Community Erosion Assessment
Aniak, Alaska
27 January 2009

1. Community: Aniak, Alaska

Figure 1: Aniak Location & Vicinity Map

2. Community Profile Summary:

Aniak (ANN-ee-ack) is a second class city located in the Unorganized Borough's Kuskokwim Recording District. It is 92 air miles northeast of Bethel and 317 miles west of Anchorage. Climate is maritime in the summer and continental in winter. Temperatures range between -55 and 87 degrees Fahrenheit. Average yearly precipitation is 19 inches and average yearly snowfall is 60 inches. According to the 2006 state demographer estimate, Aniak's population is 512 people. As the largest city in the area, Aniak is a service hub for numerous surrounding villages.

3. Concise Description of Erosion Problem:

Erosion primarily takes place during spring when the river ice begins to break up. Fragmented ice flows down the river and is arrested at natural channel constrictions just downstream of Aniak; this initiates an ice jam which then restricts flow and raises water levels upstream of the jam. During these events, the high water levels allow ice to scour the fine grained materials that compose the banks along the Kuskokwim River at Aniak.

An ice jam will generally take place sometime between April and May. Secondary flooding and erosion can also occur during snowmelt and summer rainfall, but historically these have not severely flooded Aniak.

For this study the riverbank has been divided into three reaches. Reach 1 is a 5,000-foot stretch of land just north and west of the airport and is eroding at an average rate of 4 feet per year. Reach 2 is a 1,200-foot stretch of land in town along the Kuskokwim River, and is eroding at an average rate of 0.75 feet per year. Reach 3 is a 4,000-foot stretch of land along the Aniak Slough and is eroding at an average rate of 0.5 feet per year.

The primary erosion concern for the City of Aniak is erosion of the flood protection levee that borders Aniak along the Kuskokwim River and Aniak slough. This levee was constructed in a piecemeal fashion with the original portions construction in the 1950's. Subsequent phases were constructed in 10-year intervals through the mid-1990's. The levee in its current form consists of a 2,200 foot section constructed in 1996 that is armored with concrete mat that protects the point at the upstream confluence of Aniak slough with the Kuskokwim River. South of the concrete mat the levee has a layer of gravel protecting the riverbank for approximately 1,800 feet. Two earthen levees extend to the west and south from these armored sections along the Kuskokwim River and Aniak slough, respectively. The areas of the levee that have experienced the most erosion are the areas that have been armored either with a concrete mat or with sacrificial gravel.

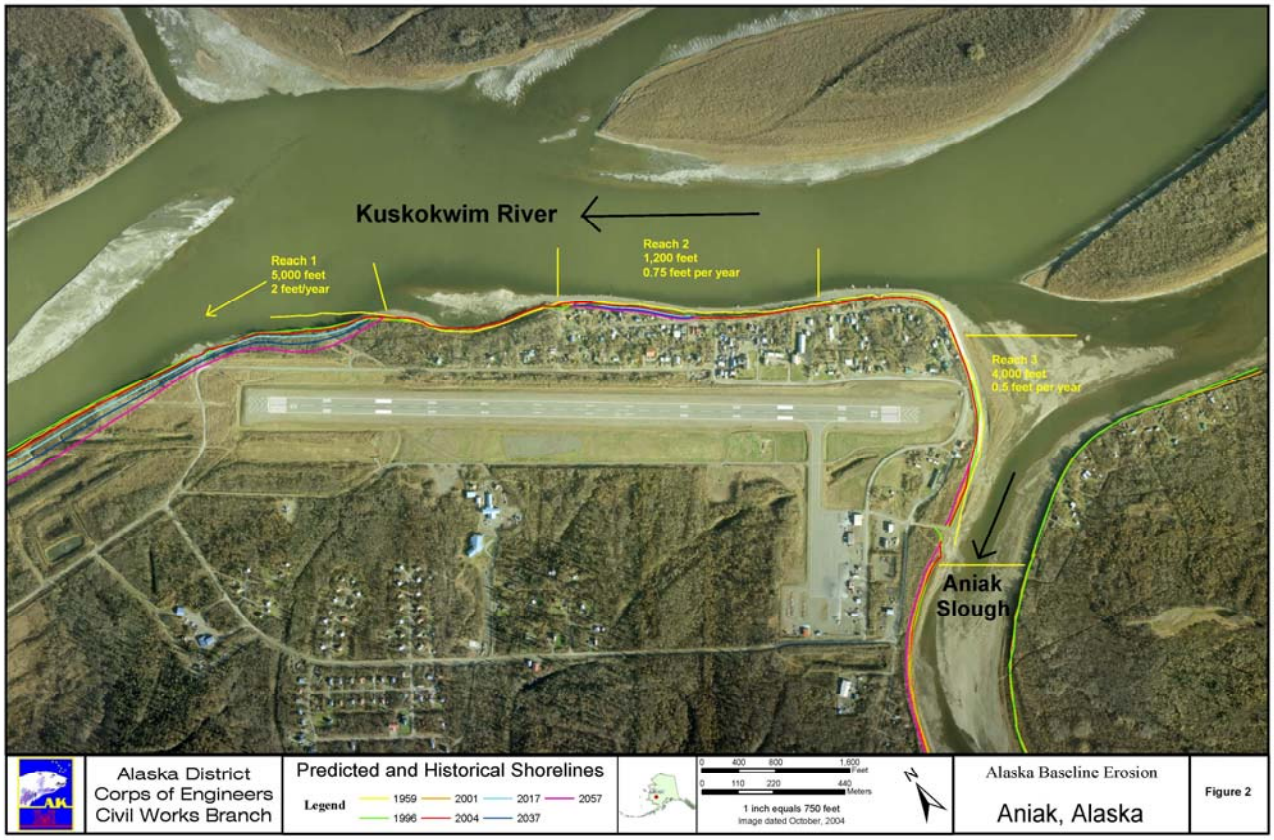


Figure 2. Aniak Erosion Map

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.

Though many potential damage categories were evaluated during this assessment, Aniak's expected erosion damages fit into three classifications: land, residential structures, and infrastructure. Structures were considered a loss when the bank line encroached within ten feet of the structure's foundation. Infrastructure expected to incur damages include roads, utilities, fuel stations, pipelines, airstrip approach lights and levees. Approximately 31 percent of erosion damages in Aniak are expected to occur within the first 10 years of the examined time period.

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.

Aniak is losing 22,900 square feet (0.53 acres) of land per year. Estimated land loss in Reach 1 is 0.46 acres with land loss in Reach 2 of 0.02 acres and land loss in Reach 3 of

0.05 acres. Aniak's land loss is expected to be approximately 26.81 acres over the 50 years valued at $268,000 with a net present value of $107,000 wirh an average annual value of $5,500.

Structural damages consist of two outbuildings, a residence, and a foundation which are valued at $255,000 with a net present value of $146,000. There are no commercial or public buildings expected to be threatened.

Damages to Aniak's infrastructure consists of the following items: a Federal Aviation Administration (FAA) approach light, the school's fueling point, a utility pole, two stretches of road totaling 350 feet and two sections of levee totaling 1,800 feet. Infrastructure damages are valued at $2.4 million with a net present value of $1.8 million. Future maintenance of existing levees is expected to be approximately $7.5 million.

Summary

Over the 50-year period of analysis, it is estimated that Aniak will experience approximately $10.5 million in damages due to erosion with a net present value of $5.0 million and an average annual value of $259,300. These values do not consider flood damages which will likely occur as the levee system around Aniak is compromised. Table 1summarizes expected damages by category.

Table 1: Summary of Expected Damages by Damage Category.

Damage Category	Quantity	Time Span (Years)			Total Damages	Net Present Value	Annual Average Value
		0-10	11-30	31-50			
Land	26.81	$ 58,000	$ 105,000	$ 105,000	$ 268,000	$ 107,000	$ 5,500
Residential structures	4	1,000	253,000	1,000	255,000	146,000	7,500
Infrastructure[1]	--	1,613,000	225,000	610,000	2,448,000	1,772,000	91,500
Future maintenance	--	1,619,000	2,944,000	2,944,000	7,507,000	2,998,000	154,800
Total damages		**$3,291,000**	**$3,527,000**	**$3,660,000**	**$10,478,000**	**$5,023,000**	**$259,300**

[1] It is assumed that the State of Alaska will protect the FAA approach light as its loss could be damaging to Aniak and the surrounding communities.

5. Potential Solutions

Based on the economic damage values given previously in Table 1, damages expected over the 50-year period of analysis are evenly split between the erosion intervals. Since Aniak's erosion problems are impacting three distinct and separate areas, each of the aforementioned reaches could utilize a unique alternative to reduce erosion. Each of these alternatives is described in the following paragraphs.

Reach 1

Riprap Revetment

One alternative to protect reach 1 is a rock revetment. This reach of the river does not have a gravel toe and erosion is primarily due to normal river forces and not ice scour. A revetment structure in this area should be designed with a launching toe that will launch to the anticipated scour depth which is approximately 40 feet below the top of bank in this area. More detailed information would be required to adequately design this type of structure. It may be possible to partner with the State of Alaska Department of Transportation & Public Facilities in a cost share agreement to fix this reach; the state has inquired about Corps programs to potentially work together.

The approximate revetment length will be 5,000 feet plus a 50-foot key at the upstream end. For this reach, a riprap revetment would be constructed from the point at which historical upstream erosion begins and it will extend approximately 5,000 feet downstream. The revetment includes a 50-foot tieback key at the upstream end to prevent erosion from flanking around the structure and a tieback or thickened section at the downstream end. The cost is roughly $3,750 per linear foot with an estimated total cost of $18.1 million.

Reach 2

Riprap Revetment

To effectively reduce erosion in reach 2, it is recommended that the levee be hardened with riprap. The approximate riprap revetment length would be 1,200 feet; 3,000 feet if extended to the end of the existing articulated concrete mat. The revetment would include a thickened section at the toe of the slope to provide some scour protection. The total cost to place a riprap revetment for the approximate 4,200 feet would be approximately $10.7 million or $3,600 per linear foot.

Articulated Concrete Mattress

For this alternative, an articulated concrete revetment would be constructed from the point at which the gravel facing on the Aniak levee ends and would extend downstream approximately 1,200 feet. The concrete mat would extend from the top of the levee to the bottom of the slope. A sacrificial gravel berm would be placed at the toe of the concrete mat to provide scour protection. The riverbank along this portion of the levee is fronted by a gravel beach that provides some natural scour protection.

The cost for this alternative is roughly $6,000 per linear foot of revetment. As an additional option the articulated concrete mat could be extended 1,800 feet along the gravel faced portion of the levee for an additional $5.8 million. To extend the rock along the 3,000 foot gravel faced portion of the levee would cost approximately $12.3 million or $4,100 per linear foot.

Reach 3

Earthen Levee Relocation

The recommended alternative for reach 3 is that approximately 600 feet of the levee be relocated further from the slough. In addition to relocating this portion of the levee the planting of willows should be extended along the Aniak Slough for an additional 1,500 feet downstream. This recommendation is based on the fact that planted willows seem to have been effective in stabilizing the bank upstream of this area.

It is assumed that construction of the relocated levee would be similar to the existing levee along this portion of the slough. The cost for this alternative is roughly $1,600 per linear foot with an estimated total cost of $960,000.

Recommendation

The recommended alternatives for Aniak are to harden the bank. The riprap materials appear to be more cost-effective and could effectively retard the erosion. The concrete mattress alternative would effectively reduce the erosion for unprotected levees however, it is not the least cost alternative. It is recommended for the area upstream of Reach 2 that riprap replace the sacrificial gravel as a low maintenance alternative to ensure that the newly-placed riprap is not undermined at the upstream end where it interfaces with the existing gravel. The most important aspect of recommending an alternative for Aniak will be minimal future maintenance. The city has been unable to perform maintenance work on the existing infrastructure due to a lack of income required to pay for the materials, as well as a lack of heavy equipment.

The costs to protect Aniak are as follows:

- Revetment in Reach 1: $18,100,000
- Revetment and Mat in Reach 2: $10,700,000
- Levee relocation and willow plantings in Reach 3: $960,000

The City of Aniak is unlikely to be able to participate in a traditional Corps cost share agreement to address their erosion problem. The city has virtually no income and struggles to maintain the existing infrastructure.

6. Conclusion:

Aniak has a definite erosion problem that is affecting the community over the next 50 years. The community has the potential to have almost $10.5 million in damages.

Aniak will likely require some sort of assistance to stop the erosion from causing significant future damages as they are unable to solve their own erosion problems due to limited financial resources.

7. Community Photos:

N 61° 34.623' W 159° 33.040' Aniak DCP_2436

Photo 1. Reach 3, Aniak Slough looking downstream.

N 61° 35.272' W 159° 33.517' Aniak DCP_2474

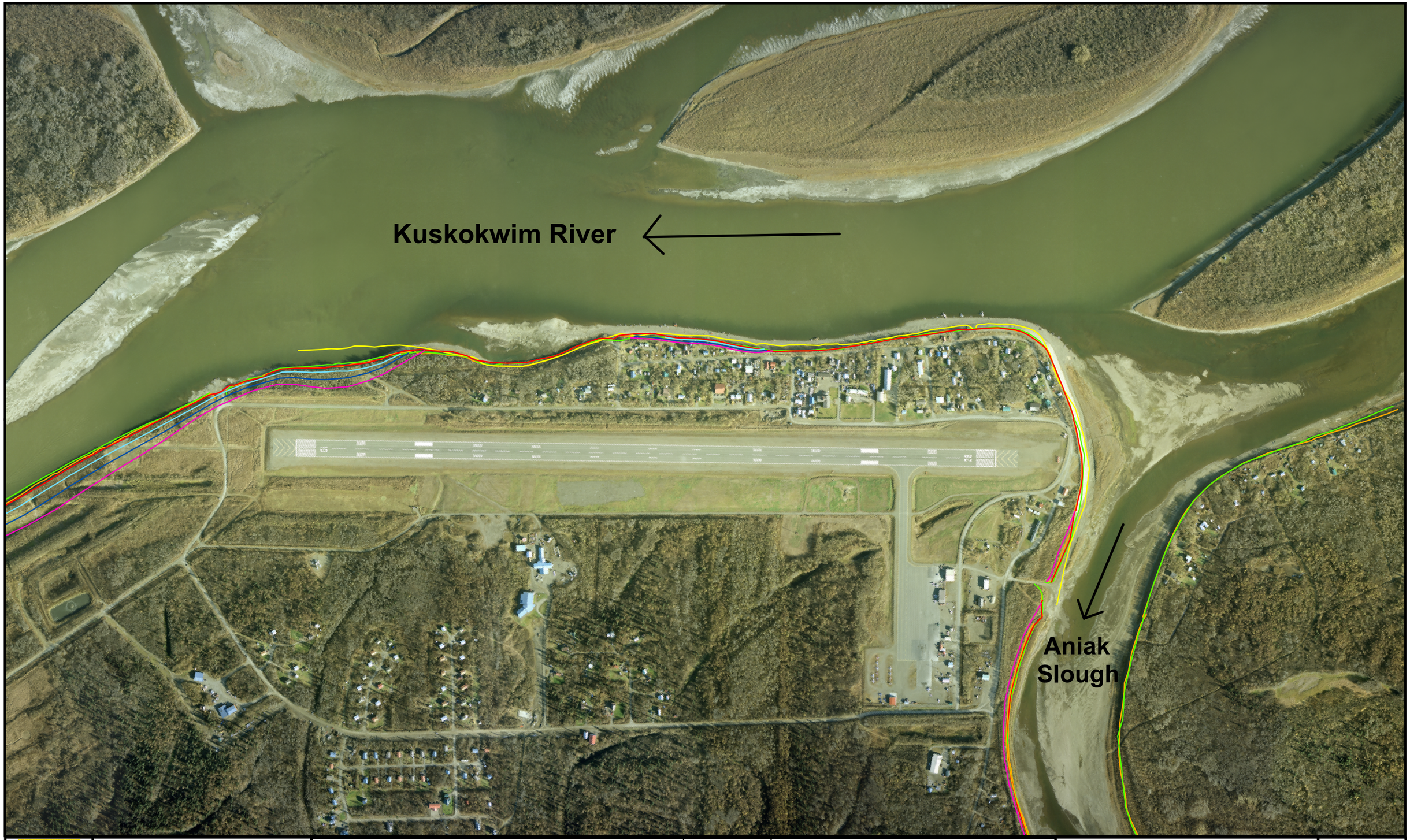
Photo 2. Reach 2, West end of the runway looking upstream along the Kuskokwim River.

N 61° 34.965' W 159° 32.182' Aniak P1011247

Photo 3. Reach 3, Looking upstream along the Kuskokwim River.

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.



Alaska District
Corps of Engineers
Civil Works Branch

Predicted and Historical Shorelines

Legend

1959 2001 2017 2057
1996 2004 2037

0 400 800 1,600 Feet
0 110 220 440 Meters

1 inch equals 750 feet
Image dated October, 2004

Alaska Baseline Erosion

Aniak, Alaska