Matanuska River
Watershed Plan

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The planning team consisted of NRCS staff with input from the Matanuska River Watershed Coalition group. The planning effort is the result of over ten years of ongoing erosion impacted-structures and public pressure to address the loss property. The following people participated in the Watershed Planning process.

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NRCS

Watershed Coalition Team

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Matanuska River Watershed Plan
Planning Team Approval

Matanuska Watershed Plan EXECUTIVE SUMMARY

INTRODUCTION

This Matanuska River Watershed Plan (MRWP) is developed under the guidance of the Watershed Protection and Flood Prevention Act, Public Law 83-566 authorizing the Secretary of Agriculture to cooperate with State and local agencies in planning and carrying out works of improvement for soil conservation and for other purposes. It provides for technical, financial and credit assistance by the U.S. Department of Agriculture (USDA) to local organizations representing the people living in small watersheds. The Watershed Protection and Flood Prevention Program requires the development of a physically, environmentally, socially, and economically sound plan of improvements scheduled for implementation over a period of years.

A NRCS planning team is responsible for leading the creation of the Watershed Plan with consultation from the Matanuska River Watershed Coalition Group. The Matanuska River Watershed Coalition group, consisting of land owners, Federal, State and local agencies, tribal entities, and conservation districts, has worked collaboratively to assist in the development of the MRWP.

The MRWP consists of five chapters and appendices. Chapter 1 provides an overview of the watershed planning process and a general discussion of the history of planning that has led up the MRWP. Chapter 2 describes the watershed and "assessment" of the watershed planning area. Resource concerns are discussed in Chapter 3 and Chapter 4 provides the recommendations developed by the planning team during the planning process. These recommendations represent the outcomes of the planning process and provide a wide-ranging and significant framework for addressing current water resource issues and for anticipating future issues. Chapter 5 gives an overview and comparison of the cost to benefit for structural and non structural recommendations. The appendices include various important supplemental documents and documentation. For further detail, please refer to the Table of Contents.

BACKGROUND

Watershed planning occurs under enabling legislation passed in the Watershed Protection and Flood Prevention Act. The Congress made it clear that the authority provided under the Act should be used to "supplement both our present agricultural soil and water conservation programs and our programs for development and flood protection of major river valleys. It will bridge the gap between these two types of programs and greatly enhance the ultimate benefits of both." (House of Representatives Report No. 1140,83d Congress, 2d Session.) The MRWP identifies other water and watershed resources, including salmon recovery, water system planning, local land use planning and a host of other regulations and planning initiatives. These were each reviewed and considered in the development of this watershed plan.

The MRWP will be the guiding document for future activities within the Matanuska River Watershed. The Matanuska River Watershed Plan goal is to reduce the loss of structures and property along the river while enhancing the natural functions of a glacial river. This plan identifies the objectives to accomplish the goal. As in any planning process, the goals establish a desirable future condition that accommodates important economic, social, and recreational uses and this plan provides the framework to achieve them. This is a long-term process and will incorporate adaptive management strategies based on the best available assessment of the watershed's natural, economic, and social features. The plan will be used to prevent future problems while addressing the existing problems.

1.0 INTRODUCTION AND PLANNING FRAMEWORK

1.1 Background and historical information

This planning document is to identify problems, needs, and recommendations related to erosion in the Matanuska River Watershed. Since establishment of the Matanuska Colony in the 1930s, residents of the Matanuska Valley have enjoyed a rural lifestyle under the grandeur of Pioneer Peak, Lazy Mountain, and other peaks of the Talkeetna and Chugach Ranges (Figure 1). Within this valley is the magnificent Matanuska River, with typical midsummer flows reaching 30,000 cubic feet per second (cfs) or more, and carrying a tremendous burden of sediment from the Matanuska Glacier and the upper valley. As the river approaches Palmer and Bodenburg Butte, the stream gradient lessens and sediment is deposited, sometimes accumulating so rapidly that the water is abruptly forced to seek a new watercourse.

The resulting braided channel is characterized by a high width to depth ratio, and a propensity to migrate horizontally in relatively short time periods, eroding the toe of the banks on the margins of the floodplain. As the toe of the banks is attacked by the river, sloughing occurs and property at the terrace level is sacrificed to the river bottomlands, which are under ownership of the State of Alaska. Structures are also at risk, as sloughing of the banks undermines foundations of buildings and utilities. Over the years, structures and acres of farmlands have been swallowed by high water eroding the streambank. This ongoing erosion and threat to structures and land necessitated a closer look at erosion control options and the potential for success, as described in detail in this report.

1.2 Previous Studies and Reports: Past and Present

From 1972 to 2004, at least ten separate studies and prior reports have been completed. All of the reports were initiated to address the erosion along the Matanuska River and related impacts on property. The damages caused to structures is most notable during an incident during 1991 when 7 houses were either directly lost, demolished or moved due to advancing bank erosion in the Circle View Estates subdivision. Several acres of farmland were lost at the Alaska Plant Materials Center due to erosion of an overflow channel (not the main thalweg of the Matanuska River) and there has been some loss to farmland since 1956. However, the greatest loss of decreasing farmland is through subdivision development in the last few years. Although not a direct damage, the potential for erosion is believed by some to have impacted the value of homes located adjacent to the river (Karabelnikoff and Karabelnikoff 1991).

The most recent study by MWH was contracted by the U.S.D.A., Natural Resources Conservation Service (NRCS) to evaluate erosion problems along the Matanuska River near Palmer, Alaska. This report was completed in November of 2004. MWH was tasked with assessing the erosion along a reach of the Matanuska River (from old Knik Bridge to the tidal influence zone near the confluence of the Knik River) and evaluating potential long-term solutions to minimize future erosion problems.

Existing Water Projects

Nine existing water projects have been constructed to address bank erosion from as early as the 1940's until recently in 1992. Erosion or the potential for erosion has impacted the transportation network in the Matanuska Valley. A series of projects were constructed in the late 80s through early 90s to address bank erosion problems along the Glenn Highway from Sutton to near Chickaloon. Portions of the Glenn Highway were relocated due to erosion threats. These projects were constructed by Alaska Department of Transportation and Public Facilities (ADOT/PF). All of these projects implemented hard engineering such as bank armoring with riprap and flow deflecting structures and dikes (U.S. Army Corps of Engineers, 2003). In 2002, approximately 3,000 feet of rock toe protection has been placed along the right bank of the Matanuska River in front of the Sky Ranch Subdivision.

In 1991, the Circle View Estates subdivision formed the Circle View and Stampede Estates Flood and Erosion Control Service Area. The designation of a Service Area give the MSB authority to tax land owners within the area and provides the opportunity for the MSB to fund erosion protection projects within the area.

<u>Current and Planned Projects</u>

In 2005, the NRCS and the MSB, signed a cooperative agreement, to provide technical and financial assistance for the construction of a fifth spur dike in the Circle View subdivision. Construction is planned for November of 2006 after all NEPA documentation has been complete and permits approved.

In 2005 the Palmer Soil and Water Conservation District hired a Watershed Education Coordinator with funding from the NRCS. The Watershed Coordinator developed several newsletters and organized the Watershed Coalition Group to focus on needs and solutions along the Matanuska River and educate the landowners about river erosion.

In 2005 the Palmer Soil and Water Conservation District, with funding from the NRCS, hired a local consulting company, Restoration Science & Engineering, to conduct a hydrologic reconnaissance survey of the tributaries of the Matanuska River. A report will be published in the spring of 2006.

In 2006 the MSB received funding to work with the U.S. Geological Survey and the U.S. Army Corps of Engineers to map erosion zones along the Matanuska River. This is expected to be a three-year project.

In May of 2006, NRCS and the MSB, through a Cooperative Agreement are implementing the Matanuska River Terrace Erosion Area Acquisition Pilot Project. This pilot project will provide technical and financial assistance to pursue a non-structural method to control or eliminate water contamination, decrease potential impairment of anadromous fish migration, decrease river terrace and riparian corridor alternation/destruction, and prevent loss of private residential buildings and businesses from riverbank erosion adjacent to the Matanuska River. This project is planned to be implemented in the summer of 2006.

The MSB is working on regulations that seek to reduce the risk of damage to development caused by erosion along waterways. The MSB will be presenting the Mat_Su Erosion Ordinance to the public and Assembly in May of 2006.

The NRCS is also conducting a flood mapping project in the fall of 2006. This project will identify flood-prone areas from the Matanuska Glacier to the confluence of the Knik River.

1.3 Purpose of the Plan

The Matanuska River is a large, dynamic river flowing through a rapidly growing region in Southcentral Alaska. As development moves closer to the river, more land and homes are threatened by erosion and flooding. The Matanuska River Watershed Plan goal is to reduce the loss of structures and property along the river while enhancing the natural functions of a glacial rive by developing open space corridors along the river through land us policies, conservation easements, and public education.

1.4 Limitations & Challenges

The largest limitation to implementation of a Watershed Plan of this scale is the lack of financial and technical assistance for planning. The Matanuska Susitna Borough is the largest and fastest growing community in Alaska, doubling its population to 60,000 residents over the last 20 years. Population growth and development are focused in the cities of Palmer and Wasilla, the “Core Area” between them, developing communities (such as Butte).

The MSB does not prohibit development in flood hazard areas. For purposes of federal flood hazard insurance, it does require a development permit for activity in the 100 year floodplain. As a second class borough MSB could invoke its planning authorities and prevent development in areas prone to flood hazard and erosion. This could be done through comprehensive land use plans, site specific land use guidelines based on underlying geology, implementing zoning ordinances, or a flood hazard overlay zone.

Up until now addressing erosion problems has been reactive to immediate threat to life and property. Planning efforts have been sporadic and low priority within the Matanuska River Watershed. There have been several attempts at planning by different groups and agencies but none have been implemented specifically for the Matanuska River Watershed.

The modern floodplains of the Matanuska (and Knik) rivers are subject to powerful and regular erosion and flooding. According to a discussion of flooding in the adopted MSB Core Area comprehensive plan (adopted 1993, amended 1994 and 1997), there is a “temptation to ignore potentially serious hazards and develop the floodplains”.

2.0 WATERSHED CHARACTERIZATION

2.1 Natural Environment

2.1.1 Geography & Climate

The Matanuska River drains a watershed area of 2,070 sq. miles upstream of Old Glenn Highway Bridge near Palmer, Alaska, with roughly 10% of the basin occupied by the Matanuska Glacier, and an additional 2 - 3% by tributary glaciers (Figure 2). The main river channel extends more than 70 miles from the glacier to its confluence with the Knik River, where the two channels are building a compound delta at the head of Knik Arm of Cook Inlet. (Fahenstock and Bradley, 1973). The river valley is located in a glacial trough bounded by the Chugach Mountains to the south and the Talkeetna Mountains to the north.

Peaks in the Chugach Mountains, which form the boundary on the south side of the watershed, rise to elevations above 10,000 feet. In the Talkeetna Mountain Range to the north, peaks rise to 6,500 feet. The average elevation of the drainage area is 4,000 feet. With treeline at approximately 3,000 feet, the majority of the watershed is not forested. The largest tributaries flow south from the Talkeetna Mountains. Portions of the upper reaches of both the Talkeetna and Chugach mountain tributaries to the Matanuska River are covered with glaciers, so stream tributary to the Matanuska River may be glacial or non-glacial in origin.

The lower Matanuska Valley lies in a structural trough that trends northeast-southwest. The northwest border of the trough is defined by the Castle Mountain Fault, along which older rocks of the Talkeetna Mountains (mostly Cretaceous and tertiary-age granitic intrusives and sedimentary rocks) (LaSage, 1992), have been thrown up against younger rocks on the valley floor (Barnes, 1962). The Chugach Mountains are composed of cretaceous-jurassic metasedimentary and metaigneous rocks. The Talkeetna Mountains are composed of granitic and gneissic rocks. Folding and faulting has deformed the rocks of the valley floor. The March 27, 1964 earthquake caused regional subsidence of about 2 feet in the lower third of the valley (Plafker, 1969).

Younger deposits in the basin are the result of the last major ice expansion. Glacier drift, including till, was deposited over scoured bedrock and as the ice receded ice-contact deposits, such as kames, eskers, and crevasse fills, produced uneven terrain. Winds in the lower valley resulted in aeolian deposits northwest of the mouth of the river (Trainer, 1961). The river itself has a broad, braided floodplain, with some bedrock constructions, for the lower two-thirds of its length. In some places, the floodplain is up to a mile wide.

The Matanuska Valley is set in a transitional maritime-continental climate, characterized by long cool winters and short warm summers. A long term climatic data station is located in Palmer at the Agricultural and Forestry Experiment Station in Palmer (NOAA recording station Palmer AAES, 6870). Based on the period of record from 1971 to 2000, annual average maximum temperature is 44.4 ^{o}F and minimum temperature is 27.2

°F. The average annual temperature in December and January is 7.5 °F and 8.6 °F, respectively. In Palmer, maritime influences are more evident and winter temperatures are relatively moderate, compared to the middle and upper reaches of the Matanuska Valley. The Palmer station reports an annual average total precipitation of 15.56 inches, which is not directly within the rainshadow of the Chugach Mountains, as the Matanuska Valley is positioned.

2.1.2 Soils

A complex of floodplains and stream terraces are found along most of the length of the Matanuska River. The broad, braided floodplains, characteristic of high gradient glacial rivers are occasionally one mile or more in width. Floodplain features include point bars, cutoff meanders, and back swamps. Stream terraces are generally discontinuous and often narrow in width. Soil parent materials on floodplains and stream terraces include stratified sandy and silty alluvium of varying thickness over gravelly and sandy alluvium. Seasonal depth to water table in floodplain soils fluctuates in response to periodic changes in river discharge and water level.

Glacial landforms include nearly level and undulating outwash and till plains, pitted outwash plains, steep hills, and in a few places, wind deposited sand sheets and dunes. Soil parent materials include loose sandy and gravelly glacial outwash, friable to firm loamy and gravelly glacial drift, and firm gravelly glacial till. On hills and lower mountain slopes, bedrock is often present within 60 inches of the surface.

Steep hills and mountain slopes and broad to narrow valleys characterize much of the landscape at higher elevations in the Talkeetna and Chugach Mountains. In the valleys and on hills and lower mountain slopes, thick deposits of glacial drift often mask the underlying bedrock topography. A variety of rock types are exposed along the upper Matanuska River canyon.

Most uplands throughout the area are covered with a layer of silty airborne or eolian deposits. Eolian deposits include loess derived primarily from floodplains of the braided glacial Matanuska and Knik Rivers, and volcanic ash originating from volcanoes in the Alaska and Aleutian Ranges. Loess is primary surface mantle in the Matanuska Valley. Loess continues to accumulate today as the Matanuska and Knik winds and the nearly barren floodplains of the Matanuska and Knik Rivers combine to produce significant amounts of airborne dust. The thickness of eolian deposits varies throughout the Watershed. Loess deposits are thickest in the Palmer vicinity. Cliff-head dunes, with loess as much as 50 feet thick can be found on escarpments adjacent to the Matanuska River.

2.1.3 Hydrology and Geohydrology

The contemporary channel morphology of Matanuska River largely reflects upstream controls established by repeated glaciation, especially during the Quaternary period. Much of the river is bounded by thick glacial outwash deposits over tertiary bedrock that is exposed in several sections along the lower two-thirds of the channel. Near Palmer, a stagnant lobe of the Matanuska--Knik glacier formed a variety of ice-contact features such as kames and eskers. Following deglaciation, the channel has eroded through the valley fill, leaving a sequence of stepped terraces formed from erosion through alluvial fan deposits.

The river is typically much wider and shallower along unconfined sections, where large deposits of sand and gravel have formed a series of alluvial braided reaches separated by narrower confined reaches. Confined sections are bounded by bedrock, glacial deposits or artificial constrictions such as roads and revetments. The constricted reaches further act as vertical control on the river by causing upstream accumulations of sand and gravel. This material is derived from a number of different sources, including landslides along valley slopes, erosion of river terraces, and tributary streams that form alluvial fans where they intersect the Matanuska River. Coarse sediment is also commonly supplied from exposed deposits at the base of receding glaciers in most proglacial watersheds, but Pearce et al. (2003) found that bedload constituted <1% of the total clastic yield, or roughly 260 metric tons per annum from Matanuska glacier. Alternatively, from several site visits (MWH, 2004) the authors noted that steep non-glacial tributaries near the glacier were much more significant bedload sources near the headwaters, and suggested that such areas potentially account for a substantial volume of coarse sediment throughout the entire watershed. Indeed, the presence of alluvial fans at the mouths of large tributaries including Gravel Creek, Chickaloon River, and Granite Creek confirms that these systems deliver large quantities of sediment directly into the main channel network.

The first comprehensive study of the deposition zone was provided by Fahnestock and Bradley (1973) who described the following:

"The Matanuska at normal summer high flows is actively changing the details of its complex pattern, vigorously attacking and undercutting a tree laden bank or island, depositing bars and levees across channel mouths, blocking flow from active channels or raising the local bed elevation to cause the reactivation of abandoned channels. Even at the gaging station at the bedrock narrows, the rattle and hiss of gravel bed load movement can be heard and discharge measurements on successive days show the changes in channel cross-section."

There are several reaches where hard points or bedrock restrict the river. One reach is near the old Glenn Highway Bridge which is bounded by a narrow bedrock gorge at its upstream extent (where the USGS gaging station is located) that produces a high velocity flow jet during large discharge events. Coarse sediments from upstream sources pass through this constriction, and are deposited as a series of complex bar forms where the channel widens, flow diverges and bed shear stresses decline. Over the past few decades, this deposition has produced a large, elevated bar/island complex in the middle of this upper reach that bifurcates the flow and has resulted in direct shear erosion along outer channel banks and undercutting/ slumping at the base of high terraces. An additional medial bar/island complex has formed in the downstream reach of this area and has caused similar concerns in the vicinity of the wastewater treatment ponds and the Circle View Estates subdivision.

At low flows, the two main channel branches are comprised of a highly complex sequence of transient bars separated by a network of narrow, shallow sub-channels with no clearly dominant thalweg. The network channels converge as discharge increases, but some bar elements remain exposed even at high (i.e. 2-year) flow, though individual units are typically small and randomly distributed. However, if woody debris becomes trapped on these surfaces, finer sand and silts are deposited in the lee, and vegetation can become established and stabilize the bar, allowing the deposit to grow. Much larger elevated bar deposits are also constructed as a remnant feature of channel abandonment. An example is found in reach 2 near the sewage treatment plant, where the channel flowed along the north bank in the 1970’s, but has since avulsed to the south side and formerly eroding banks are not currently threatened. These areas form where the channel alignment directs flows against banks or channel constrictions, and sediment can accumulate vertically, especially during high magnitude events. Since abandoned areas are not re-worked by more modest floods, vegetation becomes established and island and floodplain deposits form over periods of years to decades.

STREAM GAUGE INFORMATION

The USGS station near Palmer (site no. 15284000) has a 33 year discontinuous stream gage record, 1949-73, 1985-86, 1991-92. Table 1 provides mean monthly discharges from the 33 year record.

The median (50^{th} percentile), as well as 75^{th} and 25^{th} percentile, monthly mean discharges are provided. The median monthly mean discharge for July is the highest at 13,400 cfs, while the lowest is March at 484 cfs. The ratio between the 75^{th} and 25^{th} percentiles is a general indicator of seasonal streamflow variability. The greatest ratio is in May (2.0), while the lowest are the months of January, February, and March. These trends indicate much less variability in winter months compared to May, when break-up conditions occur and streamflow rises rapidly. The maximum daily discharge measured was 82,100 cfs on August 10, 1972 which, based upon the magnitude, may have been associated with a glacial lake damn burst event. The second highest maximum daily discharge is 46,000 cfs on September 22, 1995. However, the majority of the peak daily discharge measurements have occurred in June or July. The minimum daily mean discharge recorded is 234 cfs, which occurred on April 25, 1956 (RSE, 2006).

SEASONAL VARIATIONS IN HYDROLOGY

Long summer days in southcentral Alaska has great influence on the streamflow conditions of the Matanuska River. Streamflow is greatest in June and July, and sometimes August. With the onset of shorter days and cooler temperatures, streamflow decreases drastically from September to November, at which point tributary streams freeze and streamflow continues to decrease to the typical low-flow period in March (USGS, 2006). Summer and fall precipitation events will commonly cause high streamflow conditions as well. Although the Matanuska River is predominantly glacially-fed, there are multiple clear-water source tributaries. Figure 3 presents a profile of the Matanuska River and the position of tributary confluences and communities. River mile and site elevation were estimated from USGS quadrangle maps.

LATE SUMMER CONDITIONS

During the late summer in 2005, surveys were conducted by Restoration Science & Engineering (RSE) and 19 sites were visited. Survey site locations are provided in Figures 2.1. Surveys were conduced at 15 sites from August 2 through August 5, 2005. The mid-level Matanuska River site was visited on August 7 and 15, 2005. The East and South Forks of the Matanuska River and the upper-level Matanuska River sites were visited September 7, 2005. Discharge measurements were not collected during the annual highest flow conditions, particularly those measured in September. However, the conditions from August likely represent medium-high flow conditions. Highest flow conditions are typically in late June or July. The average maximum temperatures reported at Palmer AAES station for June, July, August, and September are 64.4 ^{o}F, 66.7 ^{o}F, 64.5 ^{o}F, and 56.1 ^{o}F respectively

Of the 19 sites visited, discharge measurements were collected at 16 sites. Discharge measurements were not collected from Ninemile Creek (site no. 11) due to safety precautions or at the lower Matanuska River site (site no. 1) because cross-section data measurements were provided by USGS from gaging site no. 15284000 on the Matanuska River near Palmer. The National Weather Service (NWS) River Forecast Center had recently upgraded the gaging station located near Glacier Park to an automated site at the time of this report. Current flow data is available for this site.

Discharge measurements and channel properties are provided in Table 2.2 (RSE, 2006). The highest discharge measurement reported is 11,950 cfs, measured by USGS at gaging station 15284000. The lowest discharge measurement reported was at Monument Creek, 93 cfs. Based upon observation, Ninemile Creek, may have had the lowest discharge of the 19 survey sites. The median discharge of the tributaries measured is 294 cfs. Discharge values reported are calculated from minimal velocity measurements due to wading safety and the reconnaissance nature of this survey. Discharge values at seven sites (2, 5, 7, 9, 10, 17, and 18) are calculated with velocity measurements recorded and estimated channel cross-sectional area, because more complete channel cross-sectional data could not be collected due to wading safety.

The section of the river traveled by non-motorized boat to access survey work stretched from the Matanuska Glacier at Glacier Park to below the mouth of Carpenter Creek (approximate river mile 65 to 35). Generally the river character is fast and braided, often with a poorly defined main channel. Rapids below Glacier Creek, between Ninemile and Coal Creek, and between Carbon Creek and Carpenter Creek are potential navigational hazards. A section of the river with notable rapids not traveled for this survey, which provides excellent recreational boating for experienced boaters, is from the mouth of Caribou Creek to Glacier Park. The river below Carpenter Creek may include some less difficult rapid sections, which are potential navigational hazards (Embick, 1994). Spawning salmon were observed at some lower tributaries. Multiple adult salmon were observed at Wolverine Creek, Moose Creek, Granite Creek and Kings River, ranging from river mile 18 to 30.

LATE WINTER CONDITIONS

In March 2006, 17 sites were visited and measured by RSE (refer to Table 2.2) (2006). Based upon general trends of discharge measured at the USGS gaging station near Palmer, low flow conditions are expected in late February and early March. Conditions for the March 2006 survey work were favorable for both travel and flow conditions. Survey work was conducted from March 9 – 16th, during which days were clear with mid-day temperatures at 15-25 ^{o}F. The average minimum temperatures reported at Palmer AAES station for January, February and March are 7.5 ^{o}F, 9.2 ^{o}F, and 17 ^{o}F respectively.

The highest discharge measured at a tributary was at Gravel Creek, 178 cfs. The lowest discharge was measured at the South Fork Matanuska River, 11 cfs, which is a glacially dominated stream. The median discharge of tributaries measured is 25 cfs, while the mean is 89 cfs. Discharge measured at the Matanuska River mid-level site, at river mile 41, was 501 cfs. Discharge measurements were not collected at three sites because no flow was observed in auger holes at the deepest point of the channel, which were Hicks Creek, Glacier Creek, and Caribou Creek. Discharge values are calculated with minimal velocity measurements due to general safety, river ice stability, the access to water, and the reconnaissance nature of this survey. Also, discharge values are calculated from either cross-sectional profiles measured during the late summer survey or a combination of measurements from late summer and winter surveys. Significant icing was observed at many of the survey sites, where ice level exceeded the bankfull channel. An excess of 4.5 ft of ice was drilled through at the Chickaloon River. River ice at the Matanuska River mid-level site was approximately 4 ft thick.

2.1.4 Biology

VEGETATION

The major vegetation type in the Matanuska Valley is boreal, or taiga, forest (Viereck et al., 1992). Boreal forests occupy the valleys of "interior" south-central Alaska. These forest are dominated by coniferous forests of black and white spruce (*Picea mariana* and *P. glauca.,* respectively), with extensive inclusions of deciduous paper birch (*Betula papyrifera*), aspen (*Populus tremuloides*), and balsam popular (*P. balsamifera*). The understory and floodplain are dominated by alders (*Alnus tenufolia*) and willows (*Salix glauca, S. alaxensis*). Extensive mosaics of subarctic lowland sedge (*Carex* spp.), sedge-moss meadows, and bogs dominated by willows (*Salix* spp.), sweetgale (*Myrica gale*), or graminoids are common within the boreal forest vegetation type (MWH, 2003).

The boreal forest exists as a nearly continuous belt of coniferous trees across North America and Eurasia. Overlying formerly glaciated areas and areas of patchy permafrost on both continents, the forest is mosaic of successional and subclimax plant communities sensitive to varying environmental conditions. These forests now occupy valleys that were filled with glacier ice or glacial lakes during the last major glaciation. Boreal forests spread from interior Alaska (north of the Alaska Range) into south-central Alaska following the retreat of glaciers.

WETLANDS

The general distribution and area of wetlands along the Matanuska River was mapped for the National Wetlands Inventory, and described in a U.S. Fish and Wildlife Service (USFWS) study of Alaska wetland status. The most common wetland delineation in the Project Area is Riverine, followed by smaller areas of Freshwater Forested/Shrub Wetland and Freshwater Emergent Wetland (Cowadrin et. al., 1979).

The *Riverine* classification is given to wetland and deepwater habitats contained within a channel with periodically or continuously moving water. The Riverine System includes all wetlands and deepwater habitats contained within a channel, with two exceptions: 1) wetlands dominated by trees, shrubs, persistent emergents, emergent mosses, or lichens, and 2) habitats with water containing ocean-derived salts in excess of 0.5 parts per thousand. A channel is "an open conduit either naturally or artificially created which periodically or continuously contains moving water, or which forms a connecting link between two bodies of standing water" (Langbein and Iseri, 1960).

The Riverine System is bounded on the landward side by upland, the channel bank (including natural and man-made levees), or wetland dominated by trees, shrubs, persistent emergents, emergent mosses, or lichens. In braided streams, the system is bounded by the banks, which form the outer limits of the depression where the braiding occurs.

The *Freshwater Forested/Shrub Wetland* is dominated by forests and shrubs – as its name implies. If vegetation (except pioneer species) covers 30 percent or more of the substrate, the Class is distinguished on the basis of the life form of the plants that constitute the uppermost layer of vegetation and that possess an areal coverage 30 percent or greater. For example, an area with 50 percent areal coverage of trees over a shrub layer with a 60 percent areal coverage would be classified as Forested Wetland (Cowardin et. al., 1979). An area with the same coverage of trees and shrubs, but with the trees less than 20 feet (6 meters) tall, would be classified as Scrub-Shrub Wetland. Forested Wetlands are most common where moisture is relatively abundant, particularly along rivers and in the mountains. They occur only in the Palustrine and Estuarine Systems and normally possess an overstory of trees, an understory of young trees or shrubs, and a herbaceous layer. The Scrub-Shrub Wetland includes areas dominated by true shrubs, young trees, and trees or shrubs that are small or stunted because of environmental conditions. Scrub-Shrub Wetlands may represent a successional stage leading to Forested Wetland, or they may be relatively stable communities (Cowardin, et. al., 1979).

The *Freshwater Emergent Wetland* classification is less common in the Study Area and is characterized by erect, rooted, herbaceous hydrophytes (excluding mosses and lichens). This vegetation is present for most of the growing season in most years and is usually dominated by perennial plants. In areas with relatively stable climatic conditions, Emergent Wetlands maintain the same appearance year after year. In other areas, such as the prairies of the central United States, violent climatic fluctuations cause them to revert to an open water phase in some years (Stewart and Kantrud, 1972).

FISH AND AMPHIBIANS

The Matanuska River watershed supports both anadromous and resident fish populations. The 11 species of fish within the Matanuska Valley watershed are: chinook, coho, and chum salmon, Dolly Varden char, rainbow trout, Arctic grayling, round whitefish, burbot, three-spine stickleback, nine-spine stickleback, and the longnose sucker. Spawning has been documented in both tributaries and the main stem of the Matanuska River (ADNR, 1998). Fish counts for the 1980s show increasing numbers of spawning chinook salmon in two tributaries of the Matanuska River. Data from 1989 indicates that the density of salmonids is, however, very low in several tributaries, as compared to other streams in Alaska. The distribution and numbers of these species within the Study Area is unknown.

For both anadromous and resident fish, an important habitat parameter is maintenance of stream flow for spawning and incubation success. Fish habitat types associated with the Matanuska River are the main-stem, slough, side channel, tributary mouth, and tributary. The changing morphology of side channels affects the number of salmon that spawn at the tributary mouth. Increased numbers of salmon are present when the channel shifts allow for additional access to the tributaries, providing adequate spawning habitat (ADNR, 1998).

BIRDS, MAMMALS, AND OTHER WILDLIFE

The majority of information available on the wildlife along the Matanuska River pertains to the Moose Range that was established in 1984. This area, however, is located in the watershed upriver from the Study Area, to the north of the Matanuska River itself.

Moose are generally found throughout the watershed, including the Study Area. The watershed supports numerous other mammals including brown bear, black bear, caribou, Dall sheep, and mountain goat. Furbearing species within the watershed include: wolf, coyote, red fox, lynx, wolverine, mink, marten, weasel, red squirrel, Arctic ground squirrel, snowshoe hare, hoary marmot, pica, porcupine, beaver, muskrat, and others (ADNR, 1998). The distribution and numbers of these species within the Study Area is unknown.

Raptors likely to occur in the watershed include: bald eagle, golden eagle, northern harrier, sharp-skinned hawk, northern goshawk, merlin, rough-legged hawk, Swainson's hawk, red-tailed hawk, American kestrel, peregrine falcon, gyrfalcon, boreal owl, saw-whet owl, great gray owl, great horned owl, short-eared owl, snowy owl, and hawk owl. The northern goshawk was the only raptor observed in summer and winter. Many of these species may use the watershed as a migration corridor to Interior Alaska in early spring. The "open mixed forest" habitat type had the highest concentration of bird species, with a total of 24 species. Many of these species are summer residents. Birds that may be present in winter include the raven, black-billed magpie, northern shrikes, and ptarmigan (ADNR, 1998).

Tidal and adjacent wetlands around the mouth of the Matanuska River are regionally important for waterfowl as staging and nesting habitat. The areas along the lower river are valuable moose wintering and calving habitat. Upriver and tributary areas of the Matanuska River provide important riverine habitat and migratory paths for many birds and mammals (USACE, 1999).

THREATENED AND ENDANGERED SPECIES

Before a plant or animal species can receive protection under the Endangered Species Act, it must first be placed on the Federal list of endangered and threatened wildlife and plants. The USFWS listing program follows a strict legal process to determine whether to list a species, depending on the degree of threat it faces. An "endangered" species is one that is in danger of extinction throughout all or a significant portion of its range. A "threatened" species is one that is likely to become endangered in the foreseeable future. The USFWS also maintains a list of plant and animals native to the United States that are candidates or proposed for possible addition to the Federal list. All of the USFWS's actions, from proposals to listings to removals ("delisting"), are announced through the Federal Register (USFWS, 2004a).

A total of 10 animals and 1 plant are listed as either threatened or endangered in the State of Alaska. Of these, none are found within the Mat-Su Borough or Cook Inlet. A single candidate for listing has been identified in the Cook Inlet waters – the Cook Inlet beluga whale (*Delphinapterus leucas).* No threatened or endangered species are known to be present within the Study Area (USFWS, 2004b).

MACROINVERTEBRATES

Macroinvertebrate samples were collected at 19 sites during late summer 2005 by RSE

(RSE, 2006). Samples were collected following the Benthic Macroinvertebrate Collection Procedures using a D-frame Dip Net (ENRI, 1999). Field observations, as described in the collection procedures were recorded. In summary, out of 19 tributaries sampled, 11 had no aquatic vegetation, seven had algae present, and one (Caribou Creek) has aquatic grasses. (RES, 2006). Information included sample identification, field observations, and habitat types from which samples were collected (ongoing).

2.2 Human Environment

2.2.1 Land Use and Demographics

Most of the population within the Matanuska River basin is located along the lower reach of the Matanuska River, near Palmer. Other major communities in the Matanuska River Valley, include: Lazy Mountain, Sutton, Chickaloon, and Glacier View. Lazy Mountain (2004 estimated population 1,238) is located along the eastern to southeastern side of the Matanuska River and is considered a large developed area outside of Palmer. The community of Sutton (2004 estimated population 1,265) is situated upriver of Lazy Mountain on the north side of the Matanuska River along the Glenn Highway. Although both Ahtna and Dena'ina Athabascans have occupied the area for centuries, Sutton was founded around 1918 for coal export on the Matanuska Branch of the Alaska Railroad. The rail extended through Sutton to the Chickaloon Mine. Similarly the community of Chickaloon (2004 population estimate 292), situated upriver and northeast of Sutton, was primarily a trade center. The Chickaloon Village Traditional Council is headquartered in Sutton serving the members of the Chickaloon Tribe.

In the 1930s, lands northwest of the mouth of the Matanuska River were opened to agricultural development. The farming area is located in a roughly rectangular area 10 to 12 miles wide and extending from the Chugach Mountains west some 15 to 20 miles. Only a portion of this farmed area is within the Matanuska River watershed. The City of Palmer is the largest urban area in the drainage area and is located to the west of the river within the study area. Agriculture and mining are not expanding in the basin; some agriculture land is being converted to urban use and old mines are being reclaimed. Rapid urban growth continues, as evidenced by the 4.5 percent annual population growth in the City of Palmer over the last 10 years. However, much of the watershed remains undeveloped.

From 1915 to 1922 the US Navy sponsored a coal mining boom in the Chickaloon River drainage (CCED, 2006). The coal mining boom in both Sutton and Chickaloon was short-lived. Since, land has been subdivided and predominantly supports residential and recreational uses. Further upriver, overlooking the Matanuska Glacier, is the community of Glacier View (2004 estimated population 264). The Glacier View-Tahneta Pass historically provided a travel route for miners and prospectors. During World War II, construction camps were developed in areas such as Hicks Creek and Sheep Mountain for construction of the Glenn Highway to Glennallen (CCED, 2006). The south side of the

Matanuska River in the Chugach Mountains, upriver of Lazy Mountain, is largely undisturbed with the exception of some small residences and recreational use, due to the lack of road access. In addition to the communities supported in the Matanuska River basin, the valley is home to multiple recreational users. The Matanuska Valley supports river travel in both summer by boat, and winter by ski, snowmachine, foot and dogsled. Other recreational activities include hiking, hunting, fishing, all-terrain vehicle travel, skiing, climbing, camping, horseback riding, flying and others. The Glenn Highway, the major road connecting Alaska to Canada and a National Scenic Byway, runs along the river through the middle of the watershed connecting the communities of Palmer, Sutton, Chickalon and Glacier View.

2.3 Tributaries

The Matanuska Glacier in the Chugach Mountains contributes glacial meltwater and a heavy sediment load to the river during the summer months. The largest tributaries flow south form the Talkeetna Mountains. The Chickaloon River is the largest tirubtary. The middle and lower reaches of Moose Creek, Eska Creek, Granite Creek, Boulder Creek, Kings River and Chickaloon River lie within the Matanuska Valley Moose Range (Figure 2.1).

The Matanuska River generally flows westward from its origins in the Talkeetna Mountains and northwestern portion of the Chugach Mountains to Knik Arm, as a tributary to Cook Inlet. The East Fork of the Matanuska River is a major upper-valley tributary with sources in the Talkeetna Mountains. The South Fork of the Matanuska River, a major upper-valley tributary which flows from the Chugach Mountains, is glacially-fed. At the confluence of the East and South Forks, the river is locally referred to as the South Fork of the Matanuska River. The South Fork of the Matanuska confluences with meltwater from the Matanuska Glacier between river mile 65 and 70, at which point it is referred to as the Matanuska River.

Very little information has been collected on the tributaries of the Matanuska River. Only recently, is hydrologic information being collected on the tributaries (RES, 2006). Many of the tributaries are inaccessible other than by raft or other non-motorized river craft. In the winter, after freeze-up, many of the tributaries on the south side of the Matanuska River offer recreational opportunities such as snowmachining.

2.4 Water Resources

2.4.1 Water Quality

Water quality parameters were measured using water quality instruments, with the exception of alkalinity (RSE, 2006). Temperature, pH, and conductivity were measured using a YSI Model 63 water quality meter. Dissolved Oxygen was measured using a YSI Model 556. Alkalinity samples were collected and submitted for analysis at a laboratory in Anchorage, Alaska.

LATE SUMMER 2005

Water quality parameters from late summer were collected for the main tributaries of the Matanuska River (RES, 2006). Water temperatures ranged from 4.5 ^{o}C to 11.4 ^{o}C. Conductivity measurements ranged from 65.9 µS/cm at Moose Creek to 426 µS/cm at Hicks Creek. The pH values ranged from 7.02 pH units at the Matanuska River mid-level site to 8.38 pH units at Hicks Creek. Similarly, the alkalinity concentration at Hicks Creek was the highest, at 111 mg/L; and the lowest was at Wolverine Creek, 29.3 mg/L. The average dissolved oxygen measurement 97.2% and ranged from 92.8% to 107.0%.

LATE WINTER MARCH 2006

Water quality parameters were measured at 17 sites (RES, 2006). Ninemile Creek and the upper-level Matanuska site near Glacier Park were not visited. Water temperatures measured were all at or near 0 ^{o}C. The pH values measured had a slightly smaller range than the summer data, from 7.7 pH units at South Fork Matanuska River to 8.4 pH units at Monument Creek. The lowest conductivity measurement was measured at Wolverine Creek (1.0 µS/cm), and the highest at Gravel Creek (270.0 µS/cm). The highest alkalinity concentration was also at Gravel Creek, 134 mg/L and, likewise, the lowest at Wolverine Creek was 40.4 mg/l. Dissolved oxygen measurements were generally in excess of 100%, indicating dissolved oxygen concentrations are at or near saturation.

2.4.2 Water Quantity

USGS Stream Gage #15284000 is located on the Matanuska River at the Old Glenn Highway Bridge in Palmer. Daily mean average flows are available from the gauge for water years 1950 through 1972, 1986, 1992, and 2002, with partial records for 1973 and 2000. Figure 2-4 shows the daily discharge from 28 years of records, compared to daily discharge record from 2004. Discharge typically varies seasonally from approximately 500 to 15,000 cfs during higher flows. A peak flow of 82,100 cfs occurred in 1971, but this reading was affected by the failure of a lake embankment on Granite Creek, a tributary of the Matanuska River (ADNR, 1998). The historic peak discharge, for the USGS record through 2001, actually occurred in 1995, with a discharge of approximately 46,000 cfs. A higher historical peak discharge may have taken place during the July 2004; however, this data is provisional and not included in Figure 2-4.

The quantity of water in the Matanuska River is highly dependent on both precipitation and the melt rate of the upland glaciers. Streamflow shows a strong seasonal variation, with 70 percent of the annual flow occurring from June through August (MWH, 2004d). Mean monthly flows are lowest during March and April, with discharges of approximately 450 to 500 cfs in a typical year. This coincides with the lowest levels of precipitation during the year. During this period, the Matanuska River is closest to its annual baseflow. Groundwater discharge becomes the dominant water supply to the river during this period (ADNR, 1998).

Groundwater flow in the Palmer area trends from the south to the southwest (Jokela et al., 1990; TERRASAT, 1998). Aerial photography interpretation and well log data also indicate that the reach immediately downstream from the Old Glenn Highway Bridge is a losing reach, with water leaving the river along that reach and contributing to the ground water recharge. Along the lower portion of the Study Area, groundwater from the surrounding area adds to the river discharge.

3.0 RESOURCE CONCERNS

Characteristic of any braided channel morphology is the constant erosion and deposition of alluvial material. The evidence of that continual cycle of movement and redeposition is evident throughout the Matanuska Valley. The classic wide braded channels, with many interfingering channels washing around unvegetated bars, and the continual motion of these bars are all indicators of the constant movement of materials by the river. The presence of larger vegetation on some bars and banks combined with the relatively short history of human development and memory in the area has pacified people into the belief that the river is stable in its current morphology. The Matanuska River is a large dynamic system that within recent geologic time has moved all over the floodplain, only ultimately controlled by structural limits imposed by bedrock outcroppings. The inherent instability of the Matanuska River system makes any prediction of its expected behavior nearly impossible.

During the last decade the main channel of the Matanuska River has concentrated energy on the south banks of the alluvial valley in the lower reach. Also, the river now flows in newly created channels to join the Knik River upstream of bedrock buttes near the present Glenn Highway bridges in the vicinity of Palmer. These changes in the channel pattern are larger than most changes observed in the last 60 years.

However, in the upper reach, north of Sutton and south of King River, the main channel has shifted to the north banks paralleling the Glenn Highway. This shift is very noticeable just down stream of the remaining spur dikes that were constructed by the AKDOT. Several homes, including a home built in the last 5 years, have witnessed a loss of property ranging from 10 feet to 50 feet during one event in the summer of 2005.

3.1 Land Use

The most important concern within the Matanuska River Watershed is the loss of private residential buildings, business and potential human harm from riverbank erosion adjacent to the Matanuska River. There are two areas of primary concern and are at risk to immediate loss of property and life. The Sutton Area (Figure 3.1) is on the north bank commencing at the confluence of Kings River in Sec. 16, T.19 N.,R. 04 E., Seward Meridian (SM) and extends westward to the westernmost boundary of Harickmans Riverview Estates subdivision in Sec. 26, T. 19 N., R. 03 E., SM. The Circle View Area (Figure 3.2) is located on the south bank commencing at the Triple Crown Subdivision in S. 14 T. 17 N., R. 20 E., Seward Meridian and extends westward to the western most boundary of the Circle View Subdivision in Sec. 21, T. 17 N., R 20 E.,SM.

In addition to residential structures, the Palmer wastewater treatment plant, located in the lower reach near Palmer, has not been threatened within the last few years with the main channel eroding the southern banks. However, during those periods when the main channel erodes northern banks of the river valley the treatment plant has been threatened. At least four small finger dikes were constructed to prevent erosion and with limited maintenance, the dikes have successfully protected the lands of the wastewater treatment plant from serious erosion.

There is also an increase in residential development on both the northern and southern banks of the Matanuska River. As property becomes developed in Palmer proper, there will be an increase need to develop in the Sutton and Chickaloon area. Without any current land restrictions along the Matanuska River, erosion on future development will continue with risks to both life and property.

3.2 Habitat Conditions

Continued development within the Matanuska River corridor can increase the possibility on water contamination, potential impairment of anadromous fish migration, river terrace and riparian corridor alteration/ destruction, and habitat fragmentation. Anadromous fish populations will remain potentially negatively impacted by built-environment structural debris. Water quality will remain threatened by active fuel storage tanks, septic system collapse, and the potential for hazardous contamination from unknown household substances. Environmentally, buildings, septic systems, fuel storage tanks, and a wide variety of commercial and household toxins will be added to Matanuska River water, imperiling fisheries and wildlife populations as well as downstream water users.

4.0 COMPARISON OF ALTERNATIVES

In response to community concerns of bank erosion along the Matanuska River several alternatives have been discussed to control the Matanuska River (Table 4.0) (MWH,2004). Each action alternative was considered to have a reasonable likelihood to control the bank erosion to threatened areas along the riverbank. Numerous other alternatives were eliminated from further consideration based on construction feasibility, effectiveness to this size and type of river, and/or other factors. Alternatives that were considered include:

- Alternative 1 – Gravel Removal
- Alternative 2 – Bank Protection
- Alternative 3 – Non-Structural Approach
- Alternative 4 – Combined Actions
- Alternative 5 – No Action

GRAVEL REMOVAL.

This method has been considered for the Circle View area (Figure 3.2) previously, but without an in-depth examination of the changes that may occur downstream, the size of excavation needed to affect the channel morphology, relative costs, and environmental consequences. The Matanuska River Erosion Assessment report (MWH, 2004) studied this alternative using computer modeling to estimate the effect of the channel excavations on flow pattern, hydraulic characteristics and sediment transport in the this Area under various discharge rates. Results indicate that excavation trenches can be successful in reducing the velocity of the flow along the riverbanks, if careful consideration is given to the location and design of the excavation. Since braided channels, such as the Matanuska River, are subject to rapid shifting in response to sediment erosion and deposition, the trenches would need annual maintenance and adaptive management to remain stable and effective. The gravel removal excavations can reduce bank erosion, but will not eliminate the need for bank erosion protection of key facilities, properties, and locations of direct flow impingement on the bank. Challenges include constraints imposed by fish migration, spawning, and rearing; cold weather operations during low-flow periods; and controlling flows to optimize access and excavation techniques.

BANK PROTECTION.

Spur dikes and riprap methods have both been used previously to provide bank protection along the Matanuska River. These methods have proved to be effective in providing erosion protection along the portion of riverbank where they have been applied. The existing spur dikes were installed near the Circle View Estates subdivision in 1991 and have withstood flows up to approximately 40,000 cfs. As has been the experience with the existing spur dikes, construction logistics and maintenance are challenges in the dynamic river environment. Furthermore, these methods are limited to the specific location where they are applied. Similar to those posed by gravel removal, flows affecting banks upstream or downstream of the bank protection would remain susceptible to bank erosion, and the effectiveness of the protection may be eliminated if the channel shifts away from the protected section of bank.

NON-STRUCTURAL APPROACH.

This method involves using land use controls to remove or minimize the human occupation along threatened portions of the riverbank. Public purchase of private property and regulatory mechanisms, including zoning restrictions, are potential approaches. While this alternative does not provide any protection of the bank to erosional forces, it removes the direct effect on the inhabitants in the area. Challenges include resistance from the community and the ability to enforce zoning restrictions.

COMBINED ACTIONS.

This method involves a combination of gravel removal, bank stabilization, and land buyout or set asides of selected areas. This alternative addresses the likelihood that each of the other alternatives is only feasible in specific locations. For example, due to the dynamic characteristics of the Matanuska River, the gravel removal option is not likely to provide bank protection in all areas of the river. If excavation were to be implemented, it should only take place in reaches prone to high velocities and shear stresses that undermine the bank and cause erosion, such as the lower portion of the area 2 (figure 3.2). Spur dikes and riprap would be placed where the bank erosion risk is greatest. The non-structural policies would be applied to those areas that are currently undeveloped.

NO ACTION

This method does not provide any protection to the community or the riverbanks. The alternative was evaluated on the basis of land value loss due to annual erosion.

Fish and aquatic wildlife resources are a principal concern in comparison of alternatives. However, baseline data on the fish resources of the Matanuska River are sparse. Sport, commercial, and subsistence fisheries on the Matanuska River are limited compared to other Southcentral Alaska streams. Permit constraints are likely to include limiting operations in the floodplain to periods of low flow and minimal fish migration. This constraint adds another level of difficulty to gravel extraction operations, as well as some constraints to construction of bank stabilization structures.

Both the Non-Structural and No Action Alternatives have potential political ramifications. The Non-Structural Alternative is likely to be difficult to implement in those areas with current development, due to resistance from the community to be bought out or relocated. The No Action Alternative does not result in protection to the community or the riverbanks. This alternative, while simple and relatively easy to implement on a technical standpoint, would not address the public concern that resulted in this study.

3.2 Costs of Alternatives

In comparing the cost of each alternative, assumptions were established to provide some basis of comparison. For gravel removal and construction of bank stabilization structures, cost estimates included assumptions on the type of equipment, hours of use, size and type of material, and value of the gravel. The Non-Structural and No Action alternatives make assumptions on the value of developed and undeveloped land, and the amount of land that would be lost per year. The costs for implementing the Gravel Removal, Bank Stabilization, or the Combined Action Alternatives are relatively high (Table 4-0). This relates directly to the construction required to implement each alternative. The Non-Structural Approach Alternative has a relatively low cost, both initially and over the long-term (50 years). The Non-Structural approach, however, may have high political ramifications, as may the No Action Alternative, which has the lowest

Relative equivalent annual costs of the five erosion control alternatives are illustrated on Figure 4. The figure illustrates that the cost of any action alternative exceeds the estimated costs associated with allowing the continued loss of property due to erosion. Buyout of property has the lowest cost of any of the action alternatives, with higher costs associated with gravel removal and structural improvements. In comparing the alternatives, the feasibility and costs must be addressed. The feasibility of each alternative is tied directly to the technical difficulty in implementing the alternative, the potential environmental consequences and associated permitting constraints, and the political ramifications. A summary of the feasibility of each alternative is presented in Table 4-1. The alternative with the highest technical complexity is gravel extraction. Numerous operational issues are related to a large gravel removal operation in an active floodplain. To be effective, nearly 1.8 million cubic yards of material would have to be removed during initial construction. Additionally, annual excavation on the order of 500,000 tons of material would be needed to maintain the trenches once constructed.

5.0 RECOMMENDATIONS

Trenching in the river or building a series of dikes are current approaches under consideration for addressing the effects of river erosion. These engineering alternatives focus on altering the forces of the river-a physical constraint- rather than guiding or preventing various land uses in the vicinity of the erosion-prone area. There will continue to be a need to provide structural alternatives for current structures that can not or do not qualify for non-structural alternatives. An example is the Palmer Waste Treatment facility located on the northern side of the Matanuska River. If the main channel migrates back to the north bank, the Palmer Waste Treatment facility could be at risk. A structural solution, such as bank armor, may be the only feasible alternative. A cost benefit analysis is required especially when plans for development of new structures in erosion prone areas are proposed.

Numerous bank stabilization methods have been used with varying successes. Gravel extraction has been proposed by many landowners as a solution to control the Matanuska River, prevent erosion along the stream banks and provide a funding source for other erosion control methods. The legal ramifications, long term impacts on salmon, and long-term financial commitments are all important considerations. Extraction of alluvial material from within or near a stream bed has a direct impact on the stream's physical habitat parameters such as channel geometry, bed elevation, substrate composition and stability, instream roughness elements (large woody debris, boulders, etc.), depth, velocity, turbidity, sediment transport, stream discharge, and temperature (Rundquist, 1980; Kondolf 1994a,b-198; OWRRI 1995).

OWRRI (1995) states that:

> "Channel hydraulics, sediment transport and morphology are directly affected by human activities such as gravel mining and bank erosion control. The immediate and direct effects are to reshape the boundary, either by removing or adding Materials. The subsequent effects are to alter the flow hydraulics when water Levels rise and inundate the altered features. This can lead to shifts in flow Patterns and patterns of sediment transport. Local effects also lead to upstream and downstream effects."

Impacts to anadromous fish populations due to gravel extraction can include reduced fish populations in the disturbed area, replacement of one species by another, replacement of one age group by another, or a shift in the species and age distributions (Moulton, 1980). Changes in physical habitat characteristics of aquatic systems can alter competitive interactions within and among species; similarly, changes in temperature or flow regimes. There is documentation and studies from the potential effects of gravel extraction activities on stream morphology, riparian habitat, and anadromous fishes and their habitats according to the National Marine Fisheries Service National Gravel Extraction Guidance document (NMFS, 2005). Gravel extraction is not recommended for erosion control in the Matanuska River as long as all reasonable efforts have been made to identify gravel sources in upland areas before any instream application of gravel extraction.

Non-structural approaches do not require construction or physical alteration of the riverbank. These could include zoning, land use changes, riparian setbacks, easements, public education, or even relocation of human structures and residents.

Land use measures that guide growth and development represent a potentially cost effective means of addressing the impact of river erosion. A combined effort in both non-structural and structural could be the foundation to address the effects of erosion (NEI, 2004b). Non-structural methods may well be a more cost effective method than repeated and recurring efforts to control flooding and erosion by building and maintaining dikes, dredging or trenching.

One recommendation is for the Mat-Su Borough to prepare an updated Flood Mitigation Plan. Such a plan would enable the Borough or other entities to qualify for Flood Mitigation Assistance grants. Eligible activities include elevation of structures, relocation of flood-threatened (erosion-prone) insurable structures, and acquisition. Monies are available through a state administered, cost-share program for grants that can cover planning for flood mitigation, technical assistance, and mitigation projects.
In addition, the following is recommended:

. • Real estate disclosure is critical in apprising current homeowners and potential homebuyers about flood hazard risk. Disclosure of erosion hazard risk should be required in the real estate transactions.
. • Provide local realtors and lending institutions with Global Information System (GIS) copies of the Flood Insurance Rate Maps.
. • Utilize GIS and other technologies (e.g. modeling) to analyze erosion risk and develop a erosion and flood-prone map for the Matanuska River.
. • The Mat-Su Borough should consider seeking public input on utilizing property acquisition as a technique for willing sellers to sell flood-prone property.
. • Identify appropriate properties for protection because of flood risks. Depending on public input, the Mat-Su Borough should pursue acquisition, conservation easements, or flood hazard protection regulations.

Some techniques for implementing such non-structural methods are listed below.

<u>Zoning And Land Use Change</u>

Zoning along the Matanuska River is described as a “least restrictive” area. This means that there are minimal restrictions on the type of development near the river. In addition to this zoning regulation, land use must comply with the federal Coastal Management Plan requirements near the river. The Mat-Su Borough planning department has proposed more extensive zoning requirements for the Matanuska River area, but these ideas have not been adopted. An erosion management option involves altering the existing zoning of the area to encourage development that is at lower risk of continual erosion. For example, the City of Palmer or the Mat-Su Borough could use zoning to limit the development of new residences in areas with a high potential for erosion. Zoning and land use issues are politically difficult to resolve and private landowners may be adverse to changes that alter property use or value.

Riparian Setbacks

Setbacks from the river may be another method of ensuring, at least temporarily, that structures are not at risk from erosion of the riverbank. The Mat-Su Borough has setback requirements for the Matanuska River of 75 feet from the high water mark to any structure or footing, although exemptions can be made to come within these limits. However, this setback requirement may not provide an adequate buffer, since 100 linear feet of previously usable land near Circle View Estates eroded in 2004 due to high summer flows.

Public Education

Public education is important in order to relay information to Borough and City officials, potential property owners, developers, and other interested parties who have property interests along the Matanuska River. Real estate transactions particularly should be accompanied by information on erosion risk for affected properties. This information could help influence and alter property use practices in the area voluntarily. Numerous sources such as television, radio, newspapers, real estate professionals, bulletins, flyers, and radio could disseminate information. This would require a long-term effort, avoiding complacency during periods of little active erosion.

Relocation and/or Acquisition

Public acquisition of conservation easements or whole properties would clearly eliminate the risks to private individuals associated with development of areas at risk. This would likely only occur through voluntary or compensatory methods. Compensation could be an expensive option and may not be acceptable to local landowners.

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Residential development north of Sutton, Alaska along the Matanuska River. Main channel has migrated to the northern banks. Properties along this reach of the river have lost anywhere from 10 to 50 feet of property in one event.

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