CEPOA-EN-CW-PF

EXPEDITED RECONNAISSANCE STUDY
Section 905(b) (WRDA 1986) Analysis
Matanuska River Erosion
Matanuska-Susitna Borough, Alaska

1. STUDY AUTHORITY.

This study is in partial response to the "Rivers and Harbors in Alaska" study resolution, adopted by the U.S. House of Representatives, Committee on Public Works, on December 2, 1970. Known as the "Rivers and Harbors in Alaska" resolution, it reads in part:

Resolved by the Committee on Public Works of the House of Representatives, United States, that the Board of Engineers for Rivers and Harbors in Alaska, published as House Document Numbered 414, 83rd Congress, 2nd Session;...and other pertinent reports, with a view to determining whether any modifications of the recommendations contained therein are advisable at the present time.

The Congressional direction source is: Public Law 107-66, the Energy and Water Development Appropriations Act, 2002, was enacted on November 12, 2001 and authorized $100,000 for a reconnaissance level general investigation study called Matanuska River Erosion Control, Alaska.

2. STUDY PURPOSE.

The purpose of this report is to guide a decision as to the advisability of further Federal planning toward solutions to land and water resources problems and opportunities for erosion control in the Matanuska River watershed.

These three major tasks, consistent with Corps policy and planning guidance, are accomplished to achieve the purpose:

- Clearly define the major problems related to erosion in the Matanuska River watershed.
- Determine whether the planning process should proceed to the feasibility phase, based on a preliminary appraisal of the alternatives' consistency with Corps policies, costs, outputs, and environmental impacts.
- Assess the level of interest and support from State and local groups to act as non-Federal sponsors for the identified potential solutions.

3. LOCATION OF PROJECT/CONGRESSIONAL DISTRICT.

Matanuska River rises in the glacier fields of the Chugach Mountains and flows westerly about 110 kilometers (km) to empty into the head of Cook Inlet through Knik Arm. In its upper reaches the channel of Matanuska River is confined within high banks, but in its downstream reaches it meanders over a bed more than 1.167 km in width. The effective drainage area is 5,360 square km. Cook Inlet is an arm of the Gulf of Alaska extending 322 km northeastward into the mainland of south-central Alaska. The Matanuska Valley is the best-known and most highly developed farming area in Alaska. The small but growing town of Palmer and the town of Sutton are located near the Matanuska River. These areas are less than 80 km from Anchorage by major highway, rail, and air. After an initial appraisal of erosion issues in the basin, no areas in the vicinity of Palmer and Sutton were identified as having erosion problems but there are areas where there is a potential for future erosion problems. The study area is identified in Figure 1.

The study area is in the Alaska Congressional District. The Alaska Congressional delegation is:

- Senator Ted Stevens (R)
- Senator Lisa Murkowski (R)
- Representative Don Young (R)

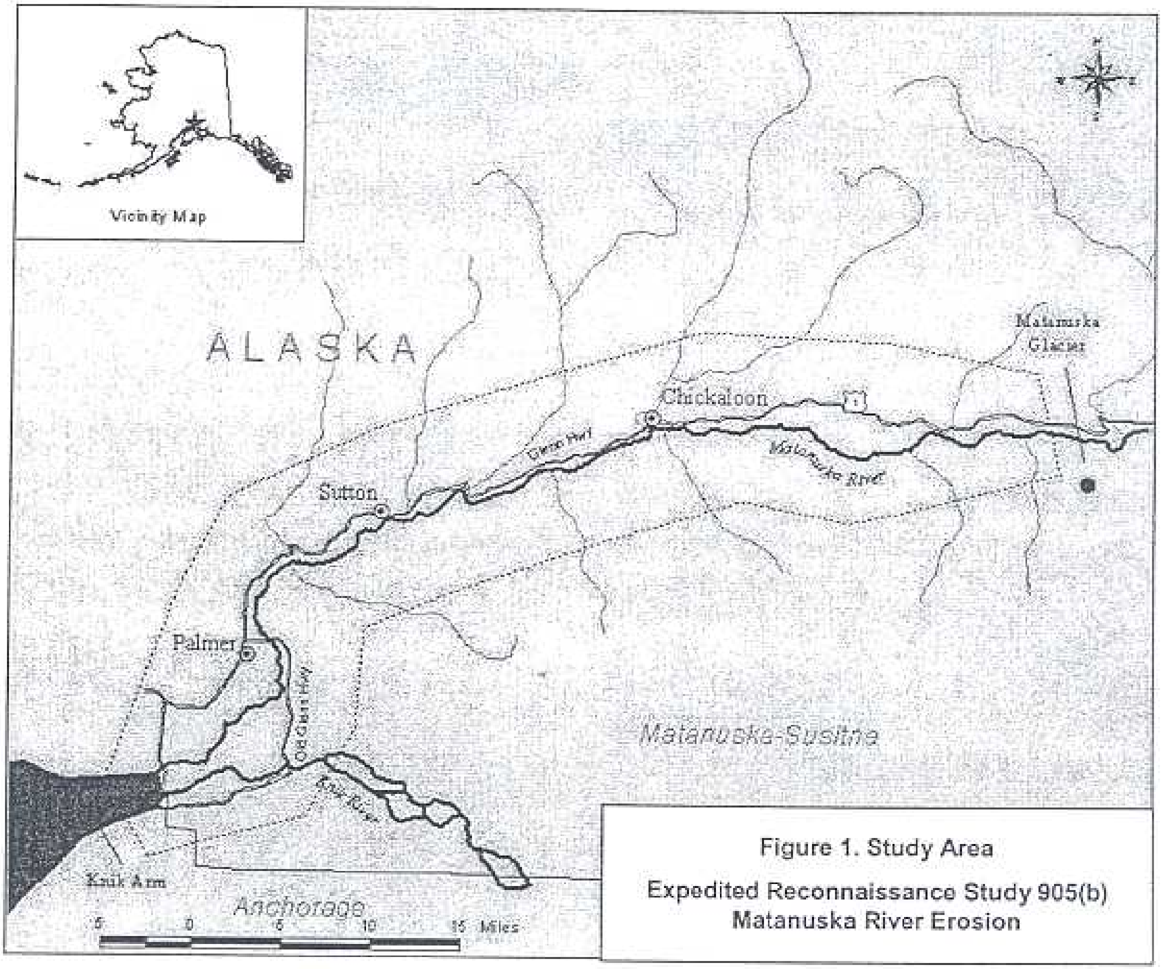


Figure 1. Study Area

Expedited Reconnaissance Study 905(b)
Matanuska River Erosion

4. DISCUSSION OF PRIOR STUDIES, REPORTS AND EXISTING WATER PROJECTS.

a. Prior Studies and Reports.

February 1972. *Review of Reports on Matanuska River and Cook Inlet and Tributaries Alaska, Matanuska and Little Susitna Rivers Flood Control Alaska.* Alaska District, U.S. Army Corps of Engineers.

September 10, 1987. *Sutton Erosion Control: A Report for the Matanuska-Susitna Borough Assembly.* G.N. McDonald & Associates.

September 8, 1989. *Emergency Flood Control Measures, State of Alaska, Plant Materials Center, Palmer, Alaska.* Alaska District, U.S. Army Corps of Engineers.

November 1991. *Matanuska River Erosion Control.* Prepared for Matanuska-Susitna Borough. Prepared by Peratrovich, Nottingham & Drage, Inc.

February 18, 1992. *Matanuska River Erosion Task Force Interim Report.* State of Alaska Division of Emergency Services.

October 1992. *Matanuska River Erosion Control Recommendations*. Prepared for Mat-Su Borough Dept. of Public Works. Prepared by Peratrovich, Nottingham & Drage, Inc.

June 1994. 1994 *Matanuska River Erosion Study: Field Trip Observations and General Erosion Control Recommendations*. Peratrovich, Nottingham & Drage, Inc.

1996. *Planning Assistance to States: Matanuska River at Bodenburg Butte Erosion Study*. Alaska District, U.S. Army Corps of Engineers.

March 1999. *Matanuska River Watershed Reconnaissance Report, Alaska*. Alaska District, U.S. Army Corps of Engineers.

b. Existing erosion damage reduction projects.

(1) Glenn Highway Erosion Control (North of Palmer). A series of projects were constructed in the late 1980's through early 1990's to address bank erosion problems along the Glenn Highway from Sutton to near Chickaloon, Alaska. These projects were constructed by Alaska Department of Transportation and Public Facilities (ADOT/PF). They involved primarily bank armoring with riprap and flow deflecting structures.

(2) Dikes along Old Glenn Highway/Ye Old River Road. A series of three dikes were constructed along the left bank of the Matanuska River near Ye Old River Road. The first of these dikes, which is armored with riprap, was constructed by the borough in 1986. Two additional dikes, one upstream and one downstream, were constructed in 1989. All three dikes were constructed to control erosion. Erosion in this area could directly cause damage to several homes in the area as well as indirectly cause damage by connecting the main channel with low lying areas. The latter process would increase flooding. See Figure 2, Item (2).

(3) Bank Protection at Old Glenn Highway Bridge. Riprap bank protection has been placed in the area of the Old Glenn Highway bridge, just north of Palmer, to protect the bridge approaches. See Figure 2, Item (1).

(4) Spur Dikes at Circle View Estates. In April 1992, the Matanuska-Susitna Borough initiated the constructed four finger dikes ranging from approximately 61 to 122 meters (m) in length on the Matanuska's left bank in the vicinity of Circle View Estates. These dikes were originally designed as a series of eight dikes but were cut back to four because of a lack of funding. These dikes are still in place and have provided some protection to the properties in Circle View Estates. See Figure 2, Item (4). A permit application in 1995 shows a plan that would add 6 additional spur dikes, to bring the total to 10 spur dikes.

(5) Old Glenn Highway Dike in the Bodenburg Butte Area. In the late 1940's a dike was constructed to confine the Matanuska River from floodplain areas east of the newly constructed Old Glenn Highway near the Bodenburg Butte area. After the dike was broken during the 1971 flood, the dike was enlarged.

(6) Alaska Railroad Sheet Pile Bank Protection. This project consists of approximately 1,220 m of dike constructed between 1947 and 1951 to divert flow away from the portion of the Alaska Railroad near the old Matanuska town site. The project has 762 m of steel sheet pile dike and 457 m of gravel and tree revetment. See Figure 2, Item (7).

(7) Palmer Sewage Lagoon Bank Protection. Under Section 14 of the Flood Control Act of 1946, emergency bank protection consisting of three rock-fill groins was placed in 1969 along the right bank of the Matanuska River adjacent to the Palmer wastewater treatment lagoons. The project protects approximately 457 m of bank. See Figure 2, Item (5).

(8) Sutton Erosion Control. This project, constructed in 1986, consists of five spur dikes constructed to protect homes and other property along the right bank of the Matanuska River just upstream of Sutton.

(9) Bank Protection at Sky Ranch. Approximately 914 m of rock toe protection has been placed along the right bank of the Matanuska River in front of the Sky Ranch Subdivision. This rock was palced in the late 1980's or early 1990. See Figure 2, Item (6).

(10) Informal Bank Protection. There also has been considerable less formal erosion control from vehicles placed along cut banks and unpermitted groins.

5. PLAN FORMULATION.

a. Identified problems.

(1) Existing conditions. The Matanuska is a highly dynamic river system with the majority of its 129-km length characterized as braided. The wide braided channel, representative of most reaches of the river not confined by bedrock, is typically indicative of a river that is unstable both vertically and laterally. The Matanuska River is no exception, with significant areas of bank erosion; evidence of aggradation, and shifting channel braids occurring throughout much of its length. In areas, the active channel width exceeds 1,524 m. The peak discharges associated with various return period events are provided below (Long 1998).

2-year	691 cubic meters per second (cms)
5-year	878 cms
10-year	1,000 cms
25-year	1,155 cms
50-year	1,271 cms
100-year	1,430 cms

The dynamic nature of the Matanuska River is not the result of human activities and disturbances but is due to natural physical processes occurring in the system dominated by active glaciers that cover 12 percent of the 5,360-square km watershed. The glaciers supply large quantities of sediments that range from clay to boulders. In the lower portions of the Matanuska near Palmer, the U. S. Geological Survey (USGS) (1992) estimated the average suspended sediment load to be 4,536,000 metric tons per year and the bed load to be 453,600 metric tons per year. The former is comprised primarily of sands, silts and clays and the latter of gravel and cobbles. In addition to the large sediment load, the bank erosion is partially attributable to the nature of the bank material, which is typically non-cohesive and easily eroded.

Bank erosion in some areas has averaged approximately 6 m per year. This number is somewhat misleading in that bank erosion may not occur for many years or even decades at a given location, then in a matter of weeks over 30 m of erosion may occur. This makes designing structures that align properly with continuously shifting flow patterns as well as determining which locations to protect difficult.

Observations in the study area indicate erosion is still occurring.

In a braided channel, an area of the bank may be attacked by erosion for several years, then the braid shifts entirely away from the bank. The braids are subject to rapid changes in alignment and the amount of flow they convey. In the case of a braided channel, future erosion and accretion cannot be quantitatively or qualitatively predicted by the same procedure as for a meandering channel. For example, the Matanuska has exhibited this behavior with the main area of bank erosion concern being along the right bank in the vicinity of the Palmer wastewater lagoons and Mountain View Estates for many years, then shifting 1,524 m across the channel to the Circle View Estates area along the left bank in the late 1980's.

(2) *Expected future conditions.* Because of the difficulty in predicting future locations of bank erosion on a braided channel, a statistical approach was utilized to estimate potential bank erosion in the future. An analysis of historic bank erosion rates was performed for the left bank of the Matanuska River from the Old Glenn Highway bridge downstream to just below Circle View Estates and for the right bank from about a mile upstream of the Palmer wastewater lagoons downstream to below Sky Ranch Subdivision. The lengths of these areas are approximately 10 km for the left bank and 5 km for the right bank. The analysis was performed to better understand the extent and magnitude of erosion and to project future erosion trends. An attempt was made to overlay digital images on the two sets of photographs in Geographic Information System (GIS). The photographs had not been orthorectified and it proved too difficult to accurately overlay the images. In order to compare the bank alignment an alternate procedure was adopted. The procedure involved drawing a reference line between identifiable points on both images. Using distances measured between identifiable points on the USGS Anchorage C-6 quad map and the two aerials, a scale factor for this specific area of each photo was developed. Offset lines at even intervals were then drawn perpendicular to the reference lines. The offset distance from the reference line to the bank line was measured on the 1939 aerial. This distance was adjusted for scale differences and then transferred to the1996 aerial. Using this procedure, a series of points representing the 1939 bank alignment was transferred to the 1996 aerial. Approximately 80 points were transferred in this manner and the points connected, from the 1939 bank line.

The erosion distance during the 57 year period was measured at 118 locations on the left bank and 80 locations on the right bank. There were areas in which accretion, growth of the banks out into the former riverbed through deposition and establishment of vegetation, occurred. For identification purposes, erosion was indicated as positive values and accretion as negative.

Two methods were applied to predict future conditions. In the first method, it was assumed that bank erosion rates were random and normally distributed. The mean and standard deviation of the computed 57-year record of erosion were adjusted to represent 50 years by multiplying by the ratio of 50 divided by 57. This ratio produces an adjusted 50 year mean and standard deviation for bank erosion of 29 m and 76 m for the left bank and 35 m and 42 m for the right bank. These values were then used to generate values of bank erosion distances associated with various ranges and their associated probability. In the second method, the actual sampled distribution was utilized after adjusting the distances by the ratio of 50 divided by 57.

One potential aspect of the erosion properties not accounted for by assuming future erosion to be randomly distributed or that it follows the actual sampled distribution from historical data is the possibility that flows concentrate on the left bank in some areas for an extended period. This is accounted for by doubling the damages in the lower left bank erosion area for a worse case scenario.

The expected value of losses from bank erosion that could occur over the next 50 years for the without-project conditions were determined by combining the value of the significant components of the area potentially subjected to erosion and the probability of erosion extending into that area. The significant features considered were the land, the structures and the Old Glenn Highway. The value of the Old Glenn Highway was estimated based on the cost of pavement, replacing 1.8 m of fill, and an allowance for miscellaneous features such as driveways and intersections. The land and structure values were obtained from the assessor's records and the parcel locations from the Mat-Su Borough files.

The erosion study area was divided into three sub areas to facilitate determination of potential benefits for alternative projects. These areas are: the left bank for 6,700 m downstream of the Old Glenn Highway bridge, the left bank from 6,700 m downstream of the Old Glenn Highway bridge to 9,750 m downstream and the right bank from about 1,524 m upstream of the Palmer wastewater lagoons to just downstream of Sky Ranch Subdivision. The three sub areas are referred to as the upper left bank, lower left bank and right bank. The length of banks in each of these three sub areas is 6,700 m, 3,050 m and 4,570 m, respectively.

Expected annual damages for the without-project condition are presented in Table 1 and 2 for the normal distribution and the sample distribution, respectively. The highest losses are associated with the potential erosion of residential structures on the right bank and the Old Glenn Highway and residential structures on the left bank. The other differences in losses between the three areas are related to the higher average value of land and structures in the right bank potential erosion area and the difference in bank lengths of the sub areas. In developing the damages, the areas that currently have some protection were not excluded from the potential erosion areas. These areas were included because the bank protection structures are isolated and could fail from erosion upstream or downstream. Additionally, the inclusion of these areas may offset some of the smaller damages that were omitted from this level of analysis such as utilities and residential roads.

Table 1. Estimated Expected Average Annual Losses from Matanuska River Bank Erosion by Sub areas Based on Assumption of Normal Distribution

Sub area	Estimated Expected Annual Erosion Losses			
	Land	Residential Structures	Old Glenn Hwy	Total
Upper Left Bank	$1,976	$5,235	$9,347	$16,558
Lower Left Bank	$3,611	$23,644	-0-	$27,255
Right Bank	$5,358	$15,638	-0-	$20,996

Table 2. Estimated Expected Average Annual Losses from Matanuska River Bank Erosion by Sub areas Based on Actual Sampled Distribution

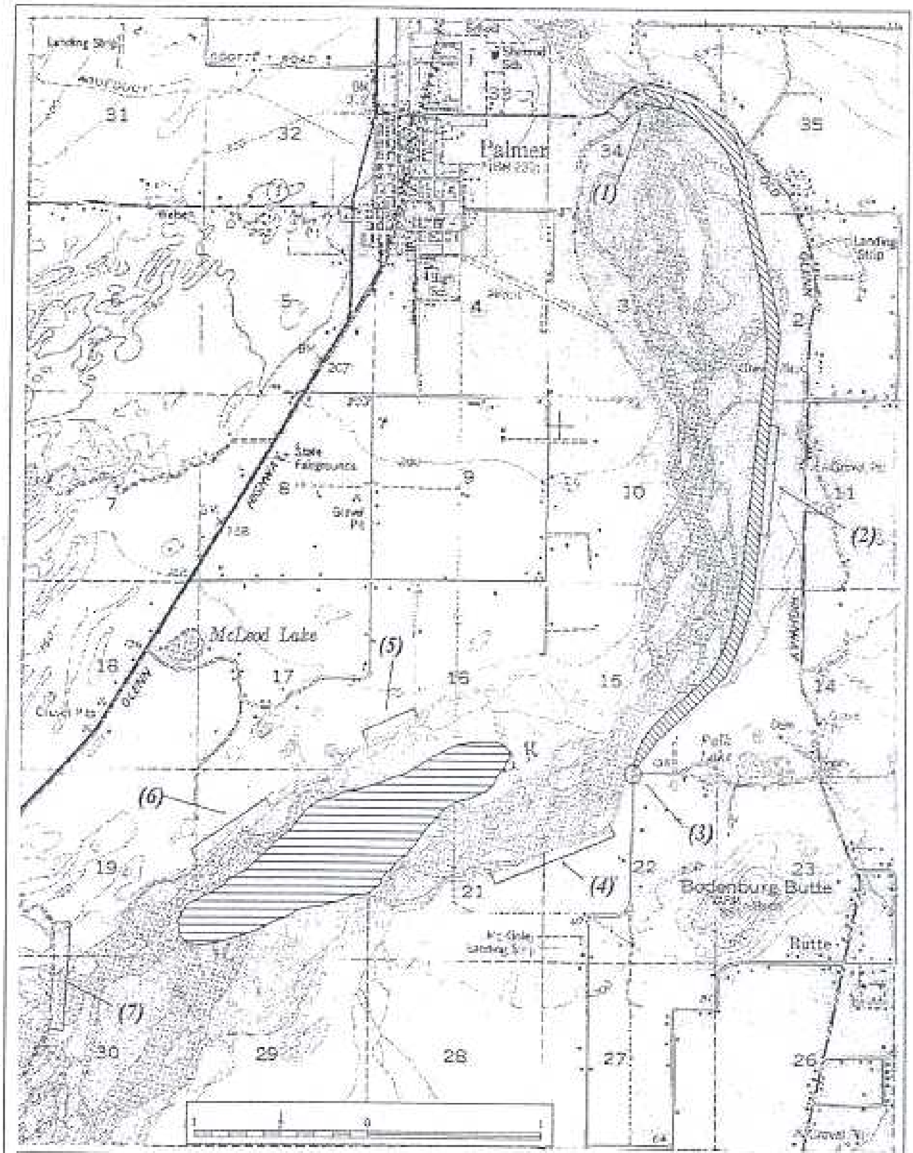
Sub area	Estimated Expected Annual Erosion Losses			
	Land	Residential Structures	Old Glenn Hwy	Total
Upper Left Bank	$2,095	$6,340	$7,893	$16,329
Lower Left Bank	$3,396	$21,551	-0-	$24,947
Right Bank	$5,642	$16,896	-0-	$22,538

The information presented in Tables 1 and 2 was based on an assumption of no new development in the study area over the period of analysis. Based on a U.S. Census Bureau estimate of the growth rate of population for the Matanuska-Susitna Borough for the decade of 1990 to 2000, a 4.1 percent annual growth rate was selected for estimating positive future development in the study area. The results are presented in Table 3 for the assumption of normal distribution and the actual sampled distribution.

Table 3. Estimated Expected Average Annual Losses from Matanuska River Bank Erosion by Subareas Based on Normal Distribution and Actual Sampled Distribution Growth Scenario

Subarea	Estimated Expected Annual Erosion Losses			
	Land	Residential Structures	Old Glenn Hwy	Total
Normal Distribution with 4.1 Percent Population Growth				
Upper Left Bank	$1,976	$10,926	$9,347	$22,249
Lower Left Bank	$3,611	$49,351	-0-	$52,962
Right Bank	$5,358	$32,640	-0-	$37,998
Actual Sampled Distribution with 4.1 Percent Population Growth				
Upper Left Bank	$2,095	$13,234	$7,893	$23,222
Lower Left Bank	$3,396	$44,983	-0-	$48,379
Right Bank	$5,642	$35,266	-0-	$40,908

- *3) Problems and opportunities.* Problems associated with bank erosion are documented as far back as 1956. Development of farmland, homes, and infrastructure continues in the areas adjacent to the Matanuska River, increasing the potential for damage. Problems are listed below:



LEGEND

Approximate Locations of Existing Bank Protection:

(1) Existing Bank Armor for bridge approach
(2) Existing Riprap Dike
(3) Existing Launched Hard Point
(4) Existing Rock Groins
(5) Existing Groins at wastewater treatment plant
(6) Existing Rock Toe Protection at Sky Ranch subdivision
(7) Existing Sheet Pile along dike

Possible Additional Bank Protection Area (Rock Armor, Spur Dikes, Groins)

Possible Gravel Extraction Area

Figure 2. Locations of Existing and Potential Erosion Control Measures

Expedited Reconnaissance Study 905(b) Matanuska River Erosion

- Erosion damages to land and residential improvements have garnered the most attention and appears to represent the largest monetary loss associated with erosion. The most notable example of this occurred during 1991 when 7 houses were either directly lost, demolished or moved due to advancing bank erosion in the Circle View Estates subdivision. Little documentation of losses of farmland is available. The 1956 erosion account indicated that farmland losses had occurred prior to that time (USACE 1996). More recently, at least several hectares of farmland have been lost at the Alaska Plant Materials Center due to erosion of an overflow channel. However, by far, the loss of residential structures has been the most significant damage in this category.

- Erosion damages to transportation and other public infrastructure has occurred. Portions of the Glenn Highway have been relocated due to erosion threats. Additionally, considerable bank protection has already been installed along the Glenn Highway from about milepost 61 (near Sutton) to milepost 78 (near Chickaloon). The Glenn Highway is the only ground transportation route for the upper portions of the Matanuska valley and also serves to connect the Anchorage area with much of Alaska. Although no documentation was found, it is expected that damage to the Old Glenn Highway occurred in the 1971 flood, when portions of the Matanuska broke out and flowed over and along the highway. Currently, there is active erosion along the portion of the Matanuska paralleling the Old Glenn Highway from the Old Glenn Highway Bridge, over the Matanuska River, south to near Stampede Estates. In this area, the river is on the order of 30 m to 488 m from the highway. The low banks occurring throughout much of this area are susceptible to erosion as well as flooding. About 914 m of levees with riprap armor have been constructed near the middle of this reach.

- Potential for damage to the Alaska Railroad resulted in construction of a 1,220 m long steel sheet pile wall and levee in the area of the Old Matanuska town site.

- Other infrastructure adjacent to the Matanuska River may also be damaged by erosion. The Corps constructed three rock-fill groins in 1969, as an emergency action, to protect the Palmer sewage lagoons from erosion. The power line crossings of the river near Bodenburg Butte utilize poles that are placed in the bed of the Matanuska. These have been eroded in the past.

- Flooding occurs as a result of bank erosion. There are cases where erosion has intersected old channel scars and main channel flows have then been captured by these features.

- Historically, this has occurred primarily in the area bounded by the Matanuska River to the northwest, the Knik River to the south and the Old Glenn Highway to the east. Two significant examples of this were the flow breakout from the 1971 flood that followed the old Glenn Highway and Bodenburg Creek to the Knik River and the flooding that still occurs near the Alaska Plant Materials Center.

- A number of residents have expressed concerns over the last 30 years that the entire Matanuska could flow across the Bodenburg Butte area and be captured by the Knik River. This could result in damages to dozens of homes, several roads and losses of many hectares of farmland. Representatives of the Corps and State have indicated that this is highly unlikely because of the topography between the two rivers and because relatively shallow depths can convey even the largest flood flows in the Matanuska River.

- Erosion and sedimentation processes continuously alter fisheries habitat in the river corridor. Several ponds have been partially filled in by deposition. In other cases, existing groundwater-fed channels are destroyed when erosion shifts the active channels to new locations. However, at the same time, new groundwater fed channels are created as active braids become abandoned. Thus, there is a continuous process of these important habitat features evolving with new channels emerging and old channels disappearing.

- Due to the wide braided channel and the large amount of silt deposited in the sediments of the Matanuska River, the strong winds blowing down the Matanuska Valley often cause particulate pollution during dry periods. This is a visual problem, but more importantly can be a health problem. The Borough Planning Department maintains two air quality monitoring stations and issues health warnings when levels exceed acceptable standards. Gravel extraction operations alongside the river are thought to add to the problem.

- Review of past reports and correspondence indicates a recurring need for emergency bank stabilization efforts in the study area.

- It is expected that any erosion control measures, including measures that would move gravel extraction operations into the river, would have insignificant impacts on air quality in the study area.

*b. **Alternative plans.***

(1) General. Opportunities may exist for implementing solutions to address the erosion problems and prevent damages to property. The review of existing documents, discussions with Corps of Engineers staff, meetings and interviews with local government and agency representatives, and site reconnaissance confirmed that erosion has been a problem that has drawn attention along the Matanuska River for at least 50 years. Over that period, a variety of solutions have been proposed that fall into the general categories of:

- Flow Deflecting Structures
- Bank Armoring
- Gravel Extraction

- Non-Structural Measures

To investigate the potential feasibility of controlling erosion on the Matanuska River, specific locations were identified that presented opportunities for implementation of erosion control measures. Locations were selected based on two primary criteria: 1) locations where valued resources are at risk of damage from erosion, and 2) where implementation of erosion control measures appears feasible.

The primary opportunities identified to address erosion problems in the study area is the more populated area near Palmer, from the Old Glenn Highway crossing downstream for approximately 11 km. In this reach, the most significant problems have centered around bank erosion threatening and in some cases actually destroying homes.

The first alterative is a plan for gravel extraction. The second alternative plan involves providing bank armoring to prevent erosion. Various groups and individuals have expressed interest in both of these alternatives over the past decades as documented by previous reports and input provided by local agencies. Additionally, a non-structural erosion damage reduction alternative is evaluated.

The gravel extraction alternative is primarily intended to protect homes from about an eighth of a km north of North Bodenburg Butte Loop Road on downstream for approximately 3 km on both sides of the river. The bank-armoring alternative would protect the Old Glenn Highway and buildings on the left bank from the bridge on downstream to near the Triple Crown Estates subdivision. The general locations of the alternatives are presented as Figure 2 and are described in the following paragraphs.

(2) Alternative 1 – Gravel Extraction. Alternative 1 is based on a conceptual plan prepared by Peratrovich, Nottingham and Drage, Inc. (PND) for the Matanuska-Susitna borough. It would be located in the Matanuska River from about 5 km downstream (south) of the Old Glenn Highway Bridge to below the Sky Ranch subdivision. The downstream location would be approximately a sixth of a kilometer upstream of the Matanuska dike constructed to protect the Alaska Railroad. In this configuration, the project would be intended to provide erosion protection for both sides of the river within this 5-km reach. Refer to Figure 2 for the location of potential gravel extraction site.

As presented by PND (1991) the project would consist of five major components:

1. The first component would be a gravel extraction pit constructed in the center of the channel corridor adjacent to Mountain View Estates. The pit is proposed to be 6 m deep and 365 m in diameter with a volume of approximately 460,000 cubic m.
2. The second component would be an 2,440-m long upstream supply channel extending from the extraction pit upstream to the narrow area in the channel corridor just upstream of North Bodenburg Loop Road and adjacent to the Triple Crown Subdivision.

3. The third component would be a similar channel extending downstream of the extraction pit for 914 m. The channels are proposed to have widths of 91 m and require approximately 306,000 cubic m of excavation. The channels are designed to be a total of 3 m deep with 1.5 m of depth created by excavation and the remaining 1.5 km created by pushing up berms along the channel from the channel excavation material. This size channel in this configuration is designed to convey the two-year flood. The design depends on the channel incising to create sufficient capacity to carry larger floods.
4. The fourth component would be a 305 m wide flared transition into the 2,440-m long upstream channel.
5. The fifth component of the system would be the gravel transportation facilities. This would consist of a 1,980 m long railroad spur constructed to haul gravel from the site and connect with the existing Alaska Railroad tracks, gravel loading facility, haul road from the pit, and a gravel stockpile pad.

The facility described above would be utilized to extract an average of 191,140 cubic m of gravel per year. PND indicates the intent of this volume roughly equals the estimated annual bed load supply. Separate estimates of the average annual bed load supply in the Matanuska River resulted in values of 204,000 cubic m and 229,400 cubic m.

(3) Alternative 2 – Bank Armoring by Riprap. Alternative 2 consists of a riprap bank extending along the left bank (east side) of the Matanuska River from the Old Glenn Highway Bridge downstream for 5.6 km to near the Triple Crown Subdivision. Refer to Figure 2 for the general extent of the bank armoring. The purpose of the bank armoring would be to control erosion in order to protect homes and the Old Glenn Highway. In this area, the Matanuska River ranges from less than 30.5 m to approximately 488 m from the Old Glenn Highway. Approximately 1,220 m of the river currently has a combination of riprapped bank and dike installed. The proposed rip-rap armoring may also help to protect the area from flooding that can result as the channel erodes into low lying overbank areas and abandoned channels, such as occurred in 1971.

A detailed site-specific design of bank protection for this reach would utilize a combination of riprap armoring applied directly to the banks that have been cut back to an appropriate slope, rip-rap armoring applied to fill, or a berm where the current bank alignment is not suitable for applying armor, and possibly some flow deflecting structures such as spur dikes and groins. Armored banks would be used in areas where the existing bank has a suitable alignment for protecting sufficiently high to prevent flood flows from flanking the protection. Armored dikes could be used in other areas where the bank is low or an irregular bank line makes protecting the existing bank difficult and expensive.

(4) Alternative 3 – Non-Structural. The non-structural plan would aim to reduce expected future erosion damages by moving homes and infrastructure out of harms way and to discourage further development in erosion prone areas. A non-structural plan could include a combination of nonstructural measures, including land acquisition in

erosion hazard areas, control of future development in erosion hazard areas, and public education to foster awareness of erosion risks along the river corridor. These nonstructural measures would reduce expected future erosion damages. The nonstructural measures would have less environmental impacts within the river corridor than the structural solutions identified in this report. Conversion of developed areas in erosion hazard zones to open space could provide environmental benefits for wildlife in the study area. Additional opportunities may exist for utilization of converted lands for agriculture or low-impact recreational activities such as camping, cross-country skiing, and walking trails.

For this expedited reconnaissance study riverine erosion hazard areas were delineated based on the same geomorphic assessment used to analyze the structural alternatives. Within these areas a mix of property acquisition of threatened land, relocation of homes where appropriate, and implementation of land use regulations and education was devised. The present value of expected damages to structures over the 50-year period of analysis was estimated to increase from $714,100 assuming no growth to $1,490,500 with the 4.1 percent annual growth rate. The added damages expected with growth could be averted by steering development outside of erosion hazard areas.

For this expedited reconnaissance study the costs were developed for each erosion zone and for each study breakout area. The costs included costs of land acquisition in erosion hazard areas, removal of existing improvements from erosion hazard areas, and labor costs for a local adminstrator of an erosion hazard mitigation program that would include erosion education and administration of the land acquisition and land use control functions of the non-structural alternative. Table 4 displays these costs.

Table 4. Cost of Land Acquisition and Removal of Improvements

Subarea	Zones Number (meters from bank)						
	Zone 1 (0 to 30.5)	Zone 2(30.5 to 61)	Zone 3 (61 to 122)	Zone 4 (122 to 183)	Zone 5 (183 to 244)	Zone 6 (244 to 488)	All Zones
Total Right Bank Cost	$202,957	$1,116,157	$796,457	$396,357	$599,056	NA	$3,110,982
Total Upper Left Bank Cost	332,060	167,960	195,886	146,585	235,860	NA	$1,078,353
Total Lower Left Bank Cost	63,241	112,540	90,241	146,140	199,041	1,009,407	$1,620,609
Total by Zone	$598,258	$1,396,657	$1,082,584	$689,082	$1,033,957	$1,009,407	$5,809,944

c. *Alternative evaluations.*

(1) Alternative 1 – Gravel extraction. Much of the Matanuska River bank erosion in the Palmer area is the result of the channel exhibiting a highly braided planform. A primary factor contributing to the braided channel condition is a high rate of bed load supply in excess of the flow's capacity to transport the material. The gravel extraction alternative would remove the oversupply of bed load with the intent of controlling the channel's tendency to braid, and therefore greatly reduce bank erosion. Such a strategy has been used on other braided rivers to reduce or control bank erosion.

i) Engineering considerations. The PND report was commissioned by the Matanuska-Susitna borough as a prefeasibility report. It is not possible to determine the engineering feasibility of gravel extraction as a means to control bank erosion along the Matanuska River based on existing information. Thus, this alternative cannot be considered technically feasible until further investigations have been conducted (technical feasibility has not been ruled out at this time). The following paragraphs identify specific issues that need to be addressed to determine engineering feasibility.

1. An extremely important question to answer is the expected amount of the gravel to be extracted. Uncertainty in this area arises from two aspects of

the plan. First, the proposed plan calls for extraction of the entire estimated bed load supply; however, this may not be a wise approach. Extracting the entire bed load supply will leave the channel downstream of the project starved of coarse material and could adversely impact the downstream channel. Typically instream gravel mining is conducted under the concept of "safe yield," where safe yield is the difference between the bed load sediment supply into the reach and the bed load sediment transport capacity within the reach. The safe yield may be much smaller than the actual supply. The second level of uncertainty involves the actual estimate of bed load. The predictions of 204,000 to 229,400 cubic m are based on only 9 measurements for the first value and an approximate relationship from other Southcentral Alaska streams for the second value.

2. Another important question to answer is what will be the upstream impact of the proposed gravel extraction project? The method assumes that a headcut will occur, but there is not an analysis indicating that the headcut will be confined to the intended area. If the headcut proceeded upstream of the controlled channel, it could result in damages to other locations. Similarly, downstream impacts to the channel morphology must also be assessed.

3. The nature and variability of the sediment supplied to the extraction area must also be better understood. In low flow years, the bed load supply would likely be much smaller than the predicted average annual yield. Conversely, in high flow years the yield would be significantly larger. In the former case, it could create a hardship for any entity that was expecting to remove 191,140 cubic m to make the gravel extraction economically viable. In the second case, the extraction area or upstream supply channel might be overwhelmed with sediment, resulting in a massive amount of deposition and shifting of the channel in the same manner as the project was intended to arrest. A better understanding of these two possibilities can only be obtained by analyzing the variability of sediment supply over a period of record and simulating the trapping characteristics of the gravel extraction pit.

4. The sediment trapping characteristics of the extraction pit under varying flow conditions must also be understood to identify the sizes of sediment trapped and their volumes. Though the plan is written as if the only material being trapped is gravel, it is inevitable that appreciable sand and some silt will be trapped. To estimate their volumes, the incoming supply must be estimated and the trapping characteristics of the proposed pit simulated over a range of flows. It is expected that the percentage of sands and silts in the sediments trapped in the extraction pit will be greater than that typically found in the channel deposits. This is due to the fact that the sediments trapped in the extraction pit will be deposited under a

much lower energy environment than currently or historically existed, on the average, in the main channel of the Matanuska River.

5. Potential impacts to the stability of the system upstream and downstream, including existing bank protection structures needs to be addressed. This would relate to the potential for upstream headcuts, downstream channel degradation and migration or filling of the upstream supply channel.

6. Reduction in sediment supply would change the expected channel form from braided to single thread, but the single threaded channel may ultimately adopt a meandering form. This in turn would cause erosion of gravel and supply additional sediments. Thus, additional study is required to assess how much maintenance or bank protection might be needed to maintain the straight approach and exit channels from the settling area.

The PND report did not provide a detailed cost breakdown of Alternative 1, but provided an estimated initial construction cost for the entire project of $3,000,000 in 1989 dollars. Applying a cost escalation factor of 1.5 (based on Engineering News Record's historic construction cost index) to this value results in an estimated cost of $4,500,000 in 2003 dollars. The PND report does not indicate the costs associated with extracting the gravel nor the value of the extracted gravel.

Annual extraction of gravel would require maintenance of the facilities such as conveyor belts, roadways and the channels. The cost of extracting the gravel and stockpiling in the project area is estimated to be $3.92 per cubic m. The annual cost of extracting 191,140 cubic m of gravel is then $750,000. If it is assumed that maintenance costs of the other project components averages 2 percent of the initial construction cost, this is an additional annual expense of $90,000 per year. Calculated over a fifty-year period at the current Federal interest rate of 5.875 percent, this operation, maintenance, repair, and replacement (O, M, R&R) have a present value of $13,474,492. The total present value cost is estimated at $17,494,492. The average annual equivalent cost is $1,120,530.

ii) Economic considerations. Implementation of the gravel extraction project would affect the study subareas delineated as Lower Left Bank and Right Bank. The erosion zones defined in this report were compared with Geographic Information System (GIS) county assessors data to determine the value of lands and improvements. Land in the lower left bank was determined to be valued at $6,802 per hectare. Structures within 305 m of the current left bank totaled 28 with an average replacement value of $156,170. In the right bank, the land was valued at $14,553 per hectare and there were 13 structures within 152 m of the current bank with an average replacement value of $224,680. Total expected erosion losses averted by this plan range from approximately 45 to 53 hectares of land and 10 to 12 structures. The calculated present value of prevented damages in these sub areas ranged from approximately $762,000 to $774,000 (average annual equivalent value of $47,500 to $48,250). The range is based upon the different analysis methodologies employed (assumptions of normal vs. actual distribution and concentration of flows on the left bank). The estimated costs of this alternative exceed the expected benefits by a factor of approximately 23 to 1. If the O&M costs are assumed to be self-liquidating, the value of prevented damages remains the same but the cost decreases. As a result, the estimated costs of this version of the alternative exceed the expected benefits by a factor of approximately 6 to 1.

If the two growth factors are applied to approximate development in the study area, expected damages and the value of prevented damages increase while the costs of the alternative remains constant. With the assumed 2% annual growth rate, expected damages prevented range from $1,000,100 to $1,018,000. Costs exceed benefits by a factor of approximately 17.66 to 1. In the self-liquidating O&M scenario, the ratio of costs to benefits is approximately 4 to 1.

Going to the assumed 4.1% growth rate, expected damages prevented range from $1,432,300 to $1,459,100. Costs exceed benefits by a factor of approximately 12 to 1. In the self-liquidating O&M scenario, the ratio of costs to benefits is approximately 3 to 1.

If this alternative were studied further, economic questions related to demand for gravel and gravel extraction/processing requirements and costs must be answered to determine if long term demand would exist for the gravel and if annual operation and maintenance of the project would be self liquidating. Demand for gravel varies based on regional construction trends, which are subject to changes in the local economy and government funding levels for large infrastructure projects.

iii) Environmental considerations. Fish and wildlife agencies expressed concern that gravel extraction within the river channel could adversely impact migrating adult and juvenile salmon and might actually result in channel destabilization. Agencies recommended a comprehensive watershed management study to document fisheries use and potential impacts of any proposed in-channel gravel extraction project.

(2) Alternative 2 – Bank Armoring by Riprap

i) Engineering considerations. Use of a riprap bank armoring to control erosion and also reduce possible flooding is a viable engineering approach in the area proposed. This type of structure has already been successfully utilized in a 1,220-m long section of river in the area of Ye Old River Road. On a larger scale, the ability to control erosion using similar measures has been proven by ADOT/PF on the reach of the Matanuska River from Sutton to Chickaloon. Further site-specific design efforts may result in including flow-deflecting structures, which have also been shown to be effective in controlling erosion in the Sutton to Chickaloon reach, as well as within portions of the Matanuska in the Palmer area.

Although engineeringly feasible, the use of the riprap bank armoring or any other bank protection measure, in a river as dynamic as the Matanuska will require that there be a commitment for significant long-term maintenance. The alternative has been formulated with the intent of controlling bank erosion along the entire reach, rather than just applying protection to areas identified as currently eroding, because the dynamic nature of the Matanuska River could quickly shift erosion to new locations. Thus, in the long run, protection would be applied along the entire reach, assuming a strategy to control erosion by structural measures was adopted. By formulating a single project, the risk of smaller individual projects failing is eliminated and an integrated approach is implemented.

It is estimated that riprap bank armoring would cost approximately $1,300 per m, or roughly $1,300,000 per km. Of the 5.6-km reach, approximately 4.3 km are not currently diked. The resulting 4,270 m of dike is estimated to cost on the order of $5,600,000. In addition, the current dike is in need of repair in several places. Allowing $325 per m for repairs on the 1,220 m of existing dike adds $400,000 to the cost of the project. The total first cost would be $6,000,000. Maintenance would be required to ensure long-term performance of the project. It is assumed that annual maintenance would average two percent of the initial construction cost. Based on this the estimated annual maintenance is $120,000 per year. The present value of first costs and O, M, R&R costs over the 50-year period of analysis is $7,924,930. This is an average annual cost of $494,000 evaluated over the 50-year period at the Federal discount rate of 5-7/8 percent.

The cost of protecting approximately 610 m of bank along Circle View Estates in 1992 with spur dikes was $500,000. Escalating the price to current dollars by a factor of 1.33 (Engineering News Record's historic construction cost index) results in a cost of $666,000 for 610 m ($1,090,000 per km), which is in the same range of cost as constructing the armored bank protection. Therefore, whether armored bank protection or spur dikes are used, the cost of continuously protecting a significant length of the Matanuska River banks will be similar.

ii) Economic considerations. Implementation of the bank armoring by riprap alternative would affect the study sub area delineated as Upper Left Bank. The erosion zones defined earlier were joined with county assessors data to determine the value of lands and improvements within each zone. Additionally, expected damages to the Old Glenn Highway in the Upper Left Bank sub area were calculated. The per hectare value of land in the upper left bank was $6,613 per hectare. The estimated value of the Old Glenn Highway was $1,300 per m. The average replacement value of the 7 structures in the estimated potential erosion zone of 152 m width was $156,168. Assuming no new development, total expected erosion losses averted by this plan range from approximately 15 to 15.8 hectares of land, 2 to 3 structures, and 300 to 356 m of Old Glenn Highway. In the no new development scenario, the combined present value of prevented damages in the Upper Left Bank subarea ranged from approximately $262,000 to $266,000 (average annual equivalent value of $16,330 to $16,580). The range is based upon the different analysis methodologies employed (assumptions of normal vs. actual distribution). The estimated costs of this alternative exceed the expected benefits by a factor of approximately 30 to 1. Therefore this bank armoring alternative does not appear to be economically justified.

If the two growth factors are applied to approximate development in the study area, expected damages and the value of prevented damages increase while the costs of the alternative remains constant. With the assumed 2% annual growth rate, expected damages prevented range from $298,100 to $301,200. Costs exceed benefits by a factor of approximately 27 to 1. Going to the assumed 4.1% growth rate, expected damages prevented range from $356,900 to $372,500. Costs exceed benefits by a factor of approximately 22 to 1.

iii) Environmental considerations. Applicable environmental agencies expressed concern that any kind of hard structural and protruding bank protection measures would create near shore velocity barriers to juvenile salmon species swimming against the current. Any proposal for implementing these controls will need to evaluate and minimize these potential velocity barriers. Agencies recommended a comprehensive watershed management study to document fisheries use and potential impacts of any proposed bank protection project.

(3) Alternative 3 – Non-Structural Alternative. *i) Engineering considerations.* A nonstructural alternative is engineeringly feasible. An initial step in the nonstructural alternative would be to identify the riverine erosion hazard areas. For the purposes of the expedited reconnaissance study this is done by evaluating historic changes in channel behavior and projecting areas where the river may migrate or erode its banks in the future. The preliminary geomorphic assessment used in the analysis of structural alternatives for this expedited reconnaissance study can be used as a model and starting point for a more in-depth engineering assessment. A more detailed identification of riverine erosion hazard areas, based upon findings of engineering studies, would provide a better basis to define erosion hazard areas on maps, establish set back distances, and delineate buffer zones.

ii) Economic considerations. A benefit-cost analysis of a range of alternative non-structural plans was performed. The range of alternatives was based upon various combinations of land acquisition in specific study breakout areas combined with the respective erosion zones. All combinations include the labor cost for a program administrator and assume that land use controls are put in place to eliminate any future development in those zones that are included in the combination. For each erosion zone in each study breakout area that is included in a combination, it is assumed that all parcels are acquired within that zone/breakout area combination.

As a first step the benefit-cost analysis was performed using only the measures described above, based on the 4.1 percent annual growth scenarios and the assumption of a normal distribution. The non-structural alternative with the highest benefit-cost ratio is the plan that includes zones 1 through 6 in the lower left portion of the study area. With a 0.4:1.0 benefit-cost ratio, the costs of this alternative exceed the benefits by a factor of approximately 2.5 to 1. The benefit-cost analysis was also conducted for the erosion rates based upon the actual observed distribution with similar results. None of the alternatives demonstrated benefits in excess of costs. The lowest benefit-cost ratios occurred for plans that only included zone 1 for all portions of the study area.

Further study of this alternative would include consideration of the potential for other beneficial land uses that could accompany the non-structural plan. Important new uses may include recreation, fish and wildlife restoration, or agricultural production. As an example, if these beneficial land uses provided monetary benefits of $545,000 (present value over 50 year period of analysis and 5.875% discount rate; or average annual value of $33,626) implementing the non-structural features for Lower Left Bank Erosion Zone 1 may be economically justified. Nonmonetary habitat restoration benefits may also be achieved for nonstructural alternatives that could support economic justification.

An analysis was conducted to illustrate the potential for recreational benefits on acquired lands. This hypothetical analysis assumed that acquired land was converted to natural space with recreational rustic camping facilities and trails for use in the summer season and wintertime activities such as cross country skiing, dog sledding, and/or snow machining. Corps Economic Guidance memorandum 03-04 was referenced to obtain unit day values that serve to estimate recreationist's willingness to pay for a recreational site visit. The memorandum defines current FY03 values for general recreational activities to range between $2.94 and $8.82 per day. This analysis assumed the midpoint, or $5.88 per user day. Yearly visitation was estimated at 7,560 user days (approximately 20 users per day). Applying the user day value of $5.88 to the 7,650 user days resulted in an estimated annual NED benefit of approximately $45,000. The present value of this annual benefit over the 50-year period of analysis equates to approximately $721,600 in NED recreational benefits.

If the benefit-cost analysis excludes other beneficial uses that may develop once lands are taken out of residential uses the nonstructural alternatives are not justified. If the benefit-cost analysis includes consideration of the beneficial uses that may occur once a nonstructural alternative is implemented some nonstructural alternatives may be economically justified.

iii) Environmental considerations. A number of fish and wildlife resource agencies advocated that a nonstructural approach be given equal consideration to structural erosion protection measures for reducing erosion damages in the study area.

6. FEDERAL INTEREST.

Based on the reconnaissance appraisal of costs, benefits, and environmental impacts of identified potential project alternatives, there does not appear to be an economically justified structural erosion damage reduction alternative that warrants further Federal involvement in a feasibility level study at this time. The costs of all structural solutions identified and evaluated exceed the expected erosion damage reduction benefits. There appears to be the potential for a technically practicable, economically feasible, and environmentally acceptable nonstructural plan. A nonstructural alternative that incorporates beneficial uses of areas acquired appears to demonstrate a potential for Federal interest in pursuing feasibility studies. There appears to be at least one nonstructural alternative that is technically possible, economically feasible, and environmentally acceptable.

7. PRELIMINARY FINANCIAL ANALYSIS.

The Matanuska-Susitna Borough requires more time to determine whether or not to sponsor the feasibility study. They are aware of the 50-percent study cost-sharing requirement. They are aware of the responsibility for sharing the implementation costs.

8. SUMMARY OF FEASIBILITY STUDY ASSUMPTIONS.

The value of the Old Glenn Highway was estimated based on the cost of pavement, replacing approximately 1.8 m of fill, and an allowance for miscellaneous features such as driveways and intersections.

9. FEASIBILITY PHASE MILESTONES.

Begin preparation of Project Study Plan	Sep 2003
Sign Feasibility Cost Sharing Agreement	Feb 2004
Feasibility Scoping Meeting	May 2004
Alternative Formulation Briefing	Sep 2005
Draft feasibility report	Nov 2006
Final feasibility report	Jun 2006

10. FEASIBILITY PHASE COST ESTIMATE.

The feasibility phase of this project is estimated to cost approximately $545,000. These costs will be apportioned as follows:

Project Management	$20,000
Planning	$60,000
Hydraulic Analyses and Design	$180,000
Economic Analyses	$60,000
Cost Estimating	$20,000
Environmental Analyses	$80,000
Real Estate Investigations	$30,000
Review	$20,000
Contingencies	$50,000
Review Support	$25,000

11. RECOMMENDATIONS.

On the basis of the findings above, I recommend that this reconnaissance study be certified as being in accordance with current policy, contingent upon a letter of intent being secured from a qualified non-Federal sponsor, and that a cost-shared feasibility level study is justified. The recommendations contained herein reflect the policies governing formulation of individual projects and the information available at this time. They do not necessarily reflect program and budget priorities inherent in the local and State programs, or the formulation of a national Civil Works water resources program.

Consequently, the recommendations may be modified at higher levels within the executive branch before they are used to support the funding. However, prior to initiating the feasibility study, the local sponsor will be advised of any modifications and will be afforded an opportunity to comment further.

Studies of nonstructural alternatives could be done under the Matanuska Watershed Study (presently in a deferred status awaiting local sponsor cost-share funding for a feasibility study). Feasibility level evaluation of nonstructural alternatives is recommended.

12. POTENTIAL ISSUES AFFECTING INITIATION OF FEASIBILITY PHASE.

If a letter of intent is not secured from a qualified non-Federal sponsor the feasibility phase will not be initiated.

13. VIEWS OF OTHER RESOURCE AGENCIES.

Twelve agencies were identified that have general interest in erosion and flood control, water and habitat quality, wildlife, vegetation, sensitive species, and archaeology and historical structures in the Matanuska River Valley, and/or would be involved in the permitting and approvals process for any potential future erosion control projects. Most of these agencies pointed out the need for environmental studies prior to bank stabilization efforts to establish appropriate baseline environmental conditions. Some suggested consideration is given to non-structural alternatives to erosion control such as purchasing properties and relocating people that may be potentially affected by channel movement and bank erosion. Others cautioned that because the river channel cross-section is so dynamic, care should be taken to ensure that an erosion problem on one bank of the river is not translated to the other bank.

14. PROJECT AREA MAP.

See Figure 1 for a vicinity/study area map and Figure 2 for approximate locations of potential erosion control features.

TIMOTHY J. GALLAGHER
Colonel, Corps of Engineers
District Engineer

REVIEW COMMENTS

PROJECT: Expedited Recon Study, Matanuska River Erosion
DOCUMENT: 905(b) (WRDA 1986) Analysis – Aug 2003

U.S. ARMY CORPS OF ENGINEERS CEPOA-EN-CW-HH	DATE: REVIEWER: Dave Mierzejewski PHONE: (907) 753-2670	Action taken on comment by: Kerr, CEPOA-EN-CW-PF			
Item No.	**Drawing Sht. No., Spec. Para.**	**COMMENTS**	**REVIEW CONF**	**DESIGN OFFICE**	**Back check By: (Initials)**
1.	p. 2	We say Palmer and Sutton have erosion problems. None were found by the AE. They state there is a potential for future problems. Suggest we say "no existing erosion problems but there is a potential for future erosion problems"?	A	Sentence changed to: "After an initial appraisal of erosion issues in the basin, no areas in the vicinity of Palmer and Sutton were identified as having erosion problems but there are areas where there is a potential for future erosion problems."	DM
2.	p. 13	First paragraph is out of place.	A	Corrected.	DM
3.	p. 13, 4th para.	We say gravel extraction will stabilize the river. The AE report doesn't state that and indicate it would. Eliminate that part of statement.	A	Sentence now reads: "The first alterative is a plan for gravel extraction."	DM

U.S. ARMY CORPS OF ENGINEERS CEPOA-EN-CW-ER	DATE: REVIEWER: B. Harper PHONE: (907) 753-2615	Action taken on comment by: Kerr, CEPOA-EN-CW-PF			
Item No.	**Drawing Sht. No., Spec. Para.**	**COMMENTS**	**REVIEW CONF**	**DESIGN OFFICE**	**Back check By: (Initials)**
1	p. 11 & 12	Last paragraph on p. 11 and first on p. 12 are confusing. I suggest that the table of discharges be moved so that it doesn't interrupt the discussion of the main channel overflowing to capture side channels.	A	Moved to 5.a. (1) existing conditions	RH

	Problems & Opportunities	The section on problems and opportunities feels disjointed. I suggest that you bullet the items just to let us know that each paragraph is a separate problem.	A	Corrections made.	[illegible]
	Table 4	Add a row to total all areas/all zones.	A	Corrections made.	[illegible]
	pp. 20-21	The report should estimate a range of potential benefits for the alternative uses of the land to support the recommendation and determination of Federal interest.		Added at p. 12: "An analysis was conducted to illustrate the potential for recreational benefits on acquired lands. This hypothetical analysis assumed that acquired land was converted to natural space with recreational rustic camping facilities and trails for use in the summer season and wintertime activities such as cross country skiing, dog sledding, and/or snow machining. Corps Economic Guidance memorandum 03-04 was referenced to obtain unit day values that serve to estimate recreationist's willingness to pay for a recreational site visit. The memorandum defines current FY03 values for general recreational activities to range between $2.94 and $8.82 per day. This analysis assumed the midpoint, or $5.88 per user day. Yearly visitation was estimated at 7,560 user days (approximately 20 users per day). Applying the user day value of $5.88 to the 7,650 user days resulted in an estimated annual NED benefit of approximately $45,000. The present value of this annual benefit over the 50-year period of analysis equates to approximately $721,600 in NED recreational benefits."	[illegible]

U.S. ARMY CORPS OF ENGINEERS CEPOA-EN-CW-ER		DATE: REVIEWER: G. McConnell PHONE: (907) 753-2614	Action taken on comment by: Kerr, CEPOA-EN-CW-PF		
Item No.	Drawing Sht. No., Spec. Para.	**COMMENTS**	REVIEW CONF	DESIGN OFFICE	Back check By: (Initials)
	General	Minor edits provided on hardcopy	A	Corrections made.	

ESPEDITED RECONNAISSANCE STUDY
Section 905(b) (WRDA 1986) Analysis
Matanuska River Erosion
Matanuska-Susitna Borough, Alaska

COMPLETION OF INDEPENDENT TECHNICAL REVIEW

The District has completed the 905(b) Analysis for Matanuska River erosion at Matanuska-Susitna Borough, Alaska. Notice is hereby given that an independent technical review has been conducted that is appropriate to the level of risk and complexity inherent in the project. During the independent technical review, compliance with established policy, principles and procedures, utilizing justified and valid assumptions, was verified. This included review of assumptions; methods, procedures, and material used in analyses; alternatives evaluated; the appropriateness of data used and level of data obtained; and reasonableness of the results, including whether the product meets the customer's needs consistent with law and existing Corps policy.

Carl E. Borash — 24 Sept 03
Carl Borash, Project Formulation — Date

Brian Harper — 24 Sept 2003
Brian Harper, Economics — Date

Guy R McConnell — 24 Sept 03
Guy McConnell, Environmental Resources — Date

Kenneth J Eisses — 24 Sept 03
Ken Eisses, Hydraulics & Hydrology — Date

CERTIFICATION OF INDEPENDENT TECHNICAL REVIEW

As noted above, all concerns resulting from independent technical review of the project have been considered. The report and all associated documents required for this phase of the study by the National Environmental Policy Act have been fully reviewed.

Dennis L Hardy — 26 Sept 03
Dennis Hardy, Chief, Civil Works Branch — Date

CEPOA-OC

30 September 2003

The Expedited Reconnaissance Study, Section 905(b) (WRDA) Analysis-Matanuska River Erosion-Matanuska-Susitna Borough, Alaska has been reviewed by the Office of Counsel and is legally sufficient.

Sara Trent
Assistant District Counsel