CCBAM)** | Stage (m) | | | 1.49 | 1.09 | 1.01 | | 1.00 | 0.69 | 0.56 | |
| | Habitat Area (ac) | Riffles | 29 | 2.70 | 1.61 | 1.52 | 6% | 1.51 | 1.14 | 1.00 | 12% |
| | | Runs | 55 | 7.40 | 6.29 | 6.14 | 2% | 6.13 | 5.58 | 5.35 | 4% |
| | | Pools | 32 | 3.32 | 2.94 | 2.89 | 2% | 2.89 | 2.71 | 2.64 | 3% |
| | | **Total** | **116** | **13.42** | **10.84** | **10.54** | **3%** | **10.53** | **9.43** | **8.99** | **5%** |
| **Crooked Creek Below Omega Gulch (CCBO)** | Stage (m) | | | 1.45 | 1.01 | 0.95 | | 0.91 | 0.58 | 0.48 | |
| | Habitat Area (ac) | Riffles | 22 | 2.01 | 1.15 | 1.12 | 3% | 1.09 | 0.90 | 0.84 | 6% |
| | | Runs | 54 | 13.35 | 10.97 | 10.78 | 2% | 10.67 | 9.70 | 9.42 | 3% |
| | | Pools | 19 | 2.82 | 2.50 | 2.47 | 1% | 2.45 | 2.30 | 2.25 | 2% |
| | | **Total** | **95** | **18.18** | **14.62** | **14.37** | **2%** | **14.22** | **12.90** | **12.51** | **3%** |
| **Crooked Creek Below Anaconda Creek (CCBA)** | Stage (m) | | | 1.46 | 0.92 | 0.87 | | 0.87 | 0.53 | 0.42 | |
| | Habitat Area (ac) | Riffles | 14 | 3.25 | 1.04 | 0.98 | 7% | 1.00 | 0.67 | 0.53 | 22% |
| | | Runs | 24 | 10.64 | 8.41 | 8.16 | 3% | 8.25 | 7.19 | 6.64 | 8% |
| | | Pools | 3 | 0.58 | 0.49 | 0.48 | 2% | 0.48 | 0.44 | 0.42 | 4% |
| | | **Total** | **41** | **14.47** | **9.94** | **9.62** | **3%** | **9.73** | **8.31** | **7.59** | **9%** |
| **Crooked Creek Below Crevice Creek (CCAC)** | Stage (m) | | | 1.52 | 0.99 | 0.90 | | 0.89 | 0.53 | 0.43 | |
| | Habitat Area (ac) | Riffles | 64 | 18.73 | 10.45 | 9.77 | 6% | 9.69 | 6.70 | 6.01 | 10% |
| | | Runs | 81 | 53.83 | 43.19 | 41.66 | 4% | 41.47 | 35.67 | 33.82 | 5% |
| | | Pools | 13 | 4.22 | 3.50 | 3.39 | 3% | 3.38 | 2.98 | 2.86 | 4% |
| | | **Total** | **158** | **76.78** | **57.14** | **54.83** | **4%** | **54.55** | **45.34** | **42.69** | **6%** |

Notes:

Some totals may not sum due to rounding.
m = stage in meters
ac = acres
Conversion: 1 acre = 0.4 hectares
Source: OtterTail 2015

A reduction in off-channel or in-channel winter habitat may adversely affect the survival of overwintering juvenile coho salmon if flows are reduced to the point where the water column becomes too shallow and freezes completely.

The number of off-channel units and corresponding areas connected to the main channel relative to estimates of total off-channel habitat surface area were calculated for baseflow conditions, at baseflow minus 16% (see Notes in **Table 4.3-3**), and at flows representing 25%, 50%, 75%, and 100% of bankfull (OtterTail 2012b) (**Table 4.3-3**). Crooked Creek from Donlin Creek downstream to American Creek has a high percentage of off-channel habitat surface area connected to the main channel at baseflow (89%). A 16% flow reduction from baseflow conditions, based on predicted flow depletion estimates in this reach in Year 20 of operations, is predicted to result in a 5% change in off-channel habitat connectivity (from 89% to 84%) and a 20% reduction in connected off-channel habitat surface area (reduced from 0.66 acre to 0.53 acre [0.27 hectare to 0.21 hectare]) (OtterTail 2012b). The greatest loss of off-channel habitat is predicted to be from Anaconda Creek to Crevice Creek where a 53% reduction in connected off-channel habitat surface area is predicted (reduced from 1.75 acres to 0.82 acre) (0.71 hectare to 0.33 hectare) (OtterTail 2012b).

Overall, without mitigation, along the Crooked Creek corridor between Donlin Creek and the Kuskokwim River the range of predicted reduction in connectivity and reduced surface area of off-channel habitat during mine construction, operation, and closure is expected to have a moderate adverse effect on rearing coho salmon that will persist through the Project duration. The greatest impact would be to rearing coho salmon between Donlin Creek and Getmuna Creek during winter.

**Streamflow Changes and Salmon Spawning Habitat**

Habitat losses from flow reductions can result in adverse impacts to both the availability of suitable spawning areas and the viability of eggs incubating in salmon redds during winter, particularly under low flow. However, based on the distribution of salmon redds documented in the mainstem Crooked Creek in 2009 by OtterTail (2014e), there would be no adverse impact to salmon spawning habitat in the lower reaches of the creek despite predicted flow reductions in the middle reaches of the mainstem near the mine. This is primarily due to the large proportion of inflows contributed to the mainstem channel in the lower drainage from Getmuna and Bell creeks. The average June baseflow in Year 10 for Crooked Creek at Crevice Creek is estimated to average 82 cfs (2.3 $m^3$/sec), at Getmuna Creek the estimated average more than doubles to 171 cfs (4.9 $m^3$/sec), and further increases to 223 cfs (6.3 $m^3$/sec) at Bell Creek (BGC 2015). Salmon redds observed in 2009 were distributed far more abundantly in the lower reaches of Crooked Creek where proportionally higher baseflows typically occur as compared to reaches farther upstream near the mine site (OtterTail 2012b).

**Table 4.3-3: Off-Channel Habitat Connectivity and Estimated Surface Area for Various Flow Conditions for Mainstream Crooked Creek (2009)**

| Flow Conditions | Parameter | Reach Description | HAB5 Flat to American | HAB4 American to Anaconda | HAB3 Anaconda to Crevice | HAB2 Crevice to Getmuna[2] | HAB1 Getmuna to Mouth[3] | Total |
|---|---|---|---|---|---|---|---|---|
| **Baseflow Minus 16%[1]** | Total Area | acres | 0.63 | 1.90 | 1.47 | 10.4 | 3.20 | 17.60 |
| | Units Connected | # | 7 | 11 | 1 | 10 | 2 | 31 |
| | Area Connected | acres | 0.53 | 1.83 | 0.82 | 5.75 | 2.34 | 11.27 |
| | % Connected [4] | % | 84 | 96 | 56 | 55 | 73 | 64 |
| | % Baseflow Loss | % Loss | 20 | 17 | 53 | 30 | 4 | 26 |
| **Baseflow** | Total Area | acres | 0.74 | 2.26 | 1.75 | 12.38 | 3.81 | 20.95 |
| | Units Connected | # | 10 | 11 | 3 | 12 | 3 | 39 |
| | Area Connected | acres | 0.66 | 2.20 | 1.75 | 8.22 | 2.45 | 15.29 |
| | % Connected [4] | % | 89 | 97 | 100 | 66 | 64 | 73 |
| **25% Bankfull1** | Total Area | acres | 0.98 | 3.36 | 2.36 | 17.37 | 5.63 | 29.70 |
| | Units Connected | # | 12 | 13 | 3 | 12 | 3 | 43 |
| | Area Connected | acres | 0.91 | 3.33 | 2.36 | 11.34 | 3.92 | 21.86 |
| | % Connected [4] | % | 93 | 99 | 100 | 65 | 70 | 74 |
| **50% Bankfull1** | Total Area | acres | 1.22 | 4.46 | 2.96 | 22.36 | 7.44 | 38.44 |
| | Units Connected | # | 13 | 14 | 3 | 14 | 3 | 47 |
| | Area Connected | acres | 1.22 | 4.46 | 2.96 | 15.64 | 5.39 | 29.67 |
| | % Connected [4] | % | 100 | 100 | 100 | 70 | 72 | 77 |
| **75% Bankfull1** | Total Area | acres | 1.67 | 6.31 | 4.31 | 30.58 | 10.33 | 53.20 |
| | Units Connected | # | 13 | 14 | 3 | 14 | 3 | 47 |
| | Area Connected | acres | 1.67 | 6.31 | 4.31 | 25.32 | 7.08 | 44.68 |
| | % Connected [4] | % | 100 | 100 | 100 | 83 | 69 | 84 |
| **Bankfull1** | Total Area | acres | 2.11 | 8.17 | 5.65 | 38.81 | 13.22 | 67.96 |
| | Units Connected | # | 13 | 14 | 3 | 21 | 4 | 55 |
| | Area Connected | acres | 2.11 | 8.17 | 5.65 | 38.81 | 13.22 | 67.96 |
| | % Connected [4] | % | 100 | 100 | 100 | 100 | 100 | 100 |

[1] Table represents off-channel habitats with connectivity at or below bankfull stage only. A 16% reduction represents flow depletion estimates from Crooked Creek at American Creek (BGC 2011).

[2] Lower portions of reach HAB2 may not experience 16% flow reductions due to tributary contributions.

[3] Getmuna Creek to the mouth of Crooked Creek would not likely experience a 16% reduction in baseflow due to tributary contributions.

[4] % Connected = Area Connected/Total Area

Conversion: 1 acre = 0.4 hectare

Source: OtterTail 2012b

Impacts of flow reductions from mine construction and operation on salmon spawning redds were evaluated using a flow depletion model to predict conservative estimates of decreases in water surface elevation and known locations and depths of salmon redds as measured during 2009 spawning surveys. Based on this analysis, it was determined that 65% (11 of 17) of the redds in Crooked Creek between American Creek and Anaconda Creek and 78% (7 of 9) of redds between Anaconda Creek and Crevice Creek were in gravels that would be outside the predicted wetted portions of the stream channel during winter low flow conditions during construction and operation. From Crevice Creek to Getmuna Creek, 2% (3 of 144) of redds observed during the 2009 survey would have been above the predicted winter low flow water line during proposed Project operation. Most redds in the reach between American Creek and Crevice Creek are likely from coho salmon because the redds were detected during fall surveys when coho salmon were present (OtterTail 2014a). Impacts of reduced flow may range from low to moderate in the middle reaches of Crooked Creek depending on the availability of alternative suitable spawning habitat for coho salmon.

Of the 532 salmon redds observed in 2009 during summer ground surveys along the mainstem Crooked Creek, more than 94% were downstream of Crevice Creek and over 88% were from approximately 4 mi (6.4 km) upstream from Getmuna Creek to the Kuskokwim River (OtterTail 2012b). Aerial observations from surveys conducted from 2004 to 2010 documented an annual average of 354 adult salmon in the Crooked Creek mainstem with 314 (88%) observed between Crevice Creek and the Kuskokwim River and 295 (83%) observed from approximately 4 mi (6.4 km) upstream from Getmuna Creek to the Kuskokwim River. Along the middle reaches of the creek near the mine site, the observed adult salmon density was considerably lower where an annual average of 40 adult salmon (12%) were observed, consisting primarily of coho and chum salmon. This indicates that, in recent years, salmon distribution has been relatively limited in the middle reaches of Crooked Creek and that relatively fewer summer redds produced near the mine site would be subject to flow reductions predicted to occur in this area during proposed operation.

**Streamflow Changes and Freezing of Spawning Substrates**

From late September 2010 to early June 2011, a study was conducted to assess the depth of stream substrate freezing along the mainstem of Crooked Creek between Flat Creek and Getmuna Creek. This study was conducted under low flow conditions and focused on areas where potential salmon spawning would be expected near the tails of pools. Based on the flow conditions observed during the study, substrate freezing was not observed in water depths greater than 1.6 ft (0.5 m). This indicates that potential over-wintering habitat for juveniles and incubating salmon eggs exists in certain areas of Crooked Creek (OtterTail 2012c).

Summer and winter flow reductions are anticipated in the middle reaches of Crooked Creek near the proposed mine site, but are not expected to have adverse impacts to salmon redds in the majority of the Crooked Creek mainstem. The majority of observed spawning habitat and adult salmon spawning distribution occurred in the lower river where predicted reductions of winter baseflows would be substantially buffered by tributary inflows (BGC 2013a, 2014).

**Streamflow Changes and Salmon Production**

Estimated changes to the flow regime in the Crooked Creek mainstem during proposed mine operation and closure are not expected to result in adverse impacts on salmon production of the Kuskokwim River system, because the Crooked Creek drainage comprises less than 1% of the total area of the Kuskokwim River watershed (Wang 1999). Based on 2008 to 2012 weir counts near the mouth of Crooked Creek, the average annual salmon escapement totaled 3,600 fish. The annual averages consisted of 59 Chinook salmon (range 29 to 100); 1,907 chum salmon (range 832 to 3,755); and 1,634 coho salmon (range 591 to 4,204) (OtterTail 2012b).

As previously described in Section 4.2.1, the distribution of adult spawning salmon in the Crooked Creek mainstem was determined from aerial surveys conducted between 2004 and 2010 where an annual average of 354 salmon was documented. Of these, 314 (88%) were observed between Crevice Creek and the Kuskokwim River; however, the majority (295, 83%) were observed farther downstream from Eagle Creek to the Kuskokwim River. Over these years, an annual average of 40 adult salmon (12%) were documented either upstream of the proposed mine site or in the middle reaches of Crooked Creek west of the mine site.

While salmon escapement values for the entire Kuskokwim River system are not available, because all tributaries are not surveyed or enumerated, annual ADF&G Chinook salmon escapement goals for all 14 monitored tributaries combined were 25,050 to 59,730 (aggregate escapement goal range) (Conitz et al. 2012). By comparison, the average 2008 to 2012 Chinook salmon escapement at the Crooked Creek weir represents between 0.1% and 0.2% of the total escapement goal range for all 14 Kuskokwim River stocks for which escapement goals have been established.

Similarly, the average 2008 to 2012 chum salmon escapement past the Crooked Creek weir represents 0.3% to 0.8% of the total escapement goal for the four Kuskokwim River stocks for which escapement goals have been established (Conitz et al. 2012). The average 2008 to 2012 coho salmon escapement past the Crooked Creek weir represents 3.4% to 4.9% of the total escapement goal for the three Kuskokwim River stocks for which escapement goals have been defined (Conitz et al. 2012).

Predicted reductions in surface flows, instream habitat quantity and quality, and over-wintering conditions in Crooked Creek due to the proposed Project are predominately limited to the middle reaches of Crooked Creek near the proposed mine site and well upstream of Getmuna Creek. In recent years, spawning salmon densities within the middle reaches of Crooked Creek have been limited; whereas, most Chinook, coho, and chum salmon spawning has been observed downstream of Getmuna Creek and/or within Getmuna Creek and Bell Creek (OtterTail 2012b). Thus, any percentage comparison of total salmon escapement based on Crooked Creek weir counts versus total escapement goals for the Kuskokwim River system tends to reflect the relative contribution of Crooked Creek stocks that primarily spawn in the lower reaches of Crooked Creek. Therefore, there is no anticipated adverse impact from the proposed mine operation and closure relative to total salmon abundance in the overall Kuskokwim River drainage. However, there is expected to be an adverse impact to rearing habitat available to Chinook and coho salmon, and spawning habitat for coho salmon, in the reaches adjacent to and immediately downstream from the mine site area.

### Stream Temperature Changes

The potential for stream temperature changes to have adverse effects on EFH were evaluated and determined to be negligible, although changes vary between mine construction and operation and mine closure. During construction and operation, stream temperatures in drainages downstream of the mine facilities are anticipated to remain relatively constant. Both surface water and groundwater from the American Creek and Snow Gulch drainages would be diverted to the mill processing circuit. While this would reduce the volume of flow ultimately reaching Crooked Creek, the amount of heat energy per unit volume of water would not be expected to appreciably change.

### Discharges

Treated water from mine operations would be discharged to Crooked Creek pursuant to an individual Alaska Pollutant Discharge Elimination System (APDES) permit. The water would be treated to meet drinking and aquatic life water quality standards and, therefore, would not be expected to have an adverse effect on EFH.

Proposed mining activities during construction, operation, and reclamation have the potential to release sediment into local drainages and tributaries from a range of activities and sources because of:

- soil disturbance and vegetation removal
- wetland in-filling that reduces sediment retention and exposes soils to erosive forces of wind and/or water
- stream erosion from increased flows resulting from inter-basin diversions and transfers
- runoff from constructed roads, airstrips, and materials sites.

However, a comprehensive array of construction and operational BMPs featuring control systems for erosion, sediment, and stormwater, will be incorporated into the proposed Project as discussed in Section 5.0. Discharges of stormwater would be authorized under the APDES Construction General Permit (during construction) and Multi-Sector General Permit (during operation), which requires implementation of Stormwater Pollution Prevention Plans (SWPPPs) and BMPs to provide a means to ensure that stormwater discharges do not exceed water quality standards. These and other mitigation measures are described in Section 5.0. BMPs are expected to be effective to minimize sediment additions; therefore, no adverse effects on EFH are expected due to sedimentation.

### Blasting

Frequent blasting activity would occur as the open pit is developed. Because the east side of the open pit would be within close proximity to Crooked Creek (< 1,000 ft) (<305 m), it is possible that fish could be affected by this activity at some point during pit development. More infrequent blasting could occur during Project construction at other locations of the Project on an as-needed basis. It is anticipated that blasting agents would consist of 70% emulsion and 30% ammonium nitrate and fuel oil (ANFO), based on projected moisture conditions. Pressures and vibrations generated from blasting have the potential to cause mortality to salmonids (ADF&G 2013). Shock can also cause mortality of eggs and larvae. The sensitivity to shock varies with the developmental stage of fish (ADF&G 1991). The estimated pressure and vibration forces generated by blast forces have not been calculated yet, pending future pit development plans. The use of blasting within or near fish-bearing waterbodies will be reviewed by the ADNR with input from ADF&G. Regulatory compliance and collaboration with agency staff would occur as the final stages of the proposed Project design are accomplished. Following ADF&G blasting standards will likely result in no adverse effects to fish life stages from blasting for those stream reaches in close proximity to the mine area. Stream reaches with the greatest habitat use by EFH species (i.e. Getmuna Creek, Bell Creek, and lower Crooked Creek) are far enough away from any blasting that adverse impacts would not be expected.

**Aquatic Invasive Species**

Invasive fish species and aquatic plant species (aquatic nuisance species (ANS)) could be transported within the drainages proximate to the mine site during both construction and operations. However, no ANS species are currently present within the drainages and risk of transfer from other regions of the state is minimal. However, routine aquatic biomonitoring and hydrology studies pose some risk of transferring ANS plant species to the Crooked Creek drainage. To help reduce the spread of aquatic invasive species, these activities will adherence to: ADF&G Fish Resource Permit conditions requiring that fish sampling gear be decontaminated prior to use, state laws prohibiting use of felt-soled wading equipment, and the ADF&G 4 step guidelines (see Section 5.2.1).

### *4.3.2. Natural Gas Pipeline*

The natural gas pipeline would cross numerous streams within the Cook Inlet, Skwentna, Yentna, and Kuskokwim drainages. Mainstem and tributary salmon habitat streams crossed by the proposed pipeline route include: Theodore River, Alexander Creek, Skwentna River, Eightmile Creek, Shell Creek, Happy River, Skwentna tributaries, Yentna River, South Fork Kuskokwim River, Windy Fork Kuskokwim River, Middle Fork Kuskokwim River, Big River, Tatlawiksuk River, Kuskokwim River, Moose Creek, Moose Creek tributaries, George River, East Fork George River, North Fork George River, and Kuskokwim River tributaries. Excluding the Yentna, all major drainages along the proposed pipeline route (Cook Inlet, Skwentna, and Kuskokwim) are classified as EFH under the MSA.

**Habitat and Hydrology Modifications**

Probable short-term impacts are alteration or temporary loss of fish habitat in the immediate vicinity of work activity and temporary obstruction to fish passage during construction (**Table 4.3-4**). Temporary loss of habitat may result from diverting rivers or stream channels, removing riparian vegetation, excavating streambed materials, or altering water quality (SRK Consulting 2013). Other potential impacts could occur as a result of stormwater runoff carrying suspended solids, and reduced flows during withdrawals for ice-road construction. Effective implementation of BMPs during pipeline construction and operations provide a means to avoid adverse effects to salmon streams. A comprehensive selection of construction and operational BMPs, including erosion, sediment, and stormwater control systems would be implemented in the proposed Project. Examples of control measures to be implemented are included in Section 5.3 below and in Appendix H of the Natural Gas Pipeline Plan of Development (SRK Consulting 2013). Over 68% of pipeline construction would be completed during winter conditions to limit impacts of soil and surface water disturbance. **Table 4.2-6** indicates the seven EFH stream pipeline crossings that would be constructed during summer. Of these, three crossings would be accomplished using HDD methods in the George River drainage (**Table 4.2-6**).

**Water Removal and Use**

Potential impacts to EFH from construction of the natural gas pipeline could result from the withdrawal of water from local lakes and streams to construct temporary ice roads and the use and release of water during pipeline hydrotesting. These activities have the potential to affect local water levels, stream flows, and water quality; however, water withdrawals are controlled by requirements specified by the Alaska Department of Natural Resources (ADNR) water use permits that establish limits, based on input from ADF&G, on the amount of water that can be withdrawn from various sources to protect fish. Water withdrawal sites within EFH, would also be controlled by ADF&G issued Fish Habitat Permits that would be conditioned to minimize impacts to anadromous fish and their habitats. The rate and volume of water withdrawal would be monitored at each source to ensure permit compliance so that over-wintering fish populations are sustained.

Discharge of hydrostatic testing water requires authorization from the Alaska Department of Environmental Conservation (ADEC) (2012) and must meet applicable water quality standards. Based on the effective implementation of these measures and proposed compliance monitoring, no adverse impacts to Pacific salmon are expected from water withdrawal during pipeline construction and hydrostatic testing.

**Table 4.3-4: Potential Impacts to Salmon-Bearing Streams along the Proposed Natural Gas Pipeline**

| Source of Impact | Impact Duration | Type of Impact | Degree of Severity |
|---|---|---|---|
| Temporary stream diversions for pipeline trenching activities & water extraction | Construction | Modification of hydrologic conditions | Low, most construction is scheduled for winter; Tatina River, Moose Creek, 1 Moose Creek tributary and 5 crossings in the George River scheduled for summer construction (see **Table 4.2-6**) |
| Instream construction work | Construction | Habitat modification of substrates or channel configuration that serve as habitat for fish and invertebrates | Low, most construction is scheduled for winter; Tatina River, Moose Creek, 1 Moose Creek tributary and 5 crossings in the George River scheduled for summer construction (see **Table 4.2-6**) |
| Water withdrawal | Construction | Reduction in Wintering Habitat | Low, permits for water removal set criteria to avoid impacts to wintering fish |
| Stormwater runoff | Construction | Creation of harmful turbidity levels | Low, most construction is scheduled for winter; Tatina River, Moose Creek, 1 Moose Creek tributary and 5 crossings in the George River scheduled for summer construction (see **Table 4.2-6**) |
| Fuel transport, refueling. Handling of POL and other chemicals. HDD drilling. Hydrostatic testing | Construction and Reclamation | Potential release of harmful or toxic materials | Low, construction is scheduled for winter, except 3 HDD crossings in the George River are scheduled for summer |
| Water withdrawal, non-HDD pipeline installation | Construction | Potential introduction of aquatic invasive species | Low, screened intake devices would prevent transfer of fish and winter construction would reduce potential for transfer of viable aquatic invasive plants |

### Spills and Leaks

Risks relating to spills or leaks of fuel during pipeline construction or operation would be reduced by implementing appropriate prevention, inspection, maintenance, monitoring, and response programs. Fuel would be dispensed to the contractor's fuel trucks on the ROW or at camp. There would also be a propane storage facility so that contractors can refuel their preheat equipment. Appropriate spill containment kits and procedures would be in place to address fueling and spills while fueling.

**Blasting**

During pipeline construction, some blasting may be required in the Project Area primarily associated with material borrow sites. All blasting would be conducted in accordance with state and federal regulatory requirements. This topic is covered in greater detail in Section 4.3.1.

**Horizontal Directional Drilling**

HDD is proposed to be used to cross six major EFH drainages; however, the drilling technique poses some potential for impacts from loss of fluid through subsurface fractures (frac-out), unconsolidated gravel or coarse sand. Drilling mud (fluid) used in HDD poses a low risk to water bodies and wetlands.

After HDD begins, specific monitoring would be conducted to determine whether a subsurface fluid loss occurs. To provide a means to ensure that the pressure on the drilling fluid is set to match the formation, the pressure levels would be set as low as possible and closely monitored. The pressure should not exceed what is needed to penetrate the formation. A significant drop in the pressure, or drop in mud return, could indicate a potential fluid loss and drilling would be halted immediately. Details regarding prevention, detection, and response to a potential frac-out or drilling fluid release would be addressed in the HDD Plan and Spill Prevention Control and Countermeasures (SPCC) Plan. Impacts to salmon from HDD construction are expected to be low because the activity will be conducted under BMPs, the drilling mud used is non-toxic, and any increase in turbidity caused by a low-probability fluid loss would be temporary.

**Aquatic Invasive Species**

Invasive fish species and aquatic plant species (ANS) could be transported within and between drainages along the pipeline route during construction. However, the intake of fish would be prevented because screened intake devices would be used at water withdrawal locations. In addition, water placed on the ground for ice pad construction would freeze upon placement, further reducing the likelihood of viable invasive fish species or plant species transfer between sites. If *Elodea spp.* were detected at any work site, additional protocols would need to be developed and employed to eliminate the potential spread of this cold-tolerant aquatic plant species. However, to date, Elodea has not been identified proximate to any of the work spreads along the pipeline. Summer work spreads occur within the same general drainage areas so the potential for movement of ANS to neighboring drainages would be reduced. Overall, the potential to transfer ANS along the pipeline corridor is low.

### *4.3.3. Transportation Facilities*

Proposed transportation facilities include a Port at Jungjuk Creek on the Kuskokwim River, an access road that connects the mine to the Port (Jungjuk Road), and an airstrip at the mine site. Fuel and cargo would be transported along the Kuskokwim River by barge to Jungjuk Port. Potential impacts from the proposed transportation facilities are summarized in **Table 4.3-5**.

**Mine Access Road**

The access road from Jungjuk Port to the mine site will cross about 50 streams or drainages; six of those are EFH that are planned to be crossed by bridge (**Table 4.3-6**). Culverts for smaller, non-fish-bearing crossings would vary in diameter from 24- to 72 inches (61 to 183 cm). Starting from the proposed Jungjuk Port site, the streams include several unnamed tributaries to the Kuskokwim River and Jungjuk Creek, Jungjuk Creek, south and north forks of Getmuna Creek, an unnamed tributary of the South Fork of Getmuna Creek, an unnamed tributary of the North Fork of Getmuna Creek, and Crooked Creek.

_Instream Work_ – Along the mine access road, impacts associated with construction and operation could temporarily degrade water quality and, therefore, could affect salmon populations. One two-lane steel girder bridge and five steel arch bridge structures would be used, which should minimize alteration of flow and habitat at these crossing sites. Fish passage design standards developed by ADF&G will be used to accommodate anticipated levels of flow, maintain sufficient channel width, and minimize slope changes. The remaining streams, which are non-fish-bearing, would be crossed by installed culverts.

_Increased Turbidity_ – Stormwater would be managed by implementing BMPs. With adherence to Project BMPs during construction and operation, impacts to salmon from increased turbidity resulting from stormwater runoff should be low, and there are likely to be no long-term adverse impacts to salmon habitat due to the mine access road.

**Table 4.3-5: Potential Impacts to Salmon-Bearing Streams from Proposed Project Transportation Facilities**

| Source of Impact | Impact Duration | Type of Impact | Degree of Severity |
|---|---|---|---|
| Mine Access Road | Construction | Instream work on bridges/culverts. Habitat modification of substrates or channel configuration that serve as habitat for fish and invertebrates | Low, because bridges will be used to cross EFH streams |
| | Construction | Potential for elevated turbidity levels during construction | Low with implementation of effective BMPs; potential for moderate impacts in the event of rare accidents in EFH streams when salmon are present |
| | Construction | Construction and operation of floodplain material site at Getmuna Creek | Low with implementation of effective BMPs. The material site has no connection to Getmuna Creek, so there should be no direct impacts |
| | Permanent | Fuel transport, refueling. Handling of POL and other chemicals. Potential release of harmful or toxic materials | Low with implementation of effective BMPs and SPCC plans. Potential for moderate impacts in the event of rare uncontrolled spills in EFH streams when salmon are present |
| Jungjuk Port | Construction and Operation | Increased turbidity from dredging during construction, propeller wash during operation | Negligible during most of the year when salmon are absent, low potential for impacts during juvenile outmigration |
| | Construction | Pile driving to install sheet piles | Negligible during most of the year when salmon are absent; low when salmon are present with implementation of ADF&G permit conditions related to in-water noise monitoring and mitigation measures |
| | Permanent | Fuel transport, refueling. Handling of POL and other chemicals. Potential release of harmful or toxic materials | Low with implementation of effective BMPs and SPCC plans. Potential for moderate impacts in the event of rare uncontrolled spills when salmon are present |
| Increased barge traffic | Construction, Operation, and Closure | Increased boat wake effects, which could increase current shoreline erosion rates, habitat and water quality degradation | Low, mostly confined to smolt outmigration at locations along cut-banks where the channel narrows |

| Source of Impact | Impact Duration | Type of Impact | Degree of Severity |
|---|---|---|---|
| | Construction, Operation, and Closure | Fish displacement and stranding | Negligible to low, mostly confined to smolt outmigration at locations with shallow gradient shoals exposed to wave run-up |
| | Construction, Operation, and Closure | Possible increase in fish injury or mortality for propeller strikes during barge maneuvering | Low, mostly confined to mid-channel region near the thalweg during smolt outmigration from mid-May to late June |
| | Construction, Operation, and Closure | Bed scour and associated increased turbidity | Low, temporary displacement of migrating salmon |
| | Permanent | Fuel transport, refueling. Handling of POL and other chemicals. Potential release of harmful or toxic materials | Low with implementation of effective BMPs and SPCC plans. Potential for moderate impacts in the event of rare uncontrolled spills when salmon are present |
| | Construction, Operation and Closure | Introduction of Invasive Species | Low with compliance with recommended conservation procedures |

**Table 4.3-6: Proposed Bridge Crossings of EFH Streams along the Proposed Mine Access Road**

| Stream Name | Road MP/KM From Mine | Span feet-inches (m) | Type of Bridge |
|---|---|---|---|
| Crooked Creek | 0.2 / 0.3 | 84-7 (25.8) | steel girder |
| North Fork Getmuna Creek | 16.1 / 26.0 | 44-5 (13.5) | steel arch |
| South Fork Getmuna Creek | 17.2 / 27.7 | 44-0 (13.5) | steel arch |
| Getmuna Tributary | 17.5 / 28.2 | 30-10 (9.4) | steel arch |
| Jungjuk Creek, Upper Crossing | 24.1 / 38.7 | 30-0 (9.1) | steel arch |
| Jungjuk Creek, Lower Crossing | 24.8 / 39.9 | 40-7 (12.3) | steel arch |

*Floodplain Material Sites* – Material site MS-10, at the confluence of the north and south forks of Getmuna Creek, will consist of a series of eight cells covering approximately 205 acres (83 hectares) created by excavating material for the proposed mine access road from the Jungjuk Port site to the mine area. The cell complex is close to both the south and north forks of Getmuna Creek. Fish abundance and populations are documented for the south fork of Getmuna Creek and data indicate that a number of species, including coho salmon, reside in and use the reaches above and below the proposed material site for spawning and rearing. Initial evaluation of topographic and satellite imagery suggested that remnant highwater channels might exist between the proposed material site and the south fork of Getmuna Creek. However, subsequent aerial reconnaissance conducted during July 2012 revealed that these are relict channels overgrown with vegetation with no surface connection to south fork of Getmuna Creek. A late winter aerial reconnaissance was conducted in March 2012 and no observable ice overflow or *aufeis* fields were noted. Because there is no active connection to Getmuna Creek and work at the material site will be isolated from contact with the stream, adverse effects to EFH from operation of the material site are unlikely. At the end of its use as a material site, the remaining pit will likely fill with groundwater.

Chemical Transport and Spills – There is potential for accidental release of chemicals used in various activities associated with mining in general. Overland fuel transport would be conducted under a SPCC plan to prevent impacts to surface water quality. Operations at the Jungjuk Port would also require that a Facility Response Plan be developed and implemented. An Oil Discharge Prevention and Contingency Plan (ODPCP) would be developed and implemented for fuel handling and storage operations at the mine and Port, and for transportation on the Kuskokwim River. Potential for impacts to surface water quality from a release from storage tanks at the Port would be minimized through installation of secondary containment around fuel storage as required by state and federal regulations.

**Jungjuk Port**

Propeller Wash Erosion – Construction at the Jungjuk Port site would occur over an area of about 26 acres (10.5 hectares), of which 4.4 acres (1.8 hectares) are below the ordinary high water mark. Impacts from construction would involve loss of aquatic habitat along the shoreline where a sheet-pile wall would be installed.

During operation, tugs would maneuver barges with propeller wash disturbing riverbed substrates and local fish populations. Densities of juvenile salmon are low during most of the summer, so the potential for adverse impacts from these activities would be confined to the 5- to 6-week period of outmigration in mid-May to late June. However, because barging is likely to commence in June of each year, impacts would primarily be limited to the first few weeks of June when primarily chum salmon smolt would be present. Such impacts would occur over the duration of the Project, affecting salmon populations in the Kuskokwim River system upstream from the Port facility. Anticipated adverse impacts to EFH species are expected to be negligible during most of the year because few salmon use habitats outside of the outmigration and adult return migration periods. Adult salmon will likely avoid the area of activity during their return migration.

Pile Driving Impacts – Pile driving would be used to install the sheet piles to construct the bulkhead earth-retaining system needed to protect the dock against ice loading. Ruggerone et al. (2008) investigated the effects of pile-driving exposure on caged yearling coho salmon. Fish were placed in cages near (6 to 22 ft) (1.8 to 6.7 m) and far (50 ft) (15.2 m) from 14 hollow steel piles (1.67 ft diameter) (0.51 m diameter), and exposed to sound from 1,627 strikes over a 4.3-hour period. Sound levels were measured in both the near and far cages. In the near cage, peak sound pressure levels (SPL) reached 208 decibels (dB) relative to 1 microPascal (re 1 μPa) and sound exposure levels (SEL) reached 179 dB re 1 μPa, leading to a cumulative SEL of approximately 207 dB re 1 μPa during the 4.3-hour period. (SEL is the integration over time of the square of the acoustic pressure. It is an indication of the total acoustic energy received by an organism.) Sounds did not exceed ambient in control cages that were kept far away from the region of pile driving. Caged fish were sampled at 10- and 19 days post exposure. The investigators found no mortality in any animals, and examination of the external and internal anatomy (gross observations and not histopathology) showed no differences between exposed and control animals.

Hart Crowser (2010) investigated effects of pile driving on juvenile coho salmon during construction of the Port of Anchorage Marine Terminal. The study exposed juvenile coho salmon to sound pressures generated by the impact and vibratory pile driving of sheet piles during the normal course of construction of the Port of Anchorage Marine Terminal Redevelopment Project. Despite attempts to expose fish to maximum potential noise, the study of sheet pile driving measured relatively low levels of sound energy compared with exposures to pipe pile driving reported in the literature to cause adverse effects on fish. No immediate or delayed mortality and no evidence of barotraumatic injury associated with sheet pile driving were found.

Despite a fairly rigorous examination of existing studies and evaluation of sound sources associated with pile driving, Popper and Hastings (2009) concluded that little is known about the effects of such sounds on fish. It seems lethal effects caused by pile driving are confined to fish that are in the immediate vicinity of the activity and that impacts would be minimal if they move away from the activity. The proposed location of the Port would be in the migration route of adult salmon returning from the sea and heading for spawning areas. If a school of fish is in the immediate pile-driving area as pile driving commences, direct mortality is possible. However, Mueller-Blenkle et al. (2010) found that Atlantic cod detect noise generated from pile driving at great distances and demonstrate an avoidance response. If salmon demonstrate a similar response, schools entering the Port area while pile driving is in progress are likely to divert their route. Outmigrating juvenile salmon will be passing the Port site primarily from mid-May to late June, while returning adult salmon will pass the site between early July and late September.

In 2008, the Fisheries Hydroacoustic Working Group, which is composed of several state and federal agencies, including NMFS, the Federal Highway Administration, and State highway agencies for California, Oregon, and Washington, signed a memorandum agreeing to interim criteria for use during all pile driving projects. These criteria have been identified as a peak sound pressure level of 206 dB and an accumulated SEL of 187 dB for all fish weighing 2 grams or larger. For fish less than 2 grams, the criterion for accumulated SEL is 183 dB (FHWG 2008). If the ADF&G determines that pile driving will occur in a location and during a timeframe that significant impacts to EFH species could occur, a noise monitoring and mitigation plan would be required to help mitigate the potential to exceed the various criteria set forth by the working group. Impacts to fish from pile-driving activities during construction of the bulkhead earth-retaining system should be minimized if these criteria are followed. If these criteria are impractical, then in-water work windows and noise mitigation techniques could be used to avoid impacts during salmon migrations.

*Chemical Transport and Spills* – This topic is discussed in the previous section (Mine Access Road).

**Kuskokwim River Barging**

Waterway shipments of fuel and cargo would increase the seasonal Kuskokwim River barge traffic from baseline levels of about 68 round trips to an average of approximately 125 round trips during construction and 134 during operation (**Table 3.3-1**). Potential impacts related to the increased barge traffic on fish and aquatic resources primarily would result from vessel-induced wave energy, propeller turbulence, and possible accidental vessel groundings. At certain times and locations, increased barge traffic also may affect small-boat traffic routing and subsistence fishing activities.

*Wake Effects and Stranding* – Wave energy impacts to shoreline erosion are likely to be low because the primary mode of bank erosion on the Lower Kuskokwim River is thermoerosional niching associated with high water levels, normally associated with spring breakup (BGC 2013b). Following high breakup flows, water levels recede and erosional forces tend to be low during summer, thus it was concluded that the barge-generated waves will not significantly affect bank erosion rates. An exception to this may be at cut banks composed of silts and sands where waves could influence erosion rates. Cut banks are by nature highly erosive, so a low to moderate increase in rate of erosion caused by barge wakes is likely to have little effect to salmon migrating past either as adults or outmigrating smolt.

Results of analyses in the Donlin Draft EIS (USACE 2015) indicate that potential stranding from vessel wakes on salmon smolt migrating along shallow-gradient gravel bars would be negligible relative to upriver-bound barge traffic traveling at about 5.2 knots (6 miles per hour [mph]), because wakes generated by slow moving barges would be too small to cause adverse effects to migrating juvenile salmon. Barges returning downstream would travel at speeds approaching 10 knots (11.5 mph), which could generate wakes up to 0.74 ft (0.23 m) in height near Aniak and less than 0.6 ft (0.18 m) elsewhere in the river (BGC 2015). Wakes of this magnitude should not produce sufficient currents or wakes to displace young-of-year salmon migrating along shorelines in the river. Morris et al. (2015) found that chum smolt used all habitats sampled during their outmigration but were captured at the highest rates in backwaters, shallow low gradient shoals and slackwaters; they also were encountered in side channel riffles at high rates. Many chum salmon smolt were in habitats that should be unaffected by barge wakes – for example in side channels and riffles where wave run-up is blocked or attenuated by an island or shoal, or in deeper offshore water and thus would not be vulnerable to potential stranding. Because of their broad distribution in a variety of habitats and the predicted small size of barge wakes, the overall risk of stranding from barge wakes to chum salmon smolts is expected to be low.

*Impacts from Propeller Strikes* – Barge traffic navigating deeper sections of the Kuskokwim River typically would not pass close to shore, depending on the river channel width and geometry. Under such conditions, rearing or migrating salmon in shore zone areas should not be adversely affected by tug propellers, vessel wakes, drawdown and surge, propeller wash, and other associated hydraulic forces unless they are located in confined channel segments. Based on available literature, most outmigrating Chinook, coho, and sockeye salmon are large enough to avoid barge propeller strikes, while a portion of the pink and chum salmon may still be small enough to be affected. For example, Killgore et al. (2001) found that the magnitude of larval mortality due to shear stress caused by propellers is size-dependent with small larvae (<10 millimeters [mm]) being the most susceptible. Even juvenile chum and pink salmon greatly exceed these sizes, with chum salmon outmigrating from the Kuskokwim River in 2015 averaging 38.0 mm (range: 27 to 50 mm) and pink salmon averaging 34.5 mm (range: 30 to 42 mm) (Morris et al., 2015). Outmigrating Chinook, coho and sockeye salmon are considerably larger, with mean lengths of 83.6, 84.8, and 53.1 mm, respectively, and would be at less risk of injury.

A study of entrainment rates though propellers conducted in the Mississippi River indicated that entrainment rate was low (<1 fish/km) in deep and wide sections of the river with swift water. However, entrainment could reach high rates (>30 fish/km) in shallow sections with slow velocity (Killgore et al. 2011). This study also points out that fish may avoid entrainment in wide or deep channels, escaping vertically or horizontally, and notes that other studies have documented transient avoidance responses to boats though radiotelemetry and hydroacoustics. During the 2015 study of outmigrating salmon from the Kuskokwim River, low catch rates overall for Chinook, coho, and sockeye salmon smolt and their relatively higher catch rates compared to chum and pink salmon in mid-channel trawls suggest that many of these larger out-migrants must be using deeper water habitats for outmigration and thus many are likely not susceptible to direct impacts from tug propellers (Morris et al. 2015). Chum salmon smolt are widely distributed throughout the river during outmigration, but use river margin habitats remote from the thalweg for outmigration more so than mid-channel habitats, thus making them less susceptible to direct impacts from tug propellers. The effect of each additional passing barge would be additive; however, with the large number of outmigrants coming from the numerous tributaries, which likely have some variation in the timing of outmigration, effects to any given stock are expected to be low. Given the pattern of habitat use and sizes of fish present the overall effect of propeller strikes is likely to be low during the smolt outmigration.

*Impacts from Bed Scour* – Barging operations are likely to scour silty sand bed material up to a depth of 3 to 4 ft (0.9 to 1.2 m) in shallow water while moving upstream, and significantly less for a moving tug in deeper water (AECOM 2015). Bed scour from existing barge traffic, flooding, and ice-out conditions also contributes to sediment re-suspension and displacement of aquatic biota. Bed scouring would occur as long as there are barging operations, and could occur from the Jungjuk Port site to Bethel. Barging to support pipeline construction could extend to approximately 30 mi (48 km) upriver from Stony River. Barging would affect shallower sections of the Kuskokwim River along the transportation route; however, barges generally operate in water much deeper than 3 to 4 ft (0.9 to 1.2 m). Existing barge traffic is expected to already be scouring the riverbed within the navigation channel, thus additive displacement of aquatic biota in previously disturbed substrates would be negligible. The larger barges used in the Project would lead to some expansion of the affected area. Minimal adverse impacts are expected from bed scour on salmon as a result of barge traffic because most salmon, both juveniles and adults, primarily use the mainstem Kuskokwim during summer as a migration channel and few are selecting habitats for rearing or feeding. Some salmon may be briefly exposed to sediment plumes; however, they are likely to move away from such areas and continue their migration. Adverse effects from scouring, if any, are likely to be brief and dissipate rapidly after the barge passes.

*Chemical Transport and Spills* – Direct effects of spills along the barge channel are most likely to impact salmon smolt during the outmigration between mid-May and late-June. Most smolt would be absent from the barge channel from July until the end of the barge season. SPCC plans and ODPCPs would be required to minimize risks of spills and risks of spills affecting aquatic environments. This topic has previously been discussed above under Mine Access Road; however, risk analyses of spills during barging activities were evaluated separately (ERM 2014). United States Coast Guard (USCG) and ADEC barging-related spill records were evaluated based on probability of occurrence, spill volume, and risk to biological resources. Greater than 90% of barging related spills that have occurred are between 0 and 50 gallons and were considered to be incidental to small risk to biological resources. In Alaska, ADEC reports that 0.2% of spills were between 1,000 and 10,000 gallons and were considered a large risk to biological resources, while the USCG database indicates that 0.9% of all spills nation-wide were in this same category. ADEC reports no incidents of spills larger than 10,000 gallons, while the USCG reports 0.8% of spills nation-wide fall into this category. Over the life of the Donlin Gold Project, ERM (2014) predicted that less than one high-risk spill over 1,000 gallons could occur. Up to 12 spills between 50 and 1000 gallons could occur and those would pose some risk to EFH species in the immediate vicinity of the spill and could require larger scale spill response and some post-cleanup remedial action. Most spills, predicted to be up to 203 over the life of the project, would be between 1 and 50 gallons and would require minor cleanup and would pose a low risk to aquatic resources including EFH and EFH species.

*Invasive Species* – Transport of materials between West Coast ports and Bethel has the potential to introduce invasive species, which is identified by NMFS (2011) as an important issue in EFH evaluations. NMFS (2011) identifies recommended conservation measures for invasive species to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH (See Section 5.4). Where practicable, these recommended measures will be incorporated into agreements with shipping companies that provide transport support for the Project.

# 5. MITIGATION

This section describes the BMPs and mitigation measures that are currently included in the Proposed Action as well as actions currently in development. These measures were developed to minimize impacts on water quality and fisheries, including EFH. Several mitigation actions are proposed for Getmuna Creek. Monitoring is also described because the results of monitoring will be used through an adaptive management process to demonstrate the effectiveness of mitigation and environmental protection and to guide future action.

## 5.1. Project Monitoring

An important component of mitigation is the existence of an adequate baseline that identifies and describes EFH, which will allow Project impacts to be measured and compared to predicted impacts through an effective monitoring program. Baseline studies were initiated in 1996 and continued through 2015. Donlin Gold will develop a monitoring program for all phases of the Project so that potential impacts of each Project component to EFH can be analyzed. The program would include monitoring the effectiveness of BMPs (e.g., regular visual inspections) and environmental monitoring (including water quality, sediments, bioassessment). Results of environmental monitoring would be compared to standards and baseline conditions and evaluated for trends. Monitoring would be tied to a program of remedial and contingent actions that would be implemented if actual effects to EFH are trending to exceed those predicted.

## 5.2. Mine Site Facilities

### *5.2.1. Construction and Operation*

BMPs would include sediment and stormwater management and monitoring measures that extend from initial mine infrastructure development through and beyond mine closure. Sediment control measures to be included in the Multisector General Permit SWPPP would include silt fences, sediment retention basins, cross bars and ditches, runoff interception and diversion, mulching and revegetating disturbed surfaces and soil stockpiles, and other BMPs designed to reduce the intensity of surface runoff, erosion, and sediment loads in downstream drainages.

BMPs and mitigation measures to minimize effects on EFH include:

- Use construction methods that eliminate or reduce the potential for bank erosion and sedimentation into fish streams
- Limit refueling activity and storage of fuel and related liquid to at least 100 ft (30.5 m) from the bank of fish-bearing streams
- Install fish screens on all inlet suction hoses
- Comply with all ADF&G Title 16 permits as well as ADNR Temporary Water Use Permits and APDES permits
- Comply with APDES general and individual permits that require implementation of SWPPPs and maintain water discharges in compliance with water quality standards that are protective of aquatic life.

- Aquatic invasive species specific BMPs:
  - Comply with ADF&G FRP conditions specific to decontamination of sampling equipment.
  - Comply with state law prohibiting use of felt-soled wading shoes and boots.
  - Adhere to ADF&G 4 step recommendations to reduce the spread of aquatic invasive plant species:
    - **"CLEAN** — Rinse and remove any mud, sediment, and/or plant debris from all gear, boats, and boat trailers, floatplane rudders and floats, and anything that comes into contact with the water. Separate all pieces of wading footgear and waders (remove liners, etc.) to check for and remove visible mud, sediment and/or plant debris before leaving the area. Use a stiff bristle brush to clean all fishing gear.
    - **DRAIN** — Empty all water from coolers, bilge pumps, buckets, and wring out gear before leaving the boat launch or fishing areas.
    - **DRY** — Completely dry gear between waterbodies or trips. Equipment that remains damp can harbor small particles of invasive species that can remain viable for weeks. If drying gear completely is not possible – decontaminate!
    - **DECONTAMINATE** — Freeze gear until solid or wash gear in 140°F hot water scrubbing with a stiff bristle brush. If drying, freezing or heating gear is not feasible, use a 2% bleach solution to clean gear away from fresh water recreation sites. Spray or rinse gear for one minute. A 2% bleach solution can be made easily by mixing 2.5 oz. of chlorine bleach with tap water to make 1 gallon of solution." (ADF&G 2017)

      <u>Note:</u> *if Elodea spp. is determined to be a potential plant of concern, freezing alone could be insufficient to eliminate viability of propagules, therefore; additional protocols to include freeze-drying with dessication and/or bleaching would be utilized.*

### *5.2.2. Habitat Modification Mitigation Options*

Getmuna Creek, which supports a significant portion of adult salmon escapement and production in the drainage, would not experience adverse impacts from mine operation because the only Project activities within the Getmuna Creek drainage are related to construction of three bridges to avoid changes to EFH (**Table 4.3-6**). MS-10, which is just upstream from the confluence of the north fork of Getmuna Creek and the south fork of Getmuna Creek, will be excavated with no connection to the creek. However, the drainage provides mitigation opportunities (Ottertail 2012a). Three identified mitigation options are: 1) Snow Gulch and Ruby Gulch Rearing Habitat Enhancements; 2) removal of an apparent migration blockage; and 3) reclaiming the Getmuna material site (MS-10) to provide fish-rearing habitat. In addition, results of substrate freezedown monitoring of Crooked Creek would be used to better predict and determine what mitigation may be necessary when water drawdowns reach their theoretical maximum about Year 20 of operation.

**Snow Gulch and Ruby Gulch Rearing Habitat Enhancements**

Placer mining in the upper Crooked Creek and lower Donlin Creek drainages have left Snow and Ruby gulches heavily disturbed. Both creeks currently provide limited to no fish habitat value. However, reclamation of the lower portions of each drainage would result in stable stream habitats that provide fish passage as well as shallow productive rearing habitats in the form of stabilized, mostly shallow, ponds. Estimates of pond habitat that could be created range from around 7 to 10 acres (3 to 4 hectares) of potential rearing habitat, far in excess of the 0.82 acres (0.33 hectares) of lost off-channel habitat predicted for upper Crooked Creek. Reclamation plans currently in development indicate that the shallow pond habitats created would more than replace the potential losses of Crooked Creek salmon rearing habitats over time, if successful. Habitat creation would focus on maximizing shallow habitats less than one meter deep to closely mimic off channel habitats and enhance zooplankton and aquatic macro-invertebrate production. While fish over-wintering and spawning habitat is not a direct goal of the enhancement projects, creation of both habitat types is probable.

**Getmuna Migration Blockage**

The upper reaches, approximately 2 miles (3.2 km) of the south fork of Getmuna Creek may not be accessible to salmon, as indicated by a complete absence of observed salmon upstream of the natural barrier during annual aerial fish surveys. Although salmon are known to migrate upstream of their natal spawning areas – particularly coho and Chinook salmon – only Dolly Varden and slimy sculpin have been captured by either minnow trap or electrofishing in the upper south fork of Getmuna Creek above the barrier. The barrier is located approximately two-thirds of the way up the south fork. The identified barrier is a series of cascades and low falls located within an incised gorge. The highest observed vertical fall (near the lower end of the gorge) is about 3.75 ft (1.14 m) over a distance of about 15 ft (4.6 m) horizontal. This fall is part of a cascade/fall series that drops about 6 ft (1.8 m) over 50 ft (15.2 m) horizontal without intermediate resting pools. The remainder of the barrier is low head with the bulk consisting of higher gradient cascades (about 6% slope). Modifying this reach by providing resting pools at appropriate locations may encourage more migration up the reach by species in search of potential spawning and rearing habitats that are quite extensive in the upper watershed.

**Getmuna Material Site (MS-10)**

The material site at the confluence of the north and south forks of Getmuna Creek will consist of a series of eight cells created by excavating material for the proposed access road from the Port to the mine. The cell complex is close to both the north and south forks of Getmuna Creek and could function as an off-channel pond to support fish populations over the winter, as well as augment summer rearing habitat for all species that occur in surrounding reaches of the creeks.

The proposed material site is within a southern aspect alluvial fan. Given that downstream portions of Getmuna Creek successfully support a significant salmon spawning population, it is known that winter groundwater movement occurs within the watershed upstream of the spawning locations. A southern aspect alluvial fan is a highly probable source for such groundwater gain. The downstream "daylighted" material cells would be fed by both the groundwater gain and surface water runoff into the ponds. Over an extended period of time, the pond complex would be filled by sediment as well as vegetation and become natural off-channel habitat and eventually wetlands.

**Crooked Creek Substrate Freezing Monitoring and Subsequent Mitigation Plan**

In middle Crooked Creek between Queen Gulch and Crevice Creek, winter flow and annual substrate freezing is poorly understood. One study focusing on substrate freezedown and available under-ice water was conducted to investigate the quantity of available overwintering habitat and viable spawning beds. The study found that while free water is not continuous throughout this reach of Crooked Creek during winter, there is potential for fish overwintering and for salmon egg survival (Ottertail 2012c). Flow reductions associated with mine operations in this same reach of Crooked Creek are predicted to be most extreme around Year 20 of operation. In consultation with ADF&G, Donlin Gold is planning to initiate a long-term study to better understand natural variability in winter flow and habitat availability in the middle reaches of Crooked Creek. The study would investigate winter substrate freezing annually pre- and post-mine construction, to establish baseline data for winter habitat viability and variability. The study would continue into operations to help establish pit dewatering and run-off diversion related effects on winter habitat. These data would be used to truth existing models predicting flow reduction during winter and to help determine what mitigation may be necessary in the long term if flow reductions indeed reduce available habitat such that significant effects on EFH and EFH species would be anticipated.

## 5.3. Natural Gas Pipeline

Mitigation measures that reduce impacts to EFH along the natural gas pipeline consist of BMPs and timing of construction to work when the species are not present. BMPs would include sediment and stormwater management and monitoring measures that extend from initial mine infrastructure development through mine closure. Sediment control measures to be included in the Erosion and Sediment Control Plan (Natural Gas Pipeline Plan of Development – Appendix H) would include silt fences, sediment retention basins, cross bars and ditches, runoff interception and diversion, mulching and revegetating disturbed surfaces and soil stockpiles, and other BMPs designed to reduce the intensity of surface runoff, erosion, and sediment loads in downstream drainages.

BMPs and Mitigation measures to minimize effects on EFH include:

- Minimize the number of pipeline and access road crossings of fish-bearing streams
- Use open-cut methods for stream crossings only at times allowed by ADF&G when spawning fish, eggs, and fry are least likely to be present
- Use temporary bridges to transport construction equipment and materials across fish-bearing streams
- Use pipeline designs and construction scheduling that minimize disruption of fish passage and spawning fish and impacts to fish habitat
- Maintain, to the maximum extent practicable, existing stream hydrologic regimes at fish-bearing stream crossings
- Maintain, to the maximum extent practicable, existing temperature regimes for streams along the corridor
- Use construction methods that eliminate or reduce the potential for bank erosion and sedimentation into fish-bearing streams
- Conduct fueling activity and storage of fuel and related liquids at least 100 ft (30.5 m) from the bank of fish-bearing streams
- Install fish screens on all inlet suction hoses
- Ensure all water discharged from hydrostatic testing meets applicable permit requirements

- Comply with all ADF&G Title 16 permits as well as ADNR Temporary Water Use Permits
- Use HDD methods to cross six major streams, including one each at the Skwentna, Happy, Kuskokwim, East Fork George, George, and North Fork George rivers. Use of HDD methods would avoid impacts to EFH because the channels will be unaltered.

## 5.4. Transportation Facilities

As with other proposed Project components, BMPs would be employed to avoid or minimize adverse impacts to EFH during construction, operation, and closure. BMPs include sediment and stormwater management and monitoring measures that extend from initial transportation infrastructure development through mine closure. Sediment control measures to be included in the SWPPP would include silt fences, sediment retention basins, cross bars and ditches, runoff interception and diversion, mulching and revegetating disturbed surfaces and soil stockpiles, and other BMPs designed to reduce the intensity of surface runoff, erosion, and sediment loads in downstream drainages.

BMPs and mitigation measures to minimize effects on EFH include:

- Minimize the number of access road crossings of streams that contain fish
- Use span bridges to cross streams containing EFH
- Maintain, to the maximum extent practicable, existing stream hydrologic regimes at fish-bearing stream crossings
- Maintain, to the maximum extent practicable, existing temperature regimes for streams along the access road corridor to avoid affecting fish movements
- Use construction methods that eliminate or reduce the potential for bank erosion and sedimentation into fish-bearing streams
- Conduct fueling activity and storage of fuel and related liquid storages at least 100 ft (30.5 m) from the bank of fish streams
- Port facilities will be designed to include practical measures for reducing, containing, and cleaning up spills
- Install fish screens on all inlet suction hoses
- Comply with all ADF&G Title 16 permits as well as ADNR Temporary Water Use Permits

Relevant NMFS invasive species specific mitigation measures to minimize effects on EFH include (NMFS 2011):

- "Uphold fish and game regulations of the Alaska Board of Fisheries (AS 16.05.251) and Board of Game (AS 16.05.255), which prohibit and regulate the live capture, possession, transport, or release of native or exotic fish or their eggs.
- Adhere to regulations and use best management practices outlined in the State of Alaska Aquatic Nuisance Species Management Plan (Fay 2002).
- Encourage vessels to perform a ballast water exchange in marine waters (in accordance with the U.S. Coast Guard's voluntary regulations) to minimize the possibility of introducing invasive estuarine

species into similar habitats.[1] Ballast water taken on in the open ocean will contain fewer organisms, and these will be less likely to become invasive in estuarine conditions than species transported from other estuaries.

- Discourage vessels that have not performed a ballast water exchange from discharging their ballast water into estuarine receiving waters.[1]
- Require vessels brought from other areas over land via trailer to clean any surfaces that may harbor non-native plant or animal species (e.g., propellers, hulls, anchors, fenders). Bilges should be emptied and cleaned thoroughly by using hot water or a mild bleach solution. These activities should be performed in an upland area to prevent introduction of non-native species during the cleaning process.

[1] Donlin Gold barges do not use ballast water.

# 6. CONCLUSIONS

## 6.1. Donlin Gold Project

### *Determination*

**Unlikley to Adversely Affect/Adverse Affects Minimal:** Development of the Donlin Gold Project will have short- and long-term adverse effects on EFH. However, as described throughout this evaluation, and summarized below for each component of the proposed mine, and in conjunction with proposed mitigation habitats and BMPs, none of those affects are likely to rise to the level of population effects to EFH species within the Crooked Creek or Kuskokwim River drainages.

## 6.2. Mine Site Facilities

Long-term adverse effects to Pacific salmon EFH could occur in the middle reach of Crooked Creek near the mine site resulting from altered flow regimes, reduction of in-stream habitat, and reduction in both the connectivity and amount of off-channel habitat. These impacts would be due to altered stream flows resulting from placing fill or constructing flow diversions, pit dewatering activities, and earth movement and grading along tributaries during construction, operation, and closure; thus, these impacts would essentially be permanent changes. Moderate adverse effects from flow alteration would mostly affect rearing Chinook and coho salmon and spawning coho salmon in Crooked Creek in the vicinity of the mine. The greatest proportion of adult salmon escapement and production in the drainage occurs in Getmuna and Bell creeks, Donlin Creek, and the lower reaches of Crooked Creek, none of which are expected to experience adverse effects from mining activities and associated water management practices. Mitigation through reducing the effect of a natural blockage to migration is proposed to increase the extent of EFH in Getmuna Creek as will creation of shallow rearing habitats in Snow and Ruby gulches, tributaries to upper Crooked Creek and Donlin Creek. Additional potential mitigation measures are connecting the Getmuna Creek material site (MS-10) to Getmuna Creek to provide rearing habitat for Chinook and coho salmon. Mitigation on this scale is expected to offset unavoidable habitat loss.

### *Determination*

**Unlikley to Adversely Affect/Adverse Affects Minimal:** Development of the mine site and all associated infrastructure, including reductions in flow in Crooked Creek, may adversely affect EFH and EFH species. Construction effects would be short-term and of low magnitude; changes in EFH species population numbers would not be expected. Operational and post-closure effects would be long-term; however, based on known uses of EFH that will be eliminated and those most likely to be affected, reductions in EFH species population numbers within the drainage would not be expected. Changes in Kuskokwim River EFH species populations would not occur as a result of mine development, operations, or closure. With appropriate mitigation measures and mitigation habitats, the project is not anticipated to reduce the quantity or quality of EFH or EFH species in the Crooked Creek drainage.

## 6.3. Natural Gas Pipeline

Anticipated effects to EFH species from along the natural gas pipeline route would involve fish populations downstream of pipeline crossings and along the construction ROW where it is aligned near and upgradient from streams. There are 77 locations along the pipeline route where this occurs. Low levels of impacts are expected from potential habitat degradation from stormwater runoff, suspended solids, and reduced flows caused by disturbed soils and water withdrawals for ice-road construction. No adverse effects to EFH are expected, assuming effective implementation of construction BMPs and implementation of the Title 16 Fish Habitat Permit and ADNR Temporary Water Use Permit conditions. Impacts would be temporary during construction, and would be limited to the immediate vicinity of the stream crossings. Remedial action would be taken at identified problem areas to restore habitat to useable condition. Use of HDD methods for six large river crossings will avoid impacts to fish populations and EFH near those crossings.

### *Determination*

**Unlikely to Adversely Affect/Adverse Affects Minimal:** Construction and operation of the natural gas pipeline is unlikely to adversely affect EFH and EFH species. Impacts would be associated with construction of the pipeline stream crossings and would be short-term and local. Impacts would be limited to the period of construction and a short period after construction while the stream banks and beds stabilize. Impacts would not extend far below the construction sites. No long-term changes in the quantity and quality of EFH or EFH species are likely to result from pipeline construction.

## 6.4. Transportation Facilities

Anticipated potential impacts would be primarily associated with hydraulic forces from propeller wash in the navigation channel. Shoreline erosion during the summer barging season is expected to be minor compared to the naturally high erosion rates documented at spring breakup. Fish displacement and stranding in confined channel segments or along shallow-gradient shorelines, and possible habitat degradation from riverbed scour, are additional potential impacts. Results of studies of juvenile salmon abundance, habitat use, and pattern of outmigration conducted in 2014 and 2015 indicate that impacts to juvenile salmon from these sources are likely to be low. There is a possibility of injury or mortality to juvenile salmon that encounter propeller blades or shear forces in the propeller flow field; however, most juvenile salmon are large enough to avoid encounter with barge propellers and tend to occupy portions of the channel where they are not at risk to propeller strikes. The highest potential for adverse impacts is where the channel narrows and confines the water to a single channel, creating a pinch point where juvenile salmon may be concentrated during the outmigration, which occurs from mid-May to late June.

Overall adverse effects to EFH by the Port facility are likely to be low, and occur mostly during construction. Adverse impacts during operation are related to barge maneuvering during the period of juvenile salmon outmigration. Potential adverse effects to EFH by the mine access road are likely to be low and occur mostly during construction.

For all phases of mine development, there is potential for accidental release of chemicals used in various activities associated with mining. While the probability of spills is low, handling procedures would be implemented to minimize the likelihood of a spill, and response plans would be implemented to address spills that may occur.

### *Determination*

**Mine Access Road**

**<u>Unlikely to Adversely Affect/Adverse Affects Minimal:</u>** Construction and operation of the Mine Access Road would be unlikely to adversely affect EFH and EFH species. Primary impacts to EFH would be short-term during construction of bridges and would be localized to near the crossings. Long-term effects to EFH and EFH species are not anticipated, because all EFH streams will be crossed using structures designed to provide for the free and efficient passage of fish and to maintain stream processes.

**Jungjuk Port**

**<u>May Adversely Affect/Adverse Affects Minimal:</u>** Construction and operation of the Jungjuk Port may affect EFH and EFH species. Primary impacts to EFH species would be associated with pile driving and sediment inputs from construction of the in-water facilities at the port. Construction impacts would be short-term and local, and would only affect salmon species if they were present during construction. The port would be constructed in a reach of the Kuskokwim River used by migrating adult and juvenile salmon. An estimated 4.4 acres of migratory EFH along a cut-bank of the river, an area of low overall salmon smolt use, would be affected long term. Maneuvering of barges at the port site could affect EFH species, particularly salmon smolt; however, population level affects to EFH species would not occur as research indicates that most smolt would not be located at the port location or would be large enough to avoid barges. Reduction in EFH quantity and quality will be minor in the context of the Kuskokwim River and no population level effects on EFH species would occur.

**Kuskokwim River Barging**

**<u>Unlikely to Adversely Affect/Adverse Affects Minimal:</u>** Operation of barges in the Kuskokwim River between Bethel and the Jungjuk Port would not reduce the quantity and quality of migratory EFH in the Kuskokwim River. Adverse effects to chum and pink salmon smolt from propeller strikes along the barge route are the most likely adverse impact to EFH species. However, research shows that chum and pink salmon smolt are present at lowest densities in the mid-channel of the river near the barge channel, with highest densities occurring along the margins of the main channel and sloughs. In addition, nearly all smolt have out-migrated from the Kuskokwim River by late-June. Kuskokwim River barging would not cause long-term, measurable reductions in EFH species populations.

# 7. REFERENCES

ADEC. 2012. 18 AAC 70 Water quality standards as amended of April 8, 2012. Alaska Department of Environmental Conservation. Division of Water. Juneau, AK. Available at: http://dec.alaska.gov/water/wqsar/wqs/index.htm accessed on June 26, 2015.

ADF&G. 1991. Blasting standards for the protection of fish. Draft Report. Alaska Department of Fish and Game.

ADF&G. 2017. Invasive Species Prevention Website. Juneau, AK. http://www.adfg.alaska.gov/index.cfm?adfg=invasive.prevention accessed on March 1, 2017.

AECOM. 2015. Technical Memorandum to Keith Gordon, USACE. Propeller Wash and Scour.

AMEC. 2014. Donlin Gold Project, River Barge Fleet Design and Operation Addendum No. 1, An Analysis of Available Channel Depths and Widths at Critical Sections of the Kuskokwim River. Prepared for Donlin Gold LLC. Project No. 173260. February 19, 2014.

Arcadis. 2013. Environmental evaluation document: Donlin Gold Project. Prepared for Donlin Gold. Anchorage, AK.

BGC. 2011a. Donlin Creek Project Memorandum. Donlin Creek Predicted Changes to Streamflow. Vancouver, British Columbia, Canada.

BGC. 2013a. Donlin Creek Predicted Changes to Streamflow – Rev. 1. BGC Project Memorandum prepared for Donlin Gold, LLC. April 29.

BGC. 2013b. Evaluation of Potential Barge Induced Bank Erosion - Kuskokwim River. BGC Project Memorandum prepared for Donlin Gold, LLC. January 9.

BGC. 2014. Predicted Changes to Streamflow – Rev. 2. BGC Project Memorandum prepared for Donlin Gold, LLC. July 11.

BGC. 2015. Update to Potential Barge Induced Bank Erosion - Kuskokwim River, Rev. 1. BGC Project Memorandum prepared for Donlin Gold, LLC. September 14, 2015

Brazil, C., D. Bue, and T. Elison. 2013. 2011 Kuskokwim area management report. Alaska Department of Fish and Game, Fishery Management Report No. 13-23, Anchorage.

Bue, D. G. 2005. Data summary for the Kuskokwim River salmon test fishery at Bethel, 1984-2003. Alaska Department of Fish and Game, Fishery Data Series No. 05-14, Anchorage.

Burril, S.E., C.E. Zimmerman, J.E. Finn, D. Gillikin. 2009. Abundance, Timing of migration, and egg-to-smolt survival of juvenile chum salmon, Kwethluk River, Alaska. Prepared for the Arctic-Yukon-Kuskokwim Sustainable Salmon Initiative. US Geological Survey, Reston, Virginia.

Conitz, J. M., K.G. Howard, and M. J. Evenson. 2012. Escapement goal recommendations for select Arctic-Yukon-Kuskokwim Region salmon stocks, 2013. Alaska Department of Fish and Game, Fishery Manuscript No. 12-07, Anchorage, AK.

Donlin Gold Project. 2014. Preliminary Draft Environmental Impact Statement. Environmental Analysis. Fish and Aquatic Resources.

ERM Alaska, Inc. 2014. Kuskokwim River Fuel Barge Oils Spill Risj Assessment. ERM Prject #0217654. Prepared for Donlin Gold, LLC. Anchorage, AK. February 2014.

FHWG (Fisheries Hydroacoustic Working Group). 2008. Agreement in Principle for Interim Criteria for Injury to Fish from Pile Driving Activities. June 11, 2008 Memorandum from the Technical/Policy Meeting, Vancouver, Washington.

Hamazaki, T. 2011. Reconstruction of subsistence salmon harvests in the Kuskokwim Area, 1990–2009. Alaska Department of Fish and Game, Fishery Manuscript Series No. 11-09 Anchorage.

Hart Crowser, Inc. /Pentec Environmental and Illingworth and Rodkin, Inc. 2010. Acoustic monitoring and in-situ exposures of juvenile coho salmon to pile driving noise at the Port of Anchorage Marine Terminal Redevelopment Project Knik Arm, Anchorage, Alaska. Report prepared by Hart Crowser, Inc./Pentec Environmental and Illingworth and Rodkin, Inc. for URS Corporation.

Hillgruber, N. and C. Zimmerman. 2009. Estuarine ecology of juvenile salmon in Western Alaska: a review. American Fisheries Society Symposium 70:183-199.

Johnson, J. and P. Blanche. 2011a. Catalog of Waters Important for Spawning, Rearing, or Migration of Anadromous Fishes –Interior Region, Effective June 1, 2011. Special Publication No. 11-05. Division of Sport Fish and Habitat, Alaska Department of Fish and Game. Anchorage, AK.

Johnson, J. and P. Blanche. 2011b. Catalog of Waters Important for Spawning, Rearing, or Migration of Anadromous Fishes –Southcentral Region, Effective June 1, 2011. Special Publication No. 11-06. Division of Sport Fish and Habitat, Alaska Department of Fish and Game. Anchorage, AK.

Johnson, J. and P. Blanche. 2011c. Catalog of Waters Important for Spawning, Rearing, or Migration of Anadromous Fishes –Western Region, Effective June 1, 2011. Special Publication No. 11-09. Division of Sport Fish and Habitat, Alaska Department of Fish and Game. Anchorage, AK.

Johnson, J. and J. Coleman. 2014a. Catalog of Waters Important for Spawning, Rearing, or Migration of Anadromous Fishes – Southcentral Region, Effective June 1, 2014. Special Publication No. 14-03. Division of Sport Fish and Habitat, Alaska Department of Fish and Game. Anchorage, AK. http://www.adfg.alaska.gov/sf/SARR/AWC/index.cfm?ADFG=data.AWCdata (accessed on 2/25/2015).

Johnson, J. and J. Coleman. 2014b. Catalog of Waters Important for Spawning, Rearing, or Migration of Anadromous Fishes – Western Region, Effective June 1, 2014. Special Publication No. 14-06. Division of Sport Fish and Habitat, Alaska Department of Fish and Game. Anchorage, AK. http://www.adfg.alaska.gov/sf/SARR/AWC/index.cfm?ADFG=data.AWCdata (accessed on 2/25/2015).

Killgore, K.J., L. E. Miranda, C.E. Murphy, D.M. Wolff, J.J. Hoover, T. M. Keevin, S.T. Maynord, and M.A. Cornish. 2011. Fish Entrainment Rates through Towboat Propellers in the Upper Mississippi and Illinois Rivers, Transactions of the American Fisheries Society, 140:3, 570-581.

Killgore, K.J., S.T. Maynord, M.D. Chan, and R. P. Morgan II. 2001. Evaluation of Propeller-Induced Mortality on Early Life Stages of Selected Fish Species, North American Journal of Fisheries Management, 21:4, 947-955.

Martin, D.J., D.R. Glass, C.J. Whitmus, C.A. Simenstad, D.A. Milward, E.C. Volk, M.L. Stevenson, P. Nunes, M. Savoie, and R.A. Grotefendt. 1986. Distribution, season abundance, and feeding dependencies of juvenile salmon and non-salmonid fishes in the Yukon River Delta. Final Report, Outer Continental Shelf Environmental Assessment Program, Research Unit 660.

Morris, W.A., L.L. Moulton, E. de la Hoz, and J. Barker. 2015. Kuskokwim River juvenile salmon investigation: 2014-2015. Report prepared by Owl Ridge NRC for Donlin Gold. Anchorage Alaska.

Mueller-Blenke, C., P.K. McGregor, A.B. Gill, M.H. Anderson, J. Metcalfe, V. Bendall, P. Sigray, D. Wood, F. Thomsen. 2010. Effects of pile-driving noise on the behavior of marine fish. COWRIE Ref. Fish 06-08, Technical Report 31st March 2010.

NMFS (National Marine Fisheries Services). 2005. Final Environmental Impact Statement for Essential Fish Habitat Identification and Conservation in Alaska. Alaska Region. Available at: http://alaskafisheries.noaa.gov/habitat/seis/efheis.htm (accessed on 2/25/2015).

NMFS (National Marine Fisheries Services). 2011. Impacts to Essential Fish Habitat from non-fishing activities in Alaska. Prepared by National Marine Fisheries Service, Alaska Region. Available at: http://alaskafisheries.noaa.gov/habitat/efh.htm (accessed on 7/24/2015).

NOAA 2004. Preparing Essential Fish Habitat Assessments: A Guide for Federal Action Agencies, Version 1, February 2004.

NPFMC, NMFS and ADF&G. 2012. Fishery Management Plan for the Salmon Fisheries in the EEZ off the Coast of Alaska. Anchorage, AK. Available at: http://alaskafisheries.noaa.gov/sustainablefisheries/fmp.htm (accessed on 4/10/2015).

OtterTail Environmental 2010. Evaluation of the effects of potential increases in barge traffic on juvenile salmon stranding in the Kuskokwim River, Alaska. Prepared for Donlin Gold, LLC.

OtterTail. 2012a. Status of Mitigation Evaluations within the Crooked Creek Watershed. Draft Technical memo to Donlin Gold, LLC.

OtterTail. 2012b. 2009 Instream Habitat Analysis of Crooked Creek for the Donlin Gold Project. Prepared for Donlin Gold, LLC. December 31.

OtterTail. 2012c. Assessment of Substrate Freezing in Winter Fish Habitat in Crooked Creek, Alaska, Fall 2010-Spring 2011 DRAFT. Prepared for Donlin Gold, LLC. December 31.

OtterTail Environmental 2014a. 2014 Aquatic biomonitoring report Donlin Gold Project 2004 through 2014 data compilation. Prepared for Donlin Gold, LLC.

OtterTail Environmental 2014b. 2014 Donlin Gold Natural Gas Pipeline Project 2010 through 2014 aquatics surveys. Prepared for Donlin Gold, LLC.

OtterTail Environmental 2014c. Donlin Gold Natural Gas Pipeline Project 2010-2013 aquatics map book. Prepared for Donlin Gold, LLC.

OtterTail Environmental 2014d. Birch Tree Crossing port site sampling. Donlin Gold Project. Prepared for Donlin Gold, LLC.

OtterTail Environmental 2014e. Instream habitat analysis of Crooked Creek, 2014 update. Donlin Gold Project. Prepared for Donlin Gold, LLC.

OtterTail. 2015. Addendum: Instream Habitat Analysis of Crooked Creek (Advanced Water Treatment). Prepared for Donlin Gold, LLC. Wheat Ridge, CO.

Popper, AN and MC Hastings. 2009. The effects of anthropogenic sources of sound on fishes. Journal of Fish Biology 75: 455-489.

Ruggerone, GT, S Goodman, and R Miner. 2008. Behavioral response and survival of juvenile coho salmon exposed to pile driving sounds. Report by Natural Resource Consultants, Inc. to Port of Seattle. Seattle, Washington

Shelden, C.A., T. Hamazaki, M. Horne-Brine, R. Chavez, and R. Frye. 2015. Subsistence salmon harvests in the Kuskokwim area, 2013. Fishery Data Series No. 15-22. Division of Sport Fish, Research and Technical Services. Alaska Department of Fish and Game. Anchorage, AK.

SRK Consulting. 2012. Plan of Operations. Project Description. Prepared by SRK Consulting (US), Inc. for Donlin Gold. Anchorage, AK.

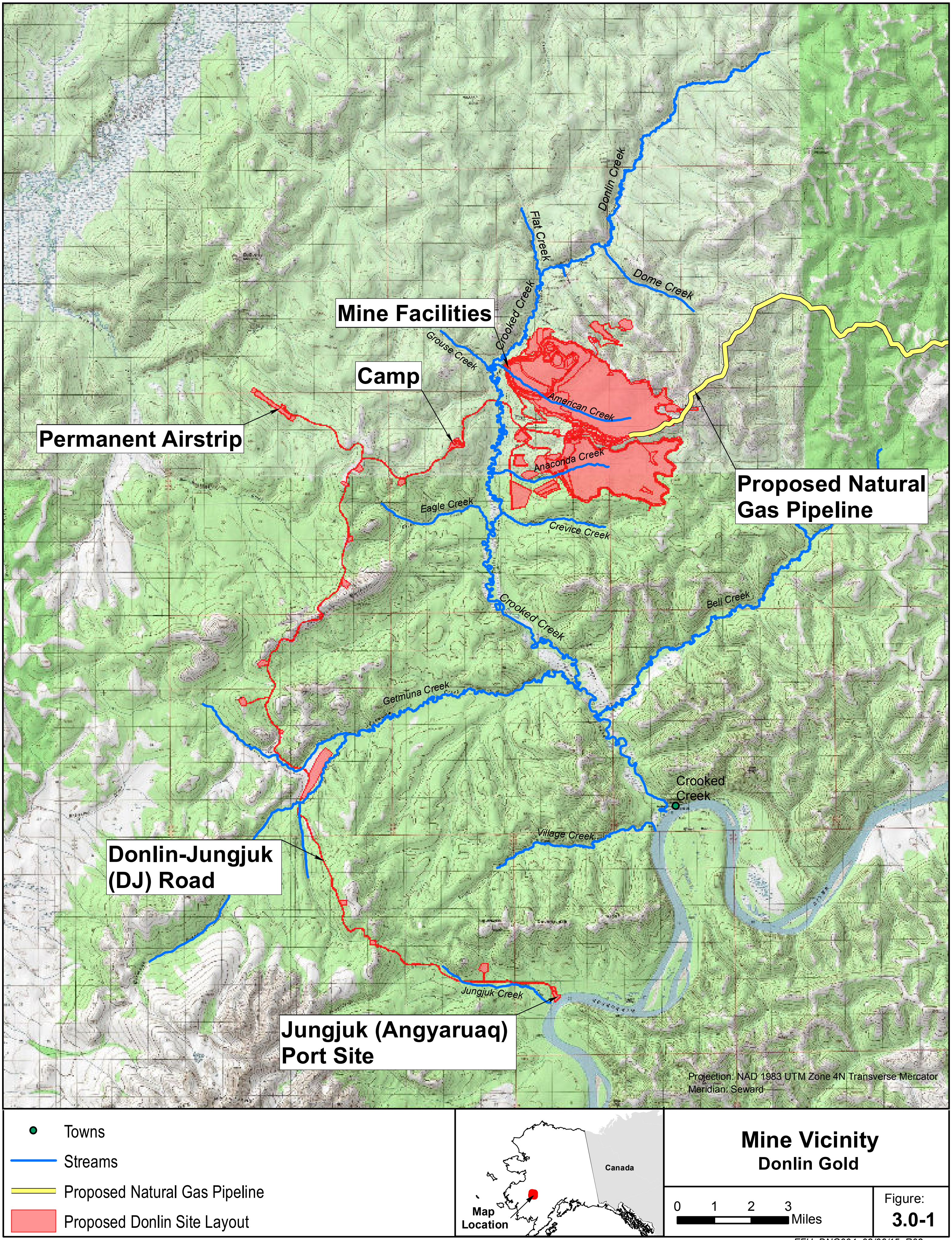
SRK Consulting. 2013. Natural Gas Pipeline Plan of Development. Prepared by SRK Consulting (US), Inc. for Donlin Gold. Anchorage, AK.

Timothy, J. 2013. Alaska blasting standard for the proper protection of fish. Alaska Department of Fish and Game Habitat Division Technical Report 13-02. Douglas, AK.

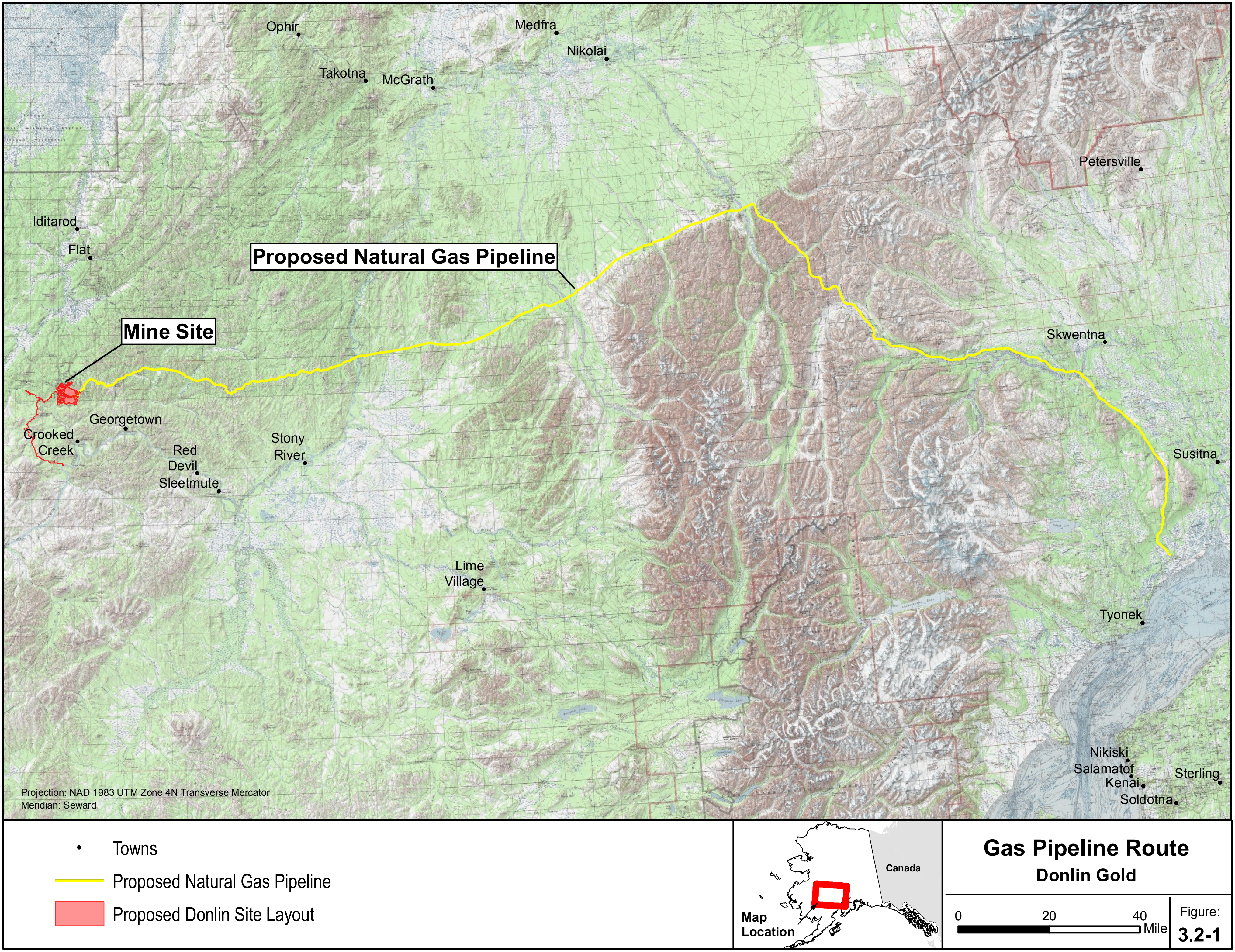
USACOE. 2015. Donlin Gold Project Draft Environmental Impact Statement. United States Army Corps of Engineers. Alaska District, Regulatory Division. November 2015.

Wang, B. (1999). Spatial Distribution of Chemical Constituents in the Kuskokwim River, Alaska U.S. Department of the Interior, U.S. Geological Survey, Water-Resources Investigations Report 99-4177. Anchorage, Alaska. Page(s) 39. http://ak.water.usgs.gov/Publications/pdf.reps/wrir99.4177.pdf

# FIGURES



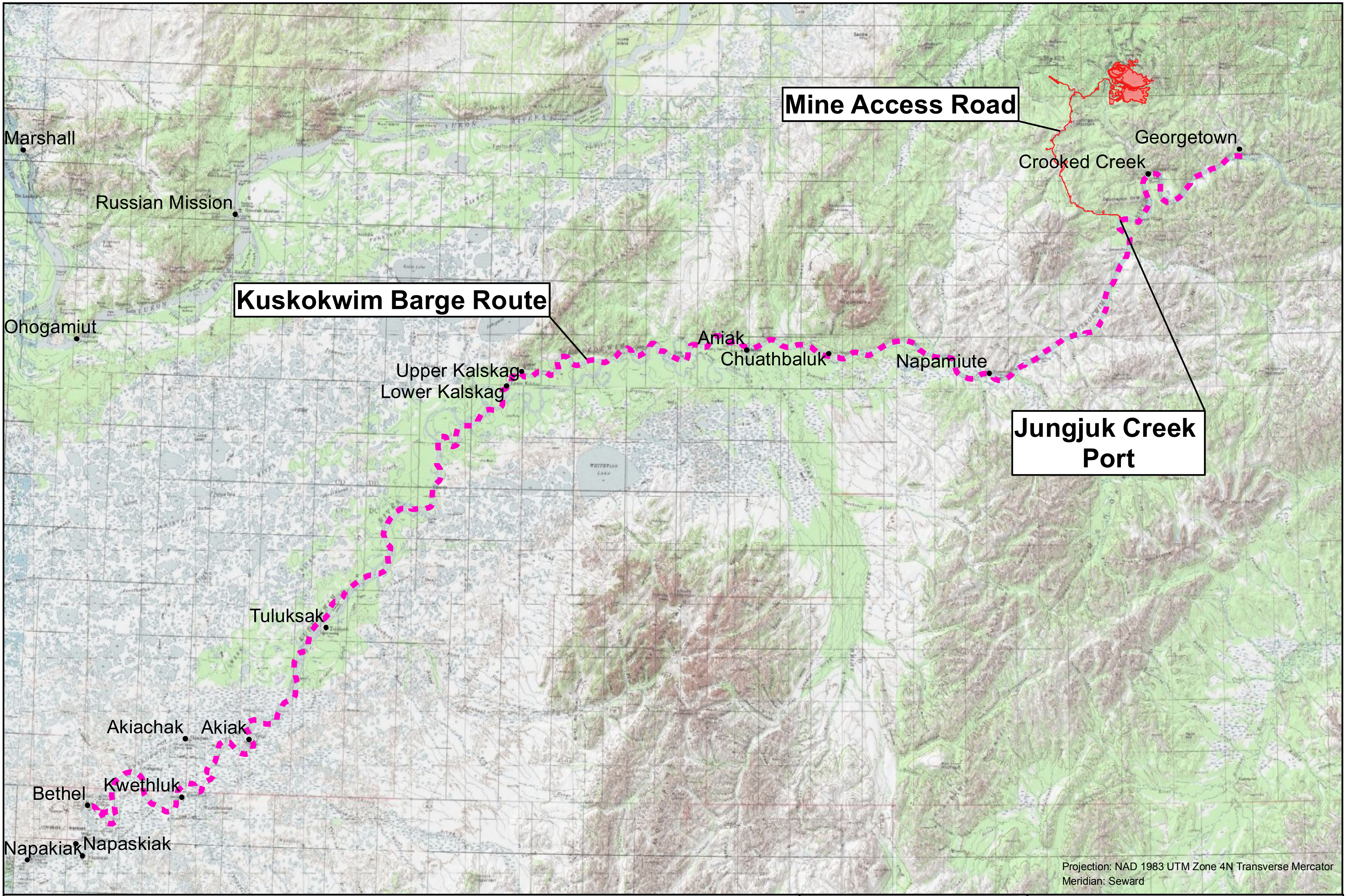
Mine Facilities
Camp
Permanent Airstrip
Proposed Natural Gas Pipeline
Donlin-Jungjuk (DJ) Road
Jungjuk (Angyaruaq) Port Site
Crooked Creek
Donlin Creek
Flat Creek
Dome Creek
Grouse Creek
American Creek
Anaconda Creek
Eagle Creek
Crevice Creek
Bell Creek
Getmuna Creek
Village Creek
Jungjuk Creek
Projection: NAD 1983 UTM Zone 4N Transverse Mercator
Meridian: Seward
Towns
Streams
Proposed Natural Gas Pipeline
Proposed Donlin Site Layout
Canada
Map Location
Mine Vicinity
Donlin Gold
0 1 2 3 Miles
Figure:
3.0-1
EFH_DNG004, 08/06/15, R02

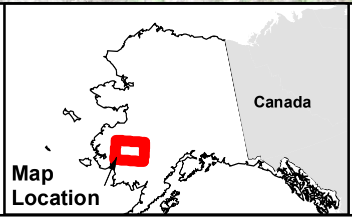



**Gas Pipeline Route**

**Donlin Gold**

Figure: **3.2-1**




Towns

Barge Route

Proposed Donlin Site Layout

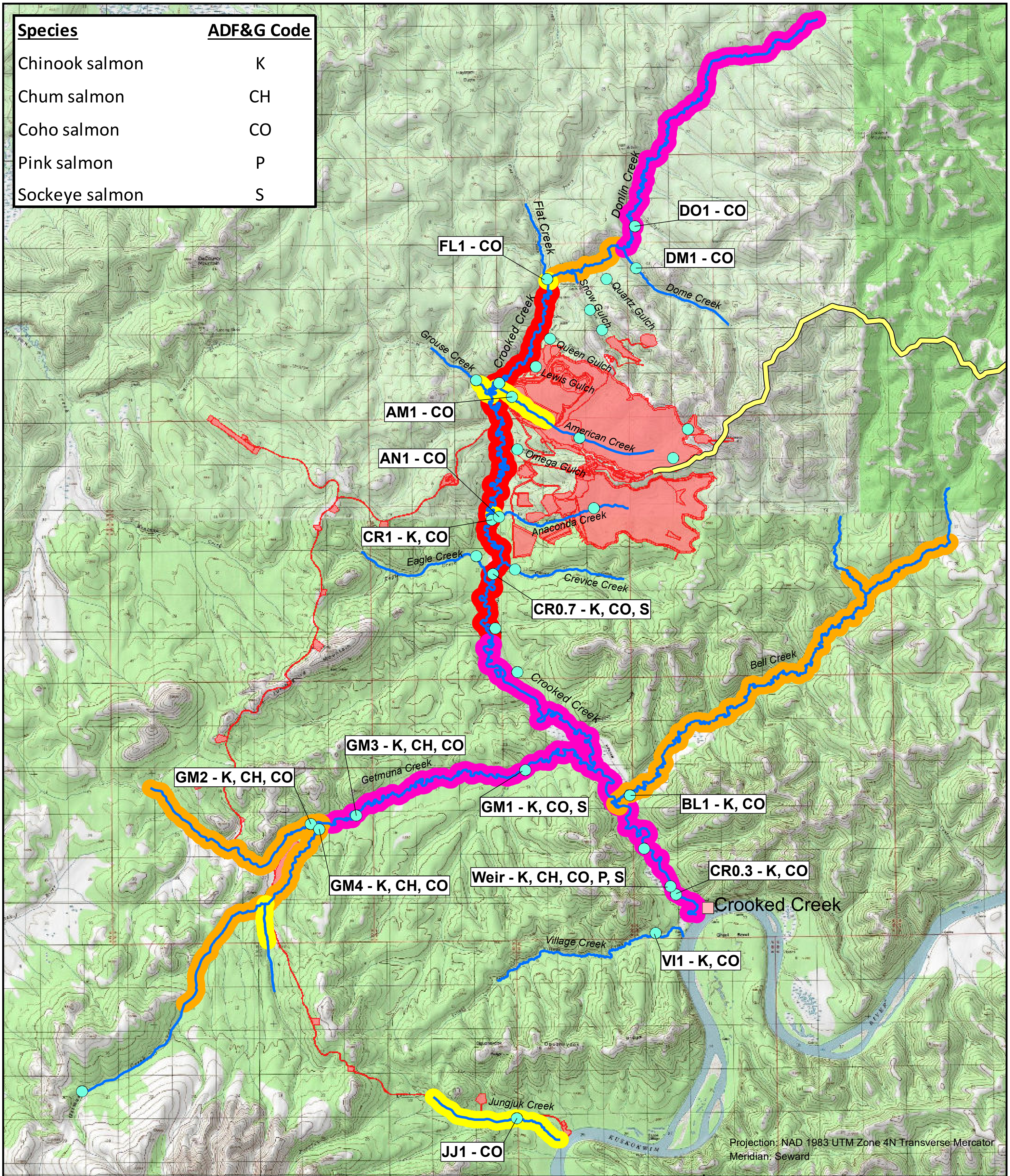
**Navigation Route**

**Donlin Gold**

0 10 20 Miles

Figure: **3.3-1**

EFH_DNG005, 02/23/15, R00




**Adult Salmon Density Mine Vicinity**
**Donlin Gold**

Figure: 4.2-1

EFH_DNG001, 01/12/17, R03

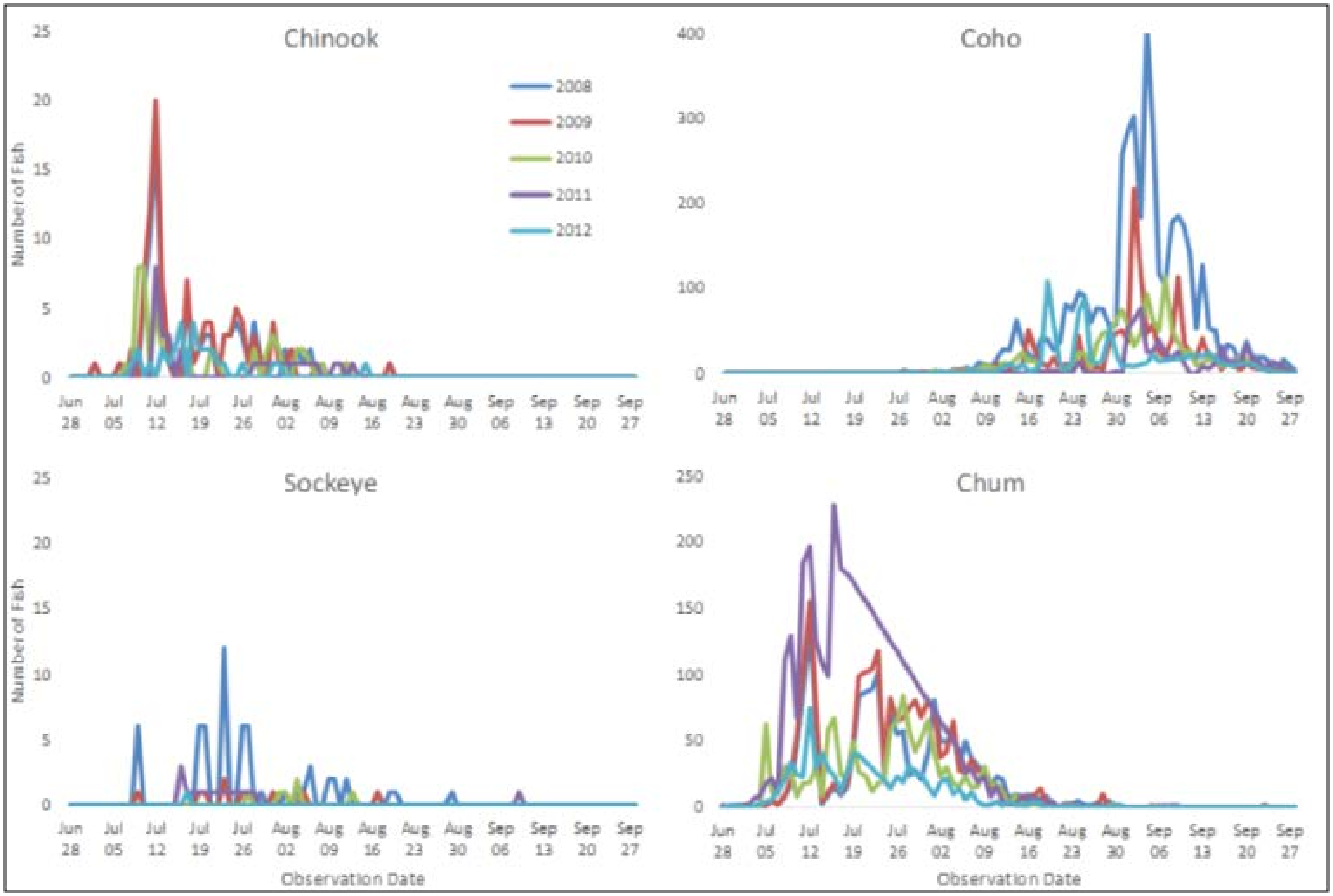
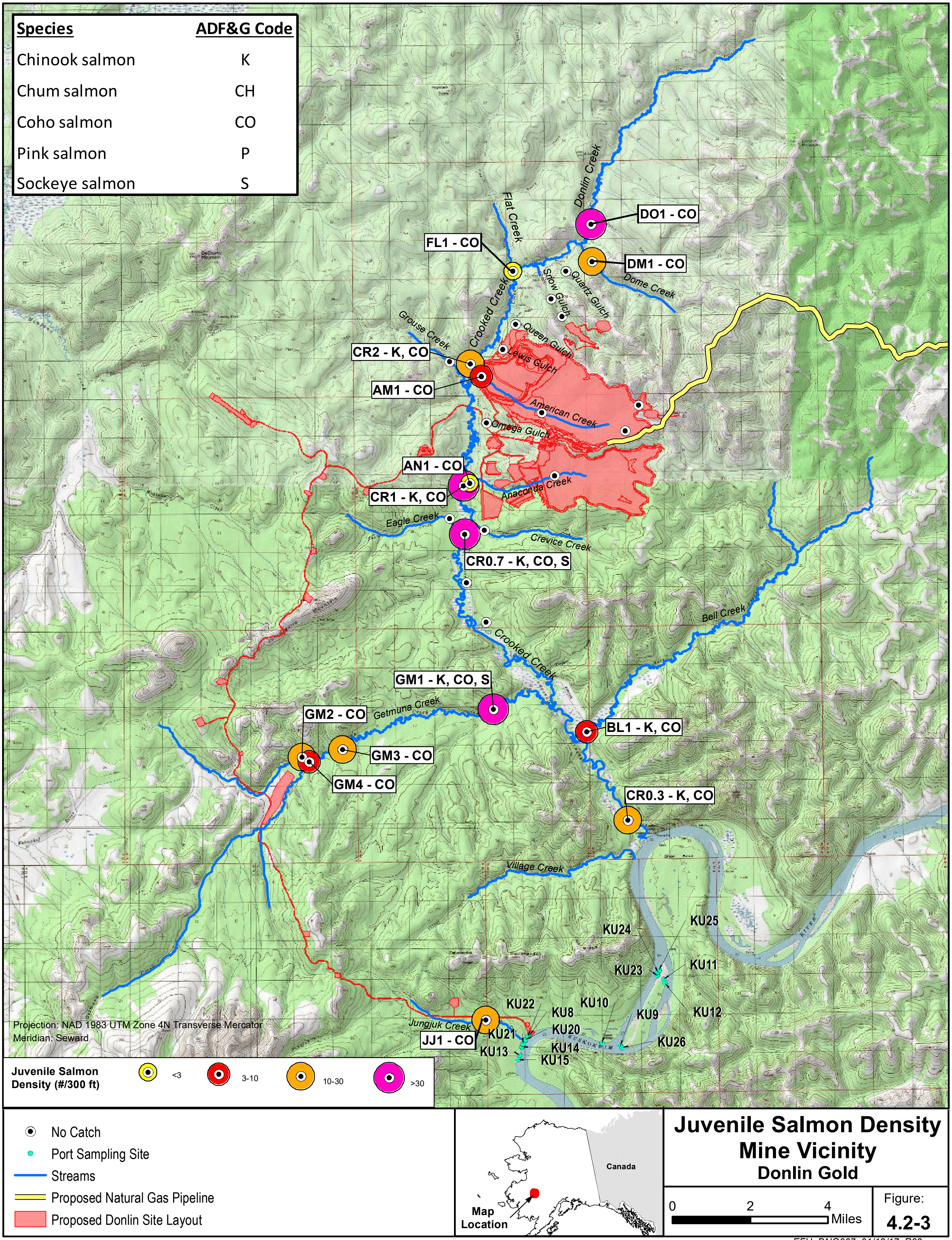
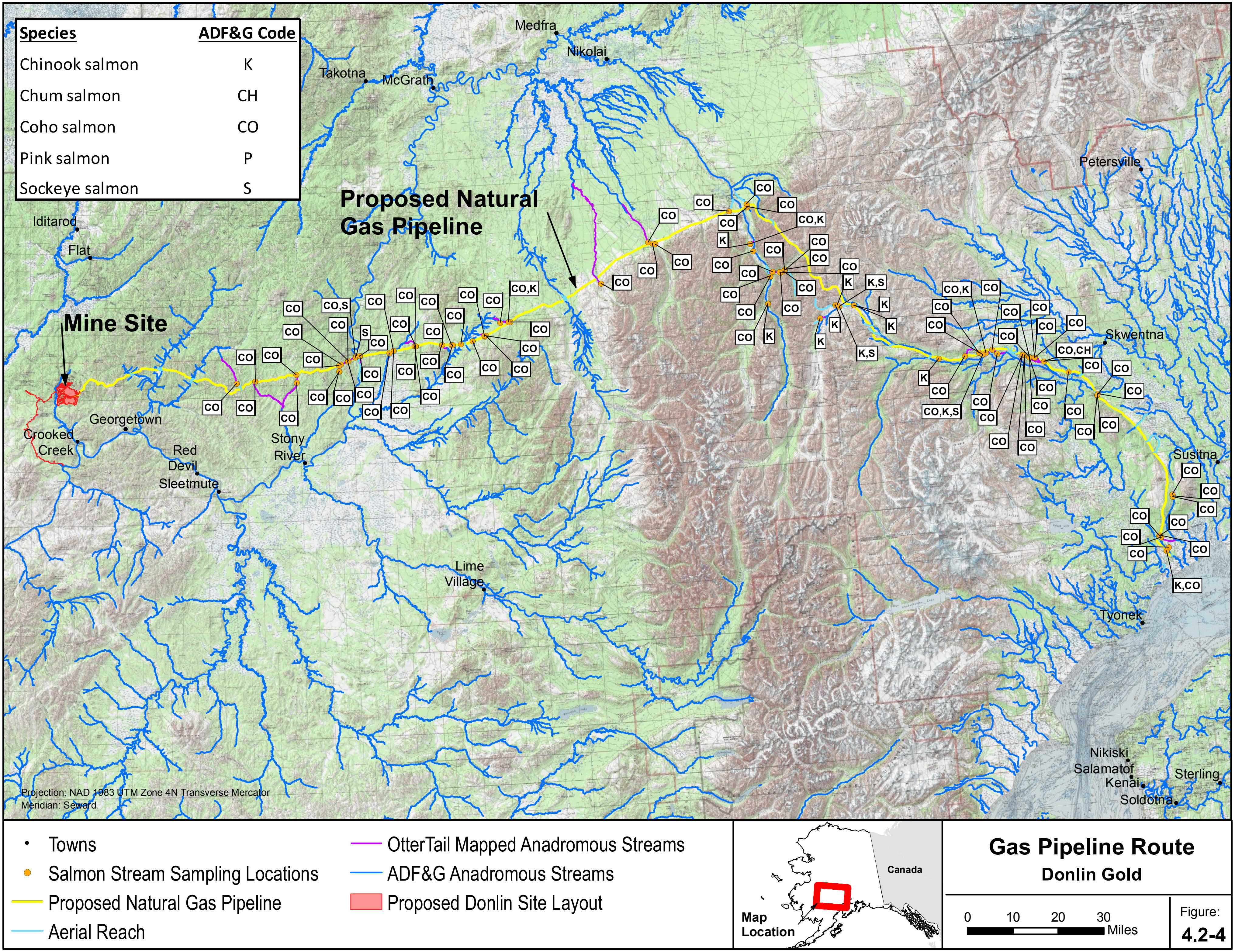



**Figure 4.2-2 - Daily Salmon Escapement at the Crooked Creek Weir**

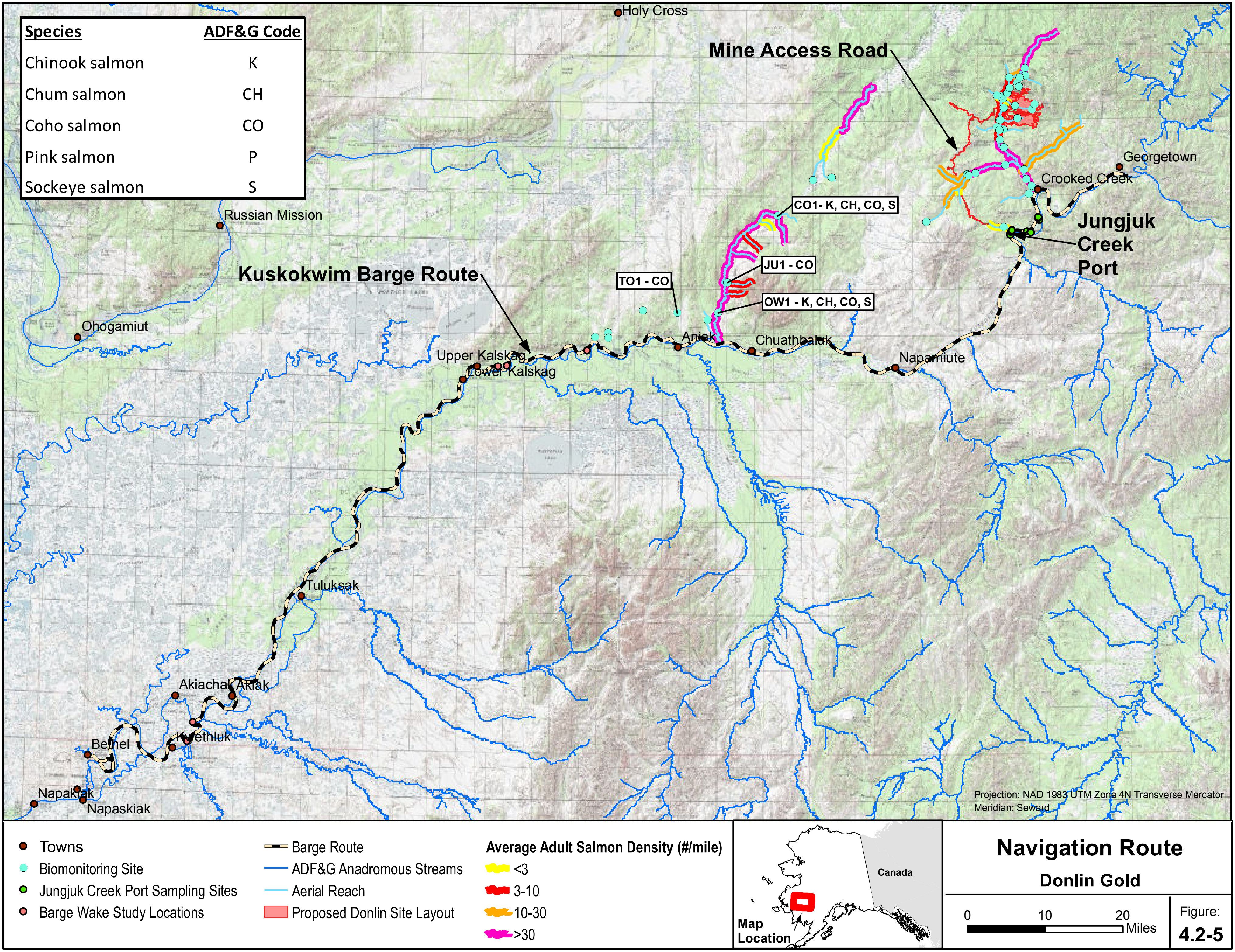
Source: OtterTail Environmental (2014a)



Species
ADF&G Code
Chinook salmon K
Chum salmon CH
Coho salmon CO
Pink salmon P
Sockeye salmon S
Donlin Creek
Flat Creek
DO1 - CO
FL1 - CO
DM1 - CO
Dome Creek
Snow Gulch
Quartz Gulch
Crooked Creek
Grouse Creek
Queen Gulch
Lewis Gulch
CR2 - K, CO
AM1 - CO
American Creek
Omega Gulch
AN1 - CO
CR1 - K, CO
Anaconda Creek
Eagle Creek
Crevice Creek
CR0.7 - K, CO, S
Bell Creek
GM1 - K, CO, S
Getmuna Creek
GM2 - CO
GM3 - CO
GM4 - CO
BL1 - K, CO
CR0.3 - K, CO
Village Creek
KU24
KU25
KU23
KU11
KU22
KU8
KU10
KU9
KU12
KU20
KU21
KU13
KU14
KU15
KU26
Jungjuk Creek
JJ1 - CO
Projection: NAD 1983 UTM Zone 4N Transverse Mercator
Meridian: Seward
Juvenile Salmon Density (#/300 ft)
<3
3-10
10-30
>30
No Catch
Port Sampling Site
Streams
Proposed Natural Gas Pipeline
Proposed Donlin Site Layout
Canada
Map Location
Juvenile Salmon Density
Mine Vicinity
Donlin Gold
0
2
4
Miles
Figure:
4.2-3
EFH_DNG007, 01/12/17, R03



EFH_DNG003, 02/20/15, R00




EFH_DNG002, 08/06/15, R01