MATANUSKA-SUSITNA BOROUGH INFORMATION MEMORANDUM IM No. 24-135

SUBJECT: INFORMING THE ASSEMBLY OF THE COMPLETED PLANNING ASSISTANCE FOR STATES (PAS) TECHNICAL REPORT FOR TALKEETNA EROSION ASSESSMENT DECEMBER 2023 BY THE USACE

AGENDA OF: August 6, 2024

ASSEMBLY ACTION:

Presented to the Assembly 08/20/24 - EMW

AGENDA ACTION REQUESTED: For information only.

Route To	Signatures
Originator	7/8/2024 X Taunnie Boothby Signed by: Taunnie Boothby
Department Director	Recoverable Signature X Alex Strawn Signed by: Alex
Finance Director	7/9/2024 X Cheyenne Heindel Signed by: Cheyenne Heindel
Borough Attorney	7/9/2024 X Nicholas Spiropoulos Signed by: Nicholas Spiropoulos
Borough Manager	8/2/2024 X Michael Brown Signed by: Mike Brown
Borough Clerk	Recoverable Signature X Lonnie McKechnie Signed by: Lonnie McKechnie

ATTACHMENT(S): Talkeetna erosion assessment December 2023 by the USACE (62 pages)

SUMMARY STATEMENT: The MSB Assembly approved RS 22-027 and accompanying IM 22-053 to enter an agreement for the US Army Corps of Engineers (USACE) to perform an erosion assessment for Talkeetna under the Planning Assistance for States (PAS) 50/50 cost share authority. The report is complete and came in under budget with a refund of $133,980.96 and the report is supporting the USACE request for a section 14 authority to assist with addressing Talkeetna's erosion issues.

Planning Assistance to States
Technical Report

Talkeetna Erosion Assessment Technical Assistance

Talkeetna, Alaska

December 2023

IM 24-135

Planning Assistance to States Technical Report

Erosion Assessment Technical Assistance
Talkeetna, Alaska

Prepared By:

U.S. Army Corps of Engineers
Alaska District

December 2023

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1.0 INTRODUCTION

1.1 Study Authority

The Planning Assistance to States (PAS) program authorizes the U.S. Army Corps of Engineers (USACE) to provide Technical Assistance concerning water resources management to an eligible non-Federal interest. Technical Assistance studies through the PAS program are cost shared on a 50% Federal and 50% non-Federal basis. The PAS program is authorized under Section 22 of the Water Resources Development Act (WRDA) of 1974, as amended (42 U.S.C. §1962d—16).

1.2 Study Background

In a letter dated 15 March 2022, the Matanuska-Susitna Borough, the current non-Federal sponsor, requested a technical assistance study through the PAS program under Section 22 of the WRDA. As a result of this request, a PAS agreement between the Department of the Army and the Matanuska-Susitna Borough for technical assistance was prepared and then executed on 05 October 2022.

1.3 Study Purpose & Objectives

The purpose of this PAS is to estimate erosion rates in Talkeetna, Alaska along the east bank of the Susitna River, below the confluence of the Chulitna River. The study area encompasses the mouth of Billion Slough, downstream to the point where the Alaska Railroad right-of way near the mouth of the Talkeetna River has been partially eroded by the Susitna River. The purpose of these erosion rate estimates is to inform planning decisions by the Matanuska-Susitna Borough, local community members, and private landowners regarding development of erosion reduction structures within Talkeetna. In recent years many riverfront properties along the Susitna River have experienced significant and rapid erosion events. Erosion is expected to continue, threatening existing infrastructure and the longevity of any new development. This PAS study will directly support the State of Alaska's Hazard Mitigation Plan (AHMP) by addressing mitigation and response to riverine erosion and will assist with resiliency planning and long-term sustainability of the Talkeetna community.

The objectives of this PAS study is to provide technical assistance to evaluate the following:

- Evaluate the east bank of the Susitna River, using available aerial photograph and satellite imagery data sets from the years 1953 to 2020, so variations in the historic erosion rates can be identified.
- Once historic erosion rates are identified, visit sites of concern to evaluate the surficial geology to see if there are any issues with the proposed protective measures.
- Develop a technical report with the findings and descriptions/maps of areas where protective measures may be required.

1.4 Study Location

Talkeetna is located in southcentral Alaska in the foothills of the Alaska Range, at the confluence of the Chulitna, Susitna, and Talkeetna Rivers (Figure 1). The core downtown area, the Talkeetna Historic District, is on the register of National Historic Places with buildings dating from the early 1900s. Talkeetna is on the road system and is the base location for mountaineering expeditions on Denali, making it a popular destination for recreational opportunities and tourism. This unincorporated, non-Native community lies 115 miles north of Anchorage and falls under the jurisdiction of the Matanuska-Susitna Borough.

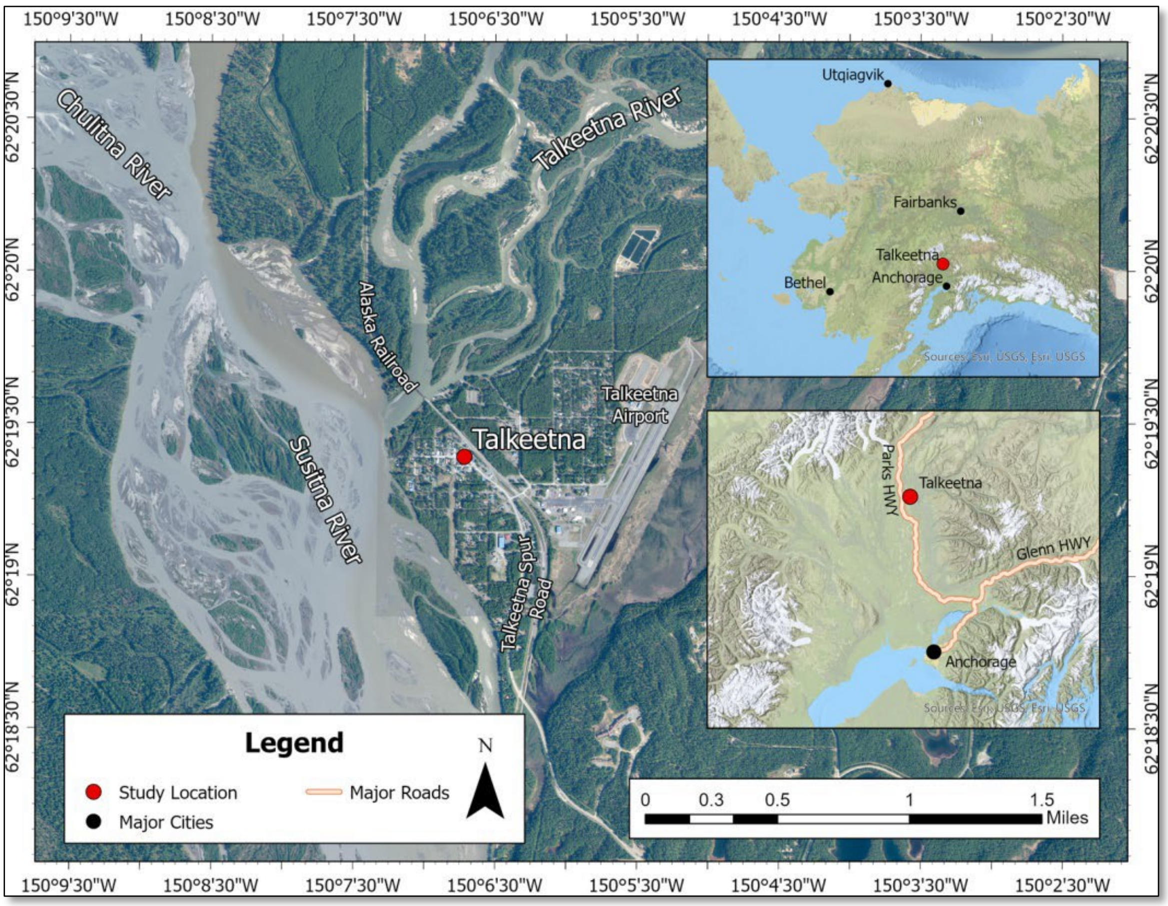

Figure 1. Vicinity Map of Talkeetna, Alaska

USACE placed a timber fascine erosion control structure along the Talkeetna River in 1951 in an emergency effort to mitigate bank erosion at the town of Talkeetna. A dike, dike extension, and a rock revetment were constructed along the Talkeetna River to protect the town from bank erosion in 1979 under the authority of the Flood Control Act of 1958 (P.L. 85-500). These structures are subject to periodic inspections by USACE. Maintenance was done on the dike extension by the Matanuska-Susitna Borough in 2017 and 2020 due to loss of armor stone. Emergency repairs were needed on the revetment during the fall of 2023 and were also completed by the Matanuska-Susitna Borough.

1.5 Non-federal Sponsor

The non-Federal sponsor for this PAS study is the Matanuska-Susitna Borough.

1.6 Scope of Work

This PAS study includes an analysis of riverbank site conditions along a section of the east bank of the Susitna River where significant erosion has been observed. The erosion analysis started from Billion Slough (a slough connecting the braided river system of the Talkeetna River to Susitna River, located north of the confluence of the Susitna River and Talkeetna River) downstream to the point where the Alaska Railroad right-of-way has been partially eroded by the Susitna River (Figure 2). USACE evaluated the extent of this riverine erosion using aerial and satellite imagery. USACE visited Talkeetna on 22 June 2023 to inspect the existing erosion control structures, observe the extent of riverbank erosion, and assess the site conditions to best identify erosion mitigation measures. The proposed mitigation measures will only include a planning level of detail and will not include a detailed design suitable for project construction. This work does not provide future erosion rate estimates or include the potential impact of climate change.

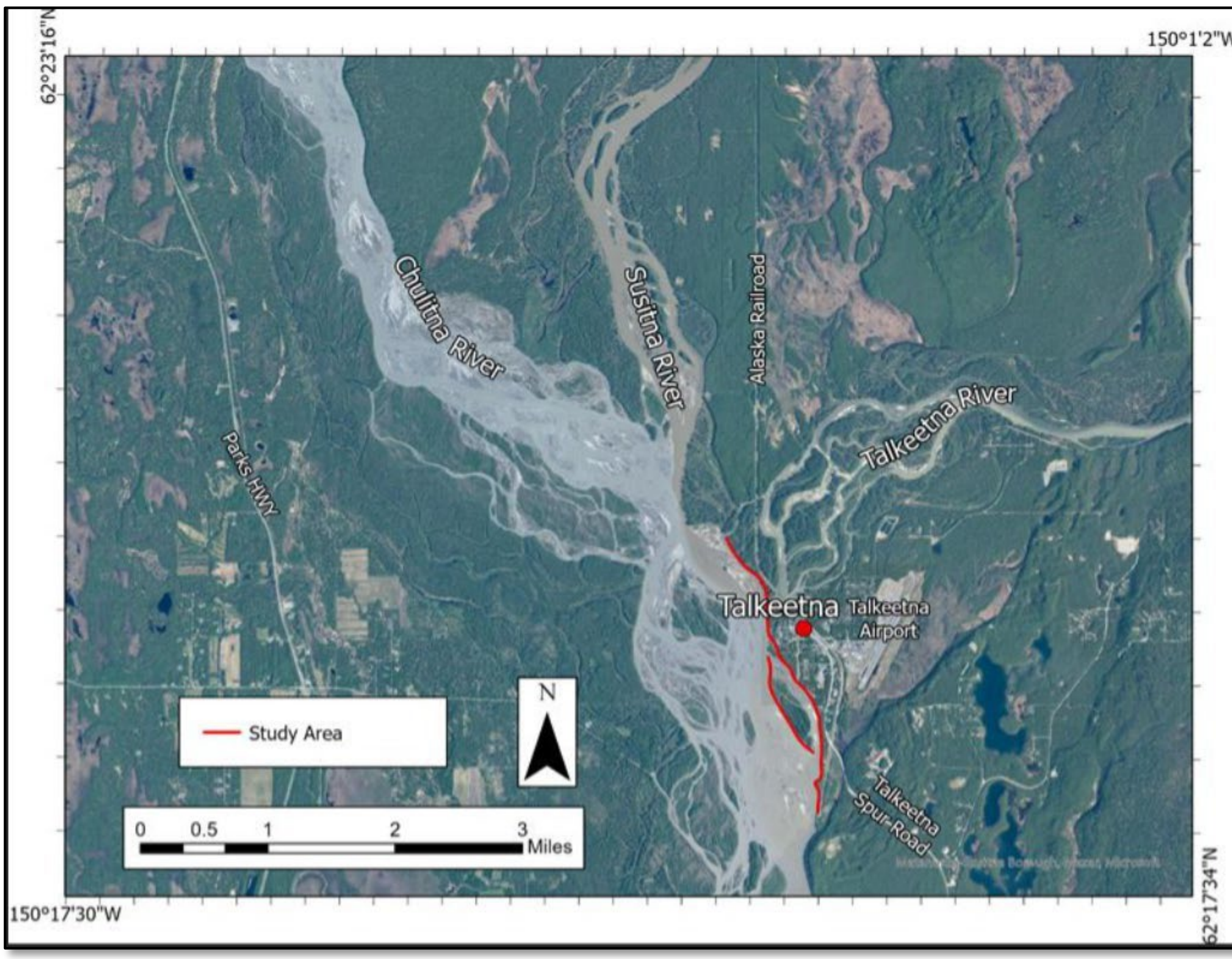

Figure 2. Extent of erosion analysis (Google Earth Imagery, 2022).

2.0 IDENTIFIED PROBLEM

2.1 Problem Statement

The main channel of the Susitna River, below the confluence of the Chulitna River, has been migrating east towards Talkeetna since approximately 2012. This has caused flow to be directed along the eastern riverbank, directly hitting the end of the dike extension, and forming eddies. The combination of eddies and the concentrated flow against the eastern bank has led to a rapid increase in erosion since the start of its migration (see Appendix A and Section 4). A large portion of the existing revetment that was constructed by USACE in 1979 was washed away during the most recent high-water event in August and September 2023 (see section 4.4). The erosion taking place threatens infrastructure along the river as well as downtown Talkeetna. Improved erosion mitigation measures are needed.

3.0 EXISTING EROSION PROTECTION EFFORTS AND GEOLOGY

3.1 Surficial Geology

The topographic relief of the area is the lowland area of the Susitna River drainage basin lying between the Talkeetna Mountains and the Alaska Range. The geology of the lowland relief of the Susitna River drainage basin is composed of stratified sedimentary rocks, where deposits are characterized by alluvial, glacial, dune sand, loess, terrace and pediment gravel, and reworked sand and silt deposits.

Soils in the Talkeetna area generally follow the topographic contours from the lowland floodplains to the mountains. Beginning along the Susitna and Talkeetna River's floodplains, the Susivar and Niklavar soil series are prevalent. Further above the floodplains in the low stream terraces, the Susitna soil service predominates. Above the low stream terraces in the area located along the outwash plains and higher stream terraces in the hills and ridges the Nancy silt loam series begins and intermixes with the Tokositna soil series. Interspersed between these soils, located in the bogs and fens, is the Histosol series. The soil types and distributions are based on information that is available from the U.S. Soil Conservation Service.

The entire town of Talkeetna and surrounding low lying areas are located in an active floodplain and are susceptible to major damage from flooding and stream erosion. The Susitna River, which has a length of about 200 miles, has a drainage area of about 11,035 square miles upriver from Talkeetna. The Susitna floodplain at Talkeetna is approximately one mile wide. Riverbed materials are coarse gravel and sand with much driftwood. The Talkeetna River is about 80 miles long and has a total drainage area of approximately 2,015 square miles. It is about 900 feet wide at its mouth where it junctions with the Susitna River. Both the Susitna River and Talkeetna River are glacially fed rivers characterized as meandering, braided, and subject to high runoff.

3.2 Previously Constructed Erosion Mitigation Structures (EMS)

Talkeetna currently has a rock revetment, dike, and dike extension along the Susitna River and Talkeetna River (Figures 3-5). USACE constructed a timber and brush fascine in 1951 as an emergency effort to stop riverbank erosion at the town of Talkeetna. The fascine began at the Alaska Railroad embankment and extended 1,000 feet downstream along the left bank of the Talkeetna River. Remnants of the fascines vertical railroad rails may still be seen in the river (Figure 10). In 1979, a 642-foot dike, 508-foot dike extension, and 1,650-foot revetment were constructed by USACE and turned over to the Matanuska-Susitna Borough for operation and maintenance (Figures 3-5). The dike, dike extension, and revetment were designed to protect the town from riverbank erosion.

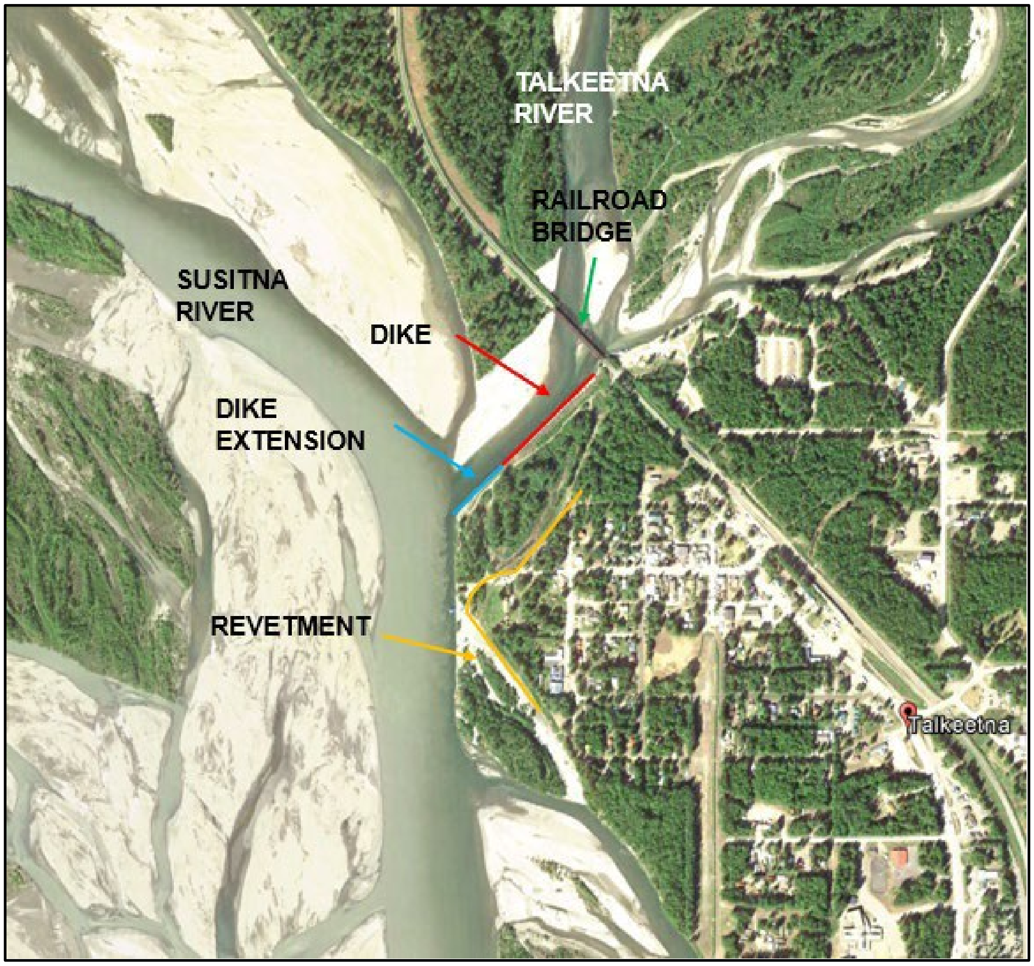

Figure 3. Location of dike, dike extension, and revetment in Talkeetna.

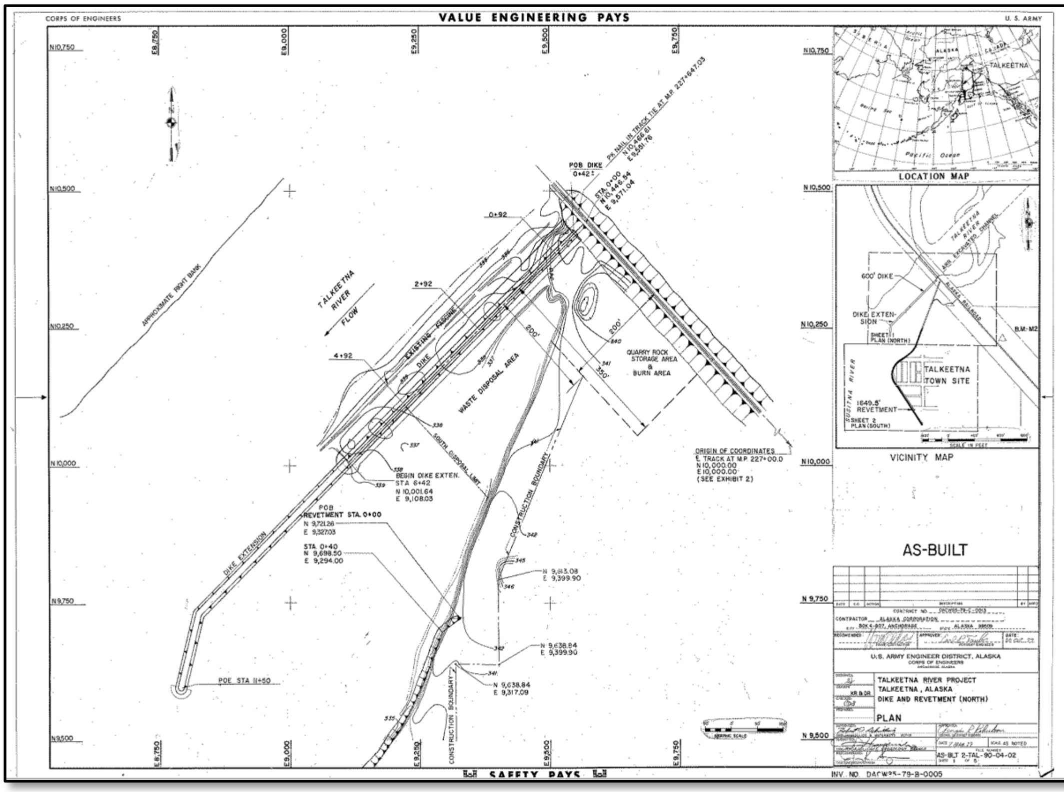

Figure 4. 1979 As Built of dike, dike extension, and upper end of revetment.

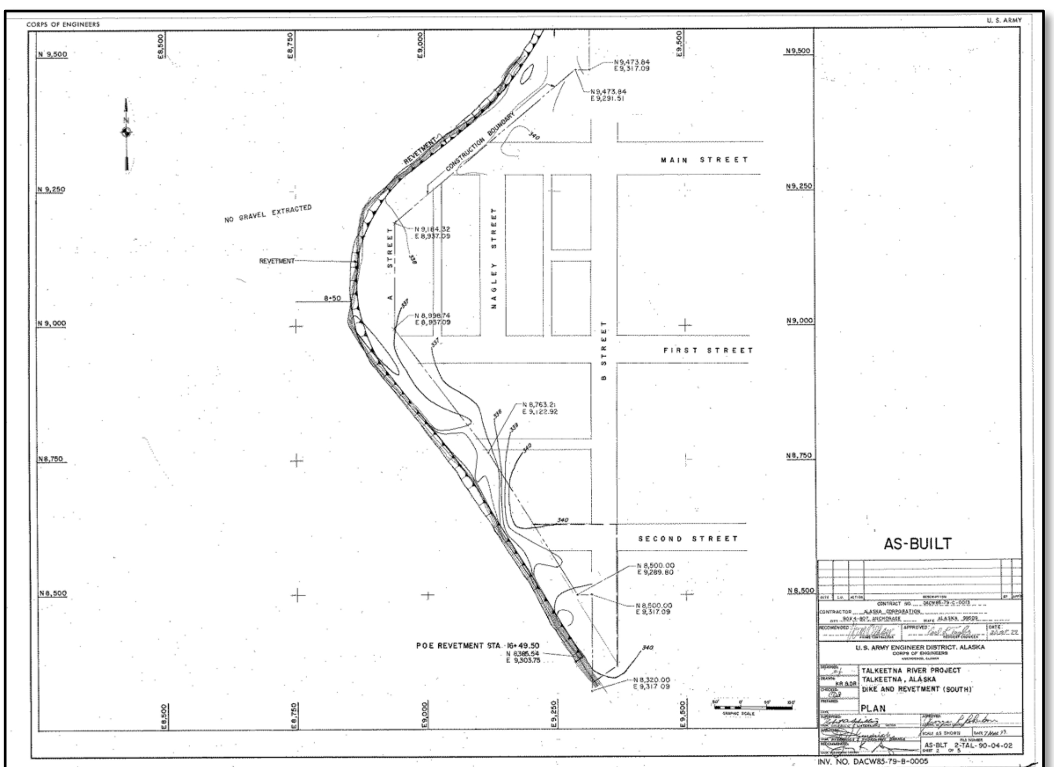

Figure 5. 1979 As Built of revetment.

The dike consists of a buried toe, raised berm, and a landward apron. The designed crest width is 8 feet wide and has an elevation of 4 feet above the ground surface (Figure 6).

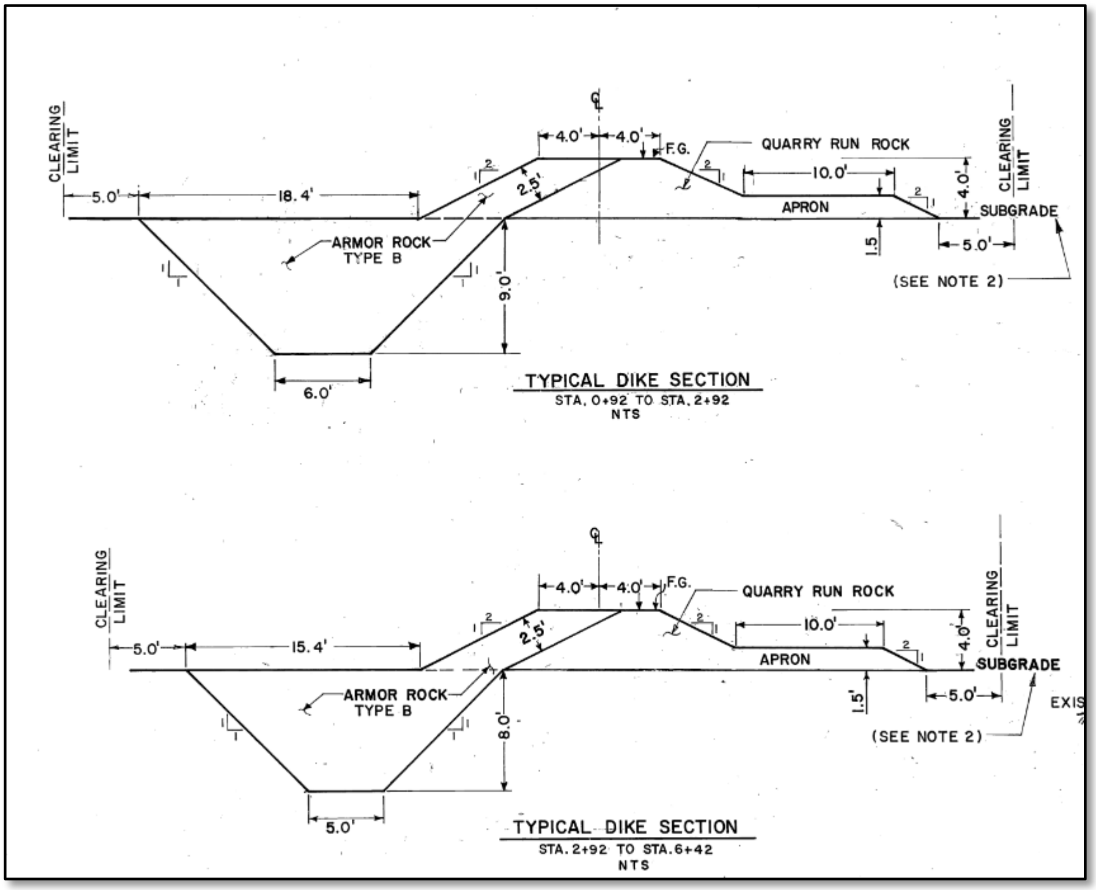

Figure 6. Typical dike cross section information.

The dike extension consists of a raised berm 2 feet above the ground surface with a designed crest width of 12 feet. The dike extension was not designed or built with any toe rock protection or landward apron (Figure 7).

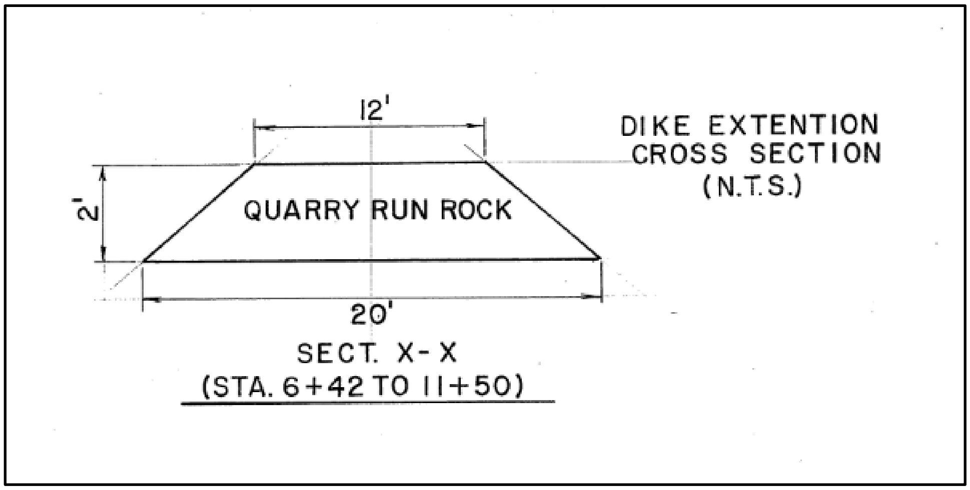

Figure 7. Typical cross section for dike extension from 1979 As Built.

The revetment consists of a buried toe with quarry run rock over gravel fill (Figure 8).

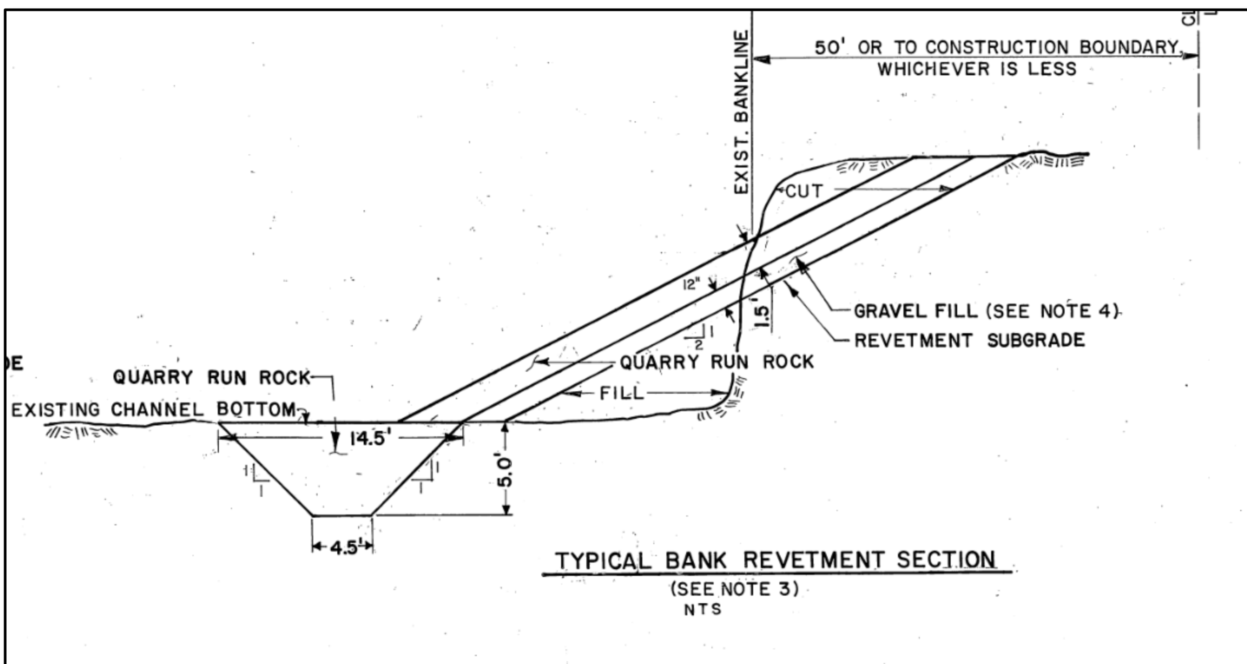

Figure 8. Typical cross section for revetment from 1979 As Built.

These structures have experienced significant erosion since they were built (Figures 9-11), with most of the erosion occurring after the 2012 flood when the main stem of the Susitna River shifted to flow against the east bank. An engineered design repair was needed on the dike extension after the 2012 flood and was completed by FEMA in 2017. Emergency repairs were needed due to severe erosion along the dike extension and revetment in 2020 and was performed by the Matanuska-Susitna Borough (Figure 12). Severe erosion is occurring at the confluence of the Talkeetna River and Susitna River after the dike extension (Figure 13), where a large and deep eddy has formed since 2017 which was measured to be up to 40 feet during the summer.

Figure 9. Erosion and loss of armor stone observed along revetment in 2021.

Figure 10. Erosion of dike observed during low water in 2020.

Figure 11. Erosion of armor stone along revetment observed in 2020.

Figure 12. Emergency rock placement occurring along dike extension in 2020.

Figure 13. Erosion occurring at the confluence of the Talkeetna River and Susitna River after the dike extension observed in 2020.

3.3 Recent August and September 2023 High Water Event

Since the initiation of this PAS study and subsequent analysis of data through 2020, a significant erosion event occurred in August and September 2023.

On 05 September 2023, Matanuska Susitna Borough Public Works (MSB-PW) staff conducted a site visit to observe reported erosion along the eastern riverbank of Susitna River near A Street in Talkeetna. Significant erosion was noted during this site visit.

On 07 September 2023, MSB-PW received a report from the Talkeetna Fire Chief that the riverbank had experienced significant erosion overnight, putting additional risk upon existing cabins along A Street (Figure 8). Four days later, the MSB-PW and USACE representatives met in Talkeetna to conduct an assessment. It was estimated that the river claimed 65 feet of land overnight, consistent with MSB-PW staff photos taken on 05 September 2023 and visual observation. The erosion removed a portion of the revetment along A Street from East Main Street to East First Street (approximately 325 feet). While in Talkeetna, MSB-PW staff reviewed the National Weather Service gage for the Talkeetna River at the railroad bridge (TKTA2). The gage had peaked at 11.10 feet (343 feet NAVD88) around 9:00 AM that morning, was receding, and forecasted to continue to decline in the coming days. The discharge along the Talkeetna River gage (U.S. Geological Survey (USGS) gage 15292700) which is located roughly 2 miles upstream from the confluence with the Susitna River, peaked at 38,000 cubic feet/second (CFS) around 12:00 AM on 27 August 2023. Multiple smaller peaks occurred until 06 September 2023 when the flow finally started to decline. The Susitna River gage at Gold Creek (USGS gage 15292000) had a peak discharge of 48,000 CFS on 02 September 2023 at 6:15 AM. This gage is approximately 37 miles upstream from the confluence of the Chulitna River and Susitna River. Based on hydrologic analyses, the peak flow for both gages were roughly a 5-year return period. The Chulitna River gage near Talkeetna (USGS gage 15292400) was disabled in the year 2016.

Figure 14. Locations of scour and land loss in Talkeetna, September 2023.

The Matanuska-Susitna Borough authorized transporting 900 tons of rock to the end of Main Street to stage for anticipated repairs to the revetment. As the Susitna River subsided, a water depth survey was conducted on 17 September 2023 in preparation for emergency repairs (Figure 15). The cabins shown in the red oval in Figure 15 are the cabins shown in Figure 16 after the early September 2023 erosion event. Repairs were conducted in late September 2023, and the as built for this repair can be seen in Figure 17.

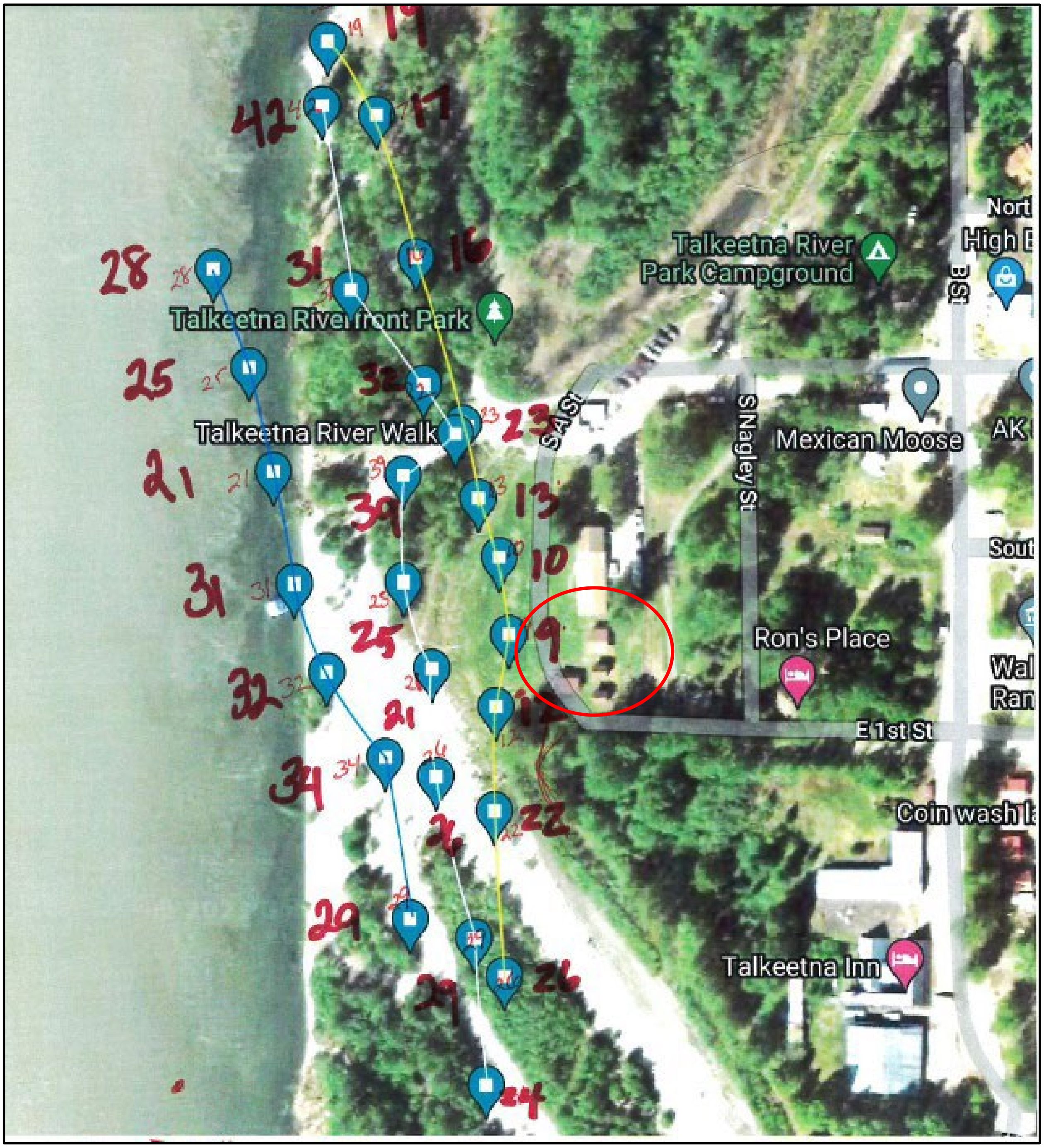

Figure 15. Water depth survey conducted 17 September 2023.

Figure 16. Emergency placement of revetment material following early September 2023 flood event.

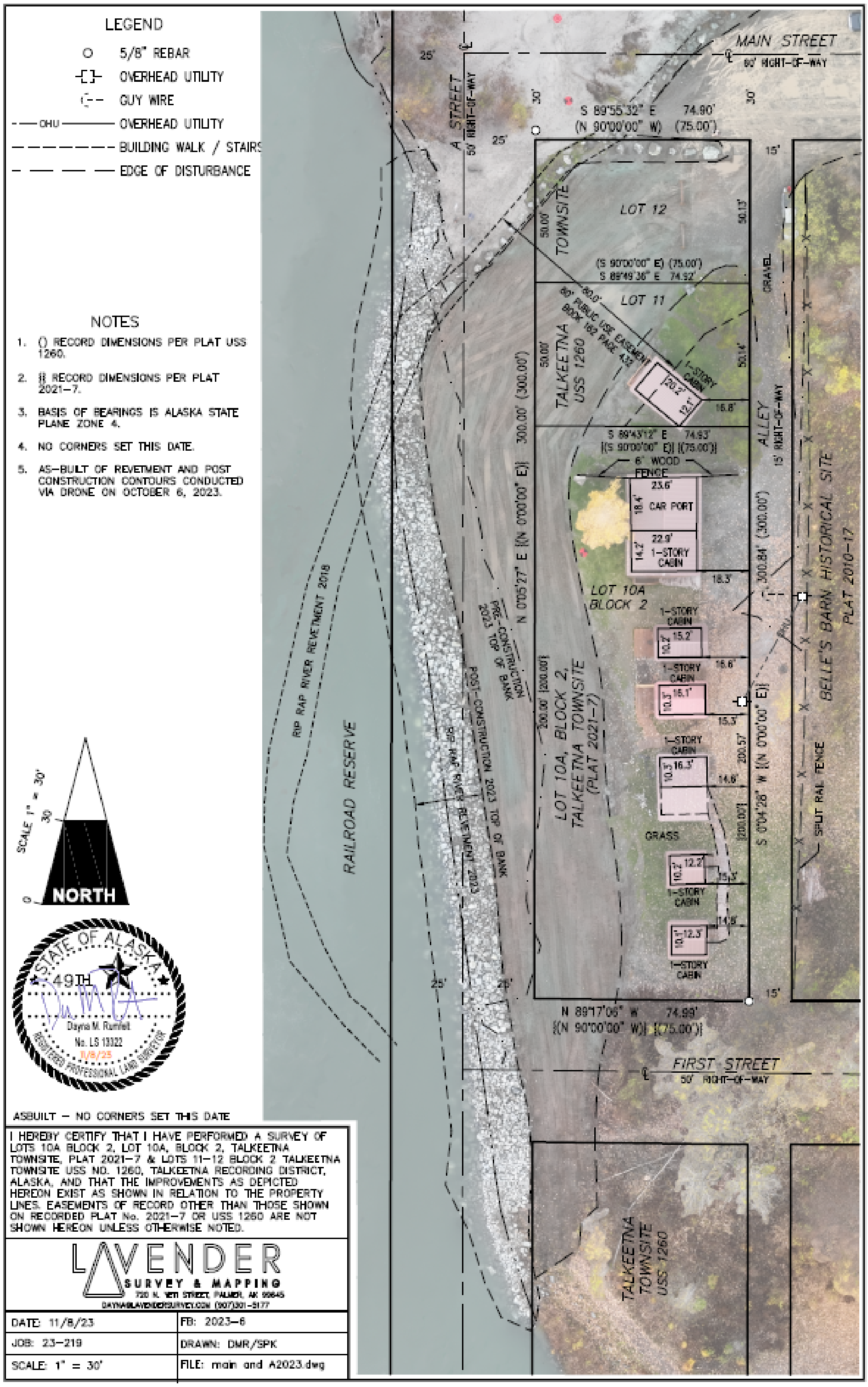

Figure 17. Final as-built for emergency repairs (as-built dated 08 November 2023).

4.0 EROSION RATE ANALYSIS

4.1 Background: Susitna River Evolution

The Susitna River is a large, glacially fed, braided river system with a high sediment load of fine silts and sands. Rivers of this nature are very dynamic, and one flood event can completely change where the main stem of the river flows due to the intense amount of erosion and accretion that takes place during a large flood. The Susitna River is a prime example of this, with the main stem of it changing course after the 2012 flood (Figure 18). Before this flood, the main stem of the Susitna River flowed to the west, away from downtown Talkeetna. There was also large amounts of accretion of fine sands and silts in front of the revetment and dike extension due to less flow in this area. After the flood, the main stem shifted and now flows east, with the main stem directly hitting the end of the dike extension and running along the current revetment, enhancing the erosion along these banks. See Appendix A for an aerial photograph time series of this confluence from 1953-2022.

Figure 18. Susitna and Talkeetna River Confluence Pre and Post 2012 Flood.

4.2 Methodology

Sixteen aerial photographs in a TIFF format were obtained spanning from 1953 to 2020 (67 years). Three of the aerial photographs were obtained from the Matanuska-Susitna Borough (years 2011, 2017, 2020) while the rest were obtained from NV5 Geospatial. Time between the photos averaged four years, with a maximum gap of nine years between 1959 and 1968. No adjustments were made to the position of the aerial imagery. These georeferenced files were projected in AutoCAD Civil3D using Alaska State Plane Zone 4 so that erosion and deposition along the Susitna River could be geographically measured. Polylines were drawn on separate layers for each year of aerial imagery along the vegetation line of the Susitna River with a different color for each date as presented in Table 1. A summary of this data is shown in Figures 19-23. Erosion was only measured along the eastern bank of the Susitna River and areas of interest surrounding the town of Talkeetna. These polylines were drawn at the vegetation line and not at the riverbank to eliminate high-water and low-water seasonal effects and to also define the riverbanks with established landmarks that are not as prone to change within the braided river. The riverbank lines were drawn to the accuracy available within the aerial imagery. Aerial photography from 1953, 1959, 1968, and 1974 were in black and white, which made it difficult to distinguish the vegetation line from debris. Shadows from the tree-line impeded sections of riverbank line delineation in almost all years of study as the intersection of bare earth and vegetation could not be identified. When the vegetation line could not be confidently determined, the polyline was estimated erring towards erosion.

Bankline's were separated into four sample regions:

- North Region: north of the Alaska Railroad bridge.
- South Region: south of Talkeetna Inn.
- AOI: Areas of interest along the 1974 revetment, the Susitna River and Talkeetna River confluence, and along protective islands.
- CHNL: The landward-facing side of a channel created by an island.

A simplified 2020 riverbank offset line (see white line in Figures 19-23) was used as a baseline from which all riverbank lines would be measured for erosion or accretion at each station. This baseline was offset by a large enough distance such that it would be farther landward than any riverbank line (between 20-100 feet). The offset baseline was then made into an alignment and sample lines (stations) were automatically generated roughly every 500 feet on the north and south sample regions. Areas AOI and CHNL had stations denoted with this symbolism since the stations were made not evenly spaced apart due to the amount of change seen along these reaches. Minor adjustments were made to the baselines and stations to ensure that no sample-lines crossed, and that the sample-lines were oriented with the direction of erosion or accretion. Erosion and accretion rates in the four areas can be seen in Table 2, Table 3, Table 4, and Table 5, with the positive values (red) indicating erosion, and the negative values (blue) indicating accretion. Erosion rates for the CHNL area started at year 1984 since this is when the gravel bar island began to form.

Table 1. Satellite photo date with corresponding bank line color.

Date	Color	Years Elapsed
1953		0
1959		6
1968		9
1974		6
1979		5
1984		5
1989		5
1995		6
1996		1
2000		4
2002		2
2006		4
2008		2
2011		3
2012		1
2017		5
2020		3

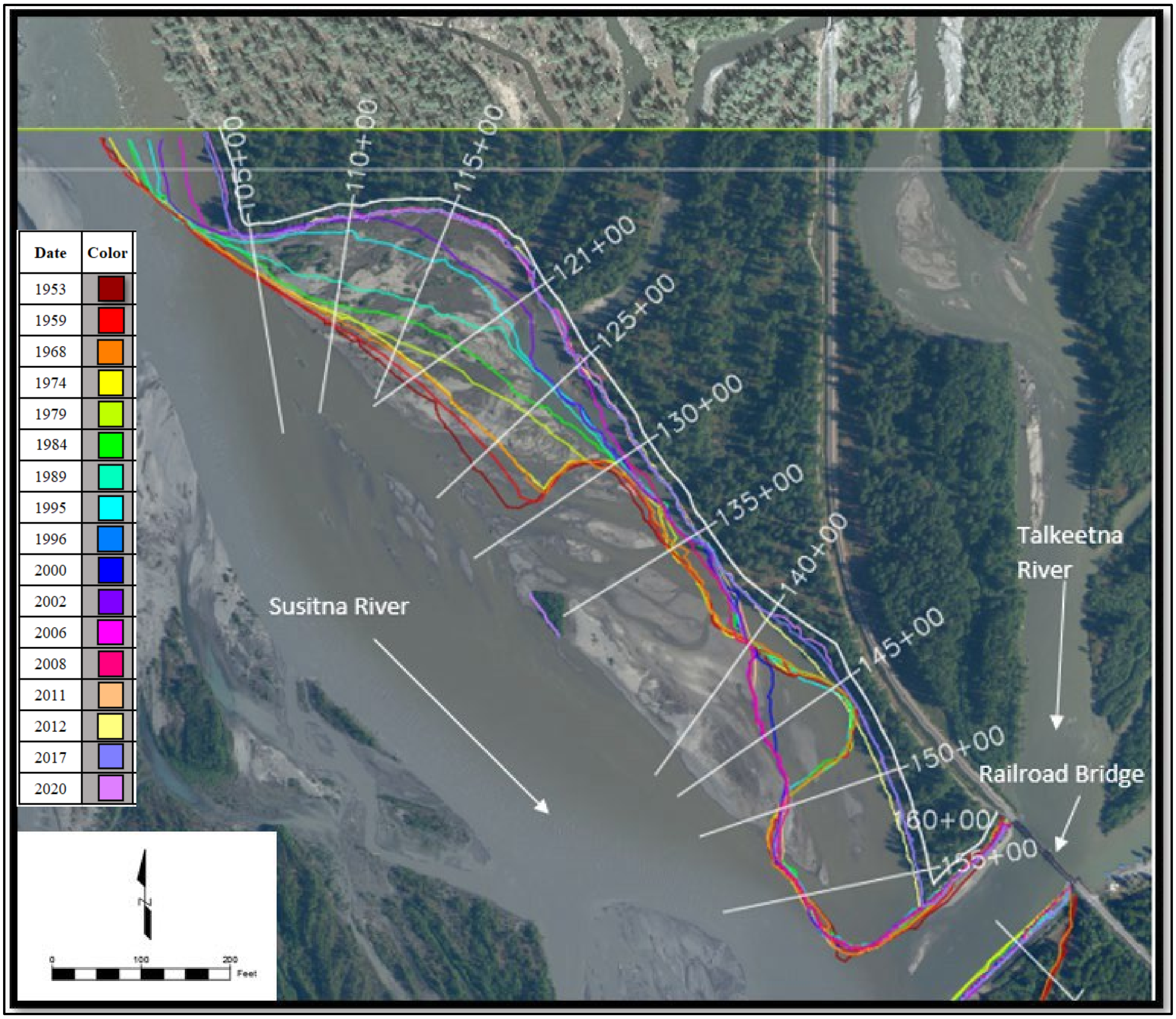

Figure 19. Overview of traced bank-lines, North Region (Google Earth Imagery, 2020).

Table 2. Erosion rates between years on record (units of feet/year) for North Region.

Station	2017-2020	2012-2017	2011-2012	2008-2011	2006-2008	2002-2006	2000-2002	1995-2000	1989-1995	1984-1989	1979-1984	1974-1979	1968-1974	1959-1968	1953-1959
105+00	-4.1			-17.6					11.0	6.2			0.1	3.3	-2.6
110+00	-1.9	-0.9	7.4	-20.7					40.6	22.5	6.6	2.2	3.6	2.9	1.3
115+00	-5.0	-1.0	7.8	-18.1					35.3	18.7	21.8	8.2	2.5	5.1	6.3
120+00	1.5	-0.8	3.0	-27.5					19.6	26.8	22.7	17.8	3.2	5.2	7.0
125+00	10.6	-0.3	3.8	-26.3			-0.7	-0.1	2.9	21.1	12.2	39.4	0.7	6.5	16.6
130+00	-5.0	0.0	12.2	-20.2			-10.7	2.8	1.6	0.4	3.0	-0.9	7.1	-2.0	4.3
135+00	-1.9	0.0	-1.2	19.1	-4.9	-0.1	-1.6	-0.7	0.2	0.4	19.5	3.5	-6.4	3.6	-1.1
140+00	1.6	5.7	126.3	6.4	-0.6	-1.0	-3.5	2.1	-2.1	-0.4	1.0	0.6	-1.7	1.0	1.6
145+00	-0.4	9.9	394.8	-1.6	0.5	2.4	-32.0	-65.6	-4.9	1.1	-1.3	2.6	-2.3	1.8	-0.7
150+00	1.0	5.4	489.0	-7.7	12.4	3.7	-1.0	-2.3	1.0	-1.0	3.5	2.3	-1.0	-1.4	1.0
155+00	-0.8	3.3	529.6	3.8	-5.2	2.6	-5.9	-1.1	0.7	-0.3	3.0	2.4	-4.5	2.2	-3.7

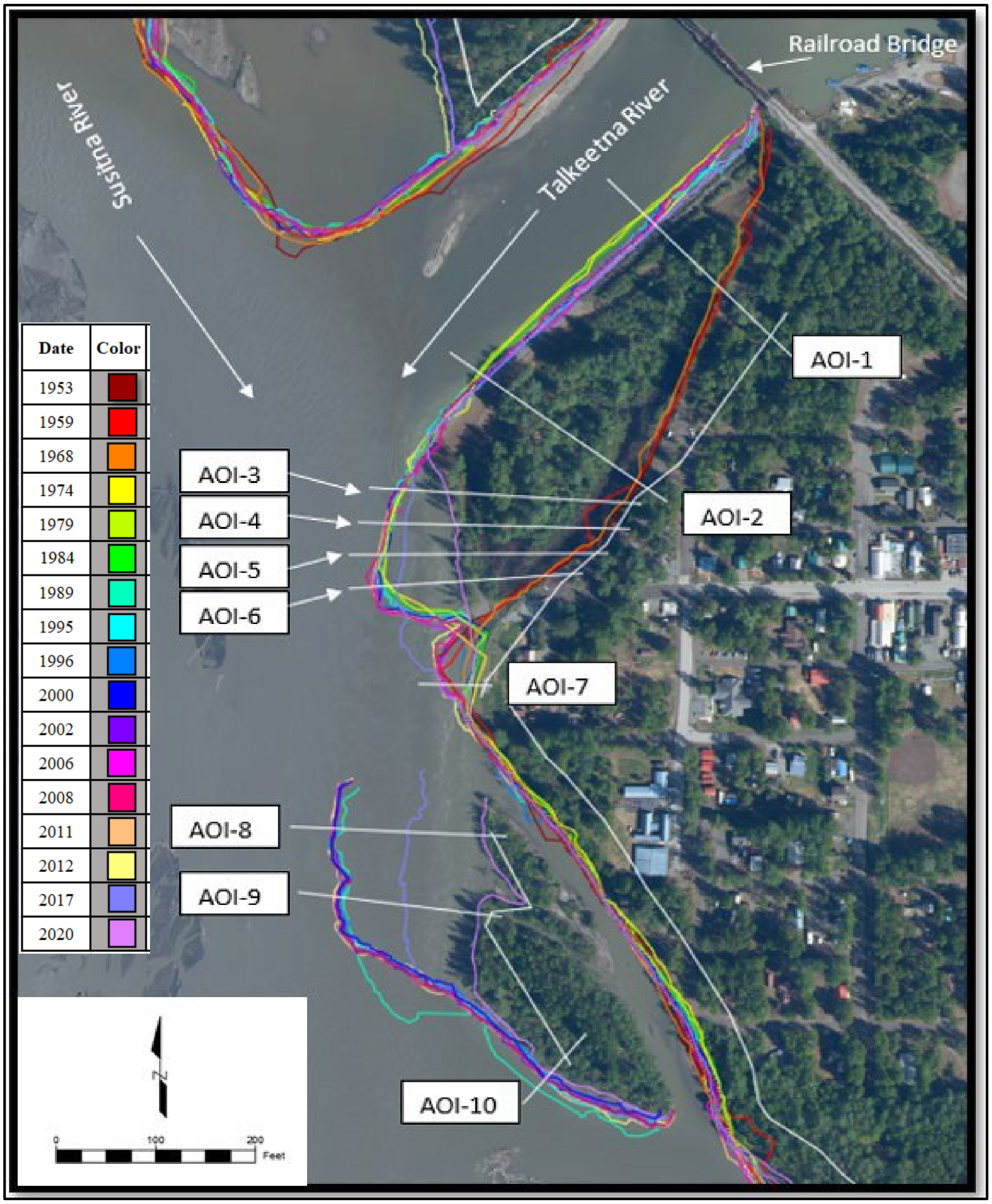

Figure 20. Overview of traced bank-lines, Area AOI (Google Earth Imagery, 2020).

Table 3. Erosion rate between years on record (units of feet/year) for Area AOI.

Station	2017-2020	2012-2017	2011-2012	2008-2011	2006-2008	2002-2006	2000-2002	1996-2000	1995-1996	1989-1995	1984-1989	1979-1984	1974-1979	1968-1974	1959-1968	1953-1959
AOI-1	0.5	0.9	8.7	-0.7	-1.0	1.2	0.4	1.2	-4.2	0.7	3.3	1.1	-0.7	-39.6	-1.8	0.2
AOI-2	-0.8	1.9	-3.8	1.3	-1.4	-0.7	1.1			-0.2	2.9	0.2	-1.1	-73.5	0.1	-1.4
AOI-3	25.5	4.9	3.3	0.0	-4.4	4.1	-2.1			1.5	-3.0	0.2	0.4	-83.9	5.2	-10.2
AOI-4	38.9	5.8	18.1	-0.7	-9.2	3.2	-1.4			0.0	-0.8	1.3	0.4	-81.9	4.1	-9.5
AOI-5	41.3	10.0	10.3	-0.8	-3.4	-0.5	-3.1			0.4	-2.0	1.9	-1.7	-71.6	-0.7	1.1
AOI-6	48.4	12.2	-2.3	0.7	-2.7	-2.5	-4.2			-1.8	-0.6	-0.7	-0.8	-58.9	0.0	-1.9
AOI-7	23.1	0.3	1.7	-0.1	-2.2	0.3	-28.9	2.1	-8.1	-1.1	-0.6	1.2	-3.7	5.0	2.8	0.7
AOI-8	58.1	33.9	3.5	-0.2	-2.7	0.5	-1.7	-1.6	1.5	-2.5						
AOI-9	56.6	32.3	1.1	-1.5	-2.0	-0.2	-0.9	-1.4	-2.4	-0.7						
AOI-10	5.1	-0.4	6.0	-0.4	1.2	0.3	-3.4	-1.3	10.4	5.0						

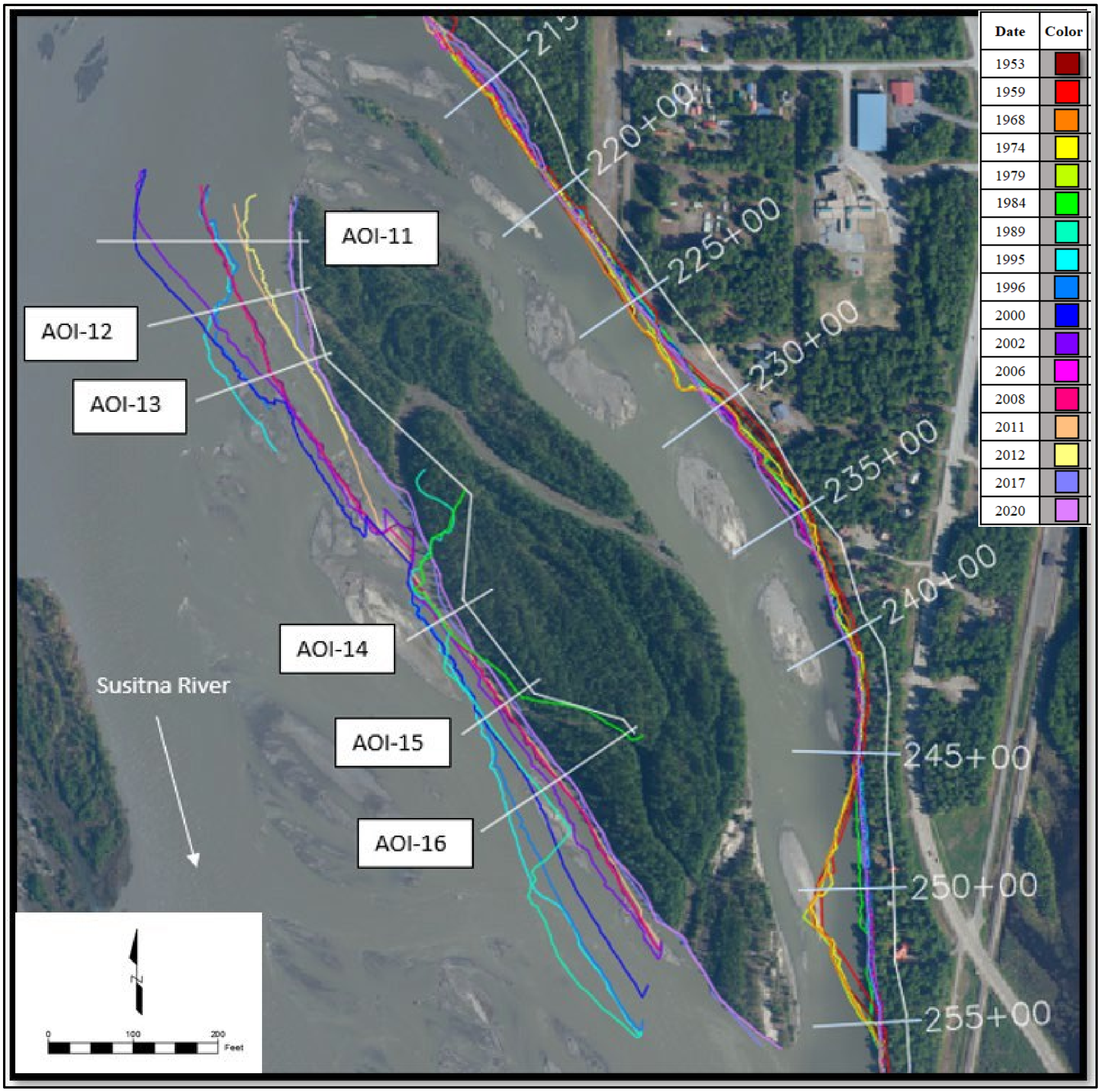

Figure 21. Overview of traced bank-lines, Area AOI, continued (Google Earth Imagery, 2020).

Table 4. Erosion rate between years on record (units of feet/year) for Area AOI, continued.

Station	2017-2020	2012-2017	2011-2012	2008-2011	2006-2008	2002-2006	2000-2002	1996-2000	1995-1996	1989-1995	1984-1989	1979-1984	1974-1979	1968-1974	1959-1968	1953-1959
AOI-11	-0.4	32.9	15.5	35.7	-2.3	57.9	32.4	-81.4	19.7							
AOI-12	2.5	16.6	22.1	30.9	-1.3	30.8	31.3	-22.5	7.1							
AOI-13	9.5	0.8	6.3	44.0	0.1	7.9	32.1	-1.0	70.4							
AOI-14	8.2			5.9	-3.6	1.3	20.1	-0.6	7.4	-8.9	0.6					
AOI-15	-2.7			4.8	-6.2	7.4	33.6	0.4	18.3	-4.4	-31.0					
AOI-16	1.6			2.6	-2.0	7.8	36.5	21.9	32.2	-24.7	-75.3					

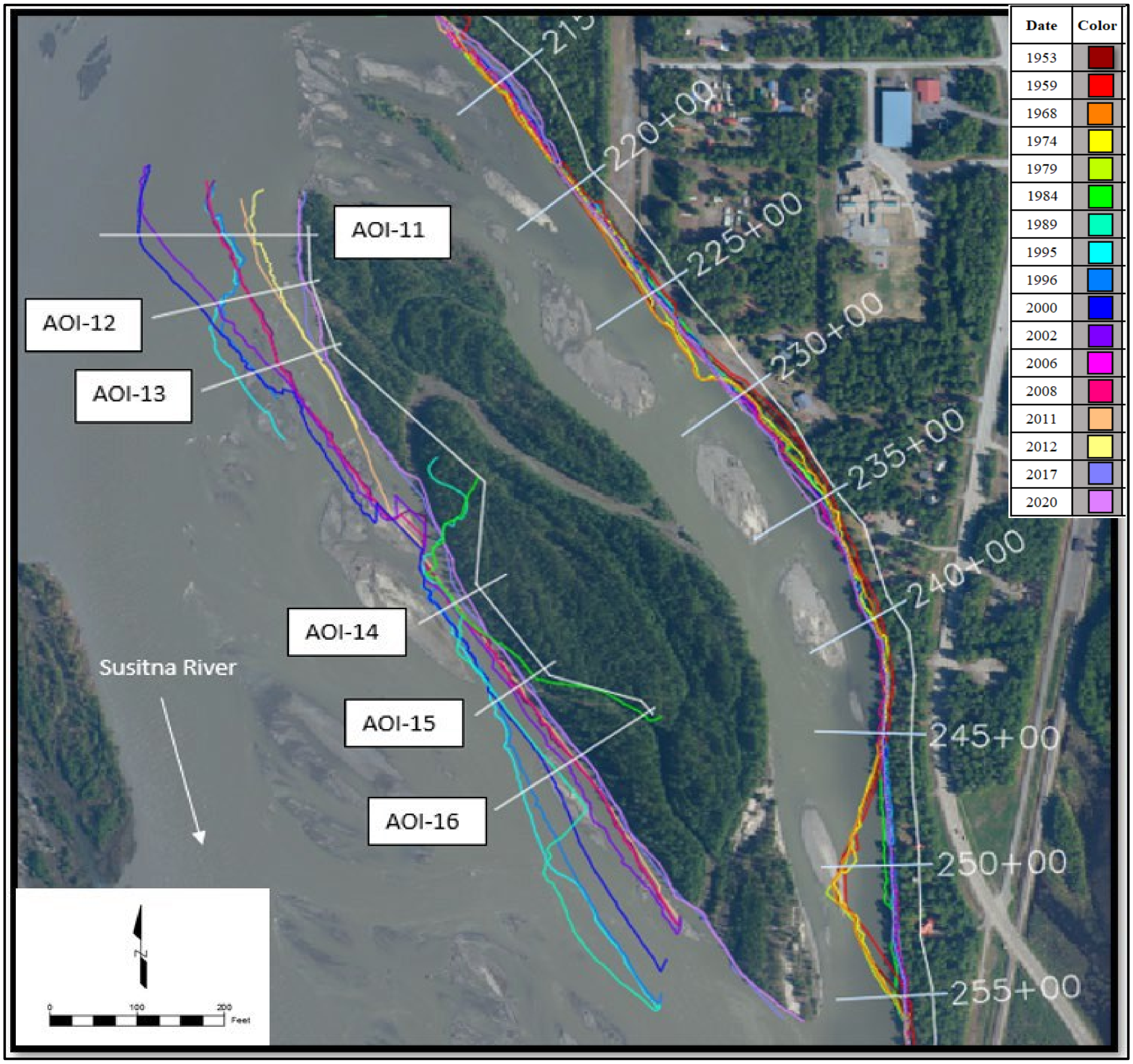

Figure 22. Overview of traced bank-lines, Area CHNL (Google Earth Imagery, 2020).

Table 5. Erosion rate between years on record (units of feet/year) for Area CHNL.

Station	2017-2020	2012-2017	2011-2012	2008-2011	2006-2008	2002-2006	2000-2002	1996-2000	1995-1996	1989-1995	1984-1989
CHNL-1	-1.3	3.1	-15.9	-2.4	0.0	2.4	-58.9	-52.7	-3.8		
CHNL-2	1.3	-14.8	14.4	-0.7	-23.9	8.3	-64.8				
CHNL-3	-0.7	-4.9	-0.9	-0.4	-1.7	-8.4	-71.4				
CHNL-4	-0.7	2.9	-5.2	-1.1	-2.7	-1.7	-2.2	-68.2	-1.5	-18.7	-0.7
CHNL-5	0.4	7.2	-21.2	1.8	-3.5	-4.2	-3.9	-61.8	4.2	-26.3	1.4
CHNL-6	-1.1			0.8	-1.5	-6.9	-1.1	-76.1	105.0	-33.3	-5.2
CHNL-7	-3.7			-4.6	9.5	-1.7	-3.4	-66.4	4.7	-2.4	-24.6
CHNL-8	2.0			-0.6	1.0	-0.7	-0.1	-74.4	12.9	-3.6	-18.1
CHNL-9	0.0			0.4	2.7	-5.1	1.4	-76.9	2.7	-2.0	-8.2

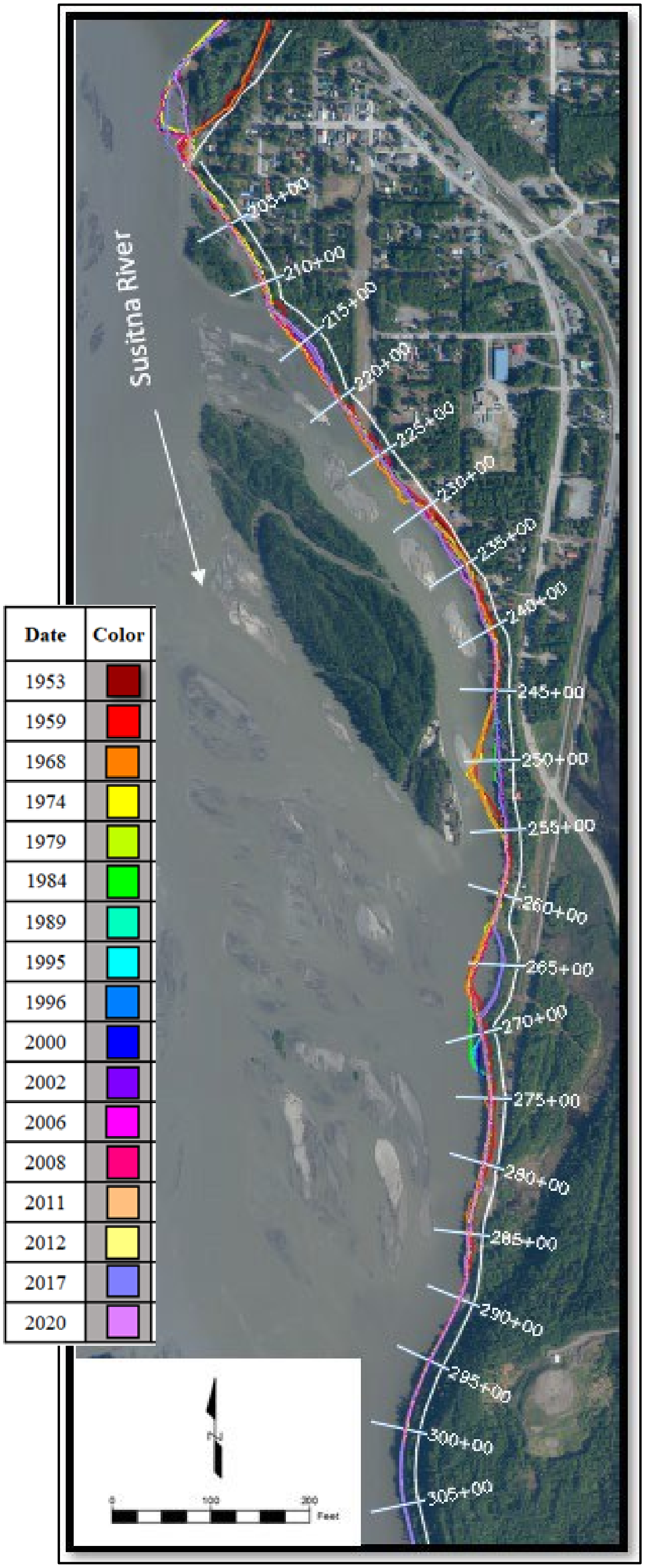

Figure 23. Overview of traced bank-lines, South Region (Google Earth Imagery, 2020).

Table 6. Erosion rates between years on record (units of feet/year) for South Region.

Station	2017-2020	2012-2017	2011-2012	2008-2011	2006-2008	2002-2006	2000-2002	1996-2000	1995-1996	1989-1995	1984-1989	1979-1984	1974-1979	1968-1974	1959-1968	1953-1959
205+00	0.0	0.3	1.8	-2.1	-0.1	-1.1	-0.9	-0.1	2.1	0.5	-1.3	1.4	-1.4	0.5	1.5	-0.3
210+00	0.0	1.4	-7.3	-0.3	4.5	1.6	-9.5	0.8	-3.7	0.2	-2.3	-0.4	1.0	5.8	-1.3	1.7
215+00	7.2	5.7	20.3	-8.2	-0.4	2.8	-9.3	1.2	4.2	4.4	-0.4	0.5	0.4	0.4	-1.6	1.4
220+00	0.0	-0.8	2.8	-0.5	2.1	0.5	-7.5	-1.1	-3.3	0.6	2.3	-2.4	0.5	1.1	-2.1	5.3
225+00	1.0			-0.9	-2.1	0.1	-2.4	-2.7	0.5	1.0	-1.3	5.0	1.4	3.4	-7.6	10.9
230+00	2.1			-10.9	10.7	-1.9	-3.1	-3.7	1.3	0.1	-1.0	0.4	-0.9	0.4	-3.7	3.5
235+00	-11.4			1.5	0.4	-2.1	-1.6	-4.1	5.0	-0.1	-0.4	0.0	-1.0	-0.3	-2.0	3.6
240+00	0.0			-1.7	-1.3	0.7	-1.8	-2.2	3.6	-0.3	-1.7	1.5	-0.5	-1.9	-2.0	3.1
245+00	0.0			3.3	-7.0	0.3	-1.9	-0.3	-1.8	0.1	2.3	0.3	-0.6	-0.2	-1.6	1.7
250+00	0.1			-1.4	0.8	-0.1	-0.7	-1.1	11.7	-1.1	5.6	29.9	-5.9	5.9	-1.0	3.4
255+00	0.0			-2.4	2.2	1.4	-2.7	1.5	-4.1	5.0	0.7	3.3	-6.2	4.0	-5.5	4.7
260+00	1.5			-1.3	-8.1	3.3	2.6	-1.7	2.6	0.8	-0.5	3.4	-3.3	1.8	-2.6	2.7
265+00	4.6			-2.5	-0.8	1.2	-2.0	2.0	6.8	1.4	-2.4	1.9	1.2	3.0	0.1	0.0
270+00	-1.8			0.9	-6.8	2.6	0.3	-1.8	16.7	-1.7	15.8	-16.1	-0.5	0.9	-3.1	4.2
275+00	0.0			-0.8	-4.0	2.7	2.3	-4.2	7.8	-0.8	0.1	1.5	-2.5	5.3	-5.3	4.5
280+00	0.0			-0.6	-0.8	5.3	-2.1	-4.0	3.0	-0.3	1.8	-0.9	-1.4	3.6	-5.2	5.3
285+00	0.0			-5.7	1.3	4.3	-6.7	-0.5			0.7	1.2	-2.6	3.6	-3.8	3.6
290+00	0.0			0.5	0.6	1.3	-4.1	0.3			0.5	0.5	-0.8	0.1	-0.7	1.3
295+00	0.0			-1.4	2.7	0.4	-1.4	0.0			0.9	-0.1	-1.3	1.6	-0.6	0.2
300+00	0.9			-1.1	-0.6	2.3	-1.5	-2.6			2.2	0.0	-0.2	1.2	-1.3	1.6
305+00	2.7															

4.3 Average Annual Erosion/Accretion Rate Estimates

The average annual erosion/accretion rates for the four areas can be seen in 7-10. The average annual rates were calculated for Area AOI using aerial imagery after 1979 due to the construction of the dike, dike extension, and rock revetment in this location during that year. Erosion and accretion tends to be an episodic event driven in this area by various environmental factors, including: high-water, floods, channel migration, rainfall, snowmelt, and ice impacts. The intensity of these events vary every year. Large flood events can completely alter a braided river system. This was seen after the 2012 flood, where the mainstem of the Susitna River changed course and started flowing east towards the end of the current dike extension, instead of flowing west away from the town of Talkeetna as it had prior to this event. Due to these three large river systems (e.g., Talkeetna River, Chulitna River, and Susitna River) being glacially fed with a large sediment load of fine silts and sands, the system is always changing and is greatly influenced by large flood events.

Table 7. Average annual erosion/accretion rates for the North Region.

Station	Average Rate (feet/year)
105+00	-0.53
110+00	5.79
115+00	7.41
120+00	7.14
125+00	6.63
130+00	-0.59
135+00	1.89
140+00	9.14
145+00	20.28
150+00	33.65
155+00	35.06

Table 8. Average annual erosion/accretion rates for Area AOI.

Station	Average Rate (feet/year)
AOI-1	0.88
AOI-2	-0.05
AOI-3	2.77
AOI-4	5.05
AOI-5	4.76
AOI-6	4.16
AOI-7	-1.22
AOI-8	8.89
AOI-9	8.09
AOI-10	2.25
AOI-11	12.22
AOI-12	13.06
AOI-13	18.90
AOI-14	3.36
AOI-15	2.22
AOI-16	0.06

Table 9. Average annual erosion/accretion rates for Area CHNL.

Station	Average Rate (feet/year)
CHNL-1	-14.41
CHNL-2	-11.45
CHNL-3	-12.66
CHNL-4	-9.07
CHNL-5	-9.62
CHNL-6	-2.14
CHNL-7	-10.28
CHNL-8	-9.07
CHNL-9	-9.44

Table 10. Average annual erosion/accretion rates for the South Region.

Station	Average Rate (feet/year)
205+00	0.05
210+00	-0.48
215+00	1.79
220+00	-0.16
225+00	0.45
230+00	-0.49
235+00	-0.89
240+00	-0.33
245+00	-0.38
250+00	3.28
255+00	0.13
260+00	0.07
265+00	1.04
270+00	0.69
275+00	0.46
280+00	0.28
285+00	-0.39
290+00	-0.05
295+00	0.09
300+00	0.07
305+00	2.68

From these analyses, three main areas were identified with the highest erosion rates (Figure 24) that should be the focus of any potential erosion reduction efforts. Areas 1 and 2 are located at the end of the previously constructed erosion mitigation structures (i.e., dike extension and revetment). Area 3 is land owned by the Alaska Railroad. Area 1 includes Stations AOI 3-6; Area 2 includes Stations 215+00 to 250+00; Area 3 includes Station 265+00.

Figure 24. Areas with the highest erosion rates (Google Earth Imagery, 2022).

5.0 EROSION REDUCTION MEASURES

5.1 Recommended Revetments

5.1.1 Rock Revetment

USACE Alaska District recommends the use of rock revetments, like the one shown in Figure 25, for long term streambank erosion protection.

Figure 25. Rock Revetment in Shishmaref, Alaska designed by USACE.

Construction of a rock revetment at Talkeetna would involve a wide gradation riprap or a layered armor rock revetment. Rock sizes and layer thicknesses would be determined by analyzing river currents and ice conditions, scour potential, and riverbank materials at the site. The revetment would need toe protection to prevent undermining. A buried toe or an above grade sacrificial toe would generally be selected based on the river cross section at the time of design. The length of the revetment, regardless of the revetment type, would need to be roughly 3,400 feet (0.64 miles). New revetment should tie into the existing erosion control structures, with rock of adequate size being added to the existing structures to meet the original design thicknesses and slopes. Rock revetments are typically designed for a 50-year life with maintenance assumed to be performed throughout the project life. Rock revetments are effective at erosion mitigation on rivers with higher banks, high flows, and high score potential. The construction costs of rock revetments are generally higher than other types of revetments.

5.2 Other Revetments

5.2.1 Root Wad Revetment

Root wad revetments can be a lower cost alternative to rock revetments, but more expensive than spruce tree revetments. Of the non-engineered, lower cost solutions, root wad revetments provide the most robust streambank protection. This comes at the expense of being more labor intensive to install, requiring the use of heavy equipment. Due to challenges with installing root wad revetments, spruce tree revetments are recommended as a better lower cost alternative.

Figure 26. Root wad revetment construction (rock layer with header log pinning) at Pioneer Lodge in Willow Creek, Alaska (Walter & Hughes, 2005).

Root wad revetments are constructed with tree boles consisting of a trunk with the tops removed at least 8 to 10 feet long with root fans at least 5 feet in diameter (Figure 26). The boles are placed into the bank by excavating a hole long enough to accommodate the trunk and partly bury the root wad. The hole is dug perpendicular to the river with the root fans parallel to the bank. Header and footer logs pinned in place above and below the boles maybe added for stabilization. The root wad is then backfilled with 4 inch to 6 inch rock. The next root wad is placed so that the root fans overlap the adjacent root wad. Root wads should be firmly anchored into the bank to mitigate lateral impact and vertical buoyant forces exerted by ice floes.

5.2.2 Spruce Tree Revetment

Spruce tree revetments are among the lowest initial cost and least intrusive methods of streambank protection. Spruce trees placed with the stump facing upstream (Figures 27-28). This slows the current along the bank and allows sediment to be deposited within the branches. The spruce trees are held in place along the streambank with a cable and anchoring system. They can typically be constructed by the local sponsor without the use of a contractor. The Alaska Department of Fish and Game (ADFG) should be consulted on the design and construction of spruce tree revetments, as they have facilitated constructing spruce tree revetments along the Kenai River, Alaska.

Spruce tree revetments are less effective at stabilization on rivers with high banks (over 12 feet), as well as rivers with water depths at the toe greater than 3 feet (Bishop 2007). There have been special cases of spruce tree revetments being used successfully on rivers with high banks (Bishop 2007).

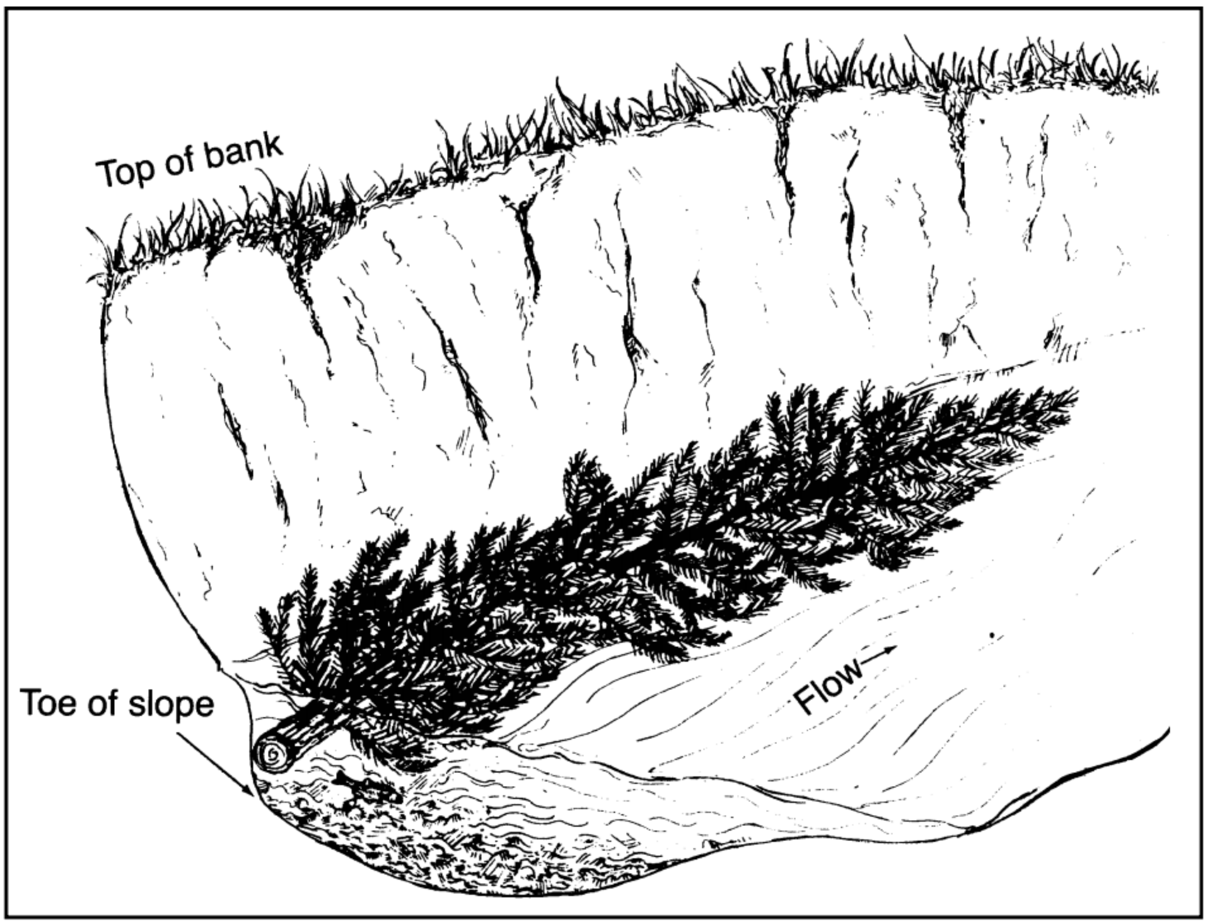

Figure 27. Diagram of a spruce tree revetment (Bishop, 2007).

Figure 28. Cabled spruce trees and brush layering immediately after installation, Ciechanski Recreation Site, Kenai River, Alaska (Walter & Hughes, 2005).

Large spruce trees (with 4-to-6-inch diameter trunks, and 10 to 15 feet in length) with many fine branches are preferred. Freshly felled spruce trees with live needles and limber branches are most efficient at trapping sediment, although dried trees are still effective. Spruce trees are abundant within the Talkeetna area, though there is an excess of beetle-killed spruce available (remnants of an outbreak that occurred in the year 2019). These dead spruce trees may be optimal for a revetment given their relative abundance within the area. Most riverine driftwood would likely be too old and battered to be appropriate. Care should be taken during placement to avoid accidental damage or removal of branches. Root wads should be cut off.

Place the spruce trees beginning downstream and work upstream, with the cut stump of the spruce tree pointing upstream. This minimizes the likelihood that branches will be broken by high flows or debris. Spruce trees must be placed tightly against the toe of the eroding bank, where the vertical bank meets the horizontal bottom. The spruce trees should overlap, filling gaps with smaller trees cabled to the larger trees. An example diagram of installing a spruce tree revetment is shown in Figure 29. For more information on design and installation of sprue tree revetments in Alaska, contact the ADFG and consult their streambank revegetation and protection guide (Walter & Hughes, 2005).

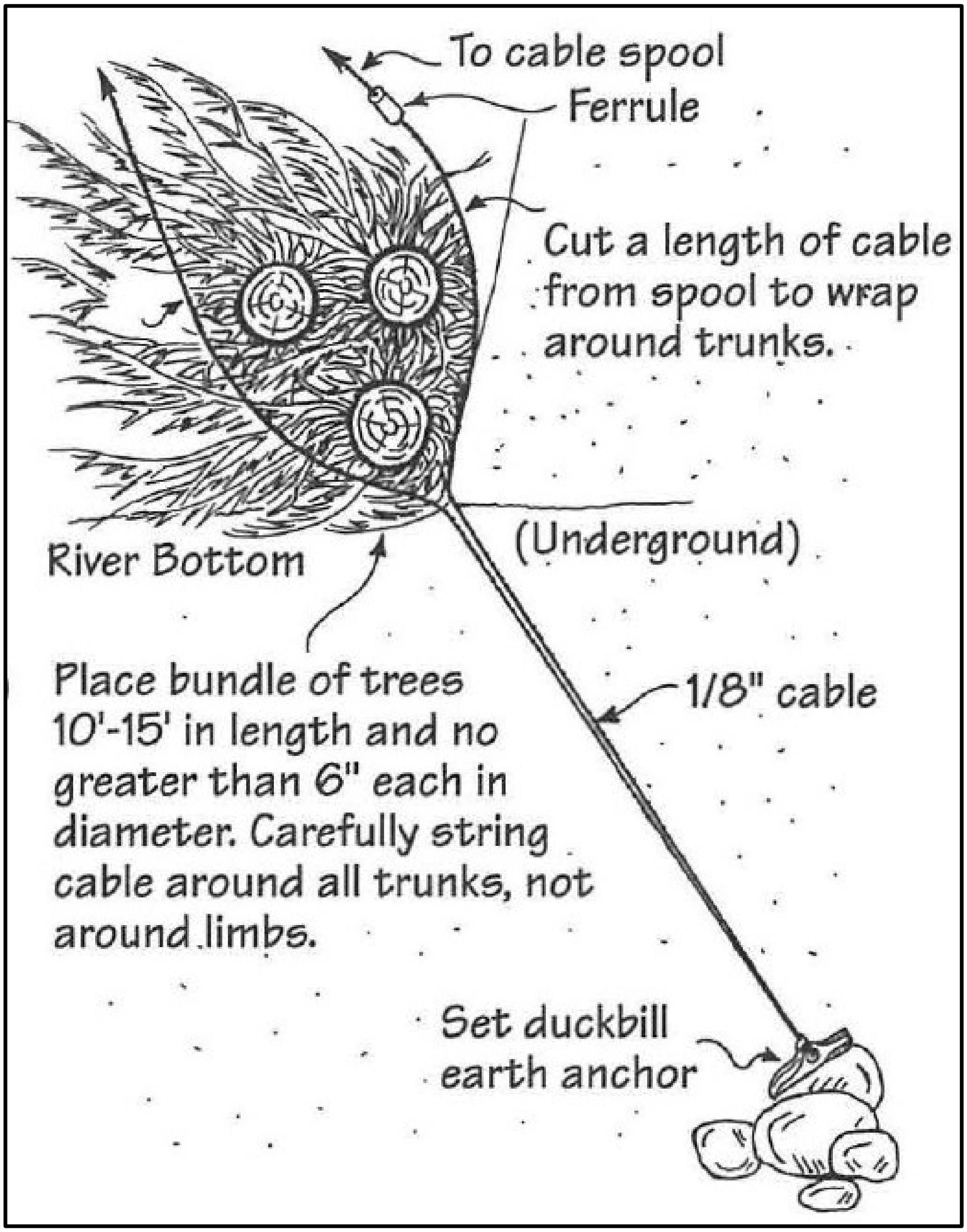

Figure 29. Installation of spruce tree revetment cable system (Walter & Hughes, 2005).

Regular maintenance is required, with new spruce trees needing to be added to the revetment every 1 to 3 years. New spruce trees are cabled directly in front of the original revetment. The existing cables should be retightened every year, with excess cable removed. Loose cable, along with improperly setting the anchors, are two major revetment failure modes. Deteriorating cable or anchors should be replaced. Note that cabling can be torn out by moving ice and should be inspected after breakup.

5.3 Revetments to Avoid

5.3.1 Automobile/Snow Machine Revetment

This type of revetment is created by placing used cars, snow machines, and other derelict motor vehicles on the bank for protection. This can cause erosion instead of mitigating for it. The complex shape of the vehicles causes high velocity microcurrents at the boundaries of the objects, which cause a local increase in scour at the banks. This can be exacerbated in fine grained soils that can easily be suspended in water with a high velocity of flow. This type of revetment is also labor intensive and there are costly clean up requirements that would be required to permit vehicle placement in a riverine environment. Due to these concerns, this type of revetment is not recommended.

5.3.2 Tire Revetment

Tire revetments are difficult to work with, as tires are hard to puncture and secure to the bank. Recommended methods of securing, such as cables and earth anchors used in spruce tree revetments, will quickly drive-up cost. One common and less expensive method is lashing tires together to form a protective mat. Tires are filled with soil or concrete to help hold them mat against the bank, which would otherwise scour out and cause the mat to float away. Tire revetments are not recommended due to the difficulty of securing the tires together against the bank.

5.3.3 Geotextile Tubes

A geotextile tube is a large, tube-shaped bag made of a porous, weather resistant geotextile material and is filled with a sand slurry to act as an artificial erosion mitigation structure. Using geotextile tubes as a standalone revetment structure is not recommended since this fabric degrades when exposed to the sun and is prone to tears. Another option is using these as a base to a rock revetment, but this option can also cause the bags to tear and pump out material from behind the fabric. Due to these factors, the costs will be more due to more maintenance requirements, and it will be less reliable over time, therefore it is not recommended to be used.

5.4 Non-Structural Alternatives

Non-structural alternatives focus on changing the way the streambank is used, without construction of a project. This could include limiting the speed of river boat vessel traffic near the shore to reduce wake; reducing pedestrian foot traffic on top of the riverbanks; or abandonment and relocation of structures within a certain distance where the majority of erosion is occurring.

6.0. GENERALIZED CONCLUSIONS

The intent of this report is to provide information that can assist the non-Federal sponsor in identifying a potential erosion protection project. The USACE Alaska District recommends a rock revetment for long term streambank erosion protection. Information and data presented in this PAS study will be used to support a Section 14 feasibility study in Talkeetna (if funded), and any other future riverine erosion protection projects within the Talkeetna area.

6.1 Current USACE Course of Action

Following the flooding and erosion damage in September 2023, the Matanuska-Susitna Borough has requested assistance under Section 14 of the 1946 Flood Control Act, as amended, which provides authority for USACE to assist in emergency streambank and shoreline protection. USACE has expressed capability to provide assistance under Section 14 of the Continuing Authorities Program (CAP) per the request from the Matanuska-Susitna Borough. This program competes for funding nationally and has a federal project CAP of $10 million but the project sponsor has the ability to pay for costs above their match.

USACE recognizes its limited authorities to assist in riverine induced erosion. For a project in Talkeetna, in order to be able to mitigate the riverine erosion in this area a systematic solution is needed. Currently, USACE has no authority to implement a “riverine” erosion protection project. Authority would come from Congress to protect the area against erosion, or a change in current authorities such as Section 8315 of Water Resources Development Act (WRDA) 2022 to include “riverine” erosion.

6.2 Potential Future USACE Assistance

Planning Assistance to States (PAS). Additional technical assistance can be implemented using the Planning Assistance to States program just as this assistance was implemented. The cost sharing for such efforts would be 50 percent federal and 50 percent local.

Continuing Authorities Program (CAP) The U.S. Army Corps of Engineers CAP is a group of nine legislative authorities under which USACE can plan, design, and implement certain types of water resources projects without additional project specific congressional authorization. The purpose of the CAP is to plan and implement projects of limited size, cost, scope and complexity.

All projects in this program include a feasibility phase and an implementation phase. Planning activities, such as development of alternative plans to achieve the project goals, initial design and cost estimating, environmental analyses, and real estate evaluations, are performed during the feasibility phase, to develop enough information to decide whether to implement the project. The feasibility phase is initially Federally funded up to $100,000. Any remaining feasibility phase costs are shared 50/50 with the non-Federal sponsor after executing a feasibility cost sharing agreement (FCSA). The final design, preparation of contract plans and specifications, permitting, real estate acquisition, project contracting and construction, and any other activities required to construct or implement the approved project are completed during the implementation phase.

USACE and the non-federal sponsor sign a project partnership agreement (PPA) near the beginning of the implementation phase. Costs beyond the feasibility phase are shared as specified in the authorizing legislation for that section. CAP Projects initiated under one of the following authorities may be appropriate to address erosion in Talkeetna:

Section 14 Emergency Streambank and Shoreline Erosion Protection. USACE is authorized to construct bank stabilization and protection projects to protect endangered public and non-profit infrastructure from flood and storm damages due to erosion. Examples of protected infrastructure include highways, bridges, approaches, cultural sites, and essential public services such as hospitals and water supply systems.

Specifically Authorized Study. Because of the magnitude of the problem in the Talkeetna area, a specifically authorized study and project would likely be needed to develop a comprehensive solution. Comparable to the CAP Section 205 program, cost sharing for this program is 50 percent federal and 50 percent local for the study and 65 percent federal and 35 percent local for construction. A specifically authorized study would require a Congressional authorization and a new study start in the Corps' annual appropriation bill. For a project to be successful under this program it must go through a feasibility study to determine if there are sufficient federal economic benefits to justify the project and support the project cost.

Watershed study. A watershed study is like a specifically authorized study in how it is initiated; however, the cost sharing and product are different. The purpose of a watershed study is to provide recommendations for actions that can be taken to solve the identified problems, and the product may take the form of a watershed management plan, watershed assessment, river basin assessment, comprehensive plan or watershed study. Recommendations can include activities under Flood Plain Management Services, PAS, the TPP or the CAP. This is a study-only authority, with the cost sharing being 75 percent federal and 25 percent local. Any Corps implementation of action items in the watershed plan would be done utilizing the other Corps construction authorities.

All these suggested methodologies are dependent upon adequate funding and approvals to proceed.

7.0 REFERENCES

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Walter, Jeanne, and Dean Hughes. 2005. Streambank Revegetation and Protection: A Guide for Alaska. Alaska Department of Fish and Game. https://www.adfg.alaska.gov/index/cfm?adfg=streambankprotection.main.

Appendix A
AERIAL PHOTOGRAPH TIME SERIES

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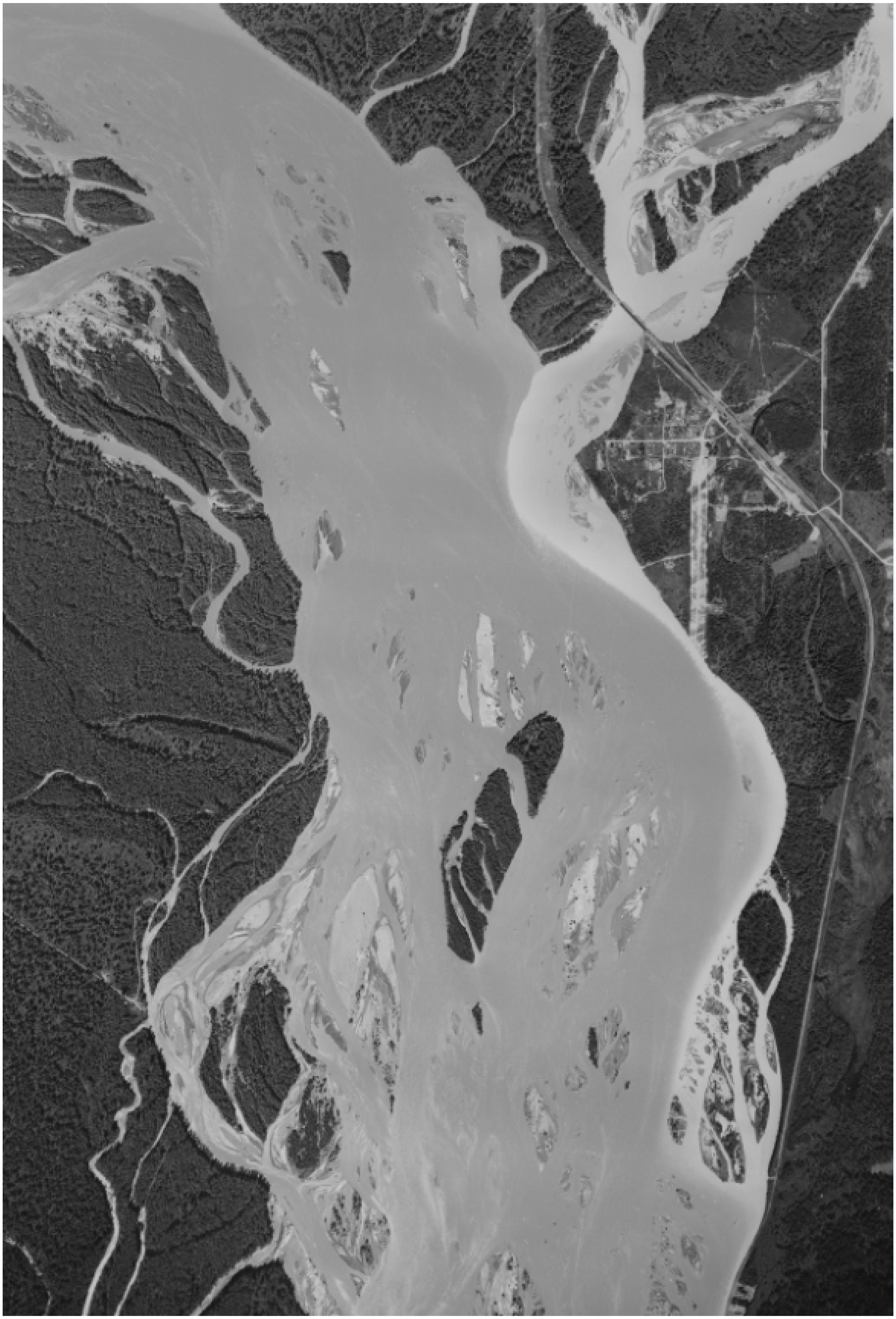
Scale: 1”=1667’



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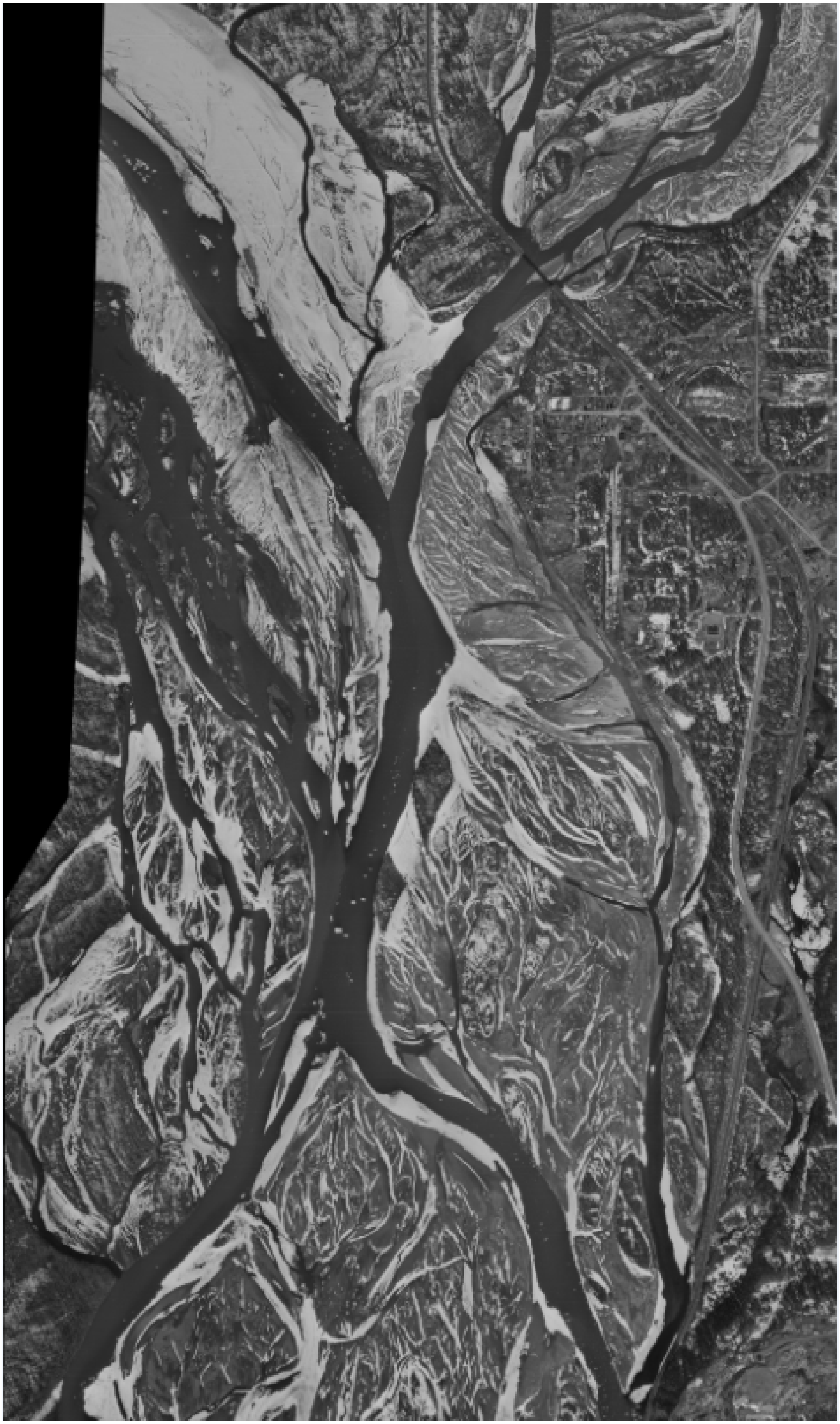

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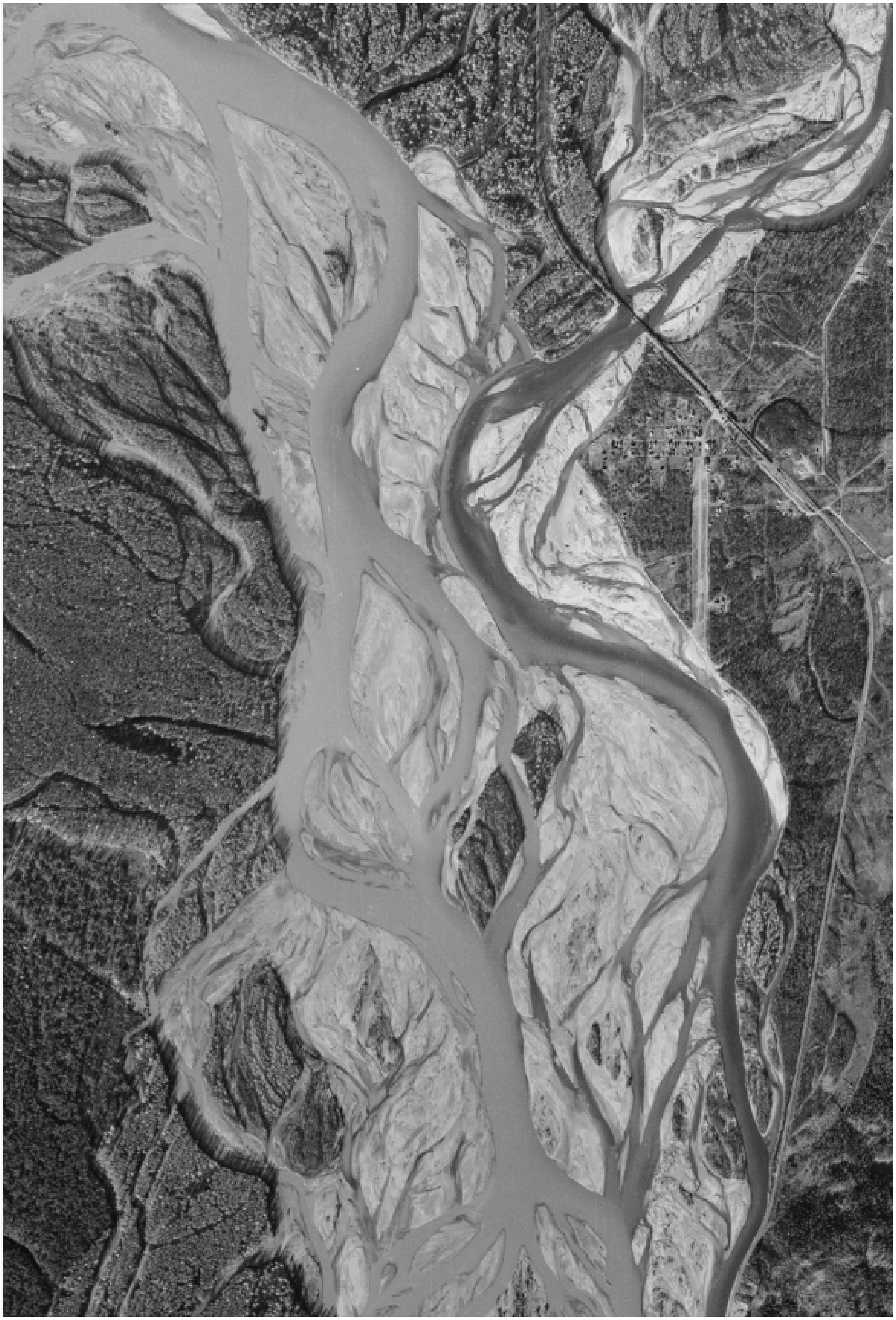

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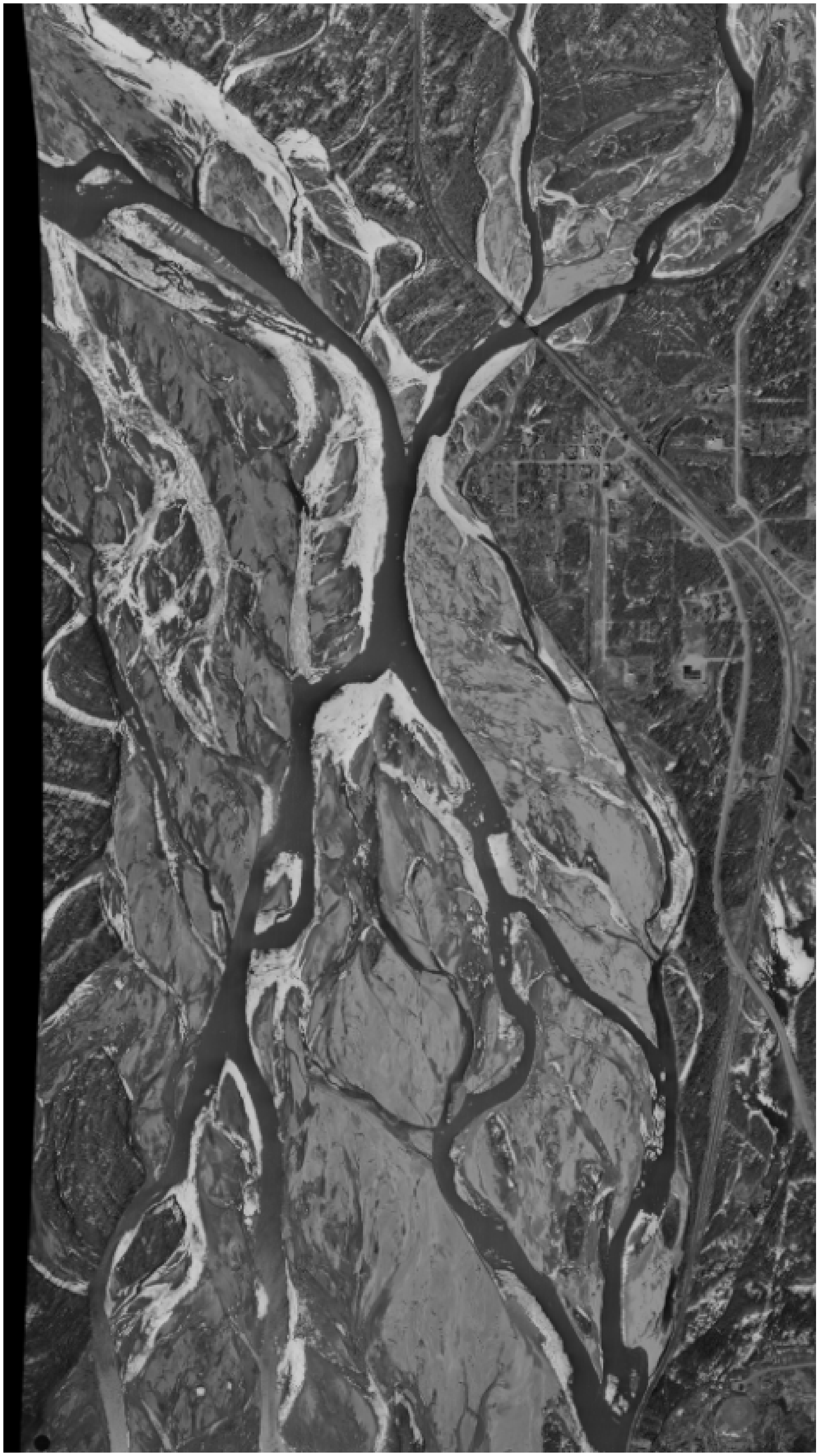

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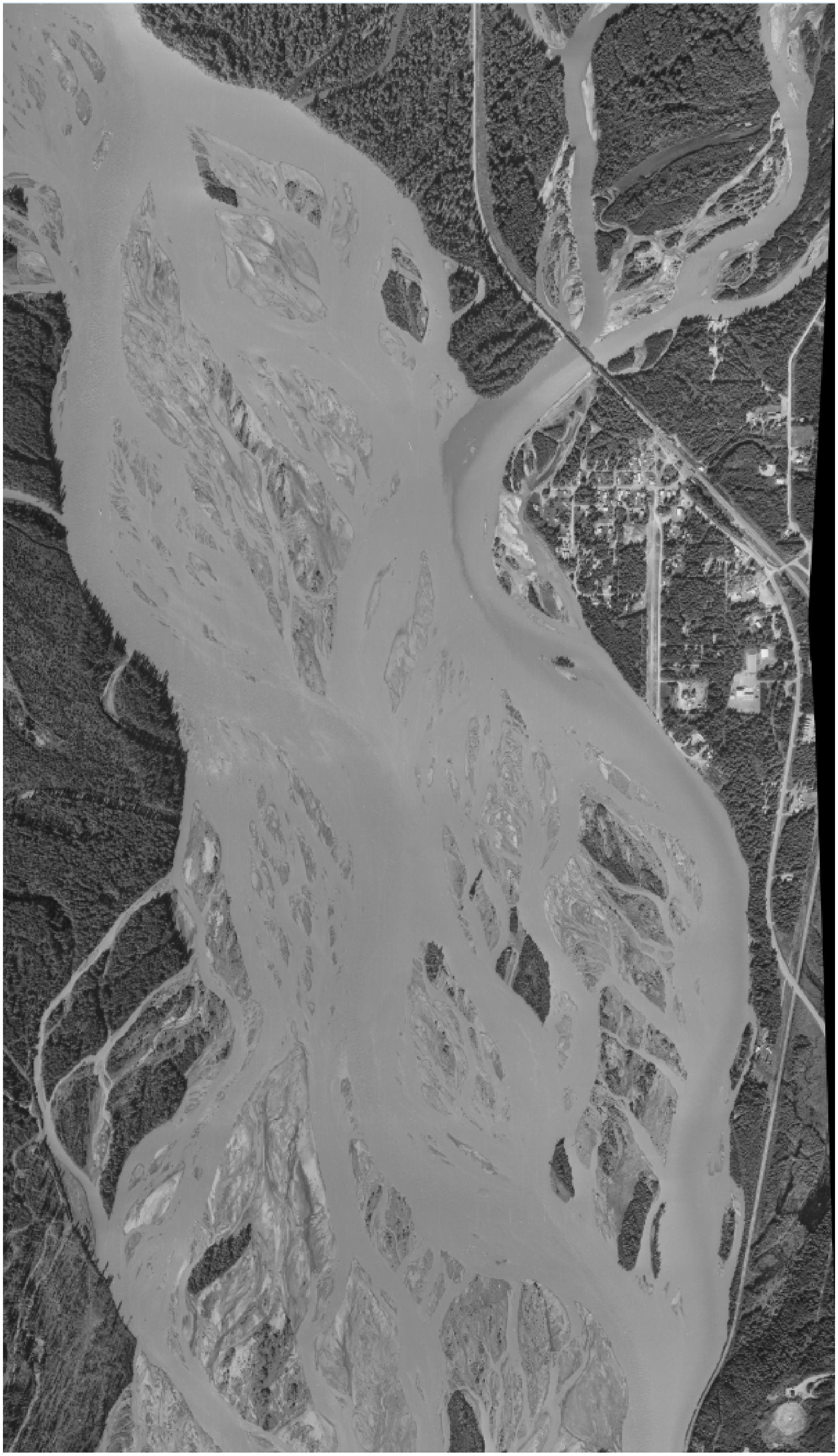
Date: September 09, 1984
Scale: 1”=1000’



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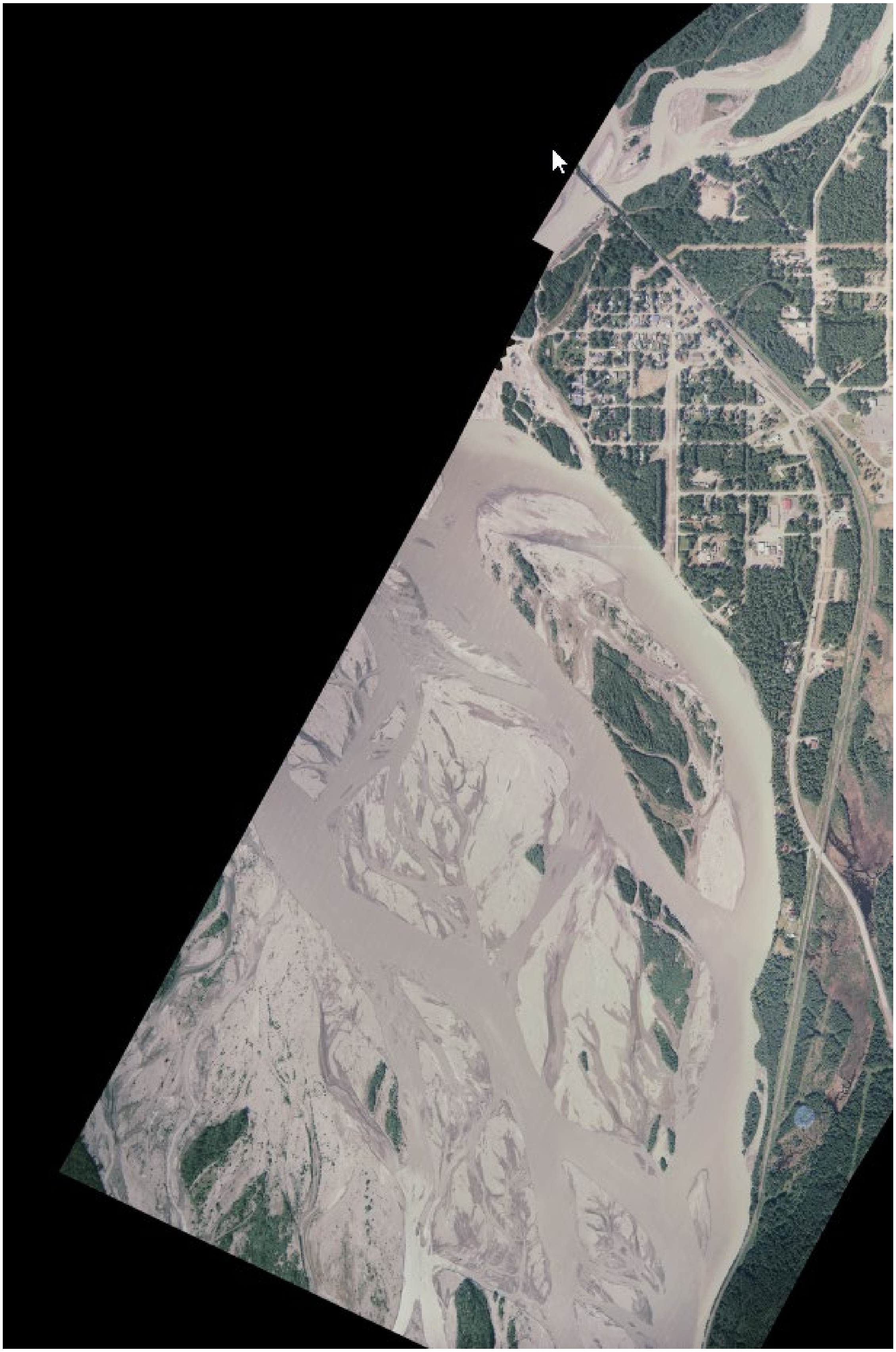
Scale: 1”=1000’

Date: June 17, 1996
Scale: 1”=800’



Date: May 21, 2000
Scale: 1"=1000'

Date: June 29, 2002
Scale: 1”=1500’

Date: August 28, 2006
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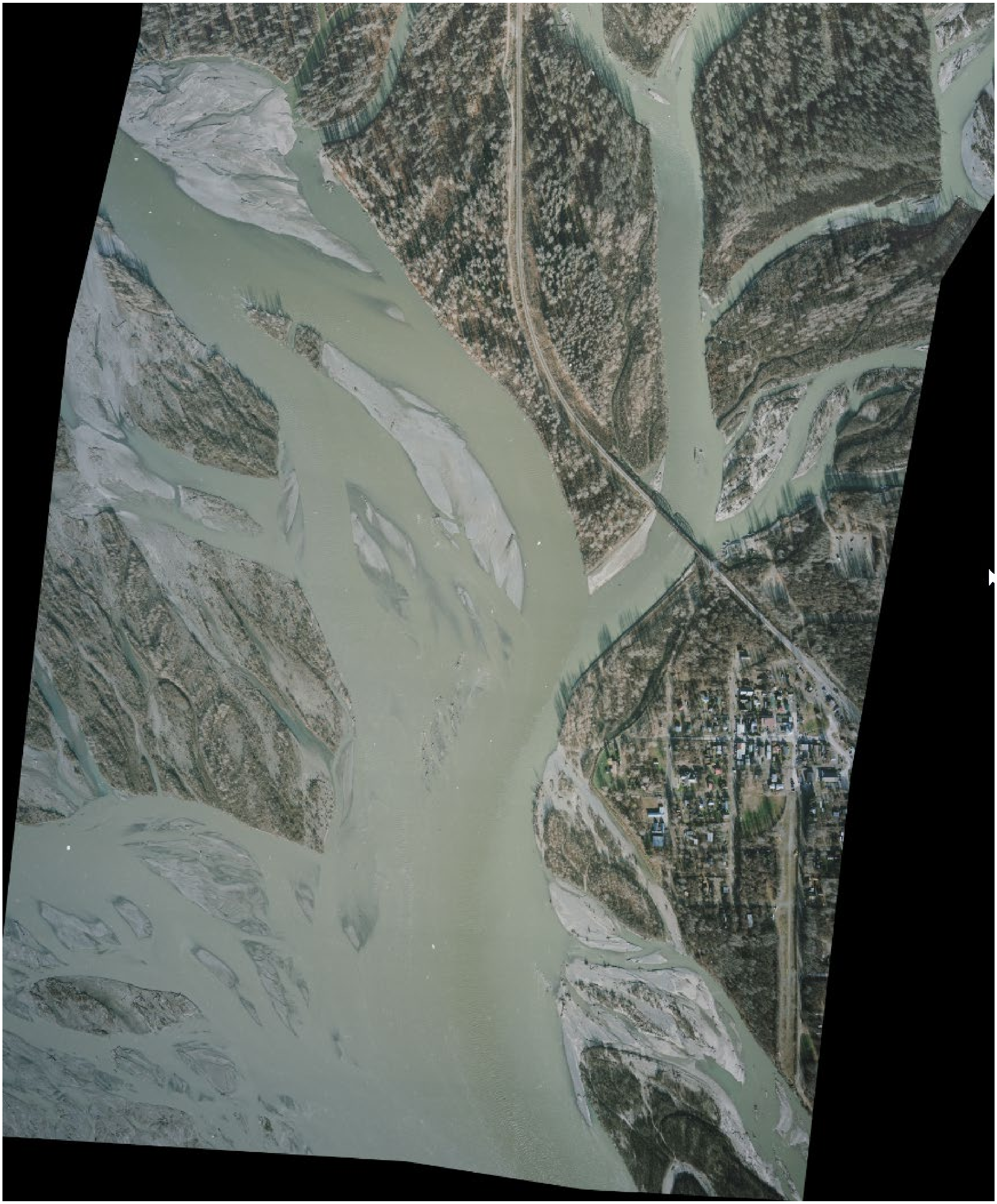
Date: May 29, 2008
Scale: 1”=1000’

Date: May 25, 2011

Date: October 10, 2012
Scale: 1"=1000'



Date: May 10, 2017

Date: May 2020

Date: October 2022