

**Community Erosion Assessment
Kipnuk, Alaska
26 January 2009**

1. Community: Kipnuk, Alaska



Figure 1: Kipnuk Location & Vicinity Map

2. Community Profile Summary:

Kipnuk is an unincorporated village of 664 located on the west bank of the Kugkaktlik River four miles inland from the Bering Sea in the Yukon-Kuskokwim Delta, 85 air miles southwest of Bethel. The community is located in a marine climate. Precipitation averages 22 inches, with 43 inches of snowfall annually. Summer temperatures range from 41 to 57 degree Fahrenheit, winter temperatures are 6 to 24 degrees.

3. Concise Description of Erosion Problem:

The primary community concerns regarding erosion deal with infrastructure such as the eroding bank in front of the fuel off-loading point and the barge landing.

Measurable erosion at Kipnuk is episodic, occurring mostly during fall storm season. In the fall high winds cause storm surge on the Bering Sea which, during high tides, causes flooding in Kipnuk. Higher water elevations in the Kugkaktlik River increase the fetch over which waves can be locally generated by winds as the point bar north of Kipnuk is submerged. Throughout the year, the south bank of the Kugkaktlik River at Kipnuk is affected by the current. South of the fuel tanks, the current impinges directly against the

bank at about a 45 degree angle. Downstream of this point, the thalweg runs along the bank removing material below the waterline causing the bank face to be vertical. Local erosion may also occur at the barge landing and fuel terminal due to prop wash if the barge keeps its screws turning while unloading.

Erosion is affecting three different areas in Kipnuk. Reach 1 is a 1,000 foot reach that starts at the barge landing and stretches downstream. This region is eroding at an average rate of 7.0 feet per year. Reach 2 is 1,500 feet long and stretches from the barge landing to the slough near the tribal offices. It is eroding at an average rate of 6.0 feet per year. Reach 3 is 1,700 feet long and eroding at an average annual rate of 9.0 feet.

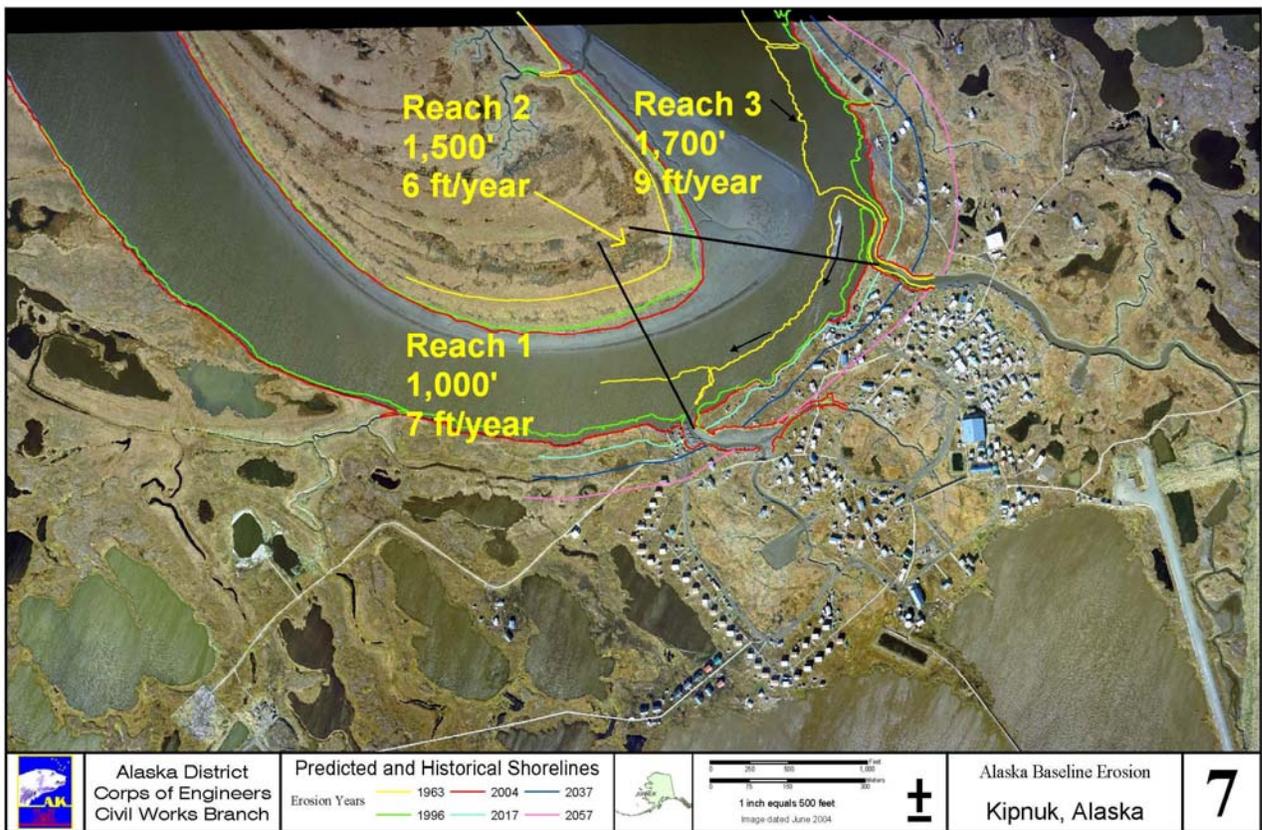


Figure 2. Kipnuk Erosion Map

4. Potential Erosion Damages

Using the projected erosion interval lines on the aerial photograph, the economic damages were developed for the 50-year period of analysis and broken down into the sub-intervals of 0-10 years, 11-30 years and 31-50 years. Breaking down the economic damages into these sub-intervals allows us to determine when the greatest economic impact is expected to occur. Determining when the greatest economic impact could occur is important so that timely decisions can be made when an erosion retarding measure needs to be taken. For the purposes of this report, damages were assessed by time interval rather than attempting to estimate the exact year that the damage occurs.

The analysis was completed in this manner to try and account for two types of uncertainty:

1. That which is associated with predicting erosion which is progressing at varying rates over time (including episodic events); and
2. That which exists when performing a surface analysis as opposed to doing an in depth investigation such as soils exploration and expensive modeling efforts.

Damage Categories

The approach used to determine potential erosion damages is based on several assumptions as they pertain to the damage categories of residential, commercial, public infrastructure, and land values. This evaluation relies on previous reports and information gathered during site visits to determine appropriate values where data was unavailable. Assumptions used for the various damage categories are described more fully in the following discussion of future damages. Structures were considered a loss when the bank line encroached within ten feet of the structure's foundation.

Expected damages caused by erosion in Kipnuk fall into six categories: land, residential structures, commercial structures, public structures, infrastructure, and environmental hazards.

Expected Damages

The period of analysis for this evaluation is 50 years and all damage categories have net present values calculated based on the federal fiscal year 2009 discount rate of 4 5/8 percent. The sections below detail expected losses with a summary provided in Table 1.

Kipnuk is losing approximately 31,300 square feet of land per year (0.72 acres). Estimated land losses for River Reach 1 are 8.20 acres with land losses for River Reach 2 of 10.54 acres and losses for Reach 3 of 17.91 acres. It is expected that 36.65 acres will be lost over the 50-year period of analysis with a corresponding value of \$366,000 and a net present value of \$146,000.

Expected residential damages in Kipnuk include 24 outbuildings (fish camps and related structures) and 13 residences. Each of the outbuildings is valued at \$1,000 and each residence is valued at \$205,000.

Eight commercial buildings are estimated to be subject to damages including the Kipnuk Tribal Council (KTC) lodge and related buildings, the old power plant, the hardware store, and the Corporation warehouses. These structures are assumed to be commercial in nature based on analysis of on-site and aerial photographs.

Three public buildings are at risk in Kipnuk including the Alaska Native Tribal Health Consortium (ANTHC) offices and related outbuildings, estimated to be lost during years 11-30.

Building damages in Kipnuk are expected to total \$4.5 million with a net present value of \$1.4 million and an average annual cost of \$70,300

Expected infrastructure damages include, the barge landing, 12 utility poles, approximately 3,910 feet of boardwalk, 90 feet of water lines, 4 utility poles, 9 fuel headers, and 30 fuel tanks.

Infrastructure damages in Kipnuk are expected to total \$20.4 million with a net present value of \$8.3 million and an average annual cost of \$428,300

The primary environmental concern in Kipnuk is erosion of fuel tanks. The surrounding soils are likely contaminated and will pose a threat to the local ecosystem and related fish stocks when they erode away. Decommission and closures of the facilities are essential to avoid these harmful effects. This process has a cost of \$4.9 million with a net present value of \$2.1 million and an average annual cost is \$110,600.

Summary

Total erosion damages in Kipnuk over the 50-year period of analysis are \$30.2 million with a net present value of \$11.9 million and an average annual value of \$616,800. Table 1 summarizes the expected damages by category.

Table 1: Summary of Expected Damages by Time Interval and Damage Category.

Damage Category	Quantity	Time Span (Years)			Total value (50 years)	Net Present Value	Average Annual Value
		0-10	11-30	31-50			
Land	36.65	\$ 79,000	\$ 144,000	\$ 144,000	\$ 366,000	\$ 146,000	\$ 7,600
Residential	13	1,000	619,000	2,072,000	2,692,000	557,000	28,700
Commercial	8	412,000	901,000	226,000	1,538,000	728,000	37,600
Public buildings	3	--	263,000	--	263,000	77,000	4,000
Infrastructure	--	4,575,000	7,204,000	8,649,000	20,428,000	8,295,000	428,300
Environmental hazards	--	1,295,000	2,083,000	1,494,000	4,871,000	2,142,000	110,600
Total Damages	--	\$6,362,000	\$11,214,000	\$12,585,000	\$ 30,158,000	\$11,945,000	\$616,800

5. Potential Solutions:

Sheet Pile Bulkhead for Reach 1

This option would replace the sheet metal barrier with a sheet pile bulkhead to protect the bank from wave and mooring forces. The bulkhead would have a 200-foot face for mooring with 50-foot wing walls to protect the structure from flanking. The toe of the structure would be protected from scour by riprap. Upstream protection of this structure is to be provided by revetments. This will allow for a repairable feature that can be adjusted to meet the changing conditions of the river. Approximate cost of the bulkhead is \$7.4 million at approximately \$24,000 per foot.

Rock Revetment Repair for Reach 2

An existing 850-foot rock revetment protects a portion of Kipnuk. The revetment is divided into two sections with a break to allow for boat mooring. This revetment has lost some rock over its life and could be repaired with the addition of material. Some areas of the revetment will need less material and some will need more. Since this revetment is already in place, the quantity of rock can be adjusted to meet budget constraints while targeting the most severely damaged areas. It is assumed that the slope of the revetment will not need to be laid back and that the existing fabric will not need to be replaced. Approximate cost of the repairs is \$2.8 million at approximately \$3,295 per foot.

Rock Revetment for unprotected banks

Four new revetments totaling 2000 feet in length will provide complete protection of the bank from the fuel terminal to the barge landing. Proposed sites are located upstream of the fuel terminal (650 feet), between the fuel terminal and the side channel (750 feet), between the side channel and the existing revetment (300 feet) and from the existing revetment to the barge landing (300 feet). The bank along all of these reaches is uniformly low with a steep slope to the waterline. Approximate cost of the revetments is \$9.5 million at approximately \$4,750 per foot.

6. Conclusion:

The community of Kipnuk has a serious erosion problem that is threatening significant amounts of infrastructure, multiple residences, and many fuel tanks and headers. The community would not likely have the financial capability of providing matching funds for any project. Any proposed project would need to work in coordination with the state.

7. Community Photos:



N 59° 56.499' W 164° 02.478'

Kipnuk

RIMG0095

Photo 1: Looking downstream from sheet metal barrier north of town. Sheet metal barrier is attached to a 2 inch pipe driven into the ground.



N 59° 56.340' W 164° 02.504'

Kipnuk

RIMG0124

Photo 2: Looking downstream at bank just north of town.



N 59° 56.308' W 164° 02.572'

Kipnuk

RIMG0132

Photo 1: Looking downstream at the riprap. This project has failed with most of the protection being provided by the fabric at this point.

8. Additional Information:

This assessment, as well as those for other communities, can be accessed on the internet at www.AlaskaErosion.com. The web site also contains additional information on addressing erosion issues, educational materials, and contact information.



	<p>Alaska District Corps of Engineers Civil Works Branch</p>	<p>Predicted and Historical Shorelines</p> <p>Erosion Years</p> <table border="0"> <tr> <td>1963</td> <td>2004</td> <td>2037</td> </tr> <tr> <td>1996</td> <td>2017</td> <td>2057</td> </tr> </table>	1963	2004	2037	1996	2017	2057		<p>0 255 510 1,020 Feet</p> <p>0 75 150 300 Meters</p> <p>1 inch equals 500 feet</p> <p>Image dated June 2004</p>		<p>Alaska Baseline Erosion</p> <p>Kipnuk, Alaska</p>
1963	2004	2037										
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