US Army Corps of Engineers®

Economics Appendix D

Elim Navigations Improvement
Elim, Alaska

April 2020

Appendix D: Economics

Elim Subsistence Harbor Feasibility Study

Elim, Alaska

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Alaska District

April 2020

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1.0 OVERVIEW

This appendix presents the economic analysis of six alternatives for providing navigation improvements at Elim, Alaska. The alternatives are evaluated using the four accounts established in the Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies: National Economic Development (NED), Regional Economic Development (RED), Environmental Quality (EQ), and Other Social Effects (OSE).

Consistent with the authority of Section 2006 of the Water Resources Development Act of 2007 (WRDA 2007) – Remote and Subsistence Harbors, as amended, an NED analysis was performed which demonstrated that none of the alternatives had a benefit-cost ratio (BCR) greater than 1.0. Since there is no NED plan, Cost Effectiveness and Incremental Cost Analysis (CE/ICA) is used to support plan selection. The non-monetary units used in the CE/ICA are access and moorage days gained for the Elim vessel fleet, which refer to the improved opportunity each alternative offers the community of Elim to participate in subsistence and commercial fisheries activities, and for improved barge deliveries.

The results of the NED analysis and CE/ICA are summarized in Table 1 and Table 2. Alternatives 6 and 7 were included in the NED analysis but screened out prior to conducting the CE/CIA due in part to the cost share burden on the local sponsor. Note that Alternative 2 has the highest average annual net NED benefits but the BCR is below 1.0, and that Alternative 5 is identified as a Best Buy plan through the CE/ICA, meaning this alternative provides the greatest increase in output for the least increase in cost. These analyses inform plan selection as detailed in the main report of the Draft Integrated Feasibility Report and Draft Environmental Assessment.

Table 1. NED Summary

Description	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7
Present Value NED Benefits	$24,140,000	$25,362,000	$25,362,000	$25,983,000	$23,446,000	$26,479,000
Present Value NED Costs	$76,308,000	$104,022,000	$105,849,000	$110,672,000	$106,859,000	$161,452,000
Average Annual Cost	$2,827,000	$3,853,000	$3,921,000	$4,099,000	$3,958,000	$5,980,000
Average Annual Benefits	$895,000	$939,000	$939,000	$962,000	$869,000	$980,000
Average Annual Net Benefits	-$1,932,000	-$2,914,000	-$2,982,000	-$3,137,000	-$3,089,000	-$5,000,000
BCR	**0.32**	**0.24**	**0.24**	**0.23**	**0.22**	**0.16**

Table 2. CE/ICA Summary

Alternative	Access Days Gained	Average Annual NED Cost	Annual Cost Per Unit of Output (Access Days)	CE/ICA Result
No Action	0	0	0	Best Buy
Alt 2	1571	$2,827,000	$1,799	Cost Effective
Alt 3	1817	$3,853,000	$2,121	Cost Effective
Alt 4	2117	$3,921,000	$1,852	Cost Effective
Alt 5	2336	$4,099,000	$1,755	Best Buy

2.0 INTRODUCTION

Limited marine infrastructure and available draft in Elim results in operational inefficiencies, vessel damages, decreased safety and threatens the long-term viability of Elim and the region. The purpose of this economic appendix is to evaluate the proposed navigation improvements at Elim through the NED analysis and CE/ICA. The NED analysis defines benefits as a change in the value of goods and services that accrue to the nation as a result of constructing the project. NED costs are the total economic costs of building and maintaining the project. The average annual economic benefits of the project are compared to the average annual economic costs to provide an estimated benefit-cost ratio (BCR). A project with a BCR greater than 1.0 is considered economically justified.

When considering the long-term viability of a community, the justification of a project cannot solely be based on a positive BCR. The CE/ICA evaluates the effects of proposed plans beyond the confines of monetary NED benefits. Specifically, based on non-monetary units such as through the Other Social Effects (OSE) account. This economic appendix discusses the economic and social factors that inform the two separate analyses.

Guidance is contained in Engineering Regulation (ER) 1105-2-100, specifically in the appendices on economic and social considerations, the USACE Civil Works program, as well as recent Economic Guidance Memoranda (EGMs) issued by Headquarters USACE. Additional guidance for the CE/ICA is found in the Institute of Water Resources (IWR) Planning Suite II Guide (2017) and Planning Manual on Risk-Informed Planning (2017).

The planning objectives of this study are:

- Provide safe, reliable, and efficient waterborne transportation systems for the movement of commerce (including commercial fishing) and subsistence in Elim.

- Support the long-term viability of Elim.

2.1 Study Authority

This study utilizes the project justification allowed under Section 2006 of WRDA 2007 – Remote and Subsistence Harbors, as modified by Section 2104 of the Water Resources Reform and Development Act of 2014 (WRRDA 2014) and further modified by Section 1105 of WRDA 2016. The authority states that in conducting a study of harbor and navigation improvements the Secretary may recommend a project without demonstrating that the improvements are justified solely by NED benefits if the Secretary determines that the improvements meet the following criteria:

1. The community to be served by the project is at least 70 miles from the nearest surface accessible commercial port and has no direct rail or highway link to another community served by a surface accessible port or harbor; or the project would be located in the State of Hawaii or Alaska, the Commonwealth of Puerto Rico, Guam, the Commonwealth of the Northern Mariana Islands, the United States Virgin Islands; or American Samoa.

2. The harbor is economically critical such that over 80 percent of the goods transported through the harbor would be consumed within the region served by the harbor and navigation improvement as determined by the Secretary, including consideration of information provided by the non-Federal interest and

3. The long-term viability of the community in which the project is located, or the long-term viability of a community that is located in the region that is served by the project and that will rely on the project, would be threatened without the harbor and navigation improvement.

2.2 Meeting the Authority

The proposed navigation improvements at Elim meet the criteria of the Remote and Subsistence Harbors authority because:

1. The project is in Alaska.

2. Based upon weight, commodities transported in the future with-project condition were analyzed to determine that over 80 percent of the goods transported through the harbor (after construction) would be consumed within the region. The region that is to be served by the navigation improvements is the village of Elim. Using available data from the Waterborne Commerce Statistics Center (WCSC), the basis of consumption is metric tons. Elim consumes 84 to 92 percent of the goods transported through the proposed harbor. Alternatives supporting commercial fishery exports from Elim are considered to provide economic opportunities in Elim that are consistent with the authority and study objectives. These exports are projected to weigh less than 20 percent of the total tonnage going through the harbor when considering market and institutional factors such as Community

Development Quotas (CDQ) and associated export prices. Imports include the weight of fuel, freight, and construction materials. Exports included the weight of raw fish and are estimated to range from 8 to 16 percent of total weight of goods transported through the harbor. These estimates are conservative, given the analysis accounts for the projected growth in exports but assumes that the imports will remain the same.

3. Remote Alaska communities face challenges that are complex and multifaceted. Rural economies in Alaska, including that which exists in Elim, can be characterized as a mixed, subsistence-cash economy in which the subsistence and cash sectors are interdependent and mutually supportive. Access to resources and the opportunity to earn some form of cash income are foundational for continued viability. Without a safe and functioning harbor, limited access to subsistence resources coupled with limited economic opportunities compounds the threats to community viability. The cultural identity of Alaska Native Tribes is highly dependent upon subsistence activities tied to specific locations and in-depth historical knowledge of land and marine subsistence resources. Given the social and cultural value of subsistence activities to tribal identities, the inaccessibility of subsistence resources can threaten communities. In addition, the costs of basic essential goods required to support a subsistence lifestyle would remain prohibitively high. Reductions in the costs of basic essential goods are necessary to community viability. While population estimates suggest that Elim's population is stable, the population alone is not an indicator of a viable community. The viability of a community is based on its ability to survive and thrive. When wage-paying employment is limited, coupled with lower than state average wages, a stable population in a remote community is still severely threatened. More on these overarching socio-economic factors are presented in the following sections.

The authority also states that while determining whether to recommend a project under the criteria above, the Secretary will consider the benefits of the project to the following:

- Public health and safety of the local community and communities that are located in the region to be served by the project and that will rely on the project, including access to facilities designed to protect public health and safety;
- Access to natural resources for subsistence purposes;
- Local and regional economic opportunities;
- The welfare of the local population; and
- Social and cultural value to the local community and communities that are located in the region to be served by the project and that will rely on the project.

The benefits listed above are associated with a project's effects on social well-being, which extend beyond the NED benefits. Social well-being effects reflect a complex set of relationships and interactions between a proposed plan and the social and cultural setting in which these are received and acted upon (USACE, Appendix D, 2004). These benefits are considered from both a quantitative and qualitative perspective. In particular, the analysis uses the CE/ICA metric of Access Days Gained, which emphasizes the occurrence of beneficial effects to quantify in non-monetary terms the contributions of a navigation project to social and economic opportunities (listed above). These social well-being effects are also expanded upon in Section 15.0 under the Four Accounts evaluations: Other Social Effects (OSE), NED, Environmental Quality (EQ) and Regional Economic Development (RED)

3.0 BACKGROUND

3.1 Location and Climate

Elim is a second class city located on the northwest shore of Norton Bay on the Seward Peninsula, 96 miles east of Nome, and 460 miles northwest of Anchorage. Elim lies at approximately 64.6 degrees North Latitude, -162.3 degrees West Longitude. The area encompasses 2.4 square miles of land.

Elim has a subarctic climate with maritime influences. Norton Sound is generally ice-free between mid-June and mid-November. Summers are cool and moist; winters are cold and dry. Summer temperatures average between 46 and 62 degrees Fahrenheit (F) while winter temperatures average -8 to 8 degrees F. Annual precipitation averages 19 inches, with about 80 inches of snow (Department of Commerce, Community and Economic Development, Division of Community and Regional Affairs, 2019)

Figure 1. Location of Elim in Alaska

3.2 History

Elim was formerly the Malemiut Inupiat Eskimo village of Nuviakchak. The Alaska Native culture was well developed and well adapted to the environment, and each tribe possessed a well-defined subsistence harvest territory. The area became a federal reindeer reserve in 1911. In 1914 Reverend L.E. Ost founded a Covenant mission and school called Elim Mission Roadhouse. The City of Elim was incorporated in 1970. When the Alaska Native Claims Settlement Act (ANCSA) was passed in 1971, Elim decided not to participate and instead opted for title to the 298,000 acres of land in the former Elim Reserve. Elim remains an Inupiat Eskimo village with a predominantly fishing and subsistence lifestyle (US Army Corps of Engineers, Alaska District, 2013, p. B-6). Residents rely upon subsistence harvests of fish, crab, seal, walrus, beluga whale, caribou, moose, greens, and berries.

3.3 Government Entities

The City of Elim was incorporated in 1970 as a second class city. As a second class city in the unorganized borough, the City of Elim has discretionary powers under state law for planning, platting, and land use regulation within municipal boundaries. The local city government consists of an elected mayor and city council. As the federally-recognized governing tribal body, the Native Village of Elim shares some of these responsibilities and powers. The Native Village of Elim also works closely with Kawerak Inc., the regional non-profit Native Corporation. The village corporation established under ANCSA is Elim Native Corporation.

3.4 Infrastructure

Elim is not connected to any other communities by road and must be accessed by plane or boat, or by snowmachine in winter. The only existing road connects Elim to Moses Point, which is approximately 9 miles northeast of Elim.

3.4.1 Marine Facilities

Elim has no dock or barge ramp infrastructure. A cargo ship brings freight from Nome annually to the beach fronting the community. Because there are no marine facilities, supplies must be lightered to shore. There are two barge landing areas at Elim. The fuel barges anchor offshore near the fuel header location at the southwest end of the community and freight barges land east of a small stream outfall along the beach where cargo is offloaded.

Moses Point is the sandy mouth of the Kwiniuk River used as a make-shift harbor, but there is no boat launch or mooring infrastructure. It is relatively protected but shallow, and only small boats use Moses Point for moorage. Moorage at the area is not always possible because of active river dynamics that causes the river mouth to migrate.

3.4.2 Airport

Elim's remote location leads to a reliance on air transportation. Two airlines operate passenger and cargo flights to Elim daily. There is a 3,401-foot long by 60-foot wide state-owned gravel runway. The Elim Native Corporation also owns a private 3,000-foot long by 60-foot wide airstrip at Moses Point that is not operational. The airstrip at Moses Point is unattended and not maintained during the winter. According to the Federal Aviation Administration (FAA), Moses Point is eroding in spots. The corporation- owned airstrip is located near where commercial fish is landed and sold during the summer months. The eastern end of the runway is reported to attract birds (Federal Aviation Administration, Department of Defense, 2008, p.89). The daily flights into Elim primarily use the state-owned runway.

3.4.3 Public Services and Utilities

3.4.3.1 Health Services

Primary health services and infrastructure in Elim are provided by the Norton Sound Health Corporation (NSHC). Healthcare services are provided through the Norton Sound Regional Hospital in Nome and it manages 15 village clinics in surrounding communities. According to the Bering Strait Community Needs Assessment, Elim hosts one of the larger clinics named Yukuniaraq Yunqcarvik Village Clinic, which staffs a physician assistant or nurse practitioner and may provide limited pharmacy and radiology services, (McDowell Group, 2019, p.79). The Yukuniaraq Yungcarvik Village Clinic is shown in Figure 2.

The NSHC manages community health services that include village health, behavioral health, and health aide training. Its programs include rotating provider teams of ancillary services such as optometry, physical therapy, and audiology to the service villages. At the time of this report, the corporation is building a Wellness Center in Nome that will house behavioral health, chemical dependency detox, and substance abuse treatment services. The Nome Public Health Center is another provider of health services in the region and offers services such as infectious disease surveillance, and tuberculosis screening and treatment.

Depending on treatment needed, Elim residents are either treated at the local clinic or travel to Nome by plane to the Norton Sound Regional Hospital. Every month an average of 10 residents leave to seek medical treatment or for medical appointments in Nome (Strickling, Kawerak Inc, 2013, p.36).

Figure 2. Yukuniaraq Yunqcarvik Village Clinic in Elim

3.4.3.2 Energy and Water Services

Elim's electricity is primarily generated by a diesel power plant by the Alaska Village Electric Cooperative (AVEC) (Strickling, Kawerak Inc, 2013, p.30). The power plant and tank farm are located west of town. Electric generation by diesel results in high electricity cost. Elim participates in the Power Cost Equalization (PCE) program, which provides economic assistance to communities and residents of rural Alaska, where the cost of electricity can be substantially higher than for customers in more urban areas of the state. The PCE subsidizes the cost of electricity to be near the cost of power in Anchorage, Fairbanks, and Juneau (Alaska Energy Authority, 2020). The majority of homes are heated by oil or kerosene, but 27 percent of Elim homes use wood for heating (McDowell Group, 2019, p. 43)

Elim participates in the consolidated bulk fuel program coordinated by the Norton Sound Economic Development Corporation (NSEDC). Through this program, which began in 2006, NSEDC groups fuel orders and negotiates purchases for participants in member communities, which allows for lower fuel prices for residents in the Norton Sound region (NSEDC 2020). NSEDC acts as an agent on behalf of participant communities to coordinate fuel orders and deliveries based on fuel suppliers' proposals. NSEDC issues requests for proposals and awards a fuel contract and acts as the point of contact for the fuel supplier and program participants. This program benefits local entities or communities as the bulk fuel orders, and the competitive bids from fuel companies for the contract lowers the cost of fuel and delivery.

The main fuel tanks in Elim are owned by the Elim Native Store (IRA council), the Aniguiin School, the Alaska Village Electric Cooperative (AVEC), and the City of Elim. The fuel tanks and associated capacity in Elim are shown in Table 3, according to the Alaska Department of Community and Regional Affairs (ADCRA). Total fuel capacity in Elim is nearly 350,000 gallons (Department of Commerce, Community and Economic Development, Division of Community and Regional Affairs, 2020).

Table 3. Fuel Tank Capacities in Elim

Fuel Tank Owners	Capacity (gallons)
City of Elim	142,430
AVEC	70,850
Elim Native Store	68,130
Bering Straits Schools	57,410
Army National Guard	4,500
AKDOT/Airport	3,000
Total Fuel Tank Capacity	**346,320**

According to the Bering Strait Community Needs Assessment, Elim is one of only three communities aside from Nome with complete piped water and sewer systems. (McDowell 2019). Water and sewer systems built in 1974, along with housing provided by the Bureau of Indian Affairs (BIA) and the Department of Housing and Urban Development (HUD), give the residents piped water and sewer, indoor water heaters and plumbing, and in-home washers and dryers. Waste flows to a sewage treatment plant with ocean outfall.

McDowell (2019) reports that Elim has a complete piped water system, but the adequacy of the water system in the community is limited. The USACE study team observed holes and slices on the community water tank toward the lower half of the exterior, cutting at least the insulation of the tank and possibly further (Site Visit, April 2019). During a site visit, it was observed that the community did not have water due to the damaged water system. Necessary facilities such as bathrooms and kitchen sinks did not have water supply. For the series of community meetings, water from a neighboring village was transported via snow machine.

4.0 SOCIOECONOMIC CONDITIONS

4.1 Population

According to the Department of Labor and Workforce Development, Research and Analysis, the population estimates between 2010 and 2018 in Elim have fluctuated between 330 and 370, but show an overall increase over the nine-year period shown in Figure 3 (2016). The Alaska Department of Labor and Workforce Development (DLWD) estimated 368 people living in Elim in 2018.

The American Community Survey (ACS) for five-year period of 2013 to 2017 estimates 98 percent of the population of Elim are Alaska Natives. This is compared to 15.4 percent for the State of Alaska (United States Census Bureau, American Fact Finder 2017). Sixty percent of the Elim population are male and 40 percent are female. The median age of Elim residents is relatively young at 25 years compared to the state's median age of 34 years. While the population trend in Elim is relatively stable, 26 percent of the residents live below the poverty line according to ACS 2013-2017 five-year estimates. This is further discussed in the section on employment and cost of living.

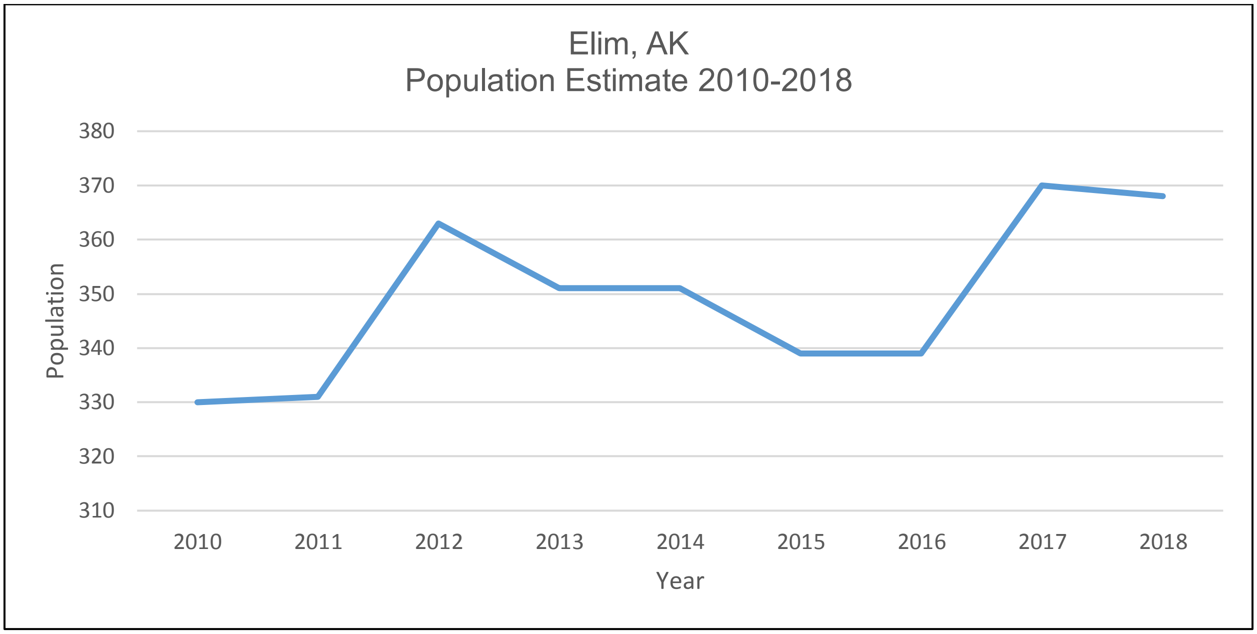


Figure 3. Elim Population Estimates, 2010-2018.

4.2 School Enrollment

The Aniguiin School in Elim operates under the Bering Strait School District and serves grades pre-kindergarten (Pre-K) through 12. Total enrollment from 2010 through 2018/19 increased from 90 to 122, representing a 36 percent increase over this period (Department of Education and Early Childhood Development, 2019). The stable enrollment trend shown on Figure 4 points to a positive sign that the school at present does not face a threat of closing. However, a stable enrollment does not translate to a robust, complete education. For Alaska Natives, one's education extends to learning from community members and elders. This learning is often knowledge shared by participating together in subsistence activities connected to specific places.

Students in Pre-K to grade 5 make up more than half of total enrollment, between 58 to 66 percent from 2010 to 2019. Grades 6 through 12 account for 37 to 42 percent of total enrollment for the period. This indicates the prominent presence of this dependent subgroup (ages 4 to 11 years old) in Elim. This age group is also the crucial formative years for instilling cultural values and identity.

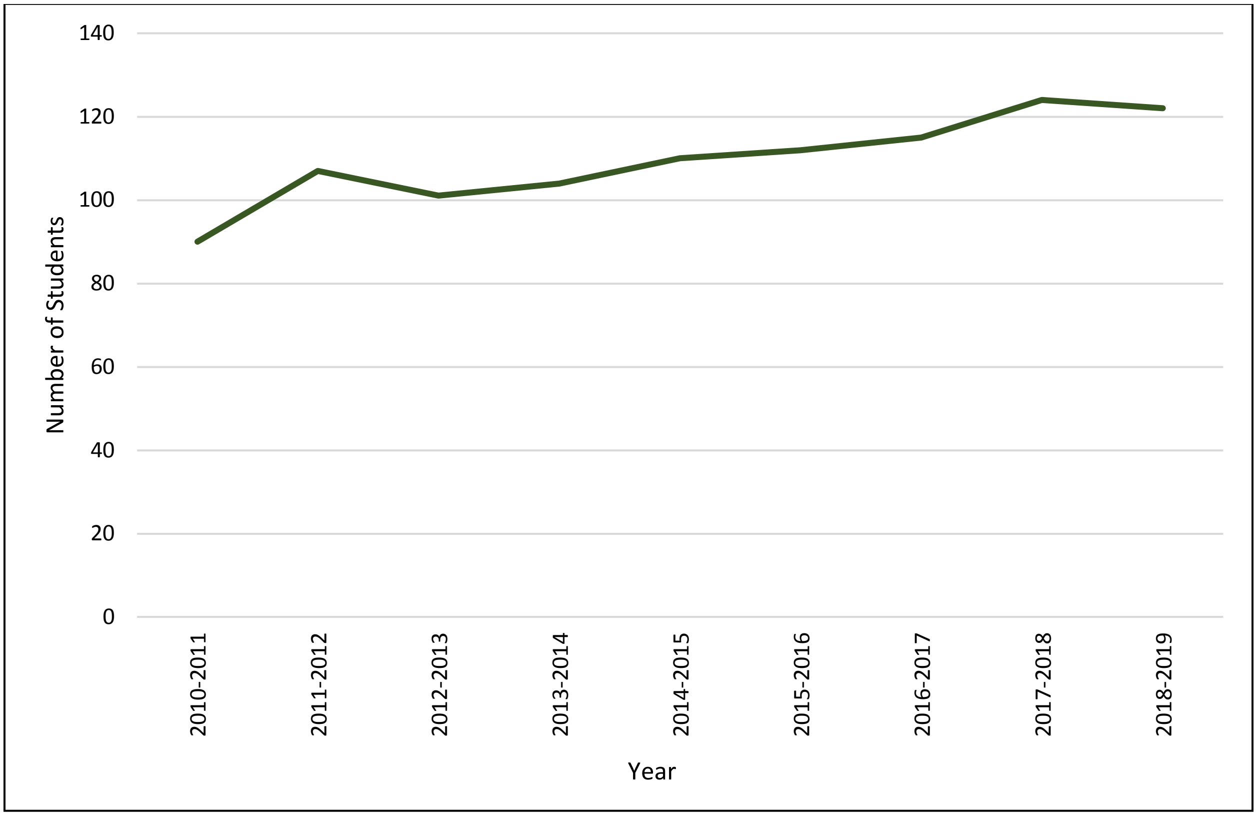


Figure 4. Aniguiin School Enrollment for Grades Pre-K through 12, 2010-2019

4.3 Employment, Income, and Cost of Living

4.3.1 Employment

Compared to the regional hub of Nome, where there are more year-round jobs, employment opportunities in rural Elim are limited and often dependent on the industries present and the extent of that presence. For example, some residents are employed in the oil and gas industry, which are dependent on resource and industry movements. The DLWD (2016) reports worker characteristics for Elim for 2012 to 2016. In the five-year period, the percentage of residents employed shows some fluctuation with a decrease in the percent of employed residents in the last two years, from 72 to 65 percent (Figure 5). The percent of working residents represents the number of employed residents relative to the workforce population of ages 16 and over, as shown in Table 4.

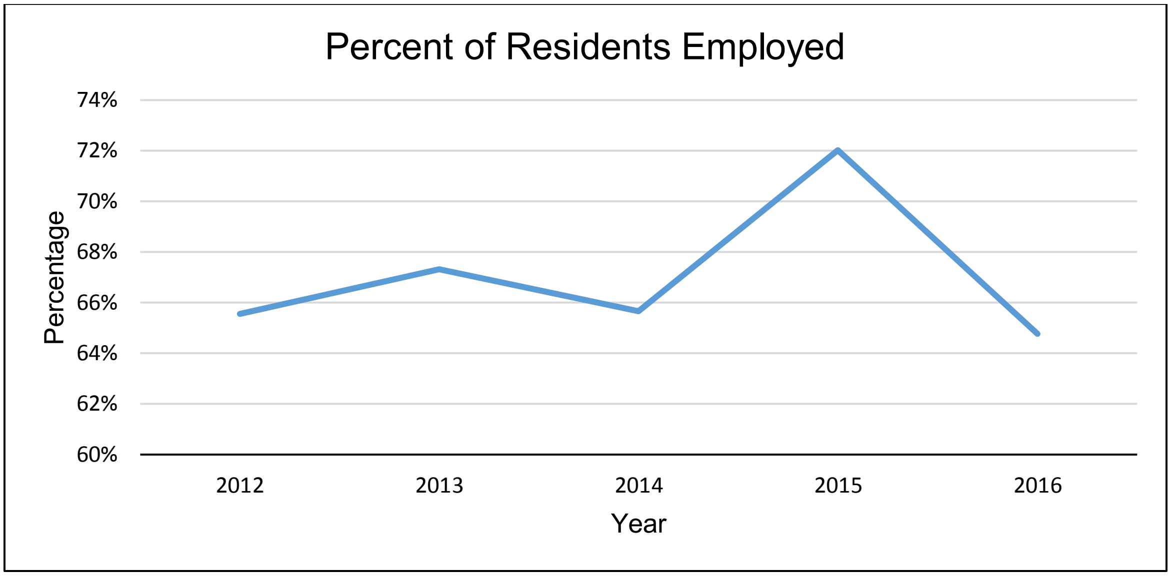


Figure 5. Percent of Elim Residents Employed, 2012-2016. Adapted from Alaska DLWD

Table 4. Employed Residents in Elim

Employed Residents	2012	2013	2014	2015	2016	Five Year Average
Residents age 16 and over	209	205	198	193	193	166
Residents employed	137	138	130	139	125	112
Percent of Residents Employed	**66%**	**67%**	**66%**	**72%**	**65%**	**67%**

The local government sector accounts for more than 60 percent of total resident employment for the five year period. The private sector employs 30 percent, and the state government employs about 2 percent of employed residents.

DLWD compiled a list of top occupations in a community each year of the occupations that employed the most residents. The following are top occupations in Elim for 2016, the most recent year available:

1. Laborers and Freight, Stock and Material Movers
2. Teacher Assistants
3. Elementary School Teachers
4. Secretaries and Administrative Assistants
5. Construction Laborers
6. Janitors and Cleaners
7. Highway Maintenance Workers
8. Water and Wastewater Treatment Plant and System Operators

The oil and gas industry drives several employment opportunities in Elim. These employments include laborers and Freight, Stock and Material Movers, Construction Laborers, and Water and Wastewater Treatment Plant and System Operators. In 2012 and 2013, Fish Cutters and Trimmers were ranked second in Elim's top occupation list, but this occupation has since dropped off the list. The loss of Fish Cutters and Trimmers suggests that the commercial fishing operations in Elim were previously a major employer for residents and downsized in recent years. This occupation category is discussed further in subsequent sections of this appendix.

Commercial fishing is a key income earning in Elim during the commercial salmon fishing season; however, it is not reported by DWLD in its worker characteristics (USACE Public Meeting, 2018). A number of commercial fishes are tracked by Norton Sound Economic Development (NSEDC) via commercial fishing permits owned by Elim fishermen, but this does not show the number of crew members employed by each commercial vessel. Sections 5.3 describes the characteristics of the commercial fisheries resources and attributes in Elim. While not captured as a top occupation by DWLD, community members in Elim who own vessels, dedicated labor, and resources in maintaining their boats and work in the commercial fishing during fishing seasons. Some of the community members have a formal full time or part-time job and work in commercial fisheries intermittently.

4.3.2 Income and Cost of Living

Income and the cost of living influence the community's livelihood and viability. Data from remote Alaska is limited, the latest available data (year 2016) is used in this discussion as representative of the current and future conditions in Elim. More than 20 percent of the working residents in Elim earned less than $5,000 in 2016. Wage ranges earned by Elim residents, from under $5,000 to $50,000 and over, compared to wage ranges statewide are shown in
Figure 6. As the wage ranges increase in dollar value the percent of Elim residents earning those wages decreases. At the statewide level, the opposite is observed; fewer residents earned the low wage ranges and more workers earned higher wage ranges. About 21 percent of residents statewide earned less than $10,000, but in Elim, this percent is doubled at 44 percent. About 33 percent of statewide residents earned $50,000 or more, while only 10 percent of Elim residents earned this wage range.

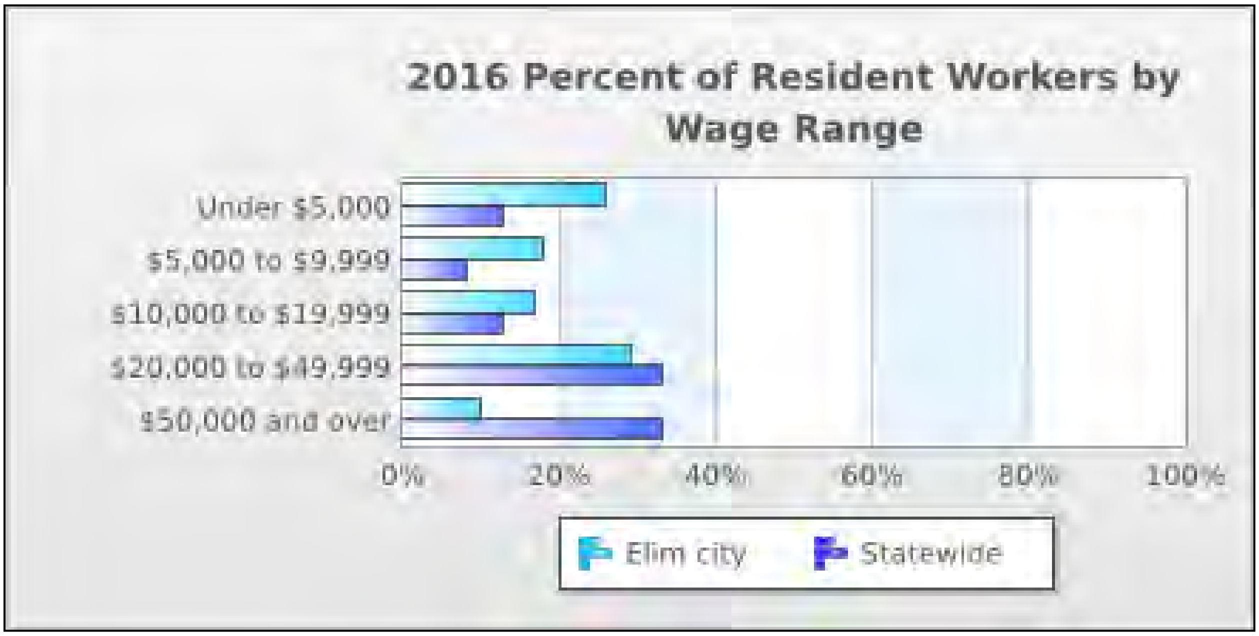


Figure 6. Percent of Elim Workers by Wage Range in 2016. Reprinted from Alaska DLWD

Another comparison is made using median household income (ACS, 2017). The median household income in Elim is $39,375, which is almost half of the Alaska state median household income of $76,114.

The University of Alaska conducts the Alaska Food Cost Survey quarterly each year. The survey compares weekly food costs for a basket of goods in various areas of Alaska with United States Department of Agriculture (USDA) information for the United States (U.S.). The food cost survey does not include Elim, but does include the regional hub community of Nome, which can be considered a proxy for the cost of living in Elim. Since Elim is even more remote and has less infrastructure and transportation services than Nome, it is reasonable to assume that the cost of living is even higher in Elim. On average, a family of four with children aged 6 to 11 can expect to spend approximately $154 a week on food in the U.S. Compared to $180 per week in Alaska statewide, an increase of 17 percent. When the sample moves more rural to a place like Nome, the costs increase further to $376 a week.[1] The cost of living for a family of four in Nome is more than double than the average cost of living in Alaska and almost 2.5 times higher than the U.S. average. If the cost of living in Nome is nearly 2.5 times higher than the U.S. average, then the cost of living in Elim is substantially higher compared to the U.S. average. Now, revisit the household income comparisons from the preceding paragraph. The median household income in Nome is $81,389. The household income in Elim is half of the household income in Nome, but Elim residents have to pay approximately 2.5 times the U.S. average for the same amount of goods. Also, recall that close to half of the employed Elim residents earned less than $10,000 per year in wages. All these income and cost of living conditions mean that households in Elim are more exposed to systemic problems such as interruptions to the transportation system. While a set of factors and thresholds

[1] Most recent data for Nome is in 2017 dollars. These values are updated to 2019 dollars

come into play when defining poverty, these comparisons aid in understanding some of the challenges faced by the 26 percent of Elim residents who are below the poverty line (United States Census Bureau, American FactFinder, 2017).

4.4 Housing Facilities

Having a safe and reliable shelter is key to public safety and viability of a community. The Bering Strait Community Needs Assessment identified a host of housing challenges in the region (McDowell Group, 2019 p. 4). These include aging housing stock, overcrowding, affordability, and air quality. According to the report, these issues add to the existing social, health, and homelessness concerns. Moreover, potential employers identify housing availability as a critical concern to employee recruitment.

Local housing units in Elim are aging, with almost 50 percent of all housing units built before 1980 and 38 percent built between 1980 and 1999. Similarily, only 12 percent of all housing units in Elim have been built since 1999 (McDowell Group, 2019). Existing housing units either need structural repairs or have inadequate facilities that contribute to poor air quality compromising the health of residents. Housing is expensive in the region, and 36 percent of households live in overcrowded conditions. US Department of Housing and Urban Development (USD-HUD) refers to overcrowding as more than one person per room in a house. A quarter (26 percent) of the homeowners in the region with a mortgage pay 30 percent or more of their household income for housing. Recall that the local median household income in Elim is under $40,000, and the cost of living is more than two and a half times the national average. For homeowners with mortgages, this $40,000 income barely covers housing and cost of living.

5.0 MARINE RESOURCES ASSESSMENT

Marine resources play a critical role in the economies and cultural practices of remote and rural communities in western Alaska, such as Elim. Subsistence activities and commercial fisheries, therefore, depend on the access to these marine resources and on the viability of fisheries and resources in the region. This Marine Resource Assessment (MRA) describes the characteristics and management institutions of marine resources in the Norton Sound region and Elim. Elim residents rely on marine resources listed in this section such as fishery, marine mammals, and terrestrial game.

5.1 Physical Characteristics

The Norton Sound is fed by several sub-arctic streams, rivers, and estuarine lagoons meeting the Bering Sea. These hydro-geographically complex systems support subsistence and commercial fisheries for salmon. The Norton Sound region stretches from Cape Douglas, northwest of the mouth of the Sinuk River to Point Romanof, south of Stebbins (Menard, Soong, Kent, Harlan & Leon, 2017, p. 2).The Norton Sound region in Western Alaska is shown in Figure 7. Kwiniuk River and Tubutulik River drain out at Moses Point, which lies nine miles northeast of Elim, and is where the community fishes for salmon.

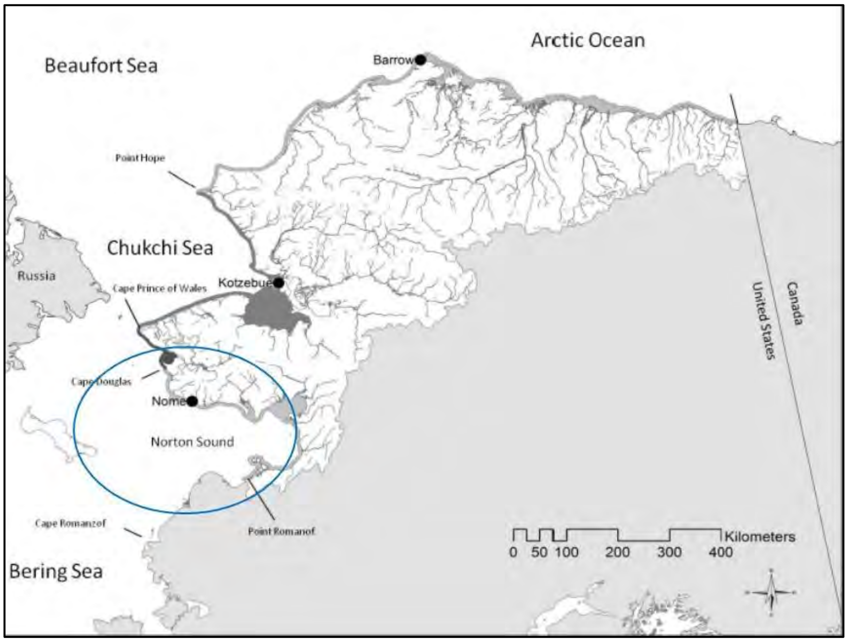


Figure 7. Norton Sound Region. Adapted from Alaska Department of Fish and Game (ADF&G)

5.2 Fisheries Management

Management authority for Alaska fisheries is based on species, or groups of species. It falls under the purview of a variety of state agencies, federal agencies, and fisheries-specific agencies depending on the species and related legislation affecting its management. For example, National Marine Fisheries Service (NMFS) manages the groundfish and halibut Community Development Quota (CDQ) fisheries. In contrast, the CDQ crab fisheries are managed by NMFS and the Alaska Department of Fish & Game (ADF&G). Salmon fisheries are managed primarily by the ADF&G to meet spawning escapement goals established for major river systems.

The fisheries management in Alaska include the following:

- Alaska Board of Fisheries (BOF)
- Alaska Department of Fish and Game (ADF&G)
- Commercial Fisheries Entry Commission (CFEC)
- National Marine Fisheries Service (NMFS)
- North Pacific Fishery Management Council (NPFMC)
- Pacific States Marine Fisheries Commission (PSMFC)
- International Pacific Halibut Commission (IPHC)
- Federal Subsistence Management Program (FSMP)

Jurisdiction for fisheries management is largely split between the ADF&G and NMFS. Per the Magnuson Fishery Conservation and Management Act (MFCMA) of 1976, ADFG generally has purview over fisheries within three miles of shore, while NMFS manages fisheries from three to 200 miles offshore of U.S. coasts. Some species may have shared jurisdiction or may be under the jurisdiction of another institution.

Community Development Quota (CDQ) Program

The federally managed fisheries of the Bering Sea and Aleutian Islands (BSAI) includes the Community Development Quota (CDQ) Program. The CDQ program was initiated to provide 65 western Alaska communities with the opportunity to participate and invest in BSAI fisheries and support economic development. Through the MFCMA, a portion of the annual catch limit for each directed fishery of the BSAI management area is allocated among the six non-profit corporations that represent the 65 western Alaska villages. The six corporations are Aleutian Pribilof Island Community Development Association (APICDA), the Bristol Bay Economic Development Corporation (BBEDC), the Central Bering Sea Fishermen's Association (CBSFA), the Coastal Villages Region Fund (CVRF), the Norton Sound Economic Development Corporation (NSEDC) and the Yukon Delta Fisheries Development Association (YDFDA). Figure 8 shows the CDQ group boundaries and community on a map of Alaska.

Norton Sound Economic Development Corporation (NSEDC)

The NSEDC region is the northernmost CDQ area bordered by the International Dateline from the northwest and the YDFDA boundary south of St. Lawrence Island. NSEDC facilitates the harvest of the CDQ species, including groundfish, crab and halibut in the Norton Sound region, of which Elim is one of the 15 communities. The annual CDQ target fisheries for red king crab in the Norton Sound, and halibut in IPHC area 4D/E are predominantly reserved for local fishermen residing in the NSEDC member communities. The annual CDQ of most other groundfish species and the greater Bering Sea CDQ fisheries are harvested and processed in cooperation with NSEDC's industry partners (CDQ Management-NSEDC, 2018).

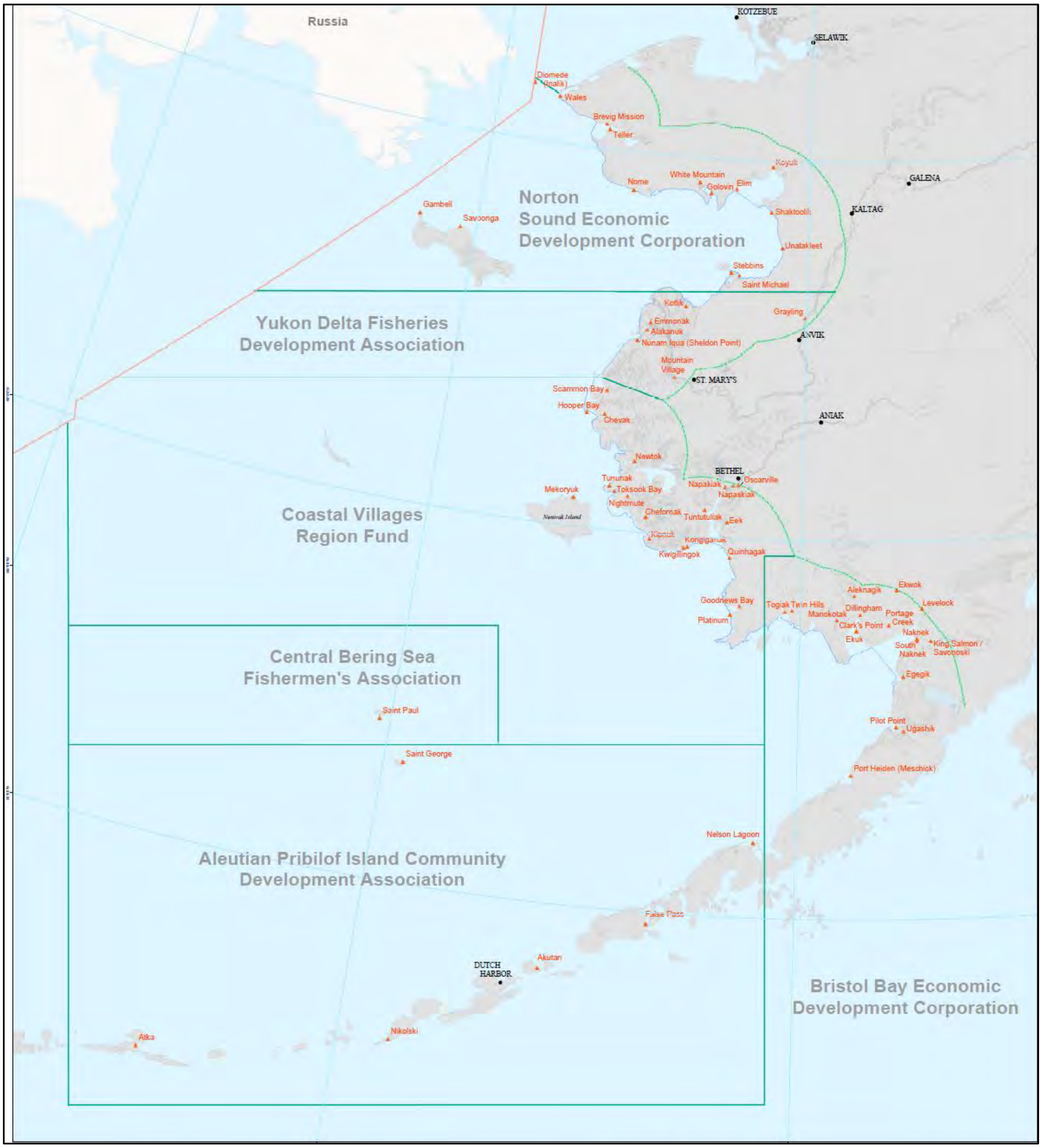


Figure 8. CDQ Communities and Group Boundaries. Reprinted from NOAA, NMFS website

5.3 Fisheries Resources

The Norton Sound region participates in the following fisheries: Salmon, Halibut, King Crab, Pacific Herring, and miscellaneous finfish. In Elim, salmon is the major fishery. As such, this assessment focuses on the commercial and subsistence salmon fisheries.

5.3.1 Salmon

There are five salmon species of importance to commercial and subsistence fisheries in Elim and the Norton Sound region. These are chum salmon, pink salmon, and coho salmon. A small number of Chinook salmon occur throughout the region and also support fisheries. Sockeye salmon occur in the western portion of the region, at the Sinuk and Pilgrim Rivers is important to the local subsistence fishery. Sport fishery targets all five species but comprises a very small portion of the fisheries in comparison to commercial and subsistence. (Mernard, Krueger, & Hilsinger, 2009, p. 621)

5.3.1.1 District Boundaries

Norton Sound Salmon District consists of all waters between Cape Douglas in the north and Point Romanoff in the south (Figure 9). The district is divided into subdistricts and corresponding statistical areas to facilitate the management of individual salmon stocks. The Norton Sound Salmon District is divided into six subdistricts:

- Subdistrict 1: Nome (333-10)
- Subdistrict 2: Golovin (333-20)
- Subdistrict 3: Elim (333-31, 32, 33)
- Subdistrict 4: Norton Bay (Koyuk) (333-40)
- Subdistrict 5: Shaktoolik (333-50)
- Subdistrict 6: Unalakleet (333-60)

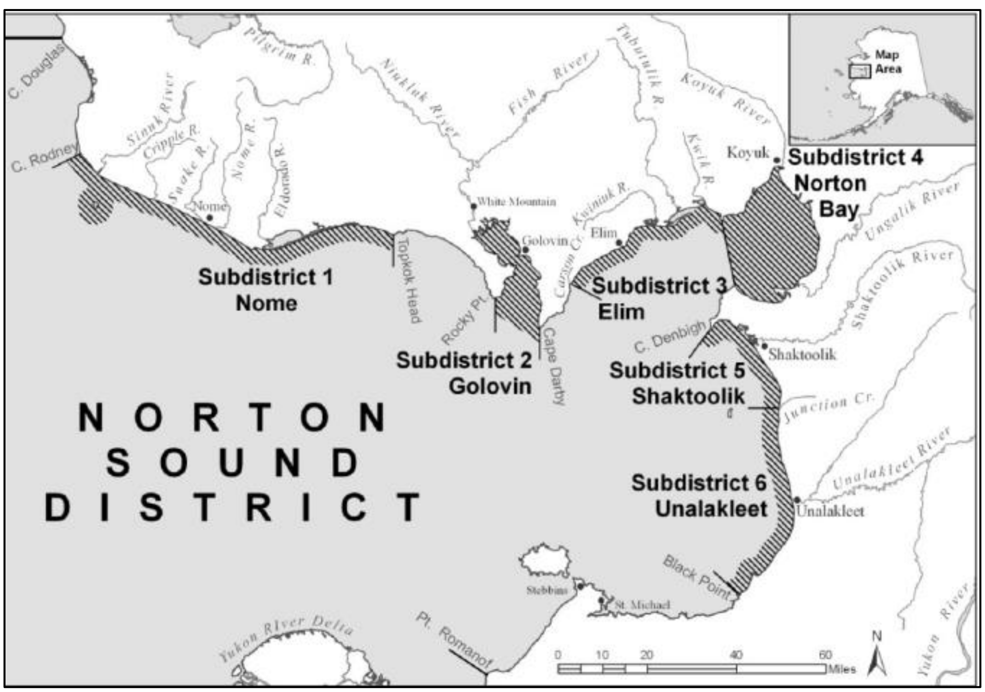


Figure 9. Norton Sound District Salmon Subdistricts

5.3.1.2 Fishery Management Techniques

Salmon fisheries are managed by ADF&G such that escapement goals are met. When salmon abundance exceeds or is predicted to exceed the established escapement goals, ADF&G permits the harvest of salmon by subsistence, commercial, and sport fisheries. Subsistence harvests take priority over commercial and sport fisheries when salmon runs are low in abundance.

Commercial fishing gear for salmon is restricted to gillnets in the Norton Sound region except for the Shaktoolik and Unalakleet (subdistricts 5 and 6, respectively). At these two subdistricts, regulations allow for the use of seine gear. ADF&G enforces restrictions on mesh sizes to try to direct harvest toward a specific species of salmon. For example, gillnet mesh size restrictions to 6.0-inch or smaller are used to target chum and coho salmon. In the Unalakleet and Shaktoolik subdistricts, if there are Chinook salmon fishing periods in June through early July, 8.25-inch stretched mesh gillnets are commonly used (Menard, Soong, Bell, & Neff, 2018).

5.3.1.3 Harvest Timelines and Fishing Seasons

Announcements on commercial and sport fishery openings, closings, fishing areas, and times are referred to as emergency orders. ADF&G considers a combination of factors before issuing emergency orders each year. These factors include comparative commercial catch data, escapements, and weather conditions, which affect the management of fishing periods, allowable mesh size, and fishing areas. The approximate season dates for salmon fisheries in the Norton Sound is summarized in Table 5.

Table 5. Norton Sound Area Commercial Salmon Fishing Season by Species

Species	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Chinook												
coho												
pink												
chum												

Note: This summary is intended as a general guide only and is non-binding. Season lengths indicated in this summary are subject to closure by emergency order as guideline harvest objectives are met or as deemed necessary by conservation concerns.

Commercial salmon fishing season usually opens by emergency order between June 8th and July 1st but depends on run timing within each subdistrict. The season closes by regulation on August 31st in subdistricts 1, 2, and 3 and on September 7th in subdistricts 4, 5, and 6. Emergency orders set possible extensions. In the past however, processors have often terminated their operations before the regulatory closure dates.

The district commercial fishing season typically begins in June, targeting Chinook salmon if a sufficient run exists. Emphasis switches to chum salmon in July, and the coho salmon fishery begins the fourth week of July and closes in September. Pink salmon are much more abundant in even-numbered year returns. Directed pink salmon fishery may coincide with or scheduled to alternate periods with historical chum salmon fishery. At Elim subdistrict specifically, chum salmon is targeted in June and most of July, pink salmon in June and July during even-numbered years, and coho salmon in late July and August. Golovin, the subdistrict west of Elim, has the same targets.

5.3.1.4 Commercial Salmon Fishery Overview

Two factors influence the commercial salmon fishery in the Norton Sound District: the abundance of the salmon run each year and the presence of buyer interest. Commercial salmon fishing in the Norton Sound District began in Shaktoolik and Unalakleet in 1961. Chinook and coho salmon were the two species of interest that were flown to Anchorage for further processing. Chum and pink salmon were purchased and processed by one U.S. freezer ship during 1961. In the following year, two floating cannery ships operated in the district, and commercial fishing was extended to Golovin, Elim (Moses Point), and the Norton Bay (Koyuk). Salmon canning operations peaked in 1963. Since then, markets have been sporadic through the 1980s. Some subdistricts were unable to attract buyers for entire seasons. The Nome Subdistrict closed commercial fishing periods from 1997 to 2012 due to regulatory restrictions on chum salmon, lack of buyer interest, and weak runs. Limited commercial fishing for chum and pink salmon began in 2013 and for coho salmon in 2016. Of all the subdistricts, Unalakleet and Shaktoolik have the most consistent markets. NSEDC established the Norton Sound Seafood Products (NSSP) in 1995 (Menard, Soong, Bell, & Neff, 2018). NSSP buys and processes salmon from the district's commercial fishermen from the NSEDC communities. NSSP operates processing plants in Nome, Unalakleet, and Savoonga.

In Elim, salmon fishing takes place at Moses Point near the Kwiniuk and Tubutulik river drainages. Historically, subdistrict 3 was not immune to the challenges associated with a lack of buyer interest and weak salmon runs. Weak salmon runs from 2002 to 2006 resulted in ADF&G's enforcement of subsistence fishery priority over commercial fishing. For five consecutive seasons, commercial salmon fishing did not occur. Salmon runs rebounded in 2007, resuming commercial salmon fisheries for coho, pink, and chum salmon and minimally for Chinook and sockeye. By the late 2000s, continued improving salmon runs sparked renewed buyer interest in the northern subdistricts (Menard, Soong, Kent, Harlan, & Leon, 2017). In 2017, the Norton Sound district reported well above average runs of chum, pink, sockeye, and coho. The sockeye salmon harvest, although a small portion of the overall harvest, was the second-highest in history at nearly 3,000 fish. The pink salmon run was one of the highest runs for an odd-numbered year; however, the only buyer had minimal interest in pink salmon.

In 2018, NSEDC reported a record harvest of more than 3.6 million pounds for these salmon species with an ex-vessel value of more than $4 million, an increase from the ex-vessel value of $2.8 million in 2017. An overall steady increase of harvest sold to NSSP by the district in recent years is shown in Table 6. The commercial salmon harvest shows a 107 percent increase for chum and more than 300 percent increase for coho and pink salmon, respectively, between 2013 and 2018. Red salmon increased the most.

Table 6. Salmon Harvest by Pound for NSEDC Communities, 2013-2018

Species	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**Percent Change**
Chum	820,615	737,906	1,017,160	344,613	1,162,302	1,695,616	107%
Coho	410,936	810,560	1,226,157	701,450	1,308,875	1,844,718	349%
Pink	24,802	572,461	215,714	748,576	71,746	116,194	368%
Red	1,145	2,102	25,656	16,057	16,568	18,978	1557%
Chinook/King	0	0	0	0	2,299	0	

Source: NSEDC Annual Reports 2013-2017

The commercial salmon harvest in the Elim subdistrict comprised between 8 and 40 percent of the total commercial salmon harvest sold to NSSP between 2013 and 2018. The rest of the NSSP salmon catch is harvested by NSDEC communities in the other four subdistricts. The harvest (in pounds) by Elim fishermen over this period is shown in Figure 10.

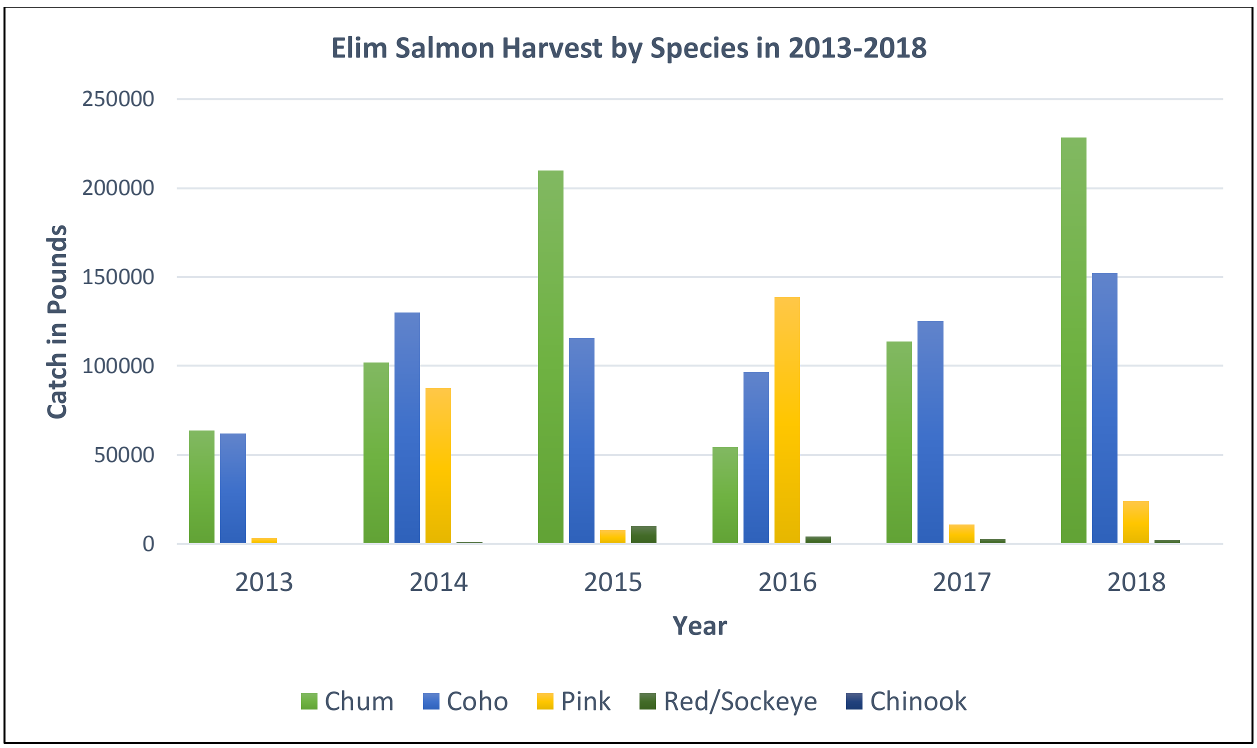


Figure 10. Elim Salmon Harvest in Pounds, 2013-2018

In 2017, NSSP was the only salmon buyer that operated in the Norton Sound. NSSP operates a fish plant in Unalakleet, where salmon was tendered from Subdistricts 2-5. Fishermen in subdistricts 1-3 also had the option to deliver their catch to the NSSP-operated fish plant in Nome. However, the option for a fisherman to deliver his catch from Elim to Nome is highly dependent on the capability of his commercial vessel to traverse to Nome and weather conditions. Table 7 below shows the average dock prices per pound for salmon from 2013 to 2017 in the Norton Sound District.

Table 7. Salmon Average Dock Prices per Pound in Norton Sound District, 2013-2017

Year	Chinook	Sockeye	Pink	Chum	Coho
2013		$1.49	$0.22	$0.55	$1.77
2014	$2.00	$0.63	$0.29	$0.60	$1.60
2015	$2.25	$0.60	$0.14	$0.50	$1.10
2016	$2.45	$0.90	$0.10	$0.48	$1.39
2017	$3.00	$1.40	$0.03	$0.79	$1.40
Five Year Average	**$2.43**	**$1.00**	**$0.16**	**$0.58**	**$1.45**

Source: (Menard, Soong, Kent, Harlan, & Leon, 2017, p. 87)

The harvest (in pounds) for each species is multiplied by the corresponding mean price for each year to calculate the value of commercial salmon harvest by the NSEDC communities (Table 7), then adjusted to current dollars using the Urban Alaska (formerly Municipality of Anchorage) Consumer Price Index (CPI). Commercial salmon fishery on a steady increase throughout this period, with the 2017 fishing season realizing the highest harvest value of close to $3 million is shown in Table 8. On average, fishermen from the 15 communities in Norton Sound earn more than $2 million each salmon fishing season.

Table 8. Value of Salmon Harvest in NSDEC Communities, 2013-2018

Year	Total	2019 Dollars
2013	$1,186,000	$1,287,000
2014	$1,907,000	$2,022,000
2015	$1,903,000	$2,008,000
2016	$1,230,000	$1,292,000
2017	$2,783,000	$2,910,000
2018	$3,706,000	$3,760,000
Average Harvest	**$2,119,000**	**$2,213,000**

Note: 2019 values are rounded

For the 2013 to 2018 period, the combined commercial salmon value harvested by Elim fishermen is an estimated $300,000 (rounded) each season. This is about $10,800 per fisherman (total value divided by 28 average commercial fishermen in Elim). The rest of the salmon harvest is caught by the rest of the NSDEC communities in other subdistricts and sold to NSSP.

5.3.2 Permit Holders

Based on ADF&G reports (Menard, Soong, Kent, Harlan, & Leon, 2017), there are 131 commercial salmon permit holders on average that participate in the Norton Sound District salmon fishery. Of this total, about 28 are Elim commercial fishermen and comprise 20 percent of the district's commercial salmon permit holders. Close to 50 percent of the commercial salmon fishermen homeport in Unalakleet, where there is a natural small boat harbor. Excluding the small boat harbor in Nome, Unalakleet is the only community in the region with a boat harbor and serves more than 100 residents and non-resident commercial vessels that participate in salmon, herring, and crab fisheries (Strickling S.E., Kawerak Inc, 2013).

5.3.3 Vessel Types

Commercial salmon fishermen in the Norton Sound District operate set gillnets from outboard-powered skiffs. The CFEC maintains a database of commercial permit holders and registered vessels in the state. However, not all vessels for some areas in western Alaska are captured in the CFEC database. The exclusion of some vessels from the CFEC database is due to a vessel license exemption enacted into law by the Alaska State Legislature that exempts skiffs used in salmon fisheries from registration with CFEC (AS § 16.05.490). The exemption state law was intended to reduce the financial burden of participation in the commercial salmon fishery on western Alaska communities. In the Norton Sound region, the requirements for exemption are often met, as most fishermen do not participate in other commercial fisheries. In short, only those fishermen in the Norton Sound District who may want to participate in other non-salmon fisheries would be motivated to register their vessel with the CFEC. As such, the description based on CFEC information of the vessel types in this fishery is not holistically representative of the vessel fleet in the region. Nevertheless, the records by CFEC show some important information about the fleet in Norton Sound District, particularly that the commercial fleet is aging.

There are 100 commercial fishing vessels in the region. The number of fishing vessels in the Norton Sound district that registered with CFEC in 2018 is shown in Table 9. The average lengths of vessels at each subdistrict range from 22 to 33 feet. Two of the commercial vessels have steel or iron hulls, 98 have aluminum hulls. More than 60 percent of the commercial fishing vessels are at least 30 years old. Newer vessels that were built in the 2000s make up 10 percent of the commercial fishing vessels. Commercial vessels may participate in multiple fisheries and use several gear types. Close to 80 of commercial vessels use set gillnets, 64 participate in gillnetting for herring, 30 use crab pot gear, 11 use longline gear, and only 1 uses drift gillnet gear. The commercial fishing vessels in Elim are further discussed in subsequent sections of this report about the fleet.

Table 9. Norton Sound District Commercial Vessel Characteristics, 2018

Subdistrict	**Number of Vessels**	**Average Length Overall (feet)**
Elim	7	25
Golovin	4	25
Koyuk	4	22
Nome	13	33
Shaktoolik	23	25
Unalakleet	49	25
Total	100	

Year Built	Percentage
1966-1979	6%
1980-1989	59%
1990-1999	25%
2000-2018	10%
Gear Type	**Percentage**
Gill Net - Drift	1%
Gill Net - Herring	64%
Gill Net - Set	77%
Pot Gear	31%
Longline	11%

5.3.4 Subsistence Salmon Overview

Subsistence fishing according to Fall et al. is an important element of Alaska's social and cultural heritage, as well as a crucial component of the subsistence sector of the state's economy (2019, p. xvi). In the Norton Sound region, nearly all residents depend on fish and game resources. The dependency on each resource varies by community due in part to a community's location and the migratory behaviors of wildlife resources. (Braem & Kostick, 2014). Subsistence fishermen operate gillnets or seines in the main rivers and, to a lesser extent, in coastal marine waters to harvest salmon (Menard, Soong, Bell, & Neff, 2018). As previously discussed in this section, the salmon fisheries are managed on a sustained yield basis. Priority is given to subsistence users over commercial and sport fishermen as required by Alaska law.

ADF&G monitors subsistence harvests through permits issued to users made available in Nome. Subsistence use permits are also distributed by field staff deployed throughout the communities prior to fish openings. The permits identify gear restrictions and require subsistence users to record gear type used, areas fished, and catch quantities by species for each day fished. The majority of subsistence fishing is conducted during the summer months, and the catch is air dried or smoked for consumption by residents or occasionally by their dogs (Fall et al., 2019)

From 2012 to 2016, subsistence users in subdistricts 1 to 6 harvested an average of 64,000 salmon. Since 2013, regulations allowed for cash sales of subsistence-taken finfish for up to $500 per household per year in the Norton Sound District.

5.4 Marine and Terrestrial Mammals

Marine-related terrestrial resources are those land-based subsistence resources residents access by vessel. Given the centrality of subsistence use to the customs and traditions of remote Native Alaska communities like Elim, this subsection provides an overview of these wildlife resources with a focus on terrestrial resources that require access by boat.

5.4.1 Subsistence Hunting and Fishing Management

Subsistence fishing and hunting in Alaska is regulated in a dual management system. There are overlapping state-federal jurisdictions in many hunting and fishing areas. Depending upon where the harvest occurs, subsistence fishing and hunting is regulated by the State of Alaska (ADFG) and the federal government. The following agencies manage and regulate subsistence hunting and fishing in Alaska:

- Alaska Board of Fisheries (BOF)
- Alaska Board of Game (BOG)
- Alaska Department of Fish and Game (ADF&G)
- U.S. Fish and Wildlife Service (USFWS)
- National Marine Fisheries Service (NMFS)
- Federal Subsistence Management Program (FSMP)

The BOF and BOG create regulations for state and subsistence fisheries or hunts The Federal Subsistence Regulations for state subsistence fisheries or hunts are created by Board creates regulations for federal subsistence fisheries or hunts. Each board follows established procedures for obtaining information and comments on proposed regulations from the public, agencies, and other interests.

The federal government manages marine mammal hunting through NMFS (seals, sea lions, and whales) or USFWS (polar bears, sea otters, and walruses). An exemption in the federal Marine Mammal Protection Act allows for the traditional harvest and use of marine mammals by coastal Alaska Natives. The USFWS manages subsistence hunting of migratory waterfowl.

Subsistence resources are harvested during different seasons. The subsistence resources Elim harvests is exhaustive. Most of wildlife resources are harvested from inland and require traveling up the Kwiniuk River. Moose, caribou, and berries are examples of such resources. During the resource harvests in the warm ice-free seasons, residents often organize camping trips, which consist of traveling up the Kwiniuk River by boat to hunt, and collect berries, eggs, and other resources. This assessment focuses on three mammals the community harvests on a subsistence basis by boat: beluga whale, caribou, and moose.

5.4.2 Beluga Whale

"Beluga whales are an important subsistence resource for coastal residents of Alaska." (Frost K.J, Alaska Beluga Whale Committee, 1998, p.1). Residents use the meat, skin, and blubber for food, certain clothing items, and equipment. It is also shared with friends and relatives in other communities. The eastern Bering Sea (Norton Sound/Yukon Delta) is one of the five summering concentrations in Alaska where belugas are found. The other summering concentrations include Cook Inlet, Bristol Bay, eastern Chukchi Sea (Kotzebue Sound and Kasegaluk Lagoon), and the eastern Beaufort Sea.

Representatives from the communities in these groups (except Cook Inlet) make up the Alaska Beluga Whale Commission (ABWC). Established in 1988, the role of ABWC includes the co-management of beluga whales with NMFS to maintain a healthy beluga whale resource for subsistence and public enjoyment by future generations (Alaska Beluga Whale Committee, 2020). At the community level, local management organizations exist to coordinate hunts and support ABWC. Elim-Shaktoolik-Koyuk Marine Mammal Commission is one of these local organizations with representatives from the three communities. The significance of belugas to coastal Native Alaska communities is noted by the traditional ecological knowledge (TEK) held by the elders. A part of this TEK is documented by Hungtington et al. (1998), specifically: the migratory and local movements, feeding, calving, and ecological interactions. The insights shared by the Elders the study found are consistent with past biological studies of beluga whales. The beluga movements follow the tide and the fish both in the spring and the fall. The movements of beluga whales in the Norton Bay during the spring and fall seasons, as documented by Huntington et al. during interviews with Elim, Shaktoolik, and Koyuk community members is shown in Figure 11.

Beluga harvest in the spring occurs from April to May when the belugas arrive into the Norton Bay from the south, along the coast past Besboro Island and Shaktoolik or from southwest, past Cape Darby and Elim. Hunters from Elim and Shaktoolik hunt from the ice edge near their villages using harpoons and nets. In the fall, beluga harvest occurs from August to September and sometimes October. All three communities often hunt cooperatively inside the Norton Bay. Beluga hunting in the fall uses vessels, nets, harpoons.

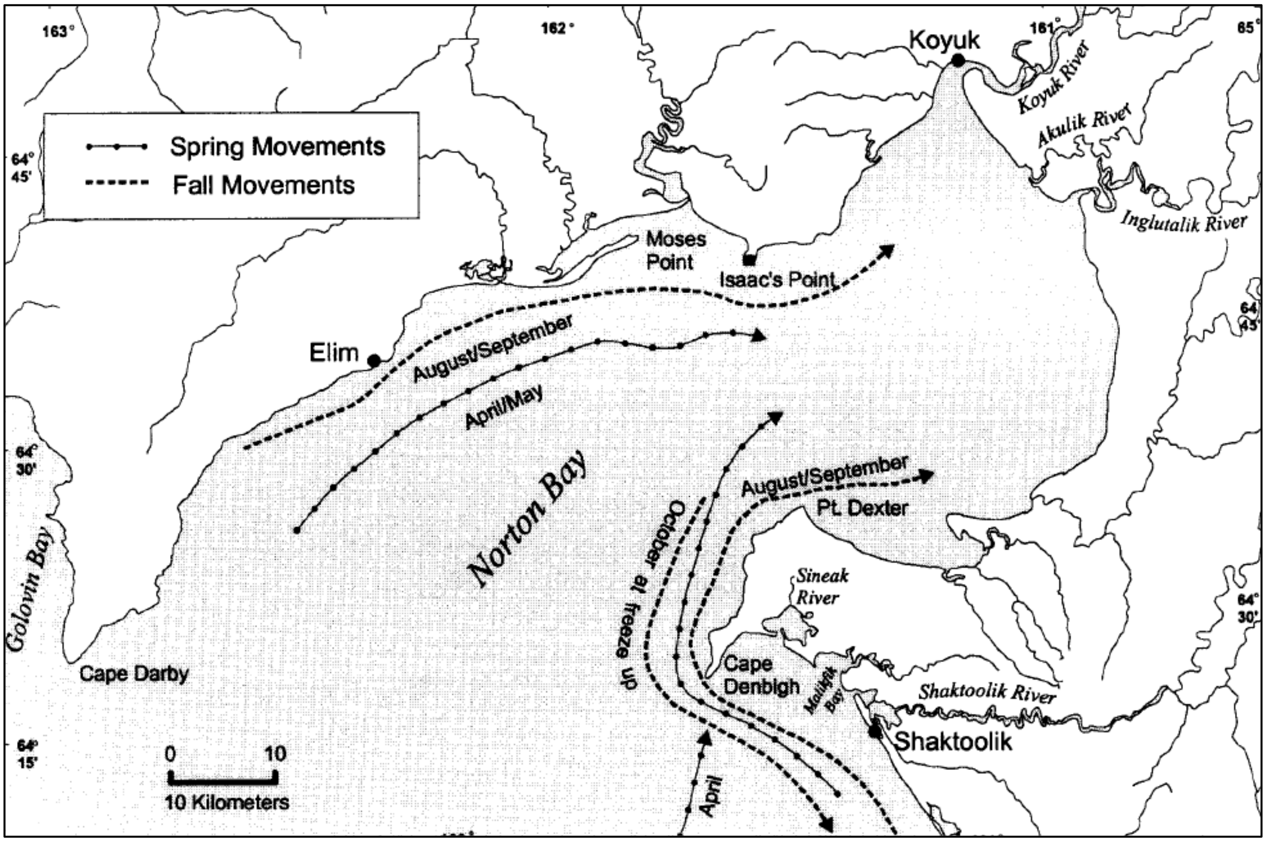


Figure 11. Beluga migratory and local movements during spring and fall in Norton Bay
(Source: Braem & Kostick, 2014)

A comprehensive survey conducted in 2006 on subsistence use in the Bering Strait region by Ahmasuk et al. (2007) estimated beluga for that year was 188 pounds per capita at Elim. At Koyuk, the survey findings estimated 10 pounds per capita. The comprehensive survey further reported 40 percent of Elim households shared a portion of the beluga harvest they obtained.

5.4.3 Caribou

The role of caribou in the nutritional, cultural, and economic health of northwestern Alaskan communities varies (Braem & Kostick, 2014, p.8). Similar to beluga whales, caribou herds are migratory. The ADF&G categorizes the caribou herd which roams the region Elim is located as the Western Arctic caribou herd (WAH). This herd roams throughout an area of 140,000 square miles, is the largest caribou herd in the state. Elim residents harvest caribou from fall through winter (October to April). During the fall months, hunting camps traverse the river to reach the hunting area, according to a community member. In the winter, snow-machines are often used. ADF&G surveyed Elim households in 2011 and reported 34.6 pounds per capita caribou harvest. The harvest per capita at Elim is low compared to its neighbor Koyuk which reported 84.4 pounds per capita. Braem and Kostick further reasoned that a village's location is one of the factors that influence a community's caribou harvest each year, residents may have only occasional access to the WAH.

5.4.4 Moose

Elim residents hunt moose during the summer months (July to September) from the same region the caribou roam. ADF&G's household survey in 2011 found that moose harvest for Elim was 18.4 pounds per capita. Koyuk, in comparison, harvested nearly twice as much as Elim: 34 pounds per capita. Braem and Kostick noted community concerns that compared to the past, there were fewer moose and that they were too far away from the community. Moose harvest is influenced by the same factors that influence the caribou harvest previously mentioned which include migratory behavior and location of the community.

5.5 Marine Resource Outlook

Subsistence and commercial salmon fisheries are expected to continue to support the demand for a harbor in Elim over the period of analysis. Despite weak salmon runs from the early to mid- 2000's, commercial salmon fisheries in the Norton Sound rebounded steadily from 2007. In Elim specifically, commercial salmon harvest increased significantly between 2013 and 2018. NSEDC's future plans and NSSP's operations in the Norton Sound Region are indicative of a continued buyer presence and market for salmon fisheries. The management of salmon by the previously mentioned entities in Alaska support sustaining the fisheries for Alaska and the Norton Sound region.

Similarly, marine and terrestrial wildlife resources are regulated to support sustainable resources and subsistence use. Subsistence harvests of terrestrial and marine resources in Elim and the region is expected to continue to support its mixed economy and sustain cultural and social practices.

5.5.1 Climate Change, Resiliency, and Adaptation

The NOAA began publishing an annual, peer-reviewed Arctic Report Card in 2006. The Report Card is a "source for clear, reliable, and concise environmental information on the current state of different components of the Arctic environmental system relative to historical records" (Osborne, Richter-Menge, & Jeffries, 2018). The 2019 Arctic Report Card states that the winter sea ice in the Bering Sea continues to decline as ocean temperature rise (NOAA Arctic Program, 2019). Elders from the Bering Sea communities note that their access to subsistence resources is more challenging and hazardous in a warming Arctic. In addition, the Bering Seas fisheries according to the report card is experiencing a northerly shift in the distribution of subarctic in the distribution of subarctic and Arctic fish species, linked to the loss of sea ice and changes in bottom water temperature.

While climate events such as a warming arctic impact the access to subsistence resources in the Bering Sea communities the reliability upon these resources remains increasingly important. As such, multi-level government and non-government organizations listed in the beginning of this section continue to work collaboratively to support the resiliency and adaptation of local communities to the changing climate.

6.0 EXISTING CONDITIONS

This section describes Elim's current conditions. Recall that Elim has limited transportation infrastructure and relies on air and maritime transportation, as described in previous sections. Existing conditions serve as the baseline for projecting the future with- and future without-project for comparison. This section discusses the vessel operations, Elim's proximity to other harbors, and the existing fleet. Existing conditions in Elim is informed by the USACE Continuing Authorities Program (CAP) 107 Elim study in 2013; community insights shared at the study charette in the fall of 2018, focus groups in April 2019, and available information by the Department of Commerce, Community and Economic Development (DCCED, 2019).

6.1 Vessel Operations

Elim has no permanent boat launch, moorage, or barge ramp infrastructure. There are two areas in Elim that are used for launching commercial and subsistence vessels: the beach in front of the community and Moses Point. This report refers to the beach site located in the community of Elim Beach (Figure 12). At Elim Beach, most boats are anchored just offshore or pulled onto the beach for storage when not in use. When strong waves or a storm is approaching, a loader is used to pull boats up from shore on to Front Street, highlighted in orange on the map. A fisherman requiring a loader to pull his skiff from the water due to rough waves in October 2018 is shown in Figure 13.

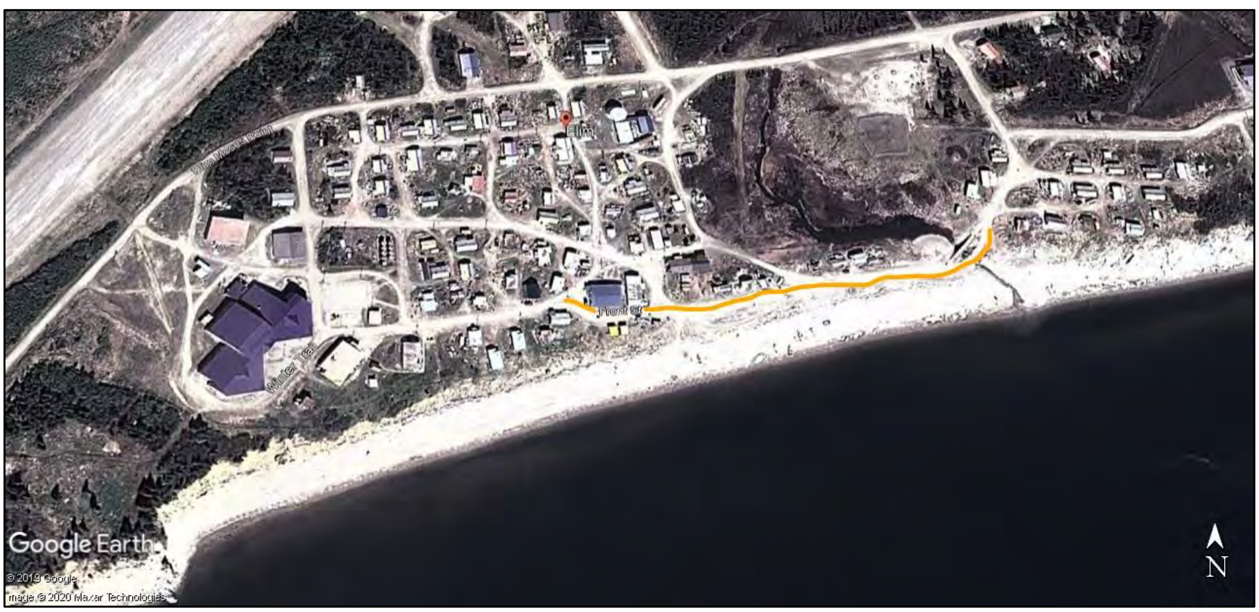


Figure 12. Elim Town and Beachfront

Figure 13. Loader pulls a salmon skiff from rough water at Elim Beach, October 2018. (Photo courtesy of a local community member: C. Nagaruk, April 2019)

Moses Point is the sandy mouth of the Kwiniuk River used as a make-shift harbor and is located about 10 miles northeast of the center of Elim. Elim and Moses Point are connected by a gravel road, which takes approximately 20 minutes to travel one-way by vehicle. Compared to Elim Beach, Moses Point provides some protected moorage for small boats. Many vessels, even the larger commercial fishing vessels, are pulled onto shore at Moses Point when not in use. Due to the shallow depth along the Kwiniuk River slough and river mouth, larger vessels with drafts of approximately 5 feet or more cannot access Moses Point.

Moses Point is an active and dynamic river mouth. During storm surges, flooding occurs at Moses Point and extends along the road. When the road floods, residents cannot drive to Moses Point to check on their boats. Flooding can also erode the road and further prohibit access. Winds of 40 knots/hour from the southwest shift the sand bar that protects the river mouth. Without protection, boat access from the ocean to Moses Point during high tide becomes challenging and unsafe. The community reported that several boats have turned over and lost motors during flood events. The current conditions at Moses Point are such that while it provides some safe moorage for small subsistence skiffs to the larger commercial vessels, safe access from the ocean and from the town via the road is weather permitting. The location of Moses Point, relative to Elim, is show in Figure 14. Dragging boats onto the shore causes boat damage and reduces the life of the vessel. Vessels anchored offshore are subject to swamping, which cause serious damage to the engines.

Figure 14. Location of Moses Point Relative to Elim

6.1.1 Subsistence Activities

Elim residents rely upon the harvest of subsistence resources for food, clothing, tools, and medicinal uses. The community's reliance on subsistence is especially significant, given Elim's relative isolation and limited connections to other communities. Additionally, while imported foods are appropriate supplements, these are not precise substitutes to subsistence foods, which are part of the community's traditional diet.

Subsistence resources are harvested by season and typically require access by boat. For example, when hunting caribou, hunters travel up the Koyuk River and set up camp. However, when they return with game weighing over 1,000 pounds, the shallow depths at Moses Point can become inaccessible. The alternative access point is Elim Beach, but due to rough water conditions, safely approaching shore is difficult. Community members often prepare to wait out the wave conditions offshore and time when they attempt to approach the shore. When the community anticipates these conditions during a harvest season, they often choose not to attempt subsistence harvest at all.

6.1.2 Commercial Fishing

During the fishing season, NSEDC sets up a fish buying station at Moses Point. The fish buying station consists of a small crane, a conex, totes for fish, and several skiffs used to transport fish to a tender moored offshore (Figure 15). Fishermen deliver their catch to the buying station by boat or by four wheeler depending on where they set nets. Fish is placed in totes and loaded onto skiffs and delivered to the offshore tender. Fish delivery skiffs are tied next to the tender vessel, and the crane on the tender transfers the totes, each weighing approximately 1,500 pounds. The skiffs make 5 to 10 trips daily to deliver fish totes to a tender during the fish openings. Tides dictate deliveries to the offshore tender, and the amount of fish caught. During rough wave activity, this operation becomes complex and unsafe. The tender then delivers the fish totes to the NSSP plant at Unalakleet.

The operability of the fish buying station is impacted when lower low tides and north winds limit navigational access to the site. Access through offshore sand bars is also variable. Some fishermen choose not to fish during openings if they anticipate that the buying station will not be accessible due to low water levels. Due to flooding events and when lower low tides restrict access, the fish buying station is periodically relocated to Iron Creek, approximately five miles northeast of Elim. An employee at the fish buying station reported that when water levels are too shallow at Iron Creek for boat access, fish totes are transported by four-wheeler to town. From the beach, a telehandler forklift (referred to as a Zoom Boom loader) transfers the fish totes onto a skiff in the water for delivery to the tender anchored offshore. Disruption to fish buying operations that require relocations to either Iron Creek or Elim Beach occur 8 to 10 times per fishing season.

Figure 15. Fish Buying Station at Moses Point

6.1.3 Freight Barge

Elim has no barge landing infrastructure. Freight barges land on the east end of Elim Beach, just east of the mouth of a small stream where there are fewer rocks obstructing beach access. The location of the landing are shown in Figure 16. Barge deliveries to Elim use a beach landing craft that is 150 feet long with a 47-foot beam. The landing craft is pushed on to the beach, and freight is offloaded using a loader. Cargo barges make deliveries to Elim twice each summer but will deliver more often if necessary.

Due to the depth at the freight barge landing site, freight barges must land at high tide. Similarly, it must launch at high tide when it departs from Elim after delivery, which means that it must either offload quickly or wait for appropriate tidal conditions to launch. In some cases, the barges will accelerate speed from offshore and ride a wave to the beach. Operators do this when after waiting for the high tide, but the high tide is not enough water depth for the keel of the barge. They wait for a breaking wave and must time with precision when to speed up to catch the wave from the halfway point to the front of the barge. The barge surfs the wave to shore and risk rough landing on the gravel beach with a heavy load. This practice poses risks to the safety of barge operators and crew.

Sometimes when the tide is not deep enough to offload cargo, self-lightering is required. Self-lightering is when the loaders and equipment are walked through the water to shore to lighten the load, which causes additional wear and tear on the equipment and leaves sheen behind in the water.

There is an exposed sewer outfall line near the middle of the shoreline fronting the community that poses a navigational hazard to barge landings. The approximate location of the sewer outfall is labeled in Figure 16. Also, there is limited staging area at the existing freight landing site, which also reduces the efficiency of deliveries. The bridge in Elim over which equipment must cross to deliver some freight is reported as "substandard" and cannot accommodate large trucks.

Figure 16. Elim, Alaska

6.1.4 Fuel Barges

Fuel delivery to Elim occurs two to three times per year using a tug and barge combination. Under existing conditions, the fuel barge anchors offshore and floats a hose to shore to deliver fuel to the commmunity. Barge operators do not land on the beach in Elim because of the rock outcrops along the west area of the beach that may damage the barge. The fuel tank farm serving Elim is near the south end of the airport runway shown in Figure 16. The fuel tank farm is 150 feet above sea level. The fuel header is located on the west side of the community near the school (see Figure 17). The fuel header and tank farm are connected by two 4-inch pipes (one for gasoline and one for diesel/fuel oil) approximately three-quarters of a mile long. To deliver fuel to the community, barges double anchor 60 to 70 feet offshore of Elim Beach near the fuel header and float a 4-inch hose to shore. The hose is dragged across the beach and up the bluffs by hand to the fuel header where it is connected. Usually, the fuel vendor tests the line to be used before the connection. Upon successful completion of testing, the fuel is pumped from the barge to the tank farm. The delivery rate is considered slow and requires 24 hours offloading; this is believed to be caused by the tank farm’s elevation above the barge. After fuel delivery, some of the fuel remaining in the pipelines will be forced into the tanks by high-pressure air from the barge. Some of the fuel remains in the pipelines. The fuel header valves are closed, and the hose disconnected and caps are placed on both header and the hose. Retrieval is again done by manpower from the header back to the beach and floated back to the barge. Fuel remaining in the hose is drained back into the barge.

There are many occasions through delivery, where small spills can occur. This practice of anchoring offshore and floating a hose to shore poses a risk of fuel spills during offloading from the barge to the fuel header.

Figure 17. Fuel Header in Elim

6.2 Proximity to Other Harbors

If local Elim boaters chose not to store their vessels in Elim, there are few options for alternative ports. Communities nearest to Elim that have harbor facilities are shown in Table 10. The nearest communities to Elim are Golovin and Koyuk, which lie approximately 23 miles west and 40 miles east of Elim, respectively. However, there are no marine facilities at either location. There are no road connections between Golovin, Koyuk, and Elim, further limiting the potential for alternate boat storage.

Table 10. Distances between Elim and Nearby Communities with Harbor Facilities

Distances from Elim to:	Nautical Miles
Nome	102
Unalakleet	60

Source: Distances Between United States Ports, NOAA 2009 & Google Earth 2012

Elim is not connected to any communities by road. The closest community to Elim, which contains marine facilities, is Unalakleet, located 60 nautical miles south of Elim. Assuming an average travel time of 10 knots, it would take about 6 hours to travel between Elim and Unalakleet by boat.

The majority of the vessels in Elim are 18- to 24-foot skiffs, which are not conducive to an approximately six-hour trip across Norton Sound. Elim residents use their vessels mostly for subsistence harvesting and some commercial fishing and need their boats available for quick launching. Boat storage in Unalakleet would reduce the availability of their vessels and, therefore, the ability to participate in commercial and subsistence harvests. Given the isolation of Elim, the usage patterns of local vessels, and the distance to any alternate ports, the benefit to Elim residents of storing their vessels at alternate port facilities outweigh the costs of air travel and reduced harvest opportunity.

6.3 Search and Rescue for Vessels in Distress

When there is a vessel in distress, the existing conditions make it difficult to safely mobilize search and rescue efforts. Response vessels often wait for better weather and wave conditions to launch from Moses Point or Elim Beach (USACE Public Meeting, 2018). These conditions are reduced depths at Moses Point and the moving sand bars in front of Elim Beach. If the water depth conditions at Moses Point are favorable for boat launch, response community members still have to drive from Elim to Moses Point provided the eroded road is not flooded. The longer the delay in launching response vessels, the greater the potential risks are for the vessel in distress.

6.4 Existing Vessel Fleet

Four vessel classes make up the vessel fleet in Elim. The first class is the subsistence vessels, which are skiffs with outboard motors used for subsistence fishing, hunting, and gathering. The second class is the commercial fishing vessels that participate in commercial salmon and herring fisheries. Due to the remote location of Elim and the lack of moorage infrastructure, there are no commercial fishing vessels from other communities. Third is the commercial fish tenders that deliver fish from the community to the processing plant in Unalakleet. Fuel and freight barges make up the fourth class. The fuel barge combines the tug boat and barge. Characteristics of the existing fleet are summarized in Table 11.

Table 11. Characteristics of Vessel Fleet in Elim

Vessel Class	Number	Length (feet)	Width (feet)	Draft (feet)
Subsistence	25	18-24	7	2
Commercial	25	20-32	12	5
Tender	2	33-66	16-24	6
Freight Barge	1	150-180	52	7
Fuel Barge	1	150-159	52	7

Tug*	1	70-86	28.5	8

Note: The tug is combined to the fuel barge and is discussed as a single unit vessel throughout the analysis

During a site visit to Elim in September 2011, there were about 50 vessels in the community. The community members reconfirmed this number at public meetings held in Elim in August 2018. The local fleet includes small skiffs (18 to 24 feet length overall) and larger seine vessels (20 to 32 feet length overall) used for subsistence and commercial fishing. NSEDC reports that 23 to 25 Elim fishermen hold permits and participate in commercial fisheries. This analysis, therefore, assumes that 25 vessels participate in both commercial and subsistence fishing, and the other 25 vessels participate in subsistence harvesting.

The tenders that call on Elim support the commercial fishery by delivering Elim's catch to NSSP's fish processing plant in Unalakleet. NSEDC operates a total of six tenders in the communities it serves. The overall lengths of tenders range from 33 to 66 feet and draft between 4 to 24 feet. The tenders dispatched to the communities are dependent on the expected size of the catch and water depths at the fish buying station sites.

Available data from WCSC shows the typical fuel and freight barges that call into Elim. The freight barges are landing crafts with overall lengths between 150 and 180 feet and draft up to 8 feet when loaded. The fuel barges are typically the following: deck barge, double and single-hull tanker barges with tugs that are up to 86 feet long. Barges that deliver construction materials or rock for the road are up to 240 feet long combined with tug and draft up to 7 feet loaded.

7.0 MOORAGE DEMAND ANALYSIS

The assessment of moorage demand in Elim is based on personal interviews or phone calls with fuel and freight barge operators, the NSSP fish processing plant manager, and community members who participate in subsistence and commercial fishing activities. Information gathered during these meetings was compared with the moorage demand analysis from the previous CAP 107 Elim study. Existing demand for moorage is similar to demand detailed in the 2013 CAP study. Given that no moorage infrastructure has been put in place since then, the demand for such infrastructure remains unmet.

There are approximately 50 vessels owned by community members in Elim. These vessels are used for commercial fishing or subsistence. About 25 vessels are used for subsistence harvesting, and 25 vessels are used for commercial fishing activities in addition to subsistence harvesting. These vessels are exposed to vessel swamping and inclement weather, whether they are moored at Moses Point or offshore at Elim Beach.

There is no moorage for tenders at Elim Beach or Moses Point. During the fishing season, two tenders alternate deliveries from Elim to the Unalakleet processing plant. The tender moors offshore and receives the fish totes from a skiff. The efficiencies of this operation could be improved with a dredged channel and protected tender dock. NSDEC plans to set up a pre-processing plant in Elim for the commercial fishery. This plant will be a head and guts facility intended to pre-process fish before it reaches the plant in Unalakleet. The pre-processing plant intends to alleviate the amount of fish delivered to the Unalakleet plant at the same time. It is a reasonable projection that with NSDEC's future plans, up to two tenders may call into Elim at the same time. The moorage demand for tenders is safe moorage for two tenders.

The barges and landing craft that serve Elim deliver fuel and cargo during the ice-free months of June through October. Deliveries occur one to three times each season. The depth restrictions at Elim continue to result in delays for cargo delivery and fuel offloading. Safe moorage demand for barges require accommodating a barge up to 240 feet in length and 50 feet in width. The maximum lengths, beam, and draft for each vessel class at Elim is shown in Table 12.

Table 12. Elim Vessel Fleet Maximum Dimensions

Vessel	Number	Vessel Length (feet)	Design Beam (feet)	Design Draft (feet)
Freight Barge	1	159	52	7
Tug	1	86	28.5	8
Tender	2	66	24	6
Commercial	25	32	12	5
Subsistence	25	18	7	2

8.0 FUTURE WITHOUT PROJECT CONDITIONS

This section provides an analysis of the adverse impacts on subsistence and commercial harvests and vessel damages that could potentially be avoided with navigation improvements at Elim. Vessel damages are assigned monetary values, and if not possible, the damages are discussed in qualitative terms. The future without-project condition (FWOP) provides a benchmark for comparison of the proposed alternative plans. This analysis uses the Federal fiscal year 2020 discount rate of 2.750 percent and a 50-year period of analysis.

This section also provides the expected future conditions under which Elim residents will operate, as a comparison to the existing conditions. This analysis uses several key assumptions about the operating conditions of Elim boaters to define the future without-project condition:

- A small fish processing plant will be built in Elim to maintain fish quality and reduce delays associated with plant capacity at Unalakleet
- Fish buying station will be relocated to wherever the commercial fishermen can land their catch, be it at Elim Beach, Iron Creek, or Moses Point

The potential benefits described in this section are specific to the vessel fleet operating in Elim. Where necessary, assumptions are developed based on similar USACE studies or communities in Alaska.

8.1 Subsistence Analysis

Subsistence is one of the two sectors of Elim's mixed economy. Elim residents rely upon the harvest of subsistence resources for food, clothing, tools, and medicinal uses. The community's reliance on subsistence is especially significant, given Elim's relative isolation and limited connections to other communities. Airfreight and cargo barges are the only methods to deliver goods to Elim. Weather conditions and lack of a protected landing area mean that barges are sometimes delayed, and residents may have to go without supplies. In addition, lack of moorage infrastructure and sufficient water depths for navigation hampers subsistence activities and result in potential harvests not being met. To estimate the potential unmet harvests, this analysis focuses on three major subsistence goods that are acquired by subsistence vessels. These goods are fish (salmon and non-salmon), beluga whale, caribou and moose. The subsistence analysis uses data from the Bering Strait Region Local and Traditional Knowledge Pilot Project, a comprehensive study on subsistence harvest in the Bering Strait Region (Ahmasuk et al. 2008). The comprehensive study reported estimated pounds harvested of fish, beluga, caribou, and moose by Elim during the 2006 and 2010 seasons.

The method used in the subsistence analysis is as follows. First, the total pounds of harvest for the selected goods by the community are determined. Second, subsistence harvests are assigned dollar values based on assumed replacement and production cost values for these resources. ADF&G Division of Subsistence conducted a study on Subsistence in Alaska reported a replacement cost value of subsistence resources range from $5.00 to $10.00 per pound in 2017 dollars or $5.23 to $10.47 in current dollars (2018). The Alaska District also conducted a study on subsistence harvests in one of the rural communities: Little Diomede and found maximum harvest value of subsistence resources is $26.15 per pound in current dollars (USACE- Alaska District, 2011). The latter study considers the cost of production for acquiring subsistence resources, whereas the former study by ADF&G considers the cost of purchasing proteins as replacements for subsistence resources. When the cost of acquiring subsistence resources is taken into account, the value of subsistence is higher. It is also more representative of the activities in the rural communities.

The values calculated for Little Diomede are specific to that community and do not necessarily represent the costs to harvest subsistence resources in Elim. However, including this cost on the distribution of possible subsistence valuations is appropriate for this analysis to address the range of methodologies for valuing subsistence. The method used for the Little Diomede feasibility study is a production cost method that assumes that subsistence resources are worth at least as much as the harvesters invest in them through expenditures of cash and labor. The production cost method is therefore considered to be a more comprehensive approach than simply considering the grocery store (or equivalent) replacement value of these resources.

The subsistence data presented in the Little Diomede feasibility study is based on comprehensive surveys to estimate subsistence production time and costs. The level of data needed to conduct a detailed update of this method is not available for Elim. Updating the value from the Little Diomede study using an economic index is an appropriate method to utilize this data for Elim. This value is used as one point on the distribution of subsistence values to represent the uncertainty in quantifying these resources.

Subsistence harvest values used in this analysis are based on the ADF&G and USACE studies previously mentioned and using @Risk, a Microsoft Excel add-in. To address variation and uncertainty in harvest values, this analysis uses an @Risk triangular distribution with the following parameters: $5.33 (minimum), $13.95 (most likely), and $25.94 (maximum). Given uncertainty and lack of historical data about production costs for subsistence resources in Alaska, a triangular distribution with these parameters is considered appropriate for this analysis. This analysis uses the mean value of $13.95 per pound from the distribution for further calculations.

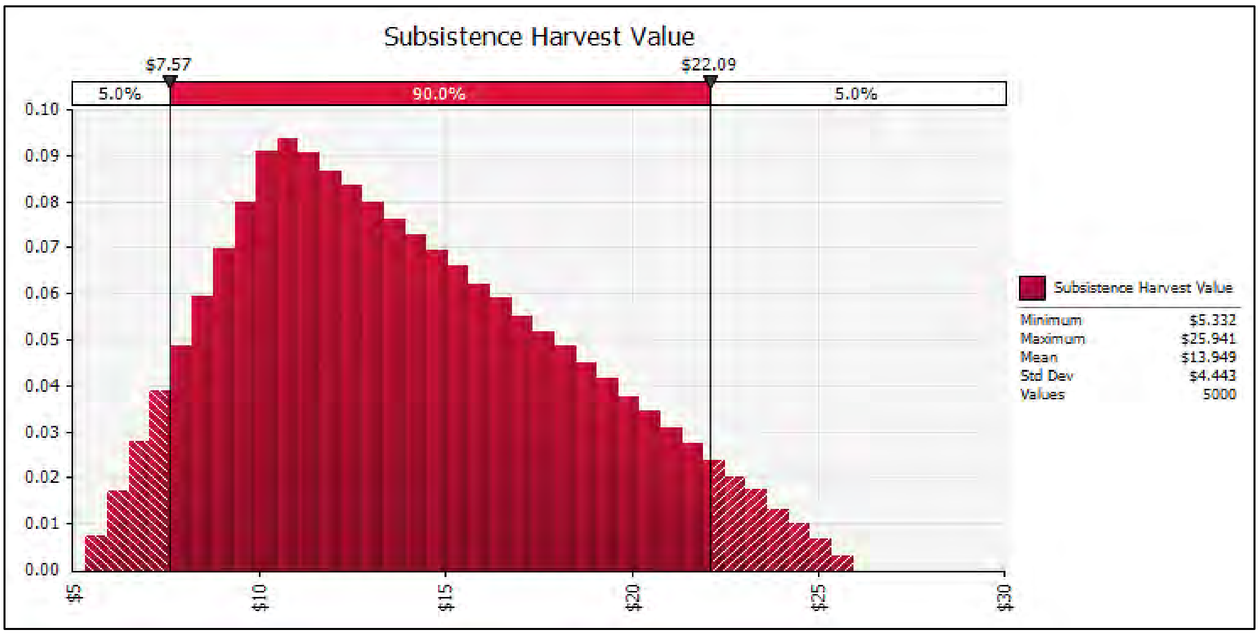


Figure 18. Subsistence Harvest Value, @Risk Simulation

Now that the subsistence value per pound is determined, the next step is estimating the subsistence harvest Elim residents forego due to the navigational inefficiencies previously described. Alaska District hydraulics and hydrology (H&H) engineers conducted wave modeling in Elim to evaluate accessibility improvements with a project. The H&H model considers historical wave conditions by month and the wave criteria requirements of each vessel class. Based on the wave model, access conditions for subsistence vessels were estimated to increase by a certain percentage with navigational improvements. The wave model is further described in the CE/ICA Framework section.

The subsistence analysis further assumes that as a result of improved access, the amount of subsistence harvest will improve by the percentage of accessibility. It is previously mentioned that subsistence harvests are dependent on the season. Fish is harvested in the summer season while beluga whales are harvested in the fall and sometimes spring. The estimated percent increase of harvest for each resource based on the projected accessibility during the harvest periods is shown in Table 13. The estimated harvest increase represents foregone subsistence harvest absent federal intervention.

Table 13. Percent of Increased Harvest by Resource

Harvest Period	Subsistence Resource	Potential Increase in Harvest
June- September	Fish (Salmon and Non-Salmon)	12%
August-September	Beluga	5%
October-November	Caribou	10%
July-September	Moose	10%

To estimate the subsistence harvest forgone, the total pounds of harvest for fish, beluga, caribou, and moose reported by the NPRB comprehensive study is multiplied by 12 percent, 5 percent, and 10 percent respectively. The estimated increase in total pounds for Elim is about 15,900 pounds. The pounds foregone is then multiplied by the mean price value of $13.95 (15,900 pounds x $13.95). The subsistence harvest foregone is $221,823 annually. The estimated harvest increase by resource is presented in Table 14. Input data for estimate the value of subsistence harvest foregone is summarized in Table 15.

Table 14. Estimated Annual Subsistence Harvest Value Increase by Resource

Resource	Reported Total Harvest in Pounds	Percent of Expected Harvest Increase	Estimated Harvest Increase in Pounds	Value of Harvest Increase
Fish	65,006	12%	7,801	$108,821
Beluga	50,209	5%	6,025	$84,050
Caribou	11,294	10%	1,355	$18,906
Moose	6,001	10%	720	$10,046
Total	**132,511**		**15,901**	**$221,823**

Table 15. Annual Subsistence Harvest Value Foregone

Variable Description	Value
Estimated Total Harvest Increase in Pounds	15,901
Average Mean Price Per Pound	$13.95
Annual Forgone Subsistence Value	$221,823
AAEQ Value	**$228,000**

8.2 Additional Commercial Harvest

Depth constraints coupled with a migrating river mouth at Moses Point, where commercial fishing vessels deliver their catch lead to inefficiencies with commercial fishery operations, Elim's commercial fishermen, lose out on some commercial harvesting opportunities. The disruption to commercial fishing operations occurs 8 to 10 times each fishing season. The resulting cascading effect is that the fish buying station is not accessible by fishermen and may choose to sit out the fishing day. The alternative option for the delivery of fish is in town at Elim Beach. Still, depth constraints there also affect the amount of time that tenders can access Elim to pick up fish, therefore, the amount of catch for which local fishermen can receive payment. NSEDC estimates that approximately 10 percent of Elim's total commercial harvest is foregone due to these inefficiencies. In other words, means that there is a 10 percent reduction in the potential fish harvest when fishermen are still able to fish.

When there are high amounts of commercial catch that the processing plant at Unalakleet cannot take in more fish, the plant shuts down. The plant shuts down to catch up with processing, and commercial fishermen are advised to stop fishing. In the past, plant closures occurred during coho openings, which is the main salmon harvested commercially by Elim residents. Commercial fishermen have had to forego potential coho harvests on the days the plant closes. NSEDC further estimates that 25 percent of the coho salmon harvest is foregone due to fishing closures when the Unalakleet plant shuts down temporarily. In the FWOP conditions, NSEDC plans to install a pre-processing plant in Elim to reduce the excessive influx of fish at the Unalakleet plant. However, even if this smaller scale plant opens, without improving navigational access for commercial and tenders vessels, 10 percent of the overall salmon harvest and an additional 25 percent of coho are still foregone.

The analysis uses Elim's salmon harvests reported in NSEDC's annual reports (from 2013 to 2018) and estimated mean prices paid to commercial fishermen (ex-vessel prices) reported by ADF&G. There are five salmon species harvested commercially by Elim fishermen. To estimate the value of Elim's salmon harvest, the annual harvest in pounds is multiplied by the ex-vessel prices of each salmon species for the associated year. The value of Elim's salmon harvest for the six-year period is approximately $1.5 million, with an average of approximately $300,000 per year.

Revisiting the assumed percent of foregone harvest: 10 percent of the overall salmon harvest and an additional 25 percent of coho, the maximum commercial harvest foregone is $70,304 each year[2]. The present value of commercial harvest foregone is $1.9M using the federal discount rate of 2.750 percent over a 50-year period of analysis. This commercial harvest present value is equal to an average annual of $72,000. In the FWOP, Elim fishermen will continue to forego a harvest value up to $72,000 each fishing season (Table 16).

[2] Estimated foregone harvest equals the sum of $29,000 (10% of $297,000) plus $40,600 (25% x $162,416).

Table 16. Commercial Harvest Key Data Inputs

Key Data Inputs	Value
Value of Elim Salmon Harvest 2013-2018	$1,487,000
Average Value of Elim Salmon Harvest 2013-2018	$297,000
Increase in Salmon Harvest Value	$29,700
Increase in Coho Harvest	$40,604
Total Harvest forgone	$70,304
Present Value	**$1,950,000**
Average Annual Equivalent	**$72,000**

The benefits associated with increased commercial fishing harvests must represent the change in net income: the value of the increased revenue minus the value of the increased vessel operating costs. However, this analysis assumes that this additional commercial harvest would occur during the existing operating times for local commercial fishermen and will not significantly increase the operating costs of Elim fishermen. This assumption is reasonable given the relatively small incremental increase in fisheries harvest resulting from navigation improvements.

8.3 Transportation Cost Savings

In addition to foregone commercial harvests, there are transportation inefficiencies associated with vehicle trips between Elim Beach and Moses Point, and skiff delivery trips from shore to tenders moored offshore. These inefficiencies represent transportation cost savings that could be realized with navigation improvements.

8.3.1 Vehicle Trips

The one-way distance between Elim and Moses Point by road is estimated 10 miles. The 2019 IRS mileage reimbursement rate of $0.58 is used to calculate the cost of each trip. NSDEC staff estimated 5 vehicle trips per day between Elim Beach and Moses Point to deliver fish totes, which is equal to 600 vehicle trips in a season. The potential vehicle transportation cost savings will be accrued for the whole 60 day season, amounting to cost savings of approximately $7,000 annually.

8.3.2 Skiff Trips

As described in the Existing Conditions section, due to the lack of moorage infrastructure for fish tenders, skiffs must deliver fish totes weighing up to 1,500 pounds from the fish buying station to a fish tender offshore. According to the fish buying station staff, skiffs make an average of eight trips daily to deliver fish to the tender, which anchors between half a mile and five miles offshore depending on sandbar movements. Each trip and transfer lasts about an hour. This operation inefficiency results in additional vessel operating costs in the FWOP condition.

8.3.2.1 Vessel Operating Costs

Vessel operating costs (VOCs) for the Elim fleet are used to calculate future-without project transportation costs and, subsequently, benefits resulting from navigation improvements. Previous Alaska District small boat harbor studies provide the basis for the methodology and assumptions used to develop these estimates. This approach has been used in several Alaska District feasibility studies, including Petersburg, Craig, Whittier, Valdez, Homer, and Port Lions. The basic framework used in those studies is applicable to Elim with changes to input data as appropriate.

Vessel costs are comprised of both fixed and variable costs. Fixed costs are induced upon the owner of the vessel regardless of productive use. Variable costs occur while the vessel is in operation, including the costs for vessel repair and maintenance, the cost of fuel and lubricating oil, and other such costs. As such, this analysis assumes that fixed expenses for any given vessel operating out of Elim will be unchanged with improved navigation conditions, whereas variable expenses for vessel operators specifically the fish shuttling skiffs could change as a result of navigation improvements.

Vessel characteristics are used as a starting point to determine operating costs. One key aspect of vessel characteristics is the vessel investment cost. Certain vessel costs are calculated as a portion of vessel investment cost. For this analysis, vessel investment costs are based on the values used in the 2014 Craig feasibility study updated to current dollars. These are considered representative of operating costs for the subsistence and commercial fishing vessels in Elim. The skiffs used to shuttle fish totes offshore to the fish tender are assumed to incur operating costs similar to subsistence vessels.

The VOC used in this analysis is derived from fuel usage by skiffs. The VOC model developed for the Craig feasibility study determined a low, medium, and high fuel use rate. Potential transportation cost savings under future without-project conditions are summarized in Table 17.

Table 17. Transportation Cost Savings Summary

Alternative	Vehicle Trip Savings	Skiff Trip Savings	Total
Present Value	$193,000	$600,000	$693,000
Annual Average Equivalent (AAEQ)	$7,000	$22,000	$29,000

Note: Values are rounded and do not reflect exact calculated values

8.4 Barge Delays

Barges that deliver to Elim experience operational delays as a result of shallow water depths and lack of landing infrastructure. Particularly in the case of landing craft, which delivers cargo to Elim, the shallow, sandy beach affects the efficiency of deliveries.

Navigation improvements at Elim could alleviate some of the inefficiencies associated with cargo deliveries. A barge landing site with adequate depth and staging area would improve delivery conditions and reduce delay time associated with delivering to Elim. These delays would only be alleviated if adequate upland facilities, including a staging area and road to the site, are constructed.

The analysis of barge delays was developed in the previous CAP 107 study. The barge conditions remain unchanged. The assumptions used in this analysis remain the same. Based on information provided by Crowley Maritime, cargo landing craft delays of 12 to

24 hours happen at least twice per year. The delay time is spent waiting for appropriate tidal conditions, and without navigation improvements, the costs associated with these barge delays will persist. Down time due to delays is additional time expended by barge companies waiting at Elim, which could otherwise be spent delivering to other communities. Daily barge operating costs were obtained from various USACE studies for barge operators that historically and currently deliver to Elim. Based on the estimated vessel operating costs and the length and frequency of delays, the annual cost of cargo delivery delays at Elim ranges from $15,000 to $30,000 annually.[3] These delays have a total present value of $621,000 over the period of analysis with an average annual value of $23,000.

8.4.1 Opportunity Cost of Time

Any opportunity cost of time associated with barge deliveries is assumed to be included in the barge operating expense and is not further quantified for this category. Similarly, no potential avoided vessel operating expenses were quantified for commercial, subsistence, or tender vessels at Elim. No corresponding opportunity cost of time calculations are made.

8.5 Fuel Offloading

The current landing configuration in Elim causes inefficiencies in fuel delivery operations. Fuel is offloaded to the fuel header located at the top of the bluffs near the beach fronting the community. The existing inefficiencies of fuel loading and offloading described in the Existing Conditions section are expected to continue in the future without project conditions. The tasks of moving the hose from the barge to the fuel header and back are intensive manual labor on the barge crew. While not possible to quantify under the NED perspective, this provides a prime opportunity for the occurrence of mistakes and accidents.

The fuel tanks in Elim are a consolidated fuel tank farm located by the south end of the runway at 150 feet above sea level. Given the elevation of the fuel tanks, inefficiencies associated with slow offloading rate would continue using existing equipment. The locations of the fuel header and tank farm are shown in Figure 19.

[3] $621 per hour x 12 hours x 2 occurrences per year = $14,904. $621 per hour x 24 hours x 2 occurrences per year = $29,808.

Figure 19. Fuel Tank Farm Relative to Fuel Header

The bulk fuel agreements utilized by NSEDC and other organizations such as AVEC and Bristol Bay school district serve to keep fuel prices competitive. Since fuel suppliers must bid for the contracts to provide service to groups of communities, there is an incentive for these suppliers to make the lowest bid to receive the contract. As a result, fuel delivery prices are set at a competitive level, and fuel barge operators often state that the fees charged for fuel delivery would not change as a result of navigation improvements at a single community. However, operational efficiencies described in this section are still calculated as a reduction in overall operating expenses, which are considered benefits to the nation.

8.6 Vessel Damages

8.6.1 Vessel Swamping

Due to a lack of mooring or landing infrastructure at Elim, vessel damages from various moorage scenarios are common. Residents report that vessels sometimes get swamped while attempting to land on the beach in front of Elim, while anchored offshore of Elim, or while accessing Moses Point during poor conditions. Also, dragging vessels onto the beach in front of the community or at Moses Point results in damages to vessel hulls, engines, and reduced vessel lives.

Residents report that vessel swamping incidents happen four to five times each year and these incidents typically do not cause a full vessel loss but do require engine repairs or replacement. Typical outboard motors used in Elim range in price from $11,500 to

$13,300. The costs for injectors are assumed to be 5 to 25 percent of the cost of the low and high engines, respectively. The engine injector costs, therefore, range from $574 to $3,328, and residents report that injectors must be replaced after each swamping.

This analysis assumes that one vessel engine must be replaced per year, while engine injectors must be replaced after each vessel swamping incident. Vessel swamping incidents will continue in the FWOP condition, given that residents will continue to have to land at an unprotected site and will still be subject to engine damage. Using the assumptions above, the potential vessel damages resulting from vessel swamping range from $14,000 to $30,000.[4]

8.6.2 Hull and Engine Damages

In addition to vessel swamping damage, Elim vessels are damaged as a result of being dragged onto the beach for storage when not in use. These damages to hull and engines from dragging along the beach may be avoided with local upland facilities of a navigational project. This analysis assumes that in the FWOP, the community is not inclined to invest in an uplands area without a protected harbor and entrance channel. As such, these avoided damages would only be realized with a harbor project. This means that in the FWOP condition, damages to boat hull and engine from excessive dragging along the beach will continue.

Potential benefits associated with reducing these damages are estimated based on vessel replacement costs and the frequency of replacement. The existing practice shortens the lifespan of the vessel. Using assumptions developed in previous Alaska District studies, commercial and Subsistence vessels in Elim are assumed to last an average of 12.5 years, but damages to vessel hulls and engines reduce vessel lifespan to 5 years. The value of potential damages is determined by first calculating the replacement costs for commercial and subsistence vessels. The second step is to determine the cost of replacing the Elim fleet (25 commercial and 25 subsistence vessels) every five years. This represents the vessel lifespan of vessels in Elim in the existing and FWOP conditions. Next, is to calculate the annual replacement cost of Elim's fleet every 12.5 years, the potential lifespan of vessels if hull and engine damages were reduced. The last step is subtracting the annual replacement cost of vessels at its potential lifespan from the replacement cost under FWOP (more frequently replaced).

The investment costs for vessels from the 2014 Craig feasibility study updated to current dollars are used to calculate the replacement cost. The replacement cost for a commercial vessel is $119,400 ($107,000 investment cost + $12,400 average engine cost). Subsistence vessels replacement cost is estimated $60,400 ($48,000 investment cost + $12,400 average engine cost). Under FWOP conditions the total vessel replacement cost per year for all 50 vessels is $899,000 ([25 commercial x 119,400] + [25 subsistence x $60,400] divided by 5 years).

[4] $11,486 engine replacement + [$574 for injectors x 4 vessel swampings]) = $13,783 per year.
$13,314 engine replacement + [$3,328 for injectors x 5 vessel swampings) = $29,957 per year.

8.6.3 Cost of Foregone Fishing Days Due to Damaged Vessel

Elim residents report that an entire fishing season can be lost when a commercial vessel is damaged while awaiting the delivery of a new motor. There are two vessel classes in Elim: subsistence vessels and combination commercial and subsistence vessels. The annual value of the fishery for each vessel is dependent upon the type of vessel damaged. Again, there are approximately 50 vessels in Elim: 25 subsistence vessels and 25 combination vessels. Based on previous data, this analysis assumes that one vessel per year is damaged enough to result in loss of fish harvesting for that year. In a given year, there is a 50 percent chance that a combination vessel will have to sit out the season and a 50 percent chance that a subsistence-only vessel will be affected.

On average, there are 28 commercial salmon permits held by Elim fishermen. The average annual commercial value per permit fished by Elim residents is approximately $10,800 ($300,000 average value of Elim harvest / 28 commercial permits). This $10,800 value represents the commercial harvest foregone when a commercial vessel is damaged and sits out the fishing season. According to the NPRB comprehensive subsistence use survey, the annual subsistence harvest of fish (including salmon and non-salmon species), caribou, beluga, and moose is 1,997 pounds per household. Recall that these are the subsistence resources that are acquired by the vessel during the ice-free months and are therefore included in the analysis. The survey analysis uses harvest pound by household rather than per capita because a subsistence vessel is typically used to acquire items for a subgroup of people or family rather than an individual. Utilizing the subsistence production values from the Subsistence Analysis of $13.95 per pound, the annual value of the subsistence harvest is estimated to be approximately $28,000 per household ($13.95 x 1,995 pounds).

If a combination vessel is damaged, the total cost of the lost fishing opportunity per vessel is approximately $19,300 ($10,800 foregone commercial catch + $27,900 subsistence value) x 0.5 probability of damage). The loss of a season of subsistence harvest when a subsistence vessel sits out the season is approximately $14,000 ($27,855 x 0.5 probability of damage). Absent federal investment, the annual damages associated with lost fishing opportunity due to an out-of-commission vessel is about $33,000 annually ($19,400 + $14,000).

8.6.4 Vessel Damages Summary

The three vessel damages categories are summarized in Table 18 below. Vessel damages costs in the FWOP condition make up more than 60 percent of the potential NED benefits. In addition, the vessel damages calculations are informed by a series of assumptions and various data sets. Given these variations and the significance of this benefit category to the overall analysis, uncertainty and risk are incorporated by applying a range similar to that used in the subsistence analysis. The low range is 70 percent of the total benefit values calculated for each vessel damage subcategory. During focus groups and discussions with local fishermen, community members further noted that sometimes residents are able to evacuate their vessels before a flooding event or storm occurs. Based on this preventative action, it is assumed that 30 percent of the time, vessel owners evacuate their vessels before an oncoming storm or flooding thereby successfully avoid vessel swamping or damage to hulls Under this 30 percent preventative scenario, only 70 percent of vessel damages occur. In other words the damages would be avoided but not attributed to the project and, therefore, not included. The vessel damages in the FWOP is expected to range between $416,000 and $595,000 annually (Table 18).

Table 18. Average Annual Vessel Damages

Vessel Damage Type	**Low Benefit Range (70%)**	**High Benefit Range (100%)**
Vessel Damage Subcategory	AAEQ	AAEQ
Vessel Swamping	$15,000	$22,000
Hull and Engine Damages	$378,000	$539,000
Lost Harvest Value	$23,000	$33,000
Total	**$416,000**	**$595,000**

8.7 Summary of Future without Project Conditions

Absent federal action to provide navigation improvements at Elim, transportation inefficiencies, vessel delays, and damages, and forgone subsistence and commercial harvest opportunities are expected to continue throughout the period of analysis. These adverse impacts incurred as a result of current and expected future conditions, and they have a total present value of approximately $26 million over the period of analysis, with an average annual value of $963,000. The values shown in Table 19 are the sum of the values estimated for each potential benefit category detailed in the without project conditions section.

Beyond the quantified transportation inefficiencies, vessel delays, damages and foregone harvests are social conditions that are expected to continue in the future without navigation improvements. Social conditions affected by the lack of an adequate harbor include public health and safety of the local community and social and cultural values that are tied to subsistence activities. These are elaborated upon in Other Social Effects (OSE) under Section 15.4.

Table 19. Future without Project Summary

Potential Benefit Categories	**Present Value**	**Average Annual**
Total Subsistence	$6,153,000	$228,000
Commercial Harvest	$1,950,000	$72,000
Transportation Cost Savings Commercial Fishery Operations	$791,000	$29,000
Barge Delays	$621,000	$23,000
Vessel Damages	$16,492,000	$611,000
Total	**$26,007,000**	**$963,000**

9.0 FUTURE WITHOUT PROJECT CONDITIONS AND COMMUNITY VIABILITY

This section describes the threats to community viability faced by Elim in the FWOP conditions. The linkages between threats to viability in the FWOP condition and the planning objectives are shown by the descriptions of community viability aspects by vessel class that a waterborne transportation system in Elim would support. In addition, the qualitative discussion on viability, aspects are organized under the CE/ICA metric used in this study: Access and Moorage Days (further discussed in Section 13.0). For the clarity of this section, the planning objectives are re-stated below:

- Provide safe, reliable, and efficient waterborne transportation systems for the movement of commerce (including commercial fishing) and subsistence in Elim.
- Support the long-term viability of Elim.

9.1 Access and Moorage for Subsistence and Commercial Vessels

Subsistence activities are a fundamental component of Elim's mixed cash-subsistence economy. Employment opportunities are limited and often seasonal. The cost of living is relatively high. The weekly cost of food for a household of four is estimated to be approximately 2.5 times the national average. Elim residents rely upon the harvest of subsistence resources for food, clothing, tools, and medicinal uses. The community's reliance on subsistence is especially significant given Elim's relative isolation and limited connections to other communities. These factors further emphasize the interdependency of the subsistence and cash sectors in Elim's economy. Different subsistence activities occur at different times of the year and are interconnected to one another. Crucial to productive subsistence activities is the equipment used to acquire subsistence resources, such as boats and four wheelers. When the vessels used for subsistence activities are damaged, the ramifications include a disruption to acquiring these resources that are vital to Elim's welfare and cultural community.

Subsistence activities are intricately tied to cultural values, historical knowledge, and specific places. The continued participation and transfer of these values and knowledge are important to the viability of the community. Subsistence activities bring the community together, cultivating a sense of identity. As access to subsistence resources becomes more difficult, participation in these activities decline, and the fostering of cultural values and identity is threatened. Lack of safe navigational access impedes participation in subsistence activities and continues to threaten community viability.

9.2 Access and Moorage for Tenders

Navigational inefficiencies cause disruptions to commercial fishing operations 8 to 10 times per season on average. The existing and FWOP conditions are such that skiffs shuttle fish totes from the fish buying station to the tender offshore. These deliveries are dictated by the tides and become complex and unsafe during rough wave activity. Moreover, Elim's commercial harvest in recent years indicates a steady increase, but the Unalakleet processing plant occasionally shuts down because it cannot take any more fish. This impacts commercial fishermen through fishing days forgone, and some harvest is lost. The planned head and guts facility in Elim is expected to improve the efficiency of the Unalakleet plant and reduce fishing day closures due to plant shutdowns. However, without access and moorage for fish tenders and commercial vessels to deliver catch to the head and guts facility in Elim, inefficiencies would still lead to plant closures and fishing days foregone.

The commercial fishery plays a key role in Elim's mixed cash-subsistence economy. Commercial fishing is a means to earn cash which can be used for basic goods and to repair or upgrade equipment used in subsistence activities. Other means of cash-earning are limited in Elim and access to the cash economy often requires individuals to leave their community and culture for extended periods of time. Moreover, Elim is a fishing community where the skills and practice are passed down by generation. The transfer of these skills is important to the community's ability to survive and thrive. In the FWOP conditions, Elim's commercial fishery would continue to experience disruptions resulting in loss of commercial harvests and residents who leave for better paying opportunities. Without navigational improvements, the transfer of fishing skills necessary for the continuity of commercial fishing is hampered and may pose risks to the safety of fishermen.

9.3 Access and Moorage for Freight and Fuel Barge

In the FWOP conditions, freight barge deliveries would continue to experience delays and operate in less than optimal conditions. An example of such conditions is when the barge surfs the wave to shore and risks rough landing on the gravel beach with a heavy load. This practice poses risks to the safety of barge operators and crew. Navigational inefficiencies would continue to hamper the delivery of critical infrastructure materials and impact Elim's capability to replace aging or threatened infrastructure. Almost 50 percent of housing units in Elim were built before 1980. Improving efficiency of delivery can lead to improved housing and combat social and health issues associated with housing conditions such as overcrowding and poor air quality. Without addressing these foundational needs, the viability of a community is threatened.

Without improved access and moorage for fuel delivery, the fuel barge would continue to anchor offshore and float the hose to shore. Under FWOP conditions, this practice would continue to pose a risk of fuel spills during offloading from the barge to the fuel header. These fuel spills can impact the marine subsistence resources the community relies on.

10.0 WITH PROJECT CONDITIONS

The following section describes anticipated conditions at Elim, assuming that a project has been constructed. The anticipated changes in the operations at the harbor are the basis for the economic analysis.

10.1 Assumptions

A small boat harbor project at Elim would enhance access to subsistence resources, commercial fisheries, and improve efficiencies of fuel and freight deliveries. The NED benefits of a small boat harbor project at Elim are expected to result from reduced vessel damages, increased subsistence, and commercial harvests. In addition, transportation cost savings are expected to accrue to the local commercial fisheries operations. Efficiencies to freight and fuel barge deliveries are also expected to reduce delays and, consequently, operating costs.

The period of analysis is 50 years, beginning with a base year of 2028, the project effective date, to 2078. The FY20 federal discount rate of 2.750 percent is used to discount benefits and costs per the Economic Guidance Memorandum (October 2019). The report uses a methodology for small boat harbor navigation analysis described in the Planning Guidance Notebook with specific guidance found in the appendices on economic and social considerations. Procedures stated in the IWR Planning Suite II User Guide for conducting CE/ICA are also followed and used in this analysis.

10.2 Proposed Alternatives

Navigation improvement measures of both structural and non-structural were initially proposed at four sites: Elim Beach, Airport Point, Iron Creek, and Moses Point. Subsequent screening led to the selection of Elim Beach and Airport Point as the relative optimal sites. Iron Creek and Moses Point were screened out due to factors such as the distance from the community center, lack of utilities, inaccessibility for barges, and possible contamination. An array of six alternatives were developed with the FWOP or No Action Plan. This section describes each alternative plan and the vessel fleet it accommodates. Please refer to the main report for the image presentations of the alternatives.

10.2.1 Alternative 1: No Action

Existing conditions in Elim will remain the same without the development of navigation improvements. Fishermen would continue to incur losses due to boat damages and missed opportunities for subsistence and commercial fishing. Delays in offloading cargo and fuel will continue to result in high costs and pose the danger of a fuel spill that could cause environmental consequences. Response times to boats in distress would still be hampered by the need to travel to Moses Point prior to launching response vessels. Vessels would also continue to experience damages during large storm surges due to the inaccessibility of Moses Point in short notice, causing some vessels to get swamped.

10.2.2 Alternative 2: Elim Beach: Commercial and Subsistence Fleet

Alternative 2 is a harbor located at the beach in front of the school in Elim. The harbor would be sized to accommodate 50 vessels varying in size from 18 feet to 32 feet. Two rubble mound breakwaters would provide a turning and berthing basin approximately 3.9 acres with a required dredge depth of -8.0 feet Mean Lower Low Water (MLLW) with a maximum pay depth of -10.0 feet MLLW. The west breakwater would be approximately 985 feet long and the east breakwater approximately 457 feet long. The entrance channel and turning basin would also have a required dredge depth of -8.0 feet MLLW with a maximum pay depth of -10.0 feet MLLW. Local service facilities required would include a single boat launch, uplands with an area of approximately 3.2 acres for parking and turn-around at the boat launch, and a road connecting the uplands to Front St. to the harbor uplands. The road would be approximately 0.15 miles and relatively flat.

Alternative 2 provides access and moorage for 50 subsistence and commercial vessels in the community. Improved navigational access is expected to accrue benefits to local subsistence and commercial harvests. Some transportation cost savings to the commercial fishery operations would be realized. This Alternative plan assumes that commercial vessels will dock in the harbor and transport their fish uplands to the fish buying station. Tenders cannot approach Elim Beach to pick up commercial harvests, which means that the catches will still have to be delivered by vehicle to Moses Point in fish totes. Commercial fishery openings per year is 60 days. The fish tender may still attempt to approach Elim Beach instead of anchoring off Moses Point 10 road miles away. This analysis, therefore, assumes that 30 days out of the season the fish tender will approach Elim Beach and pick up fish and the remaining 30 days the commercial boats will land their fish at Elim beach and deliver catch by vehicle from Elim to Moses Point to an offshore tender. Avoided vessel damages to the local fleet are also expected.

10.2.3 Alternative 3: Elim Beach: Commercial and Subsistence Fleet with One Tender

Alternative 3 is a harbor located in the same location as Alternative 2, but sized to accommodate a 66-foot tender and 50 vessels varying in size from 18 feet to 32 feet. The plan would also include a tender dock with a length of 87 feet. Two rubble mound breakwaters would provide a turning and berthing basin approximately 4.6 acres with a required dredge depth of -8.0 feet MLLW with a maximum pay depth of -10.0 feet MLLW. The west breakwater would be approximately 1,068 feet long and the east breakwater approximately 463 feet long. The entrance channel, tender dock access, and turning basin would also have a required dredge depth of -9.0 feet MLLW with a maximum pay depth of -11.0 feet MLLW. Local service facilities required would include a single boat launch, uplands with an area of approximately 3.9 acres for parking and turn-around at the boat launch, a tender dock, and a road connecting the uplands to Front St. to the harbor uplands. The road would be approximately 0.15 miles and relatively flat.

Alternative 3 provides access and moorage for the commercial and subsistence fleet, and one tender. The improved efficiencies of the commercial fishery operations are expected to render transportation cost savings. This Alternative assumes that the fish buying station and pre-processing plant will also be in Elim town. Commercial fishermen will deliver their catch to the docks and transfer it up to the fish buying station or pre-processing plant. When the fish is ready for delivery to the Unalakleet plant, the fish totes are transported to the docks in a loader where the tender picks up the fish totes using a crane onboard. This operation means that vehicle trips out to Moses Point will no longer be necessary and eliminated for the whole season.

10.2.4 Alternative 4: Elim Beach: Commercial and Subsistence Fleet with Two Tenders

Alternative 4 is the same as Alternative 3 but could accommodate two tenders. The plan would also include a tender dock with a length of 87 feet. Two rubble mound breakwaters would provide a turning and berthing basin approximately 5.1 acres with a required dredge depth of -9.0 feet MLLW with a maximum pay depth of -11.0 feet MLLW. The west breakwater would be approximately 1,099 feet long and the east breakwater approximately 463 feet long. The entrance channel, tender dock access, and turning basin would also have a required dredge depth of -9.0 feet MLLW with a maximum pay depth of -11.0 feet MLLW. Local service facilities required would include a single boat launch, uplands with an area of approximately 3.9 acres for parking and turn-around at the boat launch, a tender dock, and a road connecting the uplands to Front St. to the harbor uplands. The road would be approximately 0.15 miles and relatively flat.

Alternative 4 would provide access and moorage to the 50 local vessels and two fish tenders. There are plans for a pre-processing plant in Elim to support the Unalakleet plant and maintain salmon quality. These operations are assumed to bring an additional tender in Elim to support operations. More transportation cost-saving benefits and support to commercial harvest are expected as a result of the additional tender. However, quantifying these benefits is difficult, given the lack of detailed information. As such, the NED benefits at Alternative 4 are the same as Alternative 3.

10.2.5 Alternative 5: Elim Beach: Commercial and Subsistence Fleet with Two Tenders and Fuel and Freight Barge Access

Alternative 5 is a harbor located in the same location as Alternative 2. The harbor would be sized to accommodate one 160 foot barge and associated 86 foot tug, two tenders, and 50 vessels varying in size from 18 feet to 32 feet. The plan would also include a tender dock with a length of 87 feet. Two rubble mound breakwaters would provide a turning and berthing basin approximately 6.2 acres with a required dredge depth of -9.0 feet MLLW with a maximum pay depth of -11.0 feet MLLW. The west breakwater would be approximately 1,082 feet long and the east breakwater approximately 468 feet long. The entrance channel, tender dock access, barge landing access, and turning basin would have a required dredge depth of -12.0 feet MLLW with a maximum pay depth of -14.0 feet MLLW. Local service facilities required would include: an extension to the existing fuel header located at the top of the bluffs near the school, to a protected storage or service pad on Elim Beach; a single boat launch; developed uplands with an area of approximately 3.9 acres that will accommodate parking and turn-around at the boat launch; a tender dock; a barge landing and; two mooring points; and a road connecting the developed uplands to Front Street. The road would be approximately 0.15 miles and relatively flat.

Alternative 5 would provide access and moorage for the 50 commercial and subsistence vessels, two fish tenders, and barge. In addition to the benefits accrued at Alternative 4, freight barge delays are expected to reduce, resulting in operating cost savings. The manual labor in fuel deliveries causing inefficiencies is expected to be alleviated and allow a reduction of mistakes and accidents.

10.2.6 Alternative 6: Airport Point: Commercial and Subsistence Fleet

Alternative 6 is a harbor located at the headland west of Elim Beach, below Elim Airport (Airport Point). The harbor would be sized to accommodate 50 vessels varying in size from 18 feet to 32 feet. Two rubble mound breakwaters would provide a turning and berthing basin approximately 3.0 acres with a required dredge depth of -8.0 feet MLLW with a maximum pay depth of -10.0 feet MLLW. The west breakwater would be approximately 819 feet long and the east breakwater approximately 418 feet long. The entrance channel and turning basin would also have a required dredge depth of -8.0 feet MLLW with a maximum pay depth of -10.0 feet MLLW. Local service facilities required would include a single boat launch, uplands with an area of approximately 3.3 acres for parking and turn-around at the boat launch, and a road connecting the tank farm south of Elim Airport to the harbor uplands. The road would be approximately 0.6 miles and traverse 115 vertical feet.

Alternative 6 would access and moorage for 50 subsistence and commercial vessels in the community. Improved navigational access is expected to accrue benefits to local subsistence and commercial harvests. Avoided vessel damages to the local fleet are also expected. At Alternative 6, there would not be transportation cost savings accrued. Instead, more transportation costs are expected to accrue given the community would deliver their catch up a 115 feet of vertical road to Elim Beach or Moses Point.

10.2.7 Alternative 7: Airport Point: Commercial and Subsistence with Two Tenders

Alternative 7 is a harbor located in the same location as Alternative 6. The harbor would be sized to accommodate one 160 feet barge and associated 86 feet tug, two tenders, and 50 vessels varying in size from 18 feet to 32 feet. The plan would also include a tender dock with a length of 87 feet. Two rubble mound breakwaters would provide a turning and berthing basin approximately 6.0 acres with a required dredge depth of -9.0 feet MLLW with a maximum pay depth of -11.0 feet MLLW. The west breakwaters would be approximately 1,137 feet long and the east breakwater 594 feet long. The entrance channel, tender dock access, barge landing access, and turning basin would have a required dredge depth of -12.0 feet MLLW with a maximum pay depth of -14.0 feet MLLW. Local service facilities required would include relocation of fuel header currently located on Elim Beach, a single boat launch, uplands with an area of approximately 6.2 acres for parking and turn-around at the boat launch, a tender dock, a barge landing, two mooring points, and a road connecting the tank farm south of Elim Airport to the harbor uplands. The road would be approximately 0.6 miles traverse 115 vertical feet.

Alternative 7 would provide access and moorage for the 50 commercial and subsistence vessels, two fish tenders, and barge. Benefits at Alternative 7 are expected to be the same as those realized at Alternative 5 with the exception of vehicle transportation cost savings.

10.3 Summary of Future with Project Conditions

Each alternative provides a varying degree of improved efficiencies described in the FWOP Conditions section. The benefits estimated for each alternative are derived from vessel operations and the fleet that alternative accommodates. Alternatives 2 and 6 would serve the commercial and subsistence fleets. By improving access to commercial and subsistence activities, harvests are expected to increase. A protected harbor would result in reduced vessel damages to the local fleet. Alternative 2 is located at Elim Beach and would accrue some transportation cost savings. Given that Alternative 6 would be located at Airport Point, which is further away from the town and Moses Point transportation costs instead of cost savings would accrue.

Alternatives 3 and 4 would improve efficiencies to fish tender operations in addition to harvest increases. As mentioned in the Alternative 4 description, a second tender is expected with increased vessel traffic resulting from NSDEC's future plans in Elim. These specific benefits are not quantified under NED but are measured under the CE/ICA.

Alternatives 5 and 7 are the largest scale plans serving a fuel or freight barge in addition to the vessels at Alternative 4. The NED benefits at these alternatives would derive from increase subsistence and commercial harvests, transportation, cost savings, and barge operations. Specifically, reductions to barge delays and fuel offloading inefficiencies translate to vessel operating cost savings.

10.4 Total Project Benefits

Each alternative provides a certain amount of relief from existing and expected future inefficiencies. From a NED perspective, the differences between the FWOP conditions and those that will occur under the various With Project Conditions are benefits that accrue to the project and inform plan selection. The NED benefits are summarized below in Table 20 and Table 21.

Table 20. Present Value of Benefits by Alternative

Category	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7
Increased Subsistence Harvest	$6,153,000	$6,153,000	$6,153,000	$6,153,000	$6,153,000	$6,153,000
Increased Commercial Harvest	$824,000	$1,950,000	$1,950,000	$1,950,000	$824,000	$1,950,000
Transportation Cost Savings	$694,000	$791,000	$791,000	$791,000		$791,000
Vessel Damages	$16,492,000	$16,492,000	$16,492,000	$16,492,000	$16,492,000	$16,492,000
Reduced Barge Delays				$621,000		$621,000

Improved Fuel Offloading				$0		$496,000
Total	**$24,163,000**	**$25,386,000**	**$25,386,000**	**$26,007,000**	**$23,469,000**	**$26,503,000**

Table 21. Annual Benefits by Alternative

Category	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7
Subsistence Harvest	$228,000	$228,000	$228,000	$228,000	$228,000	$228,000
Commercial Harvest	$31,000	$72,000	$72,000	$72,000	$31,000	$72,000
Transportation Cost Savings	$26,000	$29,000	$29,000	$29,000		$29,000
Vessel Damages	$611,000	$611,000	$611,000	$611,000	$611,000	$611,000
Reduced Barge Delays				$23,000		$23,000
Improved Fuel Offloading				$0		$18,000
Total	**$896,000**	**$940,000**	**$940,000**	**$963,000**	**$870,000**	**$981,000**

11.0 PROJECT COSTS

USACE Alaska District cost engineers developed Rough Order of Magnitude (ROM) cost estimates for the alternatives, including those to construct and maintain facilities. The Cost Engineering Appendix details the procedures and assumptions used to calculate the estimates. Cost risk contingencies were included to account for uncertain items such as dredged material disposal methods. Project costs were developed without escalation and are in 2020 dollars. Table 22 shows the ROM costs for each alternative.

As with benefit cash flows, costs are discounted/indexed to a base year and amortized for comparison against the average annual benefits. As such, the project first costs shown above and detailed in the Cost Engineering appendix differ slightly from those used in the benefit-cost analysis. Costs used in the benefit-cost analysis include the project first cost compounded to the base year using the FY20 discount rate, interest during construction (IDC), and estimated operations and maintenance costs greater than the without-project condition. The costs for the benefit-cost analysis are referred to as NED or economic costs. The project costs by alternative for the benefit-cost analysis is summarized in Table 23.

Table 22. Rough Order Magnitude Project First Costs by Alternative

Cost Description	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7
Lands, Easements, Rights-of-Way, and Relocations (LERR)	$26,000	$26,000	$26,000	$26,000	$26,000	$26,000
Mobilization and Demobilization (GNF)	$7,800,000	$7,800,000	$7,800,000	$7,800,000	$7,800,000	$7,800,000
Breakwater (East & West Walls)	$39,678,061	$42,056,520	$42,971,241	$42,654,218	$49,098,639	$73,272,596
Dredge and Dispose	$2,277,425	$2,712,044	$3,598,482	$6,999,209	$1,755,072	$4,546,893
Upland	$7,699,787	$30,752,823	$30,883,408	$32,043,963	$20,439,609	$41,372,466
Access Road	$1,780,701	$1,780,701	$1,780,701	$1,780,701	$10,240,285	$10,240,285
Floating Dock, Moorage Points, Gangway	$302,635	$302,635	$302,635	$473,829	$302,635	$2,007,829
Preconstruction, Engineering and Design (PED)	$4,000,000	$4,000,000	$4,000,000	$4,000,000	$4,000,000	$4,000,000
Supervision, Inspection, and Overhead (SIOH)	$5,000,000	$5,000,000	$5,000,000	$5,000,000	$5,000,000	$5,000,000
Project First Costs	**$72,504,000**	**$99,812,000**	**$101,851,000**	**$106,513,000**	**$104,279,000**	**$161,452,000**

Note: Project first costs used in the benefit-cost analysis are discounted/indexed to a base year and amortized for comparison against the average annual benefits, so these costs will differ slightly from those presented in the Cost Engineering Appendix.

Table 23. NED Costs by Alternative

Cost Description	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7
Project First Cost	$72,504,000	$99,812,000	$101,851,000	$106,513,000	$104,279,000	$156,649,000
IDC	$992,000	$1,366,000	$1,394,000	$1,458,000	$1,427,000	$2,144,000
OMRR&R	$2,812,000	$2,844,000	$2,603,000	$2,701,000	$1,152,000	$2,659,000
Total Economic Cost	**$76,308,000**	**$104,022,000**	**$105,849,000**	**$110,672,000**	**$106,859,000**	**$161,452,000**
AAEQ Economic Cost	**$2,827,000**	**$3,853,000**	**$3,921,000**	**$4,099,000**	**$3,958,000**	**$5,980,000**

Due to climate characteristics and the remoteness of communities in Alaska, construction periods are limited to ice-free seasons. Construction is expected to be phased over four years in three month construction seasons for all alternatives. This means interest during construction is calculated by a total of 12 months spread out over the four years. This analysis assumes that the interest rate remains the same over the four years of construction.

Maintenance dredging and armor rock replacements of varying degrees are assumed for each alternative. Cost Engineering developed the Operations, Maintenance, Repair, Rehabilitation and Replacement (OMRR&R) costs, and assumptions. Maintenance dredging consists of three components: mobilization and demobilization, dredge survey, and dredging. Maintenance mobilization cost is based on historical maintenance contract for Nome. The dredge survey is assumed to be $0.50 per square foot (sf). Maintenance dredging is estimated at $10 per cubic yard. The Maintenance dredging quantities vary by alternative. Similarly, maintenance years also vary by alternative. Armor rock is also estimated to be replaced in varying amounts and years by alternative. The itemized OMRR&R costs in current dollars is presented in Table 24.

Table 24. OMRR&R Costs by Alternative

Description	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7
Mobilization and Demobilization (GNF)	$700,000	$700,000	$700,000	$700,000	$0	$700,000
Dredge	$180,000	$230,000	$250,000	$510,000	$0	$100,000
Dredging Survey	$264,000	$229,000	$392,000	$466,000	$0	$206,000
Armor Rock Replacement Mobilization and Demob.	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000
A-Rock	$432,000	$459,000	$468,000	$465,000	$530,000	$800,000
Total	**$3,576,000**	**$3,618,000**	**$3,810,000**	**$4,141,000**	**$2,530,000**	**$3,806,000**

12.0 NATIONAL ECONOMIC DEVELOPMENT (NED) SUMMARY

Net benefits and the BCR are determined using the average annual benefits and average annual costs for each alternative. Net benefits are determined by subtracting the average annual costs from the average annual benefits for each alternative; the BCR is determined by dividing average annual benefits by average annual costs. The project costs, benefits, and BCR by alternative is displayed in Table 25. None of the alternatives have a BCR greater than 1.0.

Table 25. Summary of NED Benefits and Costs by Alternative

Description	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7
Average Annual Cost	$2,827,000	$3,853,000	$3,921,000	$4,099,000	$3,958,000	$5,980,000
Average Annual Benefits	$896,000	$940,000	$940,000	$963,000	$870,000	$981,000
Average Annual Net Benefits	-$1,931,000	-$2,913,000	-$2,981,000	-$3,136,000	-$3,088,000	-$4,999,000
Benefit Cost Ratio	0.32	0.24	0.24	0.23	0.22	0.16

13.0 COST EFFECTIVENESS / INCREMENTAL COST ANALYSIS (CE/ICA)

The previous section presented the NED analysis and demonstrated that there is no NED Plan. In accordance with the Section 2006 Authority, the CE/ICA is conducted to evaluate the effects of the proposed alternatives beyond the NED perspective. These effects are non-monetary outputs. The CE/ICA is utilized to inform decisions on sound investments by identifying options that yield maximum desired outputs for the least acceptable cost. The selected outputs are measured in access and moorage days for the Elim vessel fleet served by a project. This section first describes the development of the CE/ICA variables, the underlying assumptions and Hydraulics and Hydrology (H&H) modeling that form the basis of the outputs or metric. It discusses the computations and CE/ICA results completed on the IWR Planning Suite II. Alternatives 6 and 7 are screened out from the rest of the analysis due in part to significant cost share burden on the local sponsor. In addition, overall project cost estimates are higher for the same or lesser level of benefits compared to Alternatives 2 and 5, respectively.

13.1 CE/ICA Framework

The basis of the outputs used in this CE/ICA is rooted in the planning objectives developed to address the water resource problem at Elim:

1. Provide safe, reliable and efficient waterborne transportation systems for movement of commerce (including commercial fishing) and subsistence in Elim
2. Support the long-term viability of Elim

Opportunity days for safe access and moorage conditions directly impact waterborne transportations for movement of commerce and subsistence in Elim. Given the integral significance of commercial fishing and subsistence practices to livelihoods, these support the community's long-term viability. The CE/ICA metric compares the accessibility and moorage conditions between the proposed alternative plans and the No Action plan. The alternative plans are at two locations: the current condition and operations at Moses Point and Elim Beach.

The Engineer Regulation 1105-2-100 states the following.

> Selecting the National Ecosystem Restoration (NER) plan requires careful consideration of the plan the meets planning objectives and constraints and reasonably maximizes environmental benefits while passing tests of cost effectiveness and incremental cost analyses, significance of outputs, acceptability, completeness, efficiency, and effectiveness.

While the above regulation refers to NER and environmental benefits, it is the same guiding principle for the Other Social Effects benefits under which this study is authorized. As such, the development and application of the CE/ICA tools towards a recommended plan complies with the above guidance.

The Alaska District H&H collaborated with Economics on the model development of the metric. The model was subsequently submitted to the Deep Draft Navigation Center of Expertise (DDN-PCX) for review and approval.

13.2 Assumptions for Wave Analysis

The development of the wave analysis by H&H is based on the following assumptions.

- Safe access is based on water depth requirements of vessel draft and wave condition for safe approach into the harbor. These are evaluated separately
- Water depth is based on a draw-down condition based on vessel class. These wave conditions form the wave criteria from WIS data brought in to the projected harbor locations. Since these two conditions (low water and high waves) are normally exclusive of each other, the time that these impact the specific class of vessels are additive.
- Safe mooring is based on limiting the wave height within the protected area to a height that is protective to the class of vessels being protected. This is calculated on fetch length and directional winds.
- Subsistence, commercial, and barges are assumed to gain safe moorage with access.
- Tenders require safe moorage for offloading and on-loading and are assessed against the moorage analysis
- Waves impacting Elim and Moses Point are fetch limited
- All onshore waves are shore-normal. This is a conservative assumption
- WIS ST82107 hindcast wind data is representative of winds that are impacting wave development towards Elim
- Water levels observations at Nome are representative of water level trends at Elim and Moses Point
- Vessel fleet operate in and out of Elim from May to November

13.3 Variable Descriptions

The CE/ICA is performed on Planning Suite II using two variables. First is the non-monetary outputs, and the second variable is the costs for the alternative plans. The non-monetary outputs are measured in days that allows for access and moorage. In this report, the terms output and metric are interchangeable.

13.3.1 Access and Moorage Days

Access days represent the opportunity days in a given year for safe access after accounting for wind and surge conditions that exceed safe access requirements for each vessel class for each alternative. Moorage represents the opportunity days for safe moorage after accounting for wave conditions that exceed safe tender moorage requirements at each alternative. While assessed separately, access and moorage opportunity days are combined as a single metric on the CE/ICA.

Access days are based on wave conditions at the existing moorage area at Moses Point (Alternative 1), or proposed harbor at Elim Beach (Alternatives 2 to 5). Access days are controlled by the safe operating conditions for each vessel class included in the alternative. The Wave Information Study ST82107, offshore of Elim, wind speed, and direction hindcast (1985-2014) was used for a fetch analysis to determine wave heights at the location of interest. Additionally, accessibility is based upon available draft, this was determined by evaluating the limiting conditions (shallowest dredge depth encountered and draft requirements) for each vessel class in the entrance channel, at the tender dock, or at the floats at Moses Point, Elim Beach. The measured historic water levels (from August 1992 through July 2019) at Nome was used to determine water depths for each alternative. Vessels operate in and out of Elim from May to November, and accessibility and moorage conditions are evaluated within this season.

Subsistence, commercial, and barges vessels are assumed to gain safe moorage with access. Therefore, these vessel classes are not evaluated against the moorage analysis. Tenders require safe moorage for offloading and on-loading and are assessed against the Moorage metric. The alternatives that serve tenders add moorage to access days. Moorage days are determined by wave conditions at the offloading and onloading location for the tender offshore of Moses Point and Elim Beach. Wave heights must be less than or equal to 2 feet at the tender dock for them to be offloaded/onloaded. The Wave Information Study ST82107, offshore of Elim, wave height, and direction hindcast (1985-2014), was used to determine wave height at tender offloading/onloading locations. Diffraction Diagrams, from the Shore Protection Manual, were used to determine wave heights at the tender dock for alternatives 2 to 5.

Access and Moorage days do not represent calendar days. Access days represent the opportunity days for safe access after accounting for wave conditions that exceed safe access requirements for each vessel in the fleet (Number of Vessels x Percent of Accessibility). Similarly, moorage days represent the opportunity days for safe moorage after accounting for wave conditions that exceed safe moorage requirements for tenders at each alternative. The access and moorage days by alternative for the season of interest (May through November) is summarized in Table 26. These outputs are assumed average annual benefits.

Table 26. Annual Access and Moorage Days by Alternative

Alternatives	Subsistence	Commercial	Tender	Barge	Total Average Annual
Alt 2	786	786			1571
Alt 3	863	863	91		1817
Alt 4	1003	1003	111		2117
Alt 5	1067	1067	158	43	2336

13.3.2 CE/ICA Costs

As noted in the Planning Guidance Notebook, the cost-effectiveness analysis evaluates a plan's level of outputs against its cost. The subsequent incremental cost analysis evaluates a variety of alternatives of different scales to arrive at a "Best Buy" option. Best Buy plans are considered most efficient, which provide the greatest increase in output for the least increase in cost. The costs variable for a CE/ICA refer to the average annual economic costs of each alternative. These costs include project first costs, interest during construction and operation and maintenance costs. The costs are amortized using the FY20 discount rate over the period of analysis. Table 27 summarizes the annual average costs used in the CE/ICA.

Table 27. Average Annual Costs for CE/ICA by Alternative

Cost Description	Alt 2	Alt 3	Alt 4	Alt 5
Total Economic Cost	$76,307,754	$104,022,378	$105,848,907	$110,672,038
Annual Average Cost	$2,827,000	$3,853,000	$3,921,000	$4,099,000

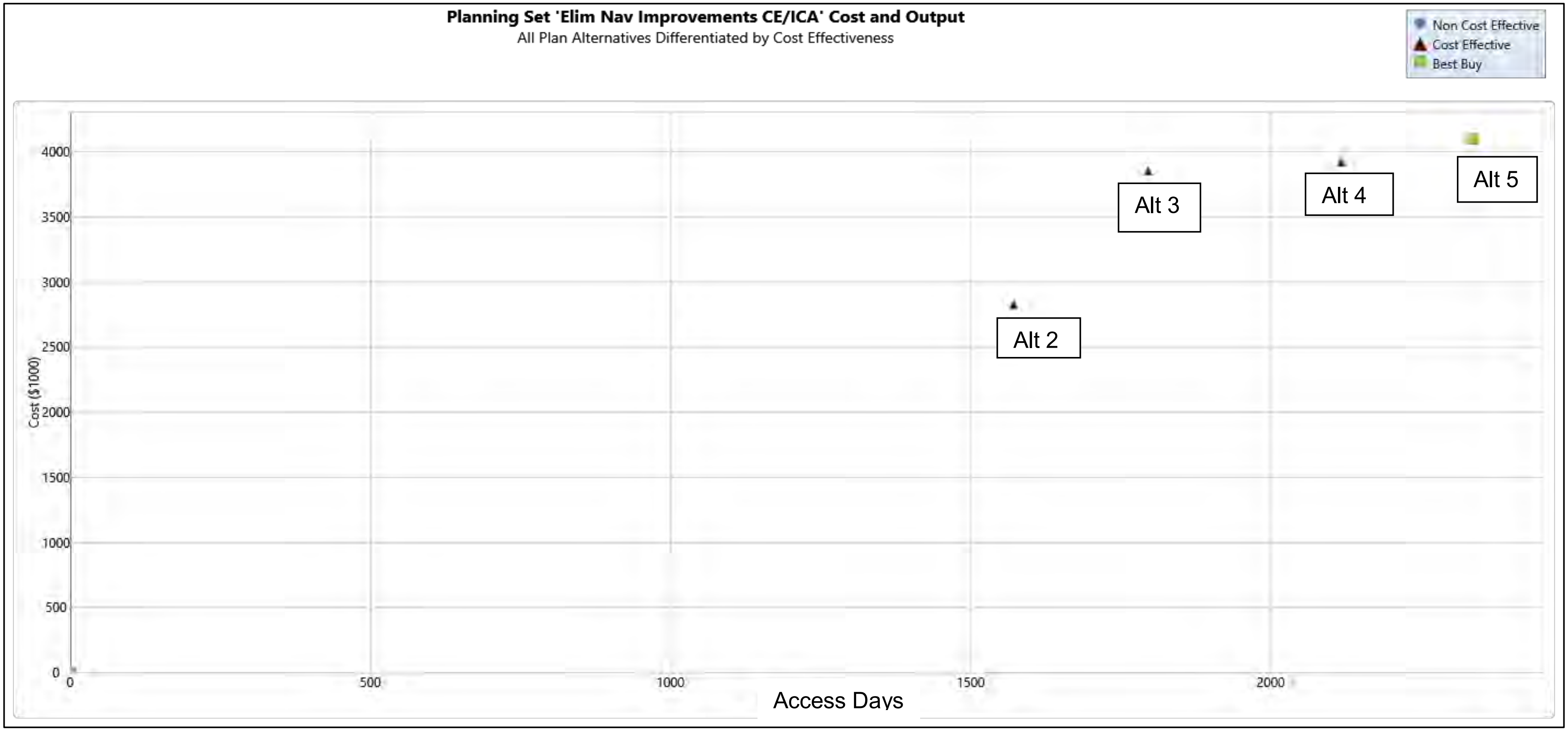
13.4 CE/ICA Calculations and Results

Performing the CE/ICA consists of four steps. First, is to estimate average annual benefits of each alternative. These average annual benefits are the non-monetary units measured in access days. Second is to estimate of average annual equivalent costs of the alternative plans. The first two steps are completed in the previous subsections. The third and fourth steps use the IWR Planning Suite II software to identify cost-effective plans and estimate incremental cost outputs, respectively. The cost-effective analysis results showed Alternative 2 to 4 are cost-effective. The incremental cost analysis yielded No Action and Alternative 5 as Best Buys or the most efficient plans. Table 28 shows a summary of the CE/ICA variables and the results of the cost-effectiveness analysis. When comparing by annual cost per output, Alternative 5 has the lowest cost of $1,754/output. The next lowest annual cost per output is the smallest scale plan, Alternative 2 ($1799/output). Alternative 2 yields about half the annual Access Days gained at Alternative 5. Figure 20 displays the relationship between cost and outputs, and the cost-effectiveness of each alternative.

Table 28. CE/ICA Results Summary

Alternative	Access Days Gained	Average Annual NED Cost	Annual Cost per Day Gained	Cost Effective
No Action	0	$0		Best Buy
Alt 2	1571	$2,827,000	$1,799	Cost Effective
Alt 3	1817	$3,853,000	$2,121	Cost Effective
Alt 4	2117	$3,921,000	$1,852	Cost Effective
Alt 5	2336	$4,099,000	$1,754	Best Buy

Figure 20. Alternatives Differentiated by Cost-Effectiveness



The two best buy plans are then compared using incremental cost analysis. The gain in access days (i.e., non-monetary outputs) relative to the increase in cost for the two best buy plans is shown in Table 29 and Figure 21.

Table 29. Best Buy Plans Incremental Cost Analysis

Alternative	Access Days Gained	Average Annual NED Cost	Annual Cost per Day Gained
No Action	0	0	-
Alt 5	2336	$4,099,000	$1,755

The Incremental Cost Analysis is performed by determining the incremental cost per unit between successively larger plan alternatives and identifying best buy plans as those for which the incremental cost output is lowest for a particular output level. The Cost-Effective Analysis identifies No Action and Alternative 5 as the best buy plans to be compared by the incremental cost analysis. The Incremental Cost Box Graph in Figure 21 displays the Best Buy plan comparisons resulting from the incremental cost analysis. Since there is only one Best Buy aside from the No Action, the chart below shows only Alternative 5.

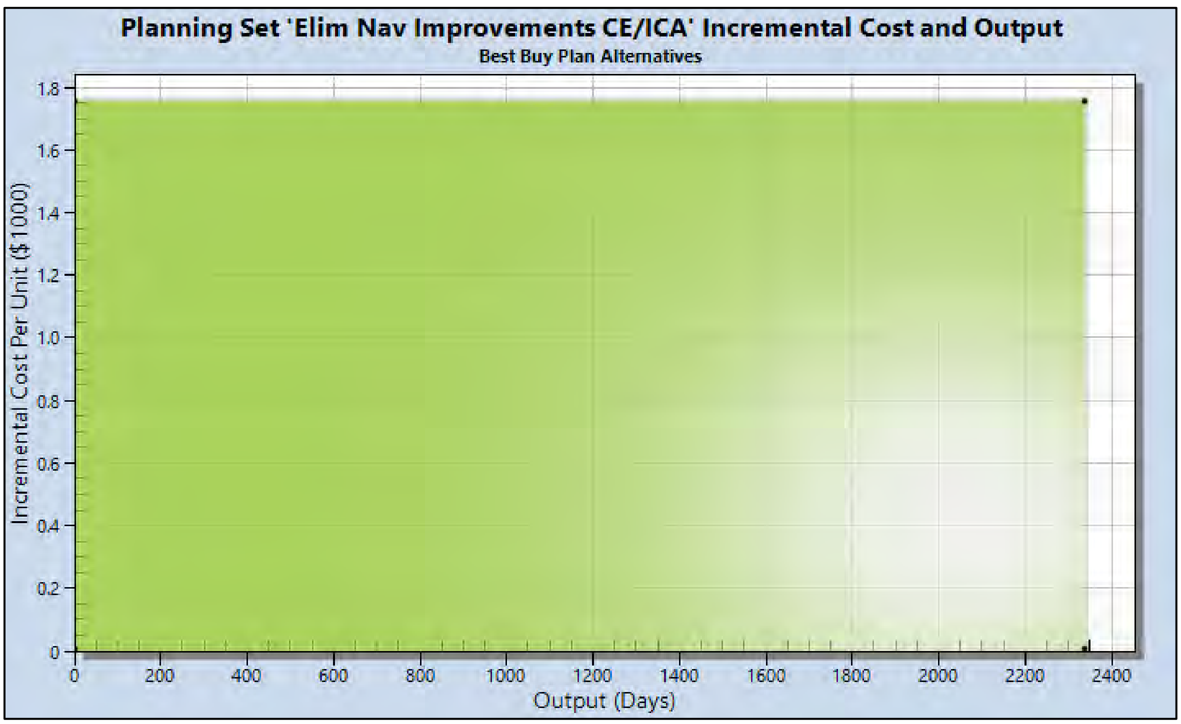


Figure 21. Incremental Cost Analysis of Best Buy Plans

14.0 ECONOMIC RISK, UNCERTAINTY, AND SENSITIVITY

The risks in the NED analysis lie in the uncertainties of the NED benefit categories. The benefit estimates are derived from the best available information. For Alaska, data is typically unavailable or limited to short time periods. Additionally, this economic analysis builds on the previous CAP 107 study in 2013. Following a review of the CAP 107 study model and literature, assumptions and extrapolations were necessarily developed to reflect current conditions at Elim. However, remaining data gaps trigger uncertainties and, in turn, give rise to the risk of benefits the project would realize.

USACE's risk-informed planning is intentional about uncertainty. As such this subsistence analysis is identified as a micro-level uncertainty which refers to the absence of complete information needed to estimate the effects of plans in an accurate and precise way. The assumptions used in this analysis are socio-economic and H&H and are subject to uncertainty. For example the predictions of accessibility by H&H uses the best information available but it uses historical data and does not account for future wave conditions under climate change. To incorporate risk and uncertainty associated with the series of assumptions used in this analysis, a range to the subsistence benefits is calculated. ADF&G documents in its studies that 30 percent of Alaskan Native households in a community produce 70 percent of the community's harvest. The remaining 30 percent of the harvest is produced by the individual households or other subgroups of households. This 70 percent subsistence production is the basis for the low range of subsistence benefits. It is reasonable to conclude that the low range amount of benefits represents a scenario where remaining uncertainties impact potential subsistence harvest. This amounts to average annual of $158,083.

A risk is considered acceptable if its consequences are so slight or the risk is adequately controlled (IWR Risk Informed Manual, July 2017). Given that plan selection is based on OSE and not NED, the consequences of this risk is considered small. Additional steps were still taken to incorporate risk-informed planning. The majority of benefits of the project would be realized in subsistence harvest and vessel damages. A SMART planning approach focuses on ways to manage the risk of these two benefit categories. A benefit range of high and low scenarios is incorporated for subsistence harvest and vessel damages. The low range represents a scenario that not all estimated benefits would be realized due to uncertainties beyond the study scope. The range scenarios are applied to the smallest and largest scale alternatives (Alternatives 2 and 5) The BCRs remain well below 0.50 as shown in Table 30. In order to achieve a positive BCR average annual benefits must increase five-fold. Given the existing and projected future conditions at Elim, the likelihood of benefits increasing five-fold is very low. Based on these considerations this is an acceptable risk.

Table 30. BCR Range Summary

Alternative	Low	High
Alt 2	0.23	0.32
Alt 5	0.18	0.23

For the CE/ICA, risk and uncertainty pertains to the wave analysis performed for Elim include the use modeled hindcast wind conditions from 1985-2014 and the use to of a fetch limited wave analysis to determine the wave conditions at Elim. The use of modeled hindcast data is a necessary low risk and is an industry-accepted practice for locations that do not have long-term buoy data. The risks associated with using a fetch limited wave analysis were managed by assuming that the waves were fully-developed, which is anticipated to over predict the wave heights at Elim, making it a conservative analysis.

15.0 FOUR ACCOUNTS

The following four accounts facilitate the evaluation and presentation of effects of alternative plans. The first is the NED account, which displays changes in the economic value of the national output of goods and services. Next, the RED account displays changes in the economic value of the national output of goods and services. The third account is EQ which displays non-monetary effects on ecological and aesthetic resources including the positive and adverse effects of plans. The last account is the OSE account, which displays plan effects on social aspects such as community impacts, health and safety, displacement and energy conservation.

Recall the project benefits considered under the Section 2006 Authority listed in earlier sections: public health and safety of the local community and communities in the region; access to natural resources for subsistence purposes; local and regional economic opportunities; welfare of the regional population to be served by the project; and social and cultural value to the local community and communities in the region. Each of these benefits is described in one or more of the four accounts, with a particular focus within the OSE account. A summary representation of the four accounts is shown by Table 31.

Table 31. Four Accounts Summary

Alternative	Net Annual Benefits & BCR	EQ	RED	OSE
2	-$1,932,000 0.32	Positive	Potential Increased employment and income for the community and region	Beneficial
3	-$2,914,000 0.24	Positive	Potential Increased employment and income for the community and region	Beneficial
4	-$2,982,000 0.24	Positive	Potential Increased employment and income for the community and region	Beneficial
5	-$3,137,000 0.23	Positive	Potential Increased employment and income for the community and region	Beneficial

15.1 National Economic Development (NED)

The NED account shows changes in the economic value of the national output of goods and services. All of the alternatives show a benefit-cost ratio of less than 1.0. Based on project costs, average annual benefits would have to increase five times to achieve a BCR greater than 1.0.

15.2 Regional Economic Development (RED)

The Regional Economic Development (RED) account measures changes in the distribution of regional economic activity that would result from each alternative. Evaluations of regional effects are measured using a nationally consistent projection of income, employment, output, and population.

The USACE Online Regional Economic System (RECONS) is a system designed to provide estimates of regional, state, and national contributions of Federal spending associated with Civil Works and American Recovery and Reinvestment Act (ARRA) Projects. It also provides a means for estimating the forward linked benefits (stemming from effects) associated with non-Federal expenditures sustained, enabled, or generated by USACE projects. Contributions are measured in terms of economic output, jobs, earnings, and/or value-added. RECONS includes three categories of economic impacts:

- **Direct effects** are defined as expenditures made by USACE. In the impact area in which the project is located, direct effects represent the portion of expenditures that flows to material and service providers in the impact area. For employment and earnings measures, the direct effect represents the jobs associated with the work activity (e.g., onsite construction jobs).

- **Indirect effects** include the backward-linked suppliers for any goods and services used by the directly affected activities.

- **Induced effects** on the region occur from household expenditures associated with direct- and indirect-affected workers spending their income within the impact area. Economic impact measures reported are a number of jobs, employment earnings output (sales), and value-added (gross domestic product).

RECONS reports indirect and induced effects collectively as secondary effects. The system was used to perform the following analysis for the Elim Navigation Improvements Project. A summary of the RECONS analysis for Alternative 5, which the CE/ICA identified as a Best Buy plan, is shown below.

Construction of a new harbor would also create jobs and regional economic opportunities (for purposes of the RECONS analysis, the region was defined as the Nome Census Area). Most of the work would be contracted to firms operating or based out of Alaska. Some work could benefit national firms. A smaller portion would benefit companies based in the Nome Census Area. The break out of benefits for Alternative 5 is shown in Table 32.

Table 32. RECONS Summary for Alternative 5

Area	Local Capture ($000)	Output ($000)	Jobs*	Labor Income ($000)	Value Added ($000)
Local**					
Direct Impact		$50,150	160.8	$16,304	$20,201
Secondary Impact		$2,970	11.5	$595	$1,719
Total Impact	$50,150	$53,120	172.3	$16,899	$21,920
State					
Direct Impact		$80,312	388.9	$30,374	$37,763
Secondary Impact		$35,014	194.6	$11,337	$21,000
Total Impact	$80,312	$115,326	583.5	$41,712	$58,763
US					
Direct Impact		$99,671	485.9	$35,658	$45,516
Secondary Impact		$121,947	605.7	$37,749	$64,031
Total Impact	$99,671	$221,617	1,091.6	$73,407	$109,547

* Jobs are presented in full-time equivalency (FTE)
** Local region was defined as the Nome Census Area

In addition to the effects shown above, there is potential to realize local and regional economic opportunities through the delivery of additional commercial fishing harvests to Elim and improved access for tenders and fuel and freight barges. Fish processing (fish cutters and trimmers) was identified as a top occupations in Elim in 2012 and 2013, indicating it was a major employer for residents before it was downsized in recent years. These opportunities provided by improved navigational access coupled with the planned head and guts pre-processing plant in Elim would potentially grow jobs in fish processing.

While Alternative 2 improves opportunities for commercial fishing and subsistence, it does little to enhance regional economic opportunities compared to the larger alternatives that provide additional access for tenders and the fuel and freight barges. The addition of a tender dock with Alternatives 3 and 4, coupled with a pre-processing plant in Elim, is expected to improve the overall efficiency of commercial fishing operations in the region. These alternatives are expected to improve job opportunities in the fishing industry, improve the quality of the product, reduce the change of a backlog at the Unalakleet plant, and allow fishermen to maximize the productivity of the salmon run.

While Alternatives 3 and 4 include a tender dock, which is critical for improving the efficiency of commercial fishing operations, these alternatives do not improve access for fuel and freight delivery.

Alternative 5 is the only alternative that provides safe access to barges that deliver fuel and freight to Elim. Having safe and efficient access to essential goods (including fuel) is foundational to community viability and is the basis for the stemming from the effects of improved fuel and goods delivery.

15.3 Environment Quality (EQ)

Environmental Quality (EQ) displays the non-monetary effects of the alternatives on natural resources and is described more fully in the environmental assessment sections of the draft feasibility report. A reduction in the fleet's fossil fuel usage and emissions resulting from reduced delays and idling time with improved access and moorage is expected, but improved efficiencies would also grow operations and may lead to more fossil fuel usage.

Enhancements to the environment as a result of constructing Alternative 5 include a reduction in the need for cargo barges to self-lighter. This in turn reduces oil leakages into the sea from construction equipment offloading into the water and 'walked to shore'. Alternative 5 would relocate the fuel header from the top of the bluffs to the barge landing on the beach. This would eliminate the need to float the hose from offshore and reduce chances for small fuel spills during offloading from the barge to the fuel header.

15.4 Other Social Effects (OSE)

OSE benefits include (1) public health and safety of the local community and communities in the region; (2) access to natural resources for subsistence purposes; (3) welfare of the regional population to be served by the project; and (4) social and cultural value to the local community and communities in the region. The OSE account displays the effects of a proposed intervention, such as a navigation project, on social aspects such as well-being that are integral to personal and community definitions of satisfaction and happiness (Dunning/Master Day LLC & Durden/USACE,2009). The USACE Planning Guidance Notebook further clarifies that these OSE also include: effects on educational, cultural and recreational opportunities; effects on security of life, health and safety; long-term productivity effects including the maintenance and enhancement of the productivity of resources for use by future generations; and effects on emergency preparedness.

These social effects reflect a highly complex set of relationships between the social and cultural setting and the proposed plan (USACE, Appendix D, 2004). The OSE account describes the above social effects (benefits) under a framework of "social well-being factors" as described by Dunning and Durden (2009, p. 6). Social well-being factors are based in part on Maslow's hierarchy of human needs theory, which states that people must have a number of essentials in order to survive and thrive (Maslow, 1943). As such, these social well-being factors are important to the long-term viability of a community. The framework of social well-being factors, discusses the effects that the proposed project would likely have on the social and cultural landscape in Elim and the region. The proposed project is a harbor of varied scales that would provide safe access and moorage for subsistence and commercial vessels, fish tenders and a freight/fuel barge. Section 12 on CE/ICA discusses safe access as the non-monetary metric by which the alternatives are compared. The following social well-being factors expand on the effects of safe navigational access on the social and cultural landscape in Elim, and the long-term viability of the community and region.

15.4.1 Health and Safety

An important basic human need is for personal and group safety (Maslow 1943). When conditions are unsafe or unhealthy it can cause stress and dissatisfaction among those affected. An important way Alaska communities promote health is through participation in the traditional harvesting and consumption of subsistence resources. Subsistence activities provide for traditional, healthy foods, and are especially important for food security and food sovereignty in remote communities like Elim. Subsistence opportunities are identified as a community strength in the project region (McDowell Group, 2019).

Despite the abundance of subsistence opportunities, however, McDowell Group (2019, p. 8) identified the lack of access to healthy foods as a community challenge in the project region. Flint et al. (2011) observed that health challenges are increasingly experienced among Alaska Native communities as traditional subsistence foods are replaced with Western, packaged foods when access to subsistence lifeways are impeded or inaccessible. They also suggest a correlation between the reduction in subsistence harvesting and decreases in physical activity, as well as increases in drug and alcohol problems. Improved access to subsistence resources support the physical health of Elders and communities who are the culture bearers and teachers of subsistence practices (Flint et al. 2011). Sections 2.2 and 6.1.1 (above) discuss Elim's reliance on vessels for subsistence activities during the open-water seasons and the challenges to subsistence activities due to the lack of safe navigational access. Improving navigation access will beneficially impact community members' abilities to pursue subsistence opportunities.

For commercial vessels, improved access effects include reduced risk of boat accidents at Moses Point during open fishing seasons. In addition, a protected boat launch could also support the timely mobilization of vessels responding to a vessel in distress. When there is a vessel in distress, the existing conditions make it difficult to safely mobilize search and rescue efforts. Response vessels often wait for better weather and wave conditions to launch from Moses Point or Elim Beach (USACE Public Meeting, 2018). These conditions are reduced depths at Moses Point and the moving sand bars in front of Elim Beach. If the water depth conditions at Moses Point are favorable for boat launch, response community members still have to drive from Elim to Moses Point provided the eroded road is not flooded. The longer the delay to launch response vessels the greater the potential risks are for the vessel in distress. The proposed project would reduce these safety risks on the community.

Navigation improvements would also promote health and safety during barge operations. A barge landing and protected harbor would reduce risks associated with wave conditions to both crew members and community members in the vicinity. Additionally, the relocation of the fuel header from the top of the bluffs to the beach near the barge landing is expected to eliminate the need to float the fuel hose to shore and then manually drag it across the beach and up the bluffs. This would improve safety and efficiency in fuel delivery overall. The fuel leakages and oil spills described in the EQ account (above) impact subsistence species. The project would reduce these leakages and spills and, in turn, reduce environmental health risks.

15.4.2 Social Connectedness

According to Dunning and Durden (2009), “social connectedness” refers to the intricate social networks within which individuals interact; these networks provide meaning and structure to life. These social networks comprise of families and community members cultivating an array of diverse voluntary associations known as “civic infrastructures.” These civic infrastructures can provide individuals with greater opportunities for connectedness, communication, and reciprocity, as well as support accessing subsistence resources. Improved access and moorage for subsistence activities support social connectedness among Elim community members. Subsistence activities consist of hunting, fishing, gathering, and the meticulous processing of those harvests; subsistence often requires a collective effort from extended family, friends, and neighbors. By having safe navigational access to these subsistence resources, the collective participation of community members in the subsistence civic infrastructures can be enhanced, strengthening an individual’s ties within and to the community.

Under the socio-economic conditions, Subsection 4.2 (School Enrollment) noted the prominent presence of students aged 4 to 11 years old in Elim. This age group encompasses the crucial formative years for instilling cultural values and social connectedness through participation in subsistence activities. A community Elder talked about the importance of a young person being immersed in their traditional ways before they venture out of the community. In Elim, community events centering on subsistence activities are often organized to involve both the young and the old. One such example was a community picnic on the beach with traditional foods harvested and prepared collectively during the beluga harvest (Nagaruk C, personal communication, April 2019).

In addition to serving as a crucial vehicle for subsistence harvests, small vessels also serve as a marine highway connecting remote villages. In this sense, the proposed navigation improvements would also support social connectedness with neighboring communities and kinship networks (e.g., Golovin, Koyuk, Shaktoolik). For example, when there is a funeral in Elim, family, and friends from neighboring communities visit by vessel often with wild foods (cite personal communication). This type of inter-village event further promotes reciprocity, which is a significant aspect of Yup’ik and Inupiaq cultural traditions and reflects the cultural importance of subsistence activities.

15.4.3 Social Vulnerability and Resiliency

Social vulnerability refers to the capacity for being damaged or negatively affected by hazards or impacts of either a physical or social nature. Vulnerability is often associated with specific groups within a population (e.g., elderly, poor) who are generally more susceptible to such impacts than other parts of the population. Social resiliency refers to the ability to cope with and recover from hazards or impacts (Dunning and Durden, 2009). Without a functional harbor, Elim residents will continue to launch their vessels from Moses Point, approximately 10 miles out of town, where the sand bar is subject to shifting and boat access from the ocean during most tides is difficult and hazardous. In addition to this ever-changing navigation hazard, the potential difficulty in landing their vessels in a timely manner can impact their ability to safely process subsistence harvests.

Fishermen are often key subsistence and cash providers for their households. As fishermen age, they are potentially more vulnerable to the hazardous conditions at Moses Point. The proposed protected harbor would create stability in commercial and subsistence activities through safe access and moorage for vessels. By providing this stability, the fishermen are less vulnerable to hazards like shifting sand bars, and impacts to their ability to bring their subsistence harvest onto land to process it in a timely manner. They would be more able to secure cash from commercial fishing that can be used for equipment repairs. This translates to improved resiliency when they are more able to cope with and recover from hazardous events or unexpected impacts. Practicing knowledge and skill transfer from older fishermen to the younger generation of fishermen can also be improved when there is safe access for commercial vessels. Social connectedness also supports the mobilization of the civic infrastructures that serve the community in a time of crisis.

15.4.4 Identity

The cultural identity of Alaska Native Tribes is highly dependent upon subsistence activities tied to specific locations and deep historical knowledge of land and marine subsistence resources. According to Dunning and Durden (2009, p.7), “Identity is the sense of self as a member of a group, distinct from and distinguished from other groups by values, beliefs, norms, roles, and culture.” Cultural identity is multidimensional and complex; while a social well-being factor on its own, it is also key to realizing other social well-being factors: health and safety, social connectedness, and social vulnerability and resilience. It is, therefore, difficult to separate the discussion on identity from the social well-being factors mentioned above. As a social effect of the proposed project, identity must first be considered in the context of its pivotal role in some of the solutions to health challenges, specifically the behavioral health challenges widely experienced by remote Alaska Native communities.

The Bering Strait Community Needs Assessment identified the top ten community challenges in the Kawerak Service Area (McDowell Group, 2019). Substance abuse and a lack of cultural-based activities are among these community challenges, which are complex and interlinked. Substance abuse is a well-documented problem in Native American and Alaska Native communities (Dickerson et al. 2011). While the scope of this evaluation does not investigate the complex causes of substance abuse, it does not overlook the links between cultural identity conflicts and these multifaceted problems (Segal et al. 1999; Allen et al. 2014). Rasmus et al. identify the externally imposed changes to the indigenous way of life that took place dramatically and quickly in Alaska Native communities as one of the causes of these behavioral health problems (2014).

In recent years, health interventions designed by and for Native communities that are culturally grounded and integrate indigenous knowledge (IK) are increasingly advocated for in the behavioral health arena (Rasmus et al. 2019; Walters et al. 2020). A report by the University of Alaska titled Alaska Natives Combating Substance Abuse and Related Violence Through Self-Healing discusses the cyclical causes and effects of substance abuse, as well as the Alaska Native initiated solutions that focus on the cultural wellbeing of participants (Segal, Burgess, Frank, Hild, & Saylor, 1999). These solutions were community-based treatment and prevention programs spearheaded by local communities with support from Native corporations and associations. One of these initiatives is Spirit Camps where participants practiced subsistence traditions of summer fish camps to harvest, cut, dry, smoke, and package a large amount of fish for storage. Other subsistence activities at the camps include harvesting berries and hunting for meat. Each of these subsistence tasks involved whole communities (social connectedness). Participation in these subsistence activities revived and sustained a sense of cultural identity and it is here where healing from substance abuse begins. The Spirit Camps included inviting elders to articulate central values by teaching subsistence activities and cultural traditions to the youths. By strengthening a sense of cultural identity in the young participants, it contributed to safeguarding culture, preventing alienation, alcohol drug abuse, and suicide. Regarding substance abuse treatment outcomes, Segel et al. reported that Alaska Native women who maintain a sense of cultural identity are more likely to complete treatment than women who have lost their cultural identity. A similar initiative called the Circumpolar Indigenous Pathways to Adulthood (CIPA) study is part of a long-term community based and participatory program at the University of Alaska Fairbanks. CIPA identifies the strengths and resilience in youths living in a Yup'ik community in southwest Alaska in the face of substance abuse related challenges. The CIPA study found that development of social and cultural connectedness within a supportive network of kinship relationships and enduring cultural traditions and practices like subsistence activities are important to youth resilience (Rasmus, 2014).

Elim and the communities in the region are not immune to the challenges of substance abuse and its associated effects. The degree of these challenges may vary from community to community but remain equally a threat to community viability. The solutions mentioned in the preceding paragraph are applicable. During focus groups, local residents echoed the importance of continued subsistence practices and indigenous knowledge to cultural identity. A harbor that provides safe access can facilitate the subsistence practices important to strengthening identity, which is part of the solutions to address substance abuse and the lack of cultural activities. The proposed project would support behavioral health interventions that are at the core, "focus on restoring of order to daily living in conformity with ancient and enduring values that affirm life" (Castellano, 2004, p. 100) It is important to recognize the role of indigenous knowledge to cultural identity beyond abstract observations. Indigenous knowledge reflects epistemologies, values, and assumptions that shape how people understand phenomena and go about daily activities such as subsistence (Walter et al. 2020). A protected harbor for the community to launch their vessels and collectively participate in the various subsistence activities can provide community members important access to cultural identity by providing stable and indigenous knowledge sharing that support resiliency to the behavioral health problems.

16.0 CONCLUSION

This appendix presented the economic analysis of six alternatives for providing navigation improvements at Elim, Alaska. The alternatives were evaluated using the four accounts established in the Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies: National Economic Development (NED), Regional Economic Development (RED), Environmental Quality (EQ), and Other Social Effects (OSE).

Consistent with the authority of Section 2006 of WRDA 2007 – Remote and Subsistence Harbors, as amended, an NED analysis was performed which demonstrated that none of the alternatives had a benefit-cost ratio (BCR) greater than 1.0. Since there was no NED plan, Cost Effectiveness and Incremental Cost Analysis (CE/ICA) was used to support plan selection. Economic risks and uncertainties were identified and discussed to support risk-informed planning and decision-making under uncertainty.

Alternative 2 had the highest average annual net NED benefits but the BCR is below 1.0, while Alternative 5 was identified as a Best Buy plan through the CE/ICA, meaning this alternative provides the greatest increase in output for the least increase in cost. The CE/ICA and OSE account demonstrate how the proposed alternatives support the long-term viability of Elim. These analyses inform plan selection as detailed in the main report of the Draft Integrated Feasibility Report and Draft Environmental Assessment.

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