Attachment F.2 Benefit Cost Analysis Newtok, Alaska

I. Introduction & Overview

The community of Newtok, Alaska is located along the Yukon Delta National Wildlife Refuge, 98 miles west of Bethel. Newtok is not connected to a road system, relying on access by boat or airplane. Newtok has a population of 354 (2010 Census) and is a predominantly Yup'ik Eskimo community. Residents depend primarily on a subsistence lifestyle supplemented with a limited cash economy.

Between 2006 and 2008 Newtok was the subject of a US Army Corps of Engineers study on coastal erosion that found the community was averaging 72 feet of land lost per year. The largest recorded loss was greater than 300 feet in one year.

During a severe fall storm in 2013 Newtok sustained in excess of $1,100,000 in damage and was part of a larger presidentially declared disaster (DR-4162).

Newtok is experiencing rapid coastal erosion that has rendered homes unsafe or in imminent peril. The US Army Corps of Engineers has concluded that there is no viable means to preserve the existing village, and it should be relocated to a new site, identified as Mertarvik, approximately 7 miles away on the northern coast of Nelson Island.

In September of 2015 President Obama became the first sitting president to visit the arctic to see for himself the problems of erosion (Whitehouse.gov, 2015). The threat of Newtok and other communities literally falling into the ocean has reached the top levels of government, with Newtok being one of the first communities expected to be lost if nothing is done.

II. BCA Summary

A summary of benefits and costs for all projects is provided below. Additional information on individual projects can be found in Section III Project BCA Narratives. Projects 2-5 have a combined BCR as many of the calculated benefits are only applicable if all of the combined projects are completed.

Aggregate Benefit Cost Ratios (BCR's) for Proposed Projects			
Project Description	**Quantitative Benefits**	**Estimated Costs**	**BCR**
1. Subdivision Design & Record Plat	-0-	$650,000	-0-
2. Mertarvik Prototype Housing/CCHRC	$102,101,995	$26,925,000	2.35
3. Residential Road Development		$9,962,000	
4. Pioneer Runway		$6,394,000	
5. Bulk Fuel Tank Farm		$3,625,000	
6. Community Landfill	-0-	$1,991,000	-0-
7. Retrofit Twelve Relocated Homes	$8,006,715	$743,000	10.78
8. Demolish Abandoned Homes in Newtok	$1,707,101	$7,232,000	0.24
Totals:	$111,815,811	$57,522,000	1.94
Direct Activity Delivery Cost (20%) Training, travel, grant management, project management, technical assistance, kick-off meetings and other supporting activity implementation		$11,504,400	
Total with Direct Activity Delivery Cost		**$69,026,400**	

III. Project BCA Narratives

BCA narratives for individual projects are provided below. Proposed projects focus on infrastructure, housing, and food and economic security at the new community of Mertarvik.

Analysis calculations applicable to more than one project is summarized under the Analysis Process Applicable to Multiple Projects heading and includes such items as determining the return interval for future disaster events, population, and other similar items. Cited references are provided in the attached Appendices.

Analysis Process Applicable to Multiple Projects

Erosion Analysis

The need for the village of Newtok to quickly relocate to the Mertarvik site has been verified through multiple assessments and projects over the last few decades. Here are a number of important looks at the erosion issues.

- The coastal erosion in Newtok has been recorded as far back as 1984 as a very real threat to the community (Ninglick River Erosion Assessment, 1984). This assessment wrote that "relocating Newtok would likely be less expensive than trying to hold back the Ninglick River."
- In 2009 the US Army Corps of Engineers named Newtok as a priority community for rapid aid based on the imminent threat of coastal erosion (Alaska Baseline Erosion Assessment, 2009).
- Satellite imagery from multiple websites which show images from years past clearly show the fast loss of land (Terraserver.com maps from 2003, 2014, 2015)
- The US Army Corps of Engineers recorded the rate of land loss due to coastal erosion at an average of 72 feet per year, with a range between 25 and 300 feet (Alaska Baseline Erosion Assessment, 2009, Newtok Planning Group, 2015). If future erosion rates are similar, structures closest to the Ninglick River will be lost as early as the next 1-2 years. Important buildings such as the school and airport will be impacted within 2-3 years.

Community Population

Community Population for Newtok is 354 residents based on information from the 2010 US Census.

Project Useful Life

Project life of 30 years based on BCA Reference Guide 2009 Appendix D.

BCA Narrative

Project 1: Subdivision Design & Record Plat

Process for Preparing the BCA

The Benefit Cost Analysis (BCA) for the Subdivision Design & Record Plat was prepared as follows:

Costs

Capital cost data was provided by the US Army Corps of Engineers.

Benefits

The completion of the subdivision design & record plat is necessary to begin construction of the new village of Mertarvik and provide for the expedient placement of infrastructure such as roadways, houses, the bulk fuel facility, and other public and private improvements.

Discount Factor

A discount factor of 7% was applied to all annual costs and benefits to calculate present dollar values of future costs and benefits.

Full Proposal Cost	Estimated Cost	Other Funding
A cost estimate is provided in Appendix F.2.1.	$650,000	

Description of Current Situation and Problem to be Solved

The Village of Newtok is experiencing rapid coastal erosion that has rendered homes unsafe or in imminent peril. The US Army Corps of Engineers has concluded that there is no viable means to preserve the existing village, and it should be relocated to a new site, identified as Mertarvik, approximately 7 miles away on the northern coast of Nelson Island. The elevation and geological composition of the site makes it less susceptible to erosion and flooding. As part of moving the community, it is necessary to design and construct a new community at the Mertarvik site. A Paper Plat of the proposed community was completed in 2015 which shows the layout of roads, lots, and proposed locations for community buildings (Dropbox: N-9). Final subdivision design and field staking has not yet started and must be completed prior to beginning construction.

Description of Proposed Project or Program

This project proposes to complete a subdivision layout design and plat to establish public and private property boundaries for the new community of Mertarvik. Subdivision design will build upon the Mertarvik Final Community Layout Plan (May 12, 2015) and the Mertarvik Final Paper Plat (May 12, 2015) to produce the design and plat. Subdivision layout and platting must be completed to establish site control prior to beginning construction. (Dropbox: N-9)

Description Risk to the Community if the Proposal is Not Implemented

Subdivision design and platting are necessary to establish an efficient community layout and ensure that proposed construction is completed within legal property boundaries. Potential risks to not implementing the proposed project include:

- Increased costs due to additional infrastructure needs due to inefficient layouts.
- Property disputes due to unknown property lines, public rights-of-way, and easements.

- Delaying construction due to lack of site control.

List of Benefits and Costs

Due to the difficulty in quantifying benefits for the planning effort a BCR was not calculated for this project. Qualitative project benefits for this project include:

- Improved community resiliency by having a plan to relocate the community to Newtok.
- Avoided future damages to structures in Newtok once properties are relocated to Mertarvik.
- Improved social cohesion due to community input in proposed layout.
- Decreased impact to the natural environment by having a well-planned process to site and develop roads, buildings and infrastructure.

A copy of the BCA is provided in Appendix F.2.1.

Descriptions of Risks to Ongoing Benefits

Even if the plat is constructed, funding for other referenced projects (i.e. roads, homes, and other public facilities) has not been secured. Therefore, no guarantee exists that, even when the subdivision design and platting is complete, that improvements in Mertarvik will occur in the near term.

Assessment of Challenges Faced with Implementing the Proposal

Public input has been completed for this project and layout. Travel challenges associated with accessing the site to stake the subdivision are considered routine for rural Alaska.

Metrics

The following metrics will be used to determine the impacts of the Subdivision Design and Record Plat Project:

Resilience Value: Reduced impacts and associated responses to disasters.
Environmental Value Factors:

- Noise levels
- Air Quality – Reduced criteria pollutants (nitrogen dioxide (NO2), ozone (03), sulfur dioxide (SO2) and particulate matter of aerodynamic diameter of the micrometers or fewer (PM-10)
- Water quality – reduced storm water runoff

Social Value Factors:

- Benefit to low- and moderate-income persons and/or households
- Improved living environment
  - improved community identity and social cohesion
  - improved recreational value
  - greater access to Cultural, historic, archaeological sites and landscapes
  - equal access to resilient community assets

Economic Revitalization Value Factors:

- Value of property other than through enhanced flood protection, independent of increases in property value captured by other benefits in the BCA or that might otherwise have occurred without the proposed project.

BCA Narrative

Project 2: Mertarvik Prototype Housing (CCHRC)

Process for Preparing the BCA

Projects 2-5 are combined into a single BCA because the primary benefits will only be realized if all of them are constructed. Each project plays a vital part in the overall construction of Mertarvik Village and achieving resiliency for the community.

Costs

Cost based on construction cost estimate provided by the Cold Climate Housing Research Center (CCHRC) construction of 66 homes in Mertarvik.

Operations and Maintenance

Operations and maintenance of the new homes will be provided by the homeowners and will be similar in scope to operating and maintaining the existing homes in Newtok. The proposed homes will be more energy efficient than the existing homes and will have an annual fuel savings of 71% relative to typical homes in the area. A 2008 study of fuel use in rural Alaska found that the average home spent $4,900 per year on heating fuel. Using the US Bureau of Labor and Statistics online inflation calculator this equates to $5,415 in 2015 dollars. A reduction in fuel usage of 71% equates to an annual savings of $3,868.07 per home.

Benefits

Calculated benefits were based on the proposed improvements (Mertarvik Prototype Housing, Community Roads, Pioneer Runway, and Bulk Fuel Tank Farm) preventing future floods from affecting the community. Benefits include:

1. Reduction in expected property damage due to future/repeat disasters.
    - Rate of loss due to erosion was estimated using the information provided above in Analysis Process Applicable to Multiple Projects.
    - Number of homes lost each year was determined based on average erosion rate relative to homes shown on maps obtained from State of Alaska Department of Commerce, Community and Economic Development (DCCED).
    - For properties located in the 100-year floodplain, the October 8, 2013 FEMA Memo: “Cost Effectiveness Determinations for Acquisitions and Elevations in Special Flood Hazard Areas using Pre-calculated Benefits” sets a standard that FEMA Pre-calculated benefits are $276,000 for acquisition projects. Based on the guidance in this memo, pre-calculated benefits can be used instead of project specific benefits (i.e. Benefit-Cost Analysis (BCA) for any site located in the FEMA 100-year floodplain; additionally, these pre-calculated benefits can be adjusted with local multipliers. By applying the local multiplier developed for Newtok, Alaska (1.977), the pre-calculated benefits increase to $546,480. The local multiplier was determined using R.S. Means value of 1.183 using the 2014 Master Format City Cost Index to determine the base Alaska multiplier, this value was then multiplied by the site specific multiplier of 1.671 which was determined using the State Department of Education Geographic Cost Factor.
    - Based on the location of each home and the average rate of erosion, a quantity of structures

per year that would be affected was determined. (i.e. in year 1 nine structures will be lost, in year 2 three structures will be lost, etc…)

- The total damages were applied to future anticipated erosion events over a 30 year design life of the project with a discount factor of 7% applied to future benefits.

2. Reduction in Cost of Loss of Water Service

- The existing water treatment plant is located approximately 1,200 feet from the riverbank. With an average erosion rate seen in Newtok of 72 feet per year, the water treatment plant is projected to be affected in year 17.
- The economic impact of loss of water service is provided as a standard value on Page 40 of the FEMA Benefit-Cost Analysis Re-engineering (BCAR) and is listed as $103 per capita per day in 2010 dollars or $112.39 per day in 2015 dollars (Bureau of Labor and Statistics online calculator www.bls.gov/data/inflation_calculator.htm). With a population of 354 in Newtok, this equates to a total cost of $39,787.72 per day of economic impact.
- The daily cost was multiplied by the number of days that the community is without a potable water source (365 days once water treatment plant is damaged) for a total annual cost of loss of water service equal to $14,522,518.
- The total costs for loss of water service were applied to future anticipated flood events over a 30 year design life of the project with a discount factor of 7% applied to future benefits.

3. Reduction in Expected Displacement Costs due to Future/Repeat Disasters

- Displacement Cost = (Disruption Cost x Sq. Ft) + (Rental Cost x Sq. Ft x Displacement Time in Months) as described in the FEMA Benefit-Cost Analysis Re-engineering (BCAR) publication.
- Rental costs per month based on Table 2 provided in BCAR. Residential Rental Costs based on Single-Family Dwelling: Duplex = $0.73 per square foot in 2008 dollars. Cost was calculated to be $0.81 per square foot in 2015 dollars based on US Bureau of Labor and Statistics Inflation Calculator (http://www.bls.gov/data/inflation_calculator.htm).
- Disruption Cost ($/square foot) is provided in Table 2 of BCAR. Residential Disruption Costs based on Single-Family Dwelling: Duplex = $0.88 per square foot in 2008 dollars. Cost was calculated to be $0.97 per square foot in 2015 dollars based on US Bureau of Labor and Statistics Inflation Calculator (http://www.bls.gov/data/inflation_calculator.htm).
- Recovery Time by Occupancy Type and Flood Depth is provided in Table 3 of BCAR. Assume a 12 month Recovery Time.
- Rental and Disruption Costs were multiplied by local multiplier developed for Newtok, Alaska (1.977) The local multiplier was determined using R.S. Means value of 1.183 using the 2014 Master Format City Cost Index to determine the base Alaska multiplier, this value was then multiplied by the site specific multiplier of 1.671 which was determined using the State Department of Education Geographic Cost Factor.
- The average area of homes in Newtok was determined to be 1,126 square feet based on aerial mapping provided by DCCED. Rental and displacements costs were determined based on damage areas multiplied by the Rental and Displacement costs listed above.
- The total displacement costs were applied to future anticipated flood events over a 30 year design life of the project with a discount factor of 7% applied to future benefits.

4. Reduction in Cost of Treatment of Psychological Issues from Future/Repeat Disasters
    - Total cost for mental health treatment for severe and mild/moderate illnesses with effect of prevalence and course determined from Table 6 in FSBMR. Cost of $2,443.10 per person who has lost a home due to erosion, per traumatic event was provided.
    - Calculation assumes that traumatic event occurs annually when erosion removes shoreline and community homes.
    - Cost of psychological treatment ($2,443.10 x Number of residents losing home) was calculated for each traumatic event and varies depending on the year.
    - The total psychological treatment costs were applied to future anticipated erosion events over a 30 year design life of the project with a discount factor of 7% applied to future benefits.
5. Reduction in Cost of Lost Productive Hours due to Psychological Issues from Future/Repeat Disasters.
    - Total cost for productivity loss due to severe mental illness determined from Table 7 in FSBMR. Cost of $8,736 per productive person in household, per traumatic event was provided.
    - 2010 US Census data lists 76 homes with an average household size of 4.65 people. Based on average household size it is assumed that 2 productive persons live in each home.
    - Calculation assumes that traumatic event occurs annually when erosion removes shoreline and community homes.
    - Cost of lost productivity ($8,736 x 152 productive persons) was calculated for each traumatic event and varies depending on the year.
    - The total lost productivity costs were applied to future anticipated flood events over a 30 year design life of the project with a discount factor of 7% applied to future benefits.
6. Reduction in Cost of Loss of Function of a School
    - Calculation assumes that elementary school aged children (kindergarten through 6th grade) will be home schooled in Newtok. Children in 7th through 12th grade will be educated at a regional boarding school in another community.
    - Students will return to Newtok twice during academic year (Winter Break and Spring Break)
    - Cost is calculated for airfare to transport students (three trips per year) and additional cost of housing at boarding school.
    - The total costs for loss of school were applied to future anticipated flood events over a 30 year design life of the project with a discount factor of 7% applied to future benefits.

Additional qualitative benefits are listed in the BCA provided in Appendix F2.2-5

Full Proposal Cost	**Estimated Cost**	**Other Funding**
A construction cost estimate is provided in Appendix F.2.2-5	$26,925,000	

Description of Current Situation and Problem to be Solved

The Mertarvik site currently lacks available homes for displaced Newtok residents to relocate to. By constructing new homes, virtually all Newtok residents can move to the new site.

Additionally, due to Newtok's lack of wastewater facilities, there is a high level of contamination of the community with bacteria common to human and animal waste products, including *E. coli*. By moving the residents into CCHRC housing at the new site, these threats will be mitigated due to housing being equipped with individual water/wastewater facilities.

Description of Proposed Project or Program

This project will purchase and construct 66 homes designed by CCHRC. These residences feature in-home power generation via gas powered generators, potable water holding and filtration, and wastewater filtration systems making individual homes highly resilient to disasters. The homes are also built specifically for cold climate areas. The labor force will be housed in a mancamp constructed specifically for initial relocation efforts. The proposed project will also include retrofitting the existing IRT structures in Mertarvik to provide a heated and insulated flex space.

Description Risk to the Community if the Proposal is Not Implemented

Without the construction of these homes, relocation of the community to Mertarvik will not be able to happen. Residents will have to remain at Newtok until other funding streams can be found for construction of homes at Mertarvik. This exposes residents to continuing threats of coastal erosion, flooding, and illness from extremely poor sanitation conditions, and an increased likelihood of residents being forced to move to distant cities to find new homes away from their ancestral villages.

List of Benefits and Costs

A list of project benefits and costs and associated computations is provided in Appendix F.2.2-5. Project benefits include:

- Benefit of reduced future structure damage in Newtok due to future erosion.
- Benefit of reduced future displacement costs of Newtok residents due to future erosion.
- Benefit of reduced loss of water service to residents.
- Benefit of improved social cohesion
- Benefit of preservation of culture and a Federally-Recognized Tribe
- Benefit of reduced cost of treatment of psychological issues from future erosion.
- Benefit of reduced cost of lost productive hours due to psychological issues from future erosion.
- Benefit of reduced loss of school

Descriptions of Risks to Ongoing Benefits

Final design for the CCHRC homes is complete and the construction process is ready to begin. The project is contingent on finalizing the community subdivision layout and plat and constructing roads and a pioneer runway to serve the community. A bulk fuel facility is necessary to provide a source for fuel to heat the homes.

Assessment of Challenges Faced with Implementing the Proposal

Several homes have already been constructed at Mertarvik by community residents. This proves that, although not without challenge, construction at the new site is feasible and can be completed by local labor as is planned for this project.

Metrics

The following metrics will be used to determine the impacts of the Mertarvik Prototype Housing Project:

Resiliency Value Factors:

- Value of protection from the effects of future/repeat disasters, including, but not limited to, flood, wind, fire, earthquakes, such as:
  - Reduction of expected property damages due to future/repeat disasters
  - Reduction of expected casualties from future/repeat disasters
  - Value of reduced displacement caused by future/repeat disasters
  - Reduced vulnerability of energy and water infrastructure to large-scale outages

Environmental Value Factors:

- Reduced energy use
- Noise levels
- Air Quality
  - Reduced particulate matter of aerodynamic diameter of the micrometers or fewer (PM-10)
- Water quality – reduced storm water runoff

Social Value Factors:

- Reductions in human suffering
  - lives lost
  - illness from exposure to environmental contamination
  - asthma and cancer rates in low income and minority populations living in areas with greater environmental risk
- Benefit to low- and moderate-income persons and/or households
- Improved living environment
  - elimination of slum and blight conditions
  - improved community identity and social cohesion
  - equal access to resilient community assets
- Greater housing affordability

Economic Revitalization Value Factors:

- Direct effects on local or regional economy net of opportunity costs.
- Value of property other than through enhanced flood protection, independent of increases in property value captured by other benefits in the BCA or that might otherwise have occurred without the proposed project.

BCA Narrative

Project 3: Subdivision Roads

Process for Preparing the BCA

Projects 2-5 are combined into a single BCA because the primary benefits will only be realized if all of them are constructed. Each project plays a vital part in the overall construction of Mertarvik Village.

Costs

Project costs were determined by estimating unit costs for various project components and multiplying the unit prices by the total quantity of each component. Unit prices were developed from published cost information in *RS Means Heavy Construction Cost Data* multiplied by the RS Means City Cost Index (1.183) and the Alaska Department of Education Geographic Area Cost Factor for Newtok (1.671). A detailed cost estimate is provided in Appendix F.3.2-5. Quantities were developed based on measurements from the community subdivision layout and conceptual cross sections of the proposed improvements.

Operations & Maintenance Costs

Operations and Maintenance Costs for gravel roads were calculated using the Assessment Procedures for Paved and Gravel Roads report (Appendix F.2.2-5). *Table 3-2. Gravel Road Costs in South Dakota based on ADT* outlines the different costs associated with maintaining a gravel road. Based on the values given in the table, the total O&M cost came out to $2,162.50/mile of gravel road. It was assumed the ADT (vehicles/day) was in the range of 100-199. Mertarvik, like Newtok, is an ATV community with no anticipated automobiles.

Benefits

Benefit calculations for the Subdivision Roads project are described under Project 2: Mertarvik Prototype Housing (CCHRC) and not repeated here.

Discount Factor

A discount factor of 7% was applied to all annual costs and benefits to calculate present dollar values of future costs and benefits.

Full Proposal Cost	Estimated Cost	Other Funding
A construction cost estimate is provided in Appendix F.2.2-5	$9,962,000	

Description of Current Situation and Problem to be Solved

The Mertarvik site currently has little to no infrastructure necessary to support permanent-habitation. Currently there are a small number of roads that connect existing facilities at Mertarvik, but these roads need to be expanded to accommodate the development of a residential area.

Description of Proposed Project or Program

This project will provide funding for the construction of gravel roads in the residential section of the Mertarvik site. These roads will serve homes to be constructed in the area and connect to the existing roads that serve the barge landing, and future landfill site. The roads will be insulated to limit settlement of permafrost below the fill.

Description Risk to the Community if the Proposal is Not Implemented

Without this project, no suitable roadways for transportation of goods or individuals will exist in the residential section of the new community. This will limit access to community facilities and make construction of the proposed homes in Mertarvik significantly more difficult if not impossible.

Additionally, the lack of reliable roads will complicate possible emergency responses, as responders will be forced to move supplies and equipment across the same tundra, necessitating lower speeds for responder safety. This will increase the time and expense of future emergencies.

List of Benefits and Costs

A list of project benefits and costs and associated computations is provided in Appendix F.2.2-5. Project benefits include:

- Benefit of reduced future structure damage in Newtok due to future erosion.
- Benefit of reduced future displacement costs of Newtok residents due to future erosion.
- Benefit of reduced loss of water service to residents.
- Benefit of improved social cohesion
- Benefit of reduced cost of treatment of psychological issues from future erosion.
- Benefit of reduced cost of lost productive hours due to psychological issues from future erosion.
- Benefit of reduced loss of school

Descriptions of Risks to Ongoing Benefits

Community roads are necessary to complete construction of new housing and other community improvements. The project is contingent on finalizing the community subdivision layout and plat to ensure improvements are constructed within public right-of-way.

Assessment of Challenges Faced with Implementing the Proposal

In addition to barging in gravel, a local quarry is available near Mertarvik to use for the construction of the gravel roads. Development of the blasted rock into gravel will require rock crushing and mixing equipment to provide appropriate material to construct the roadways.

Metrics

The following metrics will be used to determine the impacts of the Subdivision Roads Project:

Resiliency Value: Improved travel over gravel roads versus old boardwalks.
Environmental Value Factors:

- Air Quality
  - Reduced particulate matter of aerodynamic diameter of the micrometers or fewer (PM-10)
- Water quality – reduced storm water runoff

Social Value Factors:

- Benefit to low- and moderate-income persons and/or households
- Improved living environment
  - elimination of slum and blight conditions
  - improved community identity and social cohesion

- improve recreational value
- greater access to Cultural, historic, archaeological sites and landscapes
- equal access to resilient community assets

- Greater housing affordability

Economic Revitalization Value Factors:

- Direct effects on local or regional economy net of opportunity costs.
- Value of property other than through enhanced flood protection, independent of increases in property value captured by other benefits in the BCA or that might otherwise have occurred without the proposed project.

BCA Narrative

Project 4: Pioneer Runway

Process for Preparing the BCA

Projects 2-5 are combined into a single BCA because the primary benefits will only be realized if all of them are constructed. Each project plays a vital part in the overall construction of Mertarvik Village.

Costs

Project costs were determined by estimating unit costs for various project components and multiplying the unit prices by the total quantity of each component. Unit prices were developed from published cost information in *RS Means Heavy Construction Cost Data* multiplied by the RS Means City Cost Index (1.183) and the Alaska Department of Education Geographic Area Cost Factor for Newtok (1.671). A detailed cost estimate is provided in Appendix F.3.2-5. Quantities were developed based on minimum runway lengths and widths to accommodate a Cessna Caravan which is the type of aircraft used for medical evacuations. The cost assumes that the pioneer runway will be constructed at or near the location of the proposed final runway and includes an access road.

Operations and Maintenance Costs

Operations and Maintenance Costs were not calculated for the Pioneer Runway Project as Newtok already maintains the existing airport runway and the proposed project is not anticipated to increase the required effort.

Benefits

Benefit calculations for the Subdivision Roads project are described under Project 2: Mertarvik Prototype Housing (CCHRC) and not repeated here.

Discount Factor

A discount factor of 7% was applied to all annual costs and benefits to calculate present dollar values of future costs and benefits.

Full Proposal Cost	Estimated Cost	Other Funding
A construction cost estimate is provided in Appendix F.2.2-5	$6,394,000	

Description of Current Situation and Problem to be Solved

The Mertarvik site currently has no infrastructure in place for airplanes. Currently the only way to access the site is via water, which makes access to the site very limited. Not having air service makes shipping any sort of materials or goods to the community more difficult.

Description of Proposed Project or Program

The proposed project will construct a pioneer runway to accommodate an aircraft similar to Cessna Caravan. The pioneer runway will be constructed at or near the location of the proposed final runway and includes an access road (Dropbox: N-10). The proposed pioneer runway will be approximately 2,500 feet long by 60 feet wide.

Description Risk to the Community if the Proposal is Not Implemented

Without this project, aircraft will not be able to fly into Mertarvik, which means the community will not be able to receive any goods or shipments on a regular basis. The barge shipment a few times a year

would not be enough to supply and meet the communities needs to survive and function.

List of Benefits and Costs

A list of project benefits and costs and associated computations is provided in Appendix F.2.2-5. Project benefits include:

- Benefit of reduced future structure damage in Newtok due to future erosion.
- Benefit of reduced future displacement costs of Newtok residents due to future erosion.
- Benefit of reduced loss of water service to residents.
- Benefit of improved social cohesion
- Benefit of reduced cost of treatment of psychological issues from future erosion.
- Benefit of reduced cost of lost productive hours due to psychological issues from future erosion.
- Benefit of reduced loss of school

Descriptions of Risks to Ongoing Benefits

The pioneer runway is vital to complete construction of new housing and other community improvements in Mertarvik. Without the runway, it will be inefficient and significantly more expensive to bring personnel, construction equipment and materials to the site. In addition, medical evacuation will be significantly faster with a locally available runway. The location of the pioneer runway must be coordinated with the final runway design before construction.

Assessment of Challenges Faced with Implementing the Proposal

The final location for the pioneer runway has not been finalized. Costs may change based on the final location of the runway.

Metrics

The following metrics will be used to determine the impacts of the Pioneer Runway Project:

Resiliency Value Factors:

- Value of protection from the effects of future/repeat disasters, including, but not limited to, flood, wind, fire, earthquakes, such as:
  - Reduction of expected casualties from future/repeat disasters

Social Value Factors:

- Reductions in human suffering
  - lives lost
  - illness from exposure to environmental contamination
  - asthma and cancer rates in low income and minority populations living in areas with greater environmental risk

Economic Revitalization Value Factors:

- Direct effects on local or regional economy net of opportunity costs.
- Value of property other than through enhanced flood protection, independent of increases in property value captured by other benefits in the BCA or that might otherwise have occurred without the proposed project.

Environmental Value: Net reduction in erosion and impacts to surrounding areas.

BCA Narrative

Project 5: Bulk Fuel Tank Farm

Process for Preparing the BCA

Projects 2-5 are combined into a single BCA because the primary benefits will only be realized if all of them are constructed. Each project plays a vital part in the overall construction of Mertarvik Village.

Costs

CRW Engineering Group, LLC developed a construction cost estimate based on recent similar installations in rural Alaska. A breakdown of the construction cost is provided in in Appendix F.3.2-5. Costs were developed based on an average heating fuel demand of 65 gallons per month during the winter for residential structures and 3,000 gallons per year for the Mulit-Use-Center. Heating fuel usage for other structures was estimated to be 1 gallon per square foot per year. Total heating fuel demand is estimated to be 44,000 gallons of diesel #1. Gasoline demand is estimated to be 42,000 gallons (120 gallons per year per capita) for motorized transportation and 88,000 gallons per year for electrical generation.

Operations and Maintenance Costs

Operations and Maintenance Costs were not calculated for the Bulk Fuel Tank Farm Project as Newtok already maintains the existing bulk fuel tanks and the proposed project is not anticipated to increase the required effort.

Benefits

Benefit calculations for the Subdivision Roads project are described under Project 2: Mertarvik Prototype Housing (CCHRC) and not repeated here.

Discount Factor

A discount factor of 7% was applied to all annual costs and benefits to calculate present dollar values of future costs and benefits.

Full Proposal Cost	Estimated Cost	Other Funding
A construction cost estimate is provided in Appendix F.2.2-5	$3,625,000	

Description of Current Situation and Problem to be Solved

The new homes in Mertarvik will each have their own small fuel storage tanks to feed oil burners used to heat homes. The community still needs a central location for mass storage. Newtok is on the Pacific Ocean in Alaska, and obtaining fuel is very expensive. The costs can be lessened by constructing a facility with a large capacity and reducing the frequency of reshipping fuel.

Description of Proposed Project or Program

The proposed facility would consist of eight 25,000 gallon (nominal) double wall, skid-mounted aboveground storage tanks (6 diesel and 2 gasoline) and associated equipment. The facility would provide 12 months fuel supply to the community, and could be expanded in the future if need be.

Description Risk to the Community if the Proposal is Not Implemented

The standard method for fuel delivery in rural Alaska is by tanker barge. The barge fills large fuel tanks that are used by the community throughout the winter to fill smaller tanks located at homes and to fill

generators and transportation equipment (four wheelers and snow machines). If a bulk fuel facility is not constructed, fuel will have to be transported via 50-gallon drum from bulk fuel tanks in Newtok. This 7-mile trip (one-way) would require the drums to be loaded into a boat or on a sled to be hauled behind a snow machine in the winter, which would require several trips in order to supply the community with enough fuel.

When the community moves from Newtok to Mertarvik, if they do not have a central storage facility for fuel then each individual household would have to have fuel shipped directly to them on a weekly-monthly basis, resulting in massive unnecessary fees.

List of Benefits and Costs

A list of project benefits and costs and associated computations is provided in Appendix F.2.2-5. Project benefits include:

- Benefit of reduced future structure damage in Newtok due to future erosion.
- Benefit of reduced future displacement costs of Newtok residents due to future erosion.
- Benefit of reduced loss of water service to residents.
- Benefit of improved social cohesion
- Benefit of reduced cost of treatment of psychological issues from future erosion.
- Benefit of reduced cost of lost productive hours due to psychological issues from future erosion.
- Benefit of reduced loss of school

Descriptions of Risks to Ongoing Benefits

Having central bulk fuel storage allows individual homes to limit the amount of diesel fuel that they have to ship and store. Additionally, it reduces the risk of running out of fuel in cases of emergency, or during fall freeze up and spring thaw when transportation and fuel delivery over the Ninglick River is impossible.

Assessment of Challenges Faced with Implementing the Proposal

Bulk fuel facilities have been installed in almost every small rural community in Alaska. No unusual challenges are anticipated for the proposed project.

Metrics

The following metrics will be used to determine the impacts of the Bulk Fuel Tank Farm Project:

Resiliency Value Factors:
- Reduction in number of fuel shortages.
- Value of protection from the effects of future/repeat disasters, including, but not limited to, flood, wind, fire, earthquakes, such as:
  - Reduced vulnerability of energy and water infrastructure to large-scale outages

Environmental Value Factors:
- Reduced energy use, reduced carbon footprint

Social Value Factors:
- Reductions in human suffering
  - lives lost
  - illness from exposure to environmental contamination

- asthma and cancer rates in low income and minority populations living in areas with greater environmental risk
- Benefit to low- and moderate-income persons and/or households
- Improved living environment
  - elimination of slum and blight conditions
  - improved community identity and social cohesion
- Greater housing affordability

Economic Revitalization Value Factors:

- Direct effects on local or regional economy net of opportunity costs.
- Value of property other than through enhanced flood protection, independent of increases in property value captured by other benefits in the BCA or that might otherwise have occurred without the proposed project.

BCA Narrative

Project 6: Landfill

Process for Preparing the BCA

The Benefit Cost Analysis (BCA) for the Landfill Project was prepared as follows:

Costs

Capital cost data was provided by the State of Alaska.

Operations and Maintenance Costs

Operations and Maintenance cost for the landfill was calculated based on the estimate provided by the State of Alaska Department of Environmental Conservation (Appendix F.2.6). The general estimate is for a landfill for a community of about 300 residents, which is comparable to the Newtok population.

Benefits

The completion of the landfill will reduce the cost the community currently spends for waste removal. Currently, all waste produced in Mertarvik is shipped out on a barge to other communities, which incur large costs over the long term.

Discount Factor

A discount factor of 7% was applied to all annual costs and benefits to calculate present dollar values of future costs and benefits.

Full Proposal Cost	Estimated Cost	Other Funding
A construction cost estimate is provided in Appendix F.2.6	$1,991,000	

Description of Current Situation and Problem to be Solved

Mertarvik currently has no local disposal site for solid waste. All waste produced in Mertarvik must be transported 7 miles to Newtok for disposal. Transporting the waste is expensive and risks environmental harm while in transit.

Description of Proposed Project or Program

The proposed landfill will be constructed on approximately 1.75 to 2 acre site, and will operate as an above ground area fill landfill. The landfill will be classified as a Class III landfill, and will be serving the entire community of Mertarvik. Additionally, a burn unit is recommended for volume reduction of household waste at the new landfill. Burning waste in a burn unit is a common practice in rural Alaska landfills and is legal per state regulations.

Description Risk to the Community if the Proposal is Not Implemented

Without this landfill, Mertarvik will continue to barge all of their waste out of the community to the old landfill at Newtok. As the population increases the amount of waste generated will also increase. Costs associated with transferring the waste and risks of environmental contamination will increase accordingly.

List of Benefits and Costs

This landfill will give the community a central waste collection facility, resulting in:

- Financial savings due to no longer having to transport solid waste to Newtok.
- Potential for new jobs in the community, both in the construction of the landfill and in its operation.

Quantified costs and benefits are provided in Appendix F.2.6.

Descriptions of Risks to Ongoing Benefits

There is high surface water in the region that could potentially require gravel pad construction to meet groundwater separation requirements. High winds can pick up and transport waste from the landfill and disburse it. A fence surrounding the landfill will help contain windblown trash. Burning trash before it is disposed of will also limit the amount of trash that can be blown about.

Assessment of Challenges Faced with Implementing the Proposal

The landfill will be a Class III landfill, which is not designed to accept hazardous waste such as used oil, lead acid batteries, fluorescent tubes, etc. The residents will have to be educated on what can and cannot go to the landfill to prevent future problems due to improper disposal of those products. The Department of Environmental Conservation design approval and a Class III Solid Waste Permit will be obtained prior to constructing the landfill.

Metrics

The following metrics will be used to determine the impacts of the Landfill Project:

Resiliency Value: Reduction in response efforts for clean-up after a disaster.
Environmental Value Factors:

- Reduction in litter, vector issues and wind-blown trash
- Air Quality
  - Reduced particulate matter of aerodynamic diameter of the micrometers or fewer (PM-10)

Social Value Factors:

- Reductions in human suffering
  - lives lost
  - illness from exposure to environmental contamination
  - asthma and cancer rates in low income and minority populations living in areas with greater environmental risk
- Benefit to low- and moderate-income persons and/or households
- Improved living environment
  - elimination of slum and blight conditions
  - equal access to resilient community assets

Economic Revitalization Value Factors:

- Direct effects on local or regional economy net of opportunity costs.
- Value of property other than through enhanced flood protection, independent of increases in property value captured by other benefits in the BCA or that might otherwise have occurred without the proposed project.

BCA Narrative

Project 7: Retrofit 12 Relocated Homes

Process for Preparing the BCA

The Benefit Cost Analysis (BCA) for the Retrofit 12 homes was prepared as follows:

Costs

Capital cost data was provided by the State of Alaska and CCHRC.

Operations and Maintenance Costs

Operations and maintenance of the new homes will be provided by the homeowners and will be similar in scope to operating and maintaining the existing homes in Newtok.

Benefits

The completion of the housing retrofits will provide wastewater service to residents living in the homes. Each home in Mertarvik will have individual wastewater disposal systems so, without the retrofits, wastewater service will not be available. Benefit calculations are based on Loss of Water Services outlined in FEMA Benefit-Cost Analysis Re-engineering (BCAR) document.

Additional qualitative benefits include:

- Reduction in the risk of illness and disease to residents associated lack of indoor plumbing (potable water and wastewater disposal).
- Improved living conditions
- Reduction in environmental contamination from disposal of human waste on the ground using current honey bucket method.

Discount Factor

A discount factor of 7% was applied to all annual costs and benefits to calculate present dollar values of future costs and benefits.

Full Proposal Cost	Estimated Cost	Other Funding
A construction cost estimate is provided in Appendix F.2.7	$743,000	

Description of Current Situation and Problem to be Solved

Twelve homes in Newtok are currently in the process of being relocated to Mertarvik. These homes are not equipped with indoor plumbing, relying on honey buckets (5 gallon bucket used to contain human waste), and water brought in from a community well and typically stored in open top plastic containers. The lack of plumbing is a major risk factor for disease within the home due to the inability to easily wash hands and having open containers of human waste. Honey buckets are currently disposed in local waterways near the community, with a high risk of spreading raw wastewater throughout the community.

Description of Proposed Project or Program

The proposed project would provide funds to renovate and retrofit the 12 existing residences with water and wastewater filtration systems, self-contained electricity from a generator and an on-site water

holding tank.

Description Risk to the Community if the Proposal is Not Implemented

Without the installation of proper water and wastewater filtration and holding systems there is greatly increased risk of associated infections within the community. The current method of disposing of human waste is haphazard and contributes to environmental damage. Additionally, lack of easily accessible water supplies can contribute to poor general hygiene which further increases disease risks.

List of Benefits and Costs

Benefits of the proposed project include:

- Reduction in loss of water and wastewater service.
- Reduction in the risk of illness and disease to residents associated lack of indoor plumbing (potable water and wastewater disposal).
- Improved living conditions
- Reduction in environmental contamination from disposal of human waste in waterways or on the ground using current honey bucket method.

Quantified costs and benefits are provided in Appendix F.2.7.

Descriptions of Risks to Ongoing Benefits

As addressed above, there is increased risk of disease in households without proper sanitation and water facilities. Without a regularly staffed medical clinic in the community, diseases can go untreated for long periods, creating risk of sustained and potentially pandemic disease.

Assessment of Challenges Faced with Implementing the Proposal

These homes may or may not have been built with future plumbing in mind. Some installations may be more complex than initially anticipated.

Metrics

The following metrics will be used to determine the impacts of the Retrofit 12 Relocated Homes Project:

Resiliency Value Factors:

- Value of protection from the effects of future/repeat disasters, including, but not limited to, flood, wind, fire, earthquakes, such as:
  - Reduction of expected property damages due to future/repeat disasters
  - Reduction of expected casualties from future/repeat disasters
  - Value of reduced displacement caused by future/repeat disasters
  - Reduced vulnerability of energy and water infrastructure to large-scale outages

Environmental Value Factors:

- Reduced energy use
- Noise levels
- Climate change – Reduced Greenhouse Gas emissions
- Air Quality
  - Reduced particulate matter of aerodynamic diameter of the micrometers or fewer (PM-10)
- Water quality – reduced storm water runoff

Social Value Factors:

- Reductions in human suffering
  - lives lost
  - illness from exposure to environmental contamination
  - asthma and cancer rates in low income and minority populations living in areas with greater environmental risk
- Benefit to low- and moderate-income persons and/or households
- Improved living environment
  - elimination of slum and blight conditions
  - improved community identity and social cohesion
  - equal access to resilient community assets
- Greater housing affordability

Economic Revitalization Value Factors:

- Direct effects on local or regional economy net of opportunity costs.
- Value of property other than through enhanced flood protection, independent of increases in property value captured by other benefits in the BCA or that might otherwise have occurred without the proposed project.

BCA Narrative

Project 8: Existing Homes Demolition

Process for Preparing the BCA

The Benefit Cost Analysis (BCA) for the Existing Homes Demolition Project was prepared as follows:

Costs

Capital cost data was determined from the estimate by Brice Marine, LLC.

Benefits

Quantified benefits include restoration of natural habitat and reduced cost of debris removal. Benefits were calculated as follows:

1. Restoration of natural habitat
    - Total area restored is based on existing footprint of Newtok that would be relocated to Mertarvik. The total value of restored land was calculated based on the per acre value for Habitat Services in Riparian Areas outlined in the FEMA Final Sustainability Benefits Methodology Report (FSBMR) (August 2012).
    - Total disturbed area is based on the proposed footprint of the new Mertarvik site. The total value of disturbed land was calculated using the per acre value for Habitat Value in Wetlands outlined in the FEMA FSBMR.
    - The total benefit of restored land was calculated by subtracting the disturbed land value from the restored land value.
2. Reduced cost of debris removal
    - The total amount of debris generated from a building was calculated using the FEMA Debris Estimating Field Guide. Using the equation for a general building outlined in the field guide, it was determined that each structure would generate approximately 68.8 tons of debris.
    - Tipping fees for Alaska was determined using the value in the FEMA FSBMR. The value of $37.74/ton was multiplied by the total tonnage to calculate the landfill fee.
    - It was assumed the waste from Newtok would be transferred to the landfill in Bethel, Alaska. The current Newtok Landfill is unpermitted and is also threatened by erosion; therefore, it cannot accept this waste. Waste from this project must be shipped out of the community. The cost for hauling the debris from Newtok to Bethel was calculated based on a quote from Brice Marine, LLC (See appendix F.2.8 for quote).
    - The number of structures being demolished each year was determined based on a 30 year projection of the current erosion rate (See “Rate of Loss” table included in project 2-5 BCA).

Discount Factor

A discount factor of 7% was applied to all annual costs and benefits to calculate present dollar values of future costs and benefits.

Full Proposal Cost	Estimated Cost	Other Funding
A construction cost estimate is provided in Appendix F.2.8	$7,232,000	

Description of Current Situation and Problem to be Solved

While the residents of Newtok will be relocated, the existing structures in Newtok will remain to decay and eventually erode away into the river. All the debris and waste generated from Newtok could potentially contaminate the water starting from Newtok downstream all the way to the Bering Sea. It would also cause significant navigation hazards to boats and barges.

Description of Proposed Project or Program

Part of the relocation efforts will include demolishing the vacated Newtok site and lowering the human footprint in the area to as little as possible. Demolishing and removing the homes will also serve to stop their debris from falling into the river and ocean as the erosion takes away the land.

Description Risk to the Community if the Proposal is Not Implemented

Leaving the homes in Newtok uninhabited will create an unsafe environment for years to come, with potential for chemical pollution into the environment. Coastal erosion will eventually take all of the homes and dump them into the Bering Sea.

List of Benefits and Costs

A list of project benefits and costs and associated computations is provided in Appendix F.2.8. Project benefits include:

- Eliminate additional future costs such as demolishing and hauling costs associated with debris removal.
- The current Newtok site would be restored to natural conditions by removing all debris such as vacated structures and waste.
- Reduce the risk of contamination from debris and waste falling into the river that would get carried downstream and ultimately into the ocean. The project will mitigate the risk of hazardous materials from falling into the water.

Descriptions of Risks to Ongoing Benefits

Delaying or not implementing the project would increase the risk of contamination and pollution to the Ninglick River and to the surrounding environment. The current erosion rate may accelerate based on climate changes, and would be more beneficial to remove the debris rather sooner than later.

Assessment of Challenges Faced with Implementing the Proposal

Disposal of such a large amount of debris materials could overwhelm the Bethel Landfill. Debris may need to be taken to several landfills or shipped to a larger landfill that can accommodate the volume.

Metrics

The following metrics will be used to determine the impacts of the Existing Homes Demolition Project:

Resiliency Value: Reduced response to pollution clean-up and impacts to the river from erosion-caused debris.

Environmental Value Factors:

- Ecosystem and bio diversity effects (e.g. from wetlands restoration or reforestation)
- Water quality – reduced storm water runoff

Social Value Factors:

- Reductions in human suffering

- illness from exposure to environmental contamination
- asthma and cancer rates in low income and minority populations living in areas with greater environmental risk

- Improved living environment
  - improve recreational value
  - greater access to Cultural, historic, archaeological sites and landscapes
  - equal access to resilient community assets

Economic Revitalization Value Factors:

- Value of property other than through enhanced flood protection, independent of increases in property value captured by other benefits in the BCA or that might otherwise have occurred without the proposed project.

Appendices

Benefit-Cost Analyses for each project are provided in Appendices F.2.1 through F.2.8. Please also see the **Attachment F.Reference** for general reference information that is applicable to multiple projects.