US Army Corps
of Engineers
Alaska District

Final Integrated Feasibility Report
and Environmental Assessment
and Finding of No Significant Impact

Kenai Bluffs Bank Stabilization
Section 116 Feasibility Study
Kenai, Alaska

March 2019

This page left blank intentionally.

Final Integrated Feasibility Report and Environmental Assessment, and Finding of No Significant Impact

Kenai Bluffs Bank Stabilization
Section 116 Feasibility Study
Kenai, Alaska

Prepared by
U.S. Army Corps of Engineers
Alaska District

March 2019

This page left blank intentionally.

Kenai Bluffs Bank Stabilization Study
Kenai, Alaska

Finding of No Significant Impacts

The U.S. Army Corps of Engineers, Alaska District (Corps) has conducted an environmental analysis in accordance with the National Environmental Policy Act of 1969, as amended. The final Integrated Feasibility Report and Environmental Assessment (IFR/EA), dated February 2019, for the General Investigation Study addresses measures to limit storm damage and coastal erosion, as well as opportunities and project feasibility, at the Kenai Bluffs site, at Kenai, Alaska. The final recommendation is contained in the report of the Director of Civil Works, dated 30 April 2019.

The Final IFR/EA, incorporated herein by reference, evaluated a number of structural and non-structural alternatives that would limit the extent of erosion-caused property damage, based on economic, engineering, and environmental and cultural resource factors. The recommended plan is the implementation of Alternative 5, Protective Berm at the Bluff Toe, which includes:

- A protective rock berm, approximately 5,000 feet long, constructed along the base of the eroding bluff. The crest elevation of the berm will gradually decrease in height from west to east to account for the decrease in wave height upstream. The protective berm will require 42,400 cubic yards of armor rock, 33,200 cubic yards of B-rock, and 13,100 cubic yards of gravel base.

- The protective berm is designed to prevent storm damages to the lower portion of the bluff, and prevent the removal of accumulated sediment between the bluff toe and the berm.

The Corps does not propose compensatory mitigation, and none has been recommended by federal or state resource agencies. Therefore, no monitoring and adaptive management plan is required. The environment will be protected by implementing avoidance and minimization measures as detailed in the IFR/EA.

In addition to the “no action” plan (Alternative 1), 5 alternatives were evaluated:

2 Relocating the mouth of the Kenai River away from the bluff.
3 Revegetating and revetting the bluff face with a buried-toe revetment.
4 Revegetating and revetting the bluff face with a weighted-toe revetment.
5 Protective berm at the bluff toe.
6 Relocating threatened structures at top of bluff (non-structural).

These alternatives are described in Chapter 6 of the IFR/EA, compared in Chapter 7, and the selected plan identified in Chapter 8.

A non-structural alternative (Alternative 6, Structure Relocation) was evaluated and not selected during the study as the recommended plan. This alternative was not selected, in part, because land and infrastructure damages would have been the same as for the future without-project condition with a similar cost to the selected plan; which avoids these damages. In addition, and in accordance with Section 116 Implementation Guidance, plan selection was based on Cost Effectiveness/Incremental Cost Analysis (CE/ICA) in the Other Social Effects account, with plan selection also supported by a least cost analysis as there was no National Economic Development Plan. A Locally Preferred Plan (LLP) alternative was not evaluated as part for this study.

For all alternatives, the potential effects to the following resources were evaluated:

	In-depth evaluation conducted	Brief evaluation due to minor effects	Resource unaffected by action
Aesthetics	☐	☐	☒
Air quality	☐	☒	☐
Aquatic resources/wetlands	☒	☐	☐
Invasive species	☐	☐	☒
Fish and wildlife habitat	☒	☐	☐
Threatened/Endangered species	☒	☐	☐
Historic properties	☒	☐	☐
Other cultural resources	☒	☐	☐
Floodplains	☐	☒	☐
Hazardous, toxic & radioactive waste	☐	☒	☐
Hydrology	☐	☒	☐
Land use	☐	☒	☐
Navigation	☐	☒	☐
Noise levels	☒	☐	☐
Public infrastructure	☐	☒	☐
Socio-economics	☐	☒	☐
Environmental justice	☐	☒	☐
Soils	☐	☒	☐
Tribal trust resources	☐	☐	☒
Water quality	☐	☒	☐
Climate change	☐	☒	☐

All practical means to avoid or minimize adverse environmental effects were analyzed and incorporated into the recommended plan. Best management practices (BMPs) as detailed in the IFR/EA will be implemented to minimize impacts.

- The Corps will conduct a pre- and post-construction assessment of the intertidal mud flat environment in the vicinity of the project site.
- The Corps will conduct a survey for bald eagle nests within 0.25 mile of the project, and comply with published U.S. Fish and Wildlife Service (USFWS) guidelines if a potential nest site is identified.

- The Corps will comply with USFWS land clearance timing guidelines for the region to reduce the potential for take of migratory birds.
- The Corps will comply with timing restrictions on in-water work and any other measures that have been or may be recommended or stipulated by the National Marine Fisheries Service (NMFS) or the Alaska Department of Fish & Game (ADFG):

    - No in-water work will be performed, and no large project vessels (e.g., barges and tugs) will operate, within the Kenai River estuary during March 15 through May 15.

    - The Corps will establish a monitoring (shutdown) zone for all marine waters within a radius of 492 ft. (150 meters) of the vessel noise. The zone will be monitored by a dedicated, trained marine mammal observer (MMO). If marine mammals are observed approaching the intended route of any project vessel, the vessel will stop or slow, to the extent practical while maintaining control, and allow the animal(s) to pass. Vessels may also divert their heading towards the rear of the marine mammals' direction of travel.

    - Vessel captains and crewmembers shall be trained to: [a] Assist with the detection of protected marine mammals; [b] Use binoculars to facilitate marine mammal observations; [c] Continuously scan the monitoring zone (492 ft. [150 meters]) while vessels are underway to help ensure that protected species do not enter the monitoring zone; [d] Implement mitigation measures.

    - The Corps will ensure that pilots of the barges and tugs will have clear views of the monitoring zone (492 ft. [150 meters]) around each vessel to facilitate effective monitoring for marine mammals. These pilots will enforce the established monitoring zones.

    - The Corps will ensure that barges will not travel at speeds exceeding 6 knots (7 miles per hour [mph]).

    - The Corps will submit a monitoring report to NMFS within 90 days after all in-water activity has ceased. The report will provide details about marine mammal observations and interactions that occurred during the construction of the protective rock berm. Monitoring reports and all instances of marine mammal take shall be provided to NMFS AKR Protected Resources Division.

    - The selected contractor will include an Oil Spill Prevention and Control Plan in their Environmental Protection Plan, to be submitted to the Corps for review and approval.

Potential environmental impacts will be reassessed during the Pre-construction, Engineering and Design phase (PED) as more detailed information on construction practices is developed, and additional avoidance and minimization measures may be adopted in coordination with resource agencies. For example, impacts on marine mammals will be reassessed during PED, and the

Corps will apply for an Incidental Take Authorization (ITA) under the Marine Mammal Protection Act (MMPA) if new information indicates the potential for a taking of a marine mammal.

These measures are discussed in Section 8.1.6 of the IFR/EA.

Unavoidable adverse impacts would be less than significant. The existing habitat within the project footprint would be permanently altered, but it appears to be of marginal ecological value and in a continual state of disruption from the erosion and collapse of the river bluff. As the new habitat created by the rock structures is likely to be at least as productive as and more stable than the existing habitat, unavoidable adverse impacts will be negligible. The completed project is not anticipated to have any discernable effects on river flow patterns beyond the immediate project area or on tidal influence or the movement organisms within the river.

Pursuant to section 7 of the Endangered Species Act of 1973, as amended, the Corps determined that the recommended plan may affect but is not likely to adversely affect the following federally listed species or their designated critical habitat:

- Beluga whale (Cook Inlet DPS).

A draft Letter of Concurrence was received from the NMFS on 2 March 2019, concurring with the Corps determination.

Pursuant to Section 106 of the National Historic Preservation Act of 1966, as amended, the Corps determined that the recommended plan has no potential to cause effects on historic properties.

Pursuant to the Magnuson Stevens Fishery Conservation and Management Reauthorization Act of 2006, the Corps determined that the proposed project will not adversely affect essential fish habitat.

Pursuant to the Fish and Wildlife Coordination Act of 1934, as amended, the Corps engaged with the USFWS and has received a Coordination Act Report for this project.

Pursuant to the Clean Water Act of 1972, as amended, the discharge of dredged or fill material associated with the recommended plan has been found to be compliant with section 404(b)(1) Guidelines (40 CFR 230). The Clean Water Act Section 404(b)(1) Guidelines evaluation is found in Appendix A of the IFR/EA.

A water quality certification pursuant to section 401 of the Clean Water Act has been obtained from the Alaska Department of Environmental Conservation Division of Water, dated 18 July 2017 (certificate no. ER-17-05). All conditions of the water quality certification will be implemented in order to minimize adverse impacts to water quality.

Alaska withdrew from the voluntary National Coastal Zone Management Program on July 1, 2011. Within the State of Alaska, the Federal consistency requirements under the Coastal Zone Management Act do not apply to Federal agencies.

Public and agency review of the draft IFR/EA was completed on 17 July 2017. All comments submitted during the public comment period were responded to in the Final IFR/EA.

Technical, environmental, economic, and cost effectiveness criteria used in the formulation of alternative plans were those specified in the Water Resources Council's 1983 *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies*. All applicable laws, executive orders, regulations, and local government plans were considered in evaluation of alternatives. Based on these reports, the reviews by other Federal, State and local agencies, Tribes, input of the public, and the review by my staff, it is my determination that the recommended plan would not significantly affect the human environment; therefore, preparation of an Environmental Impact Statement is not required.

Date	Phillip J. Borders Colonel, Corps of Engineers District Commander

Executive Summary

This General Investigations study was conducted under authority granted by Section 116 of the Energy and Water Development and Related Agencies Appropriations Act of 2010. The study seeks to determine the existence of a Federal interest in and the feasibility of constructing coastal storm risk management measures to carry out structural and non-structural projects for storm damage prevention and reduction, coastal erosion, and ice and glacial damage.

This study evaluates alternatives to prevent and reduce coastal erosion of approximately 5,000 linear feet of bluff, herein referred to as the Kenai Bluffs. The Kenai Bluffs are located in the City of Kenai, Alaska; which is approximately 65 air miles and 155 highway miles southwest of Anchorage, Alaska. The local non-Federal sponsor (City of Kenai) has stated its intention to cost-share in federally-constructed coastal storm risk management measures in Kenai.

The Kenai Bluffs height ranges between 55 to 70 feet and the bluff face is receding at an approximate average rate of 3 feet per year. A review of aerial photographs that extended over a 56 year period of record indicate that the erosion rate ranges from 2 to 4 feet per year, as a result the 3 feet per year estimate used for study purposes appears to be a reasonable estimate. However, the erosion is episodic and the amount of bluff loss at any particular location can vary from chronic to an acute large loss of bluff face over a short period. Public and private property, structures and infrastructure, and cultural resources have been lost and continue to be threatened by the receding bluff. The bluff consists of unconsolidated sediments that remain oversteep and unstable because it is exposed to Cook Inlet coastal storms and extreme floodtides that have the fourth largest range in the world of 31.4 feet. Tidal currents and wave action during flood tides attack the toe of the bluff, removing sediments that originate from the bluff face and accumulate at its toe. Coastal storms also degrade the structural integrity of the exposed lower bluff face. In order for the bluff to stabilize, an effective structural project alternative will need to prevent the removal of accumulated sediment at the bluff and the structural damage of the lower bluff.

This study evaluates a number of alternatives based on economic, engineering, and environmental and cultural resources factors. In accordance with Section 116 Implementation Guidance, plan selection was based on Cost Effectiveness/Incremental Cost Analysis (CE/ICA) in the Other Social Effects account, with plan selection also supported by a least cost analysis as there is no National Economic Development Plan. Alternative 5 (Protective Berm at Bluff Toe) is the plan; which is supported by the non-Federal sponsor, the City of Kenai. Alternative 5 includes constructing a berm at the bluff toe that is designed to prevent the removal of accumulated sediment between the bluff toe and the berm and prevent storm damages to the lower portion of the bluff. With the bluff toe protection in place, it will eventually stabilize, and the bluff surface will erode back naturally to a more stable slope, which is estimated to take up to 15 years.

The average annual investment cost of the project based on certified costs for the elected project, including the cost of operation and maintenance, is $1.6 million (in FY 2019 dollars) with annual National Economic Development benefits of $824,000. Using certified costs for the selected plan, the project’s benefits to cost ratio is 0.51 with average Net Annual Benefits of negative $796,000. The total economic (NED) cost is $42.7 million (50 years, 2.875%).

Remaining key uncertainties and risks are mostly associated with the need to better understand site conditions, which can influence final design and long-term performance of the selected plan. Applicable geotechnical data will be collected during the PED phase of the project since additional data collection during the study would not likely differentiated the reasonable alternative plans considered for this study.

The City of Kenai would be required to pay the non-Federal share of 35 percent of the design and construction costs assigned to coastal risk management measures of the project as specified by the Flood Control Act of 1948, as amended, and as specified by the Water Resources Development Act of 1986 (Public Law 99-662), Section 103(c) (4 and 5), as amended.

Pertinent Data

Selected Plan Alternative 5: Protective Berm at Toe of Bluff		
General Berm Feature	**Units**	**Approximate Amounts**
Total Length	Feet	5,000
Crest Width Range	Feet	5.25 to 6.75
Crest Elevation Range	Feet above MSL	32.5 to 35
Armor Stone	Cubic Yards	42,400
Core Material (B-Rock)	Cubic Yards	33,200
Gravel Base 1.5 -inch	Cubic Yards	13,100
Filter Fabric / Geotextile	Square Feet	225,000
Armor Stone Maintenance / 20 years	Cubic Yards	4,200

Selected Plan, Alternative 5: Protective Berm at Toe of Bluff	Amount
Certified Project First Costs	$40,294,000
Annual Operation and Maintenance	$47,000
Total National Economic Development Cost (50 years, 2.875%)	$42,691,000
Total National Economic Development Benefits (50 years, 2.875%)	$21,702,000
Average Annual Cost	$1,620,000
Average Annual Benefits	$824,000
Average Net Annual Benefits	**–$796,000**
Benefit to Cost Ratio	**0.51**

Note: Cost and benefits in this table are at the FY 2019 price level and discount rate of 2.875 percent. These do not match the costs and benefits used for plan evaluation and selection, which are at the FY 2018 price level and discount rate of 2.75 percent.

Conversion Table for SI (Metric) Units		
Multiply	**By**	**To Obtain**
Cubic Yards (cy)	0.7646	Cubic Meters
Acre (ac)	0.4049	Hectare
Feet	0.3048	Meters
Feet Per Second	0.3048	Meters Per Second
Inches	2.5400	Centimeters
Knots (international)	0.5144	Meters Per Second
Miles (U.S. Statute)	1.6093	Kilometers
Miles (Nautical)	1.8520	Kilometers
Miles Per Hour	1.6093	Kilometers Per Hour
Pounds (mass) (lbs)	0.4536	Kilograms
Fahrenheit	C = (5/9)(F-32)	Celsius

List of Acronyms and Abbreviations

ADCRA	Alaska Division of Community and Regional Affairs
ADEC	Alaska Department of Environmental Conservation
ADCCED	Alaska Department of Commerce, Community, and Economic Development
ADFG	Alaska Department of Fish and Game
ANCSA	Alaska Native Claims Settlement Act of 1971
AK	Alaska
AKDOL&WD	Alaska Department of Labor and Workforce Development
AWQS	Alaska Water Quality Standards
AWC	Anadromous Waters Catalog
C	Celsius
CAA	Clean Air Act
CE/ICA	Cost Effectiveness/Incremental Cost Analysis
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cfs	Cubic feet per second
CIRI	Cook Inlet Region, Inc.
COL	Colonel
Corps	U.S. Army Corps of Engineers
CWA	Clean Water Act
DPS	Distinct Population Segment
EA	Environmental Assessment
ECO-PCX	Economic CO-PCX
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
ER	Engineer Regulations
ESA	Endangered Species Act
E2USN	Estuarine Intertidal Unconsolidated Shore
etc.	Et Cetera
FAA	Federal Aviation Administration
F	Fahrenheit
FC	Full Compliance
FMP	Fishery Management Plan
FONSI	Finding of No Significant Impact
FR/EA	Feasibility Report and Environmental Assessment
FWCA	Fish and Wildlife Coordination Act
ft	feet
IDC	Interest During Construction
kg	Kilograms

KPB	Kenai Peninsula Borough
lbs	Pounds
LERRD	Lands, Easements, Rights of Way, Relocations, and Dredged Material Disposal
mg	Milligrams
mg/l	Milligrams per liter
MBTA	Migratory Bird Treaty Act
MHHW	Mean Higher High Water
MHW	Mean High Water
mph	Miles Per Hour
MLLW	Mean Lower Low Water
MMPA	Marine Mammal Protection Act
MSL	Mean Sea Level
N/A	Not Applicable
NAAQS	National Ambient Air Quality Standards
NED	National Economic Development
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NTU	Nephelometric Turbidity Units
OCT	Opportunity Cost of Time
OMB	Office of Management and Budget
OSE	Other Social Effects
ppt	parts-per-thousand
PC	Partial Compliance
PED	Preconstruction Engineering and Design
R	Republican
RONA	Record of Non-Applicability
SHPO	State Historic Preservation Officer
SIP	State Implementation Plan
UDV	Unit Day Value
U.S.	United States
USACE	U.S. Army Corps of Engineers
U.S.C.	United States Code
USCG	United States Coast Guard
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey

TABLE OF CONTENTS

APPENDIXES

TABLES

FIGURES

1.0 INTRODUCTION

1.1 Authority

This General Investigations study was conducted under authority granted by Section 116 of the Energy and Water Development and Related Agencies Appropriations Act of 2010, which states:

"The Secretary of the Army is authorized to carry out structural and non-structural projects for storm damage prevention and reduction, coastal erosion, and ice and glacial damage in Alaska, including relocation of affected communities and construction of replacement facilities: Provided, that the non-Federal share of any project carried out pursuant to this section shall be no more than 35 percent of the total cost of the project and shall be subject to the ability of the non-Federal interest to pay, as determined in accordance with 33 U.S.C. 2213(m)."

1.2 Scope of Study

This study evaluates Federal interest in and the feasibility of constructing coastal storm risk management measures, and proposes a selected plan to prevent and reduce the negative effects of the receding Kenai River Bluff, herein referred to as the Kenai Bluffs. This study was conducted and the report prepared in accordance with the goals and procedures for water resource planning as contained in Engineer Regulation (ER) 1105-2-100, "*Planning Guidance Notebook*," which defines the contents of feasibility reports for coastal storm risk management projects. ER 200-2-2, "*Procedures for Implementing NEPA*" directs the contents of environmental assessments. This document presents the information required by both regulations as an integrated Feasibility Report and Environmental Assessment (FR/EA). It also complies with the requirements of the Council on Environmental Quality regulations for implementing the National Environmental Policy Act of 1969 (42 U.S.C. 4341 et seq.).

This FR/EA documents the analysis and coordination conducted to determine whether the Federal government should participate in constructing coastal storm risk management measures in Kenai, Alaska. Studies of this nature consider a wide range of alternatives and the environmental consequences of those alternatives. A consideration of benefits under authority granted by Section 116 allows the U.S. Army Corps of Engineers, Alaska District (USACE) to identify a selected plan.

1.3 Project Location

The project is located in City of Kenai on the western coast of the Kenai Peninsula, 65 air miles and 155 highway miles southwest of Anchorage (Figure 1). The project area includes the Kenai Bluffs coastal erosion area; which is approximately 5,000 linear feet of high bank that ranges in height from 55 to 70 feet above the toe along the north bank of the Kenai River at the river mouth to Cook Inlet (Figure 1). Cook Inlet extends 180 miles from the Gulf of Alaska to Anchorage in Southcentral Alaska.

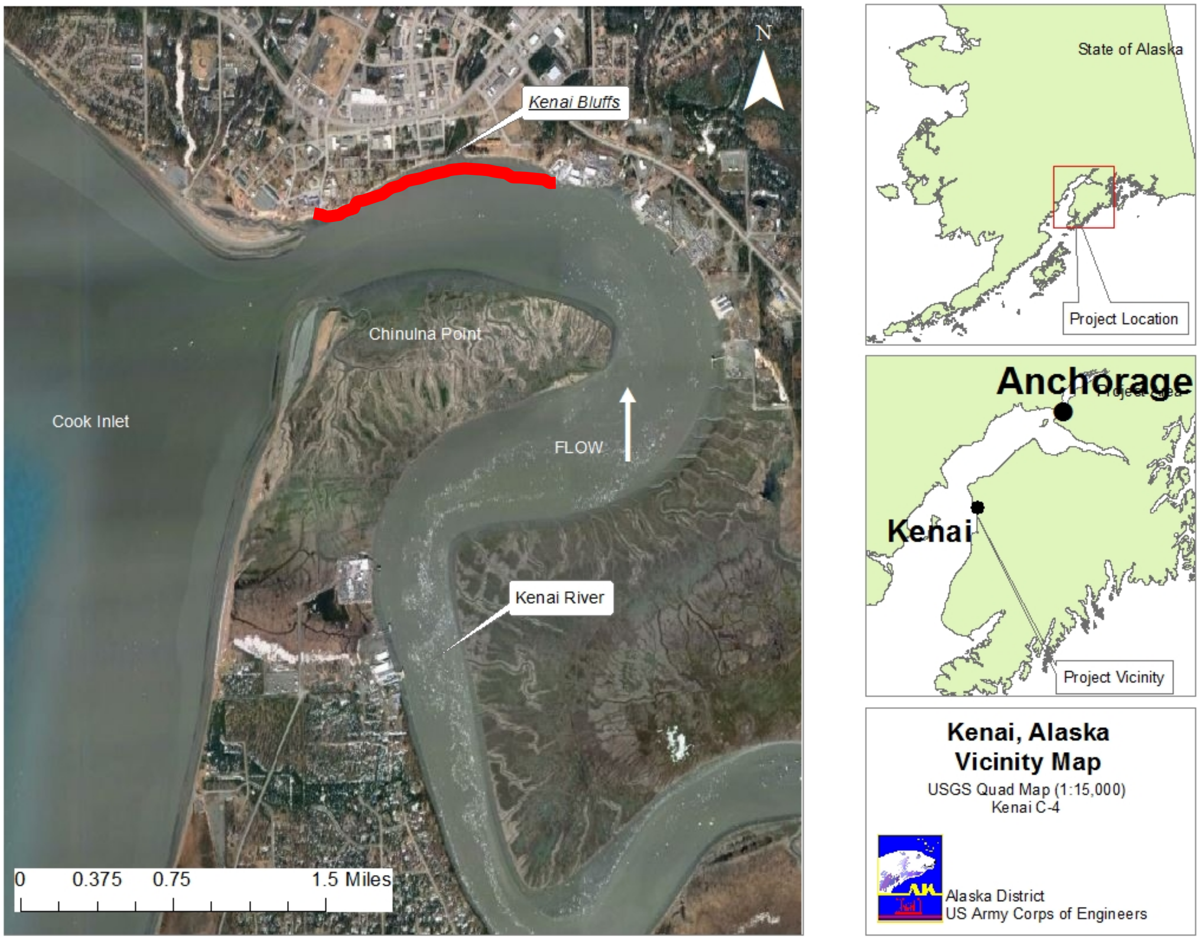

Figure 1. Project Location

1.4 Congressional District

The project is located in the Alaska Congressional District, which has the following congressional representation:

Senator Lisa Murkowski (R-AK)
Senator Dan Sullivan (R-AK)
Representative Don Young (R-AK)

1.5 Study Participants/Coordination

The USACE is the lead agency for this coastal storm risk management General Investigations study. The analyses that provide the basis for this study were conducted with the assistance of many individuals and agencies, including: The City of Kenai, the U.S. Fish and Wildlife Service (USFWS), the U.S. Coast Guard (USCG), the State of Alaska Department of Fish and Game (ADFG), the State of Alaska Department of Environmental Conservation (ADEC), Alaska Department of Commerce, Community, and Economic Development (ADCCED), Alaska

Department of Labor and Workforce Development (AKDOL&WD), the National Marine Fisheries Service (NMFS), and many members of the interested public who contributed information and constructive criticism to improve the quality of this report.

1.6 Non-Federal Sponsor

The City of Kenai is the non-Federal sponsor and has stated its intention to cost-share in federally-constructed coastal risk management measures. The Federal Cost Sharing Agreement (FCSA) for this Study was signed May 12, 2015. This agreement creates a Federal and non-Federal partnership with the objective to effectively serve both local and national interests.

1.7 Related Reports and Studies

According to the City of Kenai (Koch 2015), the receding bluff has affected residents of the community for 100 years. The USACE has been involved in various studies of the Kenai River since at least 1962 when the U.S. Army Engineer District, Alaska, Foundations and Materials Branch (USACE 1962) evaluated rip rap source materials for navigation improvement projects, and later navigability improvement studies of the Kenai River (USACE 1970 and 1976).

With respect to the bluff erosion issue specifically, The City of Kenai commissioned a study in 1982 (TAMS 1982), with the USACE intermittently involved since at least 1997 when the USACE published a reconnaissance report that investigated navigation improvements and erosion control on the Lower Kenai River (USACE 1997). The Energy and Water Development Appropriations Act of 2002, Senate Report 107-039 authorized the Corps to expend up to $500,000 to conduct a "*special technical evaluation of bank stabilization needs along the lower Kenai River*." Due to this previous Congressionally-directed work, significant technical analyses have been completed regarding Kenai Bluffs erosion. Existing analyses from this work include technical reports related to the following: geotechnical and hydraulic conditions, preliminary environmental analysis, cultural and historic resources, real estate in the affected area, groundwater conditions, a revetment design, and the construction cost of that design.

Various Kenai Bluffs erosion studies completed by Federal and state agencies and others are listed chronologically below, with brief annotations about the report content.

1.7.1 Federal Agencies

USACE. 1970. *Reconnaissance Report, Kenai River, Alaska,* U.S. Army Corps of Engineers, Alaska District, November 1970. This report performed a reconnaissance level evaluation of providing flood risk management measures along the Kenai River. A Federal interest could not be justified.

USACE. 1976. *Feasibility Study, Kenai Harbor, Alaska, Small Boat Harbor and Deep-Draft Navigation Improvements*, U.S. Army Corps of Engineers, Alaska District, February 1976. This study could not establish a Federal interest in constructing navigation improvements in Kenai at this time.

USACE. 1978. *Kenai River Review, Final,* U.S. Army Corps of Engineers, Alaska District, April 1978. This review is akin to a modern day watershed study. It detailed navigable reaches of the river, ownership of the river bottom, riparian rights, Federal jurisdiction, ordinary high water marks, and water rights. It also performed some analysis of environmental conditions related to the area's biology, geology, hydrology, and socio-economics.

USGS. 1982. *Erosion and Sedimentation in the Kenai River, Alaska,* U.S. Geological Survey, 1982. This report presented an assessment of erosion and sedimentation of the entire Kenai River.

USACE. 1997. *Reconnaissance Report for Navigation Improvements and Erosion Control,* U.S. Army Corps of Engineers, Alaska District, June 1997. This report established a Federal interest in participating in a cost-shared feasibility study of coastal erosion at the mouth of the Kenai River.

USACE. 2004a. *Geotechnical Findings Report, Kenai River Bluff Erosion, Kenai, Alaska,* U.S. Army Corps of Engineers, Alaska District, October 2004. This report provided a summary of findings based on site observations and results of field exploration, laboratory testing, and engineering computations.

USACE. 2006. *Kenai River Bank Erosion Technical Report, Kenai Alaska,* U.S. Army Corps of Engineers, Alaska District, May 2006. As directed by the Energy and Water Development Appropriations Act of 2002, Senate Report 107-039, this report assessed environmental resources at the lower Kenai River, identified the mechanisms for bluff erosion, and assessed environmental and hydrogeomorphic consequences of bluff stabilization.

USACE. 2007. *Geotechnical Investigation and Site Conditions Report, Kenai River Bluff Erosion,* U.S. Army Corps of Engineers, Alaska District, February 2007. This report documents sediment sampling and test borings for the study area along with a thorough geotechnical assessment; performed by R&M Consultants, Inc. See Appendix D.

USACE. 2008a. *Groundwater Monitoring Report, Kenai River Bluff Erosion,* U.S. Army Corps of Engineers, Alaska District, January 2008. This report documents groundwater monitoring activities performed by R&M Consultants, Inc. See Appendix D.

USACE. 2008b. *Kenai River Bluff Erosion, Bluff Stabilization Design Alternatives, Design Alternatives Report,* U.S. Army Corps of Engineers, Alaska District, October 2008, prepared by Tetra Tech. This report provides the design of bluff stabilization along with detailed engineering drawings for the preliminary design.

USACE. 2009a. *Kenai River Bluff Erosion, Bluff Stabilization Design Alternatives, Draft Design Report,* U.S. Army Corps of Engineers, Alaska District, March 2009, prepared by Tetra Tech. This report provides the design of bluff stabilization along with detailed engineering drawings for the preliminary design.

USACE. 2010. *Kenai River Bluff Limited Economic, Cultural and Historic Property Evaluation, Draft,* U.S. Army Corps of Engineers, Alaska District, December 2010. This report documents an evaluation of lost income and diminished opportunities of businesses along the bluff as they are forced to relocate because of ongoing erosion, as well as potential losses of historical and cultural sites; prepared by Tetra Tech.

USACE. 2011. *Kenai River Bluff Stabilization, Kenai, Alaska, Cost Engineering Report Draft Submittal,* U.S. Army Corps of Engineers, Alaska District, June 2011. This report contains detailed cost estimates of the construction features presented in the Design Alternatives Report dated June 2011; performed by Tetra Tech.

USACE. 2013. Kenai River Bluff Erosion Section 905(B) (WRDA) Analysis.

1.7.2 State Agencies

University of Alaska Anchorage (UAA) 2001. *Erosion at the Mouth of the Kenai River, Alaska April 2001,* University of Alaska Anchorage, Orson Smith, William Lee, and Heike Merkel. Report contains a sediment budget analysis with regard to the proposed *Kenai Coastal Trail and Erosion Control Project,* PND, February 2002.

ADF&G 2002. *Estimates of Chinook Salmon Abundance in the Kenai River Using Split-Beam Sonar,* State of Alaska Department of Fish and Game, December 2002. This report provided data on abundance of Chinook salmon (*Oncorhynchus tshawytscha*) in the Kenai River.

1.7.3 Others

Tippetts-Abbett-McCarthy-Stratton (TAMS) 1982. *City of Kenai River Bluff Erosion Study, Draft Report, November 1982*. This report was commissioned by the City of Kenai to investigate the regression of the high bluff referred to as the Kenai River Bluff and to recommend remedial measures.

Peratrovich, Nottingham, and Drage, Inc. (PND) 2000 and 2002. *Kenai Coastal Trail and Erosion Control Project, Design Concept Report,* January 2000 and February 2002 reports. These reports provide a design concept of bluff stabilization and a pedestrian trail along the bluff.

2.0 PLANNING CRITERIA/PURPOSE AND NEED

2.1 Problem Statement/Purpose and Need

The coastal erosion at the mouth of the Kenai River results in over-steepening, collapse, and inland retreat of the Kenai Bluffs. This ongoing condition negatively impacts and continues to threaten commercial, municipal, and private property (land, structures, and infrastructure), as well as cultural and historical resources in Kenai, Alaska. The purpose of this study is to determine the feasibility of constructing erosion control measures that prevent and/or reduce the effects of bluff erosion over the 50-year period of analysis, particularly damages to structures, infrastructure, and cultural and historical resources.

The ongoing condition of the receding Kenai Bluffs has resulted in:

- Lost land to the sea: commercial, municipal, non-profit (e.g., Kenai Bible Church built in 1940):
  - 7 parcels have been completely lost
  - 18 parcels have suffered land loss
  - Nearly all threatened parcels have lost value
- Lost and damaged cultural resources (i.e., historical, potentially historical, and archeological sites):
  - 4 historic wooden structures
  - Property of the historic Kenai Bible Church
  - Human remains have eroded out of the bluff
  - Prehistoric house depressions have been lost or are exposed
- Abandoned and/or condemned structures: residential, commercial, and municipal
- Threatened structures and infrastructure: residential, commercial, non-profit, and municipal (e.g., Kenai Senior Center)
- Relocation of utilities and roads

In addition, the ongoing receding Kenai Bluffs has had other negative impacts (i.e., other social effects) as listed below:

- Cultural vulnerability with local tribes and the local population
- Under use of public-use areas by locals and tourists (e.g., scenic overlooks and nearby parks)
- Health and safety issues (The unstable bluff is preventing activities at the base and near the top edge of the bluff, although soft sediments on the beach area may continue to prevent activities at the base.)
- Negatively impacted social connectedness, identity, resiliency, leisure, and recreation
- Contributes to uncertainty in community planning

2.2 Study Opportunities

Study opportunities are statements about things that will or have the potential to be realized by meeting the main study objectives. The study opportunities that could be realized with a stabilized bluff include:

- Prevented or reduced damages or loss of property, structures, and cultural resources
- Managed risks associated with bluff erosion
- Enhanced stable environment with a stable streambank and riparian corridor
- Improved recreational usage of the area
- Enhanced navigation consistent with ER 1105-2-100, Appendix E, Section II, E-8, b. (7)

The exceptional water front view from the top of the bluff encourages tourism and, if the bluff were stable, it would also:

- Enhance the economic values of property and assets
- Encourage development of the area
- Increase the tax base value of the area

2.3 Objectives

2.3.1 National Objectives

The Federal objective of water and land resources planning is to contribute to National Economic Development (NED) in a manner consistent with protecting the nation's environment. NED features increase the net value of goods and services provided to the economy of the nation as a whole. Generally, only benefits contributing to NED may be claimed for Federal economic justification of a project. However, if there is no NED plan, Section 116 Implementation Guidance allows for selection of a plan based in part or whole on non-monetary units supported by a Cost Effectiveness/Incremental Cost Analysis (CE/ICA).

2.3.2 Study Objectives

This study's general objective is to propose non-structural and structural erosion control measures or combination of measures as a plan that prevents and reduces the negative effects of bluff erosion, particularly damages to structures, infrastructure, and cultural resources caused by the receding Kenai Bluffs over the 50-year period of analysis.

2.4 Study Constraints

Study constraints are statements about what you want to avoid doing, or things you cannot change, while meeting your objectives. Due the physical location of the Kenai Bluffs at mouth of the Kenai River, physical construction of any project will pose challenges associated with a reduced construction season due to winter conditions, tidal schedules, potential coastal storms, seasonal commercial fishing fleet, and sport fishing boat traffic. Study constraints primarily involve the engineering, economic, and environmental criteria items that are discussed in the report sections that follow. Study constraints include:

- Any enacted solution must consider all natural processes that are significantly contributing to bluff erosion including: waves, tides, ground water seepage, and overbank flow.
- Plans must minimize adverse impacts to navigation.
- Plans must minimize adverse impacts to anadromous fish stocks and the commercial and personal use of those stocks.
- Plans must avoid or minimize impacts to historic sites and/or critical infrastructure.

2.5 Criteria

2.5.1 National Evaluation Criteria

Alternative plans should be formulated to address study objectives and adhere to study criteria. Each alternative plan shall be formulated in consideration of four criteria: completeness, efficiency, effectiveness, and acceptability.

- Completeness is the extent to which alternative plans provide and account for all necessary investments or other actions to ensure the realization of the planning objectives, including actions by other Federal and non-Federal entities.
- Effectiveness is the extent to which alternative plans contribute to achieve the planning objectives.
- Efficiency is the extent to which an alternative plan is the most cost-effective means of achieving the objectives.
- Acceptability is the extent to which alternative plans are acceptable in terms of applicable laws, regulations, and public policies. Mitigation of adverse effects shall be an integral component of each alternative plan.

Each alternative has a cost estimate prepared by Cost Engineering. For the NED analysis, average annual costs are then compared to average annual benefits expected to be derived from each alternative evaluated. Applying an appropriate discount rate and period of analysis makes costs and benefits comparable on the equivalent time value of money. For this analysis, the Federal fiscal year 2018 discount of 2.750 percent is used, as well as a 50-year period of analysis.

2.5.2 Study Specific Evaluation Criteria

The plan that effectively serves both the Federal and non-Federal interest must be designed and constructed so that it safely and efficiently meets the main objective of preventing and reducing the damages to structures, infrastructure, and cultural and historical resources caused by the receding Kenai Bluffs over the 50-year period of analysis. The following goals and objectives, based on the needs described in Section 2.3, are related to providing an erosion control measure that is safe, usable, and maintainable.

<u>Constructability:</u> Constructability is defined by the following question: "Do site-specific conditions cause the measure to be technically infeasible or not applicable as a storm damage risk management measure?"

<u>Constraint Avoidance</u>: Constraint avoidance is defined as a measure's ability to avoid study constraints.

<u>Social Considerations</u>: Social Considerations is defined as "The extent to which a measure is judged to be acceptable to agencies, tribes, and the general public. This also includes or captures other social effects (OSE).

3.0 BASELINE CONDITIONS/AFFECTED ENVIRONMENT

3.1 History

The City of Kenai and the surrounding area has been used extensively by Dena'ina Athabascan people in general and the Kahtnuht'ana Dena'ina people of the Kenaitze tribe in particular for generations. The Dena'ina name for the Kenai River mouth is "Kahtnu Kaq" (Trefon et al. 2014). A brief post-contact timeline is summarized in Table 1.

Table 1. Brief Post-contact Timeline

Year	Historical Activity
1741	Russian fur traders arrive at the Athabascan village of "Shk'ituk't" which has a population of about 1,000.
1791	The Russians construct the second permanent Russian settlement in Alaska at Fort St. Nicholas, a fortified fur and fish trading post.
1841	The Russian American Company builds a Russian Orthodox Church at Kenai.
1867	The U.S. purchases Alaska from Russia.
1869	The U.S. Military constructs Fort Kenai, a post for Dena'ina people in the area.
1888	The first commercial salmon cannery, the Northern Packing company, opens in Kenai.
1899	The first U.S. Post Office is constructed in Kenai.
1940	Homesteading enables the area to develop.
1951	A dirt road connects Kenai to Anchorage.
1957	Oil is discovered at Swanson River, 20 miles northeast of Kenai. It is the first major oil discovery in Alaska.
1960	The City of Kenai is incorporated.
1965	The discovery of oil in Cook Inlet brings in a period of accelerated growth.

3.2 Demographics

The City of Kenai had a population of 7,100 according to the 2010 census, up 2.3 percent from 6,942 at the 2000 census. In 2014 the State of Alaska Department of Labor and Workforce Development (AKDOL&WD) estimated the City of Kenai population to be 7,167. After rapid increases during the economic booms of the 1960's through the 1980's, population growth in Kenai began to stabilize by 2000, with more long-term residents and a generally older population. Several other communities, such as Soldotna, Nikiski, Kasilof, and Sterling, are within 20 miles of Kenai, giving the northwest Kenai Peninsula a population of roughly 34,000. The racial makeup of the Kenai population in 2010 was about 80 percent white, 14 percent Alaska Native or American Indian, and 6 percent Asian, other races, or multi-racial. The proportion of people living below the poverty line was 9.4 percent (ADCRA 2016).

3.3 Socio-Economics

The City of Kenai is the commercial and service center for the western Kenai Peninsula and a local center of government. It has a per capita income of $31,700 and a median household income of $63,000. Approximately 9 percent of residents fall below the Federal poverty level. The Kenai area has a substantial industrial economy, built largely on petroleum and fishery resources. Fisheries are a large part of Kenai's economy. The city's largest employers are the

Kenai Peninsula Borough (KPB) school district, Unocal, Peak Oilfield Services, the borough government, and the Central Peninsula General Hospital (City of Kenai 2013, ADCRA 2016). The State of Alaska Division of Community and Regional Affairs (ADCRA 2016) reported that in 2014, 282 separate commercial fishing permits were issued and that fisheries provided over $10 million in earnings. Significant economic activity is also associated with subsistence (Figure 2), sport, and personal use fisheries, particularly during the annual dip-netting opener, which allows Alaska residents to harvest at least 25 salmon per household. Additionally, the Kenai populace provides labor and services to energy exploration and production facilities in nearby Cook Inlet.

Figure 2. Personal Use Dip-netting Fishery (courtesy: ADFG)

3.4 Access to the City of Kenai

The City of Kenai is accessible by road, air, and water. A paved highway system connects the city to Anchorage and beyond. The Kenai Municipal Airport is located about 1 mile north of the Kenai Bluffs project area. It is served by three full-service commuter airlines and charter services utilizing two runways: a paved 7,500-foot and gravel 2,000-foot runway. Boat access is available via commercial and private facilities on the Kenai River and limited commercial docking facilities along Cook Inlet coast.

3.5 Government and Tax Structure

3.5.1 Kenai Peninsula Borough

The City of Kenai is within the KPB. In Alaska, boroughs are equivalent to county-level governments and are responsible for providing a number of services. The KPB is governed by an elected mayor and nine-person Borough Assembly. The KPB currently levies a 3 percent sales tax and a 4.50 mill property tax (ADCRA 2016).

3.5.2 City of Kenai

The City of Kenai is a Home Rule City that currently levies a 3 percent sales tax and an 8.86 mill property tax. A 5 percent bed tax has been suspended indefinitely. The city is governed by an elected mayor and a six-person City Council.

3.5.3 Kenaitze Indian Tribe

The Kenaitze Indian Tribe, or Sovereign Nation of the Kenaitze, is a federally recognized tribe with 1,600 members. The tribe elects a seven-person Executive Council with members serving 2-year staggered terms. The tribe is active in administering a number of programs including education, housing, environmental services, elder services, youth programs, language resources, and others. The Nitghuk’t’uch’qenashen Tribal Court upholds tribal law.

3.5.4 Cook Inlet Region, Inc. (CIRI)

CIRI is one of the 13 regional corporations established by the Alaska Native Claims Settlement Act of 1971 (ANCSA) and holds title to 1.3 million acres of subsurface estate, making it one of Alaska’s largest private landowners. These subsurface holdings include lands within the project area along the southern bank of the Kenai River. CIRI is active in many business ventures including energy, infrastructure, construction, real estate, tourism, and other services.

3.5.5 Kenai Natives Association, Incorporated

Kenai Natives Association, Inc. is the ANCSA village corporation for Kenai.

3.6 Land Use

Land divisions along the bluff are generally low density residential with some commercial and park space. Land ownership along the bluff is a mix of private and municipal, and the land is zoned “Central Mixed Use,” “Central Commercial,” or “Conservation” by the City of Kenai (City of Kenai 2013). The land along or adjacent to the bluff features in several city planning proposals, including a revitalized city center and a “Millennium Square” development making use of the vacant land east of the Senior Citizen’s Center (City of Kenai 2013, Tetra Tech 2007). Additional uses include walking, biking, and wildlife viewing.

The bluff face itself is too unstable for any current use, but the properties at the top of the bluff include a number of homes, businesses, and facilities expected to be impacted by erosion over the period of analysis. The largest structures within the threatened area are the Kenai Senior Center and Vintage Pointe Independent Senior Housing Facility, both of which are owned and operated by the City of Kenai and are valued at approximately $7.9 million. A family practice clinic (Central Peninsula Family Practice), a historic local bar (Kenai Joe's), the Kenai Bible Church, and several vacation rental operations are among the establishments fronting the bluff that would be lost to erosion without stabilization measures under the no action alternative. Three of the properties within the 50-year erosion area have been determined as historically significant, with a dozen more being eligible for significance. At the far eastern end of the bluff is the Pacific Star Seafoods processing plant, which falls outside the project area (Figure 3).

Figure 3. Pacific Star Seafoods and Eastern Terminus of the Kenai Bluff

The project footprint itself is primarily the base of the eroding bluff and the adjacent intertidal zone, an area that sees little public use (Gease 2016, Sinclair 2016). Most of the north shoreline of the river, from below Main Street eastward to the city dock, is closed to the popular shore-based salmon dip-net fishery pursued elsewhere along the river shoreline which also functions as estuary habitat (ADFG 2016a), due in part to the bluff erosion and the risk of persons being trapped against the steep bluff by a rising tide. Dip-net fishing (Figure 2) is allowed along the shore from below Main Street westward, which overlaps the western end of the project area by roughly 500 feet (Figure 4). People occasionally venture onto the intertidal zone below the bluff to angle for fish, bird-watch, or to walk.

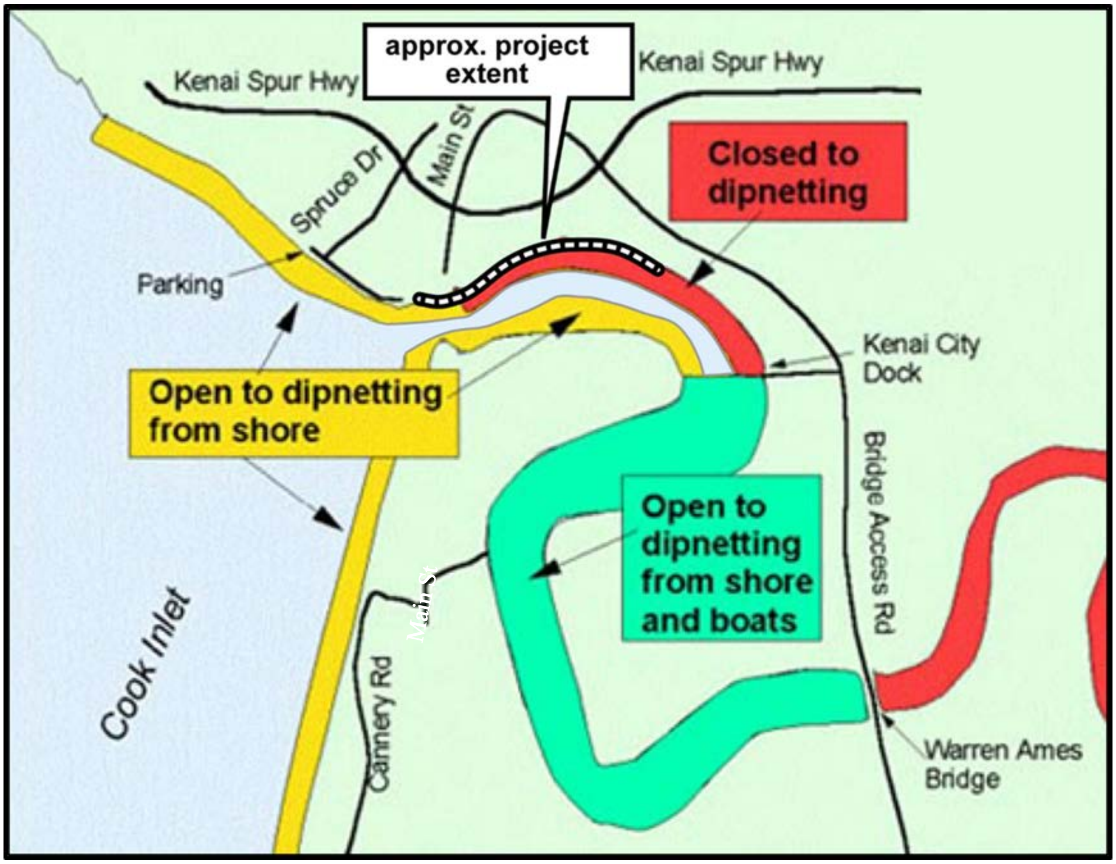

Figure 4 Personal Use Fishery Regulation Areas (adapted from ADFG 2016a)

There is currently sufficient public access to the shoreline and at the top of the bluff for public viewing. The project will not affect this access. Two City of Kenai parks are near the project area. Kenai Beach Park (600 South Spruce Street) is opposite Cemetery Creek from the west end of the project area (Figure 5). This park offers mostly access to the beaches to the west of the Cemetery Creek mouth, although the public can access the Kenai River bank east of Cemetery Creek using a footbridge across the creek about 800 feet north of its mouth. Eric Hansen Scout Park (913 Mission Avenue) is on the top of the bluff just northwest of the project's western terminus. The ADFG recommends Eric Hansen Scout Park as a vantage point from which to view birds, seals, and beluga whales using the Kenai River estuary (ADFG 2016b).

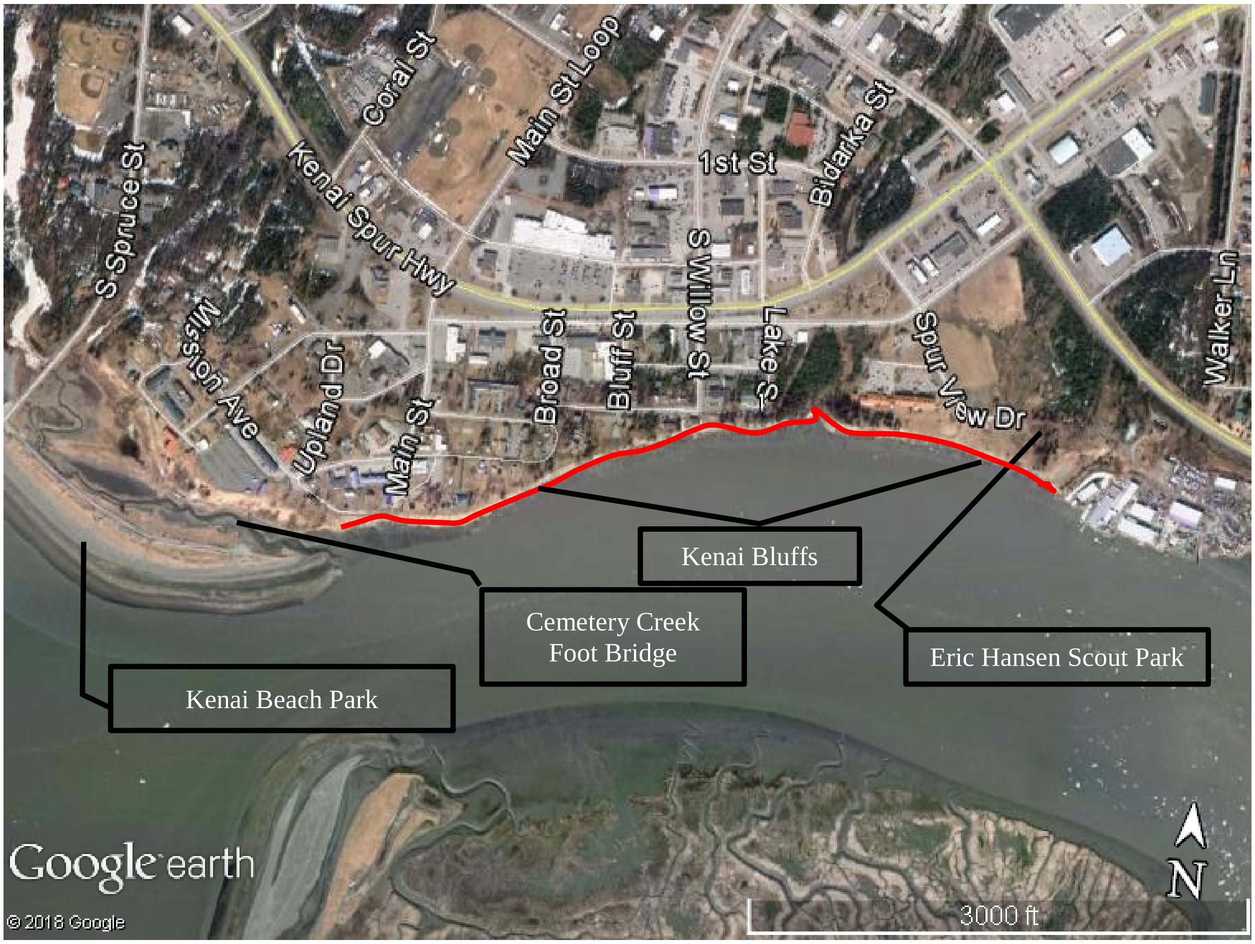

Figure 5 Project Area Features

3.7 Physical Environment

3.7.1 Climate

3.7.1.1 Historical Data

The climate along the Cook Inlet coast at Kenai shows a mix of maritime and continental interior influences, with cool summers, cold winters, frequent fog, and relatively sparse precipitation. The inlet has a moderating effect on the local climate, but Kenai's proximity to the Alaska Range to the west and the Kenai Mountains to the east give Kenai slightly cooler average temperatures than seen in Anchorage, 65 miles to the northeast. Kenai temperatures typically average from 4 to 22 °F in winter, and 46 to 65°F in the summer (City of Kenai 2013, ADCRA 2016).
Table 2 below summarizes climate data from a weather station at the Kenai Municipal Airport, less than a half-mile north of the proposed project site (WRCC 2016).

Table 2. Selected Climate Data, Kenai Municipal Airport (1899-2016)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ANNUAL
Ave. Max. Temp. (°F)	20.9	26.8	32.6	42.8	53.1	58.8	62.1	61.9	55.3	42.2	29.5	22.7	42.4
Ave. Min. Temp. (°F)	4.0	8.2	12.9	26.3	35.4	42.9	47.5	45.9	39.0	27.7	14.1	7.2	25.9
Ave. Total Precip. (in)	0.99	0.96	0.80	0.74	0.89	1.21	1.89	2.61	3.33	2.44	1.50	1.34	18.71
Ave. Total Snowfall (in)	9.5	10.3	8.6	3.5	0.3	0.0	0.0	0.0	0.1	4.8	10.3	13.8	61.2
Ave. Snow Depth (in)	12	14	13	5	0	0	0	0	0	1	3	8	5
Prev. Wind Direction	NNE	NNE	NNE	N	SSW	SSW	SSW	S	NNE	NNE	NNE	NNE	NNE
Ave.Wind Speed (mph)	7.6	8.0	8.9	8.4	8.7	8.3	8.3	7.1	7.5	7.2	7.1	7.7	7.9

Source: Western Regional Climate Center 2016

Based on wind data available from the Kenai Airport FAA station for the years 1970 through 2015, the predominant wind direction is from the northeast from September to April with an average speed of 7.9 miles per hour and peaks over 20 plus miles per hour. During the summer months of May through August, the dominant wind direction is from the southwest with much less intensity.

3.7.1.2 Sea Level Rise

The USACE Engineering Regulation (ER) 1100-2-8162 provides guidance for incorporating the effects of projected future sea level change (SLC). The range of possible future rates of change are represented by three scenarios of “low,” “intermediate,” and “high” SLC. The SLC “low” rate is the historic SLC. The “intermediate” and “high” rates are computed using National Research Council’s (NRC) Curve I, and the modified NRC Curve III and NRC equations (see Appendix B).

The NRC results were adjusted to a measured local sea level trend using approximately 40 years of National Oceanic and Atmospheric Administration (NOAA) data published for Nikiski, Alaska, which is about 10 miles from the Kenai Bluffs. The southcentral area of Alaska has been experiencing post-glacial rebound, also called isostatic rebound, with a resultant sea level trend for Nikiski at -0.03215 feet/year. This value was used to adjust the values from the NRC equations with the results presented in Table 3, with the adjusted curves shown in Figure 6.

Table 3. Relative Sea Level Rise Prediction

Sea Level Change	Low	Intermediate	High
Base year (1992)	0.00 feet	0.00 feet	0.00 feet
Project start year (2018)	-0.84 feet	-0.78 feet	-0.59 feet
50 years (2068)	-2.44 feet	-1.93 feet	-0.30 feet
100 years (2118)	-4.05 feet	-2.64 feet	1.84 feet

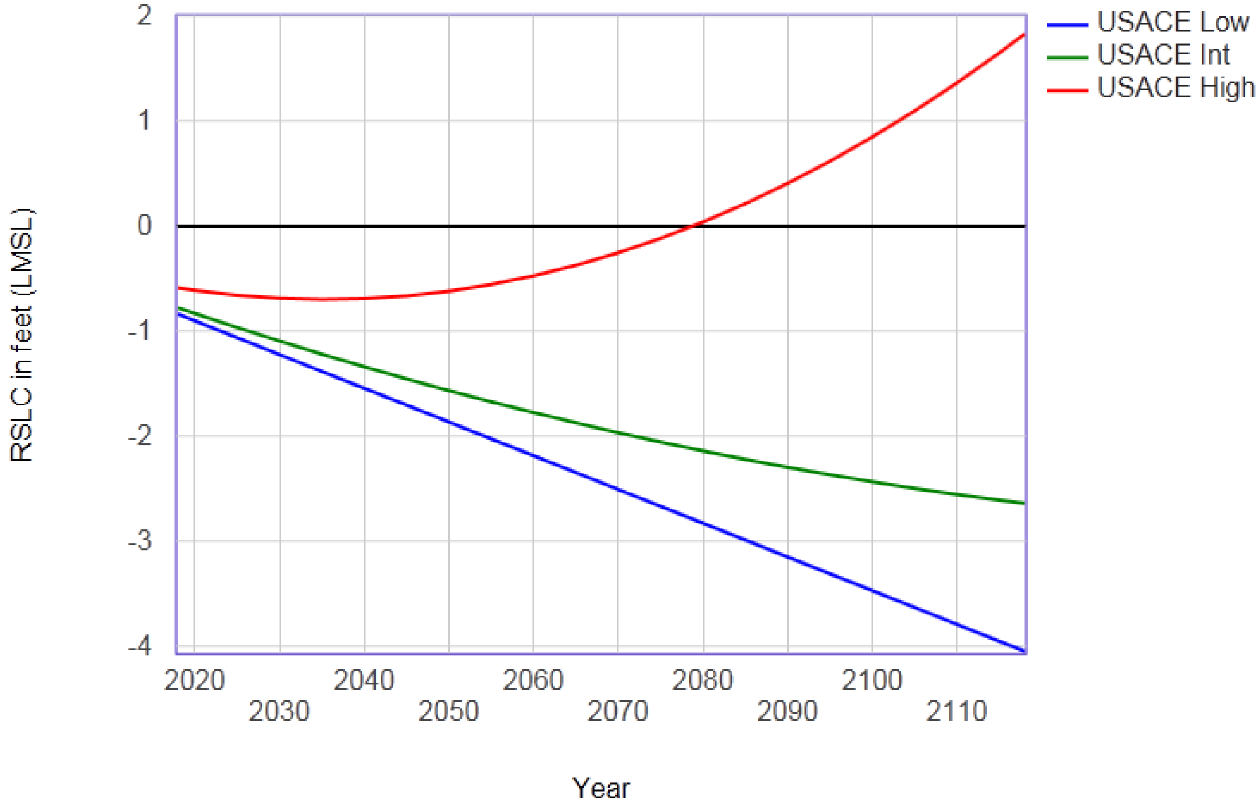

Figure 6. Plot of Relative Sea Level Rise curves

For an assumed construction start in 2018 and a 50-year period of analysis, a project at Kenai could see the relative sea level fall of 1.60 feet (i.e., minus 0.84 feet to minus 2.44 feet = 1.60 feet) or rise by as much as 0.29 feet (i.e., minus 0.59 feet to minus 0.30 feet = 0.29 feet). In 100 years, the relative sea level could fall by 3.21 feet (i.e., minus 0.84 feet to minus 4.05 feet = 3.21 feet) or rise by 2.43 feet (i.e., -0.59 feet to 1.84 feet) (Table 3). It is unlikely that the sea level would rise as much as predicted under the High scenario since, in general, the southcentral area of Alaska has been experiencing isostatic rebound. For this study the intermediate rate of sea level change was used for calculations since the historic records for the area indicate that the Kenai area is experiencing a relative sea level reduction and not a relative sea level rise. In the unlikely event that High Level of Relative Sea Level Change noted in Table 3 occurs, the design can be adapted to increase the revetment height. The proposed design can be modified by adding armor stone to the revetment crest to prevent wave attack during storm events.

3.7.2 Topography and Local Drainages

The project area is characterized by a modified glacial moraine topography, which is separated by an interlacing pattern of swamps and muskegs developed in abandoned drainage channels and broad depressions. The Kenai River and its tributaries drain an area of 2,148 square miles and flow for a total of 68 river miles from Kenai Lake to Cook Inlet, which has a tidal range as high as 31.4 feet. Tidal levels influence extends to approximately river mile 12 in the Kenai River.

The Kenai River flow is influenced by glacial melt water with the lowest daily discharges in the winter season and higher discharges occurring in the summer. Historical Kenai River discharge records at Soldotna, near river mile 20, show daily mean discharge can range from of a high of 41,400 cubic feet per second (cfs) and a low of 770 cfs. Discharge is typically between 1,300 and 15,000 cfs, with average discharges in July, August, and September of approximately 13,000 cfs.

The Kenai Bluffs height ranges from 55 to 70 feet above the toe and it is exposed to waves and tide levels from Cook Inlet. The opposite south-side bank is a low-lying wetland and tide flat area that experiences less impact from waves originating in Cook Inlet but is flooded significantly during the high tides.

Three primary drainages within the project area (USACE 2007a) contain Cemetery Creek, Ryan Creek, and an unnamed creek (Figure 7). Runoff associated with precipitation events flows to these established drainages and also over the face of the bluff, which can scour the highly erodible upper sandy layer. Cemetery Creek emerges from behind the Kenai Road beach area and discharges into the Kenai River near the western limit of the project area. Ryan Creek enters the Kenai River roughly 3,000 feet upstream from Cemetery Creek, near the center of the proposed project area (Tetra Tech 2007). A third, unnamed stream enters the Kenai River near the upstream limit of the bluff stabilization project. All three streams appear to drain the extensive wetlands to the north of the bluff and flow through the developed area between the river and the airport; Ryan Creek has been extensively channelized and even disappears underground for about 450 feet between Kenai Spur Road and Frontage Road. Cemetery Creek and the unnamed creek are catalogued as fish-bearing streams by the ADFG (see Section 3.9.2).

Overland flow has been largely disrupted by development along the top of the bluff. Most of the local stormwater drainage from the top of the bluff is diverted into the City of Kenai's storm drain network. A small amount of surface drainage flows over the top of the bluff and down the bluff face, and several pipes protrude from the bluff face near the ground surface and discharge small amounts of water that run directly down the bluff face (Tetra Tech 2007).

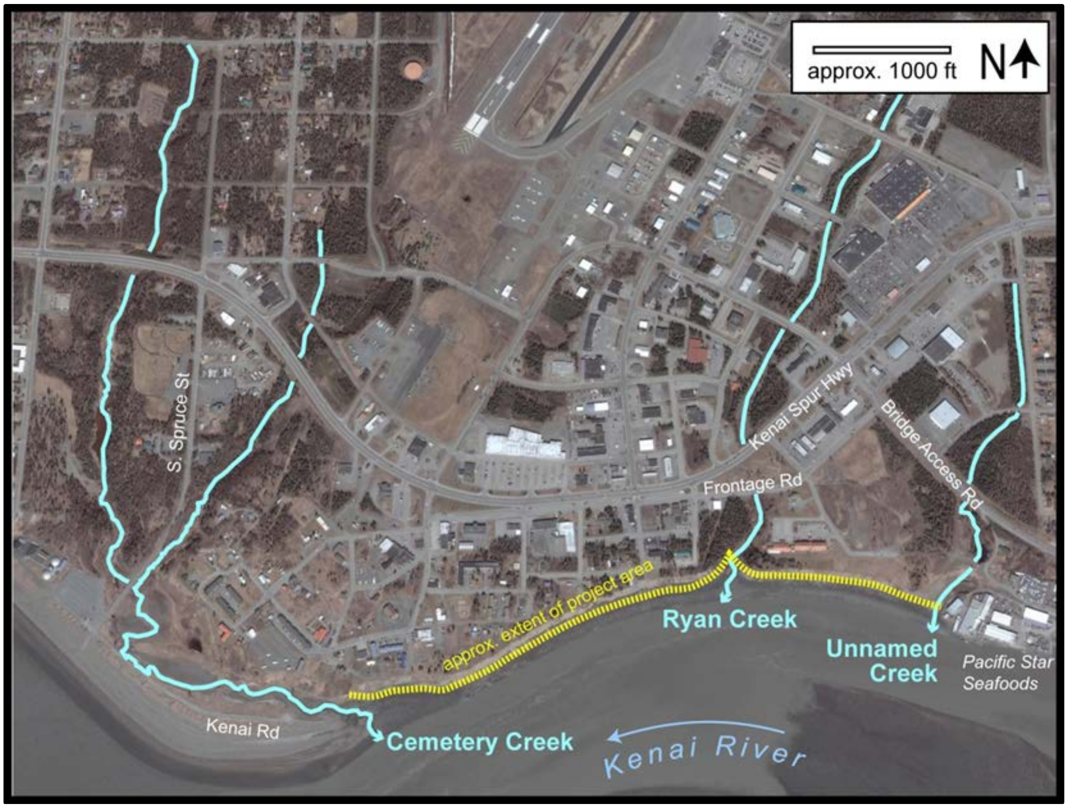

Figure 7. Major Surface Drainages at Project Site

3.7.3 Geology

The City of Kenai is located on the Nikishka Lowland geomorphological subdivision of the Kenai Lowland. This region is characterized by a modified morainal topography, which is separated by an interlacing pattern of swamps and muskegs developed in abandoned drainage channels and broad depressions. The topography and surface deposits of the region are primarily the products of repeated glaciations, which advanced from ice centers in the surrounding mountain ranges. Near the City of Kenai, the glacial moraines are fronted by a broad coastal plain consisting of terraced and channeled sand and gravel deposits, which terminate as steep sea bluffs above a series of raised tidal flats (USACE 2006a).

Relatively thick unconsolidated glacial fluvial and marine sediments overlie bedrock in the project area. Bedrock occurs too deeply in the project area to impact design parameters for a selected alternative (USACE 2006 and 2007a). In addition, permafrost is absent, so it does not influence design. The area is within a regionally active seismic zone bisected by several active and inactive faults.

The approximately 5,000 linear feet of receding Kenai Bluffs is readily identified by the general lack of vegetation on the bluff face, which exposes three distinct layers of sediment types. These exposed layers include:

- 2 feet of organic mat layer at the surface (top of the bluff) that is underlain by approximately
- 37 feet of medium dense sand with layers of sand with gravel alluvium, with a base consisting of 2 to 6 feet of gravel (lag deposit that transmits perched groundwater), and
- 36 to 45 feet of very hard lean clay containing sand and gravel (glacial till unit, with total thickness not reported).

3.7.4 Groundwater Occurrence

Groundwater discharge from the bluff is year round through the lag gravel at the base of the alluvium and through piping in the underlying till with a total potential flow rate of 7 to 10 million gallons per day (USACE 2006). The persistent groundwater seepage is readily visible about half way up the bluff at the interface of the alluvium and the glacial till deposits (Figure 8) and sporadic concentrated groundwater flow or piping daylights from the gravel lag deposits and the lower glacial till. Groundwater flow has been reported below the river's water level (USACE 2008a).

Figure 8. Soil and Groundwater Conditions

3.7.5 Bathymetry and Oceanography

The mouth of the Kenai River and adjacent seafloor of Cook Inlet is generally shallow and gently sloping with depths of less than 6 feet extending as far out as 2 miles from shore (Figure 9). Numerous rocks, shoals, and other navigation obstructions are present, including Salmo Rock and Kaluk Reef to the southwest.

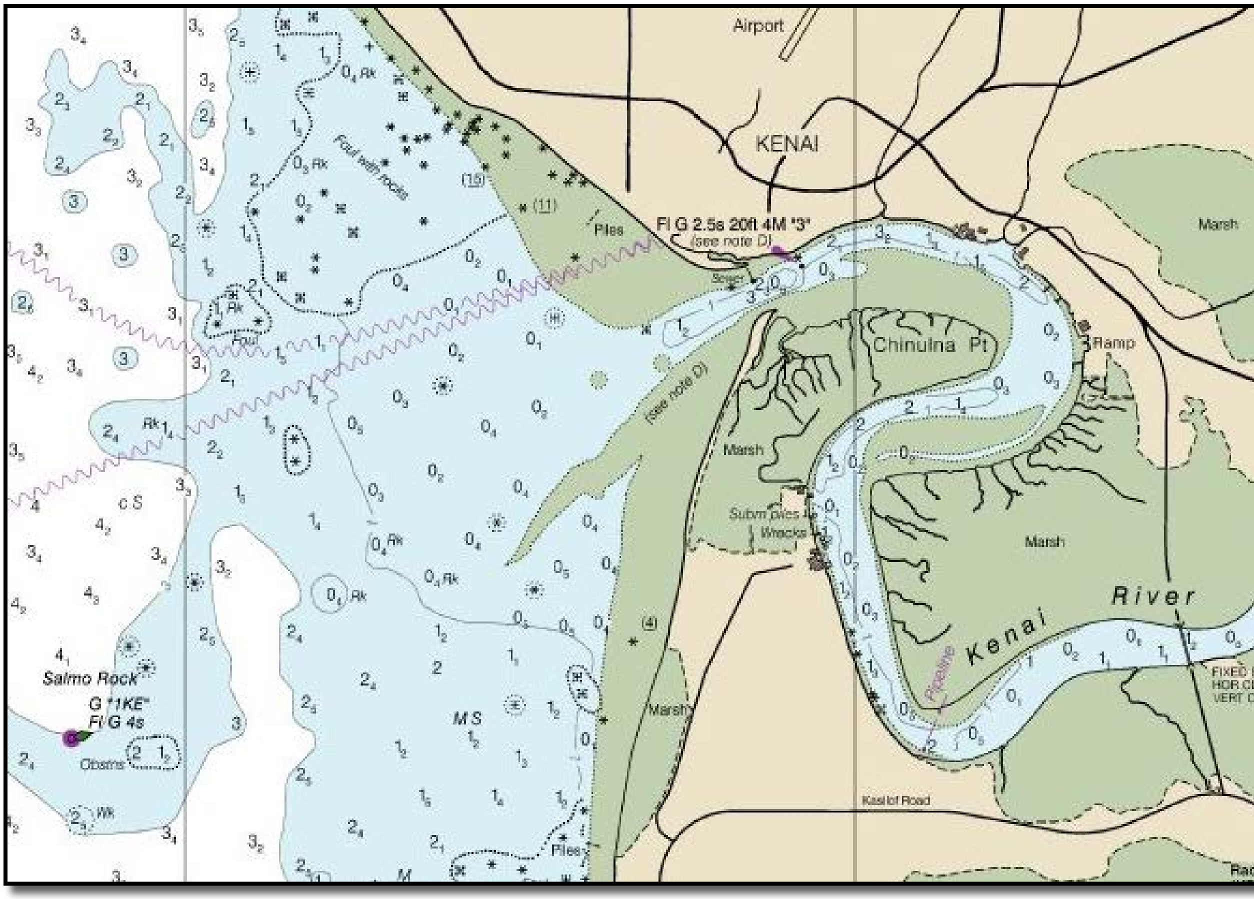

Figure 9. Depths near the Kenai River Mouth (Excerpt from NOAA Chart 16662)

Semi-diurnal tides (two high waters and two low waters each day) influence the lower section of the Kenai River. Table 4 summarizes some tidal parameters for the Kenai River entrance.

3.7.6 Currents and Tides

Below river mile 12, the Kenai River is subject to influence from semi-diurnal tides with two low waters and two high waters each lunar day. The tidal range at the Kenai Entrance in Cook Inlet is the fourth largest in the world at 31.4 feet (Table 4).

Table 4. Tidal Parameters – Kenai River Entrance

Parameter	Elevation (ft MLLW)
Highest Predicted Tide (16 October 1993)	+26.0
Mean Higher High Water (MHHW)	+20.7
Mean Tide	+11.0
Mean Lower Low Water (MLLW)	0.0
Lowest Predicted Tide (14 June 1995)	-5.4

3.7.7 Waves

Wave attack on the bluff face is most pronounced near the river's mouth and decreases as the waves move inland. Wave modeling at the mouth of the Kenai River indicates that the wave height decreases from 4.5 feet to 2.5 feet along the affected bluff area as noted in Figure 10. However, a design height of 3.5 feet was used for Zone B due to ice conditions.

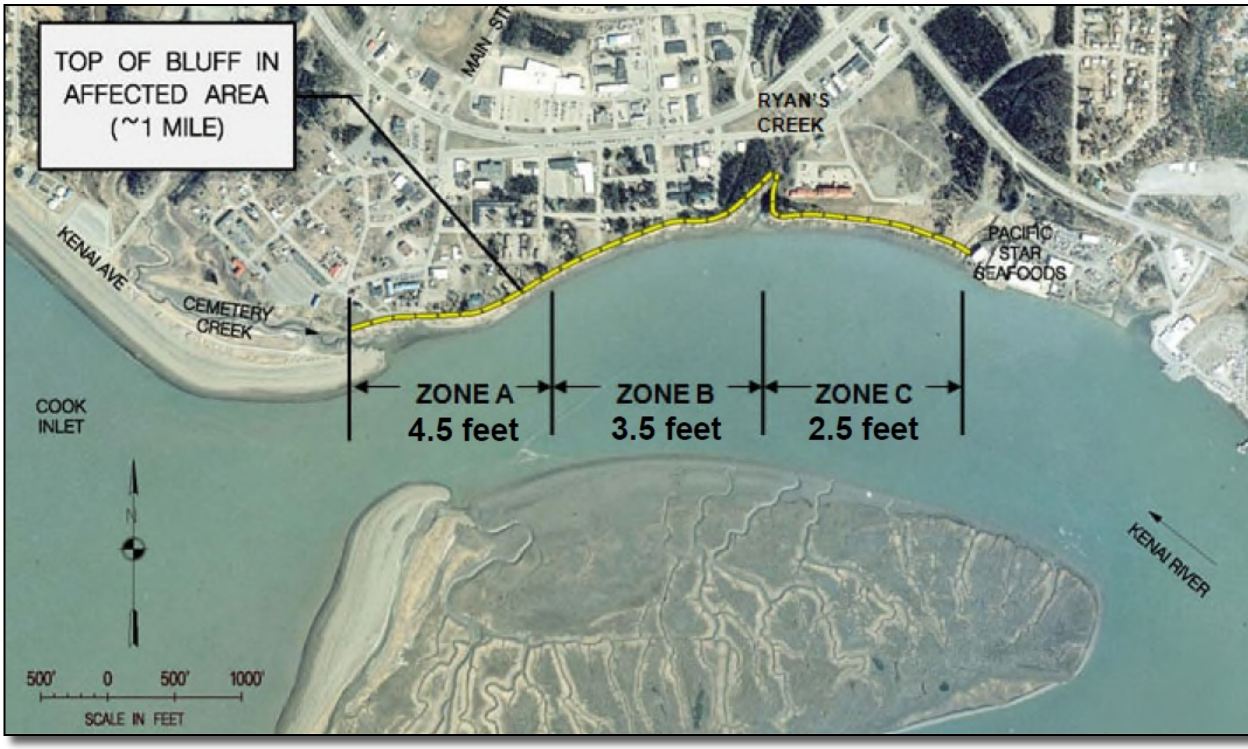

Figure 10. Design Waves by Reach

3.7.8 Ice Conditions

Both sea ice and river ice collect at the toe of the bluff during the winter months, although to what extent is dependent on temperatures, wind direction and intensity, tides, and ice concentration in Cook Inlet. The average river ice freeze-up is December 10 and the average ice break-up is April 2 (Mulherin, et. al. 2001), and ice can close the river to vessel traffic for short periods from December to early April, according to NOAA's Alaska Coast Pilot 9.

3.7.9 Water Quality

The water quality of the Kenai River and its tributaries is monitored annually through the efforts of the ADEC, the Kenai Watershed Forum (KWF 2015), and several other agencies and organizations. In 2006, the ADEC listed the lower Kenai River as an Impaired Waterbody under Section 303(d) of the Clean Water Act; concentrations of fuel hydrocarbons detected in the river water had historically exceeded Alaska Water Quality Standards (AWQS; ref. ADEC 2016) for petroleum hydrocarbons, especially during the summer. The presumed source of the petroleum hydrocarbons was the heavy traffic of motorized watercraft on the river during fishing season, particularly from watercraft with older two-stroke engines. The particular water quality standard that had been exceeded was Total Aromatic Hydrocarbons (TAH), the summed total concentrations of benzene, toluene, ethylbenzene, and xylenes. These compounds are major components of gasoline and contribute much to its toxicity, and TAH measurements provide a more sensitive and consistent means of evaluating gasoline levels in water than attempting to quantify the concentration of total gasoline. The AWQS for TAH in the water column is 10 micrograms/liter (ADEC 2016).

The ADEC began a program of annual water quality monitoring on the Kenai River in 2003 and has reported a marked decrease in TAH levels since then. Water samples collected in 2008 all complied with the TAH water quality criterion. The ADEC attributes the decrease in TAH levels to U.S. EPA hydrocarbon emissions standards for motorized watercraft that went into effect in 2006 and the gradual replacement of the older two-stroke motors with new 2006-compliant motors (ADEC 2010a). The ADEC removed the Kenai River from the Impaired Waterbodies list in 2009 after 2 years of demonstrated compliance with the AWQS.

The Kenai River is famous for the turbid, milky appearance caused by its load of fine glacial silt, but construction and development along the river course suggest that human activities contribute to the sediment load. The marine waters of Cook Inlet entering the estuary at higher tides are also relatively turbid. Erosion from the Kenai Bluffs itself (Figure 11) contributes an estimated 21,300 tons of sediment to the Kenai estuary annually. Sediments from the bank consist of a mixture of gravels, sands, silts and clays (USACE 2006a), with the finer materials adding to the turbidity within the estuary.

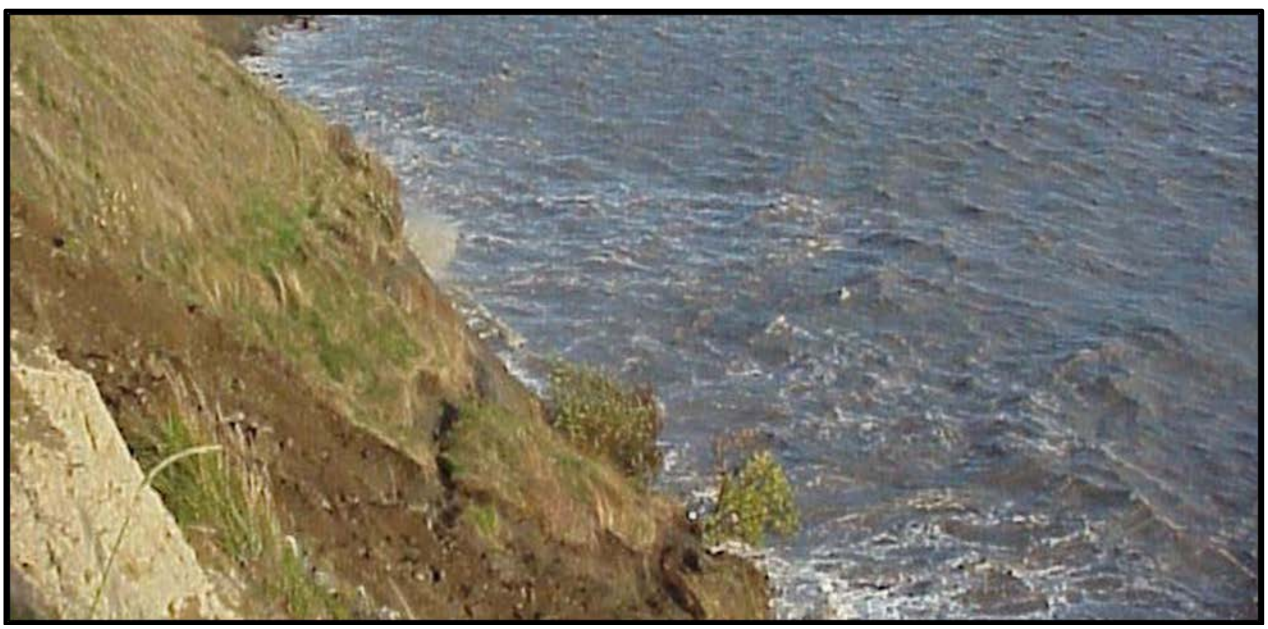

Figure 11. Kenai River at the base of the eroding bluff showing highly turbid water.

The AWQS for turbidity is 5 Nephelometric Turbidity Units (NTU) above background. However, the turbidity levels in the Kenai River are highly variable, and no background level has been established, so it is not possible to evaluate a given turbidity measurement against the water quality standard. The ADEC hydrocarbon monitoring program found ranges of 22 to 744 NTU in 2008, 7 to 19 NTU in 2007, and 14 to 735 NTU in 2003 across three stations along the river. The ADEC station at River Mile 1.5 (near the upstream end of the proposed bluff stabilization project) showed turbidity measurements that were generally less than 300 NTU, and which fluctuated less than at stations farther upstream (KWF 2015). The ADFG measured turbidity in the river channel adjacent to the proposed project site and found a pronounced gradient of lesser turbidity near the surface (between 50 and 100 NTU) and greater turbidity near the bottom (roughly 150 to 200 NTU) on two sampling events in April 2003 (ADFG 2004). Within the estuary, this gradient is probably explained by the lofting of sediment from the muddy channel bottom by tidal action.

Within the Kenai River estuary, the level of salinity is dependent upon a complex interplay of tide phase, tidal amplitude, and river flow-rate. It is common in estuaries for out-flowing fresh water to overflow colder, denser seawater and form a distinct low-salinity layer at the surface. This type of stratification has been observed in the Kenai River estuary (ADFG 2004) but appears to be complicated by other factors such as seasonal temperature differences between the fresh and marine water, and the stratification may not always form or may exist only for brief periods. The ADFG study (ADFG 2004) found that during all months except April, salinities dropped from above 20 parts-per-thousand (ppt) to near zero ppt within 2 to 3 hours of high tide. In April, salinity remained above 10 ppt even at low tide. The AWQS includes standards for human-induced changes in salinity, but these would be of little relevance in the marine-influenced estuary.

The AWQS for dissolved oxygen in fresh water is 7.0 milligrams per liter (mg/l) or greater in waters used by anadromous or resident fish; in estuaries or tidal tributaries, the concentration may not fall below 5.0 mg/l unless there is a natural process that depresses dissolved oxygen content. The State has also established a maximum allowed dissolved oxygen concentration of 17 mg/l (ADEC 2016).

3.7.10 Air Quality

The City of Kenai area enjoys generally good air quality due to a relatively low density of pollutant emission sources. There is no established ambient air quality monitoring program at Kenai for regulatory purposes, however, and little existing data to compare with the National Ambient Air Quality Standards (NAAQS) established under the Clean Air Act (CAA). These air quality standards include concentration limits on the “criteria pollutants” carbon monoxide, ozone, sulfur dioxide, nitrogen oxides, lead, and particulate matter. Due to insufficient air quality data to declare the city as either “attainment or non-attainment”, the appropriate category is considered “unclassifiable” according to ADEC. As a result, the city is not in a CAA “non-attainment” area, and the “conformity determination” requirements of the CAA would not apply to the proposed project at this time (ADEC 2015).

Potential sources of air pollution include both non-point/mobile sources and fixed point sources. Major non-point source emissions would include particulates and carbon monoxide from cars, trucks, and boats, and also particulates from wood-burning stoves. The proposed project site has a commercial and residential area immediately to the north, and the Kenai River with its heavy summer boat traffic immediately to the south. Non-point source pollution can also come from natural phenomena, such as forest fires and volcanic eruptions. The State of Alaska has conducted air quality monitoring for particulates at one site in nearby Soldotna since 2011; this monitoring was prompted by observations of significant dust and smoke from wildfires in the summer (ADEC 2015).

The nearest permitted pollutant sources are in the town of Nikiski, about 9 miles north-northwest of the project site, which has become a significant industrial center due to its proximity to the Cook Inlet oil and gas fields. In this industrial center a petroleum marine terminal, a petroleum refinery, a nitrogen fertilizer plant, and at least two electrical generation plants operate under CAA Title V permits as major potential pollutant sources. At least seven off-shore oil and gas platforms also operate under Title V permits. Several smaller oil and gas facilities exist several miles to the south of the project site in the Kalifornsky Beach Road area. The ADEC air quality division has occasionally received complaints or comments from area residents about emissions from these large industrial sources, but so far, has responded under the Title V program by policing individual emitters, as lack of funding has prevented implementation of an ambient air monitoring program for the Kenai region (Trost 2010, ADEC 2015).

3.7.11 Noise

Specific noise data does not exist for this area but is likely comparable with other similarly-sized coastal Alaskan communities. The project site is along a riverfront that is mostly light residential and commercial in nature. The Kenai Spur Highway is over 700 feet away from the project site at its nearest point to the bluff, and traffic on side streets leading to the bluff is generally light. Some noise is emitted from fish processing facilities on the eastern end of the bluff and from vessels transiting the river. Other noise is from wildlife, specifically birds. Human-generated noise increases during the personal-use fishery.

3.8 Bluff Erosion Rate Estimate and Mechanisms

3.8.1 Erosion Rate Estimate

The USACE estimates the average erosion rate is 3 feet per year, with the estimated extent of erosion to the year 2057 shown in Figure 12.

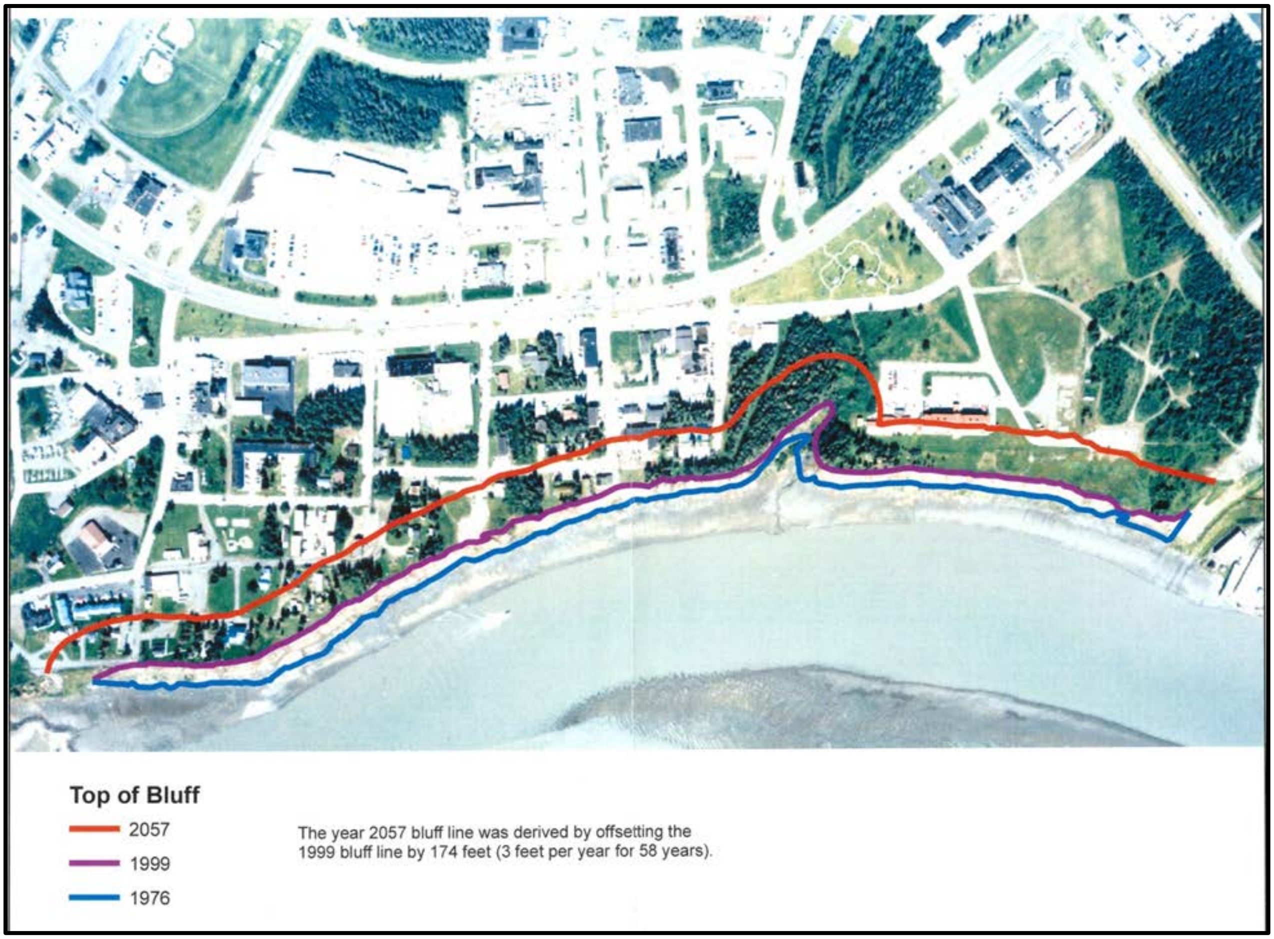

Figure 12. Expected Erosion Extent in 2057

3.8.2 Bluff Erosion Mechanisms

The various erosion mechanisms acting on the Kenai Bluffs (Figure 13) include:

- Wind scour
- Groundwater seepage and piping
- Overland flow over the bluff
- Freeze thaw cycles
- Wave action and currents at the toe of the bluff

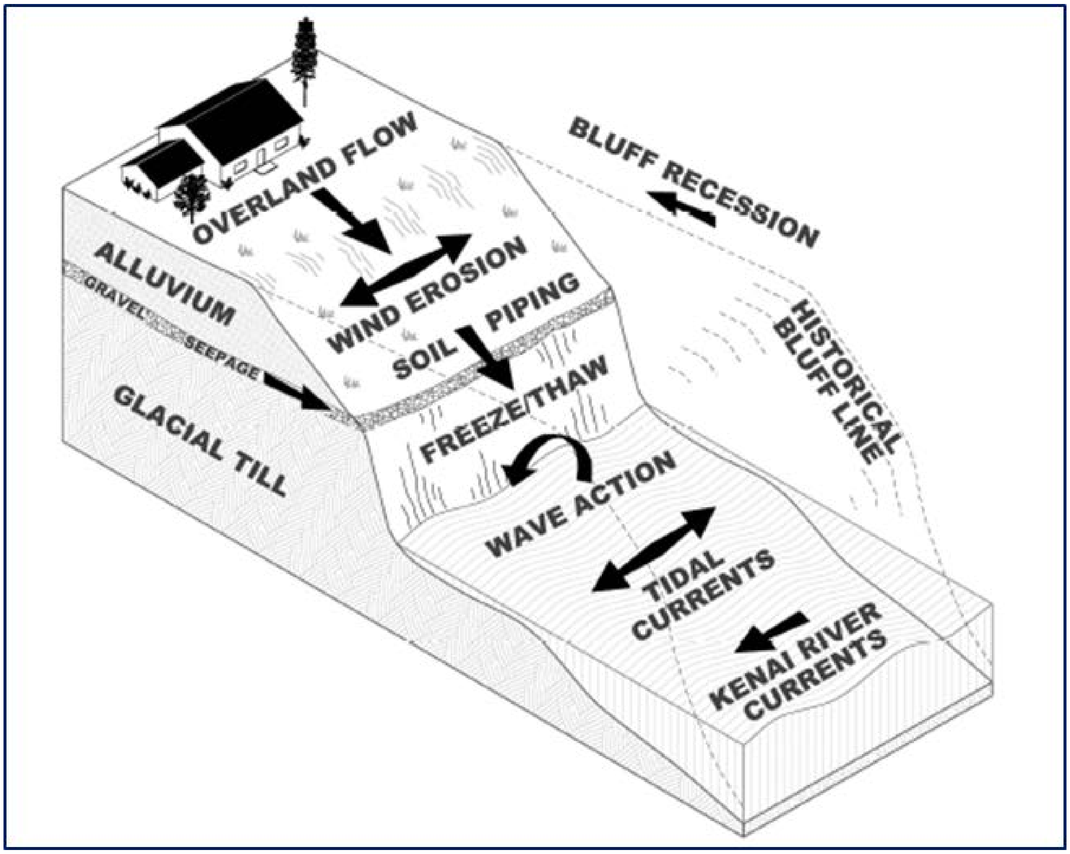

Figure 13 Erosion Mechanism Schematic

The finer grained soils transported to the bluff toe from above are mobilized and transported away by riverine and tide currents during floodtides and storm surges (Figure 14 and Figure 15). Since soil is not able to accumulate at the toe of the bluff, the lower portion of the bluff is exposed and susceptible to erosion during significant storm events at floodtides, which have the potential energy to damage the slope and remove larger material. As a result, the lower portion of the bluff erodes back and/or collapses, undercutting and collapsing the portion of the bluff above the flood tide elevation. These mechanisms keep the bluff slope steep and unstable. Vegetation does not establish and stabilize the bluff soil (Figure 14 and Figure 15).

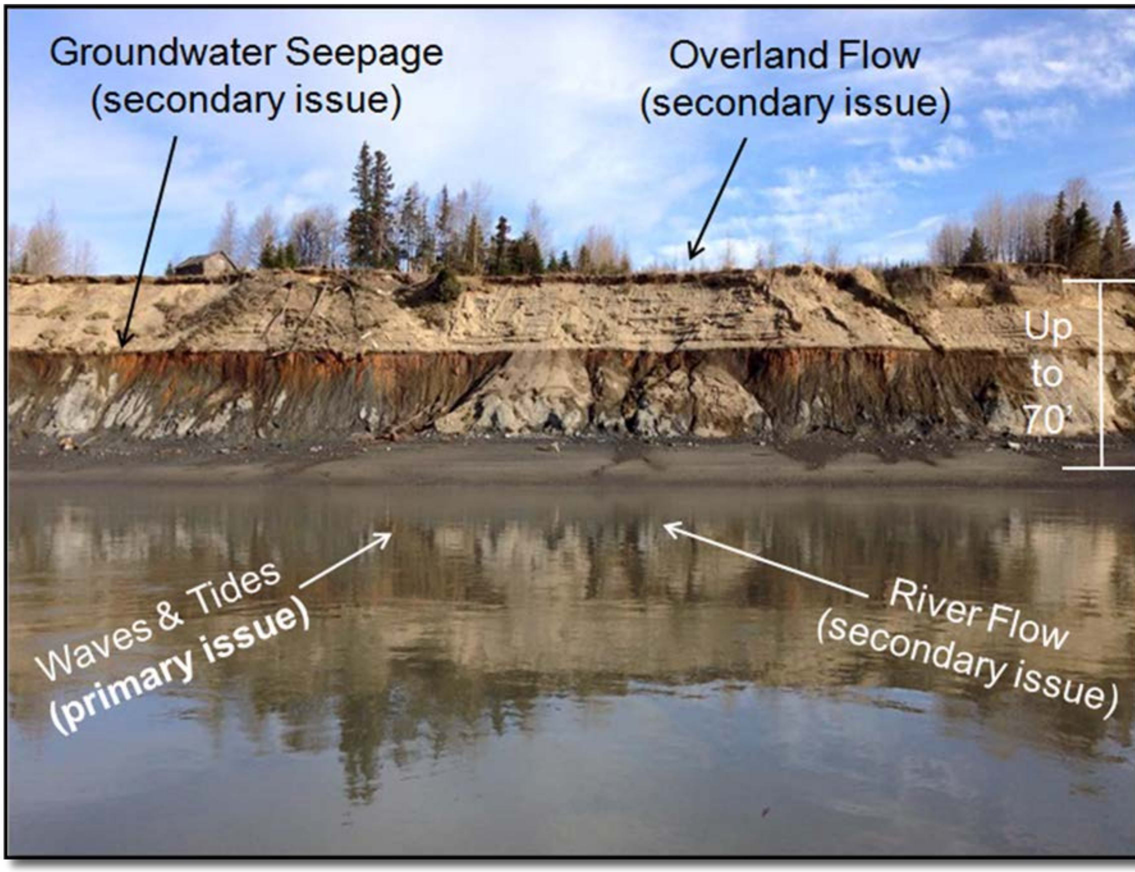

Figure 14. Kenai Bluffs Eroded Surface

Figure 15. Storm Event at Kenai Bluffs

3.9 Biological Resources

3.9.1 Vegetation

The bluff face in the proposed project area is largely un-vegetated, as steady erosion has prevented plant communities from becoming established. Grasses, fireweed (*Epilobium angustifolium*) and other forbs, and a few woody shrubs such as alders (*Alnus* spp.) grow in isolated patches along the bluff face, often anchored in fragmentary mats of organic soil that have slid down the face. The bluff face vegetation is somewhat heavier in protected areas, such as the draw where Ryan Creek cuts through the riverbank, but is still discontinuous on the steeper portions of the bluff. As the bluff face erodes, the trees and their root balls become dislodged, leading to further destabilization of the bluff (Figure 16).

Figure 16. Trees and Root Balls Failing (located near the Senior Citizen Center)

Vegetation on the existing ground surface along the top of the bluff is a patchwork of landscaped lawns and residential gardens, with pockets of original spruce (*Picea* spp.) and birch (*Betula* spp.) forest (Figure 17). The intertidal bench at the base of the bluff (Figure 18) consists of dense compacted sediment littered with boulders and debris, and is essentially devoid of established vegetation. During an April 2016 site visit, several small isolated patches of the marine alga *Ulva intestinalis* were found at the project site, but it is possible that this algae originated outside the estuary.

Figure 17. Typical distribution of vegetation along the face and top of the bluff (2001 Photo).

Figure 18. Photograph dated April 2016, showing intertidal zone at a low tide near 0.0 ft. MLLW

Across the river from the bluff, the tidelands along the inside bend (named Chinulna Point on some maps) are sparsely vegetated, probably with low, salt-tolerant plants typical of the region such as arctic pearlwort (*Sagina sanginoides*), creeping alkali grass (*Puccinellia phryganodes*) and goose-tongue (*Plantago maritime*). Slightly higher, less-frequently inundated and ice-scoured areas of wetlands farther from the river channel are more heavily vegetated, most likely with communities that are dominated by sedges (*Carex* spp.), alkali grasses (*Puccinella* spp.), and arrow grasses (*Triglochin* spp.; Gracz, et al 2008, USFWS 1981).

The south bank of the river across from the bluff is categorized by USFWS as an Estuarine Intertidal Unconsolidated Shore (E2USN). Proceeding upriver the wetlands categorization transitions to include some Estuarine Intertidal Emergency Phragmites (*Phragmites australis*) (E2EM5). The tidelands are sparsely vegetated, most likely with low, salt-tolerant plants typical of the region such as pearlwort (*Sagina sanginoides*), creeping alkali grass (*Puccinellia phryganodes*), and goose-tongue (*Plantago maritime*). Slightly higher, less-frequently inundated and ice-scoured areas of wetlands farther from the river channel are more heavily vegetated, most likely with communities that are dominated by sedges (*Carex spp.*), alkali grasses (*Puccinella spp.*), and arrow grasses (*Triglochin spp.*) (USFWS, 2010, Gracz, et al 2008, USFWS 1981).

3.9.2 Fish and Wildlife

3.9.2.1 Invertebrates

The USACE attempted to sample benthic invertebrates along the base of the bluff and in the Chinulna Point tide flats across the river in April 2003 and visual observations were made in April 2016 that indicated that conditions had not changed between 2003 and 2016. In 2003, invertebrates were found in only one shallow sample of silt from Chinulna Point and consisted of a few small clams (*Tellina nucloides*). A later sample collected from the same area also contained a small number of *Tellina nucloides* as well as two marine polychaetes, probably *Neris vexillosa*. No benthic invertebrates were found in any of the seven sediment samples collected from the upper intertidal zone along the project footprint. The fine sediments on the intertidal portion of the estuary, especially along the outer bend of the river, proved to be very highly compacted and are not believed to support significant numbers of benthic organisms (USACE 2003a). Numerous attempts to obtain benthic invertebrate samples in the middle of the Kenai River channel failed despite using a variety of sampling devices deployed from a boat. The current, even at slack tide, made it nearly impossible for the dredge to land in an orientation where it could penetrate the highly compacted sediment on the river bottom.

The USACE visited the project intertidal area in April 2016. No benthic sampling was attempted at that time, but the compacted fine sediments appeared to be unchanged from previous surveys. No visual signs of invertebrate use of the exposed sediments, such as worm or snail tracks, mollusk shells, or air holes, were found. As in the 2003 survey, numerous shorebirds were observed foraging in the mudflats on the south bank of the river directly across from the project area, but little or no such activity was seen on the north bank. The USACE's 2016 visit also specifically looked for signs of sessile epilithic organisms (e.g., barnacles, mussels, marine algae, etc.) inhabiting the boulders and cobbles scattered across the sediment of the project area. The rock surfaces were devoid of such organisms.

An ADFG study in 2003 found significant numbers of invertebrates within the estuary waters, mostly shrimp (*Crangon* spp. and *Neomysis* spp.) and isopods (*Saduria* spp.). These invertebrates were especially prevalent in an April catch, when they were far more numerous than fishes, leading the investigators to surmise that invertebrates may dominate the estuary food-web through the winter months. These invertebrates become an important food source for fishes as the fish population increases through early summer (ADFG 2004).

3.9.2.2 Fish

The ADFG maintains an online database of anadromous and fish-bearing streams, the Anadromous Waters Catalog (AWC; ADFG 2016c). As described previously, the Kenai River itself is a cataloged anadromous stream, as are many of its tributaries, including Cemetery Creek and the creek just downstream of Pacific Star Seafoods (Figure 7). The lower Kenai River is listed in the catalog as hosting the following species:

- Chum Salmon: present
- Coho Salmon: present
- Chinook Salmon: spawning
- Pink Salmon: spawning
- Sockeye Salmon: present
- Dolly Varden Trout: present
- Lamprey: present
- Eulachon: present
- Pacific Lamprey: present
- Whitefish: present

The Kenai River is famous for its annual adult in-migrations (i.e., runs) of four species of Pacific salmon and is the most heavily used river in Alaska for recreational and personal-use fishing. The river supports two runs of Chinook salmon (*Oncorhynhus tshawytscha*) each year. The early run (averaging between 8,100 and 16,000 fish) usually enters the river in mid-May and ends by mid-June; the larger late Chinook run (averaging 56,000 fish) starts in early July. Between 7,000 and 30,000 Chinook salmon are harvested from the river each year. Sockeye salmon (*O. nerka*) also arrive in two runs, starting in late June and late July, respectively. The later sockeye run ends by early to mid-August and averages about 1 million fish. Coho salmon (*O. kitsutch*) arrive in several periods from late July through early October; about 41,000 cohos are caught each year. Pink salmon (*O. gorbuscha*) have a 2-year lifecycle and are much more numerous in even-numbered years. The pink salmon run lasts from late July through mid-August (ADFG undated factsheet, The Kenai River Pamphlet). Adult chum salmon (*O. keta*) are also sometimes found in the Kenai River but are not believed to spawn in the Kenai River system (ADFG 2016c).

The Kenai River estuary is an important transitional habitat for salmon smolt as they adapt from fresh to marine waters during their out-migration in spring or early summer. Juveniles must develop the osmoregulatory capability to survive in salt water, while identifying new prey items and avoiding new predator species (ADFG 2004). Salmon do not spawn within the estuary, but several small streams entering the estuary have been identified as rearing habitat for juvenile salmon. Cemetery Creek (Figure 7) provides rearing habitat for silver, Chinook, and sockeye salmon, and the unnamed creek (catalogued by the ADFG as 244-30-10010-2003) near the east end of the project area is identified as rearing habitat for coho and sockeye salmon (ADFG 2016c).

Other anadromous species found in the estuary include eulachon smelt (e.g., eulachon, *Thaleichthys pacificus*), longfin smelt (*Spirinchus thaleichthys*), and Dolly Varden (*Salvelinus malma*). The major eulachon in-migration occurs in May and June. Longfin smelt in the Kenai River (Figure 19) are at the extreme northern limit of their range; they are present in the estuary much of the year, but it is unclear whether they have a significant run in the Kenai. The smelt species are important food fish for adult salmon and other larger fish, sea mammals, and birds. Other marine and estuarine fishes common in the estuary include flounder, sole, sandlance, sculpin, and herring (ADFG 2004).

Figure 19. Longfin Smelt Caught in Kenai River in 2002 (photo courtesy of Tim McKinley/ADFG).

The 2004 baseline fisheries assessment (ADFG 2004) took samples in April, June, September, and December, and found finfish greatly outnumbered by invertebrates (shrimp and isopods, -) in April and in December. Longfin smelt were the most numerous fish present in the sparse April catch, while eulachon were dominant in June and September. In December, longfin smelt were the only fish caught. Juvenile salmon were captured in April, June, and September, but not in December (ADFG 2004).

3.9.2.3 Birds

The project area is in a popular birding area for this region and abundant non-USACE information and local knowledge exists regarding bird use of the project area. However, the USACE conducted formal surveys for birds at the Kenai estuary on a near-monthly basis from April 2003 through March 2004; no surveys were conducted in December 2003 or in February 2004 (USACE 2003b).

The formal surveys are a mirror of the ongoing local knowledge of bird usage within the project area, and there is no evidence to suggest that conditions have changed since these earlier surveys.

The majority of birds observed during these surveys were using the low headland and intertidal zone on the opposite side of the river from the bluff (Chinulna Point). This was presumably due to better feeding opportunities in the wetlands, broad mudflats, and sand bars present along the inside bend, and the less compacted sediments. The large sand and gravel bars that form opposite the bluff are exposed to varying degrees with tidal movements, and corresponding fluctuations in the numbers of birds present were noted (USACE 2003b).

The surveyors observed relatively fewer birds along the face of the bluff and the shoreline below. The most common birds along the bluff were common ravens (*Corvus corax*), black-billed magpies (*Pica hudsonia*), and small numbers of herring gulls (*Larus argentatus*). Swallows were sometimes seen flying along the bluff, but there was no indication that they nested in the riverbank at that location. Bald eagles (*Haliaeetus leucocephalus*) use spruce trees along the top of the bluff as vantage points to observe the river and the opposite shore (USACE 2003b).

Gulls were the most abundant birds observed in the area at all times of the year, with over 1,000 present on some survey days. Most gulls were herring gulls, although a few mew gulls (*Larus canus*) and glaucous winged gulls (*Larus glaucenscens*) were also seen on occasion. Gulls are present along the inside bend across from the bluff throughout the year unless the river is frozen. Herring gull numbers peaked in July, and large numbers were seen nesting in the wetlands opposite the bluff. Nesting is possible in these wetlands during the summer months because the tides are not high enough during that time of year to inundate the area; these wetlands routinely flood during higher spring and autumn tides. USACE biologists noted during a May 14, 2003 visit that approximately 20 percent of gull nests contained an egg, while by August 21, most of the herring gull chicks had fledged. Therefore, peak use of the inside-bend wetlands by herring gulls appears to be from early May through the end of August. Gulls were also abundant along both banks at the mouth of the river in June and July, when they appeared to be attracted to discarded salmon carcasses (USACE 2003b).

Bald eagles were most abundant in April and May (up to 70 were counted in a survey on May 1, 2003) but were practically absent during the summer. Eagles presumably disperse in the summer to nest and take advantage of abundant salmon runs in shallower streams elsewhere throughout Southcentral Alaska (USACE 2003b).

Common goldeneye (*Bucephala clangula*) were the most numerous waterfowl species in late winter, with up to 77 seen during one day's survey in March 2004. The goldeneye tended to congregate in open water upstream of the bluff unless forced downstream by ice. Mallards (*Anas platyrhynchos*) were also occasionally seen in large groups in the late summer and autumn. Large flocks of migrating Canada geese (*Branta canadensis*) and other waterfowl use the grassy inner-bend wetlands, especially as this area is free of ice and snow earlier in the spring. Waterfowl species seen in smaller numbers included northern pintail (*Anas acuta*), green-wing teal (*Anas crecca*), and snow goose (*Chen caerulescencs*). Wading birds observed included yellowlegs

(*Tringa* spp.), dunlin (*Calidris alpine*), dowitchers (*Limnodromus* spp.), and rock sandpipers (*Calidris ptilocnemis*; USACE 2003b).

3.9.2.4 Mammals

The developed uplands surrounding the Kenai River estuary may be described as a mix of residential, commercial, and light industrial, and offer limited habitat for large terrestrial mammals. Likewise, the sparsely vegetated intertidal areas around the estuary provide little food or cover, but more suitable habitat is found in the marshlands farther upstream. A coyote (*Canis latrans*) was spotted between the Warren Ames Bridge and the public boat launch during a USACE survey in May 2003 (USACE 2003b), and rodents such as muskrat (*Ondatra zibethicus*) probably make use of the grassy wetlands in the more heavily vegetated stretches of the estuary. Caribou (*Rangifer tarandus*) and moose (*Alces alces*) are also commonly seen in the marshlands well upstream of the project site.

Harbor seals (*Phoca vitulina*) are routinely seen near the mouth of the Kenai River in small numbers, although large gatherings have been reported farther upstream. The USACE' 2003-2004 survey observed seals in the river in all survey sectors, and they may range several miles upstream. At low tide, seals were typically hauled out on large boulders in Cook Inlet outside the mouth of the river (USACE 2003b). Beluga whales (*Delphinapterus leucas*) are occasionally spotted within the estuary. They are most likely to enter the estuary on an incoming high tide and are easily visible from popular public viewing points on the beach north of the river mouth, at the Kenai City Dock, and near the Warren Ames Memorial Bridge, roughly 5 river-miles upstream from the river mouth (ADFG 2016b). Cook Inlet beluga whales are discussed further in section 3.10.

3.10 Protected Species

3.10.1 Endangered Species Act.

The only species listed as endangered or threatened under the Endangered Species Act (ESA) likely to be encountered near the project site is the beluga whale, *Delphinapterus leucas* (NMFS 2016a, USFWS 2016a). The Cook Inlet Distinct Population Segment (DPS) of beluga whales was listed as endangered under the ESA in October 2008 after rapidly declining numbers failed to respond to restrictions on subsistence hunting begun in 1999. The population continues to show a negative trend, with a 2014 survey estimating 340 individuals, down from an estimated 1,293 whales in 1979 (NMFS 2015).

The designation of critical habitat for Cook Inlet belugas was finalized in April 2011 (50 CFR part 226.220). Their critical habitat is divided into two areas, with Area 1 representing the northern extremity of Cook Inlet where the whales concentrate during the summer months, and Area 2 encompassing the wider distribution of Cook Inlet belugas through Cook Inlet in the winter and early spring (Figure 20).

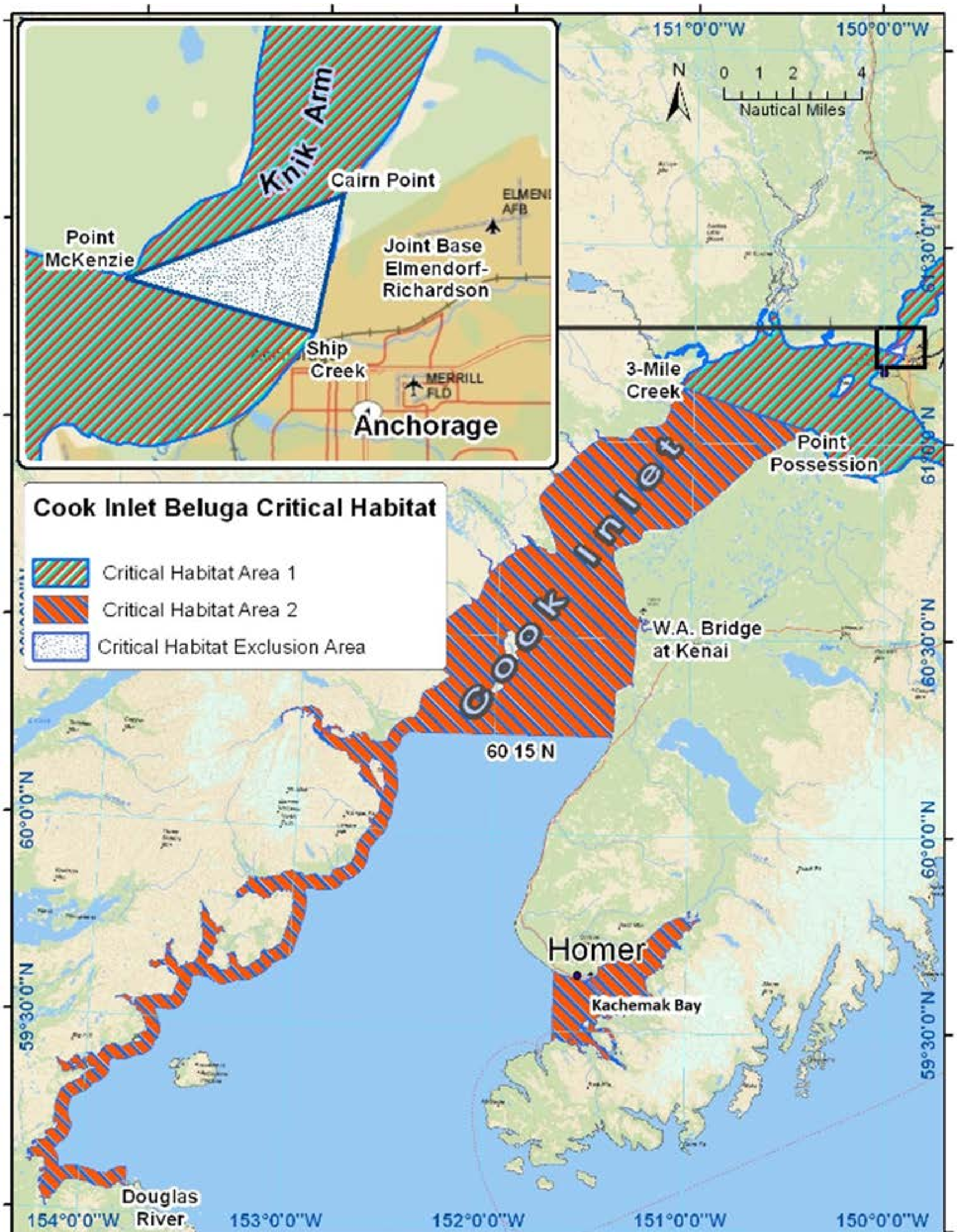

Figure 20. Cook Inlet Beluga Whale Habitat Areas (Source: NOAA)

The Kenai area falls into Area 2, with the Kenai River estuary up to the Warren Ames Bridge (roughly 5 river-miles upstream from the mouth of the Kenai River) specifically designated in the ruling as critical habitat. In addition, the NMFS identified the following primary constituent elements (PCEs) essential to the conservation of the Cook Inlet beluga whale (NMFS 2015):

1. Intertidal and subtidal waters of Cook Inlet with depths less than 30 feet mean lower low water (MLLW) and within 5 miles of high and medium flow anadromous fish streams.
2. Primary prey species consisting of four species of Pacific salmon (Chinook, sockeye, chum, and coho), Pacific eulachon, Pacific cod, walleye pollock, saffron cod, and yellowfin sole.
3. Waters free of toxins or other agents of a type and amount harmful to Cook Inlet beluga whales.
4. Unrestricted passage within or between the critical habitat areas.
5. Waters with in-water noise below levels resulting in the abandonment of critical habitat areas by Cook Inlet beluga whales.

The proposed project is within critical habitat for Cook Inlet beluga whales since it is located downstream of the Warren Ames (W.A.) Bridge (Figure 20). The proposed with project footprint for the rubblemound structure alternatives is an intertidal bench (berm) along the base of the bluff, above MLLW but at least partially below mean high water (MHW), the upland boundary for marine critical habitat areas.

Cook Inlet belugas show distinct seasonal shifts in distribution and habitat use, generally congregating in the northernmost portions of Cook Inlet during roughly June through October, then dispersing through a wider area of Cook Inlet the rest of the year (NMFS 2015). Opportunistic sightings reported to and cataloged by the NMFS suggest that the lower Kenai River is most heavily used by Cook Inlet belugas during the months of March through May; of 64 such sightings reported between 2007 and 2015, 36 occurred in April alone, primarily in the latter half of the month (Shelden 2016). This spike in beluga activity within the Kenai River roughly corresponds with the river's April-June run of Pacific eulachon, a vital early-year food resource for Cook Inlet belugas. The presence of other prey species such as longfin smelt in the early spring estuary (ADFG 2004) may account for the March and early April Cook Inlet beluga use of the Kenai River ahead of the main eulachon run. No sightings were reported to NMFS in July or August from 2007 to 2015, despite the heavy in-migrations of adult salmon that occur during these months. This is consistent with the known summer concentration of Cook Inlet belugas at the north end of Cook Inlet, away from the Kenai area, and with speculation that the intense human fishing activity on the lower Kenai River during these salmon runs may deter belugas from the river at that time (Sheldon 2016, NMFS 2015).

According to some descriptions, the project area is within the range of the endangered short tailed albatross (*Phoebastria albatrus*; USFWS 2016). While this species ranges across much of the North Pacific Ocean, it is associated with the open ocean, concentrating along the break of the continental shelf where upwelling and high primary productivity result in abundant preferred prey such as squid and pelagic fishes. The confined inland waters of Cook Inlet and the Kenai River estuary do not provide usable habitat for this species (USFWS 2008), and it would not be expected to appear within Cook Inlet except as a rare, vagrant individual.

3.10.2 Marine Mammal Protection Act.

The following species protected under the Marine Mammals Protection Act (MMPA), but not listed under the ESA, are known to be present in the Kenai River estuary at least occasionally:

- Harbor seal (*Phoca vitulina*)
- Harbor porpoise (*Phocoena phocoena*)
- Killer whale (*Orcinus orca*)

Harbor seals are a common sight within the Kenai River estuary and have been spotted many miles up-river. They may be present in the estuary at any time of year. Seasonal patterns of harbor seal use of the Kenai River estuary are not well understood. Data on their numbers are collected opportunistically, and the seals' low profile and quick movements within the turbid river waters make them difficult survey subjects. Harbor seals are most conspicuous when hauled out onto shore, which they occasionally do in masses of hundreds of individuals within the estuary. As many as 340 seals were counted in a November 2013 group hauled out across from the Inlet Seafood processing plant, and another sighting of over 200 was made in the same area in November 2015. Another major haulout location is just upstream of a wildlife viewing platform near the Kenai City Dock. Both of these identified haulouts are a mile or more upstream from the project site. A few individual seals can often be seen hauled out on the mudflats directly across the river from the proposed project site and on sandbars and rocks just outside the river's mouth (Figure 21), but no reports exist of the project area itself being used as a haulout (London 2016). The rocks and debris strewn on the project site below the bluff, and the flatter-grade shorelines existing nearby, conceivably make the project site less attractive for hauling out than other readily available options.

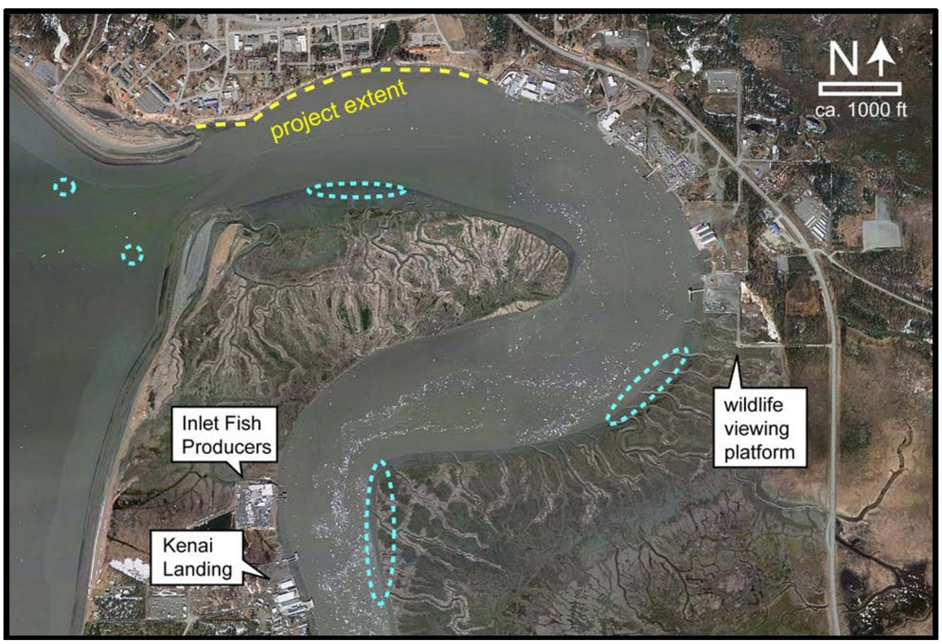

Figure 21. Harbor Seal Haulout Areas Reported in the Kenai River Estuary (in blue).

Killer whales are known from a handful of reports to occasionally enter the Kenai River estuary, presumably in pursuit of salmon or marine mammal prey. Harbor porpoises are spotted within the Kenai River, but little is known about their use of the river.

3.10.3 Bald and Golden Eagle Protection Act.

Bald eagles present at the Kenai River estuary are protected under the Bald and Golden Eagle Protection Act as well as the Migratory Bird Treaty Act (see below). In addition to prohibiting direct takes such as killing eagles or destroying nests, this act also regulates human activity or construction that may interfere with eagle's normal breeding, feeding, or sheltering habits (USFWS 2007).

There are no currently known bald eagle nesting sites in the project area; the closest nesting site recorded by the USFWS is about 0.8 mile to the southeast (Lewis 2016). A limited number of trees large enough to be suitable for eagle nesting are available along the top of the bluff, mostly at the Ryan Creek drainage.

3.10.4 Migratory Bird Treaty Act.

With the exception of State-managed ptarmigan and grouse species, all native birds in Alaska (including active nests, eggs, and nestlings) are protected under the Federal Migratory Bird Treaty Act (MBTA; USFWS 2009).

3.11 Special Aquatic Sites and Waters of the United States

The U.S. EPA identifies six categories of special aquatic sites in their Clean Water Act (CWA) Section 404 (b)(1) guidelines: Sanctuaries and refuges; wetlands; mud flats; vegetated shallows; coral reefs; and riffle and pool complexes.

The foot of the eroding bluff face, while regularly inundated, does not meet the USACE jurisdictional definition of a wetland as it is devoid of established vegetation (ERDC 2007; WES 1987). What vegetation is present is generally displaced fragments of upland growth that are regularly swept away, rather than supported, during the floodtides. Cemetery Creek, to the west of the project site, supports obvious estuarine wetlands. The surface sediments at the project site are predominantly sand, gravel, and rocky debris eroded from the bluff face, rather than fines deposited by the river, and appear to host very little biological activity. These project site sediments superficially resemble mud flats, although of diminished function and value (i.e., low benthic productivity and low usage by wildlife). Extensive, high-productivity mud flats exist along Chinulna Point directly across the river from the project site.

The U.S. Fish and Wildlife Services National Wetlands Inventory (NWI; USFWS 2016b) regards the eroding bluff face on the north side of the river as uplands. The NWI identifies broad areas to the south and west of the proposed project area as different types of estuarine, marine shoreline, or in-water habitat based upon the type of vegetation present, the substrate, and frequency of inundation (Figure 22). The alphanumeric codes on the map refer to specific habitat parameters that will not be elaborated upon here. The footprint of the berm or revetment alternatives generally avoids areas that are designated as wetlands in the NWI, although construction access to the project site from the west would need to be designed to avoid impacts to small areas of estuarine wetlands near the mouth of Cemetery Creek (Figure 22).

Any portion of the project constructed below mean high water would be within waters of the United States, and would be subject to Section 10 of the River and Harbors Act of 1899. Placement of material below the high tide line would be subject to Section 404 of the Clean Water Act.

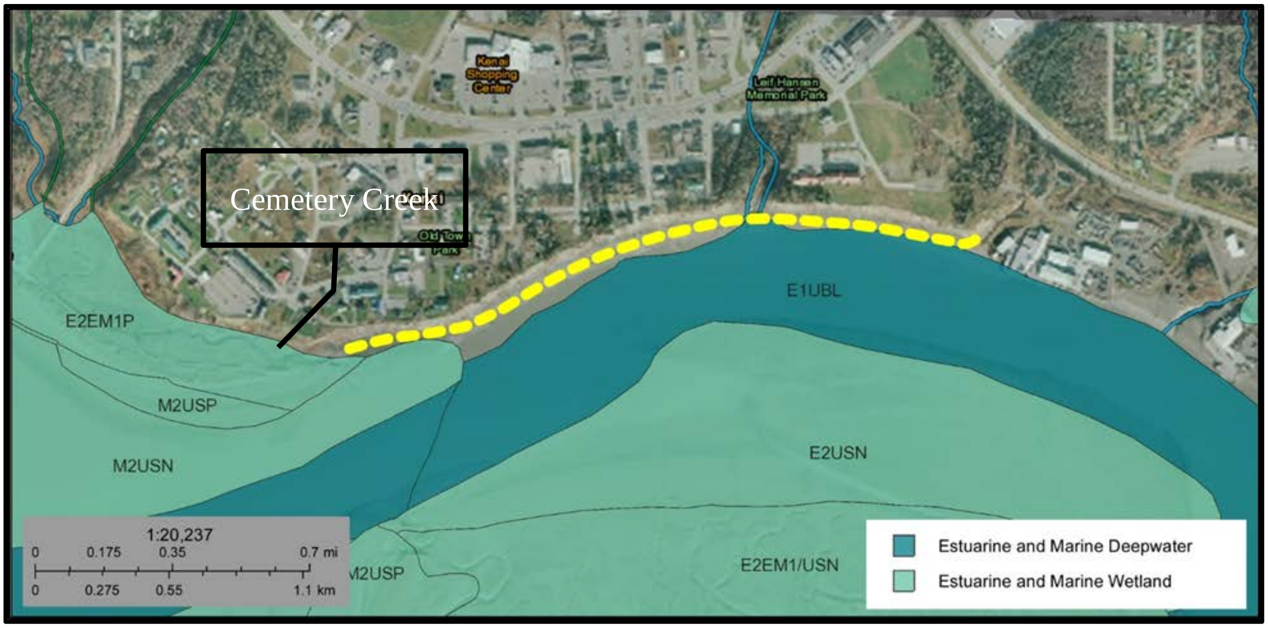

Figure 22. An Annotated National Wetlands Inventory Habitat Map of The Kenai River Estuary, Generated at the NWI Website (USFWS 2016).

3.12 Essential Fish Habitat

The NMFS designated the marine waters of Cook Inlet as Essential Fish Habitat (EFH) for salmon; this designation extends to all estuarine and freshwater bodies necessary for the development of salmon, including the Kenai River (NMFS 2016b, NPFMC 2012). The Kenai River is a catalogued anadromous stream, as are many of its tributaries.

The lower Kenai River is listed in ADFG's anadromous stream catalog as hosting the following species: Chinook salmon (*Oncorhynchus tshawytscha)*, chum salmon (*Oncorhynchus keta*), coho salmon (*Oncorhynchus kisutch*), pink salmon (*Oncorhynchus gorbuscha*), sockeye salmon (*Oncorhynchus nerka*), Dolly Varden (*Salvelinus malma*), lamprey, eulachon (*Thaleichthys pacificus*), Pacific lamprey (*Entosphenus tridentatus*), and Alaska whitefish (*Coregonus nelsonii*).

While listed in the AWC as "spawning" in the lower Kenai River, Chinook salmon and pink salmon are not understood to spawn in the Kenai River estuary itself. The catalog lists Cemetery Creek as providing rearing habitat for coho, Chinook, and sockeye salmon, and the unnamed creek shown in Figure 7 (catalogued by the ADFG as 244-30-10010-2003) near the east end of the project area as rearing habitat for coho and sockeye salmon. The Ryan Creek drainage is not cataloged as an anadromous stream (ADFG 2016c), although some observations suggest that juvenile fish may use its intertidal channel as rearing or refuge habitat (Sinclair 2016).

3.13 Cultural and Historic Resources

The Kenai Peninsula has been inhabited by indigenous peoples for at least 7,500 years (Reger 2003). A Dena'ina Kenaitze community was already well-established at Kenai when the first Russian fur traders arrived in 1741. Russians established the Nikolaevskii Redoubt near Kenai in 1786 (Znamenski 2003). This long occupation has resulted in both historic and prehistoric sites existing along the top of the river bluff. There are five historic properties within the project area identified on the Alaska Heritage Resources Survey, maintained by the State Historic Preservation Office: three historic houses and two archaeological sites. One of these archaeological sites is known to contain a late nineteenth-century cemetery, which is at risk of eroding into the river.

At least one of the two known archaeological sites along the river bluff includes both prehistoric and historic components. This archaeological site, located on Federal Aviation Administration (FAA) and City of Kenai land east of the Senior Center, is called Shk'ituk't (Alaska Heritage Resources Survey [AHRS] number KEN-020). Identified on Petroff's 1884 map as "Chkituk," it was the primary Dena'ina settlement in the area until it was abandoned shortly after the Holy Assumption of the Virgin Mary Russian Orthodox Church was built in 1895. During World War II, the Civil Aeronautics Administration bulldozed much of the site, including the village's Old Russian Orthodox cemetery, in order to build an airstrip (Boraas 2009). Despite the surface modification of the site, some house depressions remained into the 1950s, and there is a high probability that intact subsurface deposits remain (USACE 2007b; Boraas 2009). The site is considered a traditional cultural property by members of the Kenaitze Indian Tribe (Pierce 2016; USACE 2011, 2007, 2004b).

The second archeological site is located in a forested area on the western edge of Ryan Creek draw. It contains at least three house depressions and multiple cache pits, and is thought to be the remains of a former village site called Kili Betnu (AHRS number KEN-710). Additional prehistoric house depressions have been identified eroding off the bluff edge (USACE 2011, 2007, 2004b).

A survey of historic buildings was conducted in 1996 for the City of Kenai, but it was confined to the Kenai Townsite Historic District, and stopped short of most of the area near the eroding bluff (Elliott and Lane 1996). However, three historic buildings identified during the survey area do occur within the erosion threatened area that is estimated to develop over a 50-year period of analysis:

- Hermansen-Miller House, built in 1916 (AHRS number KEN-279)
- Kenai Log Cabin #2, built in 1924 (AHRS number KEN-070)
- Showalter House, built in 1936 (AHRS number KEN-276)

At least 13 other buildings within this erosion threatened area along the top of the bluff appear to be historic, but have not been evaluated. Some of these were built using the Swedish cope logging technique, and are believed to have been built and lived in by Nordic cannery workers (in fact, this area was called “Swede Town”). Other buildings have modern siding that conceals the log construction, but are known by locals to be traditional log structures (USACE 2007). The importance of many of these buildings is clear. For example:

The Mann/Peters House was originally built in 1952 by Harry James Mann, a local Alaska Native leader, commercial fisherman, and member of the Laborers Union (USACE 2011).

- The Kenai Bible Church, the first Protestant church in Kenai, was built in 1948. Today it remains an active church, and has a lighted cross that is seen as a guide to many fisherman entering the river (USACE 2011).
- Kenai Joe’s Bar (formerly “Keen-Eye Joe’s”), established in 1940, was popular in the 1940s and 1950s, and is known locally as an drinking establishment (USACE 2011, 2007).

In addition to the standing historic buildings, four unknown historic structures were identified in 2003, perched at the edge of the bluff. They have since disappeared down the eroding bluff face (USACE 2011, 2004b).

3.14 Subsistence Activities

The Kenai River and its salmon fishery is designated a “non-subsistence area” by the Alaska Board of Fisheries and Game. After a 1992 court case decision made all Alaskans eligible subsistence users, the Board moved to protect some particularly valuable fisheries from exclusive subsistence use by declaring them to be non-subsistence areas, then establishing individually-regulated “personal use fisheries.” The Kenai River has one of five personal use fisheries in upper Cook Inlet. The Kenai dip net fishery is currently open from July 10 through July 31, from 6 a.m. to 11 p.m. Alaskans harvest between 130,000 and 540,000 sockeye salmon annually in this fishery. The number of salmon escaping upstream to spawn is closely monitored, and the personal use fishery may be restricted if ADFG projects that salmon escapement goals may not be met (ADFG 2016a). Figure 23 shows the project site location relative to areas open and closed to personal use dip netting.

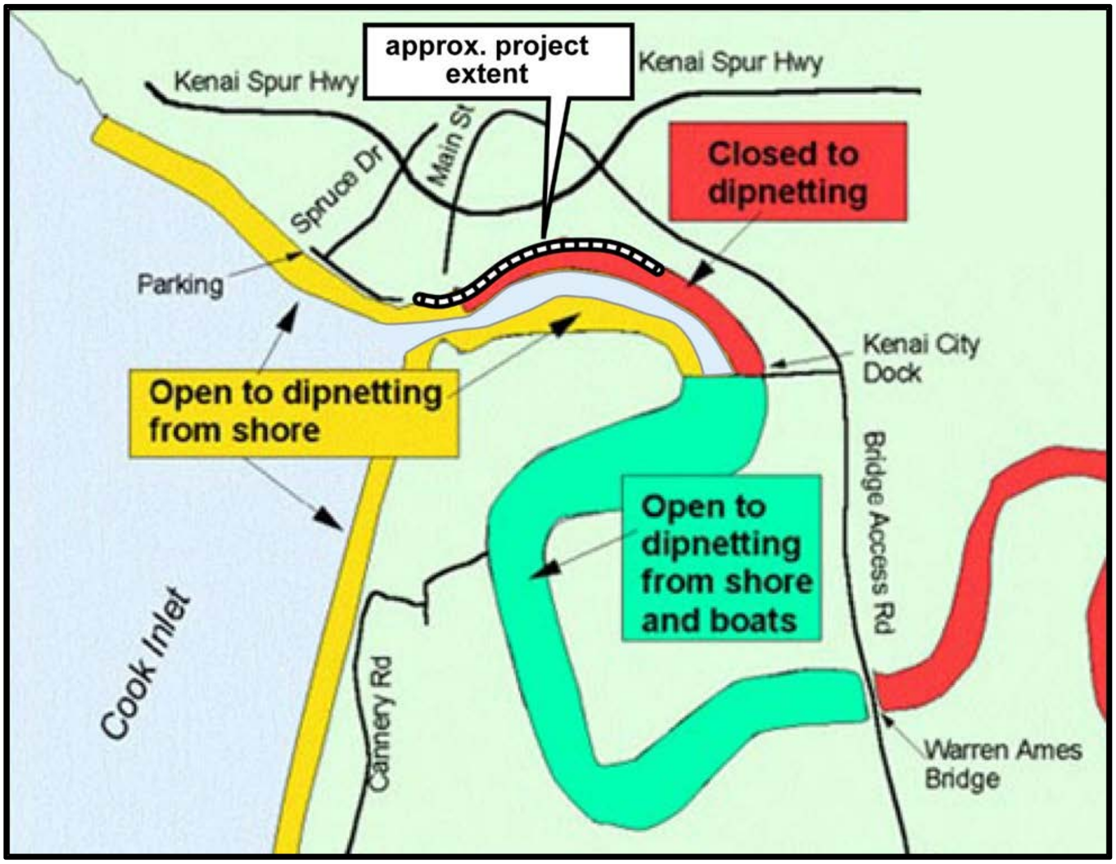

Figure 23. Kenai River Personal Use Fishery Regulation Areas (adapted from ADFG 2016a).

The Kenaitze Indian Tribe operates an educational fishery in the lower Kenai River, permitted by the State of Alaska in lieu of a rural subsistence fishery. The purpose is to teach and preserve the cultural traditions of subsistence within the Kenaitze community. The Educational Fishery is allowed a total annual quota of 8,000 fish, including 300 Chinook salmon and 500 coho salmon. The program is permitted to place set-nets at two locations near the mouth of the river; individual tribe members may request to be assigned a tide in which they fish these locations. The Kenaitze Indian Tribe operates this fishery from May through November, and the catch is shared within the Kenaitze community and with allied groups (Kenaitze Indian Tribe 2016).

4.0 FUTURE WITHOUT-PROJECT CONDITIONS

The future without-project conditions mirror those under the No Action Alternative. Absent Federal action it is unlikely that another entity will take action due to budgetary constraints. The expected without-project conditions form the basis of evaluation against with-project conditions and are presented below.

4.1 Economic Conditions

Absent Federal action, damages to land, structures and infrastructure, as well as loss of recreational value are expected to continue. The following sections describe the damage categories and estimate their value over the 50-year period of analysis. Applying an appropriate discount rate and period of analysis make damage values comparable on the equivalent time value of money. All values are reported as present values based on the Federal Fiscal Year 2018 discount rate of 2.75 percent and a 50-year period of analysis. Additional details of future without project economic conditions are in Appendix C.

4.1.1 Land Damages

Approximately 5,000 feet of riverbank bluff is eroding at an average annual rate of 3 feet per year. It’s assumed that once the erosion reaches 50 percent of the total lot size, no buyer would be willing to take the risk of purchasing the lot. There are 59 lots expected to reach this level of loss over the 50-year period of analysis. At current erosion rates, the Kenai Bluffs will continue to lose 0.34 acres of land per year, and 17.2 acres over the 50-year period of analysis.

Valuation of lost land is based on an analysis of the average value per acre of comparable parcels within the KPB against the average value per acre of parcels within the erosion zone.
Using this approach, expected future without-project land damages over the period of analysis have a present value of $1.0 million and equivalent average annual damages of $39,000. Table 5 summarizes expected land damages from erosion in ten year increments.

Table 5. Future Without-Project Land Damages

Item	Years					Total
	1-10	11-20	21-30	31-40	41-50	
Area (acres)	3.44	3.44	3.44	3.44	3.44	17.2
Total Value	$386,000	$386,000	$386,000	$386,000	$386,000	$1,930,000
Present Value	$333,000	$254,000	$194,000	$148,000	$113,000	$1,041,000
Average Annual Damages						**$39,000**

4.1.2 Structure and Non-Structural Improvement Damages

As a result of continued bluff erosion at the expected erosion rate, it is estimated that 31 properties containing structures and/or non-structural improvements in proximity to the bluff would be condemned over the period of analysis. These properties include a total of 34 structures and 23 other non-structural improvements. Some properties within the erosion zone have not been fully developed but are not considered vacant land. These properties have improvements including gravel driveways that have been installed, greenhouses, or land development such as fill being placed, etc. Damages to improved properties have been incorporated into the structural damages benefit category.

Future without-project damages to residential, commercial, and public structures over the 50-year period of analysis have a present value of $9.7 million and average annual damages of $359,000. The largest structure within the project area is the Kenai Senior Citizen Center, which has a 2016 assessed value (land plus improvements) of approximately $7.9 million. At current erosion rates, the Senior Center is expected to suffer catastrophic damage within the next 20 years. Table 6 summarizes future-without project structure damages.

Table 6. Future Without-Project Structure and Non-Structural Improvement Damages

Type	Present Value	Average Annual
Residential	$2,696,000	$100,000
Commercial	$1,655,000	$61,000
Public	$5,338,000	$198,000
Total	**$9,689,000**	**$359,000**

4.1.3 Public Infrastructure Damages

Infrastructure damages due to erosion are also expected to occur during the period of analysis. Threatened infrastructure includes roads, signs, street lights, curbs/gutters, water mains, sewer lines, lift stations, man holes, culverts, storm drains, and various utility lines (gas, electric and telecom). Please see the Economics Appendix for details on infrastructure damages.

Relocation of utilities and roads is expected to continue in the absence of a project. It is estimated that at least an additional 1,000 feet of road and utility lines are at risk of erosion. These roads and lines are anywhere from 30 to 100 feet from the bank. At the current pace of erosion, additional streets, sewer lines, and other infrastructure noted above would need to be replaced within approximately 10 to 20 years.

As a result of continued bluff erosion at the expected average annual rate of 3 feet per year, estimated infrastructure damages from erosion over the period of the analysis have a present value of $1.79 million and average annual damages of $66,000.

4.1.4 Recreation Value

The bluff offers unparalleled views of the Kenai River and Cook Inlet, and is often traversed by local residents and tourists for wildlife viewing and other outdoor activities such as hiking, biking, dog walking, or cross-country skiing along the roads and natural paths. Absent Federal action, these activities would be replaced by lower value activities pushed back to roads and properties farther inland from the bluffs. The amazing views afforded by the bluffs would be impeded, not fully, but to a large extent by remaining structures. Additionally, views may be further depreciated by condemned (but not demolished and picked up structures) as erosion causes properties to be lost.

Using the Unit Day Value (UDV) methodology described in the Economic Appendix and the Recreation Addendum, a generalized UDV of $7.09 was assigned to incidental recreation occurring in the future-without project scenario. Capacity was evaluated based on parking spaces and, as parking spaces are not expected to change from the existing condition to the future without-project condition, average daily use remains the same. The capacity analysis, which is detailed in the Recreation Addendum, estimated approximately 88,000 annual visits. The UDV for general recreation is multiplied by the area's estimated annual visitation, which yields the average annual value of recreation.

Using this approach for the future without-project scenario, the incidental recreation experience at Kenai Bluffs has a present value of approximately $16.8 million and an average annual value of $624,000 over the 50-year period of analysis, as shown in Table 7 below.

Table 7. Future Without-Project Recreation Value

Item	Annual Visitations	UDV	Present Value	Average Annual
Recreation Value	88,000	$7.09	$16,845,000	$624,000

4.2 Environmental Conditions

Absent Federal action, the bluff is expected to continue to erode at an average rate of 3 feet per year, perpetuating the ecologically unstable conditions on the bluff and along the intertidal bench along the base of the bluff. Soil and debris will continue to erode from the bluff and enter the Kenai River estuary, contributing to the river sediment load and to physical hazards in the intertidal zone. The project area will continue to be largely devoid of vegetation or a significant benthic community, and of low value to fish and wildlife. Conditions for protected species, essential fish habitat, and special aquatic sites are unlikely to change, although continued loss of trees and brush along the top of the bluff will reduce nesting and roosting habitat for bald eagles and migratory birds. While no significant sources of soil or groundwater chemical contamination are known in the immediate vicinity of the bluff, the continued unchecked recession of the bluff carries the risk of exposing some unknown contamination source to the river environment. With no project, the continuing erosion is expected to destroy 3 known historic buildings and 2 known archaeological sites, plus an additional 13 potential historic buildings, within 50 years.

4.3 Climate Change

Short observational records in Alaska make it difficult to separate climate change from natural multi-decadal variability. There are also quality problems, especially for measurements of precipitation and discharge. While there is evidence of a statewide average temperature increase of approximately 3 degrees Fahrenheit over the last 60 years, there are few spatially coherent trends in precipitation (McAfee et al. 2013); as a result it is difficult to conclude what, if any, impacts could be realized or attributed to climate change, if there is an increase or decrease in precipitation influencing associated stream flows.

4.4 Cultural Resources

In the absence of a project to address erosion, the only way to protect important cultural resources would involve full salvage recovery operations and Historic American Building Survey (HABS) recordation. There are five known historic properties identified on the Alaska Heritage Resources Survey within the project area that are expected to be impacted in the future-without project scenario. These properties includes three historic houses and two archaeological sites, one of which is known to contain a nineteenth-century cemetery. In addition to the five known historic properties, there are 13 additional historic buildings of unknown significance within the 50-year period of analysis. These buildings have not been evaluated for eligibility for listing on the National Register of Historic Places; evaluation would require surveys and archival research.

The activities described above regarding the mitigation of adversely affected cultural resources are not expected to take place in the future-without project scenario. The USACE archaeologist indicated that there are no known plans for salvage archaeological operations or documentation of historic buildings along Kenai Bluffs, whether undertaken by the City of Kenai or other entities. Therefore, costs associated with these activities are not considered as future-without project losses. These costs would be incurred in future-with project scenarios for alternatives that would impact these resources. These impacts are discussed in detail in the Economics Appendix.

4.5 Political Conditions

The State of Alaska Department of Labor and Workforce Development projects the KPB as a whole to gain approximately 9,000 residents over the next 30 years (Table 8). The degree to which this increase occurs, specifically in the greater Kenai area, is dependent upon a number of factors. The city's relative proximity to Anchorage, access to marine recreation, and rural lifestyle while maintaining common services and conveniences makes it an attractive location for some future development. However, a significantly large increase in development and population is not expected.

Table 8. State of Alaska Population Projections for the Kenai Peninsula Borough

Year	Population	Increase
2012	56,756	N/A
2017	59,225	2,469
2022	61,391	2,166
2027	63,116	1,725
2032	64,321	1,205
2037	65,098	777
2042	65,647	549

Because of this relatively stable environment, the prevailing economic and political conditions are not expected to change significantly over the period of analysis.

4.6 Summary Without-Project Conditions

Absent Federal action to prevent erosion, the above-detailed damages will continue to accrue. The present value of the expected damages to structures, land, and public infrastructure due to erosion is approximately $12.5 million with an average annual value of $464,000. The total value of incidental recreation in the future without-project scenario is $16.8 million or $624,000 annually. Table 9 summarizes the future without-project condition at Kenai Bluffs and forms the basis for comparison for the future with-project alternatives.

Table 9. Summary of Future Without-Project Conditions

Category:	Present Value	Average Annual
Structures	$9,689,000	$359,000
Land	$1,041,000	$39,000
Public Infrastructure	$1,789,000	$67,000
Damages Subtotal	**$12,519,000**	**$464,000**
Recreation Value	$16,845,000	$624,000
Total	**$29,364,000**	**$1,088,000**

5.0 FORMULATION AND EVALUATION OF ALTERNATIVE PLANS

5.1 Plan Formulation Rationale

Plan formulation is the process of building alternative plans that meet planning objectives and avoid planning constraints. Alternatives are a set of one or more management measures functioning together to address one or more planning objectives. A management measure is a feature or activity that can be implemented at a specific geographic location to address one or more planning objectives. A feature is a "structural" element that requires construction or assembly on-site whereas an activity is defined as a "nonstructural" action.

5.2 Management Measures

During the planning charette held on 4-5 May 2015, a number of measures were identified. The relative merits and drawbacks of each measure were examined with measures screened out as appropriate based on agreed upon criteria and associated metrics.

5.2.1 Criteria and Metrics

Measures were screened using the four national criteria and three study specific criteria, discussed in section 2.5. In addition each proposed measure was evaluated against the general metric whether the design would address/control the major mechanisms causing the erosion and receding bluff (groundwater seepage, overland flow, freeze thaw cycles, and wave action and currents at flood tides) as identified in section 3.8.2. Of these erosion mechanisms, wave action and currents at flood tides have been identified as key to eventual bluff stabilization. Specific engineering design criteria used to develop the measures are presented in detail in Appendix B.

5.2.2 Structural Measures

Structural measures are generally those measures that reduce the probability of erosion. Sixteen measures initially considered for this project are presented in Table 10, with those that were removed from future consideration (i.e., screened out) are shown in red with strikethrough.

Table 10. Structural Measures Considered

~~Groundwater Pumping~~	Longitudinal Dike	Toe Protection (Armoring)	Groundwater Conveyance
~~Breakwater~~	~~Gabions~~	~~Toe Wall (Sheet Pile, etc.)~~	Regrading/Re-vegetation
~~Shotcrete~~	~~Beach Nourishment~~	~~Channel Training Measures~~	~~Groundwater Cutoff Wall~~
Relocate River Mouth	Dredging	Upper Slope Stabilization	Top-of-Bluff Drainage

The reason or reasons measures from Table 10 were screened out vary, but most were removed due to ineffectiveness, cost, or feasibility. The main reason or reasons why these measures were screened out are presented below:

- Groundwater pumping alone influences one erosion mechanism and would be ineffective since it does not prevent the material that accumulates at the toe of bluff from washing away during floodtides. This measure would also be a long-term continuous maintenance cost to maintain pumping well.
- A breakwater would be ineffective at preventing flood tides from reaching the toe of the bluff and washing away material accumulating at the toe of the bluff. It is also thought to be cost prohibitive because of the size of the structure needed to combat coastal storms, and it could be a potential navigational and commercial fishing hazard.
- Shotcrete is a process where a cement or cement like mixture is sprayed on the surface to support and protect the surface. The effectiveness or chance of success of this measure would likely be limited due to the groundwater, the severe coastal environment, and freeze thaw cycles attacking the shotcrete surface.
- Gabions are rock filled wire enclosures that have the potential of using smaller less expensive rock for barriers; however, the wire would be subject to salt water corrosion and are not proven in marine environments.
- Beach nourishment relies on a source of material, typically a soil type matching the existing beach material; however, this method would not be effective because the main erosion mechanism during flood tides would likely cause an unacceptably high frequency of replenishment. In addition, a dependable cost-effective material source could not be readily identified for this measure to be effective.
- Toe wall or sheet piling has the potential for stabilizing the toe of the bluff; however, there was a concern that a vertical wall would cause rebound waves that could become a navigation hazard to small boat traffic.
- Channel training, in general, includes dredging or installing a structure that controls the channel. This measure would be ineffective because the river channel is not the main erosional mechanism that destabilizes the bluff.
- A groundwater cut-off wall as single measure would be ineffective because it does not address the main erosion mechanism. In addition, as groundwater eventually migrates around the wall, resulting in additional seepage in local drainages, there is the potential of unintended consequences, such as destabilizing the slope and enhancing erosion rates in these areas.

5.2.3 Non-structural Measures

Non-structural measures are those measures that reduce the consequences of erosion through relocations, buyouts, and demolition with reconstruction (within authority granted by Section 116). Five measures initially considered for this project are presented in Table 11 with those that were screened out shown in red with strikethrough.

Table 11. Non-Structural Measures

~~Extended No-Wake Zone~~	Zoning Changes
Demolish/Rebuild Structures	Buyouts
Relocations	

The extended wake zone was screened out because it would be ineffective since it does not address flood tides as the main erosion mechanism that prevents the bluff from stabilizing.

6.0 ALTERNATIVE DESCRIPTIONS

6.1 Initial and Final Alternative Plans

The following measures were carried forward on their merits to address the major erosion mechanisms at the project area, including wave action, flood tide currents, groundwater seepage, overland flow, and freeze thaw cycles: Longitudinal dike, toe protection, groundwater conveyance, re-vegetation, dredging, upper slope stabilization, top-of-bluff drainage, and river mouth relocation.

Based on the measures that were carried forward, the six combinations of measures, or “alternative plans” are listed below:

- Alternative 1: No Action
- Alternative 2: River Mouth Relocation
- Alternative 3: Revetting and Vegetating the Bluff Face - Buried Toe
- Alternative 4: Revetting and Vegetating the Bluff Face - Weighted Toe
- Alternative 5: Protective Berm at the Bluff Toe
- Alternative 6: Structure Relocation

All of the alternative plans listed above were carried forward after the charette for evaluation with none screened out during this study. Each of the alternatives were considered in “A Watershed Perspective” per the Planning Guidance Notebook (ER 1105-2-100, Section 2-6). Considering that the project location is a marine coast line at the terminus of a major drainage (i.e., Kenai River watershed), the alternative plans were thought to have little, if any, interconnectedness to other existing or future water and land projects in the watershed. In addition, except as considered in the economic analysis, constructing any of the alternatives plans, will also not have a significant effect on the dynamic nature of the economy, the upstream environment, and sustainability of future

Kenai River watershed resources when taking in to account environmental quality, economic development and social well-being.

Each alternative plan is described in more detail in the following sections.

6.2 Alternative 1: No Action

This alternative takes no action to reduce or halt bluff erosion at Kenai. The study objectives are not met and no opportunities are realized. The bluff continues to erode. Structures continue to be lost as the ground beneath them erodes away. These structures include historical structures, the Senior Center and Senior Housing, commercial buildings, and residences. Cultural resources associated with the Dena'ina people in general and the Kenaitze Tribe in particular are lost. Public utilities and properties suffer damages as described in the Future-Without Project conditions. As above, recreation opportunities for viewing wildlife and traversing the bluff area would lose value.

6.3 Alternative 2: River Mouth Relocation

River Mouth Relocation is a construction alternative that relocates the mouth of the Kenai River approximately 3,500 feet to the south (Figure 24). A new channel between jetties is dredged and the material stockpiled during excavation. Once the excavation is complete, the existing channel is filled in along the active erosion area to create emergent wetlands east of the cut-off dike below the Kenai Bluffs. The cut-off dike and jetties would be constructed of rock/stone as described in Appendix B, Hydraulic Design.

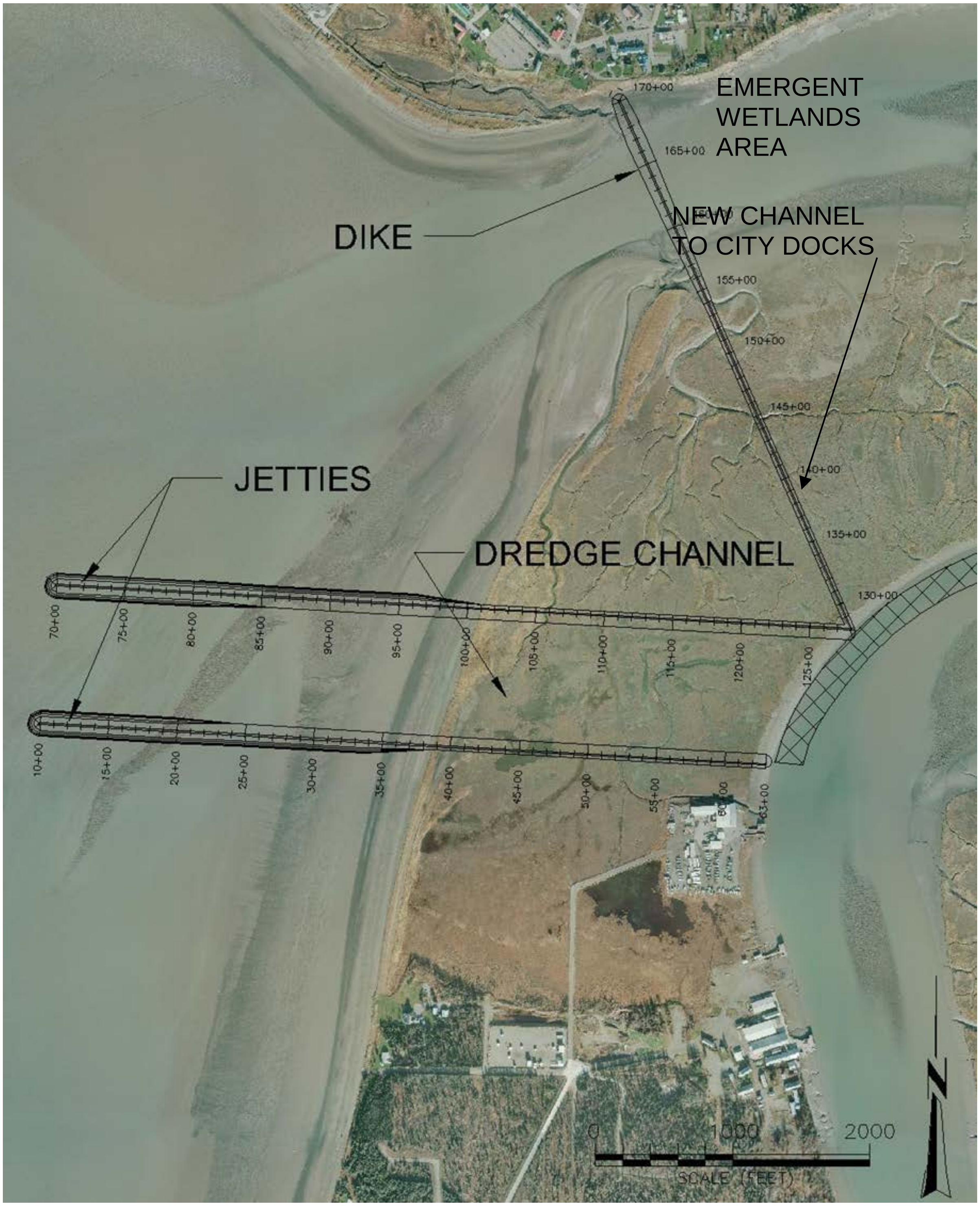

Figure 24. Plan View of River Mouth Relocation

Jetties are constructed to redirect river flow. Erosion of the bluff is reduced due to the reduction of waves, river currents, and tidal action from the bluff area. However, erosion would continue to occur to some degree due to groundwater seepage and overland flow. Some buyouts, relocations, and/or structure replacements are required within the new threatened area, though they are less than the number required under the Non-Structural Alternative.

Maintenance dredging is required for the jetty channel with this alternative on an annual basis. The channel to the City docks would be a non-Federal responsibility. It is also assumed that a portion of armor stone will need to be replaced to maintain the jetties. Significant loss of stone from the structure over the period of analysis is not expected, and is estimated at approximately 28,160 cubic yards of armor stone every 20 years.

The total economic (NED) cost including interest during construction and maintenance has a present value of approximately $594 million or $22.0 million annually over the period of analysis.

6.4 Alternative 3: Revetting and Vegetating the Bluff Face- Buried Toe

Alternative 3 addresses the erosion mechanisms by constructing over approximately 5,000 feet of bluff face (Figure 25) by:

- Cutting and filling the bluff to a more stable slope
- Constructing a stone revetment at the base of the bluff with a buried toe
- Vegetating the bluff slope above the revetment

The typical section for Alternative 3 (Figure 26), shows the armoring would extend from a buried toe 6 feet below the current river bank to a height of +32.5 feet MLLW. Filter fabric material and geotextile would be used to ensure proper filtering of groundwater seepage. The revetment height would gradually decrease in height from zone A to zone C (Figure 10) to account for the decrease in wave height further upstream.

Figure 25. Alternative 3 Plan View - Revetment with Buried Toe

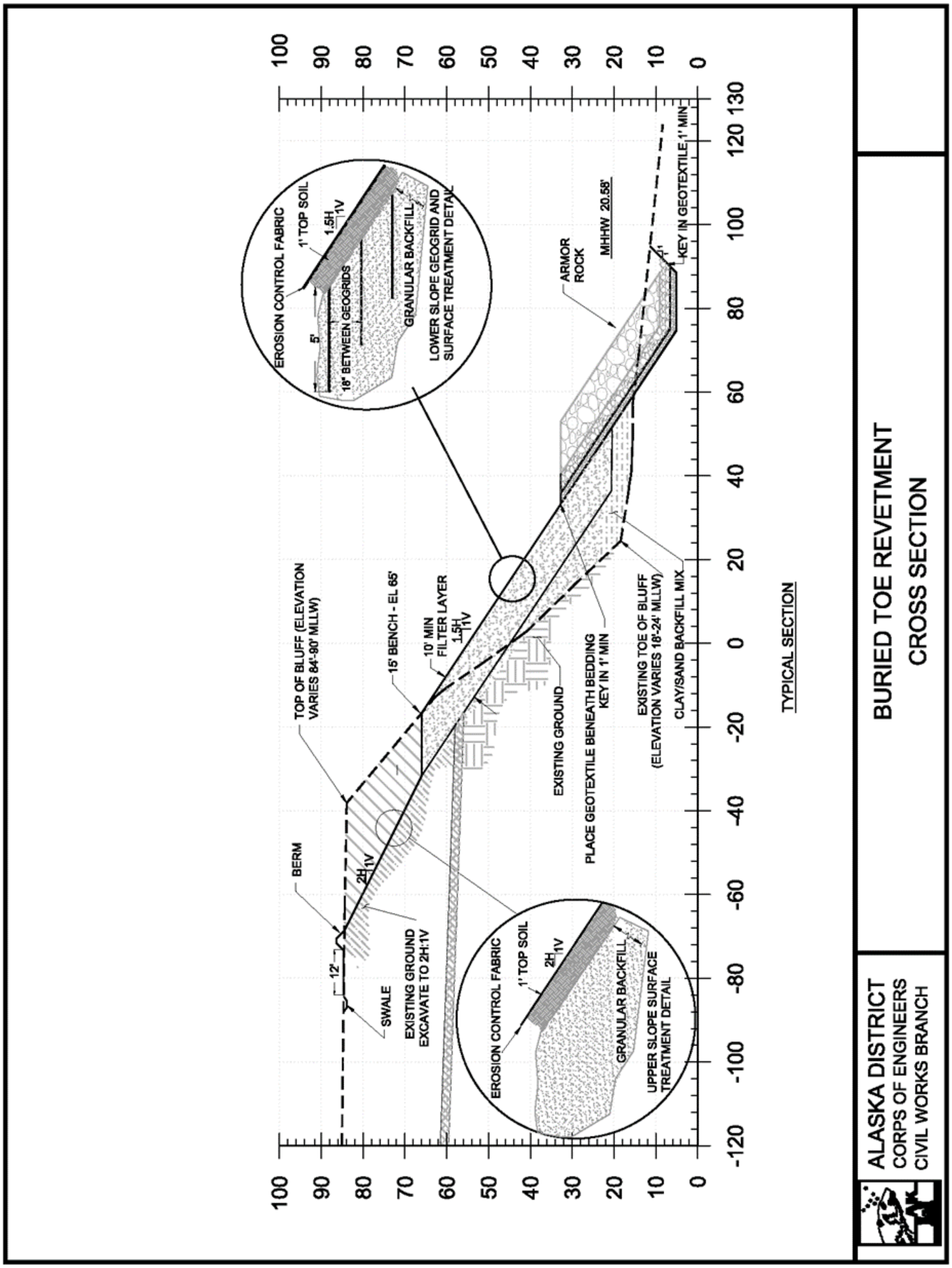

Figure 26. Alternative 3 Typical Section – Revetment with Buried Toe

Alternative 3 requires the buyout or relocation of approximately 25 structures at the top of the bluff in order to facilitate a cut back to a stable slope of 2H:1V, starting from approximately +65 feet MLLW from the bottom of the revetment. A temporary easement at the top of the bluff would be needed for construction of the revetment. It is not anticipated that there would be a significant loss of stone from the structure over the period of analysis. It is estimated that approximately 1,350 cubic yards of armor stone would need to be replaced every 20 years.

The total economic (NED) cost, including interest during construction and maintenance, has a present value of approximately $54.5 million or $2.0 million annually over the 50-year period of analysis.

6.5 Alternative 4: Revetting and Vegetating the Bluff Face- Weighted Toe

The design for Alternative 4 (Figure 27) is similar to Alternative 3 (Figure 26) in that it addresses the erosion mechanisms by constructing across the approximately 5,000 feet of bluff face by:

- Cutting and filling the bluff to a more stable slope
- Constructing a stone revetment at the base of the bluff as a “weighted toe” rather than a “buried toe”
- Vegetating the bluff slope above the revetment

However, this alternative reduces the volume of material cut from the bluff and uses fill at the base to create a stable slope. The stone revetment at the base of the fill area is not buried.

Filter fabric separates the filter rock from the native material. The revetment height decreases in height from zone A to zone C (Figure 10) to account for the decrease in wave height farther upstream. However, Zone C is designed to a height of 3.5 feet due to the influence of ice. The toe of the revetment is designed to launch material placed on the river side of the revetment to fill potential scour holes.

This alternative requires the buyout or relocation of approximately 25 structures at the top of the bluff in order to facilitate a cut back to a stable slope of 2H:1V approximately +65 feet MLLW from the bottom of the revetment. A temporary easement at the top of the bluff would be needed for construction of the revetment. It is not anticipated that there would be a significant loss of stone from the structure over the life of the project. It is estimated that approximately 2,900 cubic yards of armor stone would need to be replaced every 20 years.

The total economic (NED) cost including interest during construction and maintenance has a present value of approximately $58.1 million or $2.2 million annually over the period of analysis.

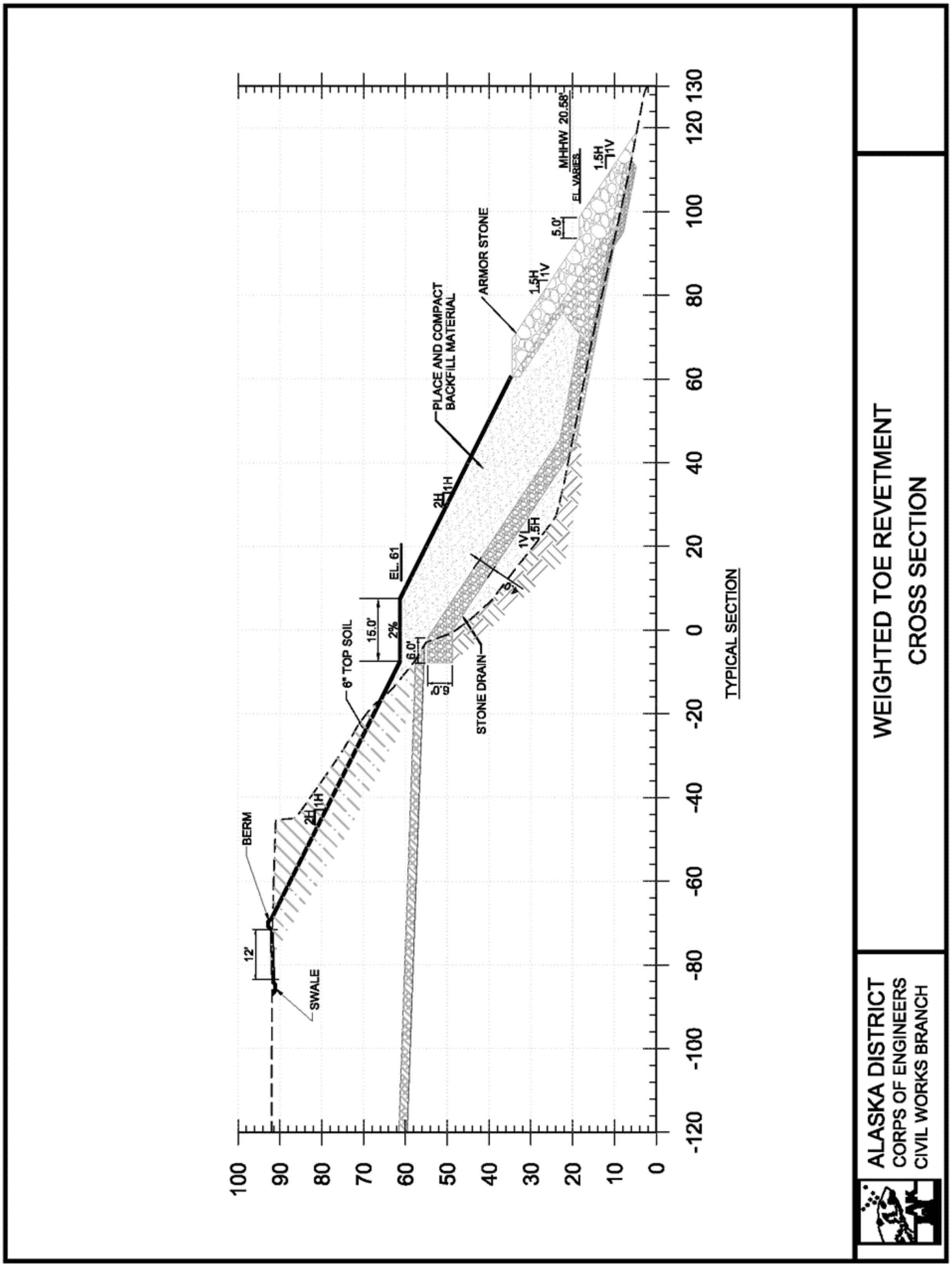

Figure 27. Alternative 4 Typical Section – Revetment with Weighted Toe

6.6 Alternative 5: Protective Berm at the Bluff Toe

The design of Alternative 5 (Figure 28) is fundamentally different from Alternatives 3 and 4 in that a protective berm is constructed along the toe of the bluff with the objectives of:

- Preventing water from flood tides washing away the material that collects at the toe between the bluff face and the berm
- Protecting the lower portion of the bluff from additional storm damage

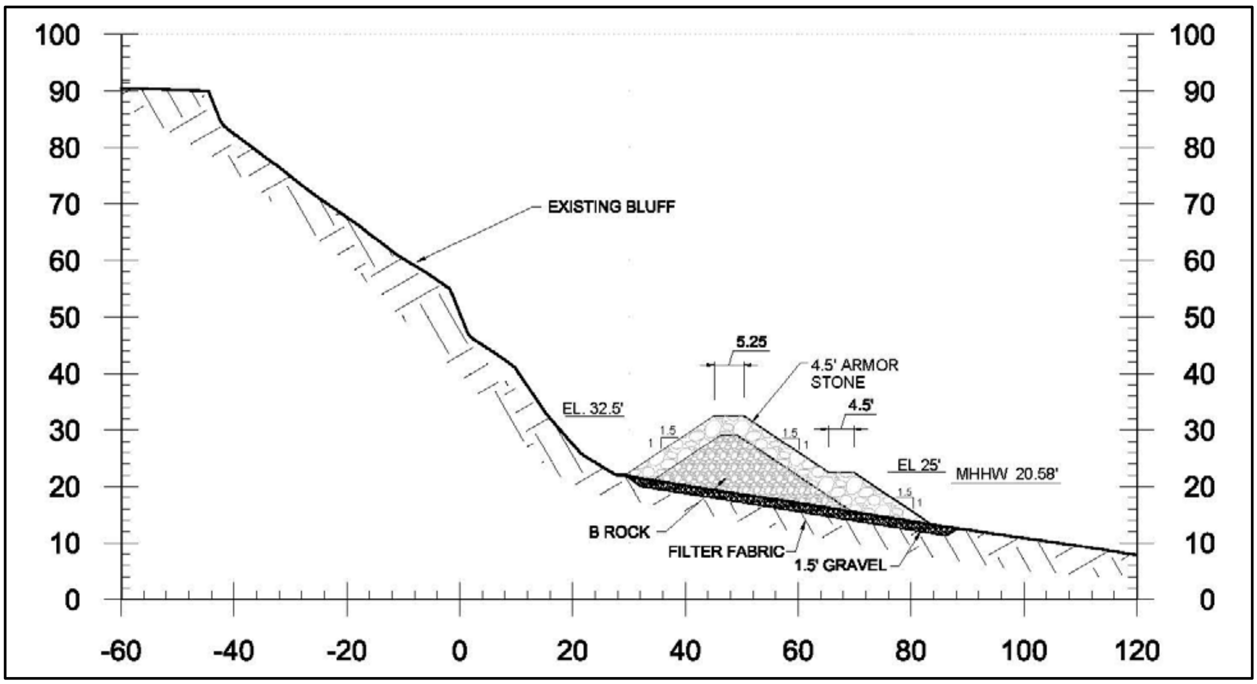

Figure 28. Alternative 5 Typical Section Berm at Bluff Toe

No cutting of the bluff face is planned for this alternative. After construction, the erosion mechanisms (e.g., overland flow and groundwater) will continue to operate, causing the bluff face to erode and recede. However, with the protective berm present, the soil transported to the toe of the bluff can accumulate and develop a stable bluff slope. This more stable bluff slope encourages vegetation to establish to further stabilize the bluff.

It is anticipated that the bluff will eventually lay back to 2H:1V over a 15-year period. The berm is located to provide storage of the bluff face material laid back on a 2H:1V slope. The berm height gradually decreases in height from west to east to account for the decrease in wave height farther upstream. The river side toe of the berm is built up to provide launch material to fill potential scour holes. A typical cross section of the berm is shown in Figure 28. Cross sections for Zones A through C, which are presented in the Appendix B (Figures 63, 64, and 65).

It is not anticipated that there will be a significant loss of stone from the structure over the period of analysis. It is estimated that approximately 4,200 cubic yards of armor stone will need to be replaced every 20 years.

The total economic (NED) cost including interest during construction and maintenance has a present value of approximately $33.8 million or $1.3 million annually over the period of analysis.

6.7 Alternative 6: Structure Relocation

The Structure Relocation alternative is non-structural. All buildings estimated to lie within the area expected to erode over the 50-year period are purchased or removed from the area through a plan likely to include demolition of existing facilities as shown in the Real Estate Plan (Appendix F). All known historical structures require significant mitigation associated with a loss of context. Cultural resources require proper documentation. This activity requires extensive coordination with the Kenaitze Indian Tribe and other tribal entities associated with the area.

The total economic (NED) cost has a present value of approximately $40.4 million or $1.5 million annually. This includes the appraised or fair market values for all properties, plus documentation costs for historic properties and archeological resources. Appraised property values were considered a more conservative (or higher) estimation of costs than physically picking up buildings and moving them to other lots in Kenai, and thus were used.

6.8 Considerations

Considerations or challenges that can impact the construction based alternatives include, but may not be limited to, the following:

- Construction will need to consider influences from inclement weather or other potential site conditions including: tide levels, coastal storm events, tide and river currents, and severe winter temperatures.
- Site access to the top of the bluff, if necessary, is challenged by multiple property owners and structures and infrastructure limiting or complicating access.
- Vessel traffic, both commercial and private, going through the mouth of the Kenai River can be significant during peak fishing seasons.
- The beach material fronting the bluffs varies in consistency with those areas with soft soils, which can hamper heavy equipment and result in differential settlement of the construction material.
- A barge should be able to work the tides and off load equipment and materials, but high tides will limit potential staging locations to either end of the bluff area to avoid inundation by flood tides.
- No local rock source appears to be available for the project. Rock will likely be transported by barge from a quarry on Kodiak Island or by truck or barge from a quarry located near the City of Seward.

7.0 COMPARISON AND SELECTION OF PLANS

7.1 With-Project Conditions

The alternatives were designed to meet the planning objectives and criteria and were evaluated based on environmental, economic, and engineering considerations. This section summarizes the damages expected to occur under the various future with-project (FWP) scenarios. Continued erosion damages in all FWP scenarios are lower than in the future without-project (FWOP) condition (i.e., Alternative 1: No Action). The same categories evaluated in the FWOP scenario, i.e. damages to land, structures, and infrastructure (as well as incidental recreational value) are presented.

7.1.1 Future With-Project Land Damages

Expected land damages in the future with-project condition for each alterative are summarized in Table 12 below. For all alternatives, except no action, while some land damages occur, they would be mitigated by buyouts.

Table 12. Future With-Project Land Damages

Alt.	Alternative Description	Net Present Value	Average Annual Value	Quantity Lost (Acres)
1	No Action	$1,041,000	$39,000	17.2
2	River Mouth Relocation	$211,000	$8,000	3.4
3	Revetting and Vegetating the Bluff Face – Buried Toe	$751,000	$28,000	6.9
4	Revetting and Vegetating the Bluff Face – Weighted Toe	$751,000	$28,000	6.9
5	Protective Berm at the Bluff Toe	$211,000	$8,000	3.4
6	Structure Relocation	$1,041,000	$39,000	17.2

Alternative 1: No Action

Land damages for this alternative are the same as for the future without-project condition. If no action is taken, approximately 17.2 acres along the top of the bluff would be lost due to erosion over the period of analysis.

Alternative 2: River Mouth Relocation

This alternative would allow the natural erosion process that the bluff experiences to continue, but would reduce the river currents and storm waves that wash the eroded material away. This would allow the naturally eroded material to accumulate and, overtime, the bluff would lay back to a stable slope. With this alternative, land damages are expected to coincide with the natural layback of the bluff.

Relocating the mouth of the Kenai would require the excavation of a new channel through the mud flats, construction of two jetties to train the new river mouth, and construction of a cut-off dike to prevent wave attack at the bluff toe during storm events. It is estimated that it would take between 3 and 15 years for the bluff to stabilize assuming an erosion rate of 3 feet per year. Over that period approximately 3.4 acres are expected to be lost along the top of the bluff. Damages that occur in the future under this alternative have been appropriately discounted with their year of loss.

Alternative 3: Revetting and vegetating the bluff face with a buried toe

This alternative would protect the bluff by laying it back on a stable slope, armoring the lower slope, and vegetating the upper slope. This alternative would provide immediate bluff protection from each erosion mechanism. However, construction of this alternative would be constrained by real estate at the top of the bluff. The impact to real estate at the top of the bluff is estimated to coincide approximately with the area of land that would be impacted in the absence of a project over the first 15 years of the period of analysis.

Alternative 4: Revetting and vegetating the bluff face with a weighted toe

Future land damages under this project alternative are similar to what is expected under Alternative 3 above.

Alternative 5: Protecting the bluff toe to prevent eroded material from being washed away

This option would construct a protective berm at the toe of the bluff. The natural erosion processes that the bluff experiences would continue, but the berm would prevent the eroded material from being washed away by river currents or storm waves. This would allow the naturally eroded material to accumulate and, overtime, the bluff would lay back to a stable slope. It is estimated that it would take between 3 and 15 years for the bluff to stabilize assuming an erosion rate of 3 feet per year. With this alternative, land damages are expected to coincide over time with the natural layback of the bluff after the toe of the bluff is armored. Land damages that occur in the future under this alternative have been appropriately discounted with their year of loss.

Alternative 6: Structure Relocation

Land damages for this alternative are the same as for the future without-project condition.

7.1.2 Future With-Project Structure Damages

Expected structure damages in the future with-project condition for each alterative are summarized in Table 13. For all alternatives, except no action, while structure damages occur, they are mitigated by buyouts and relocations.

Table 13. Future With-Project Structure Damages

Alt.	Alternative Description	Present Value	Average Annual Value	Quantity Lost (Number)
1	No Action	$9,689,000	$359,000	34
2	River Mouth Relocation	$0	$0	0
3	Revetting and Vegetating the Bluff Face – Buried Toe	$0	$0	0
4	Revetting and Vegetating the Bluff Face – Weighted Toe	$0	$0	0
5	Protective Berm at the Bluff Toe	$0	$0	0
6	Structure Relocation	$0	$0	0

Alternative 1: No action

Structure damages for this alternative are the same as for the future without-project condition. Approximately 34 structures would be lost within the 50-year period of analysis.

Alternative 2: Relocating the mouth of the Kenai River

Structure damages are expected to coincide with the natural layback of the bluff. It is estimated that it would take between 3 and 15 years for the bluff to stabilize assuming an erosion rate of 3 feet per year. Over that period no structures are lost; however, some structures that are close to the bluff would be bought out or relocated within the same parcel when possible. These structures are considered to be protected, and the cost associated with buyouts or relocation is captured in the economic (NED) costs. Damages that occur in the future under this alternative have been appropriately discounted with their year of loss.

Alternative 3: Revetting and vegetating the bluff face with a buried toe

This alternative would provide immediate bluff protection from each erosion mechanism. However, construction of this alternative would be constrained by real estate at the top of the bluff. The impact to real estate at the top of the bluff is estimated to coincide approximately with the area of land that would be impacted in the absence of a project over the first 15 years of the period of analysis. However, losses are not incurred over time, but immediately, and are calculated in current year dollars. Approximately 25 structures would be bought out or relocated.

Alternative 4: Revetting and vegetating the bluff face with a weighted toe

Future land damages under this project alternative are the same as under Alternative 3 above. Losses are incurred immediately and calculated in current year dollars. Approximately 25 structures would be bought out or relocated.

Alternative 5: Protecting the bluff toe to prevent eroded material from being washed away

Over time the bluff would lay back to a stable slope. It is estimated that it would take between 3 and 15 years for the bluff to stabilize assuming an erosion rate of 3 feet per year. With this alternative, structure damages are expected to coincide over time with the natural layback of the bluff after the toe of the bluff is armored. Over that period no structures are lost; however, some structures that are close to the bluff would be bought out or relocated within the same parcel when possible. Structure damages that occur in the future under this alternative have been appropriately discounted with their year of loss.

Alternative 6: Structure Relocation

An estimated 34 structures would be bought out or relocated for this alternative. These structures are the same structures expected to be damaged in the future without project condition. Since these structures would be bought out or relocated, they would not experience damages.

7.1.3 Future With-Project Infrastructure Damages

Expected public infrastructure damages in the future with-project condition for each alterative are summarized in Table 14.

Table 14. Future With-Project Public Infrastructure Damages

Alt.	Alternative Description	Present Value	Average Annual Value
1	No Action	$1,789,000	$66,000
2	River Mouth Relocation	$951,000	$35,000
3	Revetting and Vegetating the Bluff Face – Buried Toe	$0	$0
4	Revetting and Vegetating the Bluff Face – Weighted Toe	$0	$0
5	Protective Berm at the Bluff Toe	$951,000	$35,000
6	Structure Relocation	$1,789,000	$66,000

Alternative 1: No action

Infrastructure damages for this alternative are the same as for the future without-project condition.

Alternative 2: Relocating the mouth of the Kenai River

Infrastructure damages are expected to coincide with the natural layback of the bluff. It is estimated that it would take between 3 and 15 years for the bluff to stabilize assuming an erosion rate of 3 feet per year. Damages that occur in the future under this alternative have been appropriately discounted with their year of loss, as displayed in Table 14.

Alternative 3: Revetting and vegetating the bluff face with a buried toe

This alternative would provide immediate bluff protection from each erosion mechanism. However, construction of this alternative would be constrained by infrastructure modifications at the top of the bluff. The impact to infrastructure at the top of the bluff coincides with the area of land that would be impacted, approximately 60 feet of layback. Losses do not incur over time, but immediately, and are calculated in current year dollars. These losses are accounted for in the economic (NED) costs, which detail the removal and/or relocation of infrastructure.

Alternative 4: Revetting and vegetating the bluff face with a weighted toe

Future land damages under this project alternative are similar to those under Alternative 3 above. Losses are incurred immediately and calculated in current year dollars. These losses are accounted for in the economic (NED) costs, which detail the removal and/or relocation of infrastructure.

Alternative 5: Protecting the bluff toe to prevent eroded material from being washed away

Overtime the bluff would lay back to a stable slope. It is estimated that it would take between 3 and 15 years for the bluff to stabilize assuming an erosion rate of 3 feet per year. With this alternative, infrastructure damages are expected to coincide over time with the natural layback of the bluff after the toe of the bluff is armored. Structure damages that occur in the future under this alternative have been appropriately discounted with their year of loss.

Alternative 6: Structure Relocation

Infrastructure damages for this alternative are the same as for the future without-project condition.

7.1.4 Future With-Project Recreation Value

Even though construction of recreational facilities is not part of any alternative, if erosion is addressed there is expected to be a corresponding increase in the incidental recreational value for visitors to the bluff. Again, the value of hiking, biking, wildlife viewing and other activities that occur is expressed in Unit Day Values, which are detailed in the Economics Appendix and Recreation Addendum. The future with-project recreation experience is quantified using the same method described in the future without-project section in that annual visitation estimates are multiplied by the UDV to estimate the average annual value of recreation. Note that some alternatives preserve the view, paths, and public access better than others and therefore have a higher associated recreation value, as shown in the Table 15.

Table 15. Future With-Project Recreation Value

General Recreation	Points	Annual Visitation	UDV	Present Value	Average Annual
Alternatives 1 and 6	18	88,000	$7.09	$16,845,000	$624,000
Alternatives 2 through 5	80	88,000	$11.64	$27,655,000	$1,024,000

Source: Points based on professional judgment. UDVs from USACE EGM 18-03.

7.1.5 Future With-Project Environmental Impacts

This section compares the anticipated environmental impacts of the different alternatives in-place. Most of the environmental impacts of the construction alternatives (Alternatives 2 through 5) are expected to come from temporary construction impacts (e.g., noise, vessel operations) rather than from the finished project; an exception is Alternative 2, in which the long-term effects of the completed project may well overshadow temporary impacts. Section 9 provides a more detailed evaluation of short-term and long-term environmental consequences of the selected plan.

Alternative 2: River Mouth Relocation

The environmental impacts of this alternative have not been considered in detail, but it is assumed that they would be significant, and require an Environmental Impact Statement (EIS) level of study and review. This alternative would profoundly alter an economically and culturally important fishery, at a scale that has never been attempted in Alaska, and modify critical habitat for the endangered Cook Inlet beluga whale. The consequences of this alternative on these resources would be very difficult to anticipate even with extensive environmental studies. Cultural resources potentially affected by this alternative have not been surveyed or evaluated. The resistance to this alternative from the public, local government, and regulators would likely be intense.

Alternative 3: Revetting and vegetating the bluff face - buried toe

Alternatives 3, and each place a riprap structure, roughly 60 feet wide and 5,000 feet long, within the intertidal bench at the base of the bluff, replacing the existing sand and cobble habitat with large angular rock. The bluff slope above the revetment would be cut back to a more stable slope, recontoured, and vegetated. The existing intertidal boulders at the project site show little evidence of colonization by algae or invertebrates, probably due to ice scour, and it is uncertain whether the riprap will support a more productive invertebrate community than the existing intertidal substrate. The rugosity of the rock structure will introduce protected microhabitats that do not currently exist in the estuarine environment, and which may be exploited by various organisms in unexpected ways. The Alternative 3 revetment will require excavation within the intertidal environment to bury the revetment toe to a depth of about 6 feet. The transformation of the crumbling bluff into a stable, vegetated slope would be a beneficial consequence of this alternative. If the revegetation is done with care using native species, the completed slope would provide far more valuable habitat for birds and small mammals than what exists now. Rigorous sediment management and erosion control measures would need to be adopted and maintained during cut-and-fill operations, and while the new vegetation is being established. The presence of the revetment along the base of the bluff, and the reshaping of the bluff, will have less than significant impacts on protected species, essential fish habitat, and special aquatic sites within the estuary. The cutting-back of the bluff face required under Alternatives 3 and 4 would remove a portion of the top of the bluff and have the potential to adversely affect any cultural resources within the limits of soil removal. The Corps would be responsible for mitigating those adverse impacts, to include full salvage recovery operations and Historic American Building Survey (HABS) recordation. The historic properties along the top of the bluff that may be affected by the cutting-back activity have not been surveyed or evaluated recently for their level of risk or their eligibility for the National Registry of Historic Places; this reevaluation and further coordination with the SHPO would need to be pursued if an alternative including bluff-grading were to be chosen. This alternative would not impact subsistence activities, as none occur at the project site.

Alternative 4: Revetting and vegetating the bluff face - weighted toe

The environmental impacts of Alternative 4 would be nearly identical to those of Alternative 3, except that no extensive excavation would be required within the intertidal zone.

Alternative 5: Protective berm at bluff toe

This alternative, the protective rock berm, would be less physically invasive than Alternatives 3 and 4. The longitudinal extent (approximately 5,000 feet) and the areal footprint of the berm (roughly 8.25 acres) would be very similar to those of the rockwork under the revetment alternatives, although the cutting-and-filling of the bluff face under Alternatives 3 and 4 greatly increase the area of direct impact. Constructing the berm will require little or no excavation of existing sediment or soil, whereas the revetments would require excavation of the intertidal zone and bluff face to key-in the stonework, and more machinery working in the intertidal zone. The presence of the berm along the base of the bluff will have less than significant impacts on protected species, essential fish habitat, and special aquatic sites within the estuary. The slope above the berm would be allowed to erode, stabilize, and revegetate on its own, which would presumably occur at a much slower pace than under Alternatives 3 or 4; which have engineered cut slopes above the revetment that would be revegetated as part of their plans. With no planned revegetation for alternative 5, the slope will likely fill with opportunistic invasive vegetation, ultimately resulting in lower quality habitat on the self-stabilized slope. Allowing the upper bluff face to erode to its natural angle-of-repose is not a Federal undertaking on the part of the USACE under the National Historic Preservation Act, and the consequences of that natural erosion are not assessed here. This alternative would not impact subsistence activities, as none occur at the project site.

Alternative 6: Structure Relocation

The environmental consequences of this alternative would be identical to that of Alternative 1 (No Action), except that it would remove structures and potential contamination sources that might otherwise be undermined by erosion and collapse into the river.

7.1.6 Summary of Future With-Project Conditions

Table 16 summarizes future with-project conditions for each alternative considered. It shows the value of damages to land, structures, and infrastructure experienced under the with-project conditions, as well as the future with-project value of recreation. Note that the recreation value represents a gain over the without-project condition value, whereas the damage values for land, structure, and infrastructure represent reductions in damages from the without-project condition values.

Table 16. Summary of Future With-Project Conditions

Alt.	Alternative Description	Present Value Damages	Average Annual Damages	Present Value Recreation	Average Annual Recreation
1	No Action	$12,519,000	$464,000	$16,845,000	$624,000
2	River Mouth Relocation	$1,162,000	$43,000	$27,655,000	$1,024,000
3	Revetting and Vegetating the Bluff Face – Buried Toe	$751,000	$28,000	$27,655,000	$1,024,000
4	Revetting and Vegetating the Bluff Face – Weighted Toe	$751,000	$28,000	$27,655,000	$1,024,000
5	Protective Berm at the Bluff Toe	$1,162,000	$43,000	$27,655,000	$1,024,000
6	Structure Relocation	$2,830,000	$105,000	$16,845,000	$624,000

7.2 Alternative Plan Costs

Costs of the alternatives including those to construct and maintain the project are shown in Table 17. Each alternative has a cost estimate prepared by Cost Engineering. The total economic (NED) cost used in the benefit-cost analysis includes project first costs, interest during construction, and operations and maintenance expenses. Further discussion of costs can be found in the Economics Appendix and Cost Engineering Appendix.

The project first cost includes contingency, mobilization and demobilization, and bank stabilization, which includes the costs of excavation of bluff material, placement of excavated and imported soil, installation of rock, and erosion control fabric and vegetation. For the purposes of plan comparison and selection, a contingency of 20 percent as developed from the abbreviated risk analysis was consistently applied to each work feature. Project first costs also include costs for Lands, Easements, Rights of Way, Relocations, and Dredged Material Disposal Areas (LERRD); Preconstruction, Engineering, and Design (PED); construction supervision and administration; and cultural and archaeological site evaluations.

The total economic (NED) cost for each alternative includes the project first costs noted above as well as costs associated with interest during construction (IDC) and operations and maintenance. IDC assumes a 2-year construction window for alternatives 3 through 6 and a 4-year construction window for alternative 2. Operations, Maintenance, Repair, Replacement, and Rehabilitation (OMRR&R) assumes 10 percent of armor rock is replaced every 20 years. Alternative 2 (river mouth relocation) also includes annual maintenance dredging.

Table 17. Total Project Costs by Alternative

Alt.	Description	Project First Cost	Interest During Construction	Operations & Maintenance	Economic (NED) Cost	Average Annual Cost
1	No Action	$0	$0	$0	$0	$0
2	River Mouth Relocation	$424,769,000	$23,904,000	$145,693,000	$594,366,000	$22,016,000
3	Revetting and Vegetating the Bluff Face – Buried Toe	$51,429,000	$1,421,000	$1,606,000	$54,456,000	$2,017,000
4	Revetting and Vegetating the Bluff Face – Weighted Toe	$55,040,000	$1,521,000	$1,553,000	$58,113,000	$2,153,000
5	Protective Berm at the Bluff Toe	$31,333,000	$866,000	$1,562,000	$33,761,000	$1,251,000
6	Relocation	$39,299,000	$1,086,000	$0	$40,385,000	$1,496,000

Notes:

- Project First Costs are estimated at the October 2017 price level.
- Present value and average annual costs are calculated utilizing a 50-year project period of analysis and a Federal fiscal year 2018 discount rate of 2.750 percent.

7.3 With-Project Benefits

Each alternative provides a certain amount of relief from existing and expected future damages and inefficiencies. The differences between the expected level of damages and inefficiencies absent Federal action (without-project condition) and those that will occur under the various with-project conditions are benefits that accrue to the project. For all alternatives, except no action, while some damages to land, structures, and infrastructure occur, they would be mitigated through buyouts and relocations. Damages that occur in the future have been appropriately discounted with their year of loss.

7.3.1 Avoided Land Damages

Table 18 shows expected annual benefits of protecting land from erosion under each alternative. Note that no land damages are avoided under alternative 1 (no action) or alternative 6 (structure relocation) so no benefits are realized for these alternatives.

Table 18. Avoided Land Damages, by Alternative

Alternative	Average Annual Value
Alt. 1	$0
Alt. 2	$31,000
Alt. 3	$11,000
Alt. 4	$11,000
Alt. 5	$31,000
Alt. 6	$0

7.3.2 Avoided Structure Damages

Table 19 shows expected annual benefits of protecting structures from erosion under each alternative.

Table 19. Avoided Structure Damages, by Alternative

Alternative	Average Annual Value
Alt. 1	$0
Alt. 2	$359,000
Alt. 3	$359,000
Alt. 4	$359,000
Alt. 5	$359,000
Alt. 6	$359,000

7.3.3 Avoided Infrastructure Damages

Table 20 shows expected annual benefits realized by protecting infrastructure from erosion under each alternative.

Table 20. Avoided Infrastructure Damages, by Alternative

Alternative	Average Annual Value
Alt. 1	$0
Alt. 2	$31,000
Alt. 3	$67,000
Alt. 4	$67,000
Alt. 5	$31,000
Alt. 6	$0

7.3.4 Recreation Benefits

Table 21 shows incidental recreational benefits associated with each alternative. Note that alternative 1 and alternative 6 have no incidental recreational benefits, and the other alternative incidental benefits are consistent.

Table 21. Recreation Benefits, by Alternative

Alternative	Incidental Recreation Benefits
Alt. 1	$0
Alt. 2	$400,000
Alt. 3	$400,000
Alt. 4	$400,000
Alt. 5	$400,000
Alt. 6	$0

Note: Incidental recreation benefits utilized in the benefit-cost analysis comprise less than 50 percent of total benefits.

7.3.5 Net Benefits of Alternative Plans

Given the quantified benefits discussed above, the net annual benefits for each alternative are shown in Table 22.

Table 22. Summary of With-Project Benefits

Category:	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6
Land damages	$0	$31,000	$11,000	$11,000	$31,000	$0
Structure damages	$0	$359,000	$359,000	$359,000	$359,000	$359,000
Infrastructure damages	$0	$31,000	$66,000	$66,000	$31,000	$0
Avoided Damages	**$0**	**$421,000**	**$436,000**	**$436,000**	**$421,000**	**$359,000**
Recreation Value	$0	$400,000	$400,000	$400,000	$400,000	$0
Average Annual Benefits	**$0**	**$821,000**	**$836,000**	**$836,000**	**$821,000**	**$359,000**

Table 23 summarizes the benefits and costs for each alternative. As indicated below, no alternative analyzed in this study yields positive net annual benefits so there is no NED plan. The plan with the highest benefit-cost ratio is highlighted in yellow.

Table 23. Summary of Benefits and Costs, by Alternative

Alt.	Present Value Benefits	Average Annual Benefits	Economic (NED) Costs	Average Annual Costs	Benefit to Cost Ratio	Net Annual Benefit	Rank by Net NED Benefits
1	$0	$0	$0	$0	N/A	$0	1
2	$22,168,000	$821,000	$594,366,000	$22,016,000	0.04	-$21,195,000	6
3	$22,578,000	$836,000	$54,456,000	$2,017,000	0.41	-$1,181,000	4
4	$22,578,000	$836,000	$58,113,000	$2,153,000	0.39	-$1,317,000	5
5	$22,168,000	$821,000	$33,761,000	$1,251,000	0.66	-$430,000	2
6	$9,689,000	$359,000	$40,385,000	$1,496,000	0.24	-$1,137,000	3

Evaluation of benefits and costs for the given alternatives reveal that no alternative plan yields a benefit-cost ratio greater than 1. Alternative 5 has the greatest net annual NED benefits, other than

Alternative 1, No Action. The benefit-cost ratio associated with Alternative 5 is 0.66 with net annual NED benefits of negative $430,000.

In accordance with Section 116 Implementation Guidance, the identification of a plan is informed by a CE/ICA for the Other Social Effects (OSE) account, as detailed below.

7.4 Cost Effectiveness/Incremental Cost Analysis

This section summarizes the CE/ICA that was performed. Please see the Economics Appendix for a detailed discussion of the CE/ICA and OSE account.

Guidance was given to the USACE Pacific Ocean Division for the implementation of Section 116 Authorized projects as follows:

1. Each decision document will present the National Economic Development (NED) analysis for all viable alternatives and identify the NED Plan when alternatives exist with net positive NED benefits. If there is no NED Plan and/or the selection of a plan other than the NED Plan is based in part or whole on non-monetary units (Environmental Quality and/or OSE), then the selection will be supported by a CE/ICA consistent with established evaluation procedures (see ER 1105-2-100, Appendix E).
2. The decision document will present the tradeoffs of impacts in the four accounts for the plans contained in the final array and describe in detail the compelling justification for any plan that is not the NED Plan.
3. Non-monetary benefits that may be considered include such things as public health and safety; local and regional economic opportunities; and social and cultural value to the community. For each project, a decision document will be prepared that identifies a plan and complies with all applicable environmental laws, regulations, and policies. In addition, an ability to pay analysis will be conducted in accordance with existing Ability to Pay Guidance in the Final Amended Rule, Federal Register, (60 FR 5133), 26 January 1995 and included in the feasibility report.

The identification of a plan is based on CE/ICA for the Other Social Effects account, with plan selection also supported by a least cost analysis, as no alternatives had a benefit-cost ratio greater than one under NED analysis. Similar to how rugosity was chosen in coordination with the Corps Economic Center of Expertise (ECO-PCX) as the initial metric of analysis for CE/ICA in the Environmental Quality account, Stabilized Bluff Parcels was chosen in coordination with the Vertical Team as the metric for CE/ICA in the OSE account.

As the CE/ICA metric, stabilized bluff parcels was thought to directly address the project's problem statement that "coastal erosion at the mouth of the Kenai River … negatively impacts and continues to threaten commercial, municipal, and private property (land, structures, and infrastructure), as well as cultural and historical resources at Kenai, Alaska."

Stabilized Bluff Parcels are thought to:

- Protect against cultural vulnerability such as the loss of historical and archaeological sites. Please note that this component is extremely important to the analysis here.

Historical and archaeological resources are discussed throughout this integrated feasibility report and EA.

- Provide some environmental justice, as the coastal and riverine erosion primarily affects residents of Old Town Kenai.
- Provide residents of Old Town Kenai, and transient area users, greater safety.

Stabilizing the bluff would help preserve the social identity associated with Old Town Kenai residents and bluff residents specifically. Primarily, this identity is recognized by the larger Kenai community, but it is also recognized by many others around the state of Alaska. While the mouth of the Kenai River is famous even outside Alaska, the type of people who live there may not be well known beyond the borders of the state. Many residents of the state of Alaska recognize that the City of Kenai is very diverse and that the people of Kenai are proud of the city's history, opportunities for recreation, inherent beauty, and world-class natural resources. Protecting the bluff provides resiliency in protecting the city's diversity, recreational opportunities, beauty, and access to resources.

Figure 29 compares each alternative's average annual economic (NED) cost to the number of parcels protected under each alternative. Please note that the costs were so high for Alternative 2 that they are actually off the chart:

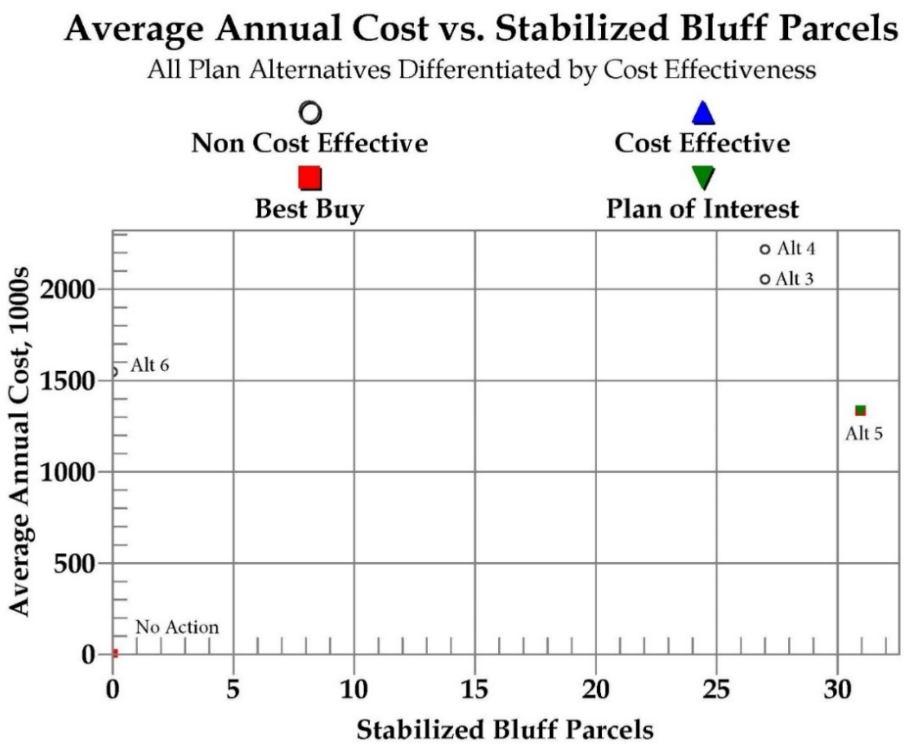

Figure 29. Cost Effectiveness for Stabilized Bluff Parcels

Table 24 shows bluff parcels protected and average annual cost by alternative.

Table 24. Cost Effectiveness/Incremental Cost Analysis Criteria

CE/ICA Criteria	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6
Stabilized Bluff Parcels	0	31	27	27	31	0
Annual Cost ($1000's)	$0	$22,016	$2,017	$2,153	$1,251	$1,496

Based on the CE/ICA, Alternative 5 is the only cost-effective plan and provides the best buy – meaning it protected the most parcels at the least cost. Because of this, no incremental cost analysis was needed. Under Alternative 5, 31 bluff parcels are protected at an average annual cost of approximately $1.3 million.

7.5 Summary of Accounts and Plan Comparison

7.5.1 National Economic Development

While there is no NED plan, Alternative 5 has the highest net annual NED benefits and benefit-cost ratio of the alternatives considered. The benefit-cost ratio for Alternative 5 is 0.66 with net annual NED benefits of negative $430,000.

7.5.2 Regional Economic Development

Economic benefits that accrue to the region but not necessarily the nation include increased income and employment associated with the construction of a project at the bluff. Additionally, commercial businesses subject to erosion are expected to experience income/revenue losses as a result of erosion. If erosion continues at the current rate, commercial activities will be disrupted as business owners and operators will eventually have to relocate their business or shut down completely. As a result, these businesses will experience a loss in income and the city/borough government will experience the loss of tax revenue.

Regarding construction spending, further analysis of regional economic benefits is detailed in the Economics Appendix and RED Addendum. The RED analysis includes the use of the regional economic impact modeling tool RECONS (Regional ECONomic System) to provide estimates of regional and national job creation, retention, and other economic measures such as sales, or value added.

7.5.3 Environmental Quality

Environmental Quality displays the non-monetary effects of the alternatives on natural and cultural resources and is described more fully in the environmental assessment sections of this report.

One of the major opportunities or enhancements that could be realized as a result of the proposed project is the restoration of degraded environmental functions and values in the project area, including establishment of an ecologically stable and functional streambank. Following Section 116 Implementation Guidance that allows for selection of a plan based in part or whole on non-monetary units in the Environmental Quality and/or OSE accounts, a rugosity index was proposed to evaluate the non-monetary effects of alternatives on ecological resources.

As a measure of complexity, rugosity is presumed to be an indicator of the amount of habitat available for colonization by benthic organisms (those attached to the seafloor), and shelter and foraging area for mobile organisms. The rugosity index was initially proposed as a CE/ICA metric; however, it did not meet the needs of the study, as habitat complexity was similar among alternatives so the index did not distinguish benefits. As such, a CE/ICA was conducted based on non-monetary units for the Other Social Effects account.

7.5.4 Other Social Effects

The OSE of each alternative are generally positive and beneficial, with the exception being the No Action Alternative. Alternative 5 protects the most parcels and structures in place, including historic and archaeological resources, resulting in a highly-beneficial OSE rating. Alternative 2 provides the same protection as Alternative 5 but at a substantially higher cost that is off the CE/ICA charts. Alternatives 3 and 4 protect slightly fewer parcels than Alternative 5 at higher cost and would require mitigation for historic and archaeological resources impacted at the top of the bluff. Alternative 6 provides some compensation to bluff residents through buyouts but provides no protection of parcels or structures in place and would do nothing to halt erosion.

7.5.5 Four Accounts Evaluation Summary

Based on the analysis of the four accounts, the plan for the Kenai Bluffs Bank Stabilization Feasibility Study is Alternative 5. Table 25 shows a summary of the four accounts for all alternatives, with the plan highlighted in yellow.

Table 25. Four Accounts Evaluation Summary

Alternative	Net Annual NED Benefits (B/C Ratio)	Average Annual Cost	EQ	RED	OSE
1. No Action	*$0* *N/A*	$0	Negative	Reduced employment and income for the region and state	Non-Beneficial
2	-$21,195,000 *(0.04)*	$22,465,000	Mixed	Increased employment and income for the region and state	Mixed
3	-$1,181,000 *(0.41)*	$2,067,000	Positive	Increased employment and income for the region and state	Beneficial
4	-$1,317,000 *(0.39)*	$2,206,000	Positive	Increased employment and income for the region and state	Beneficial
5	-$430,000 *(0.66)*	$1,251,000	Positive	Increased employment and income for the region and state	Highly-Beneficial
6	-$1,137,000 *(0.24)*	$1,534,000	Positive	Limited construction spending; Negligible changes in employment and income for the region and state	Mixed

7.5.6 Sensitivity Analysis

As in any planning process, some of the assumptions and input data used in this report are subject to complex social, economic, and natural variables. These assumptions and data are also prone to risk and uncertainty. The intent of this section is to test the sensitivity of alternatives to changes in the major variables used to compute project benefits. The value of this analysis is to reveal how the economic results might vary if inputs are applied differently; thereby providing insight into the amount of confidence in the economic analysis. A discussion of risk and uncertainty issues regarding key input variables follows.

7.5.6.1 Erosion Rate

Some additional damages to land, structures and other non-structural improvements, and infrastructure are anticipated when the erosion rate is increased from 3 feet to 4 feet per year. However, these changes do not have a large bearing on the NED analysis, especially as additional damages primarily occur near the end of the period of analysis. Increasing the erosion rate from 3 feet to 4 feet per year resulted in an approximately 0.05 increase in the benefit-to-cost (BCR) for the alternative with the highest BCR, Alternative 5.

7.5.6.2 Value of Land, Structures, Non-Structural Improvements, and Infrastructure

Assuming 3 feet per year of erosion, a sensitivity analysis was performed in which a 15 percent contingency was added to the value of all land, structures, non-structural improvements, and infrastructure in the erosion zone. This analysis yielded less than a 0.10 increase in the BCR of Alternative 5, which indicates that the value of these categories is not driving BCR changes. Since the value of these categories does not drive BRC change, the model developers determined it was not necessary to apply this analysis at the 4 feet per year erosion rate.

8.0 SELECTED PLAN

8.1 Description of the Selected Plan

Alternative 5 (Protective Berm at Bluff Toe) is the selected plan without any measures added from the other alternatives evaluated for this study. The berm is designed to prevent the higher tides from washing away the material that collects at the bluff toe and it prevents storm damage to the lower portion of the bluff. After berm construction, the bluff face will continue to erode and recede naturally, but the bluff face should reach a more stable condition over time as soil accumulates between the berm and the toe of the bluff creating a stable base. As the bluff face becomes more stable, vegetation on the bluff face should become more prevalent and established to further stabilize the bluff. It has been estimated that it will take up to 15 years to establish a stable 2H:1V slope; although the bluff face may not lay back this far since adjacent areas (not influenced by floodtides) tend to stabilize at a slope of approximately 1.5H:1V. As a result the land loss and other damages as the bluff recedes during the future with-project condition may be less than predicted in the Real Estate Plan (Appendix F) and below in Section 8.1.9. Relocation costs are not anticipated for the selected plan. A plan view of the approximate location of the berm footprint is shown in Appendix B (Figure 60) and Appendix F (Exhibit B-3). A typical cross section of the proposed berm is shown in Figure 28 and others in Appendix B (Figures 63 through 65).

8.1.1 Plan Components

The proposed rock-filled and armored berm (Figure 28) extends along the project length of approximately 5,000 feet of bluff (Figure 7). The general berm components and approximate amounts are in Table 26.

Table 26. General Berm Components

Component	Total Amount	Comments
Filter Fabric/Geotextile	250,000 square feet	Separation layer placed on native ground below berm approximately 50 feet x 5,000 feet
Gravel Base	13,100 cubic yards	Base rock placed on filter fabric
B Rock/Stone (Core Rock)	33,200 cubic yards	Approximately 600 pounds per stone for the west 1/3 of the berm that is most exposed by Cook Inlet, and 130 pounds per stone for each for the east 2/3 of the berm
Armor Rock/Stone	42,400 cubic yards	Approximately 1,280 pounds each stone for the west 1/3 of the berm that is most exposed by Cook Inlet, and 600 pounds for the east 2/3 of the berm

The crest elevation of the berm gradually decreases in height from west to east to account for the decrease in wave height as they move up the river and ice conditions (see Appendix B, Section 3.0 Design Parameters and Section 5.5, Figures 63 through 65). The river side toe of the berm is built up to provide launch material to fill potential scour holes.

8.1.2 Plan Costs and Benefits

Table 27 summarizes the benefits and costs for each alternative. As indicated below, no alternative analyzed in this study yields positive net annual benefits so there is no NED plan. Alternative plan 5 is plan with the highest benefit-cost ratio is highlighted in yellow.

Table 27. Summary of Benefits and Costs, by Alternative

Alt.	Present Value Benefits	Average Annual Benefits	Economic (NED) Costs	Average Annual Costs	Benefit to Cost Ratio	Net Annual Benefits	Rank by Net NED Benefits
1	$0	$0	$0	$0	N/A	$0	1
2	$22,168,000	$821,000	$594,366,000	$22,016,000	0.04	-$21,195,000	6
3	$22,578,000	$836,000	$54,456,000	$2,017,000	0.41	-$1,181,000	4
4	$22,578,000	$836,000	$58,113,000	$2,153,000	0.39	-$1,317,000	5
5	$22,168,000	$821,000	$33,761,000	$1,251,000	0.66	-$430,000	2
6	$9,689,000	$359,000	$40,434,000	$1,496,000	0.24	-$1,137,000	3

As shown in Table 27 above the evaluation of benefits and costs for the given alternatives reveal that no alternative plan yields a benefit-cost ratio greater than 1. As a result, and in accordance with Section 116 Implementation Guidance, plan selection was supported by a Cost Effectiveness/Incremental Cost Analysis (CE/ICA) in the OSE account. The selected plan was also supported by a least cost analysis that showed Alternative 5 is the least cost plan among alternatives with similar benefits as it provides the best buy – meaning it protected the most parcels at the least cost. Alternative 5 (Protective Berm at Bluff Toe) is the plan; which is supported by the non-Federal sponsor, the City of Kenai.

8.1.3 Construction Methodology

Typical construction practices will be used to transport and place the plan components for the berm. The rock for the project will likely be transported by barge from Granite Cove Quarry (previously called Shakmanof Quarry) on Kodiak Island or the Seward Rock Quarry near Seward. However, transporting rock by truck is a potential option if the rock originates in Seward. Road access to the construction area at the toe of the bluff is limited at this time by private property and lack of public roads to the base of the bluff. As a result, it is assumed that construction access will be by water, with a barge able to work the tides to off load equipment and materials and schedule construction at the base of the bluff. At this time, it is assumed that for berm construction, access to the top of the bluff is not required.

Construction can occur throughout the year with the exception that no in-water work will be performed during the period March 15 through May 15 to avoid potential disturbance to endangered Cook Inlet beluga whales during the period when they are most likely to be foraging within the Kenai River estuary. Other construction considerations include:

- Material storage locations at either end of the berm will require real estate coordination.
- Ice can close the river to vessel traffic for short periods from December to April.
- Considerable tide variation results in the majority of the beach fronting the bluffs being covered with water during high tides.
- Contractor will need to time his work to accommodate the tidal fluctuations.
- Soft soils in localized areas below the berm can hamper access to equipment and potentially cause localized settlement.

During the formation of plans and specifications, the method to access the site (by land, water, or both) will need to be determined for real estate coordination, cost estimate preparation, and potential additional National Environmental Policy Act (NEPA) coordination, if required.

8.1.4 Financial Self Certification

8.1.4.1 Ability to Pay

Financial Self Certification is required by the Section 116 Guidance authorizing this project. Additionally, projects carried out pursuant to Section 116 are subject to the ability of the non-Federal interest to pay; therefore, while the regulations (33 CFR 241) only discuss that ability to pay tests are required for flood control projects, in this instance, it is also required for this bank stabilization project. The Non-Federal Sponsor provided a Self-Certification of Financial Capability for Decision Document statement stating they are aware of the financial obligation of the non-Federal sponsor of the selected plan, and the financial capability to satisfy their obligations. This certification is a separate document as part of the final report submittal package.

For the Kenai Bluffs Bank Stabilization project, no reduction in cost sharing is available. Please see the Economics Appendix for further details on this analysis.

8.1.4.2 Sponsor Capability

The City of Kenai is a fully capable sponsor for acquiring the required lands, easements, and rights-of-way (See Exhibit "A" to Appendix F - Sponsor Real Estate Acquisition Capability Assessment). The Sponsor has professional experienced staff and legal capability to provide all lands, easements, and rights-of-way required for project purposes. The city has been advised of P.L. 91-646 requirements; which, in part, are to provide for uniform and equitable treatment of persons displaced by Federal and federally assisted programs; and they have been advised of the requirements for documenting expenses for LERRD crediting purposes.

8.1.5 Operations, Maintenance, Repair, Replacement, and Rehabilitation

It is not anticipated that there will be a significant loss of stone from the structure over the period of analysis. It is estimated that approximately 4,200 cubic yards of armor stone will need to be replaced every 20 years. These values are a reflection of general conditions seen for construction of similar structures in this region. The present value of Operations, Maintenance, Repair, Replacement, and Rehabilitation (OMRR&R) costs for the plan over the 50-year period of analysis are approximately $1.5 million. The average annual OMRR&R cost is $58,000. All OMRR&R will be the responsibility of the non-Federal sponsor.

8.1.6 Avoidance and Minimization

1. In its Fish and Wildlife Coordination Act Report (USFWS 2016c), the USFWS recommended the following general avoidance and minimization measures, which will be adopted by the USACE: The USACE will conduct a pre- and post-construction assessment of the intertidal mud flat environment in the vicinity of the project site. The USACE has determined that only minimal impacts to the Kenai River ecosystem will be realized by altering 8.25 acres of marginal mudflat habitat to hard bottom habitat, as the mudflat in the direct footprint of the proposed alternative has been shown to be of diminished functions and values (i.e., low benthic productivity and low usage by wildlife resources in the area). However, the USFWS is concerned about potential negative impacts to mud flats identified elsewhere in the area, such as across the river at Chinulna Point. The assessment should evaluate intertidal community in the vicinity of the proposed project to determine whether or not the intertidal environments have been altered from their preconstruction condition. The USACE will work with the USFWS develop performance criteria to assess success or failure based on the surveys. If it is determined the intertidal environment was negatively affected by the project, the USFWS will coordinate with the USACE and provide recommendations for remediation.

2. The USACE will comply with USFWS land clearance timing guidelines for the region to reduce the potential for take of migratory birds through the destruction of active bird nests, eggs, or nestlings, from project activities.
3. The USAC will conduct a survey for bald eagle nests within 0.25 mile of the project, and comply with published USFWS guidelines (USFWS 2009a) if a potential nest site is identified.
4. The USACE will comply with timing restrictions on in-water work and any other measures that may be recommended or stipulated by the NMFS or the ADFG. The USACE has proposed to suspend in-water work during the period March 15 through May 15 to protect Cook Inlet beluga whales (USACE 2016a), and is awaiting concurrence from the NMFS.

The USACE will also implement the following measures:

1. Workers conducting in-water construction will be instructed to watch for marine mammals and cease work if a marine mammal approaches within 50 meters.
2. Project vessels will be limited to a speed of 8 knots within the river, where consistent with safe navigation and ship-handling, to reduce the risk of collisions with protected species.
3. The selected contractor will include an Oil Spill Prevention and Control Plan in its Environmental Protection Plan, which is submitted to the USACE for review and approval.

8.1.7 Compensatory Mitigation

No wetlands or other special aquatic sites, or valuable habitat areas, will be destroyed or degraded in the course of this project. The USACE, therefore, does not propose compensatory mitigation for this project, and none has been recommended by the USFWS or other resource agencies.

The USACE accepts the recommendation in the USFWS CAR to perform pre- and post-construction surveys of the intertidal mud flat communities in the project vicinity in order to document any changes to the local mud flat ecosystem.

8.1.8 Integration of Environmental Operating Principles

Environmental operating principles have been integrated into the planning process wherever possible. Specific considerations are included below.

Foster sustainability as a way of life throughout the organization: This project seeks to protect the lifestyle of the citizens of rural Alaska. Prevention or reduction of bluff erosion at Kenai directly and positively impacts the community’s social connectedness, identity, and resiliency.

Proactively consider environmental consequences of all USACE activities and act accordingly: Environmental consequences were considered throughout the planning process and every effort has been made to avoid, minimize, or mitigate all anticipated impacts. These actions included early and continuing coordination with the USFWS, the NMFS, and the ADFG, to include an interagency site visit in April 2016 and initiation of Fish and Wildlife Coordination Act consultation. Coordination with resource agencies has led to the integration of the avoidance and mitigation measures listed in section 8.1.6 into this report.

Create mutually supporting economic and environmentally sustainable solutions: The selected plan provides the maximum amount of benefits to the nation among the alternatives considered, as encapsulated by the NED analysis, least cost analysis, and the analysis of the Other Social Effects, Environmental Quality, and Regional Economic Development accounts. The selected plan is the least cost and environmentally acceptable alternative among plans with similar NED benefits. The alternative was formulated in a way that makes it lasting, requiring very little in maintenance, and avoids long-term environmental impacts wherever possible.

Continue to meet our corporate responsibility and accountability under the law for activities undertaken by the USACE that may impact human and natural environments: A full environmental assessment was conducted as required by the National Environmental Policy Act. In addition, the principles of avoidance, minimization, and mitigation were enacted to the extent possible.

Consider the environment in employing a risk management and systems approach throughout the life cycles of projects and programs: For this study, a systems approach was utilized to examine the interaction between marine, estuarine, and freshwater habitat units and to formulate the selected project alternative in a way that avoided impacts that would sever or otherwise disrupt those relationships. Informal consultation with the NMFS and a review of the literature revealed the highly seasonal use of the Kenai River estuary by the endangered Cook Inlet beluga whale, which has led to seasonal avoidance measures which will be adopted both during construction and during subsequent operation and maintenance activities.

Leverage scientific, economic and social knowledge to understand the environmental context and effects of USACE actions in a collaborative manner: The USACE worked closely with other federal and state agencies, including SHPO, to develop an understanding of available environmental and cultural resource knowledge, and how these resources could be impacted by the project. The non-Federal sponsor provided insight into the other social effects. In addition, USACE utilized the results of numerous historical studies/investigation, including past USACE studies, to develop an understanding of the physical setting and how each structural alternative (i.e., Alternatives 2, 3, 4, and 5) would meet the objective of stabilizing the Kenai Bluffs bank.

Employ an open, transparent process that respects the views of individuals and groups interested in USACE activities: The USACE has followed all guidelines for public involvement and made every effort to be responsive to stakeholder concerns. Public input has been solicited throughout the study and used for both environmental and economic analysis purposes.

8.1.9 Real Estate Conditions

The project is located in the City of Kenai on the western coast of the Kenai Peninsula, fronting Cook Inlet. It is approximately 65 air miles and 155 highway miles southwest of Anchorage. LERRD necessary to implement this project includes fee simple lands already owned by the non-Federal sponsor, temporary work area easement, temporary or permanent road easements, and bank protection easements. The non-Federal sponsor owns the tides and submerged lands lying within Alaska Tideland Survey 272. Temporary staging/disposal areas are planned and land available on either end of the revetment reach, which will require temporary easements during construction. Lands, easements, relocations, rights-of-way, and disposal areas (LERRDs) required for construction include those listed below in Table 28.

Table 28. LERRDS

FEATURES	OWNERS	ACRES	INTEREST REQUIRED
Construction Boundary	9 parcels, City of Kenai 19 parcels, privately owned	35.94 9.66	Temp Work Area Easement for 3 years or until completion
Protective Berm (included in Construction Boundary	7 parcels, City of Kenai 11 parcels, privately owned	7.94 8.78	Bank Protection Easement
TOTAL PROJECT BOUNARY 45.60			

8.2 Risk and Uncertainty

As in any planning process, some of the estimates made in this report are uncertain. Elements of risk and uncertainty could affect the design and performance of the project, cost, and benefits. An ongoing effort to address risk has been made throughout the study process. The major risk elements associated with the plan design and performance are summarized in Table 29.

Table 29. Risk and Uncertainty Summary

Assumption or Estimate	**Risk Comment**
The Kenai Bluffs will become stable within 15 years of project construction.	Actual time to stabilize may vary across the bluff face due to varying erosion rates, which may depend on how well localized over land flow or water routing is managed or controlled, and other factors either natural or manmade (e.g., foot traffic or other disturbances on the slope).
The design assumes that the seepage layer will be buried with sand as it accumulates on the slope minimizing it impact to erosion.	Groundwater seepage, as an erosion mechanism, may continue to be a factor influencing bluff stabilization.
Overland flow, a known erosion mechanism across the bluff is not mitigated by the plan; however, it may be a minor impact if localized/concentrated overland flow is managed where found necessary.	Overland flow appears to erode the bluff in localized areas, which will have to be monitored and mitigation measures proposed if necessary as the bluff recedes.
River remains relatively ice free during construction. Ice can close the river to vessel traffic for short periods from December to April.	Ice can influence construction schedule.
Beluga whales maybe present between March 15 and May 15. Disturbance of beluga whales, when present, needs to be avoided.	No in-water work will be performed during the period March 15 through May 15 to avoid disturbance to endangered Cook Inlet beluga whales during the period when they are most likely to be foraging within the Kenai River estuary.
The tide variation at this site results in the majority of the beach fronting the bluffs being covered with water during high tides.	The contractor will need to time his work to accommodate the tidal fluctuations.
The beach fronting the bluffs varies between stiff material and areas with soft soils.	The contractor will need to consider this when planning access to the site along the beach.
Site will be accessed by water. Access to the site is limited by tide levels, material at the base of the bluff, and privately owned real estate at the top of the bluff.	A barge should be able to work the tides and off load equipment and materials. An intermediate bench may be needed to aid in construction equipment and material storage. Real estate coordination required for the project.

8.3 Implementation

The plan would meet the planning objectives over time that results in a stable bluff over a 3 to 15 year period. There is not much uncertainty surrounding construction activities; however, there will be additional contingency planning when scoping the Preconstruction Engineering and Design (PED) phase. The USACE has more than adequate experience in the design and construction of the plan. This project has multiple local rock sources that could provide material to the project. The non-Federal sponsor has the capabilities to maintain the berm.

No life safety considerations after implementation have been identified during this study. The structure does not retain water and in the unlikely event of a catastrophic failure there is no downstream infrastructure or structures to impact, and site conditions would be no worse than the FWOP condition.

8.3.1 Schedule

The proposed milestone schedule through construction notice of completion is shown in Table 30.

Table 30. Proposed Milestone Schedule

Milestone Name	Milestone Code	Date
Directors Report	CW170	12 Jan 2019
Sign Design Agreement	CW130	May 2019
Receive Appropriation for Design	CW300	May 2019
Plans and Specifications Approval	CW330	Jul 2020
Sign Partnership Agreement/ Ready to Advertise (RTA)	CW400	Aug 2020
Construction Contract Notice to Proceed	CW440	Nov 2020
Notice of Completion	CW480	Nov 2022

8.3.2 Cost Sharing

The certified estimated FY19 project first cost with contingency is $40,294,000. Please note that while this cost has been updated to FY19 (October 2018) price levels, the costs for other alternatives and for the selection of the plan remain at estimated FY18 (October 2017) price levels. The Federal share of the project first cost is estimated to be $26,191,000 and the non-Federal share is estimated to be $14,103,000, which equates to 65 percent Federal and 35 percent non-Federal. The non-Federal costs include the value of LERRDs estimated to be $1.9 million, which is eligible for credit. Table 31 shows preliminary cost sharing estimates.

Table 31. Cost Sharing Summary

Item	Project First Cost	Federal (65%)	Non-Federal (35%)
Project First Cost (excluding LERRDs)	$40,294,000	$26,191,000	$12,247,000
LERRDs			$1,856,000
Total	**$40,294,000**	**$26,191,000**	**$14,103,000**

9.0 ENVIRONMENTAL CONSEQUENCES OF THE SELECTED PLAN

9.1 Physical Environment

9.1.1 Climate

The selected plan will have no impact to climate.

9.1.2 Geology

The selected plan, a rock berm at the bluff toe, will cover approximately 8.25 acres of the silty sand sediments in the intertidal zone.

9.1.3 River Sediment Transport

River sediment transport effects on the Kenai Dunes and sandbars were assessed through a study performed by the University of Alaska Anchorage (UAA) (Smith et al. 2001). That study concluded that the Kenai Dunes beach as sustained by wave-induced accretion and sand replenishment from prevailing on shore winds, which balance erosion by river currents, winds and other forces, and that there would still be a large sediment surplus to the river mouth area to sustain the beach dunes if the bluff erosion is stopped, even if there is some uncertainty in the sediment transport rates estimated by the UAA study.

9.1.4 Bathymetry

The protective berm will have limited effect on the river bathymetry beyond the footprint of the berm. The berm will only be wetted during a flood tide when it is serves as a coastal structure. At low tide, the berm has no effect on the river morphology as the berm does not touch the river.

9.1.5 Ice Conditions

The design should have no impact to the seasonal river or inlet ice conditions experienced at the river mouth.

9.1.6 Water Quality

The berm will be constructed of clean, durable rock from an established quarry to be identified by the contractor; rock with mineral characteristics that may contribute to acid leaching will be avoided. Construction work performed in-the-dry on top of the compacted silty sand at the project site is unlikely to mobilize significant quantities of sediment. Even if material is placed while the project site is awash, the project is unlikely to loft a significant amount of the dense native sediments into the water column. The earth-moving activities necessary for the revetment alternatives, especially the regrading of the bluff face, have a much greater potential for introducing sediment into the river water, and will need to be attended by appropriate best management practices (BMPs). The finished selected plan will trap soil eroding from the bluff that would otherwise have ended up in the river and will therefore contribute to improved water quality within the estuary. The project's location on the edge of the estuary near the natural boundary of the bluff should cause it to have no discernable effect on river flow or tidal influence, and therefore, no effect on salinity profiles within the estuary or on other water quality parameters such as dissolved oxygen or nutrient concentrations.

The operation of construction machinery and tugs at the project site presents a potential risk for the release of fuel or lubricants into the intertidal zone and marine environment during construction. This risk would end once project construction was completed. As described in Section 8.1.6, the contractors would be required to prepare and implement spill prevention plans to minimize the risk of this impact.

9.1.7 Air Quality

In the short term, air quality in the immediate project area will be affected by emissions from project construction. The proposed construction activities will involve primarily the use of diesel powered, land based heavy construction equipment and haul trucks. The associated air pollutants of primary concern would be nitrogen oxides, sulfur dioxide, and particulate matter less than 10 microns in diameter from diesel fuel combustion and carbon monoxide from gasoline combustion. The selected plan will create little in the way of fugitive dust emissions, as no earth-moving is anticipated, and the work site would be regularly wetted by the rising and receding tide. The main source of fugitive dust emissions will be from the transport and placement of the berm materials. The alternatives that include cutting and filling of the bluff face will additionally need to address fugitive dust from the earth-moving activities, especially as the exposed soils on the upper bluff face are already prone to being moved by the wind. Collectively, construction related emissions will be temporary and intermittent, and will stop at the end of the construction period. Air quality in the Kenai area is not expected to be impacted significantly by the construction, and National Ambient Air Quality Standards are unlikely to be exceeded. The project is not in a CAA non-attainment area, or maintenance area defined in the Alaska State Implementation Plan (SIP). Air quality calculations are not required, and neither a conformity determination nor a Record of Non-Applicability (RONA) are necessary.

The completed project will not install any new emission sources or encourage the placement of emission sources in the project area, and should have no long-term adverse impact on air quality in the Kenai area. As the upper bluff stabilizes and revegetates naturally as planned, particulates lofted from exposed soils along the upper bluff by the wind should be reduced.

9.1.8 Noise

The project will generate noise above background levels, from the operation of construction machinery and the transport, unloading, and placement of rock and other fill material. Residences and businesses near the top of the bluff are within a few hundred feet of the project area, but may be shielded from much of the construction site noise by the intervening bluff. The transport of rock by truck through Kenai streets to the project may have the potential to affect the most residents through noise and disturbance. The City of Kenai municipal code does not contain specific ordinances regulating noise from construction activities; the USACE will work with the community to devise work schedules and heavy equipment traffic patterns that minimize noise and disruption within the community.

Water-propagated noise and its effects on marine life are discussed in subsequent sections.

9.1.9 Currents and Tides

The selected alternative will serve as a coastal structure and will only be wetted during flood tide events. During this time the river velocity is reduced or negated so the project will have little to no effect on river or tidal currents during the period when the berm is reached by flood tides.

9.1.10 River Flow Rate

The selected alternative will have no effect on river flow rates.

9.1.11 Biological Resources

9.1.11.1 Vegetation

The finished selected plan will have little or no effect on either upland or intertidal vegetation, as little exists in the current project area. The project footprint of the berm or revetment alternatives is essentially devoid of established vegetation, except where cutting and regrading of the bluff (alternative 2a) will remove already-imperiled upland vegetation along the edge of the bluff. The greatest potential impact to upland vegetation will be due to construction of an access road entering the project area from the east. The likely route for such a road will be just north of Pacific Star Seafoods. The land there is highly disturbed from some previous earth-moving activity, but hosts a discontinuous, re-emergent growth of willow, balsam poplar, spruce, and typical forbs. A construction access road from the west will be routed to avoid existing sea grass dunes and estuarine vegetation associated with Cemetery Creek.

The stabilized bluff slope will eventually see natural revegetation by grasses, native pioneer forbs such as fireweed, and shrubs such as alder and willow. The gap between the berm and the bluff face, after it fills with eroded soil from the bluff, will in particular create a stable, sheltered microenvironment for native vegetation.

9.1.11.2 Invertebrates

As discussed in Section 3.9.2 above, attempted sampling in 2003 (USACE 2003a) and USACE observations in 2016 suggest that intertidal sediments within the project footprint are highly compacted and harbor few if any benthic invertebrates; the project will have little or no impact on benthic invertebrates such as mollusks and polychaetes in the project area. The finished berm or revetment alternatives are not expected to have a discernable impact on river currents, tidal influence, or sedimentation at the mouth of the Kenai River, and therefore, should have no effect on more productive intertidal communities in the project area.

There is no evidence that the project footprint possesses any valuable habitat elements for epibenthic invertebrates such as shrimp or isopods, and the completed project should not have an adverse effect on such organisms. Aquatic invertebrates that can tolerate exposure for limited periods of time (e.g., some species of isopods) may benefit from new habitat in the form of damp voids in the intertidal elevations of the rock berm or revetment. It is likely that the new rock structure, with its increased surface area and protective voids and crevices, may encourage a greater diversity of invertebrates able to exploit the new ecological niches. The lack of sessile invertebrates such as mussels and barnacles on existing rock surfaces at the project site suggests that significant colonization of the rock structure by such epilithic organisms is not likely. However, the new rock structure will create a “splash zone,” which currently does not exist at the project site, along the upper intertidal zone, which may potentially recruit new types of organisms.

9.1.11.3 Fish

The effects of the finished selected plan on fish and fish habitat are also discussed in detail below in section 9.2.2, Effects on Essential Fish Habitat. In the USACE’s assessment, the intertidal zone within the project footprint does not appear to offer valuable habitat elements for fish, such as food sources or cover. The new rock structure along the intertidal edge of the river will not adversely affect existing fish habitat nor impair the movement of fish. The coarse rock structure may, when submerged, provide some benefit to small or juvenile fish by creating eddies and pockets of lower velocity flow along its face, as well as refuge areas. The risk of fish being entrapped by the finished berm is very low, as the berm would be overtopped by only rare collusions of storm surge and extreme high tide. Depending on how the project is constructed, there is potential for fish to become stranded in pockets of water behind the unfinished berm as the tide recedes; the USACE will work with the contractor to minimize this risk.

9.1.11.4 Birds

The finished selected plan should have no long-term adverse effect on birds. Available observations suggest the bluff face and the intertidal zone below is used much less heavily by birds than some of the surrounding habitat. The tidal flats along Chinulna Point across the river from the project site are especially favored by gulls, shorebirds, and waterfowl, whereas these species are seldom seen foraging in the project footprint. The finished rock structure will provide potentially useful roosting habitat for bald eagles and some shorebirds, and perhaps nesting opportunities for winter wren and other ground-cavity nesting birds. Noise and movement at the project site during construction has the potential to disturb birds using the Chinulna Point mud flats and wetlands; however, the distance between the project footprint and the mud flats on the opposite shore is a minimum of about 1,000 feet. In addition, birds using Chinulna Point are likely somewhat habituated to some level of human noise and activity given the aircraft and boat traffic and industrial activity in the area. Potential effects on nesting bald eagles are addressed below.

9.1.11.5 Mammals

Few if any terrestrial mammals use the project site, so impacts will be negligible. Any mammals using adjacent habitat, such as Chinulna Point that are disturbed by construction activity will be able to withdraw temporarily to similar habitat farther up the river until the construction activity has ended. Effects on marine mammals are addressed below.

9.2 Protected Species

9.2.1 Endangered Species Act

The only species listed as endangered or threatened under the ESA likely to be found near the project site is the Cook Inlet beluga whale. Section 3.10 listed five primary constituent elements (PCEs) identified in the critical habitat designation for the Cook Inlet beluga whale (NMFS 2015); the potential project effects are described below for each PCE.

1. *Intertidal and subtidal waters of Cook Inlet with depths less than 30 feet mean lower low water (MLLW) and within 5 miles of high and medium flow anadromous fish streams.* The project site meets the definition of this PCE, but the narrow intertidal bench along the toe of the eroding bluff does not appear to offer any features of particular ecological value to beluga whales. The boulders and chunks of concrete debris littering the existing proposed project site pose a small but plausible risk of injury or entrapment to a beluga whale that found itself at the base of the bluff during a receding tide, a risk that the proposed berm would largely eliminate.
2. *Primary prey species consisting of four species of Pacific salmon (Chinook, sockeye, pink, and coho), Pacific eulachon, Pacific cod, walleye pollock, saffron cod, and yellowfin sole.* Of the primary prey species listed under PCE #2, the Pacific eulachon is probably the most significant for Cook Inlet belugas at the Kenai River. Eulachon prefer to spawn on sandy gravel bottoms in slow-moving waterways and can be found in streams of the Kenai watershed many miles from its mouth (ADFG 2016d). Eulachon are presumably not using the tidally-exposed compacted sandy silt substrate at the project site for spawning, but will be present at the site only in transit to more favorable spawning areas upstream. The proposed rock berm will not adversely affect eulachon habitat or the availability of migrating eulachon to foraging belugas.
3. *Waters free of toxins or other agents of a type and amount harmful to Cook Inlet beluga whales.* The conditions of PCE #3 would not be threatened by the proposed project. The rock used for the berm will be clean material obtained from an established quarry. The contractor will be required to prepare a spill response plan to prevent and quickly clean up any releases of fuels or other hazardous substances into the environment at the project site.
4. *Unrestricted passage within or between the critical habitat areas.* As noted previously, the proposed rock berm will occupy a narrow intertidal shelf along the north river bluff and not impinge upon the main river channel. The finished project will not restrict the movement of Cook Inlet beluga whales in and out of or within the Kenai River estuary to any degree. The presence of project support vessels such as barges or survey craft during the time that belugas are present in the river could conceivably affect beluga behavior, either through avoidance by the belugas themselves or through changes in the movement or distribution of prey species such as eulachon.
5. *Waters with in-water noise below levels resulting in the abandonment of critical habitat areas by Cook Inlet beluga whales.* The 2015 recovery plan for Cook Inlet beluga whales (NMFS 2015) identifies noise as a "threat of high relative concern" and includes "in-water noise below levels resulting in the abandonment of critical habitat areas" as PCE #5.

NMFS has used conservative thresholds of received sound pressure levels from broad-band sounds that may cause behavioral disturbance and injury. These conservative thresholds are applied in

MMPA permits and ESA Section 7 consultations for marine mammals to evaluate the potential for effects from noise, and are summarized in Table 32.

Table 32. NOAA Noise Effects Threshold

In-Water Acoustic Thresholds		
Criterion	**Criterion Definition**	**Threshold**
Level A	Injury	190 dB_{rms} – pinnepeds 180 dB_{rms} – cetceans
Level B	Disturbance – impulse noise (e.g., impact pile-driving)	160 dB_{rms}
Level B	Disturbance – non-impulse noise	120 dB_{rms} – cetceans
In-Air Acoustic Thresholds		
Criterion	**Criterion Definition**	**Threshold**
Level A	Injury	None established
Level B	Disturbance – harbor seals	90 dB_{rms}
Level B	Disturbance – pinnipeds other than harbor seals	100 dB_{rms}

All decibels referenced to 1μPa, and are based off root mean square (rms) levels.

9.2.2 Noise Generation at the Project Site

The major sources of noise associated with project construction will be:

a. Placement of core and armor rock
b. Movement and operation of land-based construction equipment
c. Operation of motor vessels in the river in support of construction

The project construction may generate both air-transmitted and water-transmitted noise, depending on the equipment used during construction and how rock material is transported to the site. The principle anticipated sources of air-transmitted noise are heavy construction machinery such as excavators, bulldozers, and dump trucks used to transport and place the various sizes of rock needed for the project. If rock material is delivered to the project site by barge and tugboat, then a source of water-transmitted noise will also be present. No pile-driving, blasting, or other activities generating percussive, high-amplitude noise are planned. The berm core material will be placed incrementally in lifts, and the large armor rock pieces are typically maneuvered into place with some care to avoid breakage, so little impact noise is anticipated.

The intensity of air-transmitted noise from on-land construction equipment is most often expressed in decibels weighted for the human-hearing frequency range (“A-weighted” decibels, or dBA), whereas water-transmitted noise intensity is generally expressed in unweighted decibels (dB). The A-weighting convention was developed for human health and safety and emphasizes the frequencies between 1 kHz and 6.3 kHz to simulate the relative response of human hearing. Table 33 shows typical averaged maximum (L_{max}) or time-weighted (L_{eq}) noise intensity levels generated by shore-based heavy construction equipment, expressed as dBA measured at a distances of 50 feet or 10 meters (33 feet; USDOT 2006; DEFRA 2005).

Table 33. Typical Air-Transmitted Noise Levels of Anticipated Project Construction Equipment

	Averaged measured L_{max} @ 50 ft (dBA)[a]	Measured L_{eq} @ 33 ft (dBA)[b]
Bulldozer	82	81-86
Dump Truck	76	79-87
Excavator	81	69-89
Front End Loader	79	68-82

a. USDOT 2006; b. DEFRA 2005.

Studies of the frequency ranges of construction machinery noise tend to measure sound pressure levels in a general range of 0.063 to 8 kHz (Roberts 2009; DEFRA 2005), but this may again represent an emphasis on human hearing and not the full range of frequencies generated by the equipment.

Air-transmitted noise levels generated by tugboat diesel engines are comparable to those of large construction equipment, generally 70 to100 dBA within 50 feet of the engine (Navy 1987; USACE 2011; Dyer & Lundgard 1983).

The on-land construction equipment is expected to be working "in-the-dry," either when the tide has receded from the project site, or on top of previously placed fill. A fair amount of information exists on the transmission of noise generated by aircraft into water more-or-less directly beneath the aircraft (Blackwell & Green 2002; Port of Anchorage et al. 2009), but the transmission of land-generated, air-transmitted noise into an adjacent waterbody is less well studied. The transfer of sound energy from air into water via sound waves striking the air/water interface at a shallow angle is generally understood to be poor (Zhang 2002); noise generated on land at an elevation not far above the surface of an adjacent water body will be to a significant degree reflected off of the water's surface and not transmitted into the water.

Sound energy can also be transmitted from ground-based sources into water via vibration. Vibration from non-impact construction machinery transmitted through the ground is typically very low frequency, in the 10-30 Hz (0.01-0.03 kHz) range (Roberts 2009).

If a tug-and-barge is used to deliver rock material to the project site, it will be present on a periodic basis when tide and current conditions allow the barge to be safely maneuvered into the estuary, unload in the project area, and safely depart. Tugboats may generate significant underwater noise, especially when maneuvering or holding a laden barge in position against a dock or the shore. During a 2001 acoustic survey of Cook Inlet (Blackwell & Green 2002), the highest level underwater broad-frequency noise recorded (149 dB re 1µPa, at a distance of 102 meters) was generated by a tugboat docking a gravel barge. The same tug/barge combination generated a maximum level of 125 dB re 1µPa at a distance of 190 meters when in transit. The underwater noise level generated by a tugboat can vary greatly with the size/horsepower of the tugboat engine and whether noise-reducing features, such as propeller cowlings, are present (USACE 1998). Diesel-powered tugs typically generate underwater noise at relatively low frequencies, roughly in the 0.02 to 1 kHz range (USACE 1998).

9.2.2.1 Project Noise Effects on Beluga Whales

Beluga whales have excellent hearing and are able to perceive an unusually wide range of frequencies, from 0.04 to 150 kHz (NMFS 2015). Peak sound perception for belugas is between 10 and 100 kHz, above the human peak hearing range (1 to 4 kHz) and above the frequency range of most industrial noise. The hearing sensitivity of belugas at the lowest end of their frequency range (e.g., 0.04 to 0.075 Hz) is poor (Blackwell & Green 2002). Beluga whales perceive sound primarily through their lower jaws as opposed to their ears (NMFS 2015); that, and the beluga's low profile when surfacing for air, presumably limits the degree to which they are affected by air-transmitted sound.

The NMFS has not established air-transmitted noise criteria for cetaceans. Because human and beluga peak hearing ranges do not overlap, A-weighted noise data for on-shore construction machinery cannot be interchanged with unweighted dB values for underwater noise with any confidence. The USACE assesses that air-transmitted noise from project on-shore construction activities will have a negligible risk of disturbing beluga whales that may be present in the Kenai River estuary, due to:

a. The poor transmission of sound energy from air to water when the noise source is situated at a shallow angle to the water surface.
b. The generally low amplitude and low frequency of construction machinery noise (consistently less than 100 dBA at 50 feet within a frequency range of 0.063 to 8 kHz).
c. The very low frequency of ground-transmitted vibration (0.01-0.03 kHz, below the lower frequency limit of beluga hearing perception).
d. The lack of percussive or impulse noise to be generated during construction.
e. The established presence of other upland noise sources immediately along the estuary, like canneries, parking lots, and boat launch ramps, such that beluga whales habitually using the estuary can reasonably be expected to have become acclimated to similar human activity.

The USACE assesses that the operation of a tugboat maneuvering a barge within the confines of the estuary has the potential to generate underwater noise approaching or in excess of the default disturbance threshold of 120 dB_{rms} re1µPa in a setting that may afford nearby belugas limited options for distancing themselves from the disturbance. Observations of Cook Inlet belugas near the Port of Anchorage suggest that they may become tolerant of routine vessel noise, such as tugboats docking with barges and cargo ships transiting Knik Arm (USACE 2009b). However, it is unclear how accustomed Cook Inlet belugas may be to vessel noise and traffic during their March-May use of the Kenai River estuary, when human activity is relatively low, or how they may react to vessel caused disturbances within the confines of the estuary.

To avoid and minimize project impacts on Cook Inlet beluga whales, the USACE will implement following measures:

- No in-water work will be performed, and no large project vessels (e.g., barges and tugs) will operate, within the Kenai River estuary during March 15 through May 15, to avoid the period in which Cook Inlet beluga whales are most likely to be foraging within the Kenai River estuary.

- The Corps will establish a monitoring (shutdown) zone for all marine waters within a radius of 492 ft. (150 meters) of the vessel noise. The zone will be monitored by a dedicated, trained marine mammal observer (MMO). If marine mammals are observed approaching the intended route of any project vessel, the vessel will stop or slow, to the extent practical while maintaining control, and allow the animal(s) to pass. Vessels may also divert their heading towards the rear of the marine mammals' direction of travel.

- Vessel captains and crewmembers shall be trained to: [a] Assist with the detection of protected marine mammals; [b] Use binoculars to facilitate marine mammal observations; [c] Continuously scan the monitoring zone (492 ft. [150 meters]) while vessels are underway to help ensure that protected species do not enter the monitoring zone; [d] Implement mitigation measures.

- The Corps will ensure that pilots of the barges and tugs will have clear views of the monitoring zone (492 ft. [150 meters]) around each vessel to facilitate effective monitoring for marine mammals. These pilots will enforce the established monitoring zones.

- The Corps will ensure that barges will not travel at speeds exceeding 6 knots (7 miles per hour [mph]).

- The Corps will submit a monitoring report to NMFS (see Mitigation Measure 9) within 90 days after all in-water activity has ceased. The report will provide details about marine mammal observations and interactions that occurred during the construction of the protective rock berm. Monitoring reports and all instances of marine mammal take shall be provided to NMFS AKR Protected Resources Division, care of Barbara Mahoney at barbara.mahoney@noaa.gov (phone: 907-271-3448) and Greg Balogh at greg.balogh@noaa.gov (phone: 907-271-3023).

- The selected contractor will include an Oil Spill Prevention and Control Plan in their Environmental Protection Plan, to be submitted to the Corps for review and approval.

With the adoption of the avoidance and minimization measures listed above, the USACE determines that the proposed project <u>may affect, but is not likely adversely affect</u>, Cook Inlet beluga whales or their critical habitat.

The USACE determines that the proposed project <u>will not affect</u> the ESA-listed short tailed albatross, as that species is not expected within the project area.

9.2.3 Marine Mammal Protection Act

Harbor seals are the one non-ESA marine mammal known to be regularly present in the project area. Harbor seals have excellent hearing underwater, but reportedly have reduced hearing sensitivity in air. On the other hand, harbor seals may be affected by air-transmitted noise to a greater degree than beluga whales because they spend significant periods of time out of the water. The in-air peak hearing range of harbor seals (1 – 22.5 kHz) overlaps that of the human peak hearing range (1 – 4 kHz), so the use of the A-weighted construction equipment noise levels provided in Table 33 is more defensible with harbor seals than with beluga whales. The typical equipment noise intensity levels in Table 33 (measured at 33 or 50 feet) are consistently below the 90 dB harbor seal disturbance threshold for air-transmitted noise (Table 32). Harbor seals have not been observed hauled out at the project site. Small numbers are occasionally seen hauled out on exposed mudflats directly across the estuary from the project site. Seals at this location would be no closer than 1,000 feet from project construction machinery and tugboat engines at the project site, and air-transmitted noise generated by these sources at the project site will have attenuated to well below the 90 dB disturbance threshold promulgated for harbor seals (Table 32).

Harbor seals swimming submerged may be affected by underwater noise generated by project tugboat engines. Available information suggests that harbors seals may be present in the Kenai River estuary year-round, so the avoidance measures based on the beluga whales' highly seasonal use of the estuary would not be as protective of harbor seals. On the other hand, the seal's smaller size, greater maneuverability, and ability to remove itself from the water increases its options for moving out of the range of disturbing underwater noise. Harbor seals present in the estuary year-round will also be accustomed to the heavy traffic of motorized recreational boats present in the lower estuary during salmon fishing season.

The USACE will avoid and minimize impacts to non-ESA marine mammals via the same measures stipulated above for Cook Inlet beluga whales.

The NMFS, during an informal consultation, suggested that an incidental harassment authorization (IHA) may be necessary for harbor seals if noise mitigation through tug engine shut-down is not feasible; however, the NMFS has not provided correspondence stating that the need for an IHA is probable. At this stage of the project, the USACE does not have the necessary level of information on project tug equipment and usage for an IHA to be developed, or to determine if an IHA is even necessary. In the USACE's assessment, the likelihood/risk of needing an IHA is very low. If conditions change sufficiently to require and IHA, there will be sufficient time and resources to complete the necessary process prior to construction. This issue will be revisited during PED, when more information is available on how rock and other materials will be transported to and placed at the project site.

9.2.4 Bald and Golden Eagle Protection Act

While no known bald eagle nest sites are known in the project vicinity, the potential exists for eagles to have established a nest site in one or more of the few large trees along the bluff. USFWS guidelines (USFWS 2009a) recommend maintaining a buffer of at least 660 feet between construction activities and a nest or communal roosting site, or avoiding construction during the bald eagle nesting period, to avoid a taking under this act. A "take" under this act can include any disturbances that "substantially interfere with normal breeding, feeding, or sheltering behavior." If disturbing an active nest or roosting site cannot be avoided, an Eagle Take Permit may be applied to authorize the disturbance.

The bald eagle nesting season can last from February into August, so timing the project construction to avoid that period would be impractical. Likewise, the project footprint could not be shifted to any meaningful extent to avoid disturbance to a hypothetical eagle nest. The USACE will conduct a pre-construction survey for bald eagle nests within 660 feet of the project area (to include access routes), and apply for a take permit if a nest site is discovered. Individual eagles perching along the top of the bluff in the course of foraging along the river are likely to be habituated to human activity on the river and in the developed area immediately adjacent to the bluff, and are unlikely to be disturbed by project activities to the level of a "take."

9.2.5 Migratory Bird Treaty Act

USFWS guidance (USFWS 2009b) on avoiding a take under the Migratory Bird Treaty Act centers on timing vegetation clearing to avoid typical nesting periods in which bird nests may be inadvertently destroyed. For the Kenai area, the USFWS advises that most nesting will occur during the period May 1 to July 15 for woodland, scrub, or open-land nesting birds.

The project will require very little vegetation removal, as little to no vegetation exists within immediate project area. An eastern access route adjacent to Pacific Star Seafoods may require some brush removal. To the extent practicable, the USACE will time any vegetation removal related to constructing an east access road to outside the advisory nesting period described above.

9.2.6 Special Aquatic Sites and Waters of the United States

The project will not affect wetlands, mud flats or other special aquatic sites because none exist within the project footprint, and existing drainages (e.g., Cemetery Creek) or other existing water flow patterns will not be altered. Access to the project site from the west via Kenai Beach Park may involve a temporary bridge or culvert over Cemetery Creek near its mouth. Such a structure should be able to avoid estuarine wetlands associated with Cemetery Creek; the USACE will ensure that any impacts are avoided or minimized. The USACE does not anticipate that the revetment or berm alternatives will significantly affect river currents, tidal influence, or sedimentation within the wider estuary; there should therefore be no discernable impact on the function of mud flats identified across the river at Chinulna Point.

9.2.7 Essential Fish Habitat

The Kenai River estuary is designated by the NMFS as containing essential fish habitat for all five species of Pacific salmon (NMFS 2016b); four species (Chinook, coho, sockeye, and pink) are known to carry out complete life-cycles within the Kenai River watershed. Features of EFH necessary for each salmon species are detailed in the fishery management plan for Alaskan salmon (National Pacific Fishery Management Council (NPFMC) 2012). While individual species preferences vary, in general these salmon species spawn in fresh water courses containing substrates of clean gravel or cobble, with eggs and larvae developing in the interstitial spaces of the substrate. The lower Kenai River estuary, and the project site in particular, do not contain appropriate habitat for salmon spawning or the rearing of young juveniles. Juvenile salmon use river estuaries to transition from freshwater to marine salinity levels and prey species, before entering the marine environment. Juvenile salmon typically spend 1 to 6 months in their estuary phase (NPFMC 2012). In the Kenai River estuary, the timing of smolt out-migrations varies by species, with juvenile sockeye reportedly peaking in late June and early July, but juvenile Chinook reaching their highest density in early August (ADFG 2004).

The replacement of the existing unvegetated substrate of dense silty sand, boulders, and debris within the project footprint along the base of the bluff with a rock structure will not remove or reduce any estuary habitat elements necessary to juvenile or adult salmon. The rock structure will not interfere with juvenile salmon access to rearing habitat provided by any of the three drainages entering the project area; the berm or revetment alternatives do not cross the Ryan Creek drainage and will be designed to accommodate fish passage and avoid entrapment. The structure will not impede the movements of in-migrating adult salmon. The additional rugosity afforded by the coarse rock structure may, when submerged, provide some benefit to juvenile fish by creating eddies and pockets of lower velocity flow along its face, as well as refuge areas. Some small fish may potentially be entrapped in the porous rock structure as the tide recedes.

The USACE determines that the proposed project will not adversely affect essential fish habitat.

9.3 Cultural Resources

9.3.1 Archaeological and Historic Structures

The selected plan will have no adverse effect on cultural resources, as none exist within the project area of potential effect. The USACE's most recent evaluation of effects on cultural resources and its determination of "no historic properties affected" (USACE 2016b) was based only on the scenarios of constructing a rock revetment or berm along the bottom of the bluff (Alternative 5), and not on the grading or reshaping of the bluff. The Alaska State Historic Preservation Officer (SHPO) concurred with the USACE's determination in a stamped concurrence dated July 20, 2016 (SHPO 2016). Allowing the upper bluff face to erode to its natural angle-of-repose is not a Federal undertaking on the part of the USACE under the National Historic Preservation Act, and the consequences of that natural erosion are not assessed here.

9.3.1.1 Subsistence Activities

The completed project will have no impact on subsistence, as no subsistence activities are conducted on the project site. Most of the intertidal portion of the project site is closed to the Kenai River personal use fishery. Dip net and other shore-based fishing along the more popular and accessible beach west of Cemetery Creek will not be affected by the completed project. Project construction of any of the alternatives has the potential to interfere with the personal use fishery, especially the need to use Kenai River Park as an access to the project site. The timing of project construction will need to be coordinated with the City of Kenai, the ADFG, and other stakeholders, if the fishing season cannot be avoided altogether. No other subsistence or personal use resources (e.g., shellfish) are identified at the project site.

9.4 Coastal Zone Resource Management

Alaska withdrew from the voluntary National Coastal Zone Management Program (http://coastalmanagement.noaa.gov/programs/czm.html) on July 1, 2011. Within the State of

Alaska, the Federal consistency requirements under the Coastal Zone Management Act do not apply to Federal agencies, those seeking forms of Federal authorization, and State and local government entities applying for Federal assistance.

9.5 Unavoidable Adverse Impacts

The principal unavoidable adverse impact would be the permanent alteration of habitat where the project is constructed. The existing habitat within the project footprint appears to be of marginal ecological value and in a continual state of disruption from the erosion and collapse of the river bluff. As the new habitat created by the rock structures is likely to be at least as productive as and more stable than the existing habitat, the “adverse” impacts will be negligible. The completed project is not anticipated to have any discernable effects on river flow patterns beyond the immediate project area or on tidal influence or the movement organisms within the river.

9.6 Cumulative and Long-term Impacts

Federal law (40 CFR 1502.16) requires that NEPA documents assess cumulative effects, which are the impact on the environment resulting from the incremental impacts of the action when added to other past, present, and reasonably foreseeable future actions.

The project is located near the mouth of the Kenai River. This area of the river remains largely in a natural state. The completed project will add to the degree of “hardening” of the outer bend of the Kenai River Estuary. Upstream of the proposed project small areas of riprap or other forms of revetment exist along the river bank from the city dock to Pacific Star Seafoods. No similar large projects are known to be planned for the future, although it is likely that some revetments fronting some existing development up river may need to be replaced. As a result of the proposed project location, there are no measureable cumulative impacts expected outside of the direct impacts already identified previously. The same holds true regardless of the alternative identified.

9.7 Comparison of the Effects of the Project Alternatives

Table 34 provides a qualitative comparison of the six project alternatives on the environmental factors examined in this chapter.

Table 34. Comparison of the Effects of the Project Alternatives

Environmental Consequences Component	Alternative 1 No Action Plan	Alternative 2 River Mouth Relocation	Alternative 3 Revetting, Buried Toe	Alternative 4 Revetting, Weighted Toe	Alternative 5 Protective Berm	Alternative 6 Structural Relocation
Climate	No effect	Negligible effect	Negligible effect	Negligible effect	Negligible effect	No effect
Geology	No effect	Negligible effect	Negligible effect	Negligible effect	Negligible effect	No effect
Sediment Transport	No effect	Potential significant effects	Negligible effect	Negligible effect	Negligible effect	No effect

Bathymetry	No effect	Potential significant effects	Negligible effect	Negligible effect	Negligible effect	No effect
Ice Conditions	No effect	Potential significant effects	Negligible effect	Negligible effect	Negligible effect	No effect
Water Quality	No effect	Potential significant effects	Negligible effect	Negligible effect	Negligible effect	No effect
Air Quality	No effect	Negligible effect	Negligible effect	Negligible effect	Negligible effect	No effect
Noise	No effect	Low-Moderate significant effects	Low-Moderate significant effects	Low-Moderate significant effects	Low-Moderate significant effects	No effect
Currents & Tides	No effect	Potential significant effects	Negligible effect	Negligible effect	Negligible effect	No effect
River Flow Rate	No effect	Potential significant effects	Negligible effect	Negligible effect	Negligible effect	No effect
Vegetation	No effect	Potential significant effects	Negligible effect	Negligible effect	Negligible effect	No effect
Invertebrates	No effect	Potential significant effects	Negligible effect	Negligible effect	Negligible effect	No effect
Fish	No effect	Potential significant effects	Negligible effect	Negligible effect	Negligible effect	No effect
Birds	No effect	Potential significant effects	Negligible effect	Negligible effect	Negligible effect	No effect
Mammals	No effect	Low significant effects	Negligible effect	Negligible effect	Negligible effect	No effect
ESA	No effect	Will affect, potential jeopardy determination	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	No effect
MMPA	Will not result in a taking	May result in a taking	Risk of taking under consultation	Risk of taking under consultation	Risk of taking under consultation	Will not result in a taking
Bald Eagles	No effect	Low risk of taking	Low risk of taking	Low risk of taking	Low risk of taking	No effect
Migratory Birds	No effect	Moderate risk of taking	Very low risk of taking	Very low risk of taking	Very low risk of taking	No effect
Special Aquatic Sites	No effect	Sig. loss of wetlands, mudflats	No significant impact	No significant impact	No significant impact	No effect

EFH	No effect	May adversely affect EFH	Will not adversely affect EFH	Will not adversely affect EFH	Will not adversely affect EFH	No effect
Cultural Resources	Potential adverse effects	Not likely to adversely effect	Not likely to adversely effect	Not likely to adversely effect	Not likely to adversely effect	Potential adverse effects

10.0 PUBLIC AND AGENCY INVOLVEMENT

10.1 Public/Scoping Meetings

A charrette was held 4-5 May, 2015. Officials from the City of Kenai, the Kenaitze Indian Tribe, resource agencies and representatives from the U.S. Army Corps of Engineers, Alaska District, Pacific Ocean Division, and Headquarters were present. During this meeting, the driving mechanisms of the erosion were discussed and various measures were considered and screened. In addition, initial alternatives were discussed, including the positive and negative potential effects of each.

The City of Kenai has conducted public meetings concerning this project. Local residents are in favor of the project, with funding remaining an issue to be resolved. Further coordination will be ongoing between the City of Kenai, USACE, State and Federal resource agencies, and residents in the area. Study progress and expected release of the draft report was discussed at the February 2017 City Council meeting. The report was released to the public concurrently with Agency Technical and Headquarters reviews in June 2017. The draft report was also posted on the Alaska District website to provide public access for review. The USACE and the City of Kenai coordinated to ensure interested parties were aware the report was available for review. Approximately 18 comments were received from the public and 3 from the Alaska Congressional Delegation during the NEPA public review process. All of the comments were supportive of the project. A public meeting was also held in Kenai on 6 July 2017 in an ongoing effort to fulfill the NEPA public review process.

10.2 Federal and State Agency Coordination

Agency correspondence and reports are included in Appendix G.

10.2.1 Relationship to Environmental Laws and Compliance

10.2.1.1 National Environmental Policy Act (NEPA) of 1969 (42 U.S.C. 4321 et seq.)

This Act requires that environmental consequences and project alternatives be considered before a decision is made to implement a Federal project. NEPA established the requirements for preparation of an Environmental Impact Statement (EIS) for projects potentially having significant environmental impacts and an Environmental Assessment (EA) for projects with no significant environmental impacts. This EA has been prepared to address impacts and propose avoidance and minimization steps for the proposed project, as discussed in the CEQ regulations on implementing NEPA (40 CFR 1500 et seq.). This document presents sufficient information regarding the generic impacts of the proposed construction activities at the proposed project to guide future studies and is intended to satisfy all NEPA requirements.

In accordance with NEPA and USACE regulations and policies, the EA and Finding of No Significant Impact (FONSI) was circulated for public and agency review.

The objective of the Federal Water Pollution Control Act of 1972, as amended by the Clean Water Act (CWA) of 1977 (Public Law 92-500), is to restore and maintain the chemical, physical, and biological integrity of the Nation’s waters. Specific sections of the CWA control the discharge of pollutants and wastes into aquatic and marine environments.

The specific sections of the CWA that apply to the proposed project are Section 404, addressing the discharge of fill material to waters of the United States, and Section 401, which requires certification that the permitted project complies with the State Water Quality Standards for actions within State waters. The enforcement agency for Section 404 is the USACE; the USACE does not issue permits to itself, but has prepared an evaluation of the effects of its proposed discharge under Section 404(b)(1), a copy of this evaluation is provided in Appendix A.

Section 401 of the CWA water quality certification was received from the State of Alaska Department of Environmental Conservation, and is included in Appendix G, Environmental Correspondence. The major action of the project invoking this regulation is the placement of rock on intertidal lands to construct the protective berm.

10.2.1.2 Rivers and Harbors Act of 1899 (33 U.S.C. 403 et seq.)

Section 10 of this Act prohibits the obstruction or alteration of navigable waters of the U.S. without a permit from the USACE. The USACE does not issue permits to itself, so no specific permit is required under this act.

10.2.1.3 Endangered Species Act of 1973 (16 U.S.C. 1531 et seq.)

The Endangered Species Act (ESA) protects threatened and endangered species by prohibiting Federal actions that would jeopardize continued existence of such species or result in destruction or adverse modification of any critical habitat of such species. The USACE is required to coordinate with both the USFWS and NMFS to identify what ESA-listed species under those agencies respective jurisdictions may be present in the project area. The USACE then assesses how the proposed Federal action may impact listed species and makes one of several determinations including: “No Effect,” “May Affect but Not Likely to Adversely Affect,” and “May Affect and Likely to Adversely Affect.” If the determination is “No Effect” then the action may proceed without consultation with NMFS. However, ESA Section 9 prohibitions will apply if an unanticipated take to a listed species occurs.

If the determination is “May Affect but Not Likely to Adversely Affect,” NMFS must be consulted. During consultation NMFS will review the Biological Assessment (if prepared by the USACE) and either concur with the determination, end the consultation process and allowing the project to proceed, or not concurring and recommending changes or mitigation measures to remove any adverse effects and ending formal consultation.

The USACE has determined in this document that the recommended project may affect, but not likely to adversely affect, Cook Inlet beluga whales, the only ESA-listed species likely to be near the project area. The NMFS has concurred with this determination in a draft Letter of Concurrence provided 2 March 2019.

10.2.1.4 Fish and Wildlife Coordination Act (16 U.S.C. 661 et seq.)

The Fish and Wildlife Coordination Act (FWCA) requires the USACE to consult with the USFWS whenever the waters of any stream or other body of water are proposed to be impounded, diverted, or otherwise modified. The act authorizes USFWS to take the lead in consultation, to conduct surveys and investigations to determine the possible damages of proposed actions on wildlife resources, and to make recommendations to the USACE regarding measures to prevent the loss or damage to wildlife resources, as well as the development and improvement of such resources. The USACE is authorized to transfer fund to USFWS to carry out these investigations. The USACE shall give full consideration to the reports and recommendations of the wildlife agencies and include such justifiable means and measures for wildlife mitigation or enhancement as the USACE finds should be adopted to obtain maximum overall project benefits.

The USACE invited USFWS, NMFS, and ADFG to engage in FWCA coordination in its initial round of correspondence and received a Coordination Act Report (CAR) from USFWS.

10.2.1.5 Magnuson-Stevens Fishery Conservation and Management Reauthorization Act of 2006, as amended (16 U.S.C. 1801 et seq.)

The Magnuson-Stevens Fishery Conservation and Management Act provides for the conservation and management of all fishery resources between 3 and 200 nautical miles offshore. The 1996 amendments to this act require regional fisheries management councils, with assistance from the NMFS, to delineate Essential Fish Habitat (EFH) in Fishery Management Plans (FMPs) for all managed species. EFH is defined as an area that consists of “waters and substrate necessary for spawning, breeding, feeding or growth to maturity” for certain fish species. Federal action agencies that carry out activities that may adversely impact EFH are required to consult with the NMFS regarding potential adverse effects of their actions on EFH. The USACE has evaluated the project against EFH descriptions provided in the Pacific Salmon FMP, and determined that the project will not have adverse effects on EFH.

10.2.1.6 Marine Mammal Protection Act of 1972, as amended (16 U.S.C. 1361 et seq.)

The Marine Mammal Protection Act (MMPA) provides protection to marine mammals in both State waters (within 3 nautical miles from the coastline) and the ocean waters beyond. As specified in the MMPA, USFWS is responsible for the management of polar bears, walrus, and sea otters; NMFS is responsible for all other marine mammals such as whales, porpoises, and seals. The

USACE is required to coordinate with these agencies on potential impacts to species covered by this act and must address these agencies' concerns and recommendations.

USACE ESA coordination with NMFS included discussions of MMPA species; the avoidance and minimization measures specified in the NMFS draft ESA Letter of Concurrence (provided 2 March 2019) are intended to apply to all marine mammals.

Migratory Bird Treaty Act of 1918, as amended (16 U.S.C. 703 et seq.)

The essential provision of the Migratory Bird Treaty Act makes it unlawful, except as permitted by regulations, "to pursue, hunt, take, capture, kill…any migratory bird, any part, nest or egg," or any product of any bird species protected by the convention. The USACE is required to avoid a taking under this act during construction of a project. Avoidance often takes the form of construction during windows that limit brush clearing or ground preparation to periods outside of typical nesting periods for protected birds or discouraging birds from nesting within the construction area using exclusion or scare devices.

No birds protected under the MBTA are known to nest on or along the bottom of the eroding bluff.

10.2.1.7 National Historic Preservation Act of 1966, as amended (16 U.S.C. 470 et seq.)

The purpose of the NHPA is to preserve and protect historic and prehistoric resources that may be damaged, destroyed, or made less available by a project. Under this Act, Federal agencies are required to identify cultural or historic resources that may be affected by a project and to consult with the SHPO when a Federal action may affect cultural resources.

The USACE has completed required coordination under Section 106 of the NHPA. The USACE made the determination in a letter dated June 21, 2016 that the plan would not affect historic properties; the SHPO provided a stamped concurrence dated July 20, 2016.

10.2.1.8 EO 12898 – Environmental Justice, and EO 13045 - Protection of Children from Environmental Health Risks and Safety Risks

Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Communities and Low Income Populations" requires the USACE to identify and address any disproportionately high and adverse human health effects of its programs and activities on minority and low-income populations.

The USEPA defines environmental justice as the fair treatment and meaningful involvement of all people, regardless of race, color, national origin, or income, with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Fair treatment means that no group of people, including a racial, ethnic, or socioeconomic group, should bear a disproportionate share of the negative environmental consequences of industrial, municipal, or commercial operations or the execution of Federal, State, local, or tribal programs and policies. The project is not immediately adjacent to any low-income or minority residential areas, and will occupy an area that is seldom used by any group. The USACE does not foresee that construction of the project will create disproportionate adverse effects on the more vulnerable elements of the community.

Executive Order 13045 mandates Federal agencies identify and assess environmental health and safety risks that may disproportionately affect children as a result of Federal policies, programs, activities, and standards (63 Federal Register 19883 – 19888). The project would not result in short or long-term actions that would disproportionately affect the safety and health of children.

10.2.1.9 EO 13112 – Invasive Species

Section 2(a)(3) of Executive Order 13112 - Invasive Species (February 3, 1999) directs Federal agencies to "not authorize, fund, or carry out actions that it believes are likely to cause or promote the introduction or spread of invasive species…" The project is expected to utilize quarried rock and locally-contracted heavy machinery and barges. Therefore, the risk of introducing invasive species to the site is minimal. The project is not anticipated to cause or promote the spread of invasive species.

10.2.1.10 EO 13186 – Migratory Birds

Similar to actions taken under the Migratory Bird Treaty Act of 1918, as amended, the USACE will assess construction access and laydown areas once those are identified by the contractor for their potential as bird nesting habitat and apply timing windows or exclusion methods where applicable. The project is not expected to have a significant impact on migratory birds.

10.2.1.11 EO 11990 – Protection of Wetlands

Executive Order 11990 (Protection of Wetlands) requires the USACE, and other Federal agencies, to evaluate the likely impacts of their proposed actions in wetlands. The objectives of the Executive Order are to avoid, to the extent possible, the long-term and short-term adverse impacts associated with occupancy, modification, or destruction of wetlands, and to avoid indirect support of development and new construction in such areas, wherever there is a practicable alternative.

The objectives of Executive Order 11990 have been considered in the formulation of plans for this project. The following determinations have been made in response to requirements of Executive Order 11990, which pertains to wetland management. Wetlands are defined under the Clean Water Act as "areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas."

There are no jurisdictional wetlands within the project area, and therefore, no impacts to wetlands would occur. The project does not conflict with applicable State and local standards concerning wetland protection and permitting. The project will not significantly affect the natural and beneficial values of adjacent wetlands, and no wetlands will be permanently filled. The project has avoided impacts to adjacent wetlands, and therefore, mitigation to ensure no net loss of wetlands is unnecessary. The project is therefore in compliance with Executive Order 11990.

10.2.1.12 Clean Air Act of 1963, as amended (42 U.S.C. 7401, et seq.)

Activities due to construction, operation, and maintenance of the project include: surface disturbances, construction equipment movement, and vehicle traffic including some government vehicle traffic used during monitoring and inspection activities. None of these activities are expected to produce any pollutants in quantities that would exceed Federal thresholds. The project is not in a Clean Air Act non-attainment area, or maintenance area defined in the Alaska State Implementation Plan (SIP). Air quality calculations are not required, and neither conformity determination nor a Record of Non-Applicability (RONA) is not necessary.

10.2.2 Status of Project Coordination

As of November 2018, coordination activities with major resource agencies were ongoing and described in the sections below.

10.2.2.1 National Marine Fisheries Service.

The USACE provided an initial ESA determination letter to the NMFS in July 2016, making a determination of “may affect but not adversely affect” for Cook Inlet beluga whales. Barbara Mahoney of the NMFS responded by telephone requesting additional information on potential project noise effects on beluga whales and harbor seals. The USACE provided a further noise effects assessment to the NMFS in October 2016, which led to further informal consultation on ESA and MMPA, and a discussion on avoidance/minimization measures for harbor seals. Seasonal avoidance such as is proposed for beluga whales would not be effective for harbor seals. The major disturbance to harbor seals would be noise from a tug-boat delivering a barge-load of rock to the worksite; shutting down the tug engines to stop the noise if harbor seals approached would be unsafe, so a work shut-down radius is not an avoidance option. An incidental take authorization (IHA) may be necessary in the absence of effective avoidance measures, but the USACE has not developed the necessary level of information as to the magnitude and frequency of effects to pursue an IHA. This issue will be revisited during PED, when more information is available on how rock and other materials will be transported to and placed at the project site.

10.2.2.2 Alaska Department of Fish and Game.

The USACE has coordinated this project with the ADFG Kenai Office, and they have been included in the FWCA process. The project will need one or more Fish Habitat Permits from the ADFG. The ADFG has stated that they wish further information on the project and how it would be carried out (e.g., delivery of rock by barge or truck) before a Fish Habitat Permit will be issued. This information may not be available until after the feasibility process is complete.

10.3 Status of Environmental Compliance (Compliance Table)

Status of environmental compliance with relevant Federal statutory authorities is summarized in Table 35.

Table 35. Summary of Relevant Federal Statutory Authorities

Federal Statutory Authority	Compliance Status
Clean Air Act, as amended	FC
Clean Water Act of 1977, as amended	FC
Coastal Zone Management Act of 1982	N/A
Endangered Species Act of 1973, as amended	PC
Environmental Justice (Executive Order 12898)	FC
Fish and Wildlife Coordination Act, as amended	FC
Invasive Species (Executive Order 13112)	FC
Marine Mammal Protection Act	PC
Marine Protection, Research, and Sanctuaries Act of 1972	FC
Migratory Bird Treaty Act of 1918	FC
Magnuson-Stevens Fishery Conservation and Management Act	FC
National Environmental Policy Act of 1969, as amended	FC
National Historic Preservation Act of 1966, as amended	FC
Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Communities and Low Income Populations (Executive Order 12898)	FC
Protection of Children from Environmental Health Risks and Safety Risks (Executive Order 13045)	FC
Protection of Migratory Birds (Executive Order 13186)	FC
Protection of Wetlands (Executive Order 11990)	FC
Rivers and Harbors Act of 1899	FC
Migratory Birds (Executive Order 13186)	FC
Submerged Lands Act, as amended	FC

PC = Partial Compliance, FC = Full Compliance
Note: This list is not exhaustive.

10.4 Views of the Sponsor

The City of Kenai has expressed ongoing, enthusiastic support for the tentatively selected plan and has funding that would allow for a smooth transition into both the design and construction phases of the project.

11.0 CONCLUSIONS AND RECOMMENDATIONS

11.1 Conclusions

The proposed construction of the plan as discussed in this document would have short-term controllable environmental impacts during construction that will be largely minimized by avoiding the period when beluga whales may be present during construction. In the long term, the selected erosion control measure will improve the overall quality of the human environment. This assessment supports the conclusion that the proposed project does not constitute a major Federal action significantly affecting the quality of the human environment. Therefore, a Finding of No

Significant Impact has been prepared. The Alaska District Office of Counsel has reviewed this document and has issued a certification of legal sufficiency.

11.2 Recommendations

I recommend that the selected plan, as a coastal storm risk management measure at Kenai, Alaska, be constructed generally in accordance with the selected plan herein, and with such modifications thereof as in the discretion of the Director of Civil Works may be advisable at an estimated FY19 certified project first cost with contingency of $40,294,000.

Recommendations for provision of Federal participation in the plan described in this report would require the project sponsor to enter into a written Project Partnership Agreement (PPA), as required by Section 221 of Public Law 91-611, as amended, to provide local cooperation satisfactory to the Secretary of the Army. Such local cooperation shall provide, in part, the following draft items of local cooperation:

a. Provide during the periods of design and construction, a minimum of 35 percent of project costs assigned to coastal and storm damage risk reduction as further defined below:

(1) Provide, during design, 35 percent of design costs allocated to coastal and storm damage reduction in accordance with the terms of a design agreement entered into prior to commencement of design work for the project;
(2) Provide all lands, easements, rights-of-way, including suitable borrow areas, and perform or assure performance of all relocations, including utility relocations, as determined by the Federal government to be necessary for the initial construction, periodic nourishment or operation and maintenance of the project;
(3) Provide, during construction, any additional amounts necessary to make its total contribution equal to 35 percent of initial project costs assigned to coastal and storm damage reduction;

b. Prevent obstructions or encroachments on the project (including prescribing and enforcing regulations to prevent such obstructions or encroachments) such as any new developments on project lands, easements, and rights-of-way or the addition of facilities which might reduce the outputs produced by the project, hinder operation and maintenance of the project, or interfere with the project's proper function;

c. Inform affected interests, at least yearly, of the extent of protection afforded by the flood risk management features; participate in and comply with applicable federal floodplain management and flood insurance programs; comply with Section 402 of the Water Resources Development Act of 1986, as amended (33 U.S.C. 701b-12); and publicize floodplain information in the area concerned and provide this information to zoning and other regulatory agencies for their use in adopting regulations, or taking other actions, to prevent unwise future development and to ensure compatibility with protection levels provided by the flood risk management features;

d. Operate, maintain, repair, replace, and rehabilitate the completed project, or function portion of the project, at no cost to the Federal government, in a manner compatible with the project's authorized purposes and in accordance with applicable Federal and state laws and regulations and any specific directions prescribed by the Federal government;

e. For so long as the project remains authorized, ensure continued conditions of public ownership and use of the shore upon which the amount of Federal participation is based;

f. Provide and maintain necessary access roads, parking areas, and other public use facilities, open and available to all on equal terms;

g. At least twice annually and after storm events, perform surveillance of the project to determine losses of material from the project design section and provide the results of such surveillance to the Federal government;

h. Give the Federal government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-Federal sponsor owns or controls for access to the project for the purpose of completing, inspecting, operating, maintaining, repairing, rehabilitating, or replacing the project;

i. Hold and save the United States free from all damages arising from the initial construction, periodic nourishment, operation, maintenance, repair, replacement, and rehabilitation of the project, except for damages due to the fault or negligence of the United States or its contractors;

j. Keep, and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the project, for a minimum of 3 years after completion of the accounting for which such books, records, documents, and other evidence are required, to the extent and in such detail as will properly reflect total cost of the project, and in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and local governments at 32 CFR, Section 33.20;

k. Perform, or ensure performance of, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S.C. 9601-9675, that may exist in, on, or under lands, easements, or rights-of-way that the Federal government determines to be necessary for the initial construction, periodic nourishment, operation and maintenance of the project;

l. Assume, as between the Federal government and the non-Federal sponsor, complete financial responsibility for all necessary cleanup and response costs of any hazardous substances regulated under CERCLA that are located in, on, or under lands, easements, or rights-of-way required for the initial construction, periodic nourishment, or operation and maintenance of the project;

m. Agree, as between the Federal government and the non-Federal sponsor, that the non-Federal sponsor shall be considered the operator of the project for the purpose of CERCLA liability, and, to the maximum extent practicable, operate, maintain, repair, replace, and rehabilitate the project in a manner that will not cause liability to arise under CERCLA;

n. Comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended, (42 U.S.C. 1962d-5b) and Section 101(e) of the WRDA 86, Public Law 99-662, as amended, (33 U.S.C. 2211(e)) which provide that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until the non-Federal sponsor has entered into a written agreement to furnish its required cooperation for the project or separable element;

o. Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended, (42 U.S.C. 4601-4655) and the Uniform Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights-of-way necessary for construction, operation, and maintenance of the project including those necessary for relocations, the borrowing of material, or the disposal of dredged or excavated material; and inform all affected persons of applicable benefits, policies, and procedures in connection with said act;

p. Comply with all applicable Federal and state laws and regulations, including, but not limited to: Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 U.S.C. 2000d), and Department of Defense Directive 5500.11 issued pursuant thereto; Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army"; and all applicable Federal labor standards requirements including, but not limited to, 40 U.S.C. 3141-3148 and 40 U.S.C. 3701-3708 (revising, codifying and enacting without substantive change the provisions of the Davis-Bacon Act (formerly 40 U.S.C. 276a et seq.), the Contract Work Hours and Safety Standards Act (formerly 40 U.S.C. 327 et seq.), and the Copeland Anti-Kickback Act (formerly 40 U.S.C. 276c)); and

q. Not use funds from other Federal programs, including any non-federal contribution required as a matching share therefore, to meet any of the non-Federal sponsor's obligations for the project unless the Federal agency providing the funds verifies in writing that such funds are authorized to be used to carry out the project.

The recommendations for implementation of coastal storm risk management measures at Kenai, Alaska reflect the policies governing formulation of individual projects and the information available at this time. They do not necessarily reflect the program and budgeting priorities inherent in the local and State programs or the formulation of a national civil works water resources program. Consequently, the recommendations may be changed at higher review levels of the executive branch outside Alaska before they are used to support funding.

NOV 15 2018

PHILLIP J. BORDERS
COL, EN
Commanding

Date

12.0 REFERENCES

Alaska Division of Community and Regional Affairs (ADCRA). 2016. Alaska Community Database Online website: http://www.dced.state.ak.us/dca/commdb/CF_COMDB.htm.

Alaska Department of Environmental Conservation (ADEC). 2009. AAC 70 Water Quality Standards, Amended as of September 19, 2009.

ADEC. 2010. Alaska 2011 Air Monitoring Network Plan, June 2010.

ADEC. 2010. Telephone Communication, subject: Ambient Air Quality Monitoring in Kenai; Trost, Barbara.

ADEC. 2010a. Alaska's Final Integrated Water Quality Monitoring and Assessment Report, 15 July 2010.

ADEC. 2015. Annual Air Quality Monitoring Network Plan. November 2015.

ADEC. 2016. Alaska Administrative Code 18 AAC 70 Water Quality Standards, Amended as of February 19, 2016.

Alaska Department of Fish and Game (ADFG). Undated factsheet, "Run-Timing – Kenai, Soldotna, and Homer": https://www.adfg.alaska.gov/staticsf/Region2/pdfpubs/kenrun.pdf

ADFG. 2004. Kenai River Estuary Baseline Fisheries Assessment, Regional Information Report No. 2A04-13.

ADFG. 2012. Email Communication, subject: Kenai River Smelt; McKinley, Timothy.

ADFG. 2016a. Personal Use Fishing website – Kenai River Salmon Fisheries. http://www.adfg.alaska.gov/index.cfm?adfg=PersonalUsebyAreaSouthcentralKenaiSalmon.main.

ADFG. 2016b. Wildlife viewing, Kenai Peninsula, Mouth of the Kenai River website, http://www.adfg.alaska.gov/index.cfm?adfg=viewinglocations.krmscoutpark.

ADFG. 2016c. Anadromous Waters Catalog online mapper: https://www.adfg.alaska.gov/sf/SARR/AWC/index.cfm?ADFG=main.interactive.

ADFG. 2016d. Eulachon Species Profile, Alaska Department of Fish and Game website: http://www.adfg.alaska.gov/index.cfm?adfg=eulachon.main.

Alaska Division of Community and Regional Affairs. 2015. Community Information Database

Boraas, Alan. 2009. Location and Brief History of Shk'ituk't and Shk'ituk'tnu: Kenai River Mouth, Alaska. Manuscript on file, Alaska Office of History and Archaeology, Anchorage.

Elliot, Sylvia H. and Lane, Donna. 1996. Kenai Townsite Historic District Survey Report. Prepared for the City of Kenai.

Engineer Research and Development Center, U.S. Army Corps of Engineers (ERDC). 2007. Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Alaska

Region (Version 2.0). September 2007.

Gease, Ricky. 2016. Email from Kenai River Sportfishing Association dated 9 June 2016, subject: Corps of Engineers – Kenai River Bluff coastal erosion project.

Gracz, Mike; Noyes, Karyn; North, Phil; Tande, Gerald. 2008. Wetland Mapping and Classification of the Kenai Lowland, Alaska. Kenai Watershed Forum website: http://www.kenaiwetlands.net. 21 March 2008.

Kenai Watershed Forum (KWF). 2015. Water Quality Assessment of the Kenai River Watershed from July 2000 to July 2014.

Kenaitze Indian Tribe. 2016. Educational Fishery webpage: http://www.kenaitze.org/tribal/fishery/index.html.

Koch, Rick, 2015, Personal Communication between Jason Norris and Rick Koch, City Manager, City of Kenai, 13 May 2015.

Lewis, Steve – USFWS. 2016. Email dated 9 July 2016, subject: re: eagle nests along mouth of Kenai River?

London, Josh – NOAA. 2016. Email dated 23 June 2016, subject: Re: Kenai River harbor seals.

McAfee, Stephanie A., Guentchev, Galina, and Jon K. Eischeid. 2013. Reconciling Precipitation Trends in Alaska: Station-based Analysis. *Journal of Geophysical Research: Atmospheres* 118(14):7523-754.

Mulherin, Nathan D., Tucker III, Walter B., Smith, Orson P., and William J. Lee. 2001. Marine ice atlas for Cook Inlet, Alaska. Cold Regions Research and Engineering Laboratory, Hanover, NH, for NOAA Office of Response and Restoration, Seattle,WA.

NMFS. 2015. Draft Recovery Plan for the Cook Inlet Beluga Whale (Delphinapterus leucas). National Marine Fisheries Service, Alaska Regional Office, Protected Resources Division, Juneau, AK.

NMFS. 2016a. ESA/MMPA Mapper website: https://alaskafisheries.noaa.gov/mapping/esa/

NMFS 2016b National Essential Fish Habitat Mapper: http://www.habitat.noaa.gov/protection/efh/efhmapper/index.html

National Pacific Fishery Management Council (NPFMC). 2012. Fishery Management Plan for the Salmon Fisheries in the EEZ off Alaska. June 2012.

Reger, Douglas. 2003. Upper Cook Inlet Prehistory: the Archaeological Evidence. In *Shem Pete's Alaska: The Territory of the Upper Cook Inlet Dena'ina*, 2nd ed. Pp. 15-16. James Kari and James A. Fall, eds. University of Alaska Press, Fairbanks.

Sheldon, Kim - NOAA. 2016. Email dated 24 June 2016, subject: Re: Kenai River mouth and beluga sightings.

Sinclair, Jack – KWF. 2016. Email dated 27 June 2016, subject: Corps of Engineers – Kenai River Bluff coastal erosion project.

Smith, Orson; Lee, William; and Heike Merkel. 2001. Erosion at the Mouth of the Kenai River, Alaska, University of Alaska Anchorage, April 2001.

State Historic Preservation Officer (SHPO). 2016. Letter from SHPO (Judith Bittner) to USACE (Shona Pierce) re: erosion control at Kenai River Bluff. 22 July 2016.

Tetra Tech. 2007. Kenai River Bluff Erosion, Bluff Stabilization Design Alternatives, Draft Design Criteria and Preliminary Alternatives Report. August 2007.

Trefon, B., Reams, N. and A. Borass. 2014. Kenaitze Youth Speak: Notes on the Concept of Place. Kenaitze Indian Tribe, Kenai Peninsula College, and Alaska EPSCoR.

U.S. Army Corps of Engineers (USACE) 1962. Reconnaissance of Kenai and Kasil of Rivers and Ninilchik small Boat Harbors River, Alaska, Prepared by U.S. Army Engineer District, Alaska Foundations and Materials Branch, 29 May 1962.

USACE. 1970. Reconnaissance Report, Kenai River, Alaska.

USACE. 1976. Feasibility Study, Kenai Harbor, Alaska, Small Boat Harbor and Deep-Draft Navigation Improvements.

USACE. 1978. Kenai River Review, Final.

USACE. 1997. Reconnaissance Report for Navigation Improvements and Erosion Control.

USACE. 2003a. CEPOA-EN-CW-ER Memorandum for Record dated 3 Jul 2003, subject: Kenai River Bluff Erosion Project Benthic Invertebrate Sampling.

USACE. 2003b. CEPOA-EN-CW-ER Memorandum for Record, undated, subject: Kenai River Bluff Erosion Project Bird and Marine Mammal Survey.

USACE. 2004a. Geotechnical Findings Report, Kenai River Bluff Erosion, Kenai, Alaska

USACE. 2004b. CEPOA-EN-CW-ER (Grover) Memorandum for Record dated 5 January 2004, subject: Kenai River Cultural Resources.

USACE. 2006. Kenai River Bank Erosion Technical Report, Kenai, Alaska. May 2006.

USACE. 2007a. Geotechnical Investigation and Site Conditions Report, Kenai River Bluff Erosion, Prepared by R&M Consultants, Inc. dated February 2007.

USACE. 2007b. CEPOA-EN-CW-ER (Campbell) Memorandum for Record dated 3 December 2007, subject: City of Kenai, Kenai River Bank Stabilization Project.

USACE. 2008a. Groundwater Monitoring Report, Kenai River Bluff Erosion.

USACE. 2008b. Kenai River Bluff Erosion, Bluff Stabilization Design Alternatives, Design Alternatives Report.

USACE. 2009. Kenai River Bluff Erosion, Bluff Stabilization Design Alternatives, Draft Design Report, prepared by Tetra Tech.

USACE. 2009b. Biological Assessment of the Beluga Whale Delphinapterus leucas in Cook Inlet for Port of Anchorage Expansion Project and Associated Dredging at the Port of Anchorage, Alaska. April 2009.

USACE 2010. Kenai River Bluff Limited Economic, Cultural and Historic Property Evaluation, Draft.

USACE. 2011. Kenai River Bluff Stabilization, Kenai, Alaska, Cost Engineering Report Draft Submittal.

USACE 2016. Letter from USACE (Shona Pierce) to SHPO (Judith Bittner) re: erosion control at Kenai River Bluff. 21 June 2016.

USACE. 2016a. Letter to NMFS dated 7 July 2016, subject: ESA determination letter.

USACE. Undated. Memorandum for Record (EN-CW-ER), subject: Kenai River Bluff Erosion Project Bird and Marine Mammal Survey.

USACE 2016b. Undated. Memorandum for Record (EN-CW-ER, Grover), subject: Kenai River Cultural Resources.

USFWS. 1981. Wetland Types and Waterbird Utilization on the Kenai River Corridor during 1980, Office of Special Studies. William Eldridge and Daniel Rosenberg.

USFWS. 2016a. Information for Planning and Conservation website: https://ecos.fws.gov/ipac/.

USFWS. 2016b. National Wetlands Inventory website: http://www.fws.gov/wetlands/Data/Mapper.html

USFWS. 2016c. Fish and Wildlife Coordination Act Report, Kenai River Bluff Stablization. July 2016.

USFWS. 2009a. Alaska Region – Eagle Permit, Step by Step Guidelines & Conservation Measures website: http://www.fws.gov/alaska/eaglepermit/guidelines/disturbnestingbaea1.htm.

USFWS. 2009b. Land Clearing Timing Guidance for Alaska. July 2009.

USFWS. 2008. Short-tailed Albatross Recovery Plan. September 2008.

U.S. Geological Survey (USGS). 1982. Erosion and Sedimentation in the Kenai River, Alaska.

Waterways Experiment Station, U.S. Army Corps of Engineers (WES). 1987. Corps of Engineers Wetlands Delineation Manual, Wetlands Research Program Technical Report Y-87-1, Final Report. January 1987.

Western Regional Climate Center (WRCC). 2016. Website: http://www.wrcc.dri.edu.

Znamenski, Andrei A. (trans.). 2003. *Through Orthodox Eyes: Russian Missionary Narratives of Travels to the Dena'ina and Ahtna, 1850s-1930s.* University of Alaska Press, Fairbanks.