Alpine Satellites Development Plan

2003 Spring Breakup and Hydrologic Assessment

Submitted to

ConocoPhillips

By

Baker

Engineering & Energy

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1.0 Introduction

1.1 Purpose of the 2003 Monitoring Program

Spring breakup studies have been conducted on the Colville River Delta since 1992 and in the National Petroleum Reserve-Alaska (NPR-A) since 2001. These studies have been performed to further the understanding of the hydrologic characteristics associated with breakup flooding which is typically the largest annual flooding event seen in the region. Additionally, breakup studies performed in the Colville River Delta over the past five years have also been conducted in order to satisfy permit stipulations for the Alpine oilfield facilities.

Hydrologic data for the Colville River region and the NPR-A are limited, and continued monitoring efforts are required to provide information needed to ensure the safety of oilfield facilities during flood events. As oil exploration and oilfield facilities construction moves west of the Colville River, such as that proposed as part of the Alpine Satellites Development Plan (ASDP), hydrologic monitoring and evaluation will be an important component in the design and construction of future roads, pads, and other facilities. The project region is shown on Figure 1-1.

The purpose of the 2003 ASDP spring breakup monitoring program was to monitor hydrologic conditions associated with spring breakup on major streams crossed by the proposed ASDP road and pipeline routes, and on selected major streams within the vicinity of the proposed project. The major streams and channels crossed by the proposed project include the Nigliq Channel and Paleochannels located within the Colville River Delta, and the Ublutuoch River within the Fish Creek drainage in the NPRA. Other streams and channels in the ASDP project vicinity that were monitored during spring 2003 include the Main Channel of the Colville River near the upstream end of its delta, and Fish Creek and its tributary Judy Creek. Streams and channels monitored in the 2003 spring breakup program are shown on Figure 1-2. The project was conducted by Michael Baker Jr., Inc. (Baker) for ConocoPhillips Alaska, Inc. (CPAI).

Breakup field data for the ASDP were collected in conjunction with those for a breakup study for the existing Alpine Facilities (Alpine). A report that details 2003 breakup conditions specifically at Alpine was submitted in October 2003 (Michael Baker Jr., 2003). The Alpine and ASDP breakup programs overlap in several important areas with respect to conditions in the Colville River Delta. For completeness, information presented in the 2003 Alpine spring breakup report that applies to the ASDP program is also presented in this report.

1.2 Alpine Satellites Development Plan Overview

The following overview of the ASDP was presented in the October 2003 ASDP Preliminary Draft Environmental Impact Statement (BLM, 2003) as Alternative A, CPAI's proposed project alternative.

CPAI proposes to develop five satellite drilling pads - two in the Colville River Delta adjacent to the NPR-A and three in the NPRA. The pads are called CD-3 (formerly known as CD-North), CD-4 (formerly known as CD-South), CD-5, CD-6, and CD-7. The company proposes to place 20 to 30 wells on each pad and to transport the unprocessed, three-phase (oil, gas, and water) drilling product to the Alpine Central Processing Facility for processing. Processed oil would be placed in the existing pipeline system for transport to the Trans-Alaska Pipeline System.

Gravel roads would connect CD-4 through CD-7 to existing Alpine Field roads. CD-3 would be constructed with a gravel airstrip but without a gravel access road. A bridge across the Nigliq Channel near CD-2 would accommodate road traffic and pipelines. Aboveground pipelines would be supported on vertical support members (VSMs) and would be at elevations of at least five feet above the tundra. Power lines in general would be supported by cable trays placed on the pipeline VSMs. Cable trays would not hang below the pipelines. The power line from CD-6 to CD-7 would be suspended from power poles. Industry and local residents would use the gravel roads. The basic ASDP project features are shown on Figure 1-2.

1.3 Overview of 2003 Spring Breakup Monitoring Program

1.3.1 Water Surface Elevation Monitoring

Water surface elevations were monitored at the various sites using temporary staff gages installed in sets. Each gage set included from two to five staff gages that consisted of metal gage faceplates mounted on two-by-four timbers. Each gage assembly was attached with clamps to

1.5-inch angle iron posts that were driven into the ground either in or adjacent to the stream channel. The elevations of individual gages were tied to established bench marks using level loop surveys and were referenced to the British Petroleum Mean Sea Level datum (BPMSL). All elevations presented in this report are in feet relative to BPMSL unless otherwise noted. The location of each monitoring site was recorded using a handheld Global Positioning System (GPS).

During installation of the temporary staff gages, most of the sites were accessed overland with the assistance of a Hagglunds track vehicle. Helicopter travel was suspended during the initial phase of gage installation in order to reduce conflicts with local goose hunters. Monitoring sites in the southwestern-most portion of the study area were accessed by helicopter after flying a circuitous route to the west along the coast and then south to the vicinity of the sites. This allowed areas in the lower portion of the Fish Creek drainage where goose hunting was taking place to be bypassed.

1.3.1.1. Colville River and Nigliq Channel

A number of temporary staff gage sets were established to monitor water surface elevations on the Colville River and, specifically, within the river's delta along the Nigliq Channel and at the Paleochannels located to the west of the Nigliq Channel. Temporary staff gage placement was concentrated in two general areas. The first area was near permanent survey Monument 01 at the head of the delta (the downstream-most point where the Colville River flows in a single channel, located a short distance downstream of the Itkillik River confluence). The second general area of gage placement was along the northern portion of the Nigliq Channel near permanent survey Monuments 22, 23, and 28. The Colville River monitoring site locations are shown on Figure 1-2. Monitoring sites along the northern Nigliq Channel near the proposed bridge crossing are also shown on Figure 1-3.

The 2003 spring breakup on the Colville River and Nigliq Channel is summarized in Section 3.0.

1.3.1.2. Fish Creek Basin

On Fish and Judy Creeks, five temporary staff gage sets that had been established in 2001 and 2002 during previous monitoring programs were re-established for use within the 2003 monitoring program. In most cases, existing gage sets were found to be incomplete and were supplemented with new gages. Three monitoring locations were re-established on Fish Creek at river miles (RMs) 32.4, 25.1, and 11.7. Two monitoring sites were re-established on Judy Creek at RMs 13.8 and 7.0. The Fish Creek basin monitoring site locations are shown on Figure 1-2. (Note: river mile designations refer to the distance in miles along the stream channel above the stream's mouth or, in the case of tributary streams, above their confluence with the main stream.)

On the Ublutuoch River, two new monitoring sites were established at RMs 1.9 and 6.8. The sites were selected so that hydrologic conditions near two proposed bridge sites could be monitored and evaluated. Each monitoring site consisted of an upstream and downstream set of gages. The Ublutuoch River monitoring site locations are shown on Figure 1-4.

The 2003 spring breakup in the Fish Creek Basin is summarized in Section 4.0.

1.3.2 Reconnaissance Overflights

The 2003 breakup, both on the Colville River and in the NPRA, was characterized by cooler than normal temperatures that slowed regional melting and resulted in a protracted breakup process. As a result, a number of helicopter reconnaissance overflights were conducted to track the progress of regional snowmelt and breakup conditions, and the position and movement of melting fronts on the various streams under study. The submittal of overflight reports was not part of the original scope for this project. However, due to interest from the Bureau of Land Management (BLM), United States Geological Survey (USGS), and the Alaska Pacific River Forecast Center, a division of the National Weather Service, brief reports were submitted every few days via e-mail. Because these periodic reports provide a useful overview of the nature and timing of the 2003 breakup on selected North Slope streams, they are provided in Appendix A.

1.3.3 Ice Surveys

Aerial surveys of channel ice conditions were conducted during visits to the various monitoring sites. Channel ice data and observations were qualitative in nature. During ice observations, channel segments would be examined to determine the extent and condition of channel ice, and its effects on flow conditions. Characteristics observed included whether the channel ice was bottomfast or floating and, if found to be floating, whether it was intact or broken. Ice jams were also documented, as was any backwater or flooding due to the jams.

The complete results of the ice surveys are presented in Section 5.0.

1.3.4 Discharge Measurements

Two flow discharge measurements were made by boat on the Ublutuoch River. The measurement cross-section was located near the proposed bridge site at river mile 6.8, and adjacent to the upstream water surface elevation monitoring site. Discharge measurements were made on 9 and 10 June. Peak stage in the vicinity occurred either late on 6 June or early on 7 June.

Discharge measurements were completed using standard USGS midsection techniques. A Price AA current meter and sounding reel mounted on a boat boom were used to record velocity, and a 30-pound Columbus-type lead sounding weight was used to stabilize the meter. A 1,000-foot-long Kevlar tag line was used to define the cross-section and delineate the measurement sections within the channel. Discharge measurement notes are provided in Appendix B.

1.3.5 Post-Spring Breakup Activities

A post-spring breakup monitoring trip was conducted in mid-July. The trip was performed in order to collect channel and floodplain geometry data and to complete sediment sampling activities on the Ublutuoch River. Tasks included working with Kuukpik/LCMF, Inc. (LCMF) personnel to survey numerous cross-sections on the Ublutuoch River and on the Nigliq Channel, and the collection of a bed material sample from near the proposed RM 6.8 bridge site on the Ublutuoch River.

1.4 Acknowledgements

This investigation could not have been completed without the assistance of numerous people and organizations. A special thanks is extended to James Taalak, the people of the village of Nuiqsut, and to our local guide and part-time interpreter, Dora Nukapigak. Survey support and ground transportation was provided by LCMF. Air transportation was provided by Maritime Helicopters. At Alpine, we would like to recognize Mike Rodriguez, Justin Harth, Don Graika, Randy Kanady, and Shellie Colegrove. Thanks also to Stephanie Leman and Teresa Kent for getting all of our gear to the field and home again. Boats, outboard motors, gasoline, slings, and assorted hardware were provided by Alaska Clean Seas (ACS) – thanks to Tad Smith, Rob Murray, Squeak, and Bob Lebune at ACS. Finally, thanks to Caryn Rea, the CPAI Project Manager.

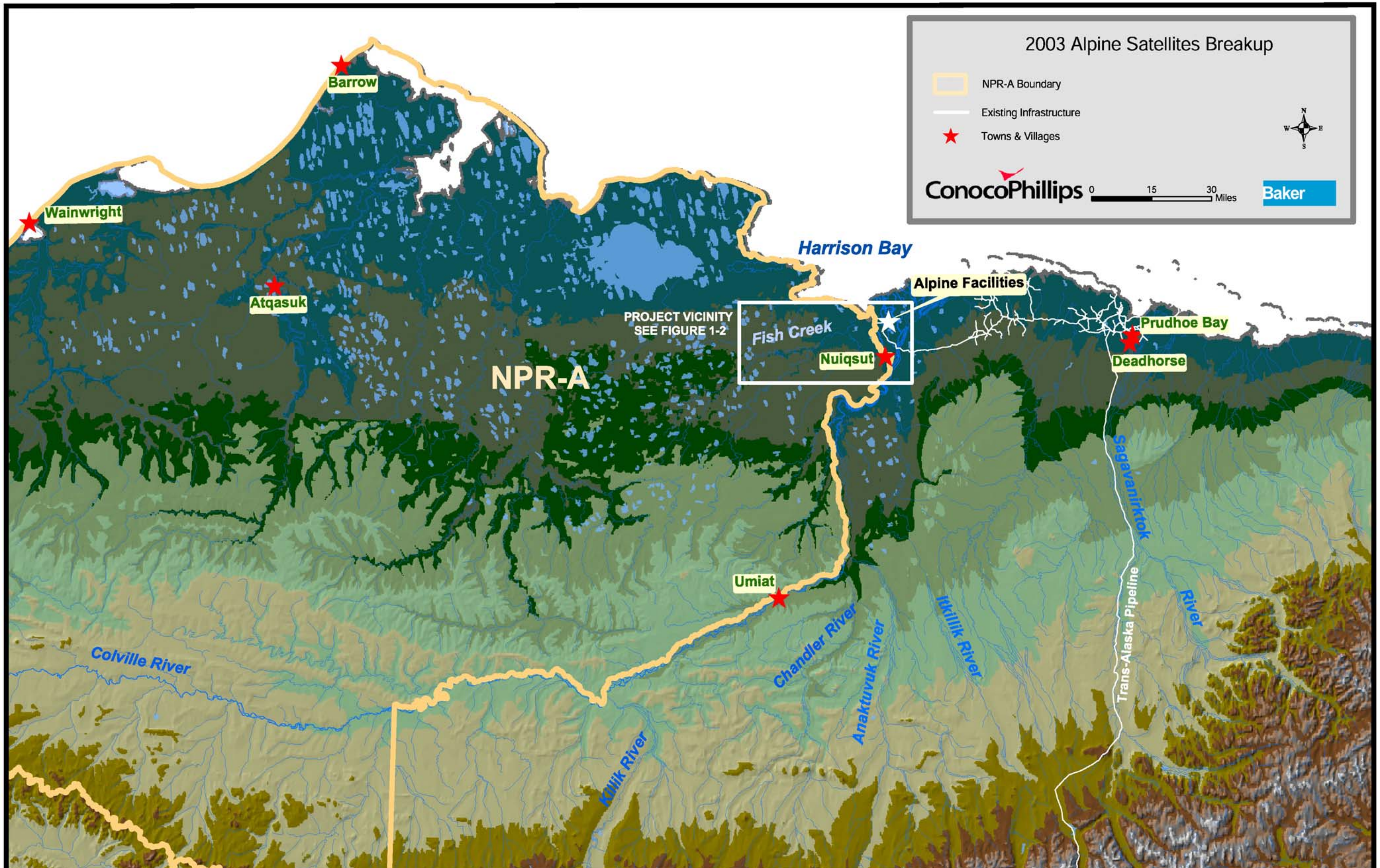

Figure 1-1 **Region Map**

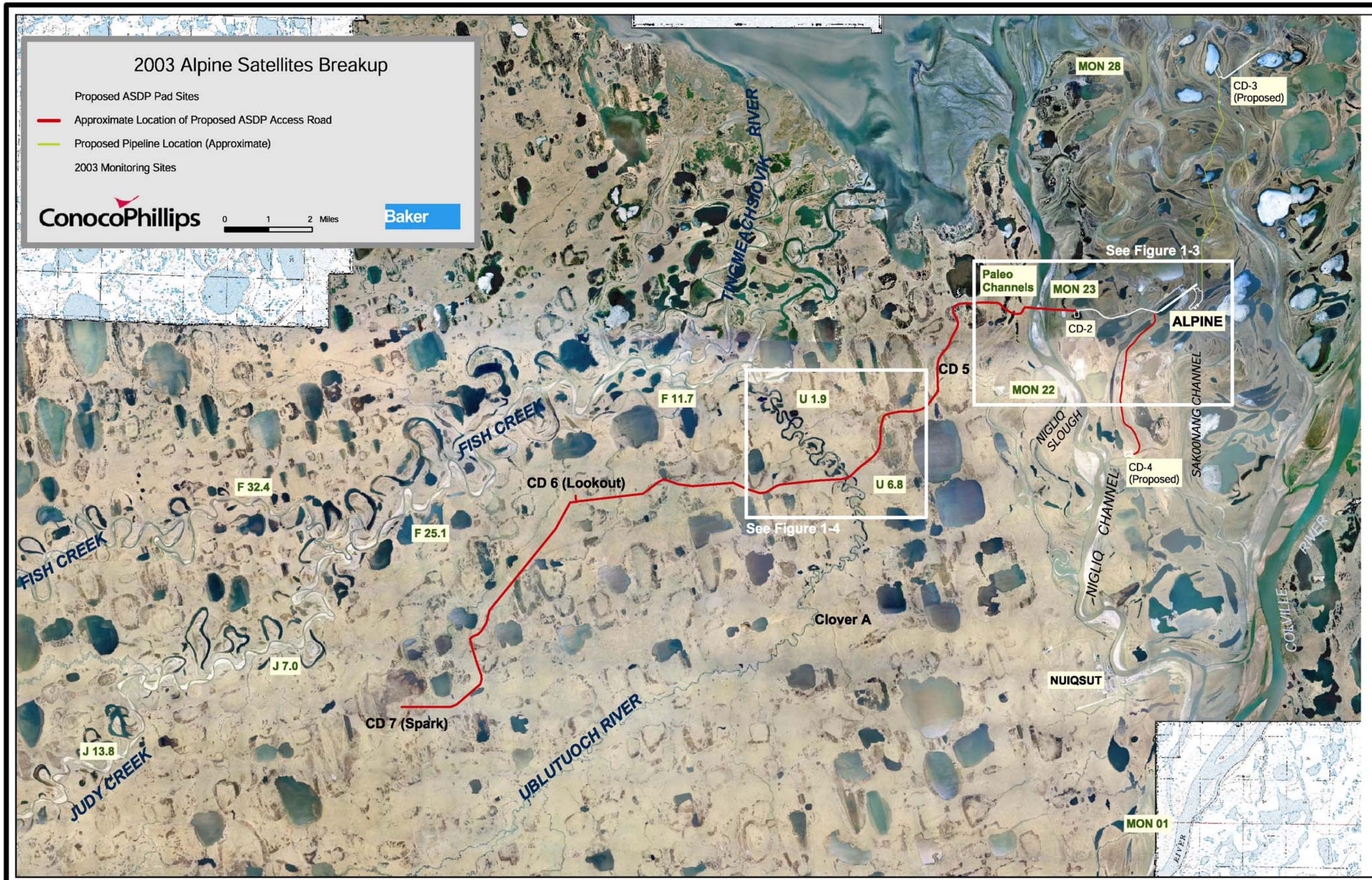

Figure 1-2 Vicinity Map

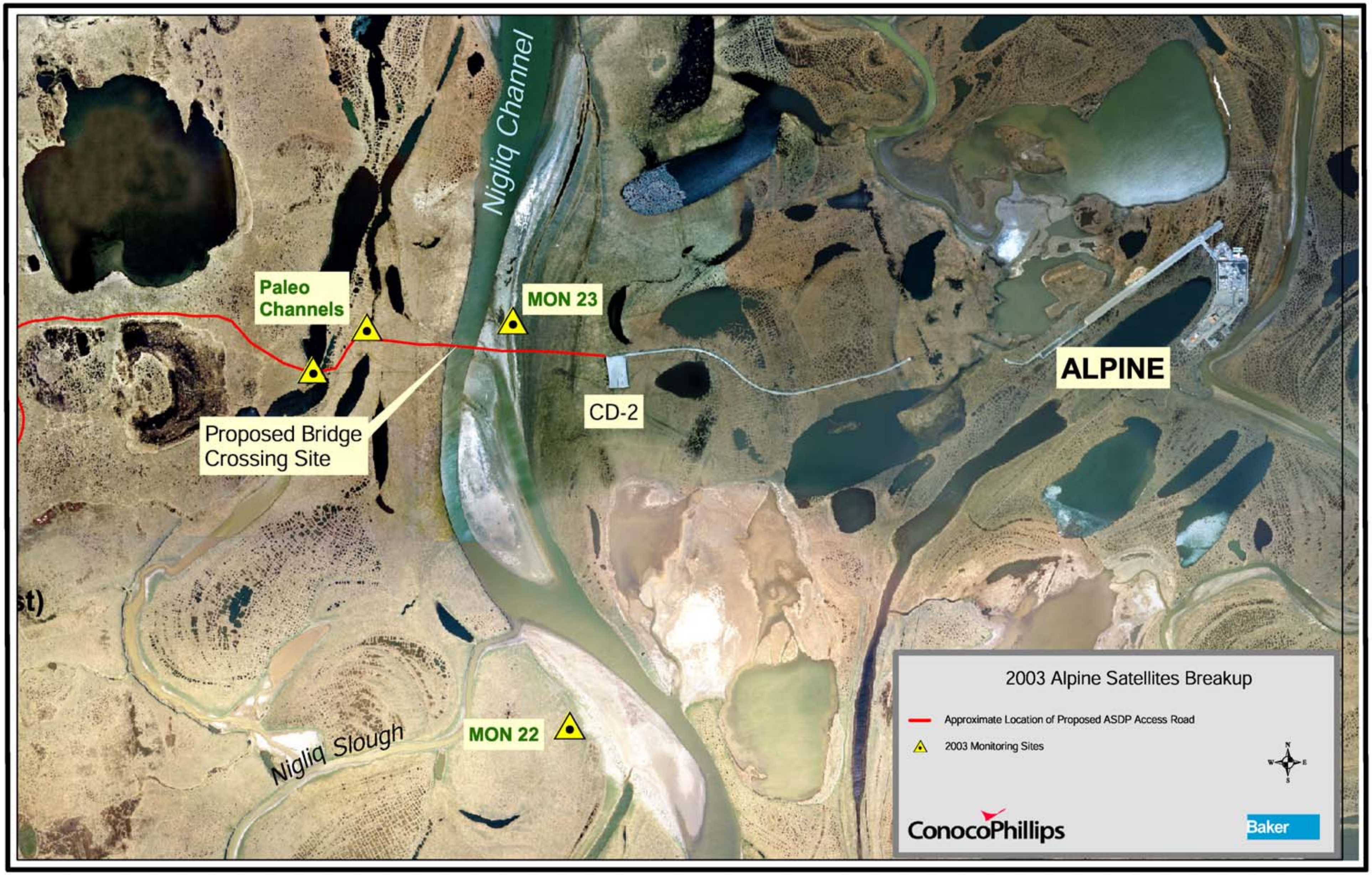

Figure 1-3 **Niqliq Channel Monitoring Site Locations**

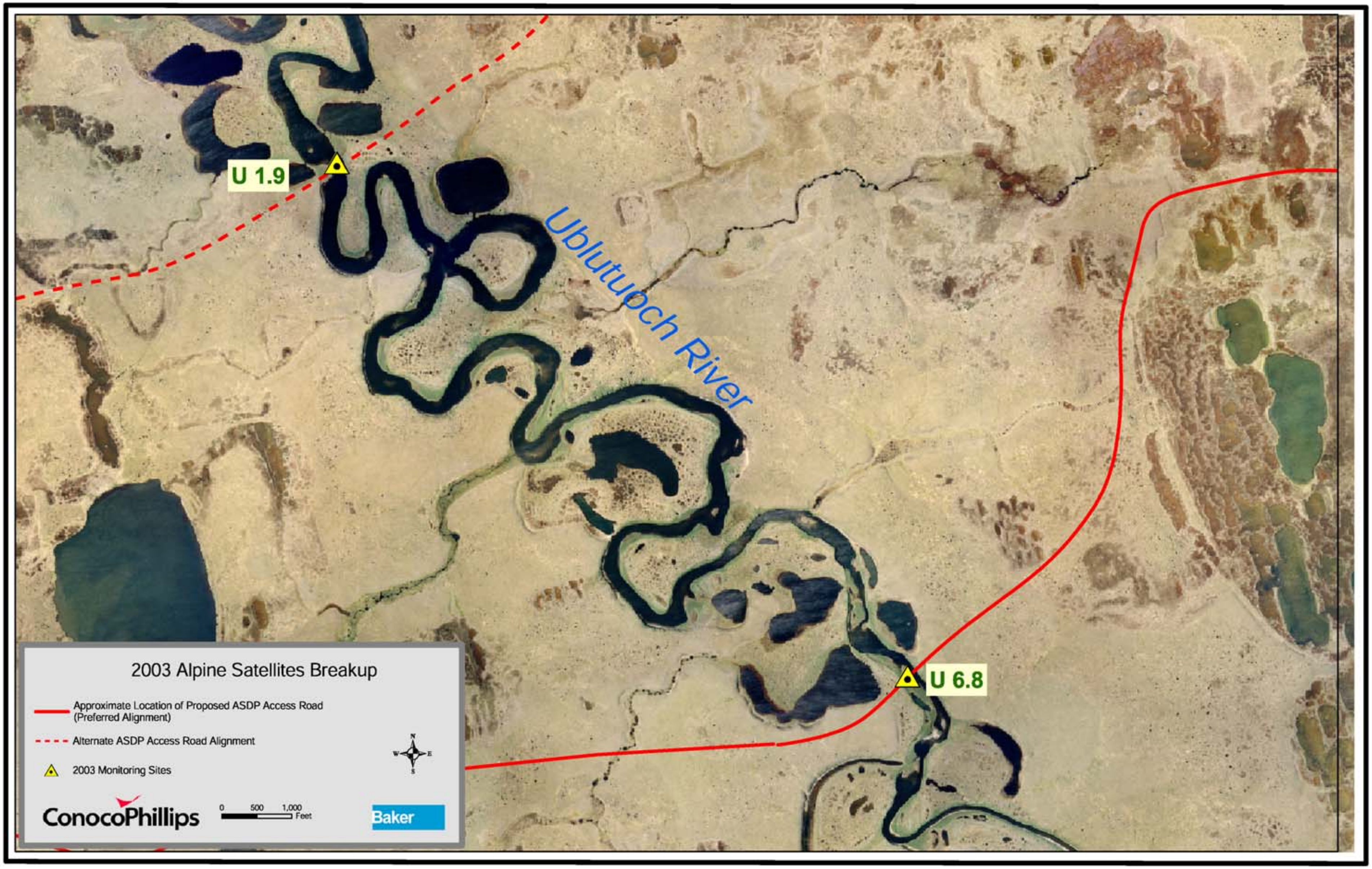

Figure 1-4 **Ublutuoch River Monitoring Site Locations**

2.0 Stream Basin and Monitoring Site Descriptions

The project area for the ASDP is situated within the drainage basins of two major North Slope streams – the Colville River and Fish Creek. A portion of the proposed access road and pipeline facilities for the ASDP will cross the Nigliq Channel and Paleochannels within the northwestern portion of the Colville River Delta, and the Ublutuoch River tributary within the eastern portion of the basin of Fish Creek.

Descriptions of the Colville River and Fish Creek basins are provided below.

2.1 Basin Physiography

2.1.1 Colville River Basin Physiography

The Colville River, with a drainage basin encompassing approximately 21,000 square miles (mi^2), drains almost 30% of Alaska's North Slope (Walker, 1983). Most of the river's major tributaries drain northward from the Brooks Range into the main stem of the Colville, which flows generally eastward before turning north approximately 75 miles south of the coast and flowing into the Beaufort Sea at Harrison Bay. Major Colville River tributaries include the Etivluk, Killik, Chandler, Anaktuvuk, Kikiakrorak, Kogosukruk, and Itkillik Rivers. The drainage basin of the river is shown on Figure 2-1.

The Colville River drainage basin is situated within three physiographic provinces – the Arctic Coastal Plain, Arctic Foothills, and Brooks Range - with the bulk of the river's basin (64%) located within the Arctic Foothills province (Walker, 1976). The ASDP project area lies entirely within the Arctic Coastal Plain province. Low relief, poor drainage, tundra vegetation, numerous lakes, low-gradient sinuous stream channels, and abundant permafrost-related landforms characterize this physiographic province.

Where the Colville River reaches the Beaufort Sea, it forms a delta more that 25 miles long that extends over an area of approximately 250 mi^2. The entire delta lies within the Arctic Coastal Plain physiographic province. At the head of the delta, a few miles north of the river's confluence with the Itkillik River, its channel pattern changes from a single meandering channel to a complex system of deltaic distributary channels. The bulk of the flow in the delta is carried by its two major distributaries – the East and Nigliq Channels. During spring breakup these two channels carry approximately 90% of the flow in the delta and approximately 99% of the delta's flow during low water periods (Walker, 1983). It has been estimated that the Nigliq Channel carries about 20% of the river's flow during spring breakup flooding (Arnborg et al, 1967) but proportions of as much as 38% of peak breakup flows have been reported (Jorgenson et al, 1996). Other major distributary channels of the delta include the Sakoonang, Tamayagiaq, Ulamnigiaq, East and West Ulamnigiaq, Kupigruak, and Elaktoveach Channels.

The scars of two formerly active delta distributary channels – termed the Paleochannels - are situated between the Nigliq Channel and the far western margin of the Colville River Delta. These channels, which will be crossed by the proposed ASDP access road connecting CD-2 and CD-5, are occupied by marshes and shallow lakes, and only carry flowing water during low frequency, high magnitude flood events.

A major side channel of the Nigliq Channel – the Nigliq Slough – begins along the left (west) bank of the Nigliq Channel approximately three river miles north of the village of Nuiqsut. The slough flows generally northward for approximately six miles before rejoining the Nigliq Channel to the south of CD-2. Ice jamming and overflow from the Nigliq Slough are the expected sources for floodwaters entering the Paleochannels. The Nigliq Slough and Paleochannels are shown on Figures 1-2 and 1-3.

2.1.2 Fish Creek Basin Physiography

Fish Creek and its tributaries flow generally northeastward and enter the Harrison Bay of the Beaufort Sea just west of the Colville River Delta. Within the approximately 1,830-mi^2-drainage basin of Fish Creek are situated three significant tributary sub-basins. These include the Ingok Creek basin with a drainage area of 270 mi^2, the 665-mi^2 Judy Creek basin, and the basin of the Ublutuoch River with an area of approximately 245 mi^2. Judy Creek and the Ublutuoch River join the main stem of Fish Creek at approximately 26 and 10 miles, respectively, above the mouth of Fish Creek (URS, 2003). Approximately 12 miles upstream of where Fish Creek enters

Harrison Bay, the channel splits into two branches – the main Fish Creek channel (the right branch when facing downstream) and the Tingmeachsiovik River distributary channel. The mouth of the Tingmeachsiovik River enters Harrison Bay several miles to the northwest of the main branch of Fish Creek. The drainage basin of Fish Creek is shown on Figure 2-2.

Almost the entire Fish Creek basin is situated within the Arctic Coastal Plain physiographic province with the exception of the upper portion of the Judy Creek basin, which extends southward into the Arctic Foothills physiographic province.

2.2 Climate

The ASDP project area is situated within the Arctic Coastal climate zone. This zone is characterized by long cold winters and short cool summers. The mean annual temperature is approximately 10 degrees Fahrenheit, and average daily temperatures can fall below freezing on 200 or more days of the year. The annual precipitation total for the area is 7.8 inches, with 3.4 inches falling as rain and the remainder as snow. Seasonal snow cover typically begins in late September and lasts until late May to mid-June.

Windy conditions are common along the Arctic Coast. Prevailing northeasterly winds blow cold air off the Arctic Ocean. These winds are strongest in the winter and result in significant drifting and redistribution of the snow pack. Significant evaporation is associated with summer winds. The mean annual wind speed in the area is approximately 12.8 miles per hour (USDOI, 2003).

2.3 North Slope Basin Hydrology

North Slope streams share common hydrologic characteristics due to the Arctic climate and the continuous nature of regional permafrost. For most of the year, North Slope streams are frozen to their beds and cease flowing. Groundwater influx to streams is essentially nonexistent, with shallow groundwater being restricted to isolated zones beneath deep lakes and large, deep river channels. Spring snowmelt produces most of the annual flow that occurs in these streams. Annual peak floods commonly occur in the spring during breakup but can occasionally occur in the summer or fall from rain events in some mountainous basins (such as that of the Sagavanirktok River located to the east of the ASDP project area). Summers are marked by generally declining low flow conditions with occasional temporary increases due to rainfall events. Freeze-up occurs in the fall and results in the cessation of flow until the following spring. Freeze-up usually begins at the coast and proceeds southward into the foothills and mountains while spring breakup usually begins in the higher terrain to the south and proceeds northward.

2.3.1 Colville River Hydrology

Spring breakup in the delta normally occurs in either late May or early June but can occur as early as mid-May or as late as mid-June. As waters from snowmelt within Brooks Range tributaries enter the delta, low water channel ice formed over the winter lifts, breaks apart, and either flows out to the sea or is trapped along channel margins and bars as river stage drops. This process of breakup of the winter ice cover frequently results in ice jams within the delta. Ice jams can cause significant overbank flooding, particularly during lower magnitude flood events. Historically, annual peak floods have always occurred during the spring in the Colville River Delta. Overbank flooding from summer or fall rain events has not been documented.

Observations from basin reconnaissance overflights made during the 2002 and 2003 spring breakups suggest that Colville River tributaries in the eastern portion of the river's drainage basin, in particular, the Anaktuvuk and Chandler Rivers, are commonly the first to begin flowing. There may be a lag of several days or more after the lower, northeastern portion of the river has begun flowing before flow from western tributaries upstream from Umiat reach the main channel of the river.

A summary of breakup data obtained at the head of the Colville River Delta between 1962 and 2003 is presented in Table 2-1.

During the winter, in the deeper distributary channels in the seaward portion of the Colville River Delta, water remains unfrozen under an ice cover that can reach more than six feet in thickness. Saline ocean water is able to move southward into the delta and replace fresh water under the ice. Although it has never been conclusively documented, it is possible that some fresh water may flow down the East Channel of the river during the winter.

Table 2-1 Summary of Breakup Data Obtained at the Head of the Colville River Delta, 1962 - 2003

Year	Approximate Date of First Flowing Water	Peak Water Surface Elevation (ft)	Date of Peak Water Surface Elevation	Peak Breakup Discharge (cfs)	Notes
2003	27 May	13.76	5 June	350,000	1,10,11
2002	23 May	16.87	24 May	300,000	1,2,10,11
2001	5 June	17.37	10 June	300,000	1,3,10,11
2000	8 June	19.33	11 June	580,000	1,4,10,11
1999	22 May	13.97	30 May	203,000	1,5,6,10,11
1998	21 May	18.11	29 May	213,000	1,7,10,11
1997	20 May	15.05	29 May	177,000	1,10,11
1996	15 May	17.19	26 May	160,000	1,8,10,11
1995	8 May	15.7	16 May	233,000	9,10,11
1994	16 May	13.0	25 May	159,000	9,10,11
1993	–	20.0	31 May	379,000	9,10,11
1992	–	14.7	2 June	188,000	9,10,11
1977	–	19.9	7 June	407,000	9,10,11
1973	25 May	–	8 June	–	9,10,11
1971	23 May	–	2 June	–	9,10,11
1964	28 May	–	3 June	–	9,10,11
1962	19 May	13.2	14 June	215,000	9,10,11

Notes:
1. Water surface elevations are based on monuments set by Lounsbury & Associates in 1996 and are based on the British Petroleum mean sea level (BPMSL) datum.
2. Data from Michael Baker, Jr., Inc., 2002b.
3. Data from Michael Baker, Jr., Inc., 2001.
4. The peak breakup discharge was estimated to range between 570,000 to 590,000 cfs. Data from Michael Baker, Jr., Inc., 2000.
5. Data from Michael Baker Jr., Inc., 1999.
6. Water was flowing in the Colville River at Umiat on this day. It is not known if this was the first day of flow, therefore, it is not known if water was flowing on the delta prior to this date.
7. Data from Michael Baker Jr., Inc., 1998.
8. Data from Shannon & Wilson, Inc., 1996.
9. Data from Jorgenson et al., 1996. The water surface elevations presented in this report were based on an elevation of 41.99 feet for the USCGS monument “River.” In 1996 Lounsbury & Associates surveyed USCGS monument “River” and tied it to BPMSL. The elevation of “River,” based on BPMSL, is 41.83 feet. The values presented in this table are based on the elevation for “River” that is based on BPMSL.
10. The timing of the peak breakup discharge is not necessarily coincident with that of the peak breakup water surface elevation. It is not uncommon for the peak discharge to occur sometime after the peak water surface elevation, at a time when channel ice has lifted and cleared from the channel, increasing the channel’s cross-section and flow-carrying capacity.
11. For the 2003 data, the date of first flowing water represents the first date on which water was noted to be flowing in the channel at the head of the delta (near Monument 01). In other years, the date of first water may indicate the first day that water reached temporary staff gages installed at the head of the delta. The timing of the two events – the day that water was first noted flowing in the channel vs. the day that water was first noted reaching temporary staff gages – will not necessarily be coincident in all years.

The results of a flood frequency analysis for the Colville River Delta are presented below in Table 2-2. The results are from an updated analysis performed by Baker and Hydroconsult EN3 Services, Ltd. (Hydroconsult) in 2002 in order to provide recommended flood frequency values for the design of facilities within the delta.

Table 2-2 Colville River Delta Flood Frequency Analysis Results

Recurrence Interval	Flood Peak Discharge [ft3/sec]
2-year	240,000
5-year	370,000
10-year	470,000
25-year	610,000
50-year	730,000
100-year	860,000
200-year	1,000,000

2.3.2 Fish Creek Basin Hydrology

The general hydrologic characteristics of North Slope streams discussed above apply to Fish Creek and its tributaries as well, based on observations made during the past three years. Like other North Slope streams, Fish Creek and its tributaries are frozen to their beds during the winter; produce most of their annual flow and their annual peak floods in the spring during breakup; display generally declining low flow conditions in the summer; have little or no influx from groundwater; and cease flowing in the fall during freeze-up.

Based on observations during the past three years, the timing of spring breakup in the Fish Creek basin occurs at roughly the same time as breakup in the Colville River Delta. Because the southern portion of Judy Creek's drainage basin is in the Arctic Foothills physiographic province, it is often the first tributary to breakup within the Fish Creek basin. The timing of breakup on the Ublutuoch River is more variable and can either lag behind or precede breakup on Judy Creek and upper Fish Creek. Regardless of when breakup begins on the Ublutuoch River, however, it consistently reaches its peak water surface elevation within a few days after the arrival of first water. Data on the timing of the arrival of first water on temporary staff gages and the timing of the peak water surface elevation for selected ASDP spring breakup monitoring sites are provided below in Table 2-3. The sites include those at Monument 01 at the head of the

Colville River Delta (Colville R.); Fish Creek RM 32.4 (Fish 32.4, located upstream from the Judy Creek and Ublutuoch River confluences); Judy Creek RM 7.0 (Judy 7.0); and Ublutuoch River RM 13.7/6.8 (Ublu 13.7/6.8; the RM 13.7 site was not monitored in 2003 and the RM 6.8 site was not monitored prior to 2003).

Table 2-3 Timing of First Water and Peak WSE at Selected ASDP Monitoring Sites

	Colville R.	Fish 32.4	Judy 7.0	Ublu 13.7/6.8
2001				
First Water	5 June	6 June	5 June	8 June
Peak WSE	10 June	15 June	10 June	10 June
2002				
First Water	23 May	21 May*	21 May*	21 May*
Peak WSE	24 May	27 May	25 May	22 May
2003				
First Water	27 May	4 June	1 June	5 June
Peak WSE	5 June	8 June	6 June	7 June

*Water on Fish Creek and its tributaries had already reached Harrison Bay by 21 May when the URS field crew arrived on site.

Data from URS, 2001; URS, 2003; and Michael Baker Jr., 2003.

For the ASDP project, the Fish Creek tributary of most interest is the Ublutuoch River. The proposed ASDP access road will most likely cross the Ublutuoch near river mile 6.8. The following two report sections address hydrologic issues specific to the Ublutuoch River and the proposed bridge sites.

2.3.2.1. Ublutuoch River Bridge Crossings Flood Frequency Analysis

The results of a flood frequency analysis for the proposed ASDP access road bridge crossings of the Ublutuoch River near river miles 6.8 and 1.9 are presented below in Table 2-4 and 2-5, respectively. The results are from an analysis performed by URS Corporation (URS, 2003) in order to provide recommended flood frequency values for the design of facilities within the Fish Creek basin. The results rely on drainage area estimates for the bridge site produced by Baker.

Table 2-4 Ublutuoch River RM 6.8 Bridge Site Flood Frequency Analysis Results

Recurrence Interval	Flood Peak Discharge [ft^3/sec]
2-year	2,290
5-year	3,670
10-year	4,680
25-year	6,140
50-year	7,380
100-year	8,670
200-year	10,130
Note: Drainage area at the Ublutuoch River RM 6.8 bridge site is estimated to be 227 mi^2.	

Table 2-5 Ublutuoch River RM 1.9 Bridge Site Flood Frequency Analysis Results

Recurrence Interval	Flood Peak Discharge [ft^3/sec]
2-year	2,430
5-year	3,880
10-year	4,940
25-year	6,480
50-year	7,780
100-year	9,130
200-year	10,660
Note: Drainage area at the Ublutuoch River RM 1.9 bridge site is estimated to be 241 mi^2.	

2.3.2.2. Ublutuoch River 100-Year Floodplain Delineation

One-dimensional water surface profile calculations were used to estimate the hydraulic conditions near the proposed road and pipeline crossings of the Ublutuoch River, and to delineate the 100-year floodplain along an approximately 12-mile section of the lower river. The analysis was performed using the Hydraulic Engineering Center River Analysis System software (HEC-RAS), developed by the U.S. Army Corps of Engineers, Hydrologic Engineering Center (US Army Corps of Engineers, 1998).

Seven river cross-sections surveyed between 2001 and 2003 by Lounsbury & Associates, Inc. (Lounsbury) and LCMF were used to model the Ublutuoch River between 1.8 and 13.7. Values for Manning's roughness coefficient were estimated for both the main channel and floodplain. In the vicinity of the proposed bridge crossing location (RM 6.8), main channel roughness estimates were produced by back-calculating roughness values from discharge measurements. In the vicinity of river miles 13.7 and 8.0, roughness values estimated during previous hydrologic investigations (URS, 2002) were used. In other sections of the channel and floodplain, roughness estimates were based on visual observations and engineering judgment based on previous experience.

Water surface profiles were completed for the 100-year flood peak discharge. It was assumed that the flood was conveyed over bottomfast channel ice, consistent with observations made during the previous three spring breakups (URS, 2001 and 2003).

Water surface elevation and water velocity data for the 100-year flood at surveyed cross-sections along the lower Ublutuoch River are presented in Table 2-6. The 100-year floodplain between RMs 1.8 and 8.0 is shown on Figure 2-3. A HEC-RAS output report for the 100-year flood model is presented in Appendix C.

Table 2-6 Ublutuoch River 100-Year Flood Water Surface Elevations and Velocities

Cross-section[1]	Water Surface Elevation[2] (ft BPMSL)	Velocity (ft/sec)
RM 1.9 Downstream (1.8)	8.65	1.8
RM 1.9 Upstream (2.1)	8.75	2.2
RM 4.8 (4.8)	10.50	2.1
RM 6.8 Bridge (6.8)	12.55	4.2
RM 6.8 Bridge Upstream (6.9)	12.75	4.0
RM 8.0 (8.0)	13.65	4.9
RM 13.7 (14.1)	21.65	3.2

Notes:
1. In the Cross-section column, the values in parentheses indicate the river stationing used in the HEC-RAS model.
2. Water surface elevations are rounded to the nearest five hundredths of a foot.

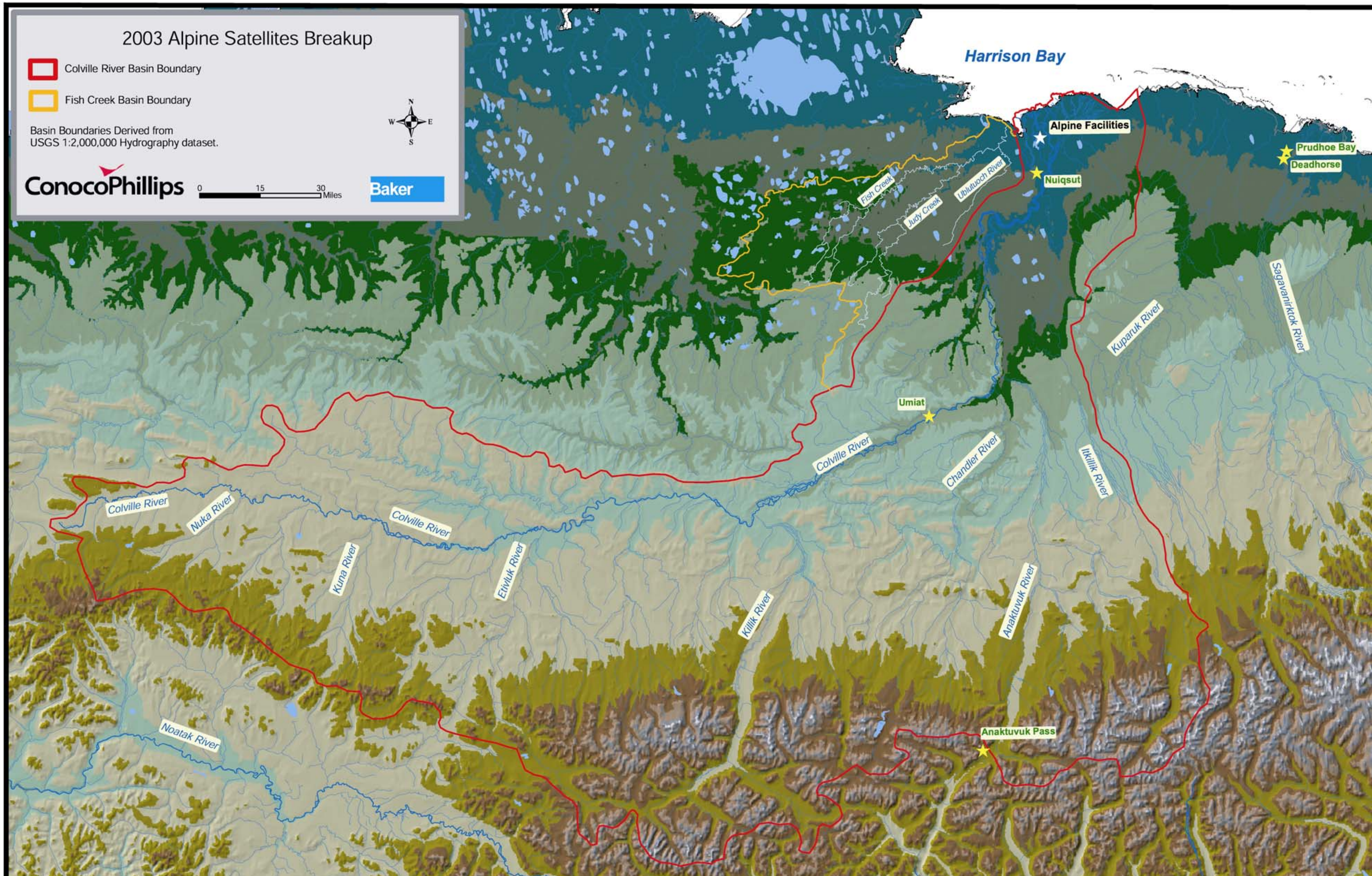

Figure 2-1 **Colville River Basin**

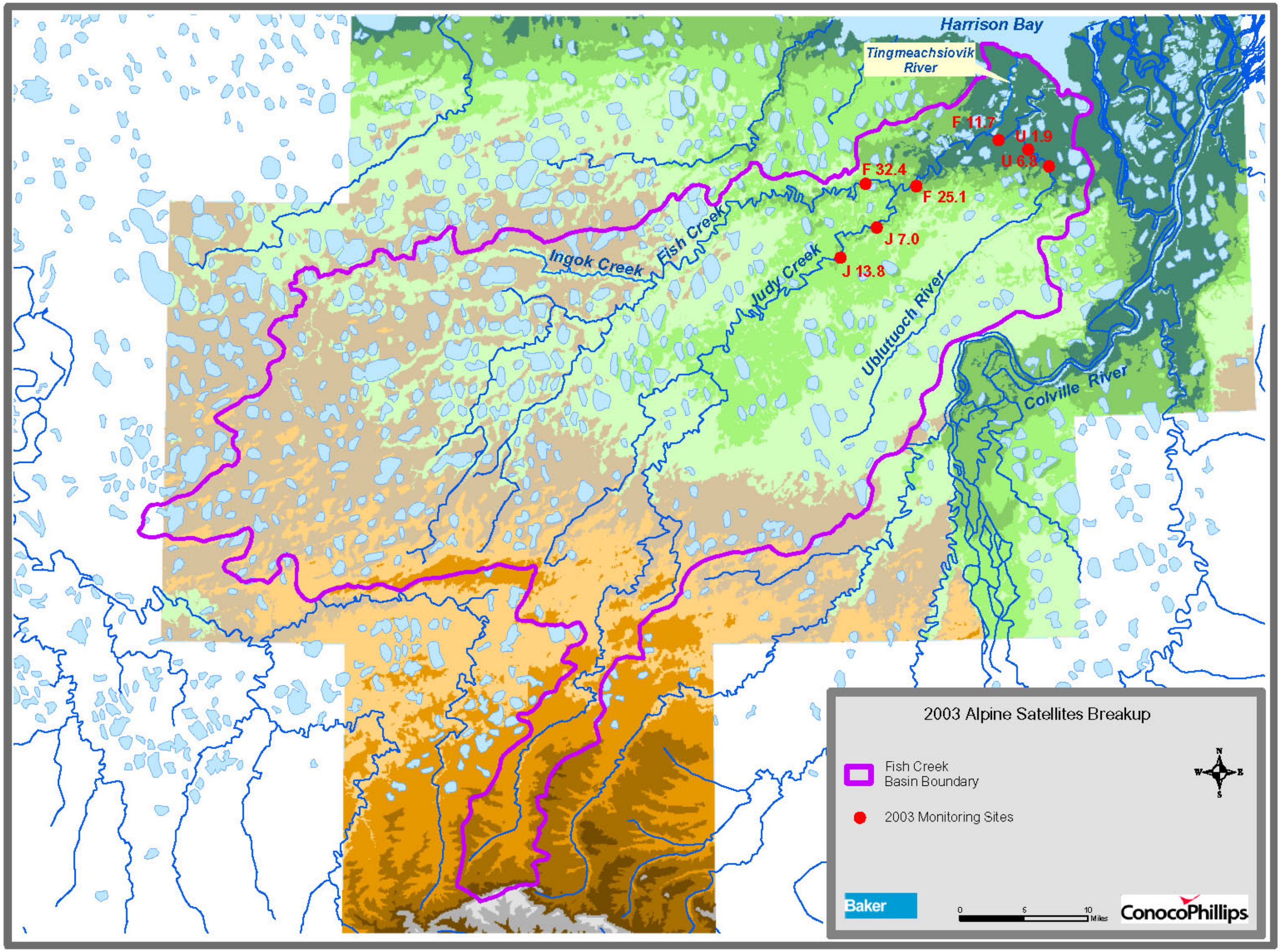

Figure 2-2 Fish Creek Basin

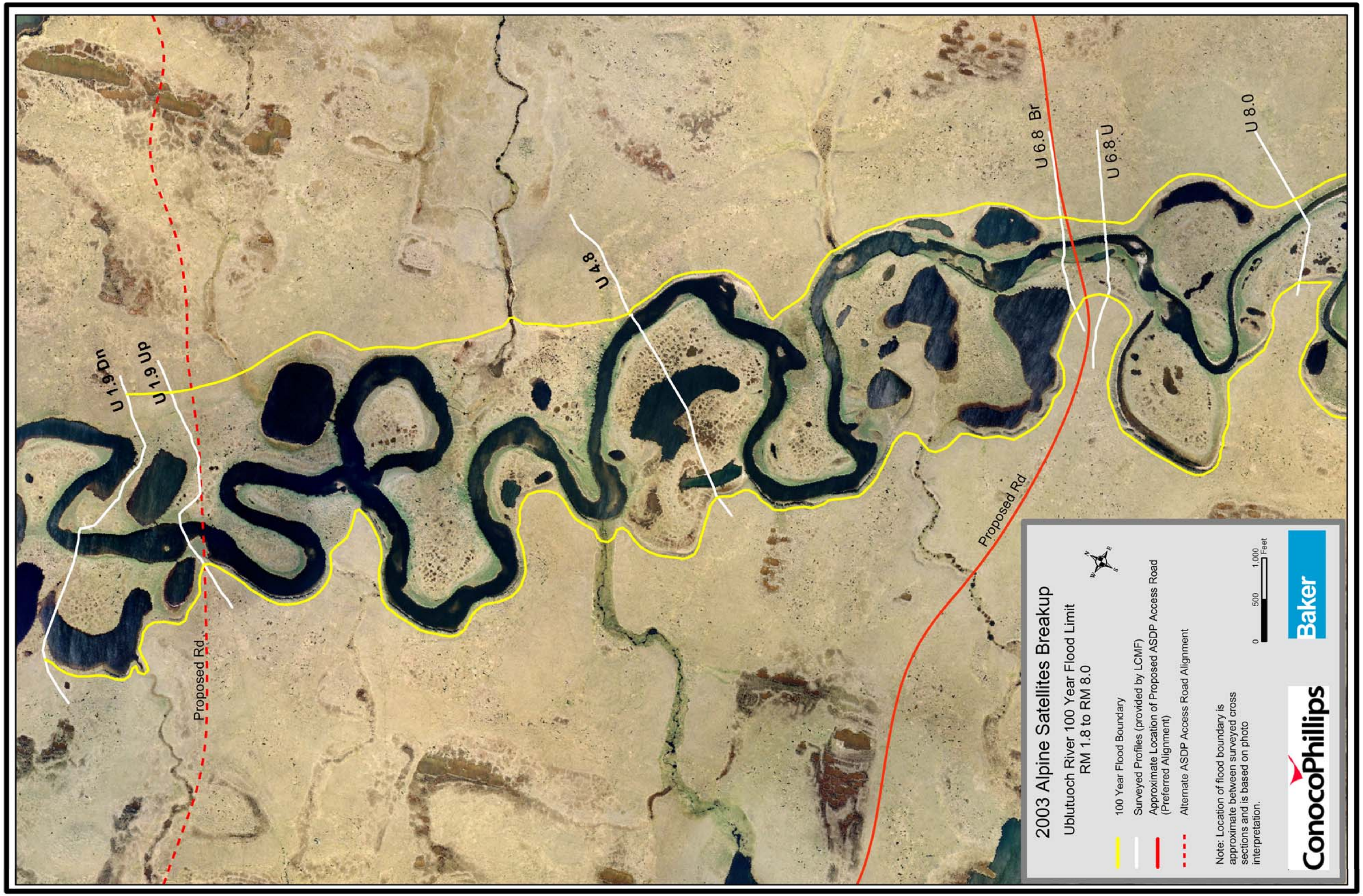

Figure 2-3 Ublutuoch River 100 Year Flood Limit– RM 1.8 to RM 8.0

3.0 2003 Colville River Delta Spring Breakup Summary

3.1 2003 Spring Breakup at Monument 01

3.1.1 Monument 01 - Water Surface Elevations and Observations

Water was first noted flowing in the channel in the Monument 01 reach on 27 May, but did not rise high enough to reach any of the gages in that vicinity until 1 June. Measurements of temporary staff gages in the delta began on 31 May when floodwaters first reached the gages near Monument 23 and continued until 13 June when the last of the temporary gages in the Monument 01 vicinity were removed. Water surface elevation and observation records for temporary staff gages at Monument 01 are presented in Tables 3-1 through 3-3.

A double peak stage was observed during the 2003 spring breakup at the Monument 01 monitoring site. The initial peak stage occurred in either the afternoon or evening of 5 June or in the morning of 6 June at a water surface elevation of 13.76 feet. A short period of receding water levels followed the initial peak. On 8 June, a slow steady rise in the water level was noted, and on 11 June a secondary peak water surface was recorded at an elevation of 13.30 feet. The floodwaters then receded a second time and by 13 June the stage had dropped to 11.13 feet. The timing and magnitude of the secondary peak stage is estimated. Strong winds that occurred between 10 and 12 June caused waves that prevented the recording of high water marks on the gages.

The initial peak stage was ice-affected, that is, water flowing over and around ribbon ice (intact, partially floating, low water channel ice) resulted in a higher stage than would have occurred for the same magnitude of flow during ice-free conditions. Channel ice had cleared by the time the secondary peak occurred.

3.1.2 Monument 01 - Discharge

The spring breakup peak discharge in the Colville River near Monument 01 was estimated using Normal Depth computations. Water surface elevation and slope data were obtained from the measurements made at Monument 01, and temporary benchmarks Monument 01 Upstream (TBM 01U) and Monument 01 Downstream (TBM 01D). Cross-section geometry was based on three cross-sections surveyed by LCMF in 2002 (Kuukpik/LCMF, 2002). Hydraulic roughness values were estimated based on a 1993 discharge measurement (Alaska Biological Research and Shannon & Wilson, 1994), on-site investigations of the channel using methods outlined by the United States Geological Survey (Arcement and Schneider, 1989), and engineering judgment based on prior experience.

The discharge at the time of the initial peak stage is estimated to have been approximately 255,000 cubic feet per second (cfs). This discharge is estimated to have a recurrence interval of between two and three years (the 2-year flood has an estimated magnitude of 240,000 cfs), based on the most recent Colville River Delta flood frequency analysis (Michael Baker Jr., Inc. and Hydroconsult EN3 Services, Ltd., 2002). In other words, the discharge associated with the 2003 initial peak stage has a 33-50% chance of being equaled or exceeded in any given year.

Based on aerial observations as far south as Umiat, the initial peak stage and associated discharge can likely be attributed to meltwaters from tributaries of the Colville River downstream of Umiat, including the Anaktuvuk, Chandler, Kogosukruk, and Kikiakrorak Rivers. These tributaries were flowing prior to any significant melt on the Colville River upstream of Umiat. The secondary peak stage and associated peak discharge are attributed to meltwaters from the Colville River and its tributaries upstream of Umiat.

The 2003 spring breakup peak discharge at the head of the Colville River Delta is estimated to have been approximately 350,000 cfs, and to have occurred on 11 June, coincident with the secondary peak stage. The channel near Monument 01 was clear of ice at the time. The 2003 peak discharge is estimated to have a recurrence interval of between four and five years (the 5-year flood has an estimated magnitude of 370,000 cfs), based on the most recent flood frequency analysis. In other words, the 2003 spring breakup peak discharge has a 20-25% chance of being equaled or exceeded in any given year. A hydrograph that shows the discharge-stage relationship over time at Monument 01 is shown on Figure 3-1.

3.2 2003 Spring Breakup on the Nigliq Channel

3.2.1 Nigliq Channel - Water Surface Elevations and Observations

The Nigliq Channel monitoring sites are located along the northern portion of the channel near permanent survey monuments 22, 23, and 28. The Monument 23 monitoring site is located along the channel adjacent to CD-2 and near the proposed bridge crossing (Figure 1-3). The peak stage at the Monument 22 and 23 monitoring sites occurred in either the afternoon or evening on 7 June or in the morning on 8 June at elevations of 7.02 and 6.07 feet, respectively. Definitive high water marks were not available at the Monument 22 site due to high winds; the peak stage at that location has therefore been estimated. At the Monument 28 monitoring site, the peak stage occurred in either the afternoon or evening of 8 June or in the morning on 9 June, at an elevation of 3.57 feet. Water surface elevation and observation records for temporary staff gages at Monuments 22, 23, and 28 are presented in Tables 3-4 through 3-6.

The double peak stage observed at Monument 01 was not clearly duplicated at the monitoring sites located along the northern portion of the Nigliq Channel. At the Monument 22 monitoring site, a subtle secondary peak was recorded on 11 June. At the Monument 23 site, located approximately 10,000 feet downstream and to the north of Monument 22, there was a flat (static) segment on the hydrograph during this same period. At the Monument 28 monitoring site, located near the mouth of the Nigliq Channel and well to the north of Monuments 22 and 23, steadily dropping water levels were observed after the peak stage occurred on 8 or 9 June. There are a number of factors that either alone or in combination may have contributed to the lack of a clearly defined secondary peak being observed at the Nigliq Channel monitoring sites. These factors include natural attenuation of flood peaks as flows spread throughout the distributary channel system of the delta; changes in the proportions of flow carried by individual distributary channels as river stage changes and as bottomfast low water channel ice lifts and clears from channels; and high winds experienced during the time period of the secondary peak that affected the recording of good high water marks on gages.

Photo 3-1 shows early breakup conditions on the Nigliq Channel near the proposed bridge site. Photo 3-2 shows conditions near the bridge site at about the time of the peak water surface elevation in the channel.

3.2.2 Nigliq Channel - Discharge

Spring breakup peak discharge in the Nigliq Channel of the Colville River Delta near CD-2 was estimated using Slope-Area computations. Water surface elevation and slope data were obtained from the measurements made at temporary stream gages near Monuments 22 and 23. Cross-section geometry was based on two cross-sections surveyed by LCMF in 2003 (Kuukpik/LCMF, 2003a). Hydraulic roughness values were estimated based on on-site investigations of the channel using methods outlined by the United States Geological Survey (Arcement and Schneider, 1989), and engineering judgment based on prior experience.

The 2003 spring breakup peak discharge near Monument 23 on the Nigliq Channel of the Colville River Delta is estimated to have been approximately 61,000 cfs, and to have occurred late in the day on 6 June or early on the morning of 7 June, prior to the occurrence of the peak water surface elevation. The channel near Monument 23 may or may not have been clear of ice at the time so it is not certain whether or not conditions were ice-affected. A hydrograph that shows the discharge-stage relationship over time in the Nigliq Channel at Monument 23 is presented in Figure 3-2.

3.3 2003 Spring Breakup at the Nigliq Channel Paleochannels

3.3.1 Water Surface Elevations and Observations in the Paleochannels

The Paleochannels monitoring sites are located within the Colville River Delta a short distance to the west of the proposed bridge crossing of the Nigliq Channel. The sites are comprised of two sets of gages that were located within roughly parallel channel scars. These channel scars – termed Paleochannels – probably mark former positions of the Nigliq Slough or possibly the Nigliq Channel (Figure 1-3). The Paleochannels do not have a hydraulic connection with the Nigliq Channel or Slough during low water or lower magnitude flooding events, and did not carry flow during the 2003 spring breakup.

Based on the results of the two-dimensional surface water model developed for the Colville River Delta (Michael Baker Jr., Inc., 2002) and a combination of aerial and ground reconnaissance, two scenarios have been identified where flow in the Paleochannels would be expected. In the first, flow in the Paleochannels is expected to occur during high magnitude floods when floodwater volume and associated water levels are sufficient to overtop the banks along the north end of the Nigliq Slough. In the second scenario, flow in the Paleochannels might also be expected to occur during years of moderate flooding in the event of significant downstream ice jamming in the Nigliq Channel. The backwater effect of a sufficiently large ice jam could result in water level increases sufficient to cause overtopping and spillage into the Paleochannels.

The two-dimensional surface water model of the delta was used to examine flow conditions in the area of the Paleochannels during floods of various recurrence intervals. The model indicates that the Paleochannels will not see flow during a 10-year flood, but that floodwaters at elevations of up to 13 feet BPMSL are predicted for the area during a 50-year event. Model runs for floods with return periods of greater that 10 years and less than 50 years have not been completed.

3.4 Comparison of Observed and Predicted Water Surface Elevations

The 2003 peak water surface elevations at the head of the delta and along the Nigliq Channel were compared to water surface elevations predicted by the two-dimensional surface water model of the Colville River Delta. The comparisons were based on linear interpolations of observed water surface elevations between elevations predicted for the 2- and 10-year open water floods.

At or near the time that the preliminary peak water surface elevation was recorded at the head of the delta, the discharge of the Colville River was estimated to be 255,000 cfs and to have a flood recurrence interval of two to three years. At Monument 01, the flood recurrence interval based on model predictions of water surface elevations was approximately two years. At the Monument 22 and 23 monitoring sites along the Nigliq Channel, flood recurrence intervals based on model prediction of water surface elevations were approximately five years. As mentioned above, the

Paleochannels, which saw no flow during the 2003 breakup, are not predicted by the model to see flow until the Colville River experiences a flood with a recurrence interval of between 10 and 50 years.

The two-dimensional surface water model was constructed to predict conditions during low frequency, high magnitude flood events such as the 50-, 100-, and 200-year recurrence interval floods. The model assumes open water, steady state conditions and does not account for channel ice or ice jams. During the development of the model, it was assumed that during large flood events the presence of snow, ice, and ice jams would have little effect on the overall water surface elevations, and this assumption remains valid. However, channel ice and ice jams are likely to always be present to some extent during peak breakup floods in the Colville River Delta. Channel ice and ice jams will block and constrict flow to some degree, and cause increases in water surface elevations during smaller flood events when flow is mainly confined to the channels. Thus, the model will generally under-predict water surface elevations during small flood events when channel ice and snow are present in the delta. For this reason, model-predicted recurrence intervals for observed peak water surface elevations during small flood events are typically higher than the estimated recurrence interval based on field measurements.

Comparisons of observed and predicted peak water surface elevations at Monuments 01, 22, 23, and the Paleochannels are presented in Table 3-7.

3.5 Proposed Nigliq Bridge Site Evaluation – Notes on Design Considerations

Mr. Wim Veldman of Hydroconsult, under subcontract to Baker, completed an independent hydraulic assessment at the potential bridge location on the Nigliq Channel during the 2003 spring breakup. Mr. Veldman was on site for a period of three days in early June. Hydroconsult's evaluation of the potential bridge crossing of the Nigliq Channel is included in Attachment 1. Also included is a brief overview of the road route in the vicinity of the Paleochannels area to the west of the Niqliq Channel.

Figure 3-1 Discharge and Water Surface Elevation – Monument 01 (Colville River)

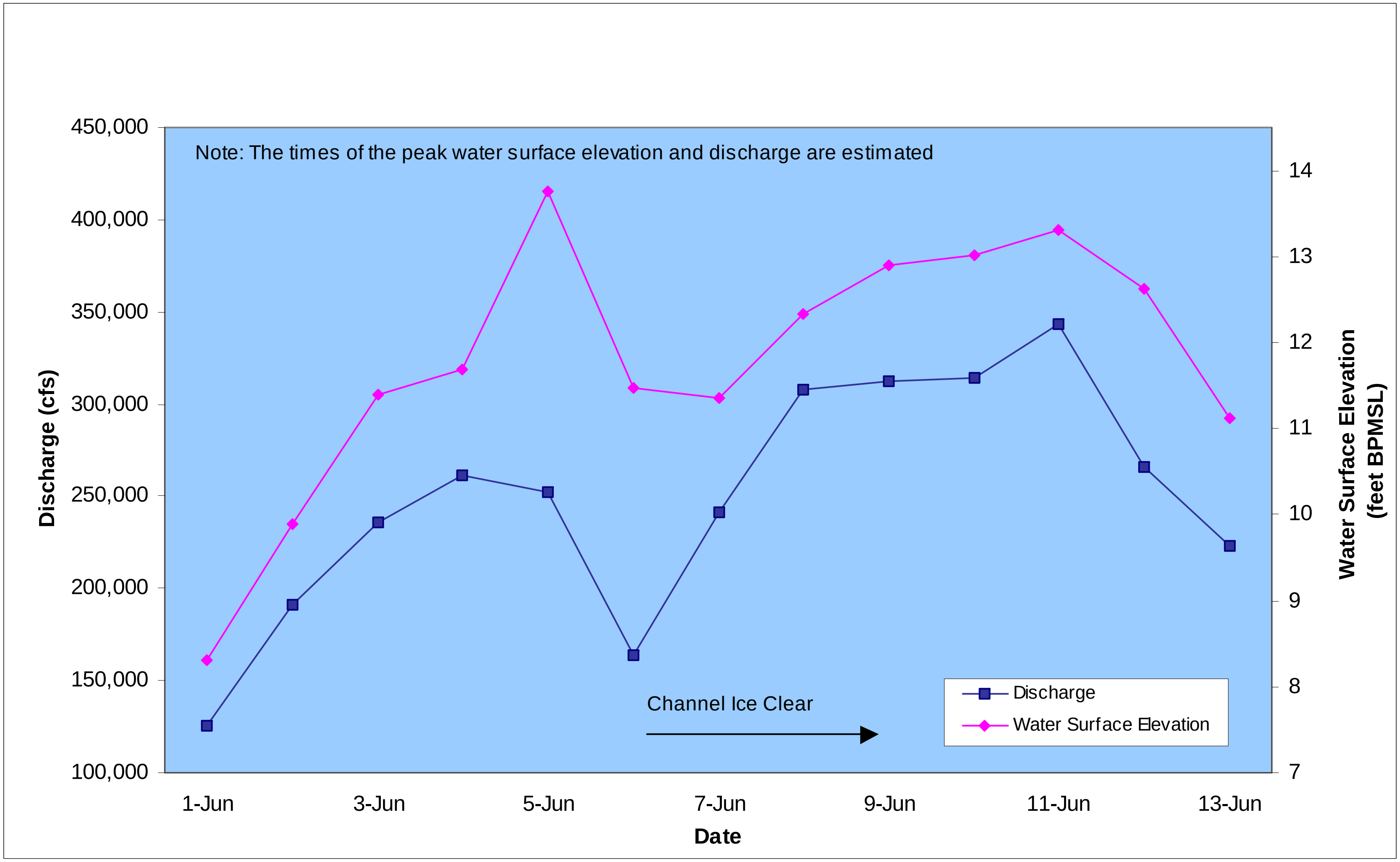

Figure 3-2 Discharge and Water Surface Elevation – Monument 23 (Nigliq Channel)

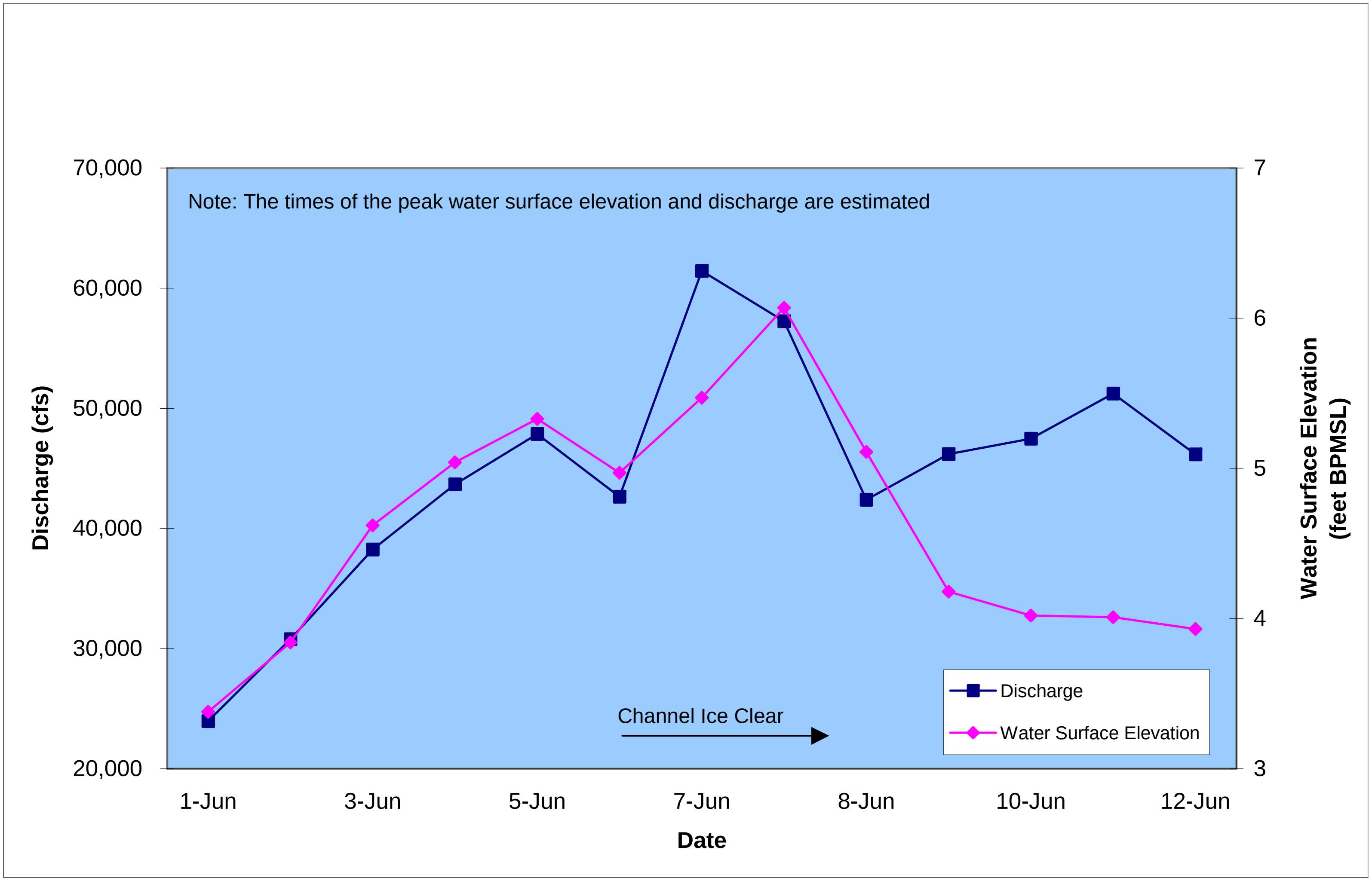

Table 3-1 Monument 01, Water Surface Elevations and Observations

Date & Time	Water Surface Elevation (feet BPMSL)	Observations
6/1/03 12:00	8.30	Flow over intact channel ice, right bank ice still above water level
6/2/03 9:00	9.89	Flow over intact channel ice, some pans floating through the section
6/3/03 9:35	11.39	Flow over mostly intact channel ice, some evidence of lift
6/4/03 9:36	11.68	Flow over mostly intact channel ice, significant lift
6/4/03 8:11	12.29	Channel ice floating and intact
6/5/03 9:14	12.31	Channel ice floating and intact
High Water Mark	13.76	Peak stage occurred in the afternoon or evening on 5 June or in the morning on 6 June
6/6/03 11:50	11.47	Channel clear of ice
6/7/03 12:50	11.35	Channel clear of ice, possible rise in stage
6/8/03 11:25	12.33	Noted significant rise in stage, channel clear
6/9/03 13:45	12.89	Rising stage
6/10/03 14:50	13.01	Stage continues to rise, 20+ knot winds
6/11/03 14:45	13.30	Secondary peak observed, readings made in 25+ knot winds
6/12/03 9:00	12.62	Stage dropping, approximately 15 knot winds
6/13/03 14:20	11.13	Significant decrease in stage

Notes:
1. Elevations are based on an elevation of 27.74 feet BPMSL for Monument 01, established by Lounsbury & Associates in 1996.
2. The distance from Monument 01 to TBM 01U is 3,040 feet. The distance from Monument 01 to TBM 01D is 2,960 feet.
3. Coordinates for Mounument 01 are N70° 09' 57.1" W150° 56' 24.1" (NAD 83), surveyed by Lounsbury & Associates.

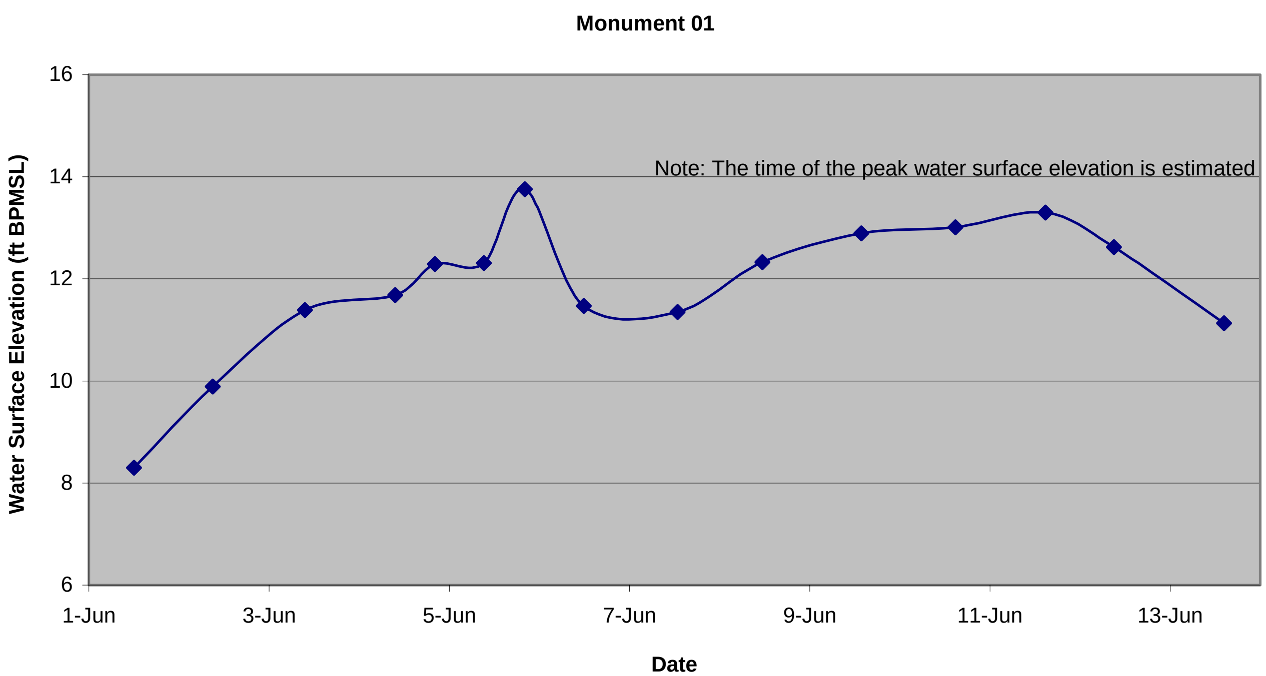

Table 3-2 Temporary Benchmark 01U, Water Surface Elevations and Observations

Date & Time	Water Surface Elevation (feet BPMSL)	Observations
6/1/03 12:00	8.41	Flow over intact channel ice, right bank ice still above water level
6/2/03 9:30	10.12	Flow over intact channel ice, some pans floating through the section
6/3/03 9:44	11.65	Flow over mostly intact channel ice, some evidence of lift
6/4/03 9:45	11.99	Flow over mostly intact channel ice, significant lift
6/4/03 20:04	12.60	Channel ice floating and intact
6/5/03 9:25	12.67	Channel ice floating and intact
High Water Mark	13.82	Peak stage occurred in the afternoon or evening on 5 June or in the morning on 6 June
6/6/03 12:15	11.59	Channel clear of ice
6/7/03 1:15	11.63	Channel clear of ice, possible rise in stage
6/8/03 11:30	12.69	Noted significant rise in stage, channel clear of ice
6/9/03 13:50	13.19	Rising stage
6/10/03 14:50	13.40	Stage continues to rise, 20+ knot winds
6/11/03 14:50	13.66	Secondary peak observed, readings made in 25+ knot winds
6/12/03 9:30	12.91	Stage dropping, approximately 15 knot winds
6/13/03 14:00	11.39	Significant decrease in stage

Notes:
1. Elevations are based on an elevation of 27.74 feet BPMSL for Monument 01, established by Lounsbury & Associates in 1996.
2. The distance from TBM 01U to Monument 01 is 3,040 feet.
3. Coordinates for Monument 01U are N70° 09' 30.2" W150° 56' 48.1" (NAD 83), by Garmin III Plus GPS.

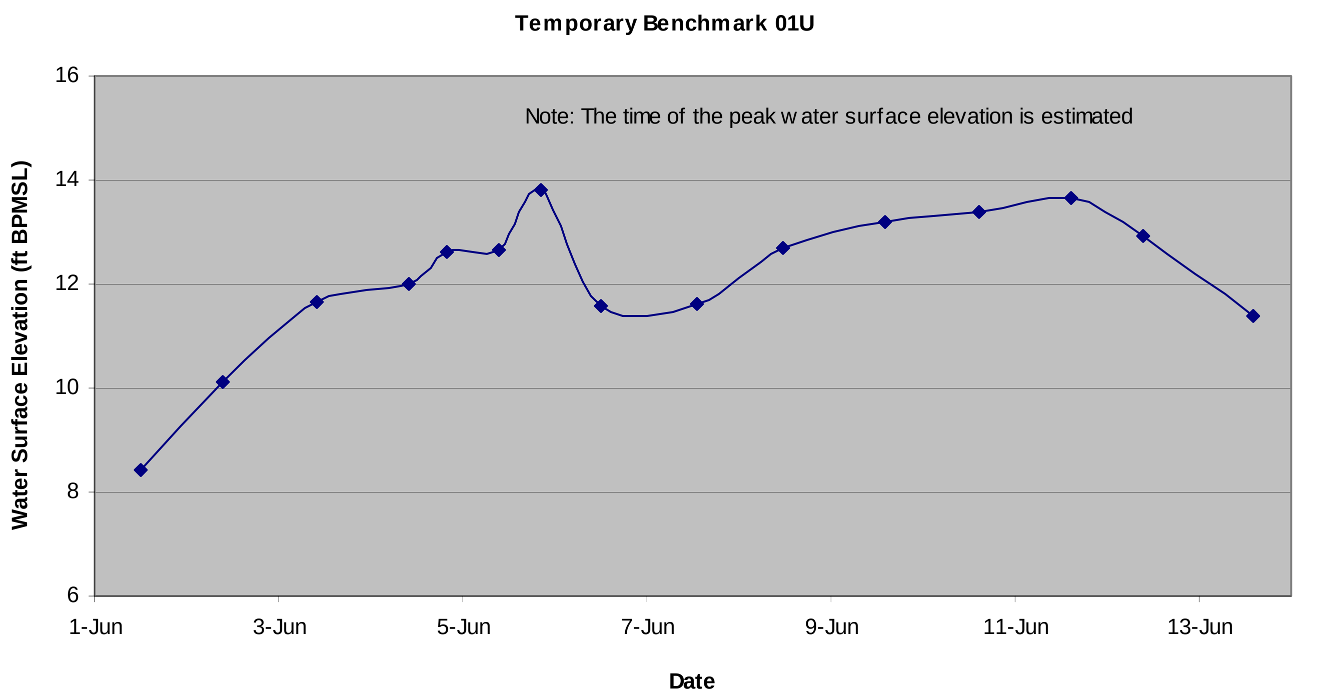

Table 3-3 Temporary Benchmark 01D, Water Surface Elevations and Observation

Date & Time	Water Surface Elevation (feet BPMSL)	Observations
6/1/03 12:00	8.12	Flow over intact channel ice, right bank ice still above water level
6/2/03 9:12	9.62	Flow over intact channel ice, some pans floating through the section
6/3/03 9:23	11.06	Flow over mostly intact channel ice, some evidence of lift
6/4/03 9:27	11.30	Flow over mostly intact channel ice, significant lift
6/4/03 20:24	11.83	Channel ice floating and intact
6/5/03 9:07	11.92	Channel ice floating and intact
High Water Mark	13.36	Peak stage occurred in the afternoon or evening on 5 June or in the morning on 6 June
6/6/03 11:20	11.31	Channel clear of ice
6/7/03 12:30	11.01	Channel clear of ice, possible rise in stage
6/8/03 11:20	11.83	Noted significant rise in stage, channel clear of ice
6/9/03 13:40	12.38	Rising stage
6/10/03 14:25	12.60	Stage continues to rise, 20+ knot winds
6/11/03 14:40	12.75	Secondary peak observed, readings made in 25+ knot winds
6/12/03 9:05	12.30	Stage dropping, approximately 15 knot winds
6/13/03 14:40	10.84	Significant decrease in stage

Notes:
1. Elevations are based on an elevation of 27.74 feet BPMSL for Monument 01, established by Lounsbury & Associates in 1996.
2. The distance from Monument 01 to TBM 01D is 2,960 feet.
3. Coordinates for Monument 01D are N70° 10' 25.4" W150° 56' 13.0", (NAD 83), by Garmin III Plus GPS.

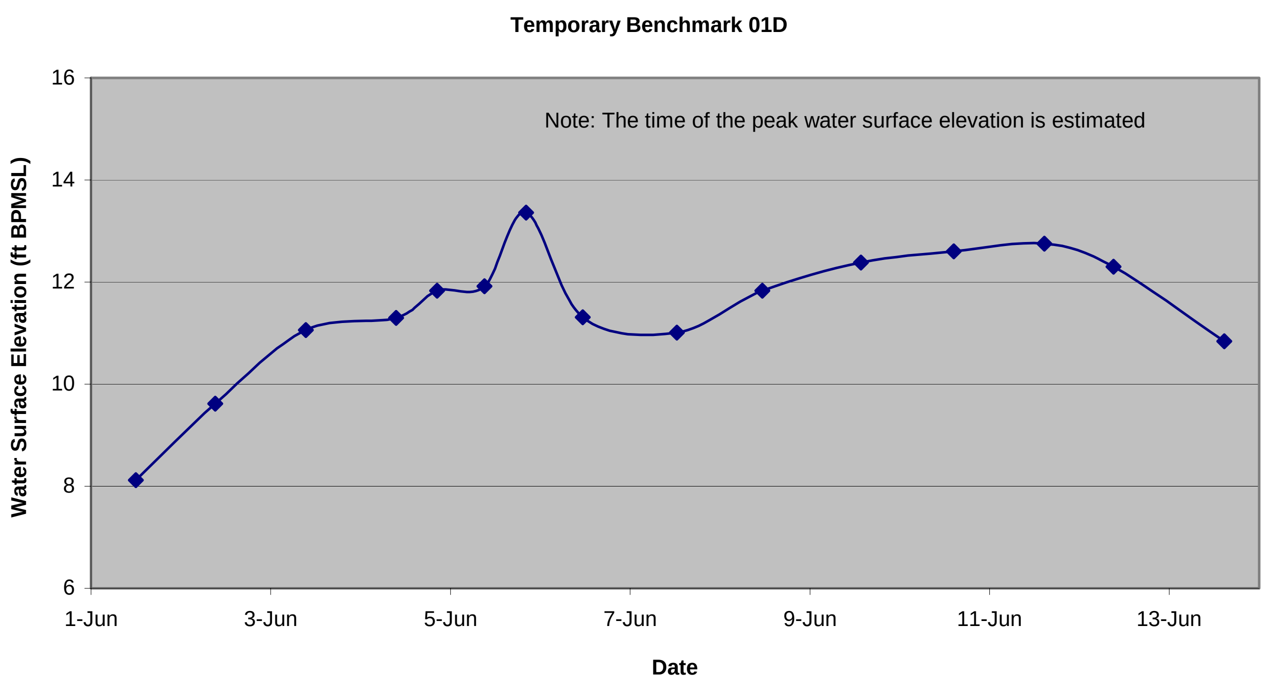

Table 3-4 Monument 22, Water Surface Elevations and Observations

Date & Time	Water Surface Elevation (feet BPMSL)	Observations
6/1/03 9:00	3.73	Snow surrounding gage but good hydraulic connection. Flow over intact channel ice
6/2/03 8:41	4.34	Snow surrounding gage but good hydraulic connection. Flow over intact channel ice
6/3/03 9:05	5.24	Flow over intact channel ice, some lifting
6/4/03 9:07	5.76	Channel ice lifting
6/5/03 8:50	6.13	Channel ice lifting
6/6/03 10:40	5.67	Channel ice lifting, ice becoming rotten
6/7/03 12:00	6.70	Channel clear of ice
High Water Mark	7.02	Estimated high water, see Note 3. Peak stage occurred in the afternoon or evening of 7 June or in the morning of 8 June.
6/8/03 10:55	5.78	Channel clear of ice
6/9/03 14:20	5.16	Channel clear of ice
6/10/03 10:55	5.09	Readings made in high wind (20+ knots)
6/11/03 13:48	5.24	Readings made in high wind (20+ knots)
6/12/03 9:40	4.97	

Notes:
1. Elevations are based on an elevation of 10.13 feet BPMSL for Monument 22, verified by LCMF in 2003.
2. Coordinates for Monument 22 are N70° 19' 05.2" W151° 03' 21.9" (NAD 83), by Garmin III Plus GPS.
3. Definitive high water marks were not available due to wind; the peak water surface elevation shown is an estimate.

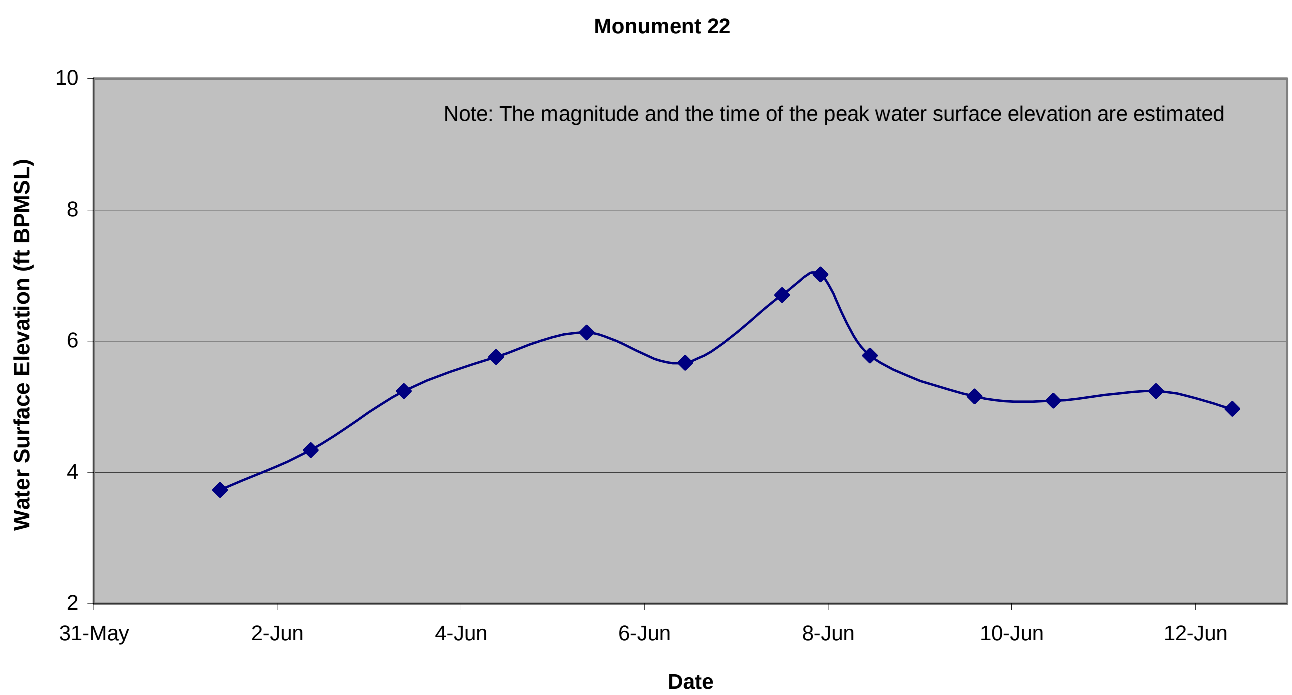

Table 3-5 Monument 23, Water Surface Elevations and Observations

Date & Time	Water Surface Elevation (feet BPMSL)	Observations
5/31/03 16:05	2.77	Snow surrounding gage but good hydraulic connection. Flow over intact channel ice
6/1/03 8:47	3.38	Snow surrounding gage but good hydraulic connection. Flow over intact channel ice
6/2/03 8:30	3.84	Flow over intact channel ice, some lifting
6/3/03 8:55	4.62	Channel ice lifting
6/3/03 17:30	4.83	Channel ice lifting
6/4/03 8:57	5.04	Channel ice lifting, ice becoming rotten
6/5/03 8:41	5.33	Ice lifted and in place
6/6/03 10:30	4.97	Ice lifted, in place and rotten
6/7/03 11:49	5.47	Ice lifted, in place and rotten
High Water Mark	6.07	Peak stage occurred in the afternoon or evening on 7 June or the morning on 8 June
6/8/03 10:30	5.11	Channel clear of ice
6/9/03 14:40	4.18	Channel clear of ice
6/10/03 10:50	4.02	Readings made in high wind (20+ knots)
6/11/03 14:00	4.01	Readings made in high wind (20+ knots)
6/12/03 9:45	3.93	

Notes:
1. Elevations are based on an elevation of 9.53 feet BPMSL for Monument 23, verified by LCMF in 2003.
2. Coordinates for Monument 23 are N70° 20' 40.1" W151° 03' 40.7" (NAD 83), by Garmin III Plus GPS.

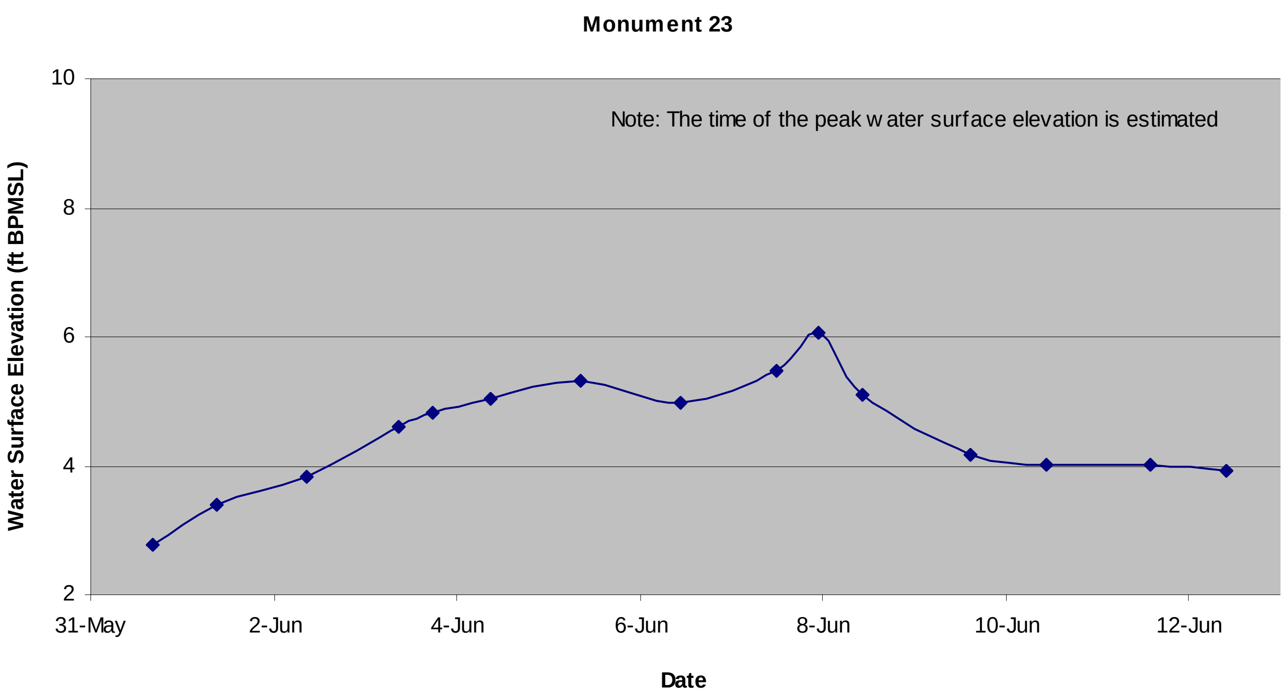

Table 3-6 Monument 28, Water Surface Elevations and Observation

Date & Time	Water Surface Elevation (feet BPMSL)	Observations
6/1/03 13:55	2.48	Snow surrounding gage but good hydraulic connection. Flow over intact channel ice
6/2/03 8:20	2.52	Snow surrounding gage but good hydraulic connection. Flow over intact channel ice
6/3/03 8:45	2.77	Flow over intact channel ice
6/4/03 8:43	2.81	Flow over intact channel ice
6/5/03 8:35	2.97	Flow over mostly intact channel ice, some lifting
6/6/03 10:17	2.84	Significant channel ice lifting, floating intact
6/7/03 11:30	3.32	Channel clear of ice
6/8/03 10:25	3.48	Channel ice cleared, chunks floating through section
High Water Mark	3.57	Peak stage occurred in the afternoon or evening on 8 June or in the morning of 9 June
6/9/03 14:40	2.45	Channel clear of ice
6/10/03 10:25	1.92	Readings made in high wind (20+ knots)
6/11/03 14:10	1.69	Readings made in high wind (20+ knots)
6/12/03 12:45	1.50	

Notes:
1. Elevations are based on an elevation of 3.66 feet BPMSL for Monument 28, verified by LCMFin 2003.
2. Coordinates for Monument 28 are N70° 25' 32.0" W151° 04' 01.2" (NAD 83), by Garmin III Plus GPS.

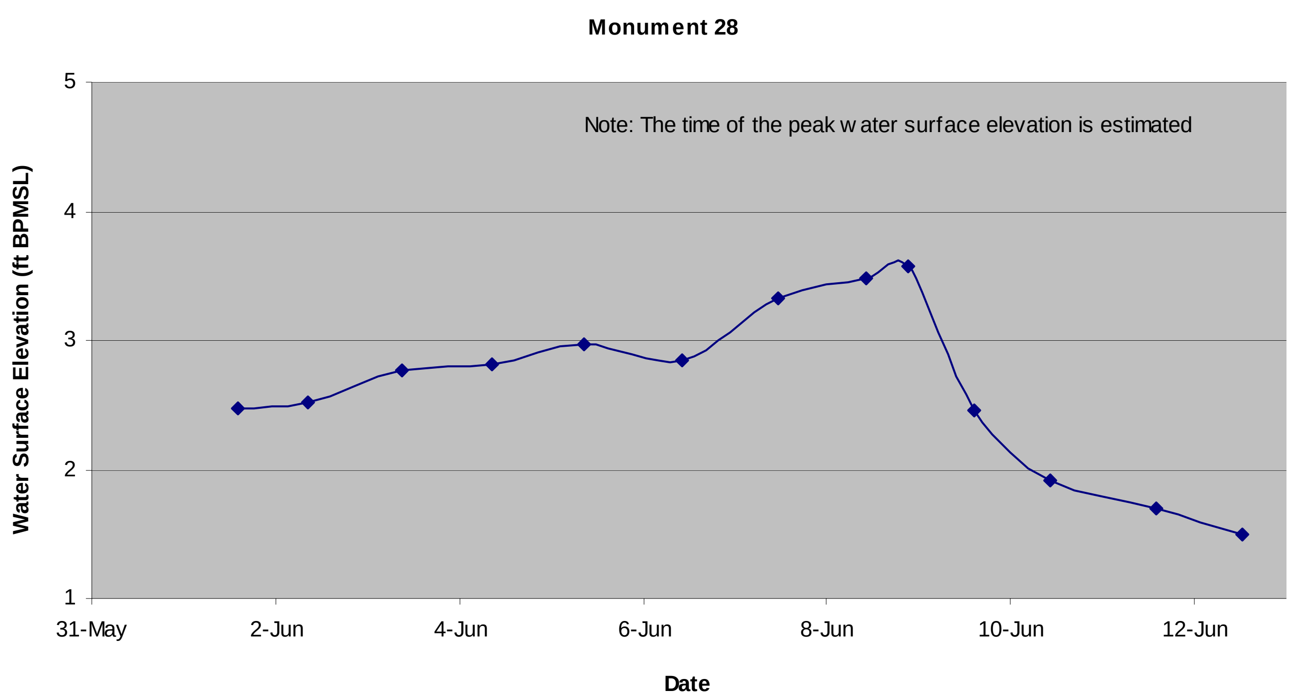

Table 3-7 Comparison of Observed and Predicted Water Surface Elevations – Monuments 01, 22, 23, and Paleochannels

Location	Observed 2003 Peak Water Surface Elevation (ft BPMSL)	Predicted 2-yr Water Surface Elevation (ft BPMSL)	Predicted 10-yr Water Surface Elevation (ft BPMSL)	Predicted 50-yr Water Surface Elevation (ft BPMSL)	Predicted 200-yr Water Surface Elevation (ft BPMSL)	Approximate Recurrence Interval of Observed Peak Water Surface Elevation (1) (years)
Monument 01	13.76	13.8	19.0	23.0	26.3	2
Monument 22	7.02	5.9	8.7	11.9	14.2	5
Monument 23	6.07	5.2	7.3	10.5	12.7	5
Paleochannels	Local Melt Only	Local Melt Only	Local Melt Only	10.7	12.9	<50

Notes:

1. The recurrence interval was interpolated between water surface elevations predicted with the two-dimensional surface-water model of the Colville River Delta (Michael Baker Jr., Inc., 2002 and Shannon & Wilson, Inc., 1997). The model considers open water conditions, therefore, the impact of an ice cover and/or ice jams has not been considered in the model's predictions.

Photo 3-1 **Early breakup conditions on the Nigliq Channel near the proposed bridge crossing site on 31 May. Photo taken near the Monument 22 monitoring site, looking downstream and northeast towards the Monument 23 monitoring site. The mouth of the Nigliq Slough is at the left-hand center of photo.**

Photo 3-2 **Breakup conditions on the Nigliq Channel near the proposed bridge crossing site on 7 June. Conditions shown are several hours prior to the occurrence of the breakup peak water surface elevation in the channel. View looking west. CD-2 is in upper right corner of photo. Flow is from right to left.**

4.0 2003 Fish Creek Basin Spring Breakup Summary

The 2003 spring breakup monitoring program in the Fish Creek Basin consisted of five monitoring sites on Fish and Judy Creeks, and two monitoring sites on the Ublutuoch River. The timing of the spring snow melt in the Fish Creek basin was such that the beginning of breakup (as defined by first observation of water on the temporary staff gages) on the three streams under study was staggered across an approximately six-day period. Flowing water was first noted on Judy Creek on 31 May, then on Fish Creek below the Judy Creek confluence a day later. Gages on the Ublutuoch River, however, did not see water until 5 June, five days after flowing water was first observed on lower Fish Creek. Detailed discussions of breakup at the three streams in the Fish Creek basin are provided below in chronological order according to when water was first observed. At the completion of the monitoring program, the gages were marked with snow poles and left in place. Water surface elevation and observation records for temporary staff gages in the Fish Creek basin are shown on Tables 4-1 through 4-9.

Baker and LCMF established the two monitoring sites and associated temporary benchmarks on the lower Ublutuoch River in 2003. The five sites located on Fish and Judy Creeks were established by URS and Lounsbury in 2001 and 2002 during previous monitoring programs. These sites were re-established by Baker during the 2003 investigation using temporary benchmark and elevation data originally established by Lounsbury. Elevations of temporary benchmarks at Fish and Judy Creek sites were not resurveyed prior to their use during 2003 and were used on an as-is basis. It is probable that temporary benchmarks established on Fish and Judy Creeks in 2001 and 2002 have been subjected to some degree of frost jacking and thus reported water surface elevations referenced to these temporary benchmarks may be biased high.

4.1 2003 Spring Breakup on Judy Creek

4.1.1 Judy Creek - Water Surface Elevations and Observations

Localized melt near the headwaters of Judy Creek was first noted during a reconnaissance overflight on 27 May. Water surface elevation measurements began when flowing water reached the gages at the Judy Creek RM 13.8 monitoring site on 31 May. Flowing water was first observed at the Judy Creek RM 7.0 monitoring site on 1 June. Measurements on Judy Creek continued until 10 June. Photo 4-1 shows the leading edge of flowing water on Judy Creek on 28 May at a location approximately 20 air miles upstream from the Judy Creek RM 13.8 monitoring site.

Peak stage at Judy Creek RM 13.8 and Judy Creek RM 7.0 occurred on the evening of 5 June or the morning of 6 June at water surface elevations of 36.58 and 27.74 feet, respectively. The channel at both monitoring locations was free of bottomfast ice at the time the peak stage occurred and the peak water surface elevations were therefore not considered ice-affected.

4.2 2003 Spring Breakup on Fish Creek

4.2.1 Fish Creek – Water Surface Elevations and Observations

On 28 and 29 May, minor isolated, localized melt and ponding on ice was noted at the headwaters of Fish Creek. On 31 May, the extent of melt at the headwaters of Fish Creek had expanded but no flow was noted. Water surface elevation measurements on Fish Creek began on 1 June when flows originating in the Judy Creek tributary were noted on the gages at the Fish Creek RM 25.1 monitoring site, just downstream from the Fish and Judy Creek confluence. Flowing water was first observed at the Fish Creek RM 11.7 monitoring site on 2 June. Flow was not observed upstream of the Judy Creek confluence until 4 June when water was first noted on the gages at the Fish Creek RM 32.4 monitoring site. Measurements on Fish Creek continued until 11 June.

The peak stage occurred at Fish Creek RM 32.4 on the evening of 7 June or morning of 8 June at an elevation of 23.92 feet. The monitoring site had been clear of low water channel ice since 5 June. Downstream of the Judy Creek confluence, peak stage occurred at Fish Creek RM 25.1 on the afternoon of 6 June at an elevation of 19.51 feet. Intact floating channel ice was still in place at the time, which would have affected the observed water surface elevation. At Fish Creek RM 11.7, the peak stage of 10.35 feet occurred on the evening of 7 June or morning of 8 June. This was near the time that low water channel ice cleared from the lower Fish Creek channel so it is not known whether or not the observed peak water surface elevation at this site was ice-affected.

4.3 2003 Spring Breakup on the Ublutuoch River

4.3.1 Ublutuoch River – Water Surface Elevations and Observations

Localized melting and ponding were not noted at the headwaters of the Ublutuoch River until 3 June. On 4 June, the leading edge of breakup flows on the stream was noted approximately 15 air miles upstream from temporary gages at the Ublutuoch River (Ublutuoch) RM 6.8 monitoring site (see Photo 4-2). Water surface elevation measurements began the following day when flowing water reached both the upstream and the downstream gages at Ublutuoch RM 6.8 monitoring site (6.8U and 6.8D) and both the upstream and the downstream gages at the Ublutuoch RM 1.9 monitoring site (1.9U and 1.9D). Photos 4-3 through 4-6 show conditions at the Ublutuoch RM 6.8 monitoring site and proposed bridge site on the first day that breakup flows were observed there. The arrival of the leading edge of flowing water is shown on Photos 4-3 and 4-5, and the arrival of breakup floodwaters approximately two hours later is shown on Photos 4-4 and 4-6. Photo 4-7 shows conditions at the Ublutuoch RM 1.9 monitoring site and proposed bridge location on 5 June shortly before the arrival of the leading edge of breakup flows. Photo 4-8 shows the site on 8 June near the time of the peak water surface elevation. Measurements on the Ublutuoch River continued until 11 June.

Peak stage at the Ublutuoch RM 6.8 upstream and downstream sites occurred on the evening of 6 June or morning of 7 June at elevations of 10.14 feet and 9.67 feet, respectively. At the Ublutuoch RM 1.9 upstream and downstream sites, peak stage occurred on the evening of 7 June or morning of 8 June at elevations of 7.66 feet and 7.58 feet, respectively. Bottomfast channel ice was intact at both monitoring locations at the time the peak stage occurred and the peak water surface elevations were therefore considered ice-affected.

The peak stage at Ublutuoch RM 1.9 occurred at about the same time as the peak stage at the Fish Creek RM 11.7 monitoring site, which is located approximately two river miles upstream from the Ublutuoch River confluence. It is likely that the flooding conditions on lower Fish Creek produced backwater effects on the lower Ublutuoch River that affected the timing and elevation of the peak water surface at Ublutuoch RM 1.9.

4.3.2 Ublutuoch River – Discharge

Spring breakup discharge on the Ublutuoch River at river mile 6.8 was estimated using Normal Depth computations. Water surface elevation and slope data were obtained from the measurements made at temporary gages at Ublutuoch RM 6.8U and Ublutuoch RM 6.8D. Cross-section geometry was based on cross-sections surveyed by LCMF in 2003 (Kuukpik/LCMF, 2003b).

During spring breakup at river mile 6.8 on the Ublutuoch River, flow was initially conveyed over drifted snow within the floodplain and bottomfast, low water channel ice that was approximately four feet thick at the channel's deepest point. The formation of this channel ice began during low water conditions at freeze-up the previous fall. Drifted snow inundated by flowing water was noted to melt relatively quickly after the initiation of breakup. Low water channel ice, which melted much more slowly, remained in place to some degree through the end of breakup observations.

Observations of breakup flows occurring over drifted snow and low water channel ice on the Ublutuoch River in 2003 are consistent with observations made during spring breakup in 2001 and 2002 at locations further upstream (URS 2001, 2003). The presence of snow and bottomfast ice in the channel of the Ublutuoch River has a significant impact on river hydraulics during breakup each year. The ice and snow elevates the riverbed and thus raises the peak water surface elevation above what it would be during snow- and ice-free conditions. The snow and ice also affects the size and shape of the channel, the slope of the channel bottom and water surface, and the roughness of the channel surface. Because the ice and snow are melting during breakup, factors such as channel geometry, slope, and roughness can be expected to change continuously throughout breakup. These dynamic characteristics of the channel were accounted for in the computations of discharge for the 2003 spring breakup on the Ublutuoch River.

In order to account for the effects of bottomfast low water channel ice during breakup, discharge measurement data, extrapolated rates of ice loss, and summer channel survey data were used to produce estimates of channel bottom geometry at various times during breakup. Discharge measurements that were made from a boat on 9 and 10 June at the Ublutuoch RM 6.8U monitoring site were used to estimate channel bottom ice surface elevations and an ice loss rate. The channel bottom ice surface elevations were overlain on the surveyed summer cross-section data for the Ublutuoch RM 6.8U site. The calculated ice loss rate was then applied to the channel bottom ice surface elevations in order to extrapolate channel geometry prior to the 9 June measurement and after the 10 June measurement. The 2003 surveyed summer water surface was used as a conservative maximum cut-off elevation for the low water ice surface in order to simulate a post-freeze-up/pre-breakup ice surface elevation.

Channel hydraulic roughness values were estimated based on the two discharge measurements made on 9 and 10 June. Roughness values were back-calculated from the discharge measurement data using Normal Depth computations. Back-calculated channel roughness values from the 9 June measurement were applied to discharge estimates for water surface elevation data collected up to and including 9 June. Channel roughness values back-calculated from the 10 June discharge measurement were applied to estimates from water surface elevation data collected on or after 10 June. Left and right overbank hydraulic roughness values were estimated based on on-site investigations using methods outlined by the United States Geological Survey (Arcement and Schneider, 1989), and engineering judgment based on prior experience.

The 2003 spring breakup peak discharge at RM 6.8 on the Ublutuoch River is estimated to have been approximately 5,300 cfs, and to have occurred in the late evening of 6 June or early morning of 7 June, coincident with the peak stage. The peak discharge was a relatively low frequency event. Based on a linear interpolation between discharge values predicted for the 10- and 20-year recurrence interval flood events in the most recent flood frequency analysis (URS, 2003), it is estimated that the 2003 spring breakup peak discharge had a recurrence interval of approximately fifteen years. In other words, the peak discharge had only a six to seven percent chance of being equaled or exceeded in any given year. Recurrence intervals and associated floods calculated for the Ublutuoch River at river mile 6.8 were provided in Section 2.0. Figure 4-1 shows the discharge-stage relationship over time on the Ublutuoch River at river mile 6.8 on.

4.4 Fluvial Sediment and Channel Bed Material Sampling on the Ublutuoch River

4.4.1 Objective

The objective of the fluvial sediment sampling program was to estimate the total sediment load and characterize channel bed material in the Ublutuoch River at the proposed river mile 6.8 bridge site. The results will be used to evaluate channel characteristics and aid in establishing engineering design criteria.

4.4.2 Methodology

Suspended sediment samples were collected on 9 June at five locations across the Ublutuoch River channel at river mile 6.8 using a US DH-48 sampler according to procedures set forth by the United States Geological Survey (Edwards and Glysson, 1999).

At the time of suspended sediment sample collection, discharge and water surface elevation at the cross-section were approximately 1,300 cfs and 7.1 feet BPMSL, respectively. Upon completion of the discharge measurement, the channel was subdivided into five areas, each carrying approximately one-fifth the total stream discharge. Samples were collected from each area. Each sample was analyzed separately for total suspend solids (TSS) using gravimetric methods.

Bed material samples were collected on 23 July at approximately 10 locations across the channel at river mile 6.8 using a weighted sample vessel. The samples were prepared for particle size distribution analysis by American Society of Testing and Materials (ASTM) Method D422. Alaska Test Labs in Anchorage, Alaska performed all sample analyses.

4.4.3 Results

Fluvial sediment collection for design was carried out as close to peak water surface elevation and peak discharge as was possible. The progression of spring breakup on the Ublutuoch River is such that peak stage and peak discharge typically occur while flows are still being conveyed over bottomfast channel ice within the channel. This was the case in 2001, 2002, and 2003. When bottomfast ice is in place, most sediment sources are effectively sealed off from the flow and suspended sediment concentrations within the water column are expected to be extremely low. This was confirmed when suspended sediment samples were collected at the Ublutuoch river mile 6.8 location on 9 June, approximately 48 hours after the peak stage and discharge. On that day, sediment yield through the cross-section was estimated at approximately 4 tons per day with concentrations in the channel subsections ranging from 2.6 to 8.5 milligrams per liter (mg/L). Due to the fact that ice was present in the channel on 9 June, bedload samples were not collected until 23 July. Bed material in the channel was identified as a Silty SAND (SM) with a mean diameter, D_{50}, of 0.0006 feet (0.18 mm).

Laboratory reports for fluvial sediment and channel material sampling are provided in Appendix D.

4.5 Proposed Ublutuoch Bridge Sites Evaluations – Notes on Design Considerations

Mr. Wim Veldman of Hydroconsult, under subcontract to Baker, completed an independent hydraulic assessment at the two potential bridge sites on the Ublutuoch River (river miles 1.9 and 6.8) during the 2003 spring breakup. The assessment includes a comparative analysis of the two bridge sites. Mr. Veldman was on site for a period of three days in early June. Hydroconsult's evaluation of the potential bridge crossings of the Ublutuoch River is included in Attachment 1.

Figure 4-1 Discharge and Water Surface Elevation – Ublutuoch River RM 6.8

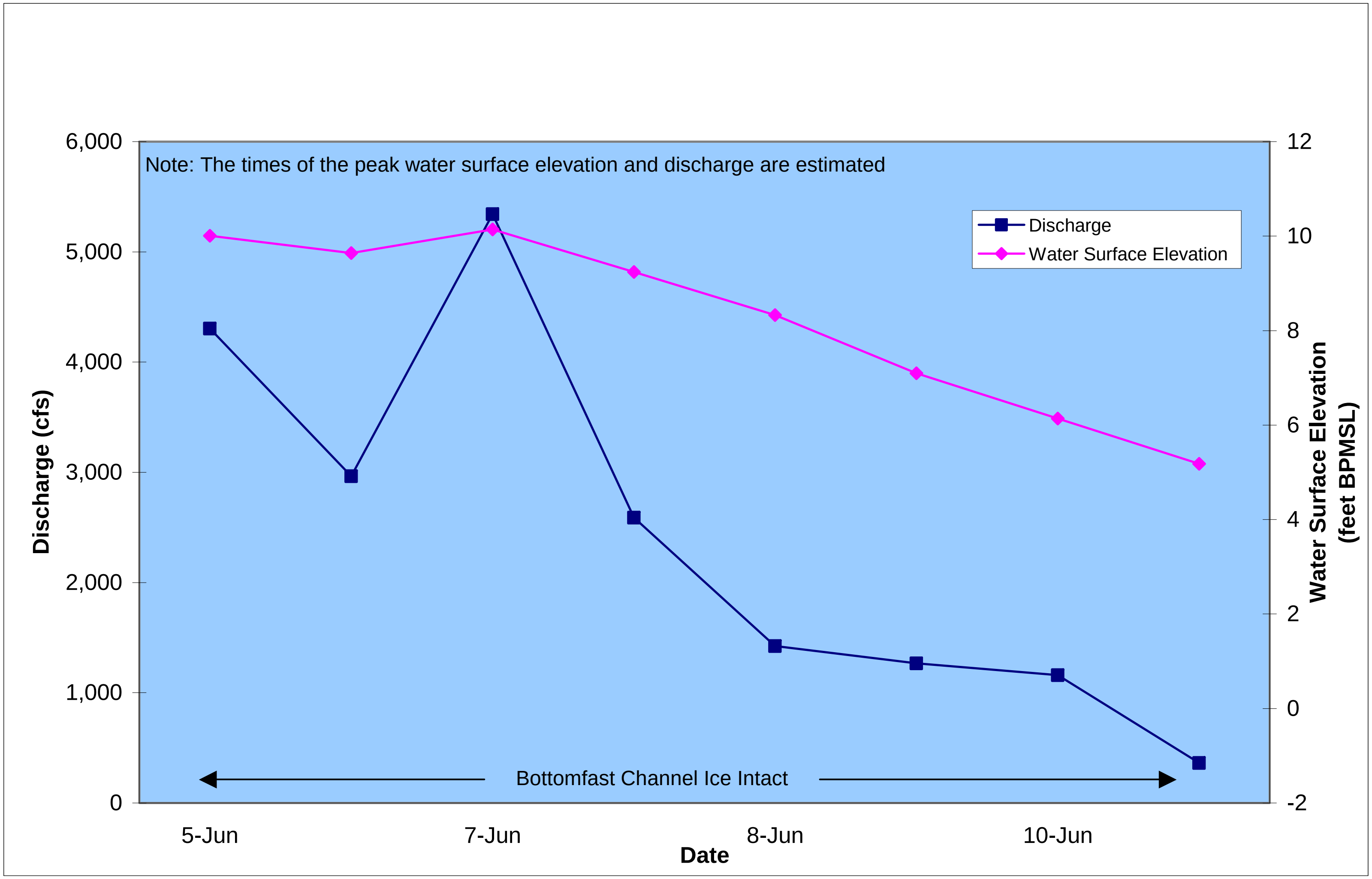

Table 4-1 Judy Creek RM 13.8, Water Surface Elevations and Observations

Date & Time	Water Surface Elevation (feet BPMSL)	Observations
5/31/03 15:00	34.79	Flow over intact channel ice
Preliminary Peak	34.98	Preliminary peak occurred on the evening of 31 May or morning of 1 June
6/1/03 12:55	34.22	Flow over intact channel ice, flow has reached the confluence with Fish Creek
6/2/03 9:58	34.70	Flow over intact channel ice, ice beginning to lift
6/3/03 10:10	34.44	Flow over intact channel ice, ice continuing to lift
6/4/03 10:18	34.88	Channel ice has lifted and is breaking apart
Secondary Peak	36.25	Secondary peak occurred on the evening of 4 June or morning of 5 June
6/5/03 9:52	36.09	Channel ice cleared, ice chunks floating through the section
High Water Mark	36.58	Peak Stage occurred on the afternoon or evening of 5 June or morning of 6 June
6/6/03 12:56	35.83	Channel clear of ice
6/7/03 14:35	34.99	Channel clear of ice
6/8/03 9:15	34.48	Channel clear of ice
6/9/03 16:05	33.81	Channel clear of ice
6/10/03 15:10	33.41	Channel clear of ice

Notes:

1. Elevations are based on an elevation of 40.87 feet BPMSL for temporary monument Line 4B West, established by Lounsbury in 2001. Elevation of Line 4B West was not resurveyed prior to use during 2003. It is probable that Line 4B West has been subjected to some degree of frost jacking and thus reported water surface elevations referenced to Line 4B West may be biased high.
2. Coordinates for Judy Creek RM 13.8 are N70° 11' 11.5" W151° 57' 40.4" (NAD 83), by Garmin III Plus GPS.

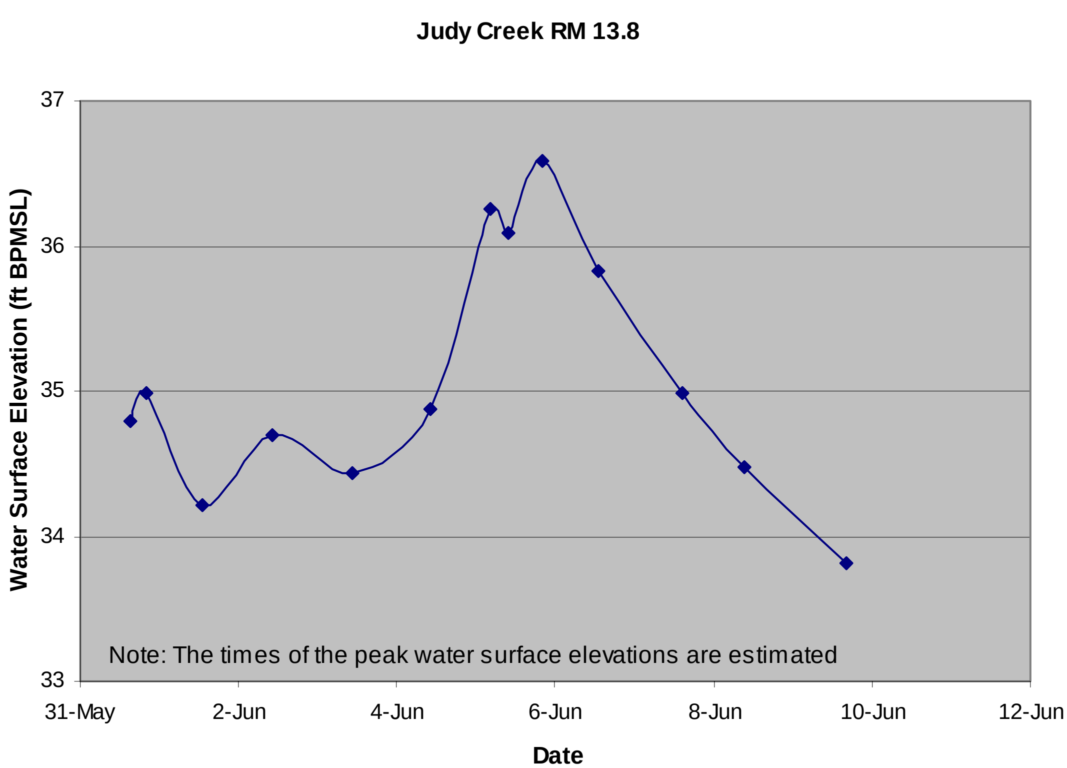

Table 4-2 Judy Creek RM 7.0, Water Surface Elevations and Observations

Date & Time	Water Surface Elevation (feet BPMSL)	Observations
6/1/03 13:00	24.74	Flow over intact channel ice, flow has reached the confluence with Fish Creek
6/2/03 10:15	25.09	Flow over intact channel ice, some lifting of channel ice occurring
Preliminary Peak	25.73	Preliminary peak occurred on the evening of 2 June or morning of 3 June
6/3/03 10:23	25.62	Flow over intact channel ice, ice continuing to lift
6/4/03 10:27	25.95	Channel ice has lifted and is breaking apart
6/5/03 10:03	27.07	Channel ice cleared, ice chunks floating through the section
High Water Mark	27.74	Peak Stage occurred on the afternoon or evening of 5 June or morning of 6 June
6/6/03 13:38	27.10	Channel clear of ice
Third Peak	27.29	Third peak occurred on the evening of 6 June or morning of 7 June
6/7/03 14:50	26.19	Channel clear of ice
6/8/03 9:35	25.69	Channel clear of ice
6/9/03 16:25	24.94	Channel clear of ice
6/10/03 15:30	24.57	Channel clear of ice

Notes:
1. Elevations are based on an elevation of 36.62 feet BPMSL for temporary monument Line 3 South 1, established by Lounsbury in 2001. Elevation of Line 3 South 1 was not resurveyed prior to use during 2003. It is probable that Line 3 South 1 has been subjected to some degree of frost jacking, and thus reported water surface elevations referenced to Line 3 South 1 may be biased high.
2. Coordinates for Judy Creek RM 7.0 are N70° 13' 10.9" W151° 50' 19.2" (NAD 83), by Garmin III Plus GPS.

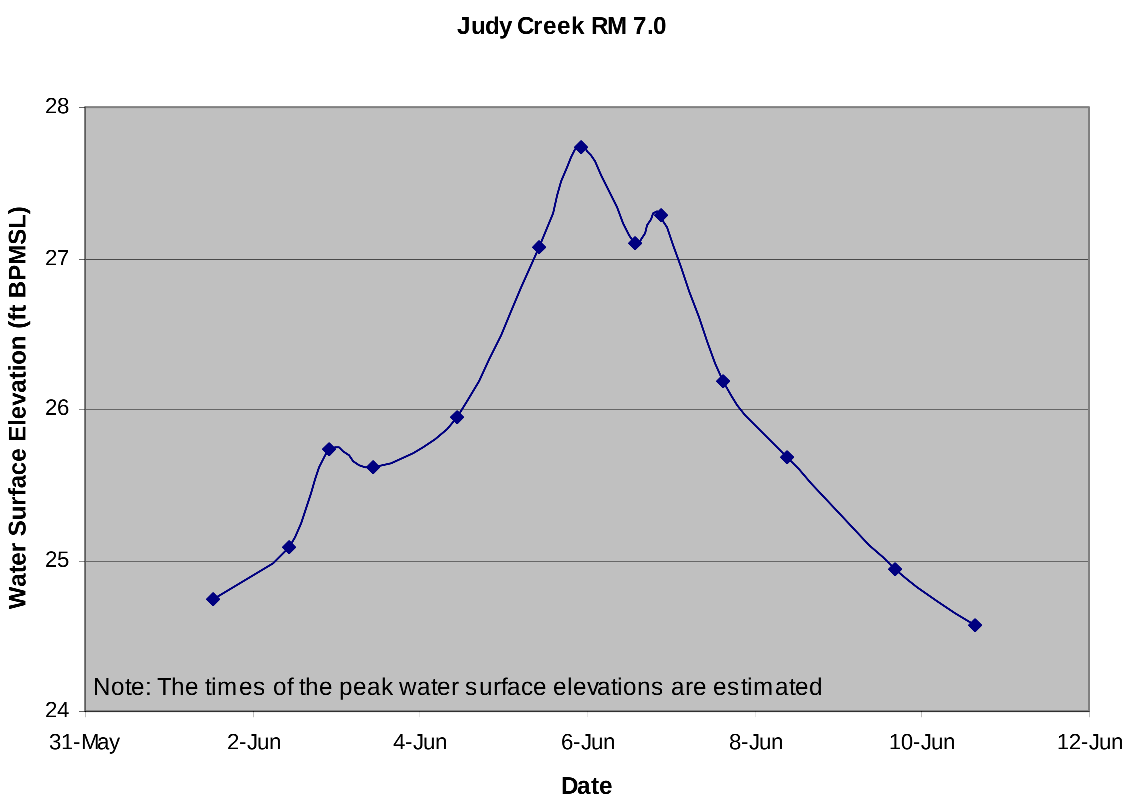

Table 4-3 Fish Creek RM 32.4, Water Surface Elevations and Observations

Date & Time	Water Surface Elevation (feet BPMSL)	Observations
6/4/03 10:34	20.59	Flow over intact channel ice
6/5/03 10:15	20.57	Channel free of ice, snow along each bank, small ice jam downstream of gages
6/6/03 13:46	21.87	Channel clear of ice
6/7/03 15:05	23.64	Channel clear of ice
High Water Mark	23.92	Peak Stage occurred on the evening of 7 June or morning of 8 June
6/8/03 10:45	22.92	Channel Clear of ice with occasional ice chunks floating through the section
6/9/03 16:45	21.99	Channel clear of ice
6/10/03 15:50	22.12	Channel clear of ice
6/11/03 15:15	21.91	Channel clear of ice

Notes:
1. Elevations are based on an elevation of 23.16 feet BPMSL for temporary monument Line 3 South 2, established by Lounsbury in 2001. Elevation of Line 3 South 2 was not resurveyed prior to use during 2003. It is probable that Line 3 South 2 has been subjected to some degree of frost jacking, and thus reported water surface elevations referenced to Line 3 South 2 may be biased high.
2. Coordinates for Fish Creek RM 32.4 are N70° 16' 09.8" W151° 52' 20.5" (NAD 83), by Garmin III Plus GPS.

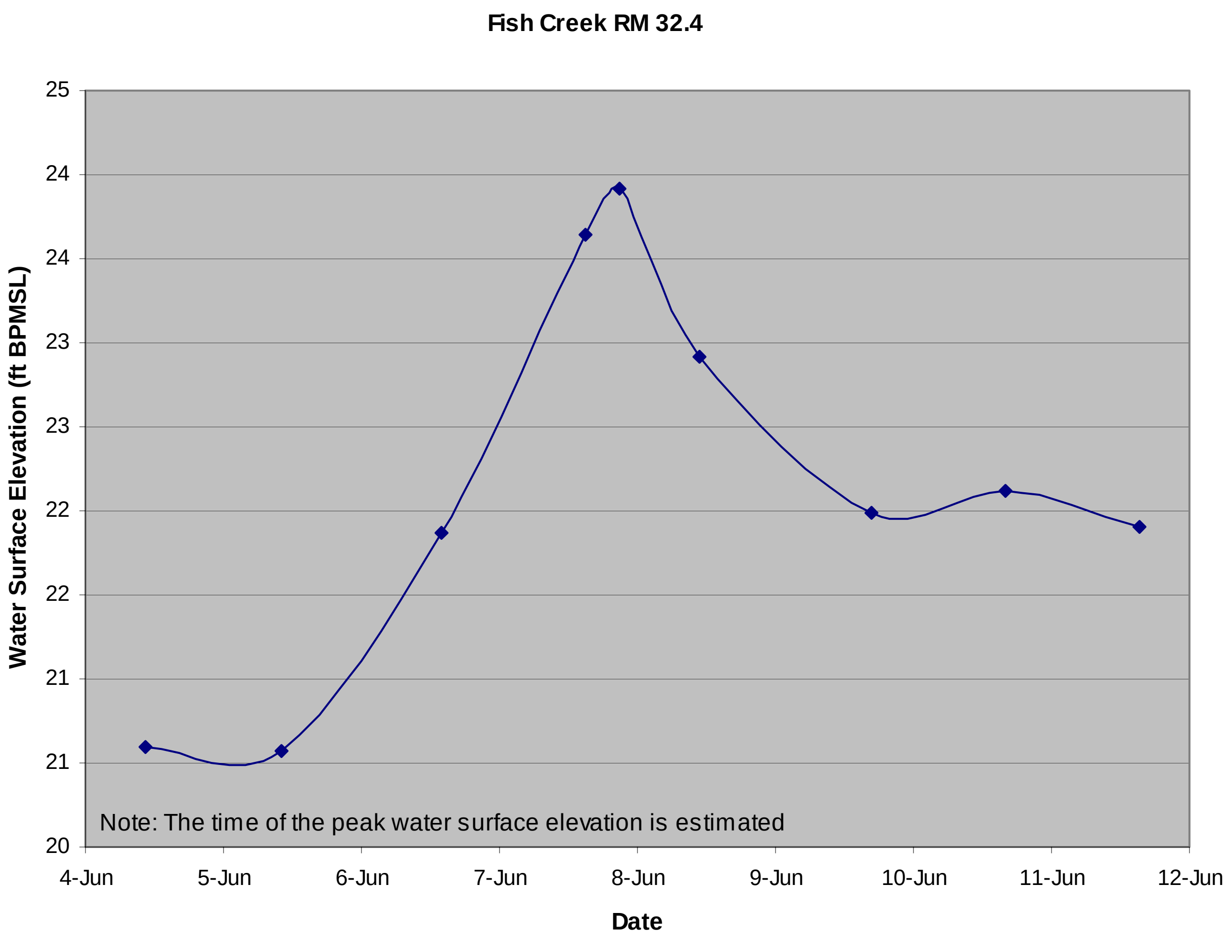

Table 4-4 Fish Creek RM 25.1, Water Surface Elevations and Observations

Date & Time	Water Surface Elevation (feet BPMSL)	Observations
6/1/03 13:22	13.87	Leading edge of water approximately 2 air miles downstream of gages
6/2/03 10:30	14.78	Channel 50% open, flow over intact channel ice
6/3/03 11:30	16.22	Flow over intact channel ice with limited ice lifting
6/4/03 10:42	17.11	Flow over intact channel ice
6/5/03 10:24	19.02	Channel ice intact, snow affected banks, ice jam located downstream of gages
6/6/03 13:56	19.51	Peak Stage occurred on the afternoon of 6 June
6/7/03 15:20	18.29	Channel clear of ice
6/8/03 10:17	17.97	Channel ice cleared, occasional ice chunks floating through the section
6/9/03 17:10	16.42	Channel clear of ice
6/10/03 16:10	16.92	Channel clear of ice
6/11/03 15:30	16.62	Channel clear of ice

Notes:

1. Elevations are based on an elevation of 24.19 feet BPMSL for temporary monument Line 2 South, established by Lounsbury in 2001. Elevation of Line 2 South was not resurveyed prior to use during 2003. It is probable that Line 2 South has been subjected to some degree of frost jacking, and thus reported water surface elevations referenced to Line 2 South may be biased high.
2. Coordinates for Fish Creek RM 25.1 are N70° 15' 56.0" W151° 42' 11.6" (NAD 83), by Garmin III Plus GPS.

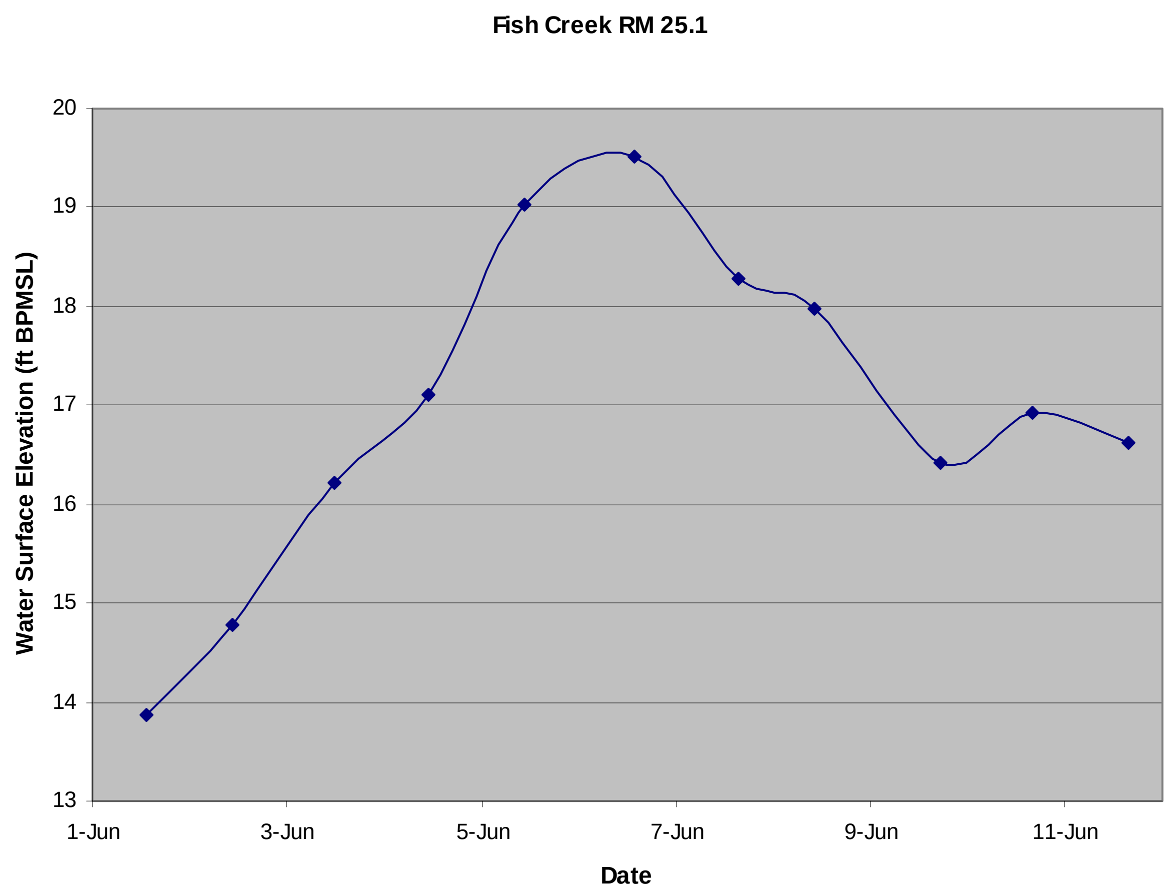

Table 4-5 Fish Creek RM 11.7, Water Surface Elevations and Observations

Date & Time	Water Surface Elevation (feet BPMSL)	Observations
6/2/03 10:45	5.96	Flow over intact channel ice, leading edge of water just downstream of gages
6/3/03 11:40	6.89	Flow over intact channel ice
6/4/03 10:51	7.09	Flow over intact channel ice, ice chunks from Judy Creek floating through the section
Preliminary Peak	9.46	Preliminary peak occurred on the evening of 4 June or morning of 5 June
6/5/03 10:36	9.33	Flow over intact channel ice
6/6/03 14:05	8.69	Flow over intact channel ice
6/7/03 15:30	10.12	Channel ice lifted and intact
High Water Mark	10.35	Peak stage occurred on the evening of 7 June or morning of 8 June
6/8/03 11:37	9.15	Channel ice cleared, occasional ice chunks floating through the section
6/9/03 17:20	8.06	Channel clear of ice
6/10/03 16:25	7.53	Channel clear of ice
6/11/03 15:40	7.24	Channel clear of ice

Notes:

1. Elevations are based on an elevation of 24.19 feet BPMSL for temporary monument C3A-East, established by Lounsbury in 2001. Elevation of C3A-East was not resurveyed prior to use during 2003. It is probable that C3A-East has been subjected to some degree of frost jacking, and thus reported water surface elevations referenced to C3A-East may be biased high.
2. Coordinates for Fish Creek RM 11.7 are N70° 18' 59.3" W151° 25' 33.2" (NAD 83), by Garmin III Plus GPS.

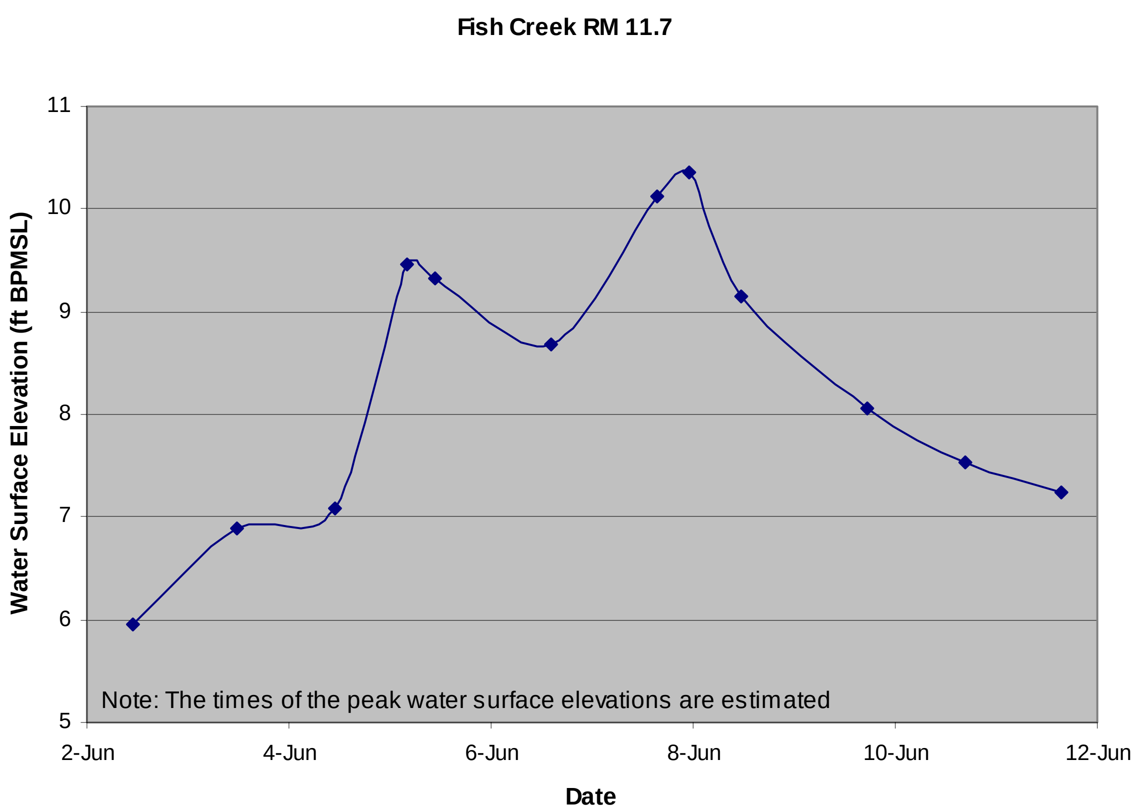

Table 4-6 Ublutuoch River RM 6.8 Upstream, Water Surface Elevations and Observations

Date	Water Surface Elevation (feet BPMSL)	Observations
6/5/03 11:00	8.73	Water flowing over the banks, channel ice intact
6/5/03 11:22	8.87	Water flowing over the banks, channel ice intact
6/5/03 16:50	10.01	Water flowing over the banks, channel ice intact
6/6/03 14:40	9.64	Flow over intact bottomfast channel ice
High Water Mark	10.14	Peak Stage occurred on the evening of 6 June or morning of 7 June
6/7/03 16:05	9.24	Flow over intact bottomfast channel ice
6/8/03 12:05	8.54	Flow over intact bottomfast channel ice
6/8/03 16:50	8.33	Flow over intact ice, small ice jams still present above and below the gages
6/9/03 13:10	7.17	Flow over intact ice, small ice jams still present above and below the gages
6/9/03 16:05	7.03	Flow over intact ice, small ice jams still present above and below the gages
6/9/03 17:00	6.84	Flow over intact ice, small ice jams still present above and below the gages
6/10/03 9:00	6.22	Channel Ice intact and beginning to lift, floating ice breaking into pans
6/10/03 11:45	6.06	Channel Ice intact and continuing to lift, floating ice breaking into pans
6/11/03 11:27	5.18	Channel ice approximately 90-95% lifted, ice breaking apart, rotten

Notes:
1. Elevations are based on an elevation of 11.96 feet BPMSL for temporary monument UBS-2, established by LCMF in April 2003.
2. Coordinates for Ublutuoch River RM 6.8 Upstream are N70° 17' 00.1" W151° 15' 30.3" (NAD 83), by Garmin III Plus GPS.

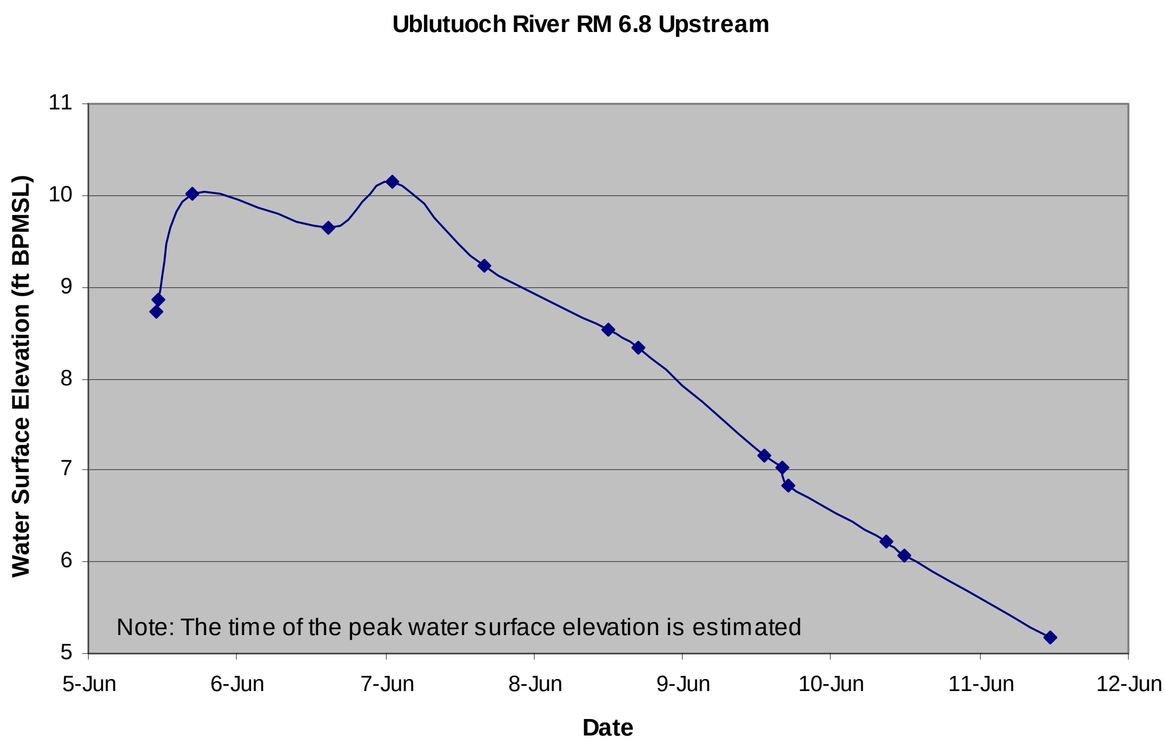

Table 4-7 Ublutuoch River RM 6.8 Downstream, Water Surface Elevations and Observations

Date	Water Surface Elevation (feet BPMSL)	Observations
6/5/03 16:25	9.45	Water flowing over the banks, channel ice intact
6/6/03 14:40	9.41	Flow over channel ice
High Water Mark	9.67	Peak Stage occurred on the evening of 6 June or morning of 7 June
6/7/03 16:00	9.06	Flow over intact bottomfast channel ice
6/8/03 12:13	8.42	Flow over intact bottomfast channel ice
6/8/03 17:00	8.25	Flow over intact bottomfast channel ice
6/9/03 13:20	7.09	Flow over intact bottomfast channel ice
6/9/03 16:07	6.92	Flow over intact bottomfast channel ice
6/9/03 16:48	6.79	Flow over intact bottomfast channel ice
6/10/03 9:13	6.13	Channel Ice intact and beginning to lift, floating ice breaking into pans
6/10/03 11:50	6.00	Channel Ice intact and continuing to lift, floating ice breaking into pans
6/11/03 10:58	5.17	Channel ice approximately 90-95% lifted, ice breaking apart, rotten

Notes:
1. Elevations are based on an elevation of 10.28 feet BPMSL for temporary monument UBS-1, established by LCMF in April 2003.
2. Coordinates for Ublutuoch River RM 6.8 Downstream are N70° 17' 08.2" W151° 15' 45.5" (NAD 83), by Garmin III Plus GPS.

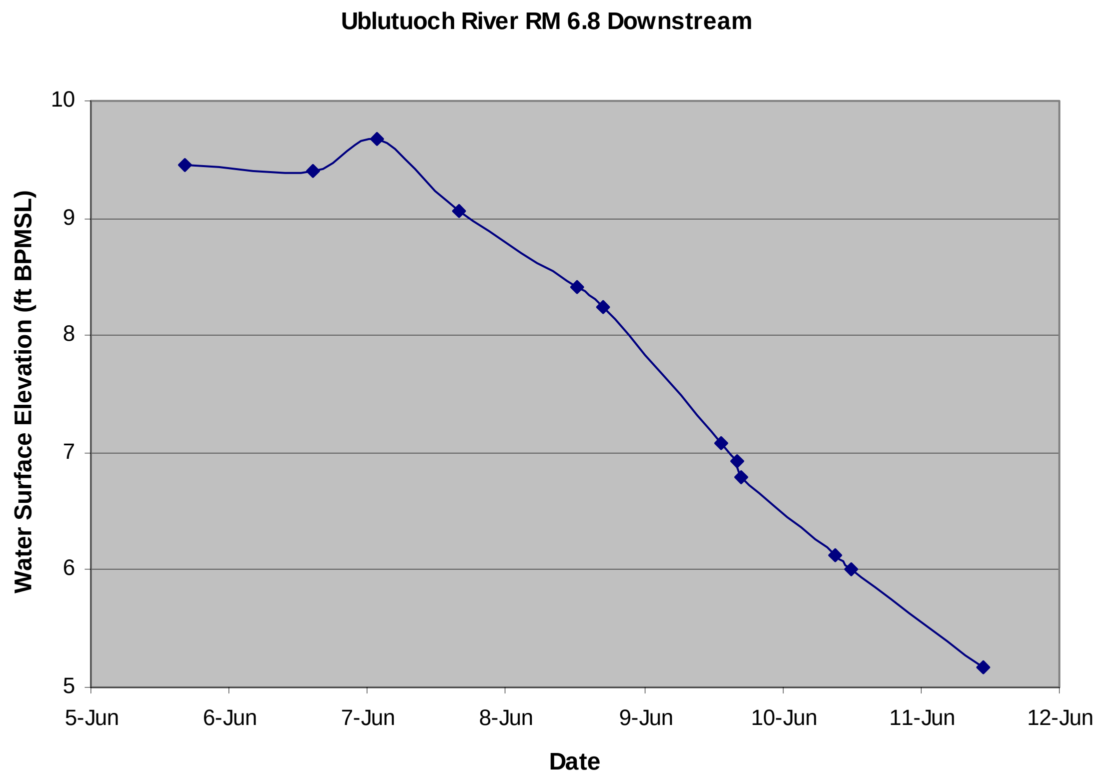

Table 4-8 Ublutuoch River RM 1.9 Upstream, Water Surface Elevations and Observations

Date	Water Surface Elevation (feet BPMSL)	Observations
6/5/03 11:41	4.89	Local melt
6/5/03 17:00	5.72	Flow over intact channel ice
6/6/03 14:25	6.70	Flow over the banks, channel ice intact
6/7/03 15:50	7.38	Flow over intact channel ice; ice starting to lift
High Water Mark	7.66	Peak Stage occurred on the evening of 7 June or morning of 8 June
6/8/03 13:08	7.43 (3)	Flow over floating intact ice, small ice jams present above and below the gages
6/9/03 17:50	6.13	Flow over floating intact channel ice
6/10/03 12:00	5.53	Flow over floating intact channel ice, floating ice breaking into pans
6/11/03 10:25	5.08	Channel ice approximately 90-95% lifted, ice breaking apart, rotten

Notes:
1. Elevations are based on an elevation of 12.80 feet BPMSL for temporary monument UBN-1, established by LCMF in April 2003.
2. Coordinates for Ublutuoch River RM 1.9 Upstream are N70° 18' 15.8" W151° 19' 41.0" (NAD 83), by Garmin III Plus GPS.
3. Water surface elevation reading made from a hovering helicopter. Accuracy of measurement is +/- 0.25 feet.

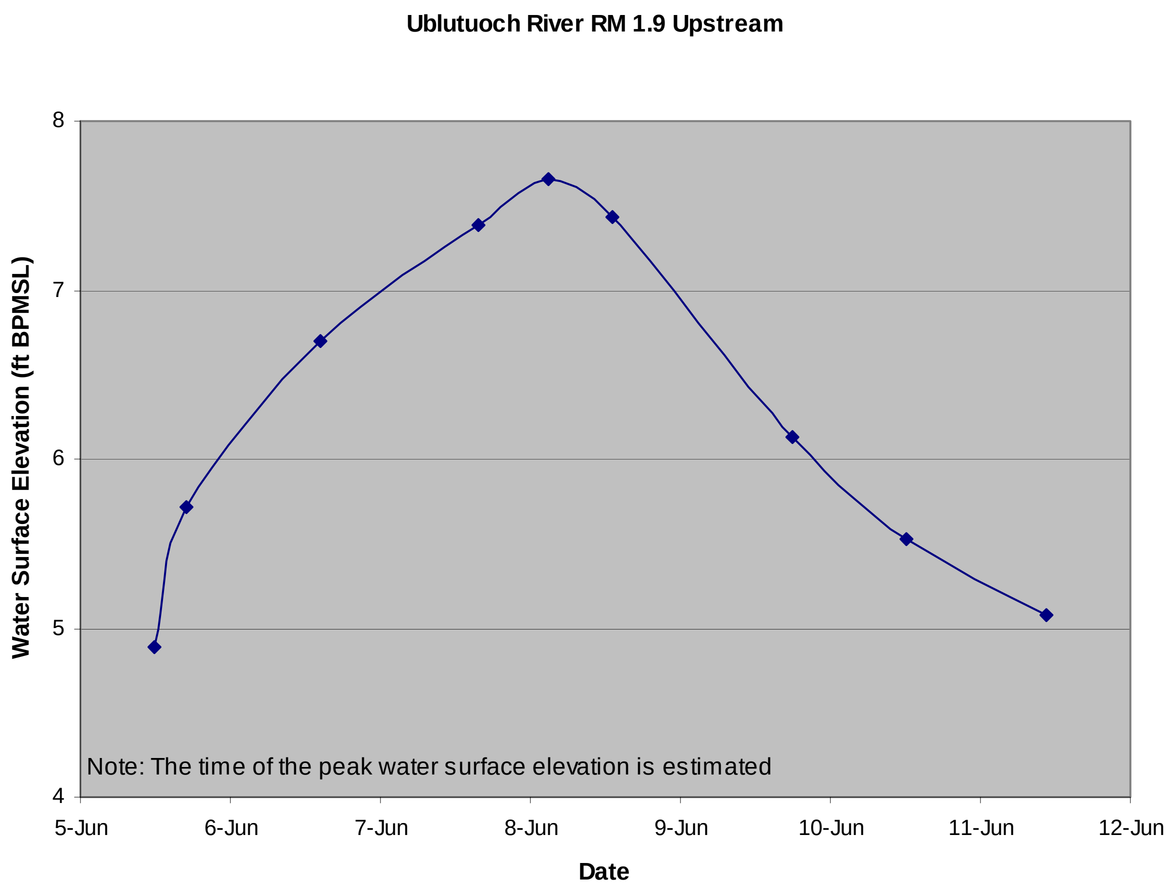

Table 4-9 Ublutuoch River RM 1.9 Downstream, Water Surface Elevations and Observations

Date	Water Surface Elevation (feet BPMSL)	Observations
6/5/03 11:54	4.86	Local melt
6/5/03 17:00	5.64	Flow over intact channel ice
6/6/03 14:15	6.56 (3)	Flow over the banks, channel ice intact
6/7/03 15:45	7.38 (3)	Flow over intact channel ice; ice starting to lift
Highwater Mark	7.58	Peak stage occurred on the evening of 7 June morning of 8 June
6/8/03 13:16	7.33 (3)	Flow over floating intact ice, small ice jams present above and below the gages
6/9/03 17:50	6.09	Flow over floating intact channel ice
6/10/03 12:05	5.45	Flow over floating intact channel ice, floating ice breaking into pans
6/11/03 10:08	5.01	Channel ice approximately 90-95% lifted, ice breaking apart, rotten

Notes:
1. Elevations are based on an elevation of 12.80 feet BPMSL for temporary monument UBN-1, established by LCMF in April 2003.
2. Coordinates for Ublutuoch River RM 1.9 Downstream are N70° 18' 27.5" W151° 19' 57.5" (NAD 83), by Garmin III Plus GPS.
3. Water surface elevation reading made from a hovering helicopter. Accuracy of measurement is +/- 0.25 feet.

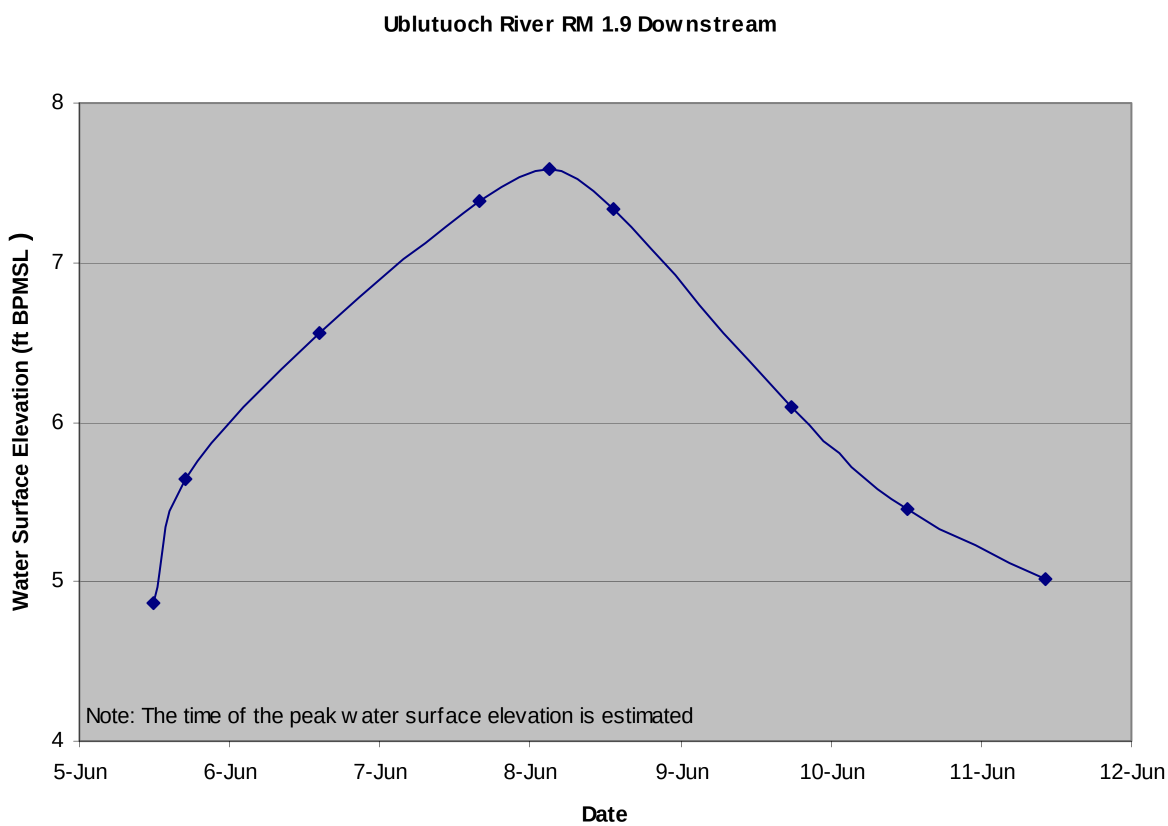

Photo 4-1 **Leading edge of flowing water on Judy Creek on 28 May, approximately 20 air miles upstream of the Judy Creek RM 13.8 monitoring site. This represents the leading edge of breakup flows within the Fish Creek basin. View looking north.**

Photo 4-2 **Leading edge of flow on the Ublutuoch River on 4 June, approximately 15 air miles upstream of the Ublutuoch River RM 6.8 monitoring site. View looking southwest.**

Photo 4-3 **Arrival of the breakup melting front at the Ublutuoch River RM 6.8 monitoring site and proposed bridge location on 5 June at roughly 9:50 a.m. View looking southeast and upstream**

Photo 4-4 **Breakup floodwaters at the Ublutuoch River RM 6.8 monitoring site and proposed bridge location on 5 June at roughly 12:00 noon. View looking southeast and upstream. Compare to Photo 4-3 above, taken from a similar perspective approximately two hours earlier.**

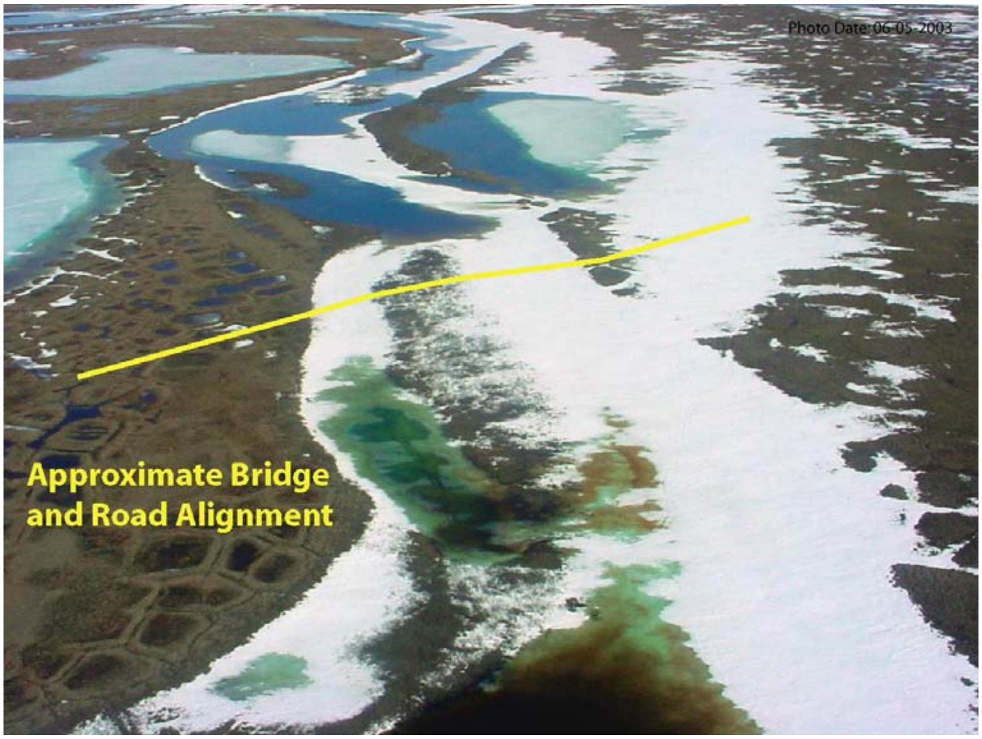

Photo 4-5 **Arrival of the breakup melting front at the Ublutuoch River RM 6.8 monitoring site and proposed bridge location on 5 June at roughly 9:50 a.m. View looking northwest and downstream.**

Photo 4-6 **Breakup floodwaters at the Ublutuoch River RM 6.8 monitoring site and proposed bridge location on 5 June at roughly 12:00 noon. View looking northwest and downstream. Compare to Photo 4-5 above, taken from a similar perspective approximately two hours earlier.**

Photo 4-7 **Ublutuoch River RM 1.9 monitoring site and proposed bridge location on 5 June prior to the arrival of breakup flows. Water in channel and nearby lake basins is from local melt and influx from minor tributaries. View looking northwest.**

Photo 4-8 **Ublutuoch River RM 1.9 monitoring site and proposed bridge location on 8 June. Conditions shown are near the time of the breakup peak water surface elevation and peak discharge. View looking northwest and downstream.**

5.0 Channel Ice Observations

Channel ice surveys began on 1 June when water first reached the temporary staff gages in the Monument 01 vicinity. Channel ice surveys were performed daily until 11 June when the secondary peak water surface elevation occurred at Monument 01. After 10 June, the major channels of the Colville River Delta and the Fish Creek drainage, excluding the Ublutuoch River, were essentially clear of channel ice and ice jams.

The area covered by the surveys included the main channel of the Colville River north from a point approximately eight river miles upstream from Monument 01 to the head of the Putu Channel (the northern connection between the Nigliq Channel and the East Channel of the Colville); the full length of the Nigliq Channel; the Sakoonang Channel north from a point approximately two miles downstream of the head of the channel to approximately five river miles downstream of the Alpine facilities; the Ublutuoch River from approximately river mile 10 to the Fish Creek confluence; Judy Creek from approximately river mile 15 to the Fish Creek confluence; and Fish Creek from approximately river mile 35 to a point approximately two miles downstream from the confluence with the Ublutuoch River. Observations of ice jamming and the clearing of channel ice are shown on Figures 5-1 through 5-9, for the period 2 June through 10 June.

5.1 Colville River Delta Ice Observations Summary

Cool temperatures characterized the early stages of breakup in the delta. As noted previously, water was first observed flowing in the channel near Monument 01 on 27 May. As flows gradually increased over the next week, low water channel ice began floating and lifting in place in a roughly south to north progression. By 4 June, water in the main channel of the Colville near Monument 01 was flowing over and around ribbon ice (intact, partially-floating low water channel ice). By 6 June, after the occurrence of the initial peak water surface elevation, the rotting ribbon ice had broken up and floated downstream, leaving the main channel of the Colville free of ice.

By 3 June on the Nigliq Channel, water was flowing over and around ribbon ice from the head of the channel north to near CD-2. To the north of CD-2, low water channel ice had not yet lifted. By 5 June, the Nigliq channel was ice-free from the head of the channel to a point just upstream of Nuiqsut, and the remaining intact low water channel ice had lifted, forming ribbon ice. Ice had cleared from the Nigliq Channel as far north as the CD-4 area by 6 June. On 7 June, ice had cleared as far north as Monument 22, and the channel near Monument 28 was ice-free. By 8 June, the entire Nigliq Channel was ice-free.

In the Sakoonang Channel, turbid flow over intact low water channel ice was noted from near the Alpine facility north toward Harrison Bay on 2 June. By 4 June, the channel ice on the Sakoonang had lifted in place forming ribbon ice, and was becoming rotten. On 8 June, the Sakoonang Channel was ice-free from near the head of the channel to just north of the Alpine facility. The ice was rapidly deteriorating and by 9 June the Sakoonang Channel was clear of ice.

5.1.1 Colville River Ice Jam Observations

Few ice jams were observed in the Colville River Delta in 2003. Small, short-lived ice jams were noted in the Nigliq Channel near Nuiqsut on 3 through 6 June. All of the Nigliq Channel ice jams were surface jams rather than grounded jams. As a result, they did not produce any notable effects on water surface elevations in the channel.

Ice jamming was more common in the main channel of the Colville River upstream and to the south of the delta. A surface ice jam was observed on 1 June approximately 17.5 river miles upstream from Monument 01. By 3 June the ice jam had moved downstream approximately three miles and was over one mile long. On 5 June the ice jam had broken apart and large pans of ice were noted flowing past the temporary staff gages at Monument 01. A small ice jam was also observed at the mouth of the Itkillik River on 5 June.

5.2 Fish Creek and Tributaries Ice Observations Summary

As noted previously, Judy Creek was the first Fish Creek tributary to begin flowing in the spring of 2003. Flowing water was first noted at the Judy Creek RM 7.0 monitoring site on 1 June. By 5 June, just prior to the occurrence of the peak water surface elevation, low water channel ice had lifted, broken up, and floated downstream from above Judy Creek RM 13.8 to just downstream of Judy Creek RM 7.0. Little change was noted on 6 June but by 7 June, the Judy Creek channel was clear of low water channel ice all the way to the Fish Creek confluence.

No flow was noted on Fish Creek upstream of the Judy Creek confluence until 4 June. By 5 June, low water channel ice in the surveyed area had cleared downstream to approximately the Fish Creek RM 32.4 monitoring site. By 6 June, the channel ice on upper Fish Creek had cleared almost as far downstream as the confluence with Judy Creek. It was at about this time that the spring breakup peak water surface elevation was recorded at Fish Creek RM 25.1, a short distance downstream of the Judy Creek confluence. By 7 June, low water channel ice had cleared to approximately river mile 20 on Fish Creek. On 8 June, near the time that the peak water surface elevation was recorded at the Fish Creek RM 11.7 monitoring site, the channel of Fish Creek was clear of ice to the northern limit of the surveyed area, downstream of the Ublutuoch River confluence.

Flowing water was first noted on the Ublutuoch River on 4 June. By 5 June, flows had reached the Ublutuoch RM 6.8 monitoring site. The peak water surface elevation and peak discharge at the Ublutuoch RM 6.8 site occurred late on 6 June or early on the morning of 7 June over bottomfast channel ice. The low water channel ice on the lower part of the Ublutuoch River was beginning to lift in place and deteriorate during this period. By 11 June, the last day that channel ice surveys were conducted in the Fish Creek basin, 90-95% of the low water channel ice in the lower Ublutuoch River had lifted and was starting to break up.

5.2.1 Fish Creek Basin Ice Jam Observations

Ice jamming in the Fish Creek basin during the 2003 spring breakup was relatively minor and short-lived. Small ice jams were noted as early as 2 June and 4 June on Fish and Judy Creek, respectively. By 6 June there was no evidence of ice jamming on either Fish or Judy Creek. None of the Fish and Judy Creek ice jams appeared to have any notable effects on flooding.

Numerous small ice jams were noted along the lower Ublutuoch River from 8 June until the Fish Creek basin ice surveys were completed on 11 June. Ublutuoch River ice jamming was minor and resulted in no major occurrences of backwater or overbank flooding.

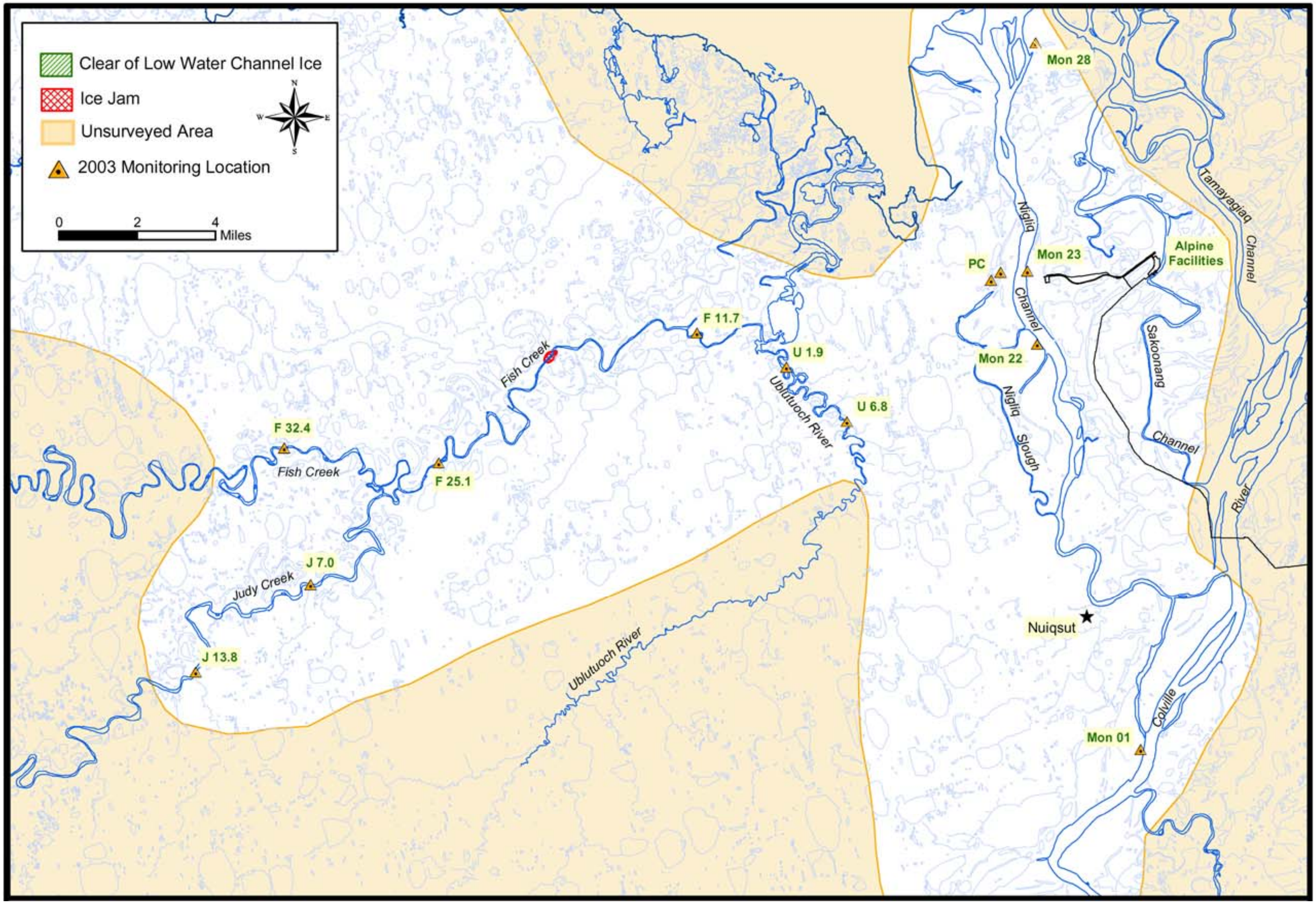

Figure 5-1 **Low Water Channel Ice Survey, June 2, 2003**

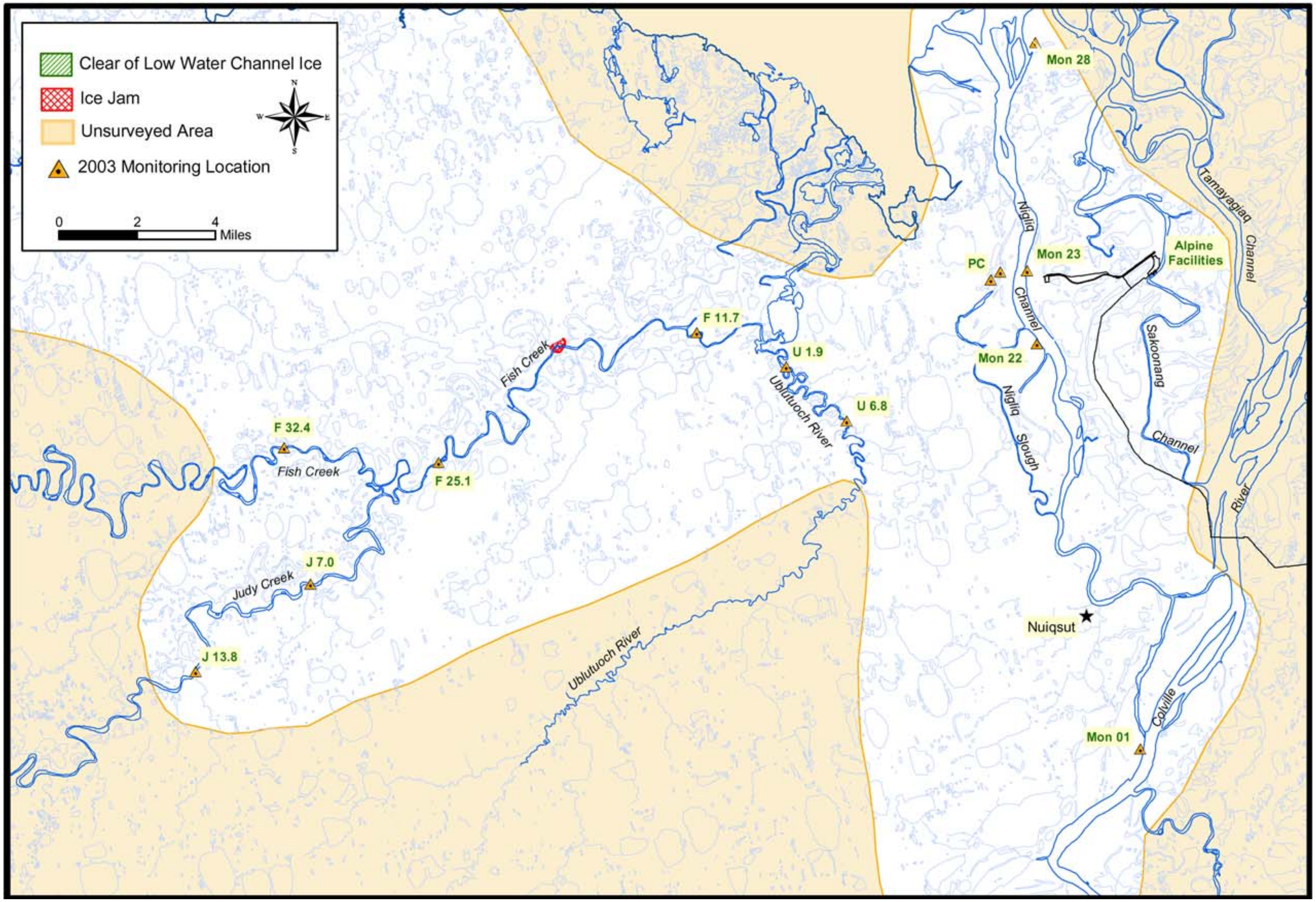

Figure 5-2 **Low Water Channel Ice Survey, June 3, 2003**

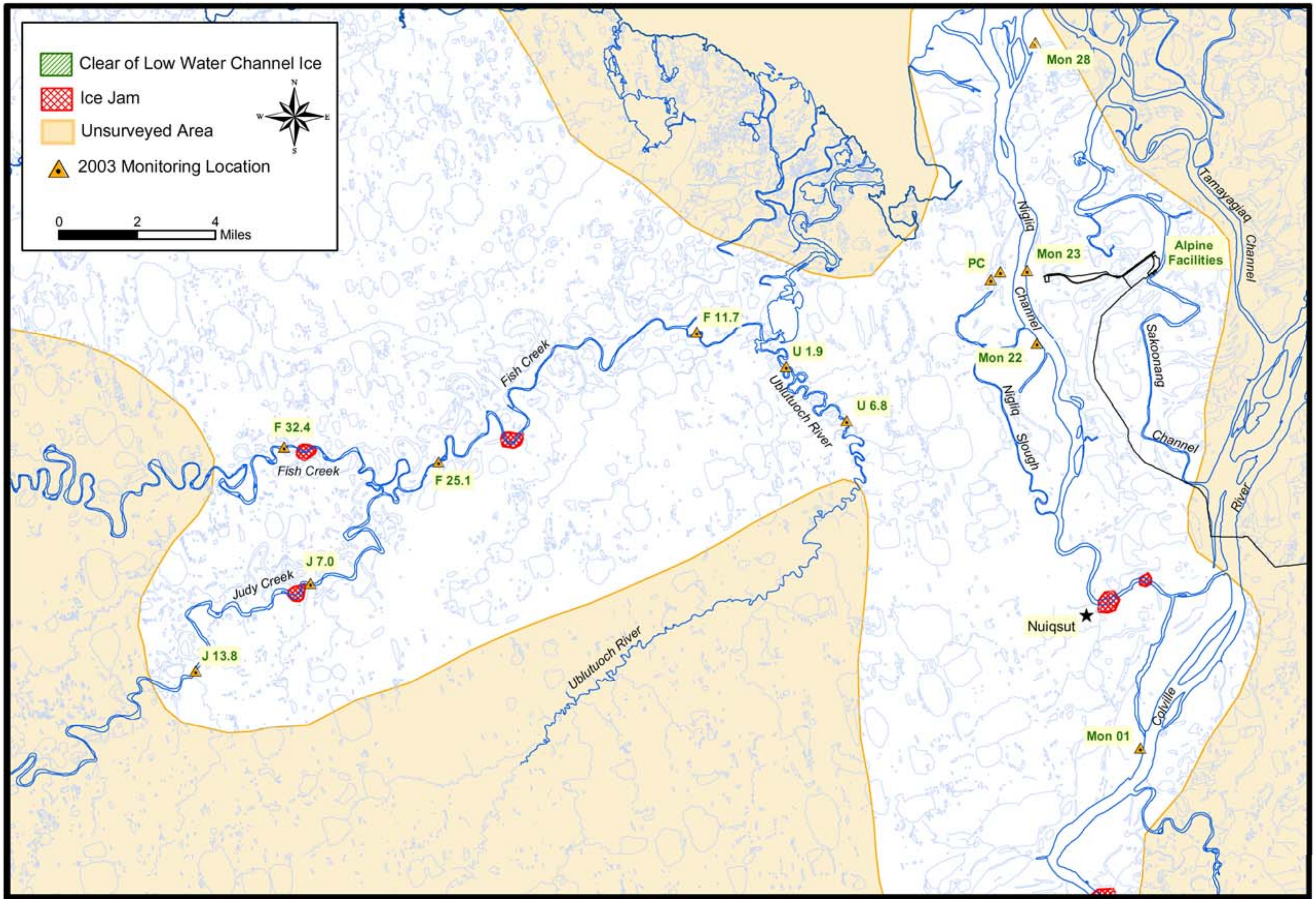

Figure 5-3 Low Water Channel Ice Survey, June 4, 2003

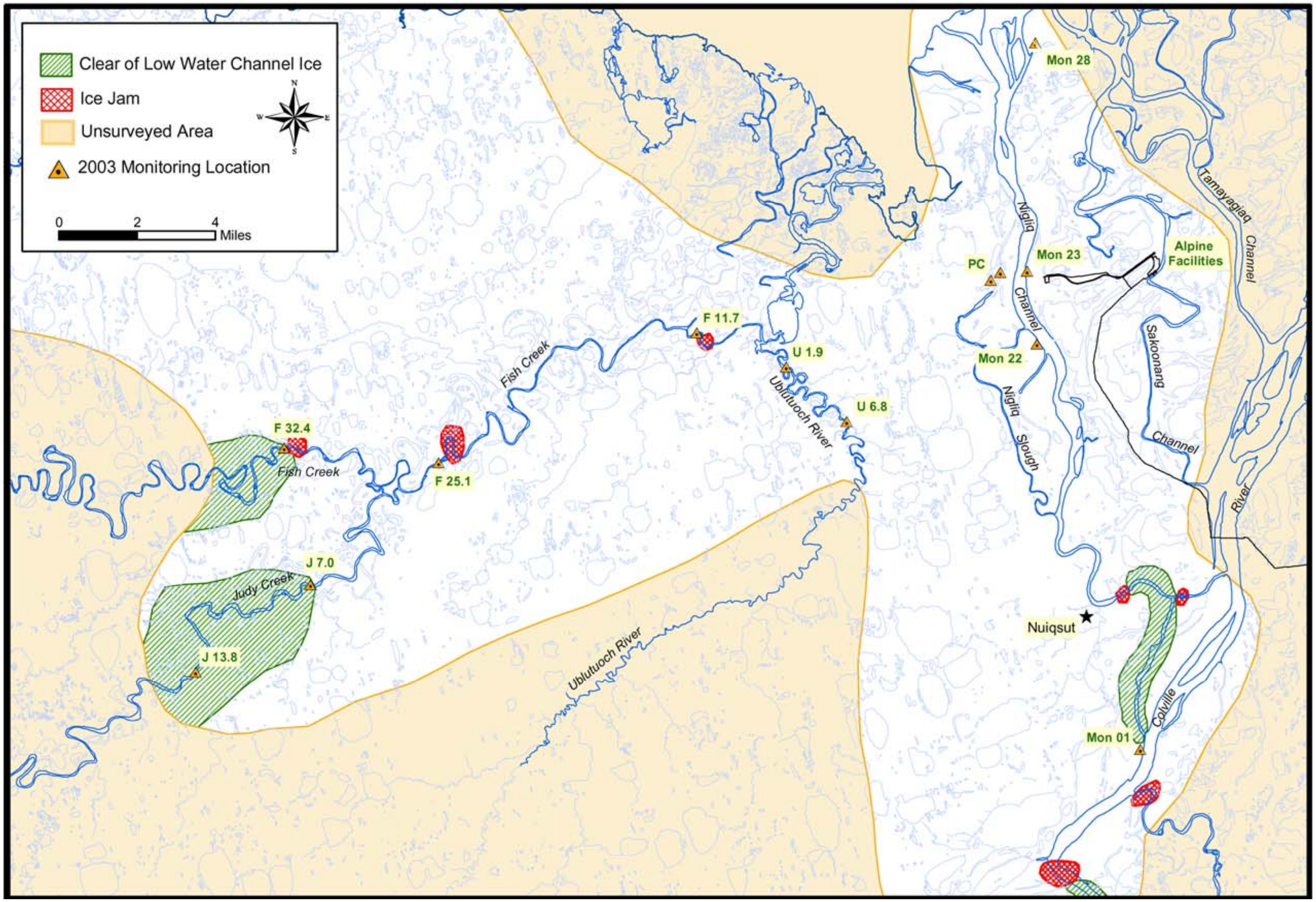

Figure 5-4 Low Water Channel Ice Survey, June 5, 2003

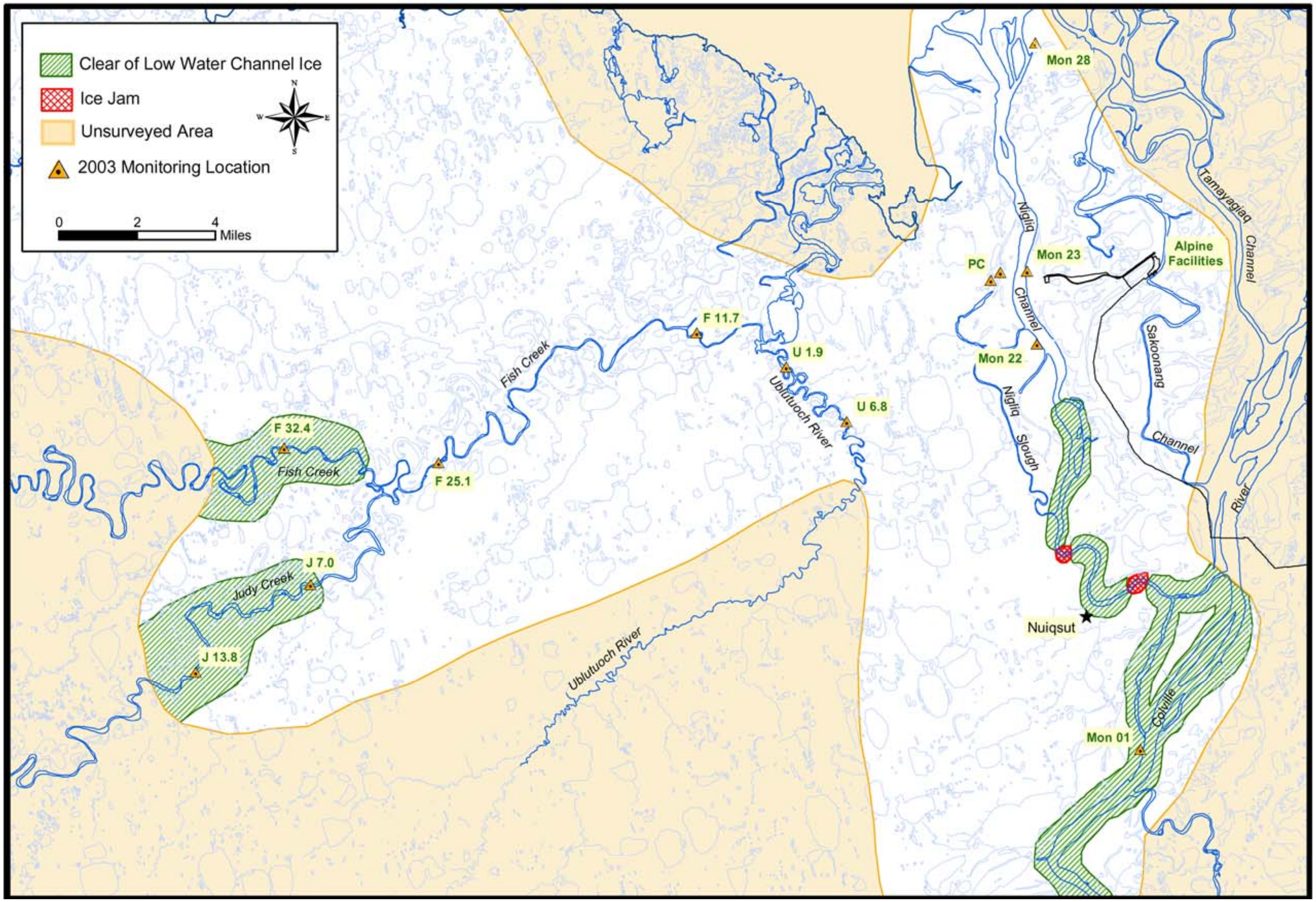

Figure 5-5 Low Water Channel Ice Survey, June 6, 2003

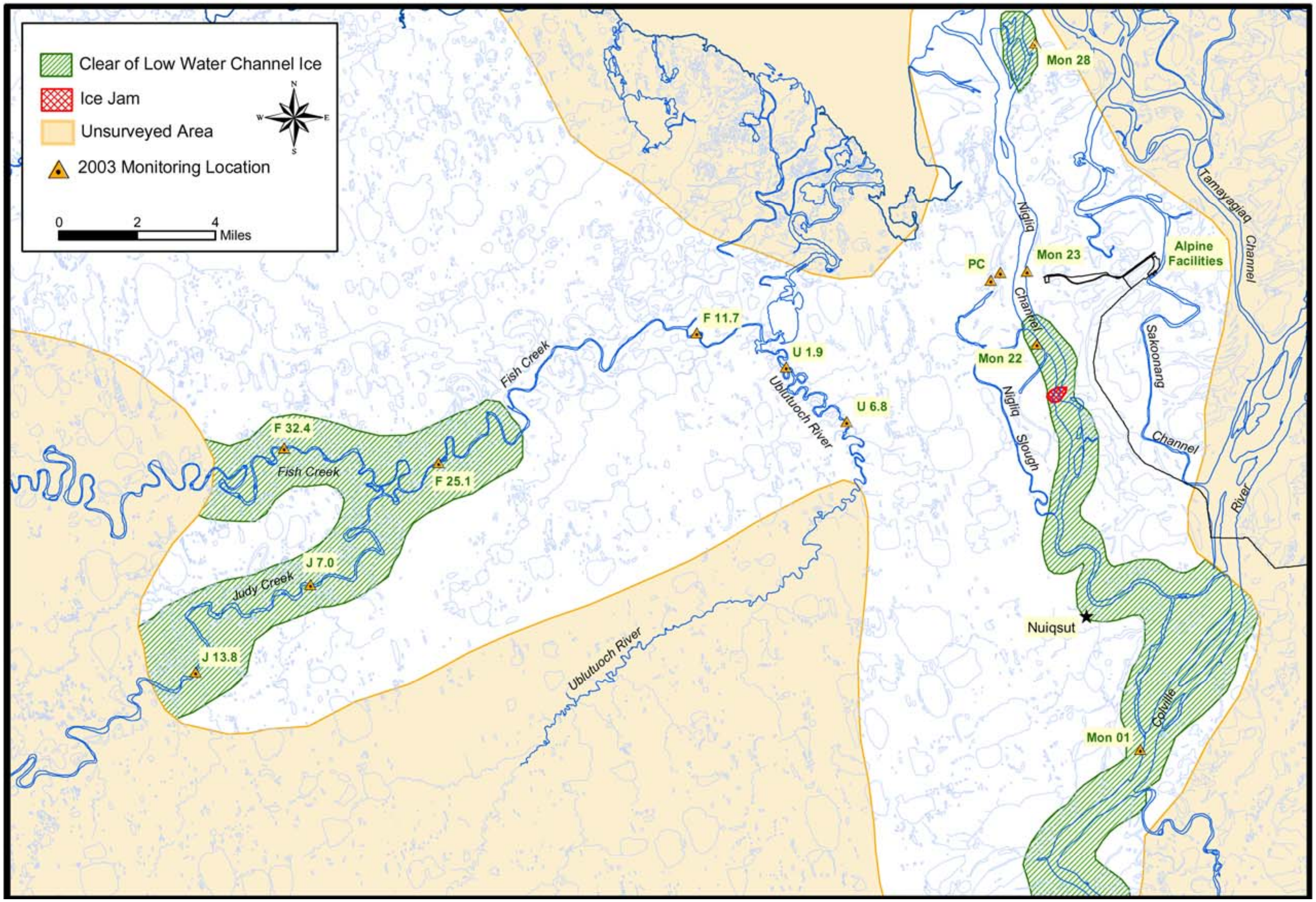

Figure 5-6 Low Water Channel Ice Survey, June 7, 2003

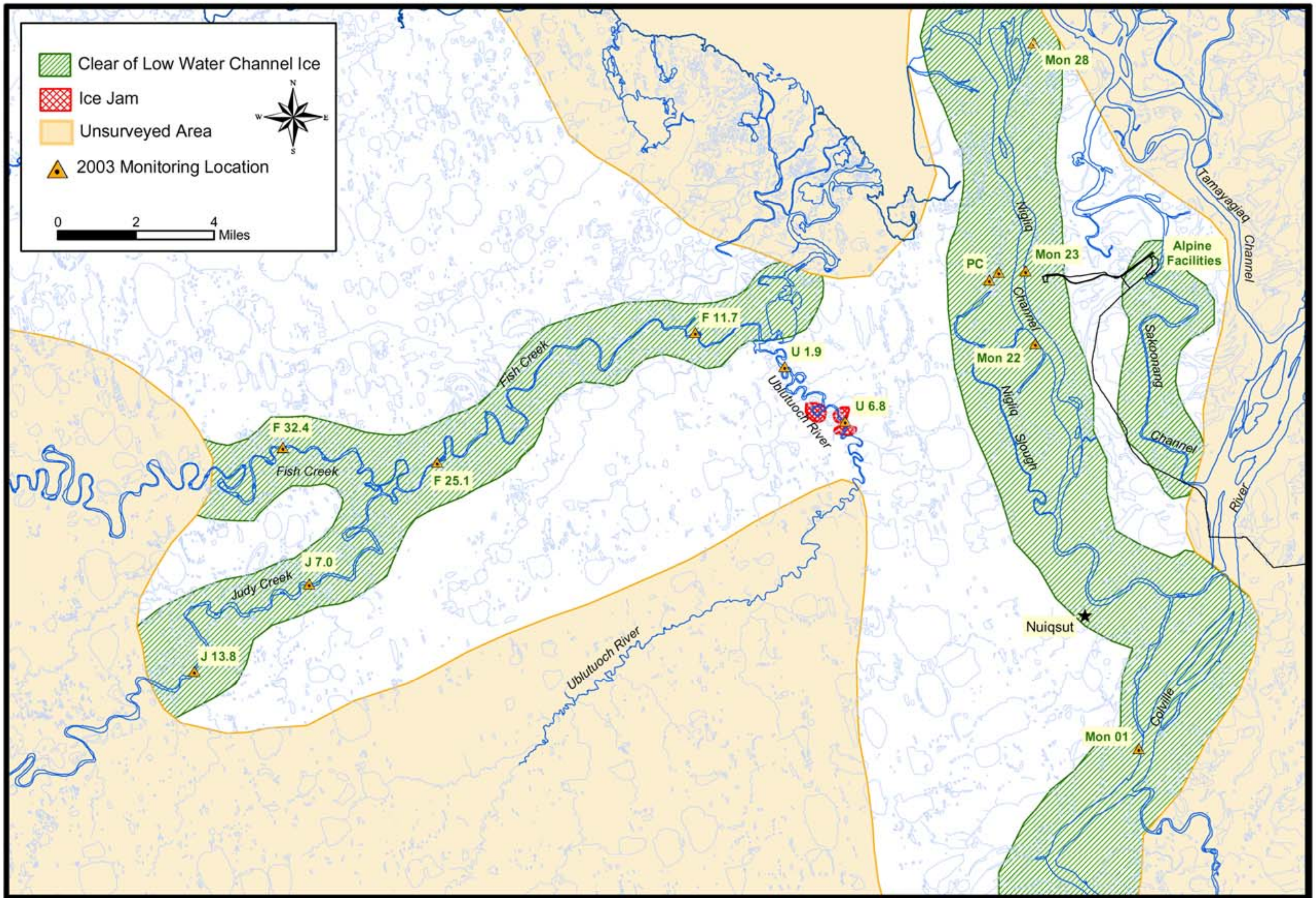

Figure 5-7 **Low Water Channel Ice Survey, June 8, 2003**

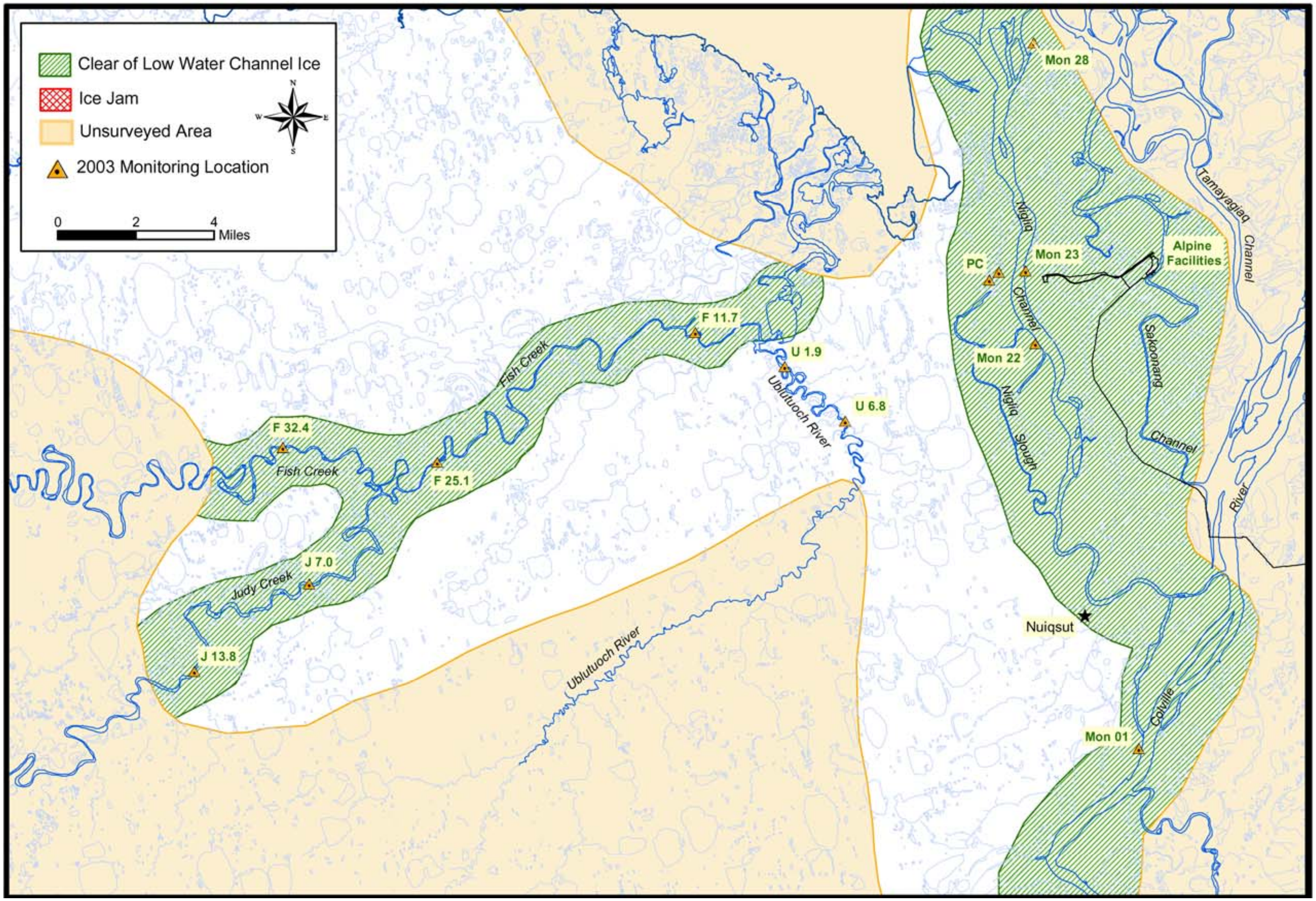

Figure 5-8 Low Water Channel Ice Survey, June 9, 2003

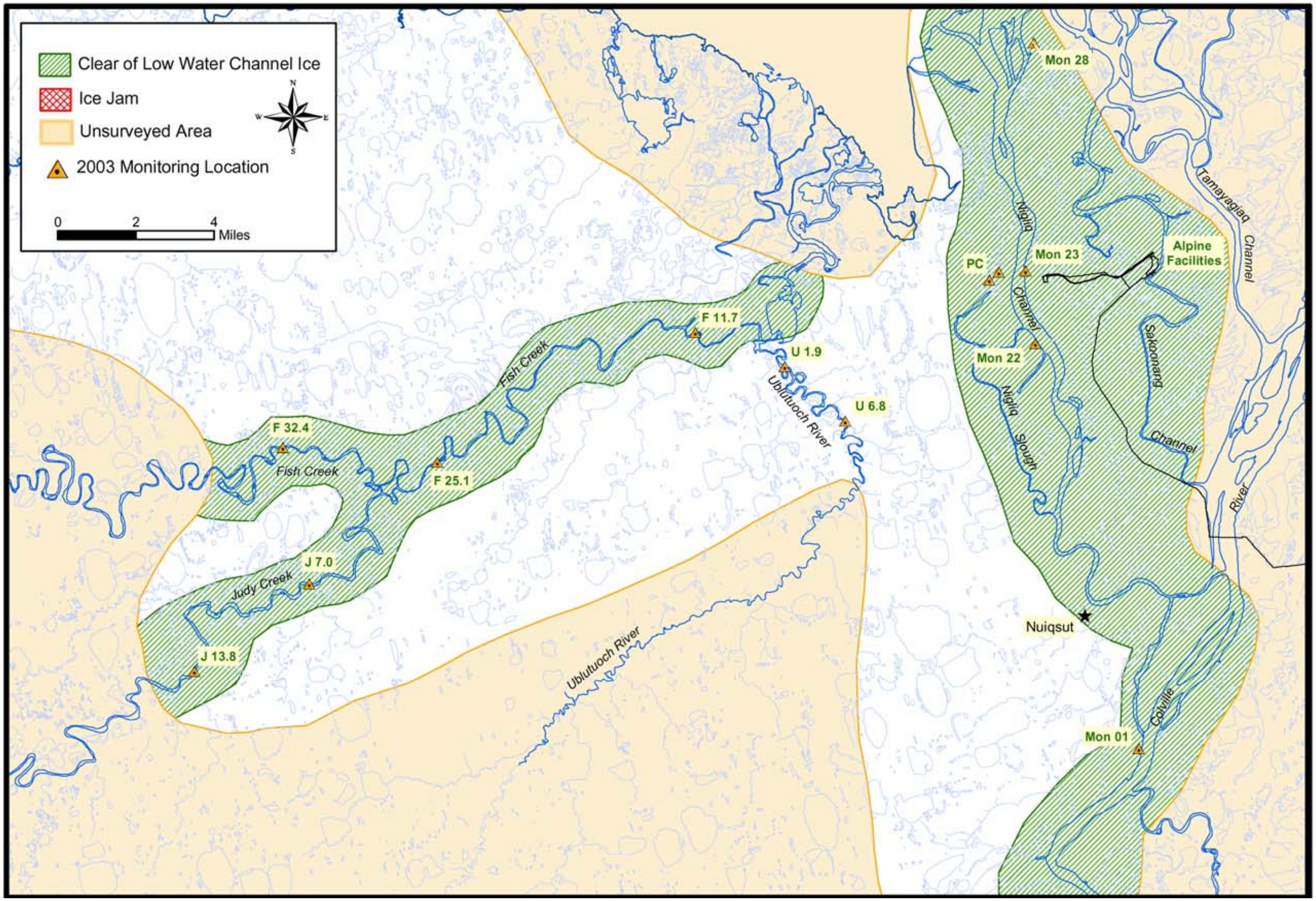

Figure 5-9 Low Water Channel Ice Survey, June 10, 2003

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APPENDIX A – Reconnaissance Flight Summaries

May 18, 2003 Reconnaissance Flight Summary

Everyone,

Jim Meckel and I took a reconnaissance flight to the south this afternoon to check on the progress of breakup in the Colville River, Fish Creek, Judy Creek, and Ublutuoch River basins. We flew up the Colville River to the confluence with the Anaktuvuk River (about 90 river miles upstream from Monument 01), and then flew up the Anaktuvuk River to a point approximately 35 river miles above the confluence. About one or two miles downstream of Ocean Point (approximately 25 miles upstream of Monument 01) saturated snow and ponded water were noted within portions of the braided channel system of the Colville. This melting was assumed to be the result of local melt from exposed sand and mud bars, melting around willows within the floodplains, and melting concentrated along the bluffs along the left bank of the river. These conditions presumably extend all the way up to Umiat where similar conditions were noted, however, we didn't fly along the river between the Anaktuvuk/Colville confluence and Umiat.

Conditions along the lower Anaktuvuk River were similar to those noted on the Colville – significant ponding and saturated snow from local melt within portions of the braided channel system. Outside the floodplain, there was a fairly continuous snow cover with little tundra exposed. About 25 miles upstream of the confluence, we first noted concentrated but discontinuous areas of flow within portions of the braided channel system. This may or may not represent the leading edge of the breakup front. Jim Meckel's thought while we were flying over was that it was probably too discontinuous to be the leading edge of a significant push of water downstream.

From a point approximately 35 river miles upstream from the Anaktuvuk/Colville confluence we flew to Umiat where we fueled up. (As a side note, Umiat's Colville Ice Classic has already been closed and Jim and I weren't able to put our bets down on the date of first ice movement.) On our flight to Umiat there was more melting in the high country than we had seen anywhere else on our trip but there still wasn't any significant amount of ponded water anywhere and no surface flows were noted.

From Umiat we flew to the headwaters of Judy Creek, then to the headwaters of Fish Creek, and finally to the headwaters of the Ublutuoch River. Similar conditions were notes at all of these areas – an extensive and continuous snow cover with little exposed tundra, and no evidence of melting except along exposed sand and mud bars. Breakup in the NPR-A appears to be lagging far behind that in the Colville River basin.

Temperatures throughout the flight were in the high 30's. This is the second day in a row of warm weather after about a week and a half of generally cool temperatures.

If the flow on the Anaktuvuk River really does represent the leading edge of the breakup front then water could reach the Anaktuvuk/Colville confluence in the next day or two. Last year it took four days for the breakup front to travel from the confluence to Monument 01, with no contribution of water from the main channel of the Colville upstream of the confluence. Based on this, water could arrive at Monument 01 in about four to five days if warm conditions continue. If it cools down significantly then it could be longer. We'll take another flight on Tuesday and provide another update.

I hope that this information is useful.

May 20, 2003 Reconnaissance Flight Summary

Everyone,

Jim Meckel took another reconnaissance flight to the south this afternoon to check on the progress of breakup in the Colville River, Fish Creek, Judy Creek, and Ublutuoch River basins. The route was similar to that flown on the 18th - up the Colville River to the confluence with the Anaktuvuk River, then up the Anaktuvuk River to a point approximately 35 river miles above the confluence, then cross-country to Umiat, and finally to the headwaters of Judy Creek, Fish Creek, and the Ublutuoch River.

Conditions were similar to those noted on the 18th. There was more water in the channels of the Colville from Ocean Point upstream but it is assumed to all be from local melt since the water was clear, did not appear to be flowing, and there were no signs of the ice cover cracking, lifting, or floating. Similar conditions were noted at and for some distance above the Anaktuvuk/Colville River confluence.

About 30 miles upstream from the Anaktuvuk/Colville River confluence some ice within the braided channel system was becoming buoyant, exhibiting cracking and small thin chunks moving a short distance with the flow. The water was still flowing clear, however, and there was little concentrated or continuous flow.

At Umiat there was significant additional snowmelt and ponding since the 18th. Some channel ice was noted to be cracking and being lifted. Several small open leads were noted to carry flows with some velocity. The water in the leads was flowing clear. Conditions were similar 8 miles upstream from Umiat.

In the headwaters of Fish and Judy Creeks, and the Ublutuoch River there is still a 90-95% snow cover. A little more tundra has been exposed since the 18th. There was still no sign of water accumulating in ponds, depressions, or small tributaries except in areas of exposed sand and mud bars, and along the base of bluffs.

Temperatures throughout the flight were in the low to mid-30's, with periods of snow and flurries, and moderate to strong southwesterly winds. This is the fourth day in a row of above freezing temperatures.

Given current conditions, water might be expected to reach Monument 01 in about five or six days.

I hope that this information is useful.

Hans

May 21, 2003 Reconnaissance Flight Summary

Everyone,

Michael Baker Jr., represented by Jim Meckel and Hans Arnett, and accompanied by Nuiqsut resident and observer Dora Nukapigak, took another reconnaissance flight to the south today to check on the progress of breakup on Fish and Judy Creeks, and the Colville, Anaktuvuk, and Ublutuoch Rivers.

We first flew to the headwaters of the Ublutuoch River and Fish Creek. There is still an approximately 90% snow cover in the basins with a barely perceptible change in snow cover over the past 24 hours. The ice surface on ponds and lakes, however, appears to be somewhat wetter than yesterday with blue saturated areas becoming more common. We were unable to fly to the Judy Creek headwaters due to low clouds but it is hard to imagine that conditions there are much different from what we saw in the Fish Creek headwaters.

We next flew to Umiat. En route we flew over the Kogosukruk River, a tributary to the Colville, and one of its major tributaries, Henry Creek. Henry Creek was noted to be carrying a continuous flow of brown water at a moderate rate throughout a visible reach of about five miles (observation made at N69 32 27, W151 58 08, NAD83). Dora noted that Nuiqsut elders warn about traveling across this river in the spring since its one of the first in the area to start flowing.

At Umiat, more uplift pressure was visible in the ice of the Colville River, evidenced by longitudinal cracks and localized doming. Some small ice floes were breaking off and collecting at the downstream end of discontinuous open leads. Ponded water was common. Flowing water was clear. (See attached four photographs of the Colville River at Umiat taken near the end of the runway at 12:10 p.m.) We flew 10 miles upstream from Umiat before turning east toward the Anaktuvuk River. Similar conditions to those at Umiat were observed upstream.

Significant flows of turbid brown water were noted along visible reaches of six to eight miles while crossing the Chandler and Tuluga Rivers on the way to the Anaktuvuk River (Chandler observation made at N69 13 35, W151 26 16, NAD83). Flows were contained within channels and ice movement was noted.

We arrived at the Anaktuvuk River at a point about 35-40 miles (straight line distance) upstream from the mouth. We flew to a point 55 miles upstream from the mouth (N68 51, W151 09, NAD83), then turned and flew down to the confluence of the Anaktuvuk and Colville Rivers. Throughout the reach from 40 to 55 miles upstream from the confluence small ice floes were developing and being carried within low channels. Surprisingly little channel ice – bottomfast or otherwise – was present in this reach. Flow was contained in low channels. Aufeis was very common along the reach from 32 to 40 miles upstream from the confluence (this reach contains the Schrader Bluffs). The aufeis fields are all flooded, exhibiting blue to green coloration, and show no evidence of appreciable surface flow. (See attached five photos of Anaktuvuk River aufeis taken at about 1:20 p.m.) Throughout the first 15 miles upstream from the confluence there is little evidence of uplifting or fracturing of channel ice, however, there is considerable ponding. All flows are clear. (See attached 3 photos of the Anaktuvuk-Colville River confluence taken at about 1:40 p.m..)

Significant ponding is present in the channels of the Colville downstream from the confluence of the Anaktuvuk River to a few miles past Ocean Point. Brown water is noted along the left side of the braided channel system and is assumed to be related to drainage and melting along the bluffs. Short discontinuous open leads are noted with clear water flowing in them.

I hope that you find this information useful. I'll be in Anchorage for some well deserved R&R from Thursday morning through Sunday afternoon. Jon Wolf will be taking over the reconnaissance flight summaries in the mean time. He can be reached at jwolf@mbakercorp.com or 670-4073.

Hans

Spring Breakup Recon Flights
May 23 and 24, 2003

On Friday May 23, and Saturday May 24, Michael Baker Jr., represented by Jim Meckel and Jon Wolf, and accompanied by Nuiqsut resident and observer Dora Nukapigak, took reconnaissance flights south and west to check on the progress of breakup on Fish and Judy Creeks, and the Colville, Anaktuvuk, and Ublutuoch Rivers. The weather here in the last several days has cooled considerably and as a result, breakup conditions overall can be characterized as somewhat sluggish.

On the 23rd, we flew to Umiat generally along the Colville and via the Kogosukruk, Anaktuvuk, and Chandler Rivers. Each of these contributaries of the Colville were flowing to some degree and contributing flows to the main branch of the Colville. The flows were typically very turbid and generally appeared to have low velocity and low relative volume. Some of the surface ice and most of the channel ice in these rivers appeared to still be in place with the majority of flows observed over ice. Some floating ice was also noted. As a result of contributions from the above sources, turbid floodwaters in the Colville extended from the mouth of the Chandler to a point just downstream of the confluence of the Colville and the Kogosukruk. Again, these waters typically appeared to be of relatively low volume and velocity.

Conditions at Umiat had not changed markedly since our last flight (Wednesday May 21). Discontinuous clear, ponded and standing water was again observed, but there was no evidence that a large-scale melt had begun. No turbid water was observed. After fueling at Umiat, a mechanical problem with the helicopter forced an early return to Alpine.

We continued our recon this morning, the 24th, flying south along the Colville from Nuiqsut to point about 7 air miles upstream from Ocean Point before turning west for the NPRA. Overnight, turbid flows in the main channel of the Colville had traveled a good distance downriver. The roughly defined leading edge of the flood marked by slowly advancing turbid water was noted at a point approximately one mile downstream of Ocean Point. Large areas of local melt and puddles of standing, clear water characterized the Colville further downstream of that area.

In the NPRA, we flew to the approximate headwaters of the Ublutuoch River and Fish Creek. Again, conditions had not changed since our previous recon flight. There was still an approximately 90% snow cover overall with cover in the basins somewhat less. The ice surface on ponds and lakes appeared to have firmed up from what was observed on May 21, with blue saturated areas becoming less common. Dora stated that goose hunters were still out in full force on Fish and Judy Creeks and that hunting would likely continue for at least another week due to solid snow and ice conditions.

It appears based on these most recent flights that flooding on the Colville River will likely preceed flooding of the smaller streams in the NPRA.

Spring Breakup Recon Flight
May 25, 2003

On Sunday May 25, Michael Baker Jr., represented by Jim Meckel and Jon Wolf took a brief reconnaissance flight south to check on the progress of breakup on the Colville River. Nuiqsut resident and observer Dora Nukapigak was ill and did not accompany us.

On the Colville, the leading edge of turbid flow had moved about 20 river miles downstream overnight and was observed about 10 river miles upstream from our southernmost gage sets located at Monument 01 near the Colville River/Itkilik River confluence. The leading edge of the flood was confined to a single narrow channel along the right bank and flowed over the top of snow and ice in that location. No broken, floating, or lifted ice was noted. Low velocity and volume characterized the leading edge, and the overall impression was one of the water creeping rather than flowing downstream.

The main body of the floodwaters was observed at a location approximately 18 river miles upstream from Monument 01. Floodwater volume in that area was markedly increased. Instead of being confined to a single channel, flow had spread out and was moving through a number of braided channels in that area. Some broken and floating ice was noted, but flow was still primarily over intact ice.

At a point approximately 20 miles upstream from Monument 01, large amounts of broken and floating ice were observed. Floodwaters had filled most of the braided channels and were clearly starting to encroach onto exposed point and mid-channel bars. We observed these same conditions upstream for a distance of about 8 miles, and then turned west toward NPRA.

We intersected the Ublutuoch River at a point approximately 22 air miles upstream from our Ublutuoch Mile 6.8 monitoring location and followed the river downstream for a distance of about 10 air miles. Over that distance, we observed only very isolated pockets of minor local melt. Otherwise the river appeared snow-covered and frozen solid. Based on conditions observed on the Ublutuoch, we did not overfly Fish or Judy Creeks.

At about 2pm, we placed a call to Mick Killion's camp at Umiat. Our contact there said that aside from local melt, the Colville itself was still mostly frozen. Apparently Seavee Creek is flowing strong however, and runoff from the creek is flowing out onto the Colville ice just downstream from Umiat.

Spring Breakup Recon Flight
May 26, 2003

On Monday May 26, Michael Baker Jr., represented by Jim Meckel and Jon Wolf took a reconnaissance flight south and west to check on the progress of breakup on the Colville River and NPRA. Nuiqsut resident and observer Dora Nukapigak was again ill and did not accompany us.

Due to cooling temperatures, overcast skies, and a 25-30 knot **northeasterly** wind, the pace of breakup slowed even further overnight. On the Colville, the leading edge of turbid flow was observed at the confluence of the Colville and Itkilik Rivers, having moved only about seven river miles downstream in the last 24 hours. The leading edge of the flood was still confined to a single narrow channel along the right bank. We flew a short distance up the Itkilik River and noted that the leading edge of floodwaters in that channel was about eight river miles upstream of the mouth.

In the NPRA, we overflew the headwaters regions of the Ublutuoch River and Fish and Judy Creeks, and monitoring locations Judy 13.8 and Ublutuoch 6.8. Similar conditions were noted at each of these NPRA locations, namely very isolated pockets of minor local melt in otherwise snow-covered and frozen channels. Snow coverage in the tundra over much of the northeastern portion of the NPRA is still generally between 95 and 100 percent.

Spring Breakup Reconnaissance Flight Summary
May 27, 2003

All-

This will be Michael Baker Jr.'s last formal breakup reconnaissance flight summary of the 2003 season.

On Tuesday May 27, Michael Baker Jr., represented by Jim Meckel, Jon Wolf, and Hans Arnett, and accompanied by Nuiqsut resident and observer Dora Nukapigak, took a reconnaissance flight to the south and west of Alpine to check on the progress of breakup on the Colville and Ublutuoch Rivers. The morning's weather was warmer than the last few days, with a high thin overcast, light southerly winds, and temperatures on the Coastal Plain reaching the low 40's.

Clear green water and saturated snow was noted in the Nigliq Channel on the flight to Nuiqsut. At 9:05 a.m. the wetting front was near the CD-South pad (about four river miles south of CD-2). On the return flight at 11:50 a.m., the wetting front had progressed about one mile northward. No sign of ice movement was noted.

At the Monument 01 measurement site on the Colville River some flow (represented by clear green water and saturated snow) was noted creeping along both sides of the Main Channel but predominately along the left-hand side, parallel to the big mud bar along the left bank of the river. Water on top of the mud bar is from local melt only.

Conditions at the mouth of the Itkillik River were similar to those noted on the previous day.

At a point approximately eight miles upstream of Monument 01 turbid water was noted to be covering much of the channel ice. Some uplift pressure on the ice, represented by cracks, and the formation of ice chunks and small floes were noted. Velocities appeared to be low to moderate. This can probably be considered the leading edge of turbid breakup flows.

At a point approximately 17.5 miles upstream from Monument 01 moderate to large ice floe formation was occurring. Many ice chunks were noted to be moving downstream and a few small ice jams had formed. Turbid water was flowing onto low sand and mud bars. This can probably be considered the leading edge of the zone of significant ice breakup.

The leading edges of both turbid breakup flows and the zone of significant ice breakup have progressed approximately 10 miles downstream in the last 24 hours. Telephone contact with Umiat determined that the river is still frozen up there.

The flight continued to the Ublutuoch River drainage and flew part way towards the headwaters before turning around. Along the lower thirty (air) miles of the river very little evidence of concentration of water in ponds or in the channel was noted. All signs point to breakup of the NPR-A streams lagging well behind that on the Colville River.

APPENDIX B – Ublutuoch River Discharge Measurement Notes

DISCHARGE MEASUREMENT NOTES

LOCATION: Ublutuoch River Mile 6.8

Date: June 9, 2003 **Party:** James Meckel, Ian Moore, Mike Cox

Width: 270 **ft** **Area:** 1241 **ft^2** **Vel:** 1.04 **fps** **G.H.:** 7.12' (US) & 7.03' (DS) **Discharge:** 1296 **cfs**

No Secs. 34 **G.H. change:** -0.14 **in.:** 3 **hrs.:** **Susp.:** 30 C

Method coef 1 **Hor. Angle coef.** noted **Sus. Coef.:** 1 **Meter No.** Standard

Gage Readings

Time	Location	Measurement
13:10	6.8 Ublutuoch Upstream Gage	7.17' BPMSL
13:20	6.8 Ublutuoch Downstream Gage	7.09' BPMSL
16:05	6.8 Ublutuoch Upstream Gage	7.03' BPMSL
16:07	6.8 Ublutuoch Downstream Gage	6.92' BPMSL
Weighted M.G.H.		7.12' BPMSL
G.H. corrections		
Correct M.G.H.		

Type of meter: Price AA

Date rated:

Meter: 0.5 **ft. above bottom of weight.**

Spin before meas. 2 min 30 sec **after** 2 min 30 sec

Method: 0.2 & 0.8/ 0.6/ Surface
Boat and Tag Line

Levels obtained: Yes, before and after

Measurement rated: Fair

Rating based on following conditions:

Cross section: Uniform main channel - willow bar sta 25+00 to 150+00 - Streambed hard (possibly ice)

Flow: Fairly steady - recession

Weather: Cloudy **Air Temp.** ~40 degrees F

Gage: Upstream and downstream staff gages

Water Temp. ~35 degrees F

Other:

Record Removed:

Intake flushed:

Observer

Control Snow gone from banks, channel downstream has stranded ice chunks and floating ice mostly stationary causing backwater.

Remarks Dense willow near or to water surface station 100 to 150.
Suspended sediment samples collected at 185, 214, 237, 252, and 277.

G.H. of zero flow: Channel control **ft.**

Angle Coef. (deg)	Dist. From Initial Point (ft)	Width (ft)	Depth (ft)	Observ. depth (ft)	Revo-lutions	Time (sec)	VELOCITY		Adjust for Angle Coef.	Adjusted Velocity (fps)	Area (s.f.)	Discharge (cfs)	Description
							At Point (fps)	Mean in-vertical (fps)					
0	25	2.5	0.0									0	LEW
0	30	10.0	3.7	0.2	0	40	0.0	0.0	1.00	0.0	37.0	1	
				0.8	0	40	0.0						
0	45	15.0	4.5	0.2	5	46	0.3	0.2	1.00	0.2	67.5	16	
				0.8	5	55	0.2						
0	60	15.0	4.4	0.2	10	44	0.5	0.5	1.00	0.5	66.0	34	
				0.8	10	45	0.5						
60	75	15.0	3.3	0.2	10	49	0.5	0.4	0.50	0.2	49.5	9	
				0.8	5	42	0.3						
25	90	12.5	3.4	0.2	7	57	0.3	0.2	0.91	0.2	42.5	9	
				0.8	5	60	0.2						
45	100	10.0	2.5	0.6	5	57	0.2	0.2	0.71	0.1	25.0	4	
45	110	10.0	1.9	Surface	10	43	0.5	0.5	0.71	0.3	19.0	6	
									0.90				adjusted for surface velocity
45	120	10.0	2.3	0.6	10	42	0.5	0.5	0.71	0.4	23.0	9	
25	130	10.0	2.0	Surface	7	49	0.3	0.3	0.91	0.3	20.0	5	
									0.90				adjusted for surface velocity
32	140	10.0	1.9	Surface	15	46	0.7	0.7	0.85	0.6	19.0	11	
									0.90				adjusted for surface velocity
25	150	10.0	2.5	Surface	7	57	0.3	0.3	0.91	0.2	25.0	6	
									0.90				adjusted for surface velocity
0	160	10.0	3.2	0.2	20	43	1.0	0.9	1.00	0.9	32.0	29	
				0.8	15	42	0.8						
0	170	10.0	5.1	0.2	20	45	1.0	0.8	1.00	0.8	51.0	41	
				0.8	15	56	0.6						
0	180	10.0	6.1	0.2	30	46	1.4	1.3	1.00	1.3	61.0	78	
				0.8	20	40	1.1						
PAGE TOTAL		**160.0**									**538**	**258**	**Page 1 of 3**

Angle Coef. (deg)	Dist. From Initial Point (ft)	Width (ft)	Depth (ft)	Observ. depth (ft)	Revo-lutions	Time (sec)	VELOCITY At Point (fps)	VELOCITY Mean in-vertical (fps)	Adjust for Angle Coef.	Adjusted Velocity (fps)	Area (s.f.)	Discharge (cfs)	Description
0	190	10.0	6.2	0.2	30	55	1.2	1.2	1.00	1.2	62.0	73	
				0.8	30	58	1.1						
0	200	9.5	6.6	0.2	30	43	1.5	1.5	1.00	1.5	62.7	92	
				0.8	30	48	1.4						
0	209	8.0	6.9	0.2	30	46	1.4	1.5	1.00	1.5	55.2	80	
				0.8	30	45	1.5						
0	216	7.0	6.7	0.2	30	45	1.5	1.5	1.00	1.5	46.9	70	
				0.8	30	44	1.5						
0	223	7.0	6.6	0.2	40	50	1.8	1.6	1.00	1.6	46.2	76	
				0.8	30	44	1.5						
0	230	6.0	6.6	0.2	40	52	1.7	1.6	1.00	1.6	39.6	63	
				0.8	30	44	1.5						
0	235	5.0	6.6	0.2	30	42	1.6	1.7	1.00	1.7	33.0	56	
				0.8	40	49	1.8						
0	240	5.0	6.8	0.2	40	47	1.9	1.8	1.00	1.8	34.0	60	
				0.8	40	53	1.7						
0	245	5.0	6.9	0.2	30	43	1.5	1.5	1.00	1.5	34.5	52	
				0.8	30	45	1.5						
0	250	5.0	6.8	0.2	40	48	1.8	1.7	1.00	1.7	34.0	59	
				0.8	30	40	1.7						
0	255	5.0	6.9	0.2	30	40	1.7	1.5	1.00	1.5	34.5	52	
				0.8	30	49	1.4						
0	260	5.0	6.8	0.2	40	47	1.9	1.6	1.00	1.6	34.0	54	
				0.8	30	50	1.3						
0	265	5.0	6.9	0.2	40	48	1.8	1.7	1.00	1.7	34.5	57	
				0.8	30	45	1.5						
0	270	5.0	7.0	0.2	30	47	1.4	1.4	1.00	1.4	35.0	49	
				0.8	30	47	1.4						
0	275	5.0	7.2	0.2	30	41	1.6	1.4	1.00	1.4	36.0	52	
				0.8	30	52	1.3						
PAGE TOTAL		**92.5**									**622**	**946**	**Page 2 of 3**

Angle Coef. (deg)	Dist. From Initial Point (ft)	Width (ft)	Depth (ft)	Observ. depth (ft)	Revo-lutions	Time (sec)	VELOCITY At Point (fps)	Mean in-vertical (fps)	Adjust for Angle Coef.	Adjusted Velocity (fps)	Area (s.f.)	Discharge (cfs)	Description
0	280	5.0	7.2	0.2	30	48	1.4	1.4	1.00	1.4	36.0	49	
				0.8	30	50	1.3						
0	285	5.0	6.0	0.2	30	54	1.2	1.2	1.00	1.2	30.0	35	
				0.8	20	41	1.1						
0	290	5.0	3.0	Estimated Velocity - Meter in Willows				0.6	1.00	0.6	15.0	9	
0	295	2.5	0.0									0	REW
PAGE TOTAL		**17.5**									**81.0**	**92.2**	

DISCHARGE SUMMARY

	Width	Area	Discharge	
TOTAL	**270.0**	**1241**	**1296**	**Page 3 of 3**

DISCHARGE MEASUREMENT NOTES

LOCATION: Ublutuoch River Mile 6.8

Date: June 10, 2003 **Party:** James Meckel, Ian Moore, Mike Cox

Width: 274 **ft** **Area:** 1097 **ft^2** **Vel:** 1.08 **fps** **G.H.:** 6.12' (US) & 6.06' (DS) **Discharge:** 1187 **cfs**

No Secs. 38 **G.H. change:** -0.16 **in.:** 2.5 **hrs.:** **Susp.:** 30 C

Method coef 1 **Hor. Angle coef.** noted **Sus. Coef.:** 1 **Meter No.** Standard

Gage Readings

Time	Location	Measurement
9:00	6.8 Ublutuoch Upstream Gage	6.22' BPMSL
9:10	6.8 Ublutuoch Downstream Gage	6.13' BPMSL
11:35	6.8 Ublutuoch Upstream Gage	6.06' BPMSL
11:40	6.8 Ublutuoch Downstream Gage	6.00' BPMSL
Weighted M.G.H.		6.12' BPMSL (US)
G.H. corrections		6.06' BPMSL (DS)
Correct M.G.H.		

Type of meter: Price AA

Date rated:

Meter: 0.5 **ft. above bottom of weight.**

Spin before meas. 2 min 30 sec **after** 2 min 30 sec

Method: 0.2 & 0.8/ 0.6/ Surface
Boat and Tag Line

Levels obtained: Yes, before and after

Measurement rated: Fair **Rating based on following conditions:**

Cross section: Uniform main channel -bottom firm (possibly ice)

Flow: steady - falling stage **Weather:** Windy **Air Temp.** ~36 degrees F

Gage: Upstream and downstream staff gages **Water Temp.** ~35 degrees F

Other:

Record Removed: **Intake flushed:**

Observer

Control snow nearly gone from channel, some stranded ice pans on shallow portions of channel - possible backwater

Remarks station 100 to 160 shallow willow bar - growth of dense willow to water surface

G.H. of zero flow: Channel control **ft.**

Angle Coef. (deg)	Dist. From Initial Point (ft)	Width (ft)	Depth (ft)	Observ. depth (ft)	Revo-lutions	Time (sec)	VELOCITY At Point (fps)	VELOCITY Mean in-vertical (fps)	Adjust for Angle Coef.	Adjusted Velocity (fps)	Area (s.f.)	Discharge (cfs)	Description
0	18	1.0	0.0									0	LEW
28	20	3.5	2.0		Estimated	Velocity		0.1	0.88	0.097	7.0	1	estimated because of willows
28	25	10.0	2.5	0.6	5	55	0.2	0.2	0.88	0.2	25.0	5	
32	40	17.5	4.1	0.6	7	42	0.4	0.4	0.85	0.3	71.8	23	
32	60	20.0	4.0	0.6	5	47	0.3	0.3	0.85	0.2	80.0	17	
32	80	20.0	2.5	0.6	5	45	0.3	0.3	0.85	0.2	50.0	11	
32	100	15.0	1.8	Surface	5	43	0.3	0.3	0.85	0.2	27.0	6	
									0.90				adjusted for surface velocity
0	110	10.0	1.2		Estimated	Velocity		0.2	1.00	0.2	12.0	2	estimated because of willows
0	120	10.0	0.9		Estimated	Velocity		0.0	1.00	0.0	9.0	0	estimated because of willows
0	130	10.0	1.2	Surface	7	44	0.4	0.4	1.00	0.4	12.0	4	
0	140	10.0	1.4		Estimated	Velocity		0.3	1.00	0.3	14.0	4	estimated because of willows
0	150	10.0	1.8		Estimated	Velocity		0.4	1.00	0.4	18.0	7	estimated because of willows
0	160	10.0	3.1		Estimated	Velocity		0.5	1.00	0.54	31.0	17	estimated because of willows
0	170	9.0	4.3	0.2	20	46	1.0	0.8	1.00	0.8	38.7	31	
				0.8	15	52	0.6						
0	178	7.0	5.0	0.2	30	49	1.4	1.1	1.00	1.1	35.0	37	
				0.8	15	44	0.8						
PAGE TOTAL		**163**									**430**	**166**	**Page 1 of 3**

Angle Coef. (deg)	Dist. From Initial Point (ft)	Width (ft)	Depth (ft)	Observ. depth (ft)	Revo-lutions	Time (sec)	VELOCITY At Point (fps)	VELOCITY Mean in-vertical (fps)	Adjust for Angle Coef.	Adjusted Velocity (fps)	Area (s.f.)	Discharge (cfs)	Description
0	184	6.0	5.4	0.2	25	48	1.2	1.1	1.00	1.1	32.4	36	
				0.8	20	42	1.1						
0	190	5.5	5.5	0.2	30	55	1.2	1.1	1.00	1.1	30.3	34	
				0.8	30	64	1.0						
0	195	5.0	5.9	0.2	30	49	1.4	1.3	1.00	1.3	29.5	38	
				0.8	30	56	1.2						
0	200	5.0	5.9	0.2	30	46	1.4	1.3	1.00	1.3	29.5	39	
				0.8	30	54	1.2						
0	205	5.0	6.2	0.2	30	41	1.6	1.5	1.00	1.5	31.0	46	
				0.8	30	48	1.4						
0	210	5.0	6.3	0.2	40	53	1.7	1.6	1.00	1.6	31.5	50	
				0.8	30	44	1.5						
0	215	5.0	6.1	0.2	40	51	1.7	1.5	1.00	1.5	30.5	46	
				0.8	30	51	1.3						
0	220	5.0	6.1	0.2	40	49	1.8	1.6	1.00	1.6	30.5	48	
				0.8	30	49	1.4						
0	225	5.0	6.0	0.2	40	43	2.0	1.8	1.00	1.8	30.0	55	
				0.8	30	41	1.6						
0	230	5.0	6.0	0.2	30	40	1.7	1.6	1.00	1.6	30.0	47	
				0.8	30	45	1.5						
0	235	5.0	6.4	0.2	40	42	2.1	1.9	1.00	1.9	32.0	62	
				0.8	40	49	1.8						
0	240	5.0	6.4	0.2	40	42	2.1	1.8	1.00	1.8	32.0	58	
				0.8	30	43	1.5						
0	245	5.0	6.5	0.2	40	48	1.8	1.7	1.00	1.7	32.5	56	
				0.8	30	42	1.6						
0	250	5.0	6.5	0.2	30	43	1.5	1.5	1.00	1.5	32.5	50	
				0.8	30	43	1.5						
0	255	5.0	6.5	0.2	40	44	2.0	1.8	1.00	1.8	32.5	57	
				0.8	30	44	1.5						
PAGE TOTAL		**77**									**467**	**723**	**Page 2 of 3**

Angle Coef. (deg)	Dist. From Initial Point (ft)	Width (ft)	Depth (ft)	Observ. depth (ft)	Revo-lutions	Time (sec)	VELOCITY At Point (fps)	VELOCITY Mean in-vertical (fps)	Adjust for Angle Coef.	Adjusted Velocity (fps)	Area (s.f.)	Discharge (cfs)	Description
0	260	5.0	6.5	0.2	40	46	1.9	1.9	1.00	1.9	32.5	61	
				0.8	40	48	1.8						
0	265	5.0	6.5	0.2	30	48	1.4	1.4	1.00	1.4	32.5	44	
				0.8	30	49	1.4						
0	270	5.0	6.6	0.2	40	44	2.0	1.7	1.00	1.7	33.0	57	
				0.8	30	46	1.4						
0	275	5.0	6.8	0.2	30	41	1.6	1.5	1.00	1.5	34.0	52	
				0.8	30	46	1.4						
0	280	5.5	6.7	0.2	30	43	1.5	1.4	1.00	1.4	36.9	51	
				0.8	30	54	1.2						
0	286	5.0	5.5	0.2	30	48	1.4	1.1	1.00	1.1	27.5	31	
				0.8	20	50	0.9						
0	290	3.0	1.1		Estimated	Velocity		0.6	1.00	0.6	3.3	2	
0	292	1.0	0.0									0	REW
PAGE TOTAL		**35**									**200**	**299**	

DISCHARGE SUMMARY

	Width	Area	Discharge	
TOTAL	**274**	**1097**	**1187**	**Page 3 of 3**

APPENDIX C – HEC-RAS Output Report for Ublutuoch River 100-year Flood Model

HEC-RAS Version 2.1 October 1997
U.S. Army Corp of Engineers
Hydrologic Engineering Center
609 Second Street, Suite D
Davis, California 95616-4687
(916) 756-1104

```
X     X  XXXXXX    XXXX        XXXX       XX      XXXX
X     X  X        X    X       X   X     X  X    X
X     X  X        X            X   X    X    X   X
XXXXXXX  XXXX     X       XXX  XXXX     XXXXXX    XXXX
X     X  X        X            X  X     X    X        X
X     X  X        X    X       X   X    X    X        X
X     X  XXXXXX    XXXX        X    X   X    X   XXXXX
```

PROJECT DATA
Project Title: Ublutuoch River
Project File : ex2.prj
Run Date and Time: 12/15/2003 2:33:58 PM

Project in English units

Project Description:
Ublutuoch River 13.7 - 1.9

FLOW DATA

Flow Title: Ubl Riv 100 YR Flood ND
Flow File : C:\HECRAS\ex2.f08

Flow Data (cfs)

River	Reach	RS	100-YR
Ublutuoch River	13.7 - 1.9	14.10	7933
Ublutuoch River	13.7 - 1.9	8.0	8600
Ublutuoch River	13.7 - 1.9	6.9	8660
Ublutuoch River	13.7 - 1.9	4.8	8931
Ublutuoch River	13.7 - 1.9	2.10	9109

Boundary Conditions

River	Reach	Profile	Upstream	Downstream
Ublutuoch River	13.7 - 1.9	100-YR		Normal S = .0000669

GEOMETRY DATA

Geometry Title: Ub Riv 100 YR Rev N Del X-Sec 1500 Int
Geometry File : C:\HECRAS\ex2.g12

CROSS SECTION   RIVER: Ublutuoch River
REACH: 13.7 - 1.9   RS: 14.10

INPUT
Description: River Mile 13.7
Station Elevation Data   num=   50

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	30.8	99	27.2	286	23.3	336	20.8	430	17.2
473	17.2	500	17.2	517	17.2	556	17.2	583	16.9
593	18.1	600	16	609.9	14.68	615	14	632	12.7
634.5	11.51	642	11.51	647	11.51	649.5	11.51	652	11.51
654.5	11.51	657	11.51	659.5	11.51	662	11.51	664.5	11.51
667	11.51	669.5	11.51	672	11.51	674.5	11.51	677	11.51
679.5	11.51	682	11.51	692.5	13.9	694.8	14.67	705	18.1
713	18.6	721	18.7	810	15.9	985	16.1	1011	17.1
1104	16.9	1189	18.5	1288	19.2	1381	19.2	1471	19.7
1568	20.3	1649	19.9	1755	23	1807	25.3	1875	26.2

Manning's n Values   num=   3

Sta	n Val	Sta	n Val	Sta	n Val
0	.045	609.9	.0301	705	.045

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
609.9	705	1509.5	1482.5	1309	.1	.3

CROSS SECTION RIVER: Ublutuoch River
REACH: 13.7 - 1.9 RS: 13.795*

INPUT
Description:
Station Elevation Data num= 128

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	30.48	39.87	29.02	82.39	27.37	101.7	26.5	109.63	26.25
137.53	25.62	191.35	24.57	200.66	24.43	214.61	24.13	243.85	23.65
276.4	22.95	293.67	22.62	293.81	22.61	299.65	22.39	332.21	20.84
344.17	20.36	345.17	20.31	352.15	19.99	373.4	19.21	411.95	17.87
441.74	16.82	451.81	16.82	461.11	16.89	465.1	16.82	478.38	16.83
481.04	16.86	483.04	16.83	485.91	16.83	513.65	16.81	517.59	16.81
530.22	16.83	531.12	16.83	556.79	16.85	560.77	16.9	563.43	16.87
571.18	16.83	584.7	16.62	598.92	16.48	605.96	17.27	609.19	17.62
615.93	15.74	616.38	15.63	620.57	15.19	626.56	14.41	628.34	14.15
631.01	13.75	632.01	13.58	632.8	13.49	635.03	13.32	637.27	13.16
639.49	12.97	641.72	12.76	643.95	12.58	646.18	12.41	648.42	12.25
649.53	12.18	650.2	12.13	650.64	11.94	651.76	11.46	652.88	10.98
660	10.98	664.75	10.98	667.12	10.98	669.5	10.98	671.88	10.98
674.25	10.98	676.62	10.98	679	10.98	681.38	10.98	683.75	10.98
686.12	10.98	688.5	10.98	690.88	10.98	693.25	10.98	695.62	10.98
698	10.98	699.22	11.24	700.43	11.49	701.65	11.75	702.87	12
704.08	12.24	705.31	12.49	706.52	12.74	707.74	12.99	708.96	13.24
709.11	13.27	710.17	13.59	711.4	13.94	711.55	13.99	713.83	14.68
716.27	15.56	718.46	16.39	721.37	17.32	722.35	17.65	730.32	18.14
738.28	18.25	750.5	17.91	757.01	17.66	766.75	17.46	826.32	15.75
826.93	15.73	836.07	15.68	843.65	15.73	897.8	15.88	898.88	15.92
970.36	16	1001.22	16.06	1027.12	17.02	1055.92	16.98	1119.74	16.89
1153.38	17.5	1204.4	18.42	1222.69	18.54	1303.01	19.13	1306.08	19.14
1390.55	19.12	1395.63	19.12	1430.63	19.33	1485.27	19.65	1529.18	19.95
1581.88	20.25	1598.49	20.18	1662.56	19.89	1689.46	20.64	1768.13	22.87
1796.68	24.09	1819.92	25.08	1887.65	25.97				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.045	626.56	.03	722.35	.045

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
626.56	722.35	1509.5	1482.5	1309	.1	.3

CROSS SECTION RIVER: Ublutuoch River
REACH: 13.7 - 1.9 RS: 13.49*

INPUT
Description:
Station Elevation Data num= 128

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	30.16	40.93	28.65	84.58	26.86	104.41	25.79	112.54	25.47
141.19	24.77	196.44	23.77	205.99	23.66	220.31	23.36	250.33	22.98
283.75	22.24	301.48	21.93	301.62	21.93	307.62	21.77	341.04	20.25
353.32	19.87	354.35	19.81	361.51	19.44	383.33	18.68	422.9	17.43
453.48	16.44	463.82	16.44	473.37	16.57	477.46	16.44	491.1	16.45
493.83	16.52	495.88	16.45	498.83	16.45	527.31	16.42	531.35	16.42
544.31	16.45	545.24	16.45	571.59	16.51	575.68	16.6	578.41	16.53
586.37	16.45	600.24	16.18	614.84	16.06	622.07	16.81	625.39	17.14
632.3	15.35	632.77	15.25	637.07	14.92	643.21	14.13	645.11	13.85
647.96	13.37	649.02	13.16	649.86	13.04	652.24	12.86	654.62	12.69
656.99	12.47	659.37	12.22	661.74	12.01	664.12	11.83	666.5	11.67
667.69	11.61	668.4	11.56	668.87	11.38	670.06	10.92	671.25	10.45
678	10.45	682.5	10.45	684.75	10.45	687	10.45	689.25	10.45
691.5	10.45	693.75	10.45	696	10.45	698.25	10.45	700.5	10.45
702.75	10.45	705	10.45	707.25	10.45	709.5	10.45	711.75	10.45
714	10.45	715.29	10.71	716.57	10.95	717.85	11.2	719.14	11.44
720.42	11.66	721.71	11.89	722.99	12.13	724.28	12.37	725.57	12.61
725.73	12.64	726.85	12.94	728.14	13.26	728.3	13.31	730.71	13.97
733.28	14.95	735.59	15.91	738.67	16.85	739.7	17.2	747.64	17.68
755.57	17.8	767.74	17.5	774.22	17.21	783.92	17.11	843.25	15.58
843.86	15.55	852.96	15.44	860.51	15.54	914.44	15.77	915.52	15.85
986.71	15.93	1017.45	16.01	1043.24	16.95	1071.92	16.93	1135.49	16.87
1168.99	17.47	1219.81	18.34	1238.02	18.46	1318.02	19.07	1321.08	19.07
1405.21	19.03	1410.27	19.04	1445.12	19.27	1499.55	19.61	1543.28	19.92
1595.77	20.21	1612.31	20.14	1676.12	19.88	1702.91	20.6	1781.26	22.75
1809.7	23.91	1832.85	24.86	1900.3	25.73				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.045	643.21	.029	739.7	.045

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
643.21	739.7	1021	1041	799.5	.1	.3

CROSS SECTION RIVER: Ublutuoch River
REACH: 13.7 - 1.9 RS: 13.185*

INPUT
Description:
Station Elevation Data num= 128

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	29.84	41.98	28.28	86.77	26.35	107.11	25.09	115.45	24.68
144.84	23.92	201.52	22.97	211.32	22.9	226.01	22.59	256.81	22.32
291.09	21.53	309.29	21.25	309.43	21.24	315.58	21.15	349.87	19.66
362.47	19.39	363.52	19.32	370.87	18.89	393.26	18.15	433.85	16.99
465.22	16.06	475.83	16.06	485.62	16.25	489.82	16.06	503.82	16.07
506.62	16.18	508.72	16.08	511.75	16.08	540.96	16.04	545.1	16.03
558.4	16.07	559.35	16.08	586.39	16.16	590.59	16.29	593.39	16.2
601.55	16.08	615.78	15.74	630.76	15.64	638.17	16.35	641.58	16.66
648.67	14.96	649.15	14.88	653.56	14.65	659.86	13.85	661.88	13.55
664.91	13	666.03	12.75	666.92	12.59	669.45	12.4	671.97	12.22
674.49	11.98	677.01	11.68	679.53	11.44	682.06	11.26	684.58	11.09
685.84	11.04	686.6	10.99	687.1	10.82	688.36	10.38	689.62	9.92
696	9.92	700.25	9.92	702.38	9.92	704.5	9.92	706.62	9.92
708.75	9.92	710.88	9.92	713	9.92	715.12	9.92	717.25	9.92
719.38	9.92	721.5	9.92	723.62	9.92	725.75	9.92	727.88	9.92
730	9.92	731.35	10.18	732.71	10.4	734.05	10.65	735.41	10.88
736.76	11.08	738.11	11.3	739.46	11.53	740.82	11.75	742.17	11.97
742.35	12	743.52	12.29	744.88	12.58	745.05	12.63	747.58	13.26
750.29	14.34	752.72	15.43	755.96	16.37	757.05	16.75	764.95	17.22
772.85	17.35	784.98	17.1	791.43	16.76	801.09	16.76	860.18	15.41
860.78	15.38	869.85	15.21	877.37	15.35	931.08	15.66	932.15	15.78
1003.05	15.86	1033.67	15.96	1059.36	16.87	1087.92	16.88	1151.24	16.85
1184.6	17.44	1235.21	18.26	1253.35	18.37	1333.02	19	1336.07	19.01
1419.86	18.94	1424.9	18.96	1459.61	19.2	1513.82	19.56	1557.37	19.89
1609.65	20.16	1626.12	20.1	1689.67	19.87	1716.36	20.55	1794.39	22.62
1822.71	23.73	1845.77	24.64	1912.95	25.49				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.045	659.86	.028	757.05	.045

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
659.86	757.05	1021	1041	799.5	.1	.3

CROSS SECTION RIVER: Ublutuoch River
REACH: 13.7 - 1.9 RS: 12.88*

INPUT
Description:
Station Elevation Data num= 128

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	29.52	43.04	27.91	88.96	25.83	109.81	24.39	118.37	23.89
148.5	23.06	206.61	22.16	216.66	22.13	231.72	21.81	263.29	21.65
298.44	20.82	317.1	20.56	317.24	20.56	323.55	20.53	358.71	19.06
371.62	18.9	372.7	18.82	380.23	18.33	403.19	17.62	444.8	16.55
476.97	15.67	487.84	15.68	497.88	15.94	502.19	15.68	516.54	15.7
519.41	15.84	521.56	15.7	524.67	15.7	554.62	15.65	558.86	15.64
572.5	15.7	573.47	15.7	601.19	15.82	605.5	15.99	608.37	15.86
616.73	15.7	631.32	15.3	646.68	15.22	654.28	15.9	657.77	16.18
665.04	14.57	665.54	14.5	670.06	14.38	676.52	13.58	678.65	13.24
681.86	12.62	683.05	12.33	683.99	12.13	686.66	11.93	689.33	11.75
691.99	11.48	694.66	11.14	697.33	10.87	700	10.68	702.66	10.51
704	10.47	704.8	10.42	705.33	10.25	706.67	9.84	708	9.4
714	9.4	718	9.4	720	9.4	722	9.4	724	9.4
726	9.4	728	9.4	730	9.4	732	9.4	734	9.4
736	9.4	738	9.4	740	9.4	742	9.4	744	9.4
746	9.4	747.42	9.65	748.84	9.86	750.26	10.11	751.68	10.32
753.1	10.51	754.52	10.7	755.94	10.93	757.36	11.14	758.78	11.34
758.97	11.37	760.2	11.64	761.62	11.91	761.81	11.95	764.46	12.55
767.3	13.73	769.86	14.95	773.26	15.9	774.4	16.3	782.27	16.76
790.14	16.9	802.22	16.69	808.64	16.31	818.27	16.42	877.11	15.24
877.71	15.2	886.74	14.97	894.23	15.16	947.72	15.56	948.79	15.71
1019.4	15.79	1049.9	15.91	1075.48	16.79	1103.93	16.83	1166.99	16.84
1200.22	17.41	1250.62	18.18	1268.69	18.28	1348.03	18.93	1351.07	18.94
1434.52	18.86	1439.54	18.88	1474.11	19.14	1528.09	19.52	1571.47	19.86
1623.53	20.12	1639.94	20.05	1703.23	19.86	1729.81	20.51	1807.53	22.49
1835.73	23.55	1858.69	24.42	1925.6	25.26				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.045	676.52	.027	774.4	.045

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
676.52	774.4	1003	1029.67	885.67	.1	.3

CROSS SECTION RIVER: Ublutuoch River

REACH: 13.7 - 1.9 RS: 12.6766*

INPUT
Description:
Station Elevation Data num= 128

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	29.31	43.75	27.66	90.42	25.49	111.61	23.92	120.31	23.37
150.94	22.49	210	21.63	220.22	21.62	235.52	21.29	267.61	21.21
303.34	20.35	322.3	20.1	322.45	20.11	328.86	20.12	364.6	18.67
377.72	18.57	378.82	18.49	386.47	17.96	409.81	17.26	452.1	16.26
484.79	15.42	495.85	15.43	506.05	15.73	510.43	15.43	525.01	15.45
527.93	15.61	530.12	15.45	533.28	15.45	563.71	15.39	568.03	15.38
581.89	15.45	582.88	15.45	611.06	15.59	615.43	15.79	618.35	15.64
626.85	15.45	641.68	15.01	657.29	14.94	665.02	15.6	668.57	15.86
675.95	14.31	676.46	14.25	681.06	14.2	687.62	13.4	689.83	13.04
693.15	12.37	694.39	12.05	695.37	11.83	698.13	11.62	700.89	11.44
703.66	11.15	706.42	10.78	709.19	10.49	711.95	10.3	714.72	10.13
716.1	10.09	716.93	10.04	717.48	9.88	718.87	9.48	720.25	9.05
726	9.05	729.83	9.05	731.75	9.05	733.67	9.05	735.58	9.05
737.5	9.05	739.42	9.05	741.33	9.05	743.25	9.05	745.17	9.05
747.08	9.05	749	9.05	750.92	9.05	752.83	9.05	754.75	9.05
756.67	9.05	758.13	9.3	759.6	9.5	761.06	9.74	762.53	9.95
763.99	10.12	765.46	10.3	766.92	10.53	768.39	10.73	769.85	10.92
770.04	10.95	771.32	11.21	772.78	11.46	772.97	11.5	775.71	12.07
778.64	13.32	781.27	14.63	784.79	15.59	785.97	16	793.82	16.45
801.66	16.6	813.71	16.42	820.11	16.01	829.72	16.19	888.4	15.12
889	15.09	898	14.81	905.47	15.03	958.81	15.49	959.88	15.67
1030.3	15.75	1060.72	15.88	1086.23	16.74	1114.59	16.8	1177.48	16.83
1210.62	17.39	1260.89	18.13	1278.91	18.22	1358.04	18.89	1361.07	18.9
1444.29	18.8	1449.3	18.82	1483.77	19.1	1537.61	19.49	1580.87	19.84
1632.79	19.91	1649.15	19.92	1712.27	19.85	1738.78	20.48	1816.28	22.41
1844.4	23.43	1867.31	24.27	1934.03	25.1				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.045	687.62	.027	785.97	.045

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
687.62	785.97	1003	1029.67	885.67	.1	.3

CROSS SECTION RIVER: Ublutuoch River
REACH: 13.7 - 1.9 RS: 12.4733*

INPUT
Description:
Station Elevation Data num= 128

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	29.09	44.45	27.42	91.88	25.14	113.41	23.45	122.26	22.84
153.37	21.92	213.39	21.09	223.77	21.11	239.33	20.78	271.93	20.76
308.24	19.88	327.51	19.65	327.65	19.65	334.17	19.7	370.48	18.27
383.82	18.25	384.93	18.16	392.71	17.6	416.42	16.91	459.4	15.96
492.62	15.16	503.85	15.17	514.22	15.52	518.67	15.17	533.49	15.2
536.46	15.39	538.68	15.2	541.89	15.19	572.82	15.13	577.2	15.12
591.28	15.2	592.29	15.21	620.92	15.36	625.37	15.59	628.34	15.41
636.97	15.2	652.04	14.72	667.91	14.66	675.76	15.29	679.36	15.54
686.87	14.04	687.39	13.99	692.05	14.03	698.73	13.22	701.01	12.83
704.45	12.12	705.73	11.77	706.74	11.52	709.61	11.31	712.46	11.13
715.32	10.82	718.19	10.41	721.05	10.11	723.91	9.91	726.77	9.74
728.21	9.71	729.07	9.66	729.64	9.5	731.07	9.11	732.5	8.7
738	8.7	741.67	8.7	743.5	8.7	745.33	8.7	747.17	8.7
749	8.7	750.83	8.7	752.67	8.7	754.5	8.7	756.33	8.7
758.17	8.7	760	8.7	761.83	8.7	763.67	8.7	765.5	8.7
767.33	8.7	768.84	8.94	770.35	9.13	771.86	9.38	773.37	9.57
774.88	9.74	776.39	9.9	777.9	10.12	779.41	10.31	780.92	10.5
781.12	10.53	782.43	10.77	783.94	11	784.14	11.04	786.96	11.6
789.98	12.91	792.7	14.31	796.32	15.27	797.53	15.7	805.36	16.15
813.19	16.31	825.2	16.15	831.59	15.71	841.16	15.96	899.68	15.01
900.28	14.97	909.26	14.66	916.71	14.9	969.91	15.42	970.97	15.62
1041.2	15.7	1071.53	15.85	1096.97	16.69	1125.26	16.76	1187.98	16.82
1221.03	17.36	1271.16	18.07	1289.13	18.17	1368.04	18.84	1371.06	18.85
1454.06	18.75	1459.05	18.77	1493.43	19.05	1547.12	19.47	1590.26	19.82
1642.04	20.06	1658.36	20	1721.31	19.84	1747.74	20.45	1825.04	22.32
1853.08	23.32	1875.92	24.13	1942.47	24.95				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.045	698.73	.026	797.53	.045

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
698.73	797.53	1003	1029.67	885.67	.1	.3

CROSS SECTION RIVER: Ublutuoch River
REACH: 13.7 - 1.9 RS: 12.27*

INPUT
Description:
Station Elevation Data num= 128

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	28.88	45.16	27.17	93.34	24.8	115.22	22.98	124.2	22.32
155.82	21.35	216.79	20.56	227.33	20.6	243.13	20.26	276.25	20.32
313.14	19.41	332.71	19.19	332.86	19.2	339.48	19.29	376.37	17.88
389.92	17.92	391.05	17.83	398.95	17.23	423.04	16.55	466.7	15.67
500.45	14.91	511.86	14.92	522.4	15.31	526.92	14.92	541.97	14.95
544.98	15.16	547.24	14.95	550.5	14.94	581.92	14.87	586.38	14.86
600.68	14.95	601.71	14.96	630.79	15.13	635.31	15.39	638.32	15.19
647.1	14.95	662.41	14.43	678.52	14.38	686.5	14.99	690.16	15.22
697.79	13.78	698.31	13.74	703.06	13.85	709.83	13.04	712.2	12.63
715.75	11.87	717.07	11.49	718.12	11.22	721.08	11	724.03	10.82
726.99	10.49	729.95	10.05	732.91	9.73	735.87	9.53	738.83	9.36
740.31	9.33	741.2	9.28	741.79	9.13	743.27	8.75	744.75	8.35
750	8.35	753.5	8.35	755.25	8.35	757	8.35	758.75	8.35
760.5	8.35	762.25	8.35	764	8.35	765.75	8.35	767.5	8.35
769.25	8.35	771	8.35	772.75	8.35	774.5	8.35	776.25	8.35
778	8.35	779.55	8.59	781.11	8.77	782.66	9.01	784.22	9.2
785.78	9.35	787.33	9.5	788.89	9.72	790.44	9.9	791.99	10.08
792.2	10.11	793.55	10.34	795.11	10.55	795.31	10.59	798.22	11.12
801.33	12.5	804.12	13.99	807.86	14.96	809.1	15.4	816.91	15.84
824.71	16.01	836.69	15.88	843.06	15.41	852.61	15.73	910.97	14.89
911.57	14.86	920.52	14.5	927.95	14.77	981.01	15.35	982.07	15.58
1052.1	15.66	1082.35	15.82	1107.72	16.64	1135.93	16.73	1198.48	16.81
1231.44	17.34	1281.43	18.02	1299.35	18.11	1378.05	18.8	1381.06	18.81
1463.83	18.69	1468.81	18.71	1503.09	19.01	1556.64	19.44	1599.66	19.8
1651.3	20.03	1667.57	19.97	1730.35	19.83	1756.71	20.42	1833.79	22.24
1861.76	23.2	1884.54	23.98	1950.9	24.79				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.045	709.83	.026	809.1	.045

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
709.83	809.1	1144	1378	1143	.1	.3

CROSS SECTION RIVER: Ublutuoch River
REACH: 13.7 - 1.9 RS: 11.965*

INPUT
Description:
Station Elevation Data num= 128

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	28.56	46.22	26.8	95.53	24.29	117.92	22.28	127.11	21.53
159.47	20.5	221.87	19.76	232.66	19.83	248.83	19.48	282.73	19.65
320.48	18.7	340.51	18.51	340.67	18.51	347.44	18.67	385.2	17.29
399.06	17.43	400.22	17.34	408.31	16.68	432.96	16.02	477.65	15.23
512.19	14.53	523.87	14.54	534.65	14.99	539.28	14.54	554.68	14.57
557.76	14.82	560.08	14.58	563.41	14.57	595.57	14.48	600.14	14.47
614.77	14.57	615.82	14.58	645.59	14.78	650.21	15.09	653.29	14.86
662.28	14.58	677.95	13.99	694.44	13.96	702.6	14.53	706.35	14.74
714.16	13.39	714.69	13.37	719.55	13.58	726.48	12.76	728.97	12.33
732.69	11.49	734.08	11.07	735.18	10.77	738.28	10.54	741.38	10.35
744.49	10	747.6	9.51	750.7	9.16	753.81	8.96	756.91	8.78
758.46	8.76	759.4	8.71	760.02	8.57	761.57	8.21	763.12	7.82
768	7.82	771.25	7.82	772.88	7.82	774.5	7.82	776.12	7.82
777.75	7.82	779.38	7.82	781	7.82	782.62	7.82	784.25	7.82
785.88	7.82	787.5	7.82	789.12	7.82	790.75	7.82	792.38	7.82
794	7.82	795.62	8.06	797.24	8.22	798.86	8.46	800.49	8.64
802.11	8.77	803.73	8.9	805.36	9.11	806.98	9.28	808.6	9.45
808.81	9.47	810.22	9.69	811.85	9.87	812.06	9.91	815.09	10.41
818.34	11.89	821.25	13.51	825.15	14.49	826.45	14.95	834.22	15.38
842	15.56	853.92	15.48	860.27	14.96	869.78	15.38	927.9	14.72
928.5	14.69	937.41	14.27	944.81	14.58	997.65	15.24	998.7	15.51
1068.45	15.59	1098.57	15.77	1123.84	16.56	1151.93	16.67	1214.23	16.79
1247.05	17.31	1296.84	17.94	1314.68	18.02	1393.05	18.73	1396.05	18.74
1478.48	18.6	1483.44	18.63	1517.58	18.94	1570.91	19.39	1613.75	19.77
1665.18	19.98	1681.38	19.93	1743.9	19.82	1770.16	20.37	1846.92	22.11
1874.78	23.02	1897.46	23.76	1963.55	24.56				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.045	726.48	.025	826.45	.045

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
726.48	826.45	1144	1378	1143	.1	.3

CROSS SECTION RIVER: Ublutuoch River
REACH: 13.7 - 1.9 RS: 11.66*

INPUT
Description:

```
Station Elevation Data    num=      128
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
       0    28.24    47.28    26.43    97.72    23.77   120.63    21.57   130.03    20.74
  163.13    19.64   226.96    18.95   237.99    19.07   254.54     18.7   289.22    18.99
  327.83    17.99   348.32    17.82   348.48    17.83   355.41    18.05   394.03     16.7
  408.21    16.95    409.4    16.84   417.67    16.12   442.89    15.49    488.6    14.79
  523.94    14.15   535.88    14.16   546.91    14.68   551.64    14.16    567.4     14.2
  570.55    14.48   572.92     14.2   576.33    14.19   609.23    14.09    613.9    14.08
  628.87     14.2   629.94    14.21   660.39    14.44   665.12    14.79   668.27    14.52
  677.46     14.2   693.49    13.55   710.36    13.54   718.71    14.07   722.55    14.26
  730.53       13   731.08    12.99   736.05    13.31   743.14    12.49   745.74    12.02
  749.64    11.11   751.09    10.65   752.24    10.31   755.49    10.07   758.74     9.88
  761.99      9.5   765.25     8.97    768.5     8.59   771.75     8.38      775      8.2
  776.62     8.19    777.6     8.14   778.25     8.01   779.87     7.67    781.5     7.29
     786     7.29      789     7.29    790.5     7.29      792     7.29    793.5     7.29
     795     7.29    796.5     7.29      798     7.29    799.5     7.29      801     7.29
   802.5     7.29      804     7.29    805.5     7.29      807     7.29    808.5     7.29
     810     7.29   811.69     7.53   813.38     7.68   815.07     7.92   816.76     8.08
  818.45      8.2   820.14     8.31   821.83     8.51   823.52     8.67   825.21     8.82
  825.43     8.84    826.9     9.04   828.59      9.2   828.81     9.23   831.97      9.7
  835.35    11.28   838.39    13.04   842.45    14.02    843.8     14.5   851.54    14.92
  859.29    15.11   871.16    15.07   877.48    14.51   886.95    15.04   944.83    14.55
  945.43    14.51    954.3    14.03   961.67    14.39  1014.29    15.14  1015.34    15.45
  1084.8    15.52   1114.8    15.73  1139.97    16.49  1167.94    16.62  1229.98    16.78
 1262.66    17.28  1312.25    17.86  1330.02    17.94  1408.06    18.67  1411.05    18.68
 1493.14     18.7  1498.08    18.75  1532.08    18.88  1585.18    19.35  1627.85    19.74
 1679.07    19.94   1695.2    19.89  1757.46    19.81  1783.61    20.33  1860.06    21.98
  1887.8    22.84  1910.39    23.54   1976.2    24.32

Manning's n Values        num=        3
     Sta    n Val      Sta    n Val      Sta    n Val
       0     .045   743.14     .024    843.8     .045

Bank Sta: Left   Right    Lengths: Left Channel    Right     Coeff Contr.    Expan.
        743.14   843.8              1101  1497.5     1160              .1        .3

CROSS SECTION          RIVER: Ublutuoch River
REACH: 13.7 - 1.9         RS: 11.355*

INPUT
Description:
Station Elevation Data    num=      128
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
       0    27.92    48.34    26.06    99.91    23.26   123.33    20.87   132.94    19.96
  166.78    18.79   232.04    18.15   243.32    18.23   260.24    17.93    295.7    17.99
  335.18    17.29   356.13    17.14   356.29    17.14   363.38    17.43   402.86    16.11
  417.36    16.46   418.57    16.35   427.03    15.57   452.81    14.96   499.55    14.35
  535.68    13.77   547.89    13.78   559.17    14.36      564    13.78   580.12    13.82
  583.34    14.14   585.76    13.83   589.25    13.82   622.88    13.71   627.66    13.69
  642.96    13.82   644.06    13.83   675.19    14.09   680.03    14.49   683.25    14.19
  692.64    13.83   709.03    13.12   726.28    13.12   734.82    13.61   738.74    13.78
   746.9    12.61   747.46    12.61   752.54    13.04    759.8    12.22   762.51    11.72
  766.58    10.74    768.1    10.23    769.3     9.86    772.7     9.61   776.09     9.41
  779.49     9.01   782.89     8.43   786.29     8.02   789.68      7.8   793.08     7.62
  794.78     7.62    795.8     7.57   796.48     7.45   798.17     7.13   799.88     6.76
     804     6.76   806.75     6.76   808.12     6.76    809.5     6.76   810.88     6.76
  812.25     6.76   813.62     6.76      815     6.76   816.38     6.76   817.75     6.76
  819.12     6.76    820.5     6.76   821.88     6.76   823.25     6.76   824.62     6.76
     826     6.76   827.76        7   829.52     7.14   831.27     7.37   833.03     7.52
  834.78     7.62   836.55     7.72    838.3      7.9   840.06     8.05   841.81     8.19
  842.04     8.21   843.58     8.39   845.33     8.52   845.56     8.55   848.84     8.99
  852.36    10.67   855.52    12.56   859.74    13.55   861.15    14.05   868.86    14.46
  876.57    14.66    888.4    14.66   894.69    14.06   904.12    14.69   961.76    14.38
  962.35    14.34   971.19     13.8   978.53     14.2  1030.93    15.03  1031.98    15.38
 1101.15    15.45  1131.02    15.68  1156.09    16.41  1183.94    16.57  1245.72    16.76
 1278.27    17.25  1327.65    17.78  1345.35    17.85  1423.07     18.6  1426.04    18.61
 1507.79    18.44  1512.71    18.47  1546.57    18.81  1599.45     19.3  1641.94    19.71
 1692.95    19.89  1709.02    19.85  1771.02     19.8  1797.06    20.29  1873.19    21.85
 1900.81    22.66  1923.31    23.32  1988.85    24.08

Manning's n Values        num=        3
     Sta    n Val      Sta    n Val      Sta    n Val
       0     .045    759.8     .023   861.15     .045

Bank Sta: Left   Right    Lengths: Left Channel    Right     Coeff Contr.    Expan.
         759.8  861.15              1101  1497.5     1160              .1        .3

CROSS SECTION          RIVER: Ublutuoch River
REACH: 13.7 - 1.9         RS: 11.05*

INPUT
Description:
Station Elevation Data    num=      128
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
```

0	27.6	49.4	25.69	102.1	22.74	126.03	20.17	135.86	19.17
170.44	17.94	237.13	17.34	248.66	17.4	265.95	17.15	302.18	17.25
342.53	16.58	363.94	16.45	364.1	16.46	371.35	16.81	411.69	15.52
426.51	15.97	427.75	15.85	436.39	15.02	462.74	14.42	510.5	13.91
547.42	13.39	559.9	13.4	571.43	14.05	576.37	13.4	592.84	13.45
596.13	13.8	598.6	13.45	602.17	13.44	636.54	13.32	641.42	13.3
657.06	13.45	658.18	13.46	689.99	13.75	694.94	14.19	698.23	13.85
707.83	13.45	724.58	12.68	742.2	12.7	750.93	13.16	754.93	13.3
763.28	12.22	763.85	12.24	769.04	12.78	776.45	11.94	779.28	11.41
783.53	10.36	785.12	9.81	786.37	9.4	789.91	9.14	793.45	8.94
797	8.51	800.54	7.88	804.08	7.45	807.62	7.22	811.17	7.04
812.94	7.05	814	7	814.71	6.88	816.48	6.58	818.25	6.24
822	6.24	824.5	6.24	825.75	6.24	827	6.24	828.25	6.24
829.5	6.24	830.75	6.24	832	6.24	833.25	6.24	834.5	6.24
835.75	6.24	837	6.24	838.25	6.24	839.5	6.24	840.75	6.24
842	6.24	843.83	6.47	845.65	6.6	847.47	6.83	849.3	6.96
851.12	7.04	852.95	7.12	854.77	7.3	856.6	7.43	858.42	7.56
858.66	7.58	860.25	7.75	862.08	7.84	862.31	7.87	865.72	8.28
869.38	10.06	872.66	12.08	877.04	13.08	878.5	13.6	886.18	14.01
893.86	14.21	905.64	14.26	911.9	13.6	921.29	14.35	978.69	14.21
979.28	14.16	988.09	13.56	995.39	14.01	1047.58	14.93	1048.62	15.31
1117.5	15.38	1147.25	15.63	1172.21	16.33	1199.95	16.52	1261.47	16.74
1293.88	17.22	1343.06	17.7	1360.68	17.76	1438.08	18.53	1441.04	18.55
1522.45	18.35	1527.34	18.39	1561.07	18.75	1613.73	19.26	1656.04	19.69
1706.83	19.85	1722.84	19.81	1784.58	19.79	1810.51	20.25	1886.32	21.73
1913.83	22.48	1936.23	23.1	2001.5	23.85				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.045	776.45	.023	878.5	.045

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
776.45	878.5	1454.5	1477.5	1081	.1	.3

CROSS SECTION RIVER: Ublutuoch River
REACH: 13.7 - 1.9 RS: 10.745*

INPUT
Description:
Station Elevation Data num= 128

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	27.28	50.46	25.33	104.29	22.23	128.73	19.47	138.77	18.39
174.09	17.09	242.22	16.54	253.99	16.71	271.65	16.38	308.66	16.79
349.87	15.87	371.74	15.77	371.91	15.77	379.31	16.19	420.52	14.93
435.66	15.48	436.92	15.36	445.75	14.47	472.66	13.89	521.45	13.47
559.16	13.01	571.91	13.02	583.68	13.73	588.73	13.02	605.55	13.07
608.91	13.46	611.44	13.08	615.08	13.07	650.19	12.93	655.17	12.91
671.15	13.07	672.3	13.08	704.79	13.4	709.84	13.88	713.2	13.52
723.01	13.08	740.12	12.24	758.12	12.28	767.03	12.7	771.12	12.82
779.65	11.83	780.23	11.86	785.53	12.51	793.1	11.66	796.05	11.11
800.48	9.99	802.13	9.4	803.43	8.95	807.12	8.68	810.8	8.48
814.5	8.02	818.18	7.34	821.87	6.88	825.56	6.65	829.25	6.47
831.09	6.48	832.2	6.43	832.94	6.32	834.78	6.04	836.62	5.71
840	5.71	842.25	5.71	843.38	5.71	844.5	5.71	845.62	5.71
846.75	5.71	847.88	5.71	849	5.71	850.12	5.71	851.25	5.71
852.38	5.71	853.5	5.71	854.62	5.71	855.75	5.71	856.88	5.71
858	5.71	859.89	5.93	861.78	6.05	863.67	6.28	865.57	6.4
867.46	6.46	869.35	6.52	871.24	6.69	873.14	6.81	875.03	6.93
875.28	6.95	876.92	7.1	878.82	7.16	879.06	7.19	882.6	7.56
886.39	9.45	889.79	11.6	894.33	12.6	895.85	13.15	903.49	13.55
911.14	13.76	922.87	13.85	929.11	13.15	938.46	14	995.62	14.04
996.21	13.99	1004.98	13.32	1012.25	13.82	1064.22	14.82	1065.26	15.24
1133.85	15.31	1163.47	15.58	1188.33	16.25	1215.95	16.47	1277.22	16.72
1309.49	17.18	1358.46	17.62	1376.01	17.67	1453.09	18.46	1456.03	18.48
1537.1	18.26	1541.97	18.31	1575.56	18.68	1628	19.21	1670.13	19.66
1720.71	19.8	1736.65	19.77	1798.13	19.78	1823.96	20.2	1899.45	21.6
1926.84	22.3	1949.15	22.88	2014.15	23.61				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.045	793.1	.023	895.85	.045

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
793.1	895.85	1454.5	1477.5	1081	.1	.3

CROSS SECTION RIVER: Ublutuoch River
REACH: 13.7 - 1.9 RS: 10.44*

INPUT
Description:
Station Elevation Data num= 128

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	26.96	51.52	24.96	106.48	21.71	131.44	18.76	141.69	17.6
177.75	16.23	247.31	15.73	259.33	16.02	277.36	15.6	315.15	16.33

357.22	15.16	379.55	15.08	379.72	15.09	387.28	15.57	429.35	14.33
444.81	15	446.1	14.86	455.11	13.92	482.59	13.36	532.4	13.02
570.91	12.62	583.92	12.64	595.94	13.42	601.09	12.64	618.27	12.7
621.7	13.12	624.28	12.7	628	12.69	663.85	12.54	668.93	12.52
685.25	12.7	686.42	12.71	719.6	13.06	724.75	13.58	728.18	13.18
738.2	12.7	755.66	11.8	774.05	11.86	783.14	12.25	787.32	12.34
796.02	11.43	796.62	11.49	802.03	12.24	809.76	11.39	812.83	10.8
817.43	9.61	819.14	8.98	820.49	8.49	824.33	8.21	828.16	8.01
832	7.52	835.83	6.8	839.66	6.31	843.5	6.07	847.33	5.89
849.25	5.92	850.4	5.86	851.17	5.76	853.08	5.5	855	5.18
858	5.18	860	5.18	861	5.18	862	5.18	863	5.18
864	5.18	865	5.18	866	5.18	867	5.18	868	5.18
869	5.18	870	5.18	871	5.18	872	5.18	873	5.18
874	5.18	875.96	5.4	877.92	5.51	879.88	5.73	881.84	5.84
883.8	5.88	885.76	5.93	887.72	6.09	889.68	6.2	891.64	6.3
891.9	6.32	893.6	6.45	895.56	6.48	895.82	6.51	899.48	6.85
903.4	8.84	906.93	11.13	911.63	12.13	913.2	12.7	920.81	13.09
928.43	13.31	940.11	13.45	946.32	12.7	955.63	13.66	1012.55	13.87
1013.14	13.81	1021.87	13.08	1029.11	13.63	1080.86	14.71	1081.9	15.18
1150.2	15.25	1179.7	15.54	1204.45	16.18	1231.96	16.42	1292.97	16.71
1325.11	17.15	1373.87	17.54	1391.34	17.59	1468.1	18.4	1471.03	18.42
1551.76	18.18	1556.61	18.23	1590.05	18.62	1642.27	19.17	1684.23	19.63
1734.6	19.76	1750.47	19.73	1811.69	19.77	1837.41	20.16	1912.58	21.48
1939.86	22.13	1962.08	22.66	2026.8	23.38				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.045	809.76	.022	913.2	.045

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
809.76	913.2	885.5	1450	1798	.1	.3

CROSS SECTION RIVER: Ublutuoch River
REACH: 13.7 - 1.9 RS: 10.135*

INPUT
Description:
Station Elevation Data num= 128

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	26.64	52.58	24.59	108.67	21.2	134.14	18.06	144.6	16.81
181.4	15.38	252.39	14.93	264.66	15.25	283.06	14.83	321.63	15.66
364.57	14.46	387.35	14.4	387.53	14.41	395.24	14.94	438.18	13.74
453.96	14.51	455.28	14.37	464.47	13.37	492.51	12.83	543.35	12.58
582.65	12.24	595.93	12.26	608.2	13.1	613.45	12.26	630.98	12.32
634.49	12.78	637.12	12.33	640.91	12.31	677.5	12.15	682.69	12.13
699.34	12.32	700.53	12.33	734.4	12.71	739.65	13.28	743.16	12.85
753.38	12.33	771.2	11.37	789.97	11.44	799.25	11.79	803.51	11.86
812.39	11.04	813	11.11	818.52	11.97	826.42	11.11	829.6	10.5
834.37	9.24	836.15	8.56	837.55	8.04	841.54	7.75	845.51	7.54
849.5	7.03	853.47	6.26	857.45	5.75	861.43	5.5	865.41	5.31
867.4	5.35	868.6	5.29	869.39	5.2	871.38	4.96	873.38	4.65
876	4.65	877.75	4.65	878.62	4.65	879.5	4.65	880.38	4.65
881.25	4.65	882.12	4.65	883	4.65	883.88	4.65	884.75	4.65
885.62	4.65	886.5	4.65	887.38	4.65	888.25	4.65	889.12	4.65
890	4.65	892.02	4.87	894.05	4.96	896.08	5.18	898.11	5.28
900.13	5.3	902.17	5.34	904.19	5.48	906.22	5.58	908.24	5.67
908.51	5.68	910.27	5.8	912.3	5.8	912.57	5.83	916.35	6.14
920.41	8.23	924.06	10.65	928.92	11.66	930.55	12.25	938.13	12.63
945.71	12.86	957.34	13.04	963.53	12.25	972.8	13.31	1029.48	13.7
1030.06	13.64	1038.76	12.85	1045.97	13.44	1097.5	14.6	1098.53	15.11
1166.55	15.18	1195.92	15.49	1220.57	16.1	1247.96	16.36	1308.71	16.69
1340.72	17.12	1389.27	17.46	1406.67	17.5	1483.1	18.33	1486.03	18.35
1566.42	18.1	1571.24	18.14	1604.54	18.55	1656.54	19.12	1698.33	19.6
1748.48	19.71	1764.28	19.69	1825.25	19.76	1850.85	20.11	1925.71	21.35
1952.88	21.95	1975	22.44	2039.45	23.15				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.045	826.42	.021	930.55	.045

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
826.42	930.55	885.5	1450	1798	.1	.3

CROSS SECTION RIVER: Ublutuoch River
REACH: 13.7 - 1.9 RS: 9.83*

INPUT
Description:
Station Elevation Data num= 128

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	26.32	53.64	24.22	110.86	20.69	136.85	17.35	147.51	16.02
185.06	14.52	257.48	14.12	270	14.49	288.77	14.05	328.11	14.99
371.92	13.75	395.16	13.71	395.34	13.73	403.21	14.32	447.01	13.15
463.11	14.02	464.46	13.87	473.84	12.81	502.44	12.29	554.3	12.14

594.39	11.86	607.94	11.88	620.46	12.79	625.82	11.88	643.7	11.95
647.28	12.44	649.96	11.95	653.83	11.93	691.15	11.76	696.45	11.74
713.44	11.95	714.65	11.96	749.2	12.37	754.56	12.98	758.14	12.51
768.56	11.95	786.75	10.93	805.89	11.02	815.36	11.34	819.71	11.38
828.77	10.65	829.39	10.73	835.02	11.71	843.07	10.84	846.37	10.19
851.32	8.86	853.16	8.14	854.62	7.59	858.75	7.29	862.87	7.07
867	6.53	871.12	5.71	875.25	5.18	879.37	4.92	883.5	4.73
885.56	4.78	886.8	4.72	887.62	4.63	889.69	4.41	891.75	4.13
894	4.13	895.5	4.13	896.25	4.13	897	4.13	897.75	4.13
898.5	4.13	899.25	4.13	900	4.13	900.75	4.13	901.5	4.13
902.25	4.13	903	4.13	903.75	4.13	904.5	4.13	905.25	4.13
906	4.13	908.09	4.34	910.19	4.42	912.28	4.64	914.38	4.72
916.47	4.73	918.57	4.74	920.66	4.88	922.76	4.96	924.85	5.04
925.13	5.05	926.95	5.15	929.04	5.13	929.32	5.15	933.23	5.43
937.42	7.62	941.2	10.17	946.22	11.19	947.9	11.8	955.45	12.17
963	12.42	974.58	12.63	980.74	11.8	989.97	12.97	1046.42	13.53
1046.99	13.46	1055.65	12.61	1062.84	13.25	1114.15	14.5	1115.17	15.04
1182.9	15.11	1212.15	15.45	1236.69	16.02	1263.97	16.31	1324.46	16.68
1356.33	17.09	1404.68	17.38	1422.01	17.42	1498.11	18.26	1501.03	18.29
1581.07	18.01	1585.88	18.06	1619.04	18.49	1670.82	19.08	1712.43	19.57
1762.37	19.67	1778.1	19.65	1838.81	19.75	1864.3	20.07	1938.85	21.22
1965.9	21.77	1987.92	22.22	2052.1	22.91				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.045	843.07	.02	947.9	.045

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
843.07	947.9	1328.5	1335	940	.1	.3

CROSS SECTION RIVER: Ublutuoch River
REACH: 13.7 - 1.9 RS: 9.525*

INPUT
Description:
Station Elevation Data num= 128

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	26	54.7	23.85	113.05	20.18	139.55	16.65	150.42	15.24
188.72	13.67	262.56	13.32	275.33	13.72	294.47	13.28	334.59	14.32
379.26	13.04	402.96	13.03	403.15	13.04	411.17	13.7	455.84	12.56
472.25	13.53	473.63	13.38	483.2	12.26	512.37	11.76	565.25	11.7
606.13	11.48	619.95	11.5	632.71	12.47	638.18	11.5	656.41	11.57
660.06	12.1	662.8	11.58	666.75	11.56	704.8	11.38	710.21	11.35
727.53	11.57	728.77	11.59	764	12.02	769.46	12.68	773.11	12.18
783.74	11.58	802.29	10.49	821.81	10.6	831.46	10.88	835.9	10.9
845.14	10.26	845.77	10.35	851.52	11.44	859.72	10.57	863.14	9.89
868.26	8.48	870.17	7.72	871.68	7.14	875.95	6.83	880.22	6.6
884.5	6.04	888.77	5.17	893.04	4.61	897.31	4.35	901.58	4.15
903.71	4.21	905	4.15	905.85	4.07	907.99	3.87	910.12	3.6
912	3.6	913.25	3.6	913.88	3.6	914.5	3.6	915.12	3.6
915.75	3.6	916.38	3.6	917	3.6	917.62	3.6	918.25	3.6
918.88	3.6	919.5	3.6	920.12	3.6	920.75	3.6	921.38	3.6
922	3.6	924.16	3.81	926.33	3.87	928.48	4.09	930.65	4.16
932.81	4.15	934.97	4.14	937.13	4.28	939.3	4.34	941.46	4.41
941.74	4.42	943.62	4.5	945.78	4.45	946.07	4.47	950.11	4.72
954.43	7.01	958.33	9.69	963.52	10.72	965.25	11.35	972.77	11.71
980.28	11.97	991.81	12.22	997.95	11.35	1007.14	12.62	1063.35	13.35
1063.92	13.29	1072.54	12.38	1079.7	13.05	1130.79	14.39	1131.81	14.97
1199.25	15.04	1228.37	15.4	1252.81	15.94	1279.97	16.26	1340.2	16.66
1371.94	17.06	1420.08	17.3	1437.34	17.33	1513.12	18.19	1516.02	18.22
1595.72	17.93	1600.51	17.98	1633.53	18.42	1685.09	19.04	1726.52	19.54
1776.25	19.62	1791.91	19.61	1852.37	19.74	1877.75	20.02	1951.98	21.09
1978.91	21.59	2000.84	22	2064.75	22.67				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.045	859.72	.019	965.25	.045

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
859.72	965.25	1328.5	1335	940	.1	.3

CROSS SECTION RIVER: Ublutuoch River
REACH: 13.7 - 1.9 RS: 9.22*

INPUT
Description:
Station Elevation Data num= 128

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	25.68	55.76	23.48	115.24	19.66	142.26	15.95	153.34	14.45
192.38	12.81	267.65	12.52	280.66	12.96	300.18	12.5	341.07	13.66
386.61	12.33	410.77	12.34	410.96	12.36	419.14	13.08	464.68	11.97
481.4	13.05	482.81	12.88	492.56	11.71	522.3	11.23	576.2	11.26
617.88	11.1	631.96	11.12	644.97	12.16	650.55	11.12	669.13	11.2
672.85	11.76	675.64	11.2	679.67	11.18	718.46	10.99	723.97	10.96

741.62	11.2	742.89	11.22	778.8	11.68	784.37	12.38	788.09	11.84
798.93	11.2	817.83	10.05	837.73	10.18	847.57	10.42	852.1	10.42
861.51	9.87	862.15	9.98	868.02	11.17	876.38	10.3	879.91	9.58
885.21	8.1	887.19	7.3	888.75	6.68	893.16	6.36	897.58	6.13
902	5.54	906.42	4.63	910.83	4.04	915.25	3.77	919.67	3.57
921.87	3.64	923.2	3.58	924.08	3.51	926.29	3.33	928.5	3.07
930	3.07	931	3.07	931.5	3.07	932	3.07	932.5	3.07
933	3.07	933.5	3.07	934	3.07	934.5	3.07	935	3.07
935.5	3.07	936	3.07	936.5	3.07	937	3.07	937.5	3.07
938	3.07	940.23	3.28	942.46	3.33	944.69	3.55	946.92	3.6
949.15	3.57	951.38	3.54	953.61	3.68	955.84	3.73	958.07	3.78
958.36	3.79	960.3	3.85	962.53	3.77	962.82	3.79	966.99	4.01
971.45	6.4	975.46	9.21	980.82	10.25	982.6	10.9	990.09	11.25
997.57	11.52	1009.05	11.82	1015.16	10.9	1024.32	12.28	1080.28	13.18
1080.85	13.11	1089.43	12.14	1096.56	12.86	1147.43	14.29	1148.45	14.91
1215.6	14.97	1244.6	15.36	1268.93	15.87	1295.98	16.21	1355.95	16.65
1387.55	17.03	1435.49	17.22	1452.67	17.25	1528.13	18.13	1531.02	18.16
1610.38	17.84	1615.15	17.9	1648.03	18.36	1699.37	19	1740.62	19.51
1790.13	19.58	1805.73	19.56	1865.93	19.73	1891.2	19.98	1965.11	20.97
1991.93	21.41	2013.77	21.78	2077.4	22.44				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.045	876.38	.019	982.6	.045

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
876.38	982.6	1276.5	1389.5	862.5	.1	.3

CROSS SECTION RIVER: Ublutuoch River
REACH: 13.7 - 1.9 RS: 8.915*

INPUT
Description:
Station Elevation Data num= 128

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	25.36	56.82	23.11	117.43	19.15	144.96	15.25	156.25	13.66
196.03	11.96	272.74	11.72	285.99	12.19	305.88	11.73	347.55	12.99
393.96	11.63	418.58	11.65	418.77	11.67	427.1	12.46	473.51	11.38
490.55	12.56	491.98	12.39	501.92	11.16	532.22	10.7	587.15	10.82
629.62	10.72	643.97	10.74	657.23	11.84	662.91	10.74	681.85	10.82
685.64	11.42	688.48	10.83	692.58	10.81	732.11	10.6	737.72	10.57
755.71	10.82	757.01	10.84	793.6	11.33	799.28	12.07	803.07	11.51
814.11	10.83	833.37	9.62	853.65	9.76	863.68	9.96	868.29	9.94
877.88	9.48	878.53	9.6	884.51	10.9	893.04	10.02	896.68	9.28
902.16	7.73	904.2	6.89	905.81	6.23	910.37	5.9	914.93	5.67
919.5	5.05	924.06	4.09	928.62	3.47	933.18	3.19	937.75	3
940.03	3.07	941.4	3.01	942.31	2.95	944.59	2.79	946.88	2.55
948	2.55	948.75	2.55	949.12	2.55	949.5	2.55	949.88	2.55
950.25	2.55	950.62	2.55	951	2.55	951.38	2.55	951.75	2.55
952.12	2.55	952.5	2.55	952.88	2.55	953.25	2.55	953.62	2.55
954	2.55	956.29	2.75	958.59	2.79	960.89	3	963.19	3.04
965.49	3	967.79	2.94	970.08	3.07	972.38	3.11	974.67	3.15
974.97	3.15	976.97	3.2	979.27	3.1	979.57	3.11	983.86	3.29
988.46	5.79	992.59	8.73	998.11	9.77	999.95	10.45	1007.4	10.79
1014.85	11.07	1026.29	11.41	1032.37	10.45	1041.49	11.93	1097.21	13.01
1097.78	12.94	1106.32	11.91	1113.42	12.67	1164.07	14.18	1165.08	14.84
1231.95	14.9	1260.82	15.31	1285.05	15.79	1311.98	16.15	1371.7	16.63
1403.16	16.99	1450.89	17.14	1468	17.16	1543.13	18.06	1546.01	18.09
1625.03	17.76	1629.78	17.82	1662.52	18.29	1713.64	18.95	1754.71	19.48
1804.01	19.53	1819.55	19.52	1879.48	19.71	1904.65	19.93	1978.24	20.84
2004.95	21.23	2026.69	21.56	2090.05	22.2				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.045	893.04	.018	999.95	.045

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
893.04	999.95	1276.5	1389.5	862.5	.1	.3

CROSS SECTION RIVER: Ublutuoch River
REACH: 13.7 - 1.9 RS: 8.61*

INPUT
Description:
Station Elevation Data num= 128

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	25.04	57.88	22.74	119.62	18.63	147.66	14.54	159.17	12.87
199.69	11.11	277.83	10.91	291.33	11.43	311.59	10.95	354.04	12.33
401.31	10.92	426.39	10.97	426.58	10.99	435.07	11.84	482.34	10.78
499.7	12.07	501.16	11.89	511.28	10.6	542.15	10.16	598.1	10.38
641.36	10.34	655.98	10.36	669.49	11.53	675.27	10.36	694.57	10.45
698.43	11.08	701.32	10.45	705.5	10.43	745.77	10.21	751.48	10.18
769.81	10.45	771.13	10.47	808.4	10.99	814.19	11.77	818.05	11.17
829.3	10.45	848.92	9.18	869.57	9.34	879.79	9.51	884.48	9.46

894.26	9.08	894.92	9.23	901.01	10.64	909.69	9.75	913.46	8.97
919.11	7.35	921.21	6.47	922.87	5.77	927.58	5.43	932.29	5.2
937	4.55	941.71	3.54	946.42	2.9	951.12	2.61	955.83	2.42
958.19	2.5	959.6	2.44	960.54	2.38	962.9	2.24	965.25	2.02
966	2.02	966.5	2.02	966.75	2.02	967	2.02	967.25	2.02
967.5	2.02	967.75	2.02	968	2.02	968.25	2.02	968.5	2.02
968.75	2.02	969	2.02	969.25	2.02	969.5	2.02	969.75	2.02
970	2.02	972.36	2.22	974.73	2.25	977.09	2.45	979.46	2.48
981.83	2.42	984.19	2.35	986.55	2.47	988.92	2.49	991.28	2.52
991.59	2.52	993.65	2.56	996.02	2.42	996.32	2.43	1000.74	2.58
1005.47	5.18	1009.73	8.26	1015.41	9.3	1017.3	10	1024.72	10.33
1032.14	10.62	1043.53	11.01	1049.58	10	1058.66	11.59	1114.14	12.84
1114.71	12.77	1123.22	11.67	1130.28	12.48	1180.72	14.08	1181.72	14.77
1248.3	14.84	1277.05	15.26	1301.17	15.72	1327.99	16.1	1387.45	16.62
1418.78	16.96	1466.3	17.06	1483.34	17.07	1558.14	18	1561.01	18.03
1639.69	17.67	1644.42	17.74	1677.01	18.23	1727.91	18.91	1768.81	19.46
1817.9	19.49	1833.37	19.48	1893.04	19.7	1918.1	19.89	1991.38	20.71
2017.97	21.06	2039.62	21.34	2102.7	21.97				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.045	909.69	.017	1017.3	.045

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
909.69	1017.3	723.5	1438.5	1301.5	.1	.3

CROSS SECTION RIVER: Ublutuoch River
REACH: 13.7 - 1.9 RS: 8.305*

INPUT
Description:
Station Elevation Data num= 128

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	24.72	58.94	22.37	121.81	18.12	150.36	13.84	162.08	12.09
203.34	10.26	282.91	10.11	296.66	10.66	317.29	10.18	360.52	11.66
408.65	10.21	434.19	10.28	434.39	10.31	443.03	11.22	491.17	10.19
508.85	11.58	510.34	11.39	520.64	10.05	552.07	9.63	609.05	9.94
653.1	9.96	667.99	9.98	681.74	11.21	687.63	9.98	707.28	10.07
711.21	10.74	714.16	10.08	718.42	10.05	759.42	9.82	765.24	9.79
783.9	10.07	785.25	10.1	823.2	10.64	829.09	11.47	833.02	10.84
844.48	10.07	864.46	8.74	885.49	8.92	895.89	9.05	900.67	8.98
910.63	8.69	911.3	8.85	917.5	10.37	926.34	9.48	930.23	8.67
936.05	6.98	938.22	6.05	939.93	5.32	944.79	4.97	949.64	4.73
954.5	4.06	959.35	3	964.21	2.33	969.06	2.04	973.91	1.84
976.34	1.93	977.8	1.87	978.77	1.82	981.2	1.7	983.62	1.49
984	1.49	984.25	1.49	984.38	1.49	984.5	1.49	984.62	1.49
984.75	1.49	984.88	1.49	985	1.49	985.12	1.49	985.25	1.49
985.38	1.49	985.5	1.49	985.62	1.49	985.75	1.49	985.88	1.49
986	1.49	988.43	1.69	990.86	1.7	993.29	1.9	995.73	1.92
998.16	1.84	1000.59	1.76	1003.02	1.86	1005.46	1.88	1007.89	1.89
1008.21	1.89	1010.32	1.91	1012.76	1.74	1013.07	1.75	1017.62	1.87
1022.48	4.57	1026.86	7.78	1032.7	8.83	1034.65	9.55	1042.04	9.87
1049.43	10.17	1060.76	10.6	1066.79	9.55	1075.83	11.24	1131.07	12.67
1131.64	12.59	1140.11	11.44	1147.14	12.29	1197.36	13.97	1198.36	14.7
1264.65	14.77	1293.28	15.21	1317.29	15.64	1343.99	16.05	1403.2	16.6
1434.39	16.93	1481.71	16.98	1498.67	16.98	1573.15	17.93	1576	17.96
1654.34	17.58	1659.05	17.66	1691.5	18.16	1742.18	18.87	1782.9	19.43
1831.78	19.44	1847.18	19.44	1906.6	19.69	1931.55	19.84	2004.51	20.59
2030.98	20.88	2052.54	21.12	2115.35	21.74				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.045	926.34	.017	1034.65	.045

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
926.34	1034.65	723.5	1438.5	1301.5	.1	.3

CROSS SECTION RIVER: Ublutuoch River
REACH: 13.7 - 1.9 RS: 8.0

INPUT
Description: River Mile 8.0
Station Elevation Data num= 83

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	24.4	60	22	124	17.6	165	11.3	207	9.4
288	9.3	302	9.9	323	9.4	367	11	416	9.5
442	9.6	451	10.6	500	9.6	518	11.1	530	9.5
562	9.1	620	9.5	680	9.6	694	10.9	700	9.6
720	9.7	724	10.4	727	9.7	779	9.4	798	9.7
838	10.3	844	11.17	848	10.5	880	8.3	912	8.6
927	8.3	934	10.1	943	9.2	947	8.36	953	6.6
957	4.86	962	4.5	967	4.26	972	3.56	977	2.46
982	1.76	987	1.46	992	1.26	994.5	1.36	997	1.26
999.5	1.16	1002	.96	1004.5	1.16	1007	1.16	1009.5	1.36

```
    1012     1.36  1014.5     1.26     1017     1.16  1019.5     1.26     1022     1.26
  1024.5     1.26    1027     1.26   1029.5     1.06  1034.5     1.16   1039.5     3.96
    1044      7.3    1050     8.36     1052      9.1    1078     10.2     1084      9.1
    1093     10.9    1148     12.5     1157     11.2    1164     12.1     1214    13.87
    1215    14.64    1281     14.7     1360       16    1450     16.9     1514     16.9
    1591     17.9    1669     17.5     1706     18.1    1797     19.4     1861     19.4
    1945     19.8    2044     20.7     2128     21.5

Manning's n Values        num=        3
     Sta   n Val     Sta   n Val      Sta   n Val
       0    .045     943  .01604     1052    .045

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
           943    1052             1775    2084    1282               .1       .3

CROSS SECTION          RIVER: Ublutuoch River
REACH: 13.7 - 1.9         RS: 7.45*

INPUT
Description:
Station Elevation Data    num=      142
     Sta     Elev     Sta     Elev      Sta     Elev     Sta     Elev      Sta     Elev
       0     23.4   77.63    22.14   160.43    19.87  179.76     18.7   213.47    16.43
  267.81    15.06  287.83    14.89   360.36    14.71   372.6    14.69   390.72    14.97
  415.24    14.72  417.89    14.69   474.81    15.18  489.96    14.92   538.21    14.09
  565.33    13.99  571.84    13.96   583.49    14.38  640.78    13.55   646.88    13.39
  670.17    13.71   685.7    12.63   717.19     11.9   727.1    11.34    740.3    10.69
  767.43     9.26  789.19     8.87   802.13     8.83  832.73     8.67   863.45     8.94
  879.34      8.5  879.76      8.5   897.87     9.32  905.64     8.75   931.51     9.04
  936.69     9.44  940.57     9.12   948.59     9.18  989.78     8.79  1007.84     8.79
 1032.42     8.99 1034.85     9.01  1084.17     9.74 1085.25     9.81  1091.94    10.15
 1094.31     9.98 1097.11     9.22  1105.23     7.33 1138.51     6.45  1172.83     6.57
 1175.72     6.48 1179.91     6.69   1182.3     6.78 1199.32     6.57  1204.18     7.03
 1208.38     7.34 1218.03     6.73  1220.02     6.65 1222.59     5.61  1222.94     5.45
 1226.45      4.5 1229.03     3.53  1231.35      3.3 1232.24     3.24  1235.46     3.08
 1238.68      2.7 1241.89     2.11  1244.33     1.81 1245.11     1.71  1248.33     1.49
 1251.54     1.32 1253.15     1.34  1254.76     1.25 1256.37     1.17  1257.97     1.03
 1258.08     1.03  1262.7     1.03  1271.51     1.03 1278.02     1.03  1289.24     1.03
 1299.45     1.03 1307.69     1.03  1312.35     1.03 1314.13     1.03  1315.59      1.2
 1317.05     1.26 1318.51     1.43  1319.96      1.5 1321.42     1.51  1322.88     1.53
 1323.96     1.62 1324.34     1.66   1325.8     1.75 1327.26     1.85  1328.72     1.95
 1330.17     1.95 1333.09      2.2  1334.35     2.88 1336.01     3.92  1338.63     5.97
 1342.13     7.01  1343.3     7.55  1356.64     9.01 1369.75     9.47  1371.28     9.54
 1377.74     9.15 1379.78     9.39   1382.8     9.22 1387.43      9.7  1387.74      9.7
 1393.53    10.48 1407.75    11.02  1439.46     11.9 1446.62    12.08  1456.31    11.55
 1463.84    12.08 1482.34     12.6  1517.66    13.53 1518.73    13.92  1528.96    14.02
 1586.74     14.4 1589.77    14.41  1674.61    15.45 1674.79    15.45  1762.34    16.36
 1771.66    16.43 1840.54    16.62  1852.54    16.72 1923.41    17.95  1945.73    18.15
 2007.36    18.14 2036.24    18.42  2047.18    18.58 2120.87    19.59  2145.12     19.9
    2214    20.34 2224.12    20.42  2304.41    20.86 2317.68    20.96  2406.51    21.78
 2410.96     21.8 2501.37     22.1

Manning's n Values        num=        3
     Sta   n Val     Sta   n Val      Sta   n Val
       0    .078 1220.02    .025   1343.3    .087

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
       1220.02  1343.3             2857    1688    1271               .1       .3

CROSS SECTION          RIVER: Ublutuoch River
REACH: 13.7 - 1.9         RS: 6.9

INPUT
Description: 6.8 Upstream
Station Elevation Data    num=       64
     Sta     Elev     Sta     Elev      Sta     Elev     Sta     Elev      Sta     Elev
       0     22.4  220.58     22.1   353.18     20.4  442.19     20.1   509.53       20
  601.21     19.2   693.7     18.4   786.28     17.4  880.04     14.6    908.4     12.2
  941.69      9.2  968.39      8.3  1021.81      7.8 1059.51      8.3  1079.01      7.4
 1163.98      8.7 1214.52      8.1  1269.82      8.3 1331.67      9.2  1342.79      9.1
 1356.18      4.6 1439.14      4.6  1442.68      4.4 1450.75        5   1477.6      4.8
  1494.6      4.1 1497.04      4.1  1498.34      2.7 1502.09        2  1507.87      1.7
 1513.95      1.1 1514.16      1.1   1523.4      1.1 1541.01      1.1  1554.03      1.1
 1576.49      1.1 1596.89      1.1  1613.37      1.1 1622.71      1.1  1626.26      1.1
 1629.07        2 1632.04      3.4   1634.6        6 1648.89      8.4  1662.92      8.8
 1673.66      9.3  1676.9      8.4  1682.19      8.5 1688.39      9.9  1703.62     10.6
 1737.57     11.5 1783.49     12.5  1833.42     13.4 1895.29     14.1  1989.39     14.9
 2083.34     15.9 2179.93     16.4  2279.72     18.5 2376.65     18.9  2467.27     20.1
 2577.84     21.4 2678.03       22  2773.16     22.9 2874.74     22.7

Manning's n Values        num=        3
     Sta   n Val     Sta   n Val      Sta   n Val
       0     .11 1497.04   .0345   1634.6     .13
```

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Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
       1497.04  1634.6              522     540     509               .1       .3

CROSS SECTION          RIVER: Ublutuoch River
REACH: 13.7 - 1.9         RS: 6.80

INPUT
Description: 6.8 Bridge
Station Elevation Data    num=      53
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0    19.1   45.13    18.3  135.95    16.9  238.38    14.3  289.74    12.5
  347.26    10.5  365.45       9  395.99       7  430.25     5.9  519.93     7.5
  582.53     8.9  675.46     9.4  750.15     9.3  824.12    10.2  842.05     9.2
  855.42     8.2  868.19     4.1  874.87     3.2  891.13       2  906.09       2
  926.57     3.3   946.5     5.9  975.75     6.1 1006.06     4.8  1021.5     3.2
 1036.13     1.4  1037.9    1.09 1086.04    1.09 1117.73    1.09 1121.21    1.09
 1121.59     1.3 1125.56     5.9  1130.5     6.8 1132.98     8.8 1135.27       9
 1139.55     9.3 1162.38     9.7 1198.12     8.9 1234.27     8.3 1264.44     7.8
 1354.68    10.5 1445.96    12.9 1518.92    14.6 1603.32    15.6 1693.39    16.5
 1787.94    17.8 1882.44    18.7 1975.38    20.3 2069.61    20.6 2161.93    21.3
 2251.21    21.1 2336.51    21.8 2432.77    21.6

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0     .11 1006.06   .0345 1132.98     .13

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
       1006.06 1132.98             2674    2418    2654               .1       .3

CROSS SECTION          RIVER: Ublutuoch River
REACH: 13.7 - 1.9         RS: 6.3*

INPUT
Description:
Station Elevation Data    num=     108
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0   19.38   61.68   18.36   74.79   18.16  132.96   16.97  168.97   15.42
  183.93   14.57  185.81   14.54  219.94   13.92  317.45   12.59  325.81   12.49
  396.01   11.24  399.44   11.18  458.16   10.01  474.62     9.6  499.48    8.32
  541.22    6.57  547.91    6.41  588.05    5.86  609.41    6.16  661.48    6.49
  710.62    6.93  716.33       7  773.39    7.75  796.18    8.02  923.19     8.4
 1018.82    8.33 1025.28    8.32 1067.57    8.58 1124.08    8.96 1126.38    8.98
 1150.88    8.31 1169.16    7.62 1177.82    6.12 1186.61     4.6 1195.74    3.95
 1217.96    3.11 1233.22    3.15 1238.41    3.03 1243.75    3.09  1266.4    3.98
 1283.08    5.24 1291.94    6.15 1293.64    6.29 1332.39     6.7 1333.62    6.69
 1353.44    6.03 1372.27    5.34 1375.05    4.93 1380.49    3.54 1387.18    2.81
 1396.81    1.59 1398.68    1.34 1400.08    1.08 1401.89    1.08 1406.14    1.08
 1432.23    1.08 1453.52    1.08 1468.15    1.08 1482.27    1.08 1512.96    1.08
 1517.88    1.08 1518.42    1.27 1518.47    1.31 1524.02    4.71 1528.08    5.09
 1529.15    5.32 1530.21    6.35 1530.99    6.41 1531.82    6.76 1532.88    7.69
 1534.48    8.75 1536.82    8.97  1541.2    9.33 1547.66    9.61 1554.24    9.94
 1564.51     9.8 1565.53    9.76 1577.77   10.03 1601.02     9.7 1637.94    9.32
 1668.09    9.01 1668.76       9  1760.3   11.29 1760.93    11.3 1854.16   13.15
 1854.39   13.15 1928.68   14.86 1939.07   15.02 2014.89   15.91 2028.45   16.05
 2106.88   16.48 2122.54   16.61 2203.45   17.75 2210.04   17.82 2299.98   18.38
 2300.37   18.38 2389.75   19.68  2394.9   19.77 2475.37   20.19 2491.15   20.27
 2562.88   20.85 2585.44   21.03 2656.02   21.08 2676.63   21.04 2748.23   21.46
 2763.76   21.57 2767.99   21.57 2862.08   21.35

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0    .106 1375.05    .033 1534.48    .121

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
       1375.05 1534.48             1260    2480    1727               .1       .3

CROSS SECTION          RIVER: Ublutuoch River
REACH: 13.7 - 1.9         RS: 5.8*

INPUT
Description:
Station Elevation Data    num=     108
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0   19.65   78.23   18.43   94.86   18.18  168.64   16.45  214.31   13.74
  233.29   12.21  235.67   12.18  278.96   11.58  402.63   10.73  413.24   10.68
  502.27    9.99  506.63    9.96  581.11    9.11  601.98     8.7  633.52    7.64
  686.46    6.13  694.94    5.97  745.85    5.83  772.94    6.14  838.99    6.13
  901.31    6.36  908.55     6.4  980.93    6.96 1009.83    7.15 1170.93     7.4
 1292.21    7.35  1300.4    7.34 1354.05    7.49 1425.72    7.74 1428.63    7.76
 1459.71    7.42 1482.89    7.04 1493.88    6.08 1505.03     5.1 1516.61     4.7
  1544.8    4.22 1564.15     4.3 1570.73    4.05  1577.5    3.92 1606.23    4.65
 1627.39     5.6 1638.63    6.57 1640.78    6.67 1689.92     7.3 1691.49    7.28
 1716.63    6.59 1740.52    5.79 1744.03    5.05 1747.99    2.99 1752.87    2.43
 1759.87     1.5 1761.24    1.28 1762.25    1.08 1764.59    1.08  1770.1    1.08
```

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 1803.82    1.08 1831.35    1.08 1850.26    1.08 1868.51    1.08 1908.19    1.08
 1914.55    1.08 1915.25    1.24 1915.31    1.27 1922.48    3.52 1927.72    3.76
  1929.1    4.08 1930.48       6 1931.47    6.03 1932.54    6.24 1933.92    7.49
 1935.99     8.7 1938.38    8.94 1942.84    9.36 1949.44    9.81 1956.16   10.36
 1966.65     9.9 1967.69    9.84 1980.18   10.65 2003.92   10.49 2041.61   10.33
 2072.39   10.21 2073.07    10.2 2166.53   12.09 2167.17    12.1 2262.36    13.4
 2262.59    13.4 2338.44   15.13 2349.04   15.31 2426.45   16.22  2440.3   16.37
 2520.37   16.46 2536.36   16.51 2618.97    17.7 2625.69   17.78 2717.51   18.05
 2717.91   18.05 2809.17   19.16 2814.43   19.23 2896.58   19.83 2912.69   19.93
 2985.92   20.57 3008.96   20.76 3081.02   21.02 3102.06   20.99 3175.15   21.24
 3191.01   21.34 3195.33   21.35 3291.39    21.1

Manning's n Values         num=        3
     Sta   n Val     Sta   n Val     Sta   n Val
       0    .103 1744.03    .032 1935.99    .113

Bank Sta: Left   Right    Lengths: Left Channel   Right      Coeff Contr.   Expan.
       1744.03 1935.99             2843    1965     197              .1       .3

CROSS SECTION          RIVER: Ublutuoch River
REACH: 13.7 - 1.9         RS: 5.3*

INPUT
Description:
Station Elevation Data    num=     108
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0   19.93   94.79   18.49  114.93   18.19  204.32   15.92  259.66   12.07
  282.64    9.86  285.53    9.83  337.98    9.24  487.82    8.86  500.67    8.86
  608.54    8.73  613.81    8.73  704.05     8.2  729.35     7.8  767.55    6.97
  831.69     5.7  841.97    5.54  903.65    5.79  936.47    6.12 1016.49    5.76
    1092    5.79 1100.78     5.8 1188.46    6.18 1223.48    6.28 1418.66     6.4
 1565.61    6.38 1575.53    6.37 1640.52    6.39 1727.36    6.52 1730.89    6.55
 1768.55    6.54 1796.63    6.47 1809.94    6.04 1823.45     5.6 1837.48    5.45
 1871.63    5.33 1895.07    5.45 1903.05    5.08 1911.25    4.76 1946.06    5.33
 1971.69    5.95 1985.31    6.98 1987.92    7.06 2047.46     7.9 2049.36    7.86
 2079.81    7.14 2108.76    6.25 2113.01    5.18  2115.5    2.45 2118.55    2.04
 2122.94     1.4 2123.79    1.22 2124.43    1.07 2127.29    1.07 2134.05    1.07
 2175.41    1.07 2209.17    1.07 2232.37    1.07 2254.76    1.07 2303.42    1.07
 2311.23    1.07 2312.08    1.22 2312.16    1.24 2320.94    2.33 2327.36    2.43
 2329.05    2.84 2330.74    5.65 2331.96    5.64 2333.27    5.72 2334.96     7.3
  2337.5    8.65 2339.93    8.91 2344.49    9.39 2351.22      10 2358.08   10.78
 2368.78    10.8 2369.84    10.9 2382.59   11.28 2406.81   11.29 2445.28   11.35
  2476.7    11.4 2477.39   11.41 2572.77    12.9 2573.42    12.9 2670.56   13.65
  2670.8   13.65  2748.2   15.39 2759.02   15.61 2838.02   16.52 2852.15   16.68
 2933.87   16.44 2950.18    16.4 3034.48   17.65 3041.35   17.74 3135.05   17.73
 3135.46   17.73 3228.58   18.63 3233.95    18.7 3317.79   19.46 3334.23    19.6
 3408.96   20.28 3432.47   20.49 3506.01   20.96 3527.48   20.93 3602.08   21.02
 3618.26   21.11 3622.66   21.12 3720.69   20.85

Manning's n Values         num=        3
     Sta   n Val     Sta   n Val     Sta   n Val
       0    .099 2113.01    .031  2337.5    .104

Bank Sta: Left   Right    Lengths: Left Channel   Right      Coeff Contr.   Expan.
       2113.01  2337.5              524    2508    2723              .1       .3

CROSS SECTION          RIVER: Ublutuoch River
REACH: 13.7 - 1.9         RS: 4.8

INPUT
Description: River Mile 4.8
Station Elevation Data    num=      61
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0    20.2     135    18.2     240    15.4     305    10.4     332     7.5
     397     6.9     573       7     721     7.5     827     7.3     989     5.1
    1100     6.1    1194     5.4    1293     5.2    1396     5.4    1839     5.4
    1927     5.3    2029     5.3    2126       6    2226     6.6    2245     5.6
    2316     6.3    2332     7.4    2405     8.5    2443     7.7    2477     6.7
    2482     5.3    2483     1.9    2486     1.3  2486.6    1.06    2490    1.06
    2498    1.06    2547    1.06    2587    1.06    2641    1.06  2707.9    1.06
    2709     1.2    2727     1.1    2729     1.6    2731     5.3    2734     5.2
    2736     7.1    2739     8.6    2753    10.2    2760    11.2    2772    11.5
    2785    11.9    2881    12.6    2979    13.7    3079    13.9    3169    15.9
    3264      17    3364    16.3    3457    17.7    3553    17.4    3648    18.1
    3739    19.1    3832      20    3931    20.9    4029    20.8    4050    20.9
    4150    20.6

Manning's n Values         num=        3
     Sta   n Val     Sta   n Val     Sta   n Val
       0   .0955    2482  .02975    2739   .0955

Bank Sta: Left   Right    Lengths: Left Channel   Right      Coeff Contr.   Expan.
          2482    2739           1453.5  1196.5     641              .1       .3
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CROSS SECTION          RIVER: Ublutuoch River
REACH: 13.7 - 1.9         RS: 4.4625*

INPUT
Description:
Station Elevation Data    num=     105
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
       0    19.62   123.96    17.88   220.38    15.44   280.07    11.08   281.24    10.96
  304.86     8.52   364.55     7.94   526.16     7.88   565.14     7.96   662.06      8.3
   759.4     8.16   846.38     7.06   908.16     6.23  1010.09     7.04   1096.4     6.39
 1117.01     6.34  1187.31     6.15  1281.89     6.24   1395.6     6.15  1671.53     5.93
 1688.68     5.91  1769.49     5.66  1841.35     5.52  1863.15     5.49   1928.9     5.88
 1952.22        6  2044.05     6.39  2061.49      5.5  2126.69     6.01  2135.85      6.6
 2141.38     6.91  2154.42     6.99  2208.42     7.82  2243.31     7.16  2274.53     6.32
 2279.12      5.1  2281.66     2.06  2288.86     1.35  2289.26     1.31  2290.79     1.05
 2294.26     1.05  2302.45     1.05  2310.55     1.05  2352.58     1.05  2357.17     1.05
 2388.25     1.05  2393.51     1.05  2439.17     1.05  2448.76     1.05  2488.39     1.05
 2501.34     1.05  2516.02     1.05  2517.21     1.05  2518.26     1.21  2519.54     1.24
 2526.77     1.36   2535.5     1.35  2537.42     1.79  2539.33     5.04  2542.21     4.97
 2544.12     6.64     2547     7.97  2561.91     9.38  2569.36    10.27  2581.31    10.01
 2582.15     9.99  2595.99    10.83  2619.13    10.87  2667.46     11.3  2698.24    11.53
 2712.28    11.68  2737.48     12.1  2801.92    12.66  2802.62    12.66  2865.64    12.79
 2909.14    12.85  2940.58    13.41   2997.3    14.52     3005    14.68  3035.82    15.06
 3085.54    15.37  3106.18    15.48  3161.88    14.92  3212.69    14.67  3234.01    14.95
 3304.04    15.76  3311.75    15.86  3367.07    15.77     3414    15.65  3422.39     15.7
 3442.01    15.85  3515.19    16.27  3558.96    16.66  3612.11    17.24  3628.29     17.4
 3692.01    18.12  3711.17    18.35  3757.14    18.88  3816.61     19.5  3831.37    19.54
 3902.81    19.45  3920.99    19.44  3943.36    19.54  3971.44    19.48  4049.88     19.6

Manning's n Values        num=       3
     Sta    n Val      Sta    n Val      Sta    n Val
       0     .094  2279.12     .029     2547     .094

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
       2279.12    2547           1453.5  1196.5     641              .1       .3

CROSS SECTION          RIVER: Ublutuoch River
REACH: 13.7 - 1.9         RS: 4.125*

INPUT
Description:
Station Elevation Data    num=     105
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
       0    19.03   112.93    17.56   200.77    15.48   255.14    11.75   256.21    11.65
  277.73     9.53    332.1     8.97   479.33     8.75   514.83     8.78   603.13     9.11
   691.8     9.02   771.04     8.11   827.32     7.36   920.18     7.99   998.81     7.37
 1017.58     7.32  1081.62     7.09  1167.79     7.08  1271.37      6.9  1522.74     6.47
 1538.37     6.41  1611.98     6.01  1677.44     5.73  1697.31     5.68   1757.2     5.94
 1778.45     6.01   1862.1     6.19  1877.99     5.39  1937.39     5.73  1945.73     6.21
 1950.77     6.43  1962.65     6.36  2011.84     7.14  2043.63     6.62  2072.07     5.94
 2076.25      4.9  2080.32     2.21  2091.88     1.37  2092.53     1.32  2094.98     1.05
 2098.53     1.05  2106.91     1.05  2115.19     1.05  2158.17     1.05  2162.86     1.05
 2194.64     1.05  2200.03     1.05  2246.72     1.05  2256.53     1.05  2297.05     1.05
 2310.29     1.05   2325.3     1.05  2326.52     1.05  2327.53     1.22  2328.75     1.29
 2335.66     1.56  2344.01      1.6  2345.84     1.99  2347.67     4.78  2350.42     4.73
 2352.25     6.18     2355     7.33  2370.82     8.57  2378.73     9.34  2391.41     8.53
  2392.3     8.47  2406.99     9.77  2431.54     9.69  2482.82    10.22  2515.49    10.46
 2530.38    10.61  2557.13    11.19   2625.5    11.62  2626.25    11.63  2693.12    11.76
 2739.28     11.8  2772.64    12.27  2832.83     13.3     2841    13.46   2873.7    13.88
 2926.46    13.96  2948.37    13.95  3007.47     13.2  3061.39    13.04  3084.01     13.3
 3158.32    13.92   3166.5    14.02   3225.2       14     3275     13.9  3283.91    13.94
 3304.72     14.1  3382.38    14.44  3428.82    14.76  3485.23    15.39  3502.39    15.56
 3570.01    16.42  3590.34     16.7  3639.12    17.37  3702.23    18.11  3717.89    18.19
 3793.69    18.09  3812.99    18.09  3836.73    18.18  3866.52    18.14  3949.75     18.6

Manning's n Values        num=       3
     Sta    n Val      Sta    n Val      Sta    n Val
       0     .092  2076.25     .029     2355     .092

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
       2076.25    2355           1461.5  1331.5    1134              .1       .3

CROSS SECTION          RIVER: Ublutuoch River
REACH: 13.7 - 1.9         RS: 3.7875*

INPUT
Description:
Station Elevation Data    num=     111
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
       0    18.44   101.89    17.24   181.15    15.53   230.21    12.43   231.17    12.34
  250.59    10.55   299.65    10.01   432.49     9.62   464.52      9.6    544.2      9.3
   624.2      9.3    695.7     9.16   746.48     8.49   830.26     8.94   901.21     8.36
  918.15      8.3   975.93     8.03  1053.68     7.93  1147.14     7.65  1373.95     7.01
 1388.05     6.91  1454.47     6.37  1513.53     5.94  1531.46     5.87   1585.5        6
```

```
 1604.67    6.01 1680.15    5.98 1694.49    5.29 1748.08    5.44 1755.61    5.82
 1760.15    5.94 1770.87    5.74 1815.26    6.46 1843.94    6.08  1869.6    5.56
 1873.38     4.7 1878.98    2.36  1894.9     1.4 1895.79    1.34  1895.8    1.33
 1899.17    1.04 1902.79    1.04 1902.81    1.04 1911.36    1.04 1919.82    1.04
 1963.75    1.04 1968.55    1.04 2001.03    1.04 2006.54    1.04 2054.27    1.04
 2064.29    1.04  2105.7    1.04 2105.71    1.04 2119.23    1.04 2119.25    1.04
 2134.57    1.04 2134.59    1.04 2135.83    1.04 2136.79    1.23 2137.95    1.34
 2137.96    1.35 2144.55    1.77 2152.51    1.85 2154.26    2.18 2156.01    4.52
 2158.63     4.5 2160.38    5.71    2163    6.69 2179.73    7.75  2188.1    8.41
 2201.51    7.76 2202.44    7.71 2217.98    8.71 2243.95    8.51 2298.18    9.13
 2332.73    9.39 2348.48    9.54 2376.77   10.27 2449.08   10.58 2449.88   10.59
  2520.6   10.73 2569.41   10.74  2604.7   11.12 2668.36   12.08    2677   12.24
 2711.58    12.7 2767.38   12.55 2790.55   12.43 2853.05   11.49 2910.08   11.41
    2934   11.65  3012.6   12.08 3021.25   12.17 3083.33   12.23    3136   12.15
 3145.42   12.18 3167.43   12.35 3249.56   12.61 3298.68   12.87 3358.34   13.53
 3376.49   13.71 3448.01   14.71 3469.51   15.05  3521.1   15.86 3587.84   16.71
 3604.41   16.84 3684.57   16.73 3704.99   16.73 3730.09   16.82  3761.6    16.8
 3849.62    17.6

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0     .09 1873.38    .028    2163     .09

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
       1873.38    2163            1461.5  1331.5    1134             .1       .3

CROSS SECTION          RIVER: Ublutuoch River
REACH: 13.7 - 1.9         RS: 3.45*

INPUT
Description:
Station Elevation Data    num=     105
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0   17.85   90.86   16.92  161.53   15.57  205.28    13.1  206.14   13.03
  223.45   11.56   267.2   11.04  385.66   10.49  414.22   10.42  485.27   10.72
  556.61   10.74  620.36   10.21  665.64    9.61  740.35    9.89  803.62    9.35
  818.72    9.28  870.25    8.97  939.57    8.77 1022.91     8.4 1225.16    7.55
 1237.73    7.41 1296.96    6.72 1349.62    6.15 1365.61    6.06  1413.8    6.06
  1430.9    6.01  1498.2    5.78 1510.99    5.18 1558.77    5.15 1565.49    5.44
 1569.54    5.46  1579.1    5.11 1618.68    5.79 1644.25    5.54 1667.13    5.18
  1670.5     4.5 1677.64    2.51 1697.92    1.42 1699.07    1.35 1703.35    1.03
 1707.07    1.03 1715.81    1.03 1724.46    1.03 1769.35    1.03 1774.24    1.03
 1807.43    1.03 1813.05    1.03 1861.82    1.03 1872.05    1.03 1914.36    1.03
 1928.19    1.03 1943.86    1.03 1945.15    1.03 1946.06    1.24 1947.16     1.4
 1953.44    1.98 1961.02     2.1 1962.69    2.38 1964.35    4.27 1966.84    4.27
 1968.51    5.25    1971    6.05 1988.65    6.94 1997.47    7.48 2011.61    6.99
 2012.59    6.94 2028.98    7.65 2056.36    7.33 2113.55    8.04 2149.98    8.32
 2166.59    8.47 2196.42    9.36 2272.67    9.55 2273.51    9.55 2348.08    9.71
 2399.55    9.69 2436.76    9.98 2503.89   10.87    2513   11.03 2549.47   11.52
 2608.31   11.14 2632.74    10.9 2698.64    9.77 2758.78    9.78    2784      10
 2866.88   10.25 2876.01   10.33 2941.47   10.47 2997.01    10.4 3006.94   10.43
 3030.14    10.6 3116.75   10.79 3168.55   10.98 3231.45   11.67 3250.59   11.87
 3326.01   13.01 3348.68   13.41 3403.08   14.35 3473.46   15.32 3490.93   15.49
 3575.46   15.36 3596.99   15.38 3623.45   15.46 3656.68   15.46  3749.5    16.6

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0    .088  1670.5    .027    1971    .088

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
        1670.5    1971              1131  1471.5  1617.5             .1       .3

CROSS SECTION          RIVER: Ublutuoch River
REACH: 13.7 - 1.9         RS: 3.1125*

INPUT
Description:
Station Elevation Data    num=     105
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0   17.26   79.82    16.6  141.91   15.61  180.35   13.78   181.1   13.73
  196.31   12.58  234.75   12.08  338.82   11.37  363.91   11.24  426.33   11.52
  489.01    11.6  545.02   11.26   584.8   10.74  650.44   10.84  706.02   10.34
  719.29   10.26  764.56    9.92  825.46    9.61  898.68    9.15 1076.37    8.09
 1087.41    7.92 1139.45    7.08 1185.71    6.36 1199.76    6.25  1242.1    6.12
 1257.12    6.02 1316.25    5.58 1327.48    5.08 1369.46    4.87 1375.36    5.05
 1378.92    4.97 1387.32    4.48 1422.09    5.11 1444.56       5 1464.66     4.8
 1467.62     4.3  1476.3    2.67 1500.94    1.44 1502.33    1.36 1507.54    1.02
 1511.33    1.02 1520.26    1.02 1529.09    1.02 1574.93    1.02 1579.93    1.02
 1613.82    1.02 1619.56    1.02 1669.36    1.02 1679.81    1.02 1723.02    1.02
 1737.14    1.02 1753.14    1.02 1754.46    1.02 1755.32    1.25 1756.37    1.45
 1762.33    2.18 1769.53    2.35 1771.11    2.58 1772.68    4.01 1775.05    4.03
 1776.63    4.79    1779    5.41 1797.56    6.12 1806.83    6.55  1821.7    6.22
 1822.74    6.17 1839.97    6.58 1868.77    6.15 1928.91    6.95 1967.23    7.25
 1984.69     7.4 2016.06    8.44 2096.25    8.51 2097.13    8.52 2175.56    8.68
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  2229.69    8.64 2268.82    8.83 2339.41    9.65 2348.99    9.81 2387.35   10.13
  2449.23    9.73 2474.92    9.38 2544.23    8.05 2607.48    8.14    2634    8.35
  2721.16    8.41 2730.76    8.49  2799.6     8.7 2858.01    8.65 2868.45    8.67
  2892.85    8.85 2983.94    8.96 3038.41    9.08 3104.56    9.81 3124.69   10.03
     3204   11.31 3227.84   11.76 3285.06   12.83 3359.07   13.92 3377.44   14.14
  3466.34      14 3488.98   14.02 3516.81    14.1 3551.76   14.12 3649.38    15.6

Manning's n Values         num=        3
     Sta   n Val     Sta   n Val     Sta   n Val
       0    .087 1467.62    .027    1779    .087

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
       1467.62    1779             1131  1471.5  1617.5              .1       .3

CROSS SECTION          RIVER: Ublutuoch River
REACH: 13.7 - 1.9         RS: 2.775*

INPUT
Description:
Station Elevation Data    num=      105
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0   16.67   68.79   16.27   122.3   15.65  155.42   14.45  156.07   14.42
   169.18   13.59   202.3   13.11  291.98   12.24  313.61   12.06   367.4   12.33
   421.41   12.46  469.68    12.3  503.96   11.87  560.53   11.78  608.43   11.32
   619.86   11.24  658.87   10.86  711.36   10.45  774.46     9.9  927.58    8.62
    937.1    8.42  981.94    7.43 1021.81    6.57 1033.92    6.44  1070.4    6.18
  1083.34    6.02  1134.3    5.37 1143.98    4.97 1180.16    4.58 1185.24    4.67
  1188.31    4.48 1195.55    3.85 1225.51    4.43 1244.88    4.46  1262.2    4.42
  1264.75     4.1 1274.96    2.82 1303.96    1.46  1305.6    1.37 1311.73    1.02
   1315.6    1.02 1324.72    1.02 1333.73    1.02 1380.52    1.02 1385.62    1.02
  1420.21    1.02 1426.08    1.02 1476.91    1.02 1487.58    1.02 1531.68    1.02
   1546.1    1.02 1562.43    1.02 1563.77    1.02 1564.59    1.26 1565.58     1.5
  1571.22    2.39 1578.04     2.6 1579.53    2.78 1581.02    3.75 1583.26     3.8
  1584.76    4.33    1587    4.78 1606.47    5.31  1616.2    5.62  1631.8    5.44
  1632.89     5.4 1650.97    5.52 1681.18    4.96 1744.27    5.87 1784.48    6.18
  1802.79    6.34 1835.71    7.53 1919.83    7.47 1920.76    7.48 2003.04    7.65
  2059.83    7.59 2100.88    7.69 2174.94    8.43 2184.99    8.59 2225.23    8.75
  2290.15    8.32 2317.11    7.85 2389.82    6.33 2456.18    6.51    2484     6.7
  2575.44    6.57 2585.51    6.65 2657.73    6.93 2719.01     6.9 2729.97    6.91
  2755.57     7.1 2851.13    7.13 2908.27    7.19 2977.68    7.96  2998.8    8.19
     3082    9.61 3107.01   10.11 3167.04   11.32 3244.69   12.53 3263.96    12.8
  3357.23   12.63 3380.98   12.66 3410.18   12.74 3446.84   12.78 3549.25    14.6

Manning's n Values         num=        3
     Sta   n Val     Sta   n Val     Sta   n Val
       0    .085 1264.75    .026    1587    .085

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
       1264.75    1587           1147.5  1251.5     117              .1       .3

CROSS SECTION          RIVER: Ublutuoch River
REACH: 13.7 - 1.9         RS: 2.4375*

INPUT
Description:
Station Elevation Data    num=      105
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0   16.08   57.76   15.95  102.68   15.69  130.49   15.12  131.03   15.11
   142.04   14.61  169.85   14.15  245.14   13.11   263.3   12.88  308.47   13.14
   353.81   13.32  394.34   13.35  423.12      13  470.62   12.73  510.83   12.31
   520.43   12.22  553.18    11.8  597.25   11.29  650.23   10.65  778.79    9.16
   786.78    8.92  824.43    7.79   857.9    6.79  868.07    6.63   898.7    6.24
   909.56    6.02  952.35    5.17  960.48    4.87  990.85    4.29  995.12    4.29
    997.7       4 1003.77    3.23 1028.93    3.75 1045.19    3.92 1059.73    4.04
  1061.88     3.9 1073.62    2.97 1106.98    1.48 1108.87    1.38 1115.92    1.01
  1119.87    1.01 1129.17    1.01 1138.36    1.01 1186.11    1.01 1191.31    1.01
   1226.6    1.01 1232.59    1.01 1284.45    1.01 1295.34    1.01 1340.34    1.01
  1355.05    1.01 1371.71    1.01 1373.08    1.01 1373.85    1.27 1374.79    1.55
  1380.11    2.59 1386.55    2.85 1387.95    2.97 1389.36    3.49 1391.47    3.57
  1392.89    3.87    1395    4.14 1415.38    4.49 1425.57    4.69  1441.9    4.67
  1443.04    4.64 1461.97    4.46 1493.59    3.78 1559.63    4.78 1601.73    5.11
  1620.89    5.27 1655.35    6.61 1743.41    6.44 1744.39    6.44 1830.52    6.62
  1889.97    6.54 1932.94    6.54 2010.47    7.21 2020.99    7.37 2063.11    7.77
  2131.07    6.91 2159.29    6.32 2235.41    4.62 2304.88    4.88    2334    5.05
  2429.72    4.74 2440.26    4.81 2515.86    5.16 2580.01    5.15 2591.48    5.15
  2618.28    5.35 2718.32     5.3 2778.13     5.3 2850.79     6.1  2872.9    6.34
     2960     7.9 2986.18    8.46 3049.02    9.81 3130.31   11.14 3150.48   11.45
  3248.11   11.27 3272.98   11.31 3303.54   11.38 3341.92   11.44 3449.12    13.6

Manning's n Values         num=        3
     Sta   n Val     Sta   n Val     Sta   n Val
       0    .083 1061.88    .025    1395    .083

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
```

1061.88	1395	1147.5	1251.5	117		.1	.3

CROSS SECTION RIVER: Ublutuoch River
REACH: 13.7 - 1.9 RS: 2.10

INPUT
Description: 1.9 Upstream
Station Elevation Data num= 50

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	15.5	106	15.8	213	13.7	319	14.4	421	13.2
526	11.4	630	9.7	694	7	727	6.3	805	3.9
812	2.6	859	3.7	910	1.5	920.11	1.01	943	1.01
997	1.01	1033	1.01	1092	1.01	1149	1.01	1164	1.01
1181	1.01	1182.39	1.01	1184	1.6	1189	2.8	1203	3.5
1252	3.9	1306	2.6	1375	3.7	1439	4.2	1475	5.7
1567	5.4	1658	5.6	1765	5.4	1846	6	1901	6.8
1972	5.5	2081	2.9	2184	3.4	2284	2.9	2374	3.4
2453	3.4	2481	3.6	2648	3.4	2747	4.5	2838	6.2
2931	8.3	3037	10.1	3139	9.9	3237	10.1	3349	12.6

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.081	859	.025	1203	.081

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
859	1203	2027	1339	741	.1	.3

CROSS SECTION RIVER: Ublutuoch River
REACH: 13.7 - 1.9 RS: 1.80

INPUT
Description: 1.9 Downstream
Station Elevation Data num= 69

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	11.9	55	10.8	159	11.6	259	10.6	356	10.6
454	10.6	554	10.2	651	7.6	679	5.9	709	3.8
833	5.3	860	3.2	1261	3.2	1322	3.5	1427	3.4
1527	3.5	1621	3.4	1718	3.5	1824	5.3	1894	5.9
1922	5.7	1926	4.9	1930	3.5	1931	2.2	1934	1.3
1936	1	1940.11	1	1966	1	1986	1	2066	1
2119	1	2170	1	2174	1	2180.91	1	2182	1.6
2183	2.7	2184	2.9	2186	3.9	2189	5.4	2219	3.3
2232	4.8	2243	5.3	2280	5.5	2382	4.6	2418	5.2
2521	4.7	2622	5.9	2726	4.7	2807	3.1	2844	5.1
2943	5.8	3044	5.6	3152	4.9	3251	5.6	3298	5.6
3374	5.2	3467	4.2	3532	4.1	3560	4.3	3593	4.7
3688	2.5	3775	2.8	3863	2.3	3962	3.8	4059	5.9
4154	7.5	4255	8.8	4355	10.4	4456	12		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.081	1922	.025	2189	.081

Bank Sta: Left	Right	Coeff Contr.	Expan.
1922	2189	.1	.3

Profile Output Table - Standard Table 1
HEC-RAS Plan: Plan 17 River: Ublutuoch River Reach: 13.7 - 1.9

Rivers   = 1
Hydraulic Reaches = 1
River Stations   = 38
Plans   = 1
Profiles   = 1

Reach	River Sta	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)
13.7 - 1.9	14.10	7933.00	11.51	21.66		21.73	0.000237	3.24
13.7 - 1.9	13.795*	7933.00	10.98	21.30		21.38	0.000259	3.43
13.7 - 1.9	13.49*	7933.00	10.45	20.90		21.00	0.000285	3.73
13.7 - 1.9	13.185*	7933.00	9.92	20.61		20.73	0.000282	3.90
13.7 - 1.9	12.88*	7933.00	9.40	20.33		20.46	0.000275	4.04
13.7 - 1.9	12.6766*	7933.00	9.05	20.03		20.18	0.000297	4.21
13.7 - 1.9	12.4733*	7933.00	8.70	19.72		19.88	0.000295	4.36
13.7 - 1.9	12.27*	7933.00	8.35	19.40		19.58	0.000319	4.52
13.7 - 1.9	11.965*	7933.00	7.82	18.95		19.16	0.000327	4.77
13.7 - 1.9	11.66*	7933.00	7.29	18.52		18.75	0.000315	4.88
13.7 - 1.9	11.355*	7933.00	6.76	18.04		18.31	0.000327	5.18
13.7 - 1.9	11.05*	7933.00	6.24	17.56		17.85	0.000346	5.33
13.7 - 1.9	10.745*	7933.00	5.71	17.00		17.33	0.000379	5.54
13.7 - 1.9	10.44*	7933.00	5.18	16.40		16.77	0.000391	5.82
13.7 - 1.9	10.135*	7933.00	4.65	15.84		16.25	0.000382	5.99
13.7 - 1.9	9.83*	7933.00	4.13	15.32		15.75	0.000362	6.09
13.7 - 1.9	9.525*	7933.00	3.60	14.89		15.30	0.000314	5.99
13.7 - 1.9	9.22*	7933.00	3.07	14.53		14.90	0.000285	5.75
13.7 - 1.9	8.915*	7933.00	2.55	14.20		14.54	0.000233	5.54
13.7 - 1.9	8.61*	7933.00	2.02	13.95		14.25	0.000182	5.26
13.7 - 1.9	8.305*	7933.00	1.49	13.80		14.04	0.000147	4.82
13.7 - 1.9	8.0	8600.00	0.96	13.63		13.87	0.000131	4.92
13.7 - 1.9	7.45*	8600.00	1.03	13.25		13.52	0.000256	4.71
13.7 - 1.9	6.9	8660.00	1.10	12.74		12.92	0.000338	3.98
13.7 - 1.9	6.80	8660.00	1.09	12.53		12.71	0.000430	4.22
13.7 - 1.9	6.3*	8660.00	1.08	11.63		11.77	0.000323	3.69
13.7 - 1.9	5.8*	8660.00	1.08	11.09		11.19	0.000235	3.17
13.7 - 1.9	5.3*	8660.00	1.07	10.68		10.75	0.000158	2.63
13.7 - 1.9	4.8	8931.00	1.06	10.49		10.53	0.000098	2.14
13.7 - 1.9	4.4625*	8931.00	1.05	10.32		10.38	0.000125	2.46
13.7 - 1.9	4.125*	8931.00	1.05	10.11		10.20	0.000164	2.78
13.7 - 1.9	3.7875*	8931.00	1.04	9.83		9.96	0.000195	3.08
13.7 - 1.9	3.45*	8931.00	1.03	9.54		9.68	0.000206	3.21
13.7 - 1.9	3.1125*	8931.00	1.02	9.23		9.38	0.000220	3.24
13.7 - 1.9	2.775*	8931.00	1.02	8.95		9.07	0.000190	3.05
13.7 - 1.9	2.4375*	8931.00	1.01	8.81		8.89	0.000132	2.61
13.7 - 1.9	2.10	9109.00	1.01	8.74		8.78	0.000092	2.16
13.7 - 1.9	1.80	9109.00	1.00	8.66	4.43	8.68	0.000067	1.85

APPENDIX D – Sediment Sampling Laboratory Reports

ALASKA TESTLAB
A Division of DOWL LLC

July 28, 2003
W.O. A30341

Mr. Mike Cox
Michael Baker Jr., Inc.
4601 Business Park Boulevard., Suite 42
Anchorage, Alaska 99503

Subject: Ublutuoch River Mile 6.8

Dear Mr. Cox:

Alaska Testlab has completed the testing on the four samples that you delivered to us. We tested the samples to determine the Total Suspended Solid (TSS) content. The testing was performed according to the procedure that you provided. The results are provided in the table below.

Project Name	Date	Station	Total Suspended Solids (TSS)
Ublutuoch River Mile 6.8	6/9/2003	185+00	5.1 milligrams per Liter
Ublutuoch River Mile 6.8	6/9/2003	214+00	8.1 milligrams per Liter
Ublutuoch River Mile 6.8	6/9/2003	237+00	2.6 milligrams per Liter
Ublutuoch River Mile 6.8	6/9/2003	252+00	6.0 milligrams per Liter
Ublutuoch River Mile 6.8	6/9/2003	277+00	8.5 milligrams per Liter

All test results will be posted to the ATL website for your access. If you have any questions regarding this report of if we can be of further service please call.

Sincerely,
Alaska Testlab

Reviewed by:

Chris Christensen EIT
Engineer

David L. Andersen P.E.
Engineer

A30341.Cox.GSC.072803.seh

ALASKA TESTLAB
A Division of DOWL LLC

Client: Michael Baker Jr., Inc.

Project: Ublutuoch River Mile 6.8

PARTICLE-SIZE DIST. ASTM D422

W.O. A30341

Lab No. 1651

Received: 7/31/03

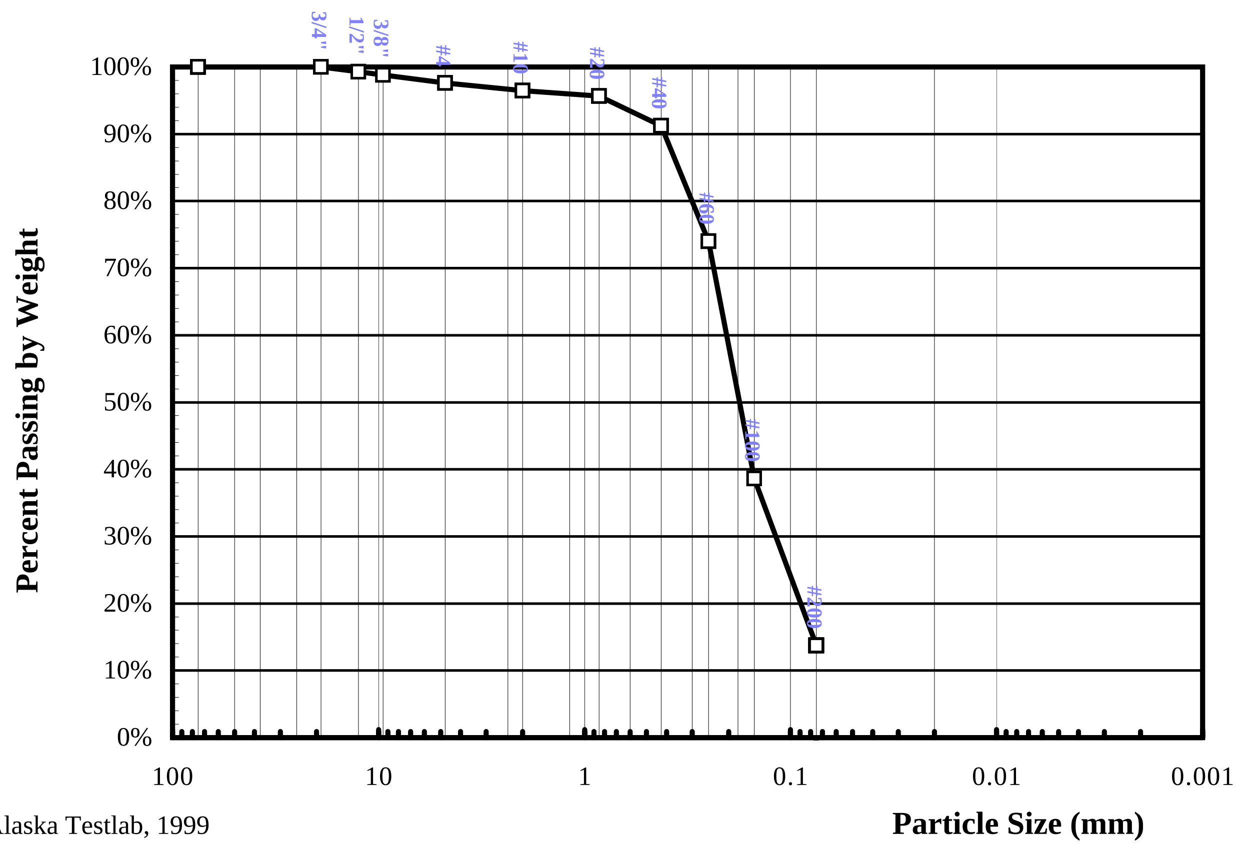
Reported: 8/5/03

Location: Native Material

Composite Sample

Engineering Classification: Silty SAND , SM

Frost Classification: Not Measured



SIZE	PASSING	SPECIFICATION
+3 in Not Included in Test = ~0%		
3"		
2"		
1 1/2"		
1"		
3/4"	100%	
1/2"	99%	
3/8"	99%	
No. 4	98%	
Total Wt. = 998g		
No. 8		
No. 10	96%	
No. 16		
No. 20	96%	
No. 30		
No. 40	91%	
No. 50		
No. 60	74%	
No. 80		
No. 100	39%	
No. 200	14%	
Total Wt. of Fine Fraction = 487.4g		
0.02 mm		

David L Andersen
David L. Andersen, P.E., General Manager

ATTACHMENT 1 – Spring 2003 Hydraulic Assessment and Notes on Design Considerations for Roads and Bridges

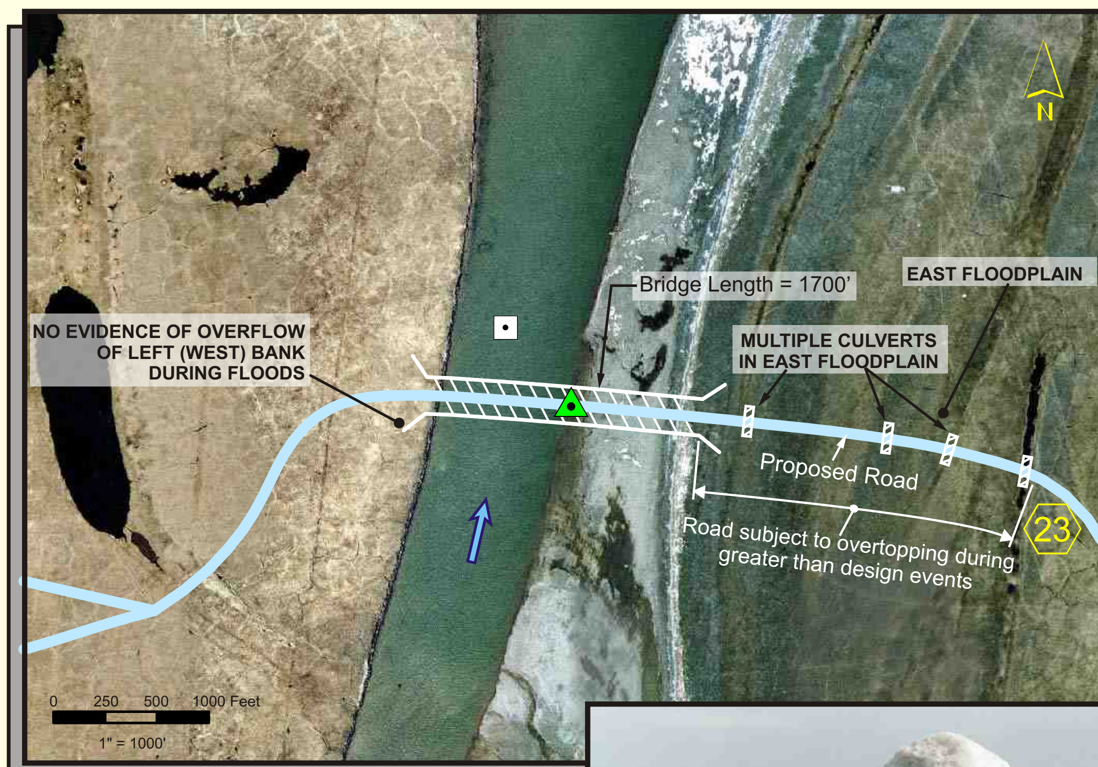
Baker

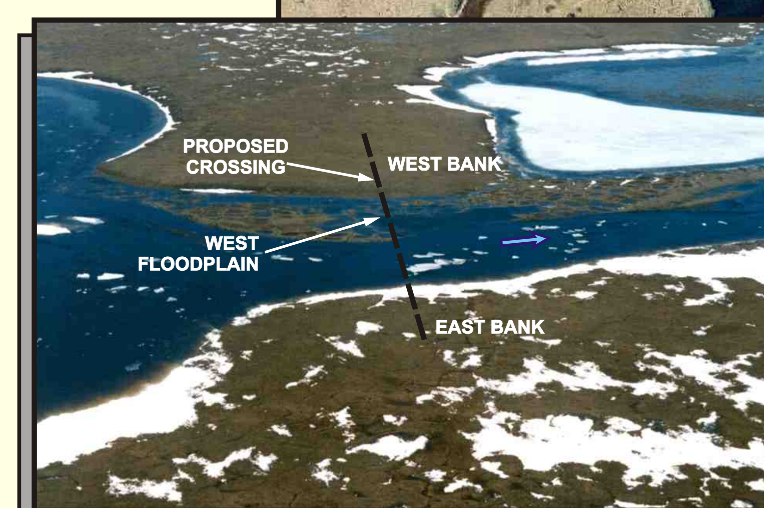
ConocoPhillips

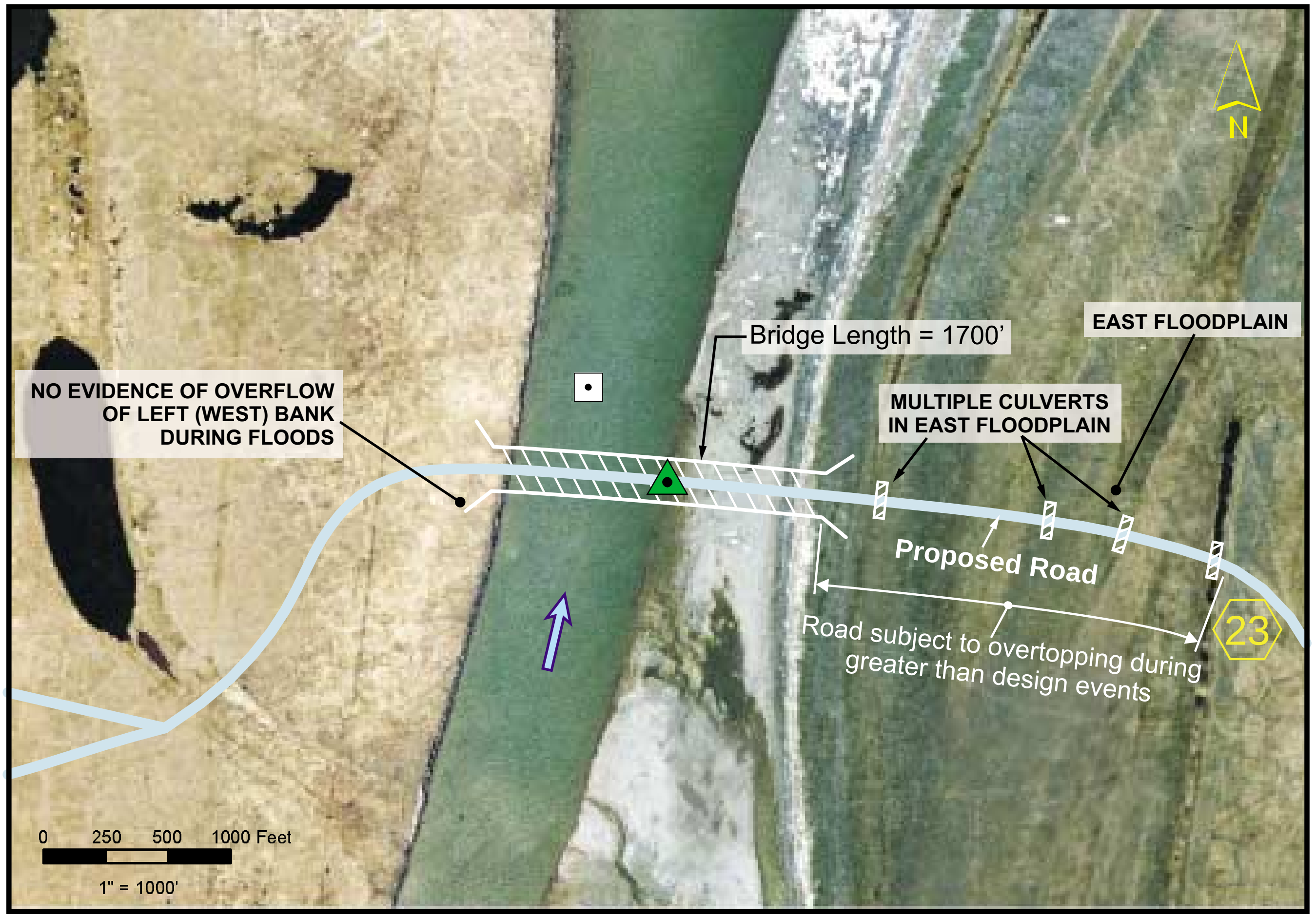
ALPINE SATELLITE DEVELOPMENT PLAN
SPRING 2003
HYDRAULIC ASSESSMENT AND NOTES ON DESIGN CONSIDERATIONS FOR ROAD BRIDGES

Hydroconsult

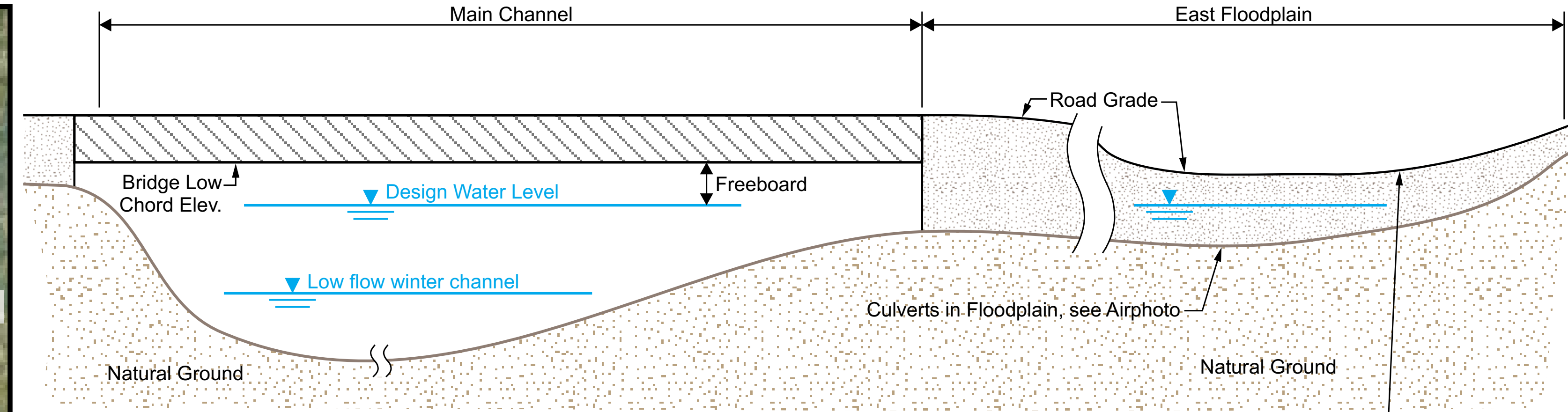
LIST OF FIGURES





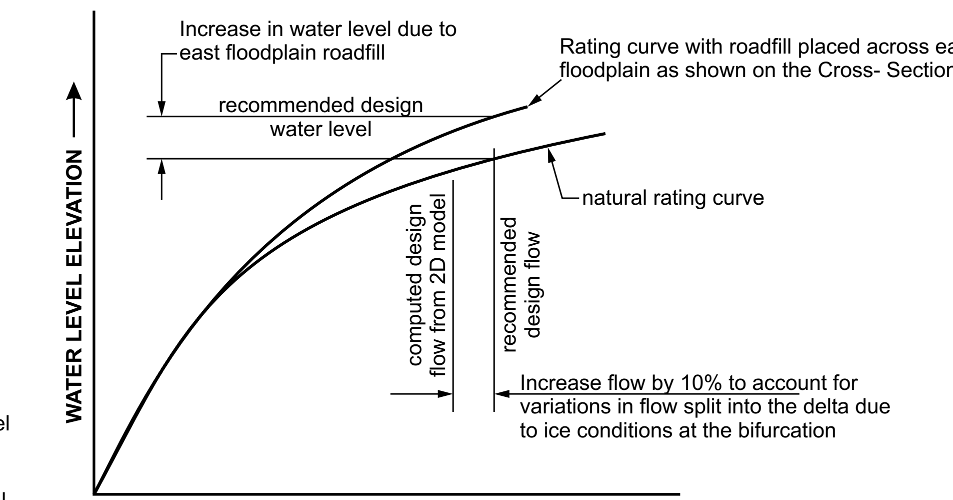


2. Local Scale



CROSSING CROSS-SECTION
N.T.S.

FLOODPLAIN ROAD GRADE:
1. Higher than the Design Water Level thus not a "designed" overflow.
2. Lower than the bridge's Low Chord Elevation - to provide an emergency overflow for extreme flow/ice events.



RATING CURVE

1.0 SCOPE OF HYDROCONSULT'S ASSESSMENT

1.1 A general assessment of river engineering considerations and factors in the preliminary design of a proposed bridge crossing as based on Wim Veldman's site evaluation June 3 to 5, 2003 and his long term experience on the North Slope of Alaska, which included field assessments on the Colville River in June 2001.

1.2 **It should be stressed that site-specific multi-year observations are essential in order to fully describe design considerations and prepare conceptual design recommendations.**

2.0 CONSIDERATIONS

2.1 Water Level

2.1.1 Maximum water level likely generated by a rapid breakup with the winter ice cover still in place. That is a pre-peak flow over the ice.

2.1.2 Ice Jam or Ice Cover at the Main Channel/Nigliq Channel Bifurcation could alter the flow split computed in the 2D model. For example a jam/ice cover primarily on the East Channel Colville River could divert perhaps an extra 10-15% flow into the Nigliq Channel. This is an important consideration if the pre-peak flow over the ice (Sec. 2.1.1) is the critical factor establishing the peak water level.

2.1.3 Main flow channel presently is along the west bank and is unlikely to change in the foreseeable future. The flow over the east floodplain at the crossing is a function of:
- the elevation of the "ridge" between the main channel and the floodplain (Photo 3, Figure 2).
- a small depression at the upstream end of the east floodplain (Photo 3, Figure 2).

2.1.4 The magnitude of the flow in the east floodplain is therefore likely not a direct function of the cross sectional area of the floodplain at the crossing. This is an important consideration in establishing the need for and elevation of road overflow section in the east floodplain.

Airphoto and road alignment on the airphoto as per Baker.

2.2 Ice

2.2.1 Ice at the crossing consists of the winter ice, its extent as per the low flow channel width shown on the airphotos, and ice transported into the crossing area from upstream.

2.2.2 Velocities in this lower part of the delta probably not sufficient to move the original winter ice (at least not as observed by Wim Veldman June 3 to 5, 2003 although other years may be different) until it is highly deteriorated. Ice from the East Channel Colville River certainly deteriorated by the time it moves to this location (see photos on Figure 3).

2.2.3 Thus ice movement at the crossing, re: the ice design forces on the piers, expected to be consistent with moderate to low ice strengths.

2.2.4 The volume of ice from the Colville River that passes through the proposed crossing could vary from year to year due to varying ice jam/cover conditions at the bifurcation of the Colville River and Nigliq Channel (Photos 2 & 3, Figure 3).

3.0 CONCEPTUAL DESIGN RECOMMENDATIONS

3.1 Water Level due to Ice - From historic measurements, determine maximum water level and flow with ice in place at the crossing and/or arriving from upstream. Determine impact on water level if the flow is increased by 10% due to ice conditions at the Colville River/Nigliq Channel Bifurcation. (Figure 3).

3.2 Need for East Floodplain Overflow - From the 2D model, determine the flow approaching the road fill across the east floodplain. Assess using 3-4 sections between the upstream end of the floodplain (Photo 3, Figure 2) and the road alignment. Compute natural water level and "no east floodplain overflow water level" to determine the sensitivity of water level to the flow in the east floodplain. From this, assess need for an east floodplain overflow.

3.3 East Floodplain Overflow Design Options - The overflow could be designed as a critical component of the crossing, like the east side of the Kuparuk River crossing, or it could be simply a prudent design approach for a "what if" flow scenario. For the latter, its elevation could be set midway between the design water level and the low chord elevation of the bridge to provide an "escape" or "safety valve" to the bridge in the event of unforeseen flow or ice conditions (see cross-section).

3.4 Ice - Design ice forces expected to be consistent with moderate to weakened, candled ice, ie. use forces at the moderate to low end of the Building Code. Sloping pier noses or separate sloping piles are effective in reducing ice forces.

3.5 Bridge Length and Abutment Design - Minor erosion anticipated at the left (west bank). A "non-main channel designed" abutment should be setback about 100 feet. If designed for main channel flow conditions, could be closer. Bridge should span to the vegetated east floodplain plus a setback of 50-100 feet on that side.

3.6 Pier Scour - Primarily dependent on size and shape of the pier. Compute upon finalization of the pier design.

Hydroconsult

Baker

ConocoPhillips

NO.	DATE	REVISION	BY
2	Dec. 2/03	Finalized following Baker's review	WMV
1	Oct. 24/03	Added Cross-section and Rating Curve	WMV

DRAWN Gary Evenson
DESIGN Wim Veldman
APP Wim Veldman
SCALE As shown
DATE 03/10/08

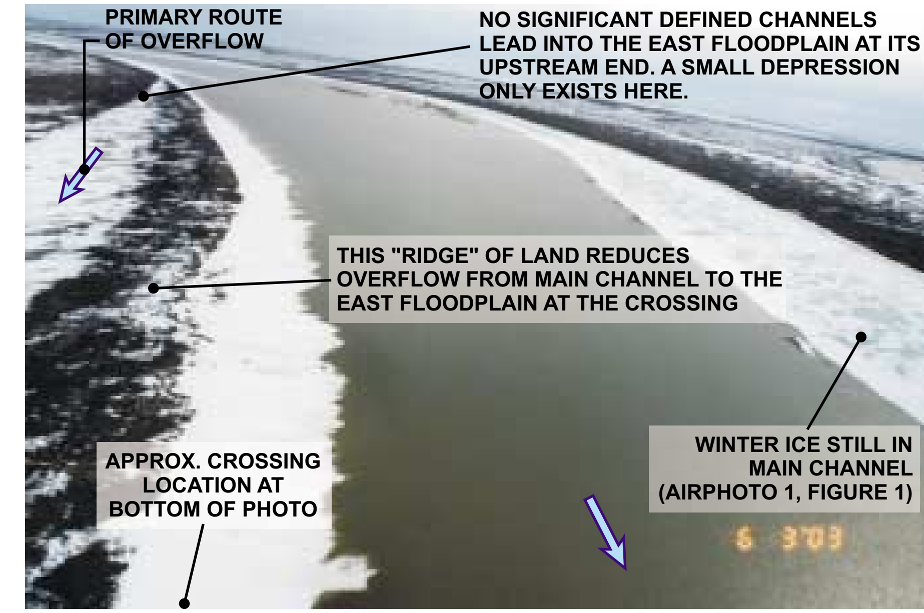
ALPINE SATELLITE DEVELOPMENT PLAN

NIGLIQ CHANNEL AIRPHOTOS AND ASSESSMENT

FILE (CDR) 782-03-07-18-A1
JOB NO. 782
FIGURE 1

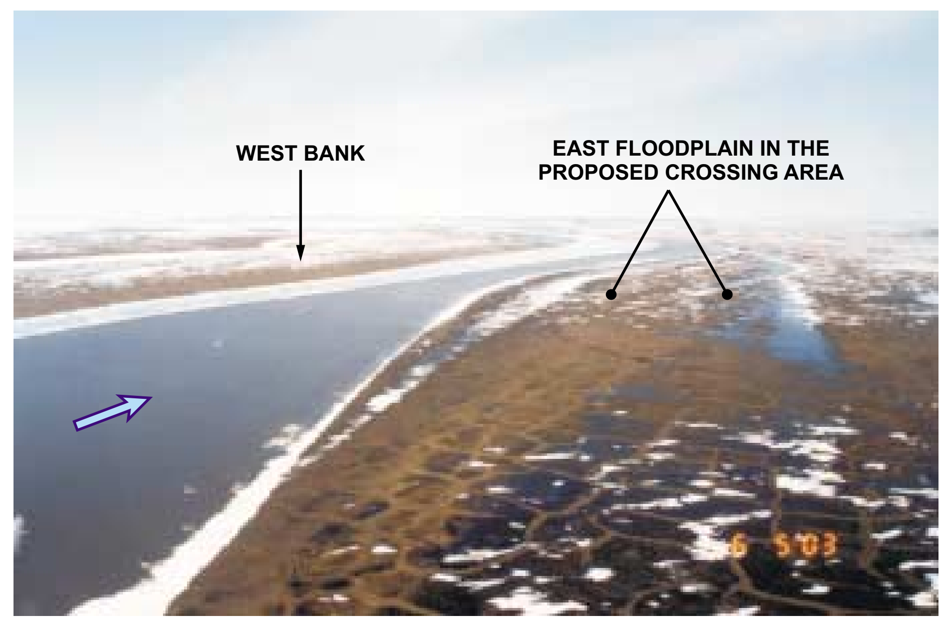
1.

2. Close up of east floodplain.

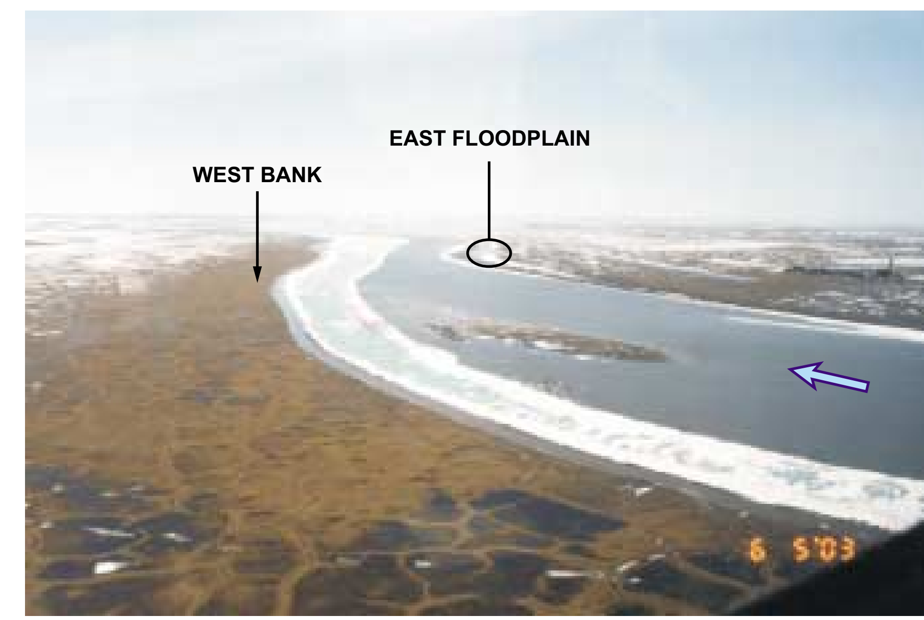


3.

4.



5.



6. Extent of winter ice is indicative of main low flow channel as shown in Airphoto Figure 1.

The magnitude of flow across the east floodplain at the crossing is a function of the floodplain's hydraulic characteristics upstream (Photo 3) and not the cross-sectional area of the floodplain at the crossing.

Photos by Wim Veldman, Hydroconsult, June 3 & 5, 2003.

Hydroconsult

Baker

ConocoPhillips

NO.	DATE	REVISION	BY
2	Dec. 2/03	Finalized following Baker's review	WMV
1	Oct. 24/03	Minor edits	WMV

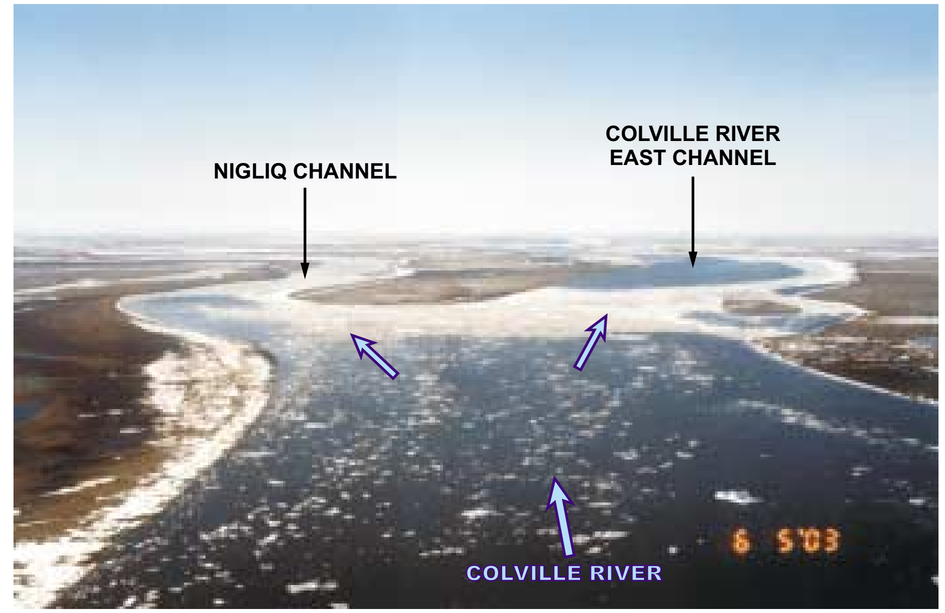
DRAWN	Gary Evenson
DESIGN	Wim Veldman
APP	Wim Veldman
SCALE	As shown
DATE	03/10/08

ALPINE SATELLITE DEVELOPMENT PLAN

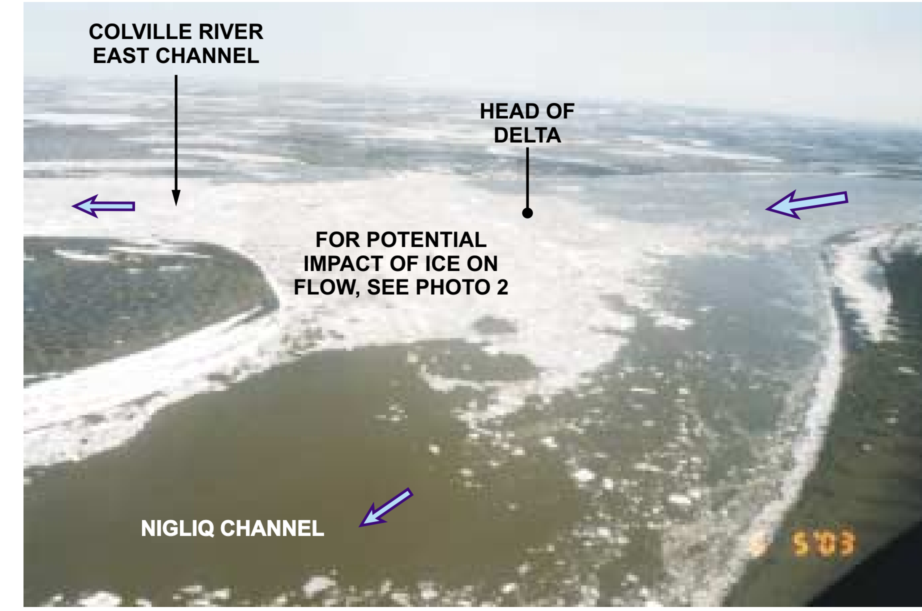
NIGLIQ CHANNEL SITE PHOTOS

FILE (CDR)	JOB NO.	
782-03-07-18-A1	782	FIGURE 2

1. Ice jam in vicinity of Ocean Point. Floes vary from small pieces to ones 0.33-0.5 the width of the river. This jam, due likely to the narrower river section downstream, was in place for less than 1 day.



2. Depending on ice cover/jam conditions at the head of the delta, the flow split into the East and Nigliq channels can be affected and be different than that modeled for open water conditions.



3. Ice from the East Channel moving into the Nigliq Channel is deteriorated into relatively small pieces, compared to the size of ice floes in Photo 1.

4. Ice is "candled" indicating significant deterioration from strong ice conditions which exist at the beginning of breakup.

5. Ice shove on banks of main channel of Colville River near Ocean Point.

Ice conditions in Photos 5 and 6, taken upstream in the Colville River main channel, may not be representative of potential ice in the Nigliq Channel. Ice strengths would generally be lower in the Nigliq Channel than in the Colville River upstream of the delta although, depending on the rate and timing of breakup, ice strengths can be variable from year to year.

6. Ice shove on the west bank of the Colville River near Ocean Point. Banks in this area, particularly on the outside of bends, generally have a relatively uniform 2H:1V to 3H:1V slope indicative of ice shove.

Photos by Wim Veldman, Hydroconsult, June 3 - 5, 2003.

Hydroconsult

Baker

ConocoPhillips

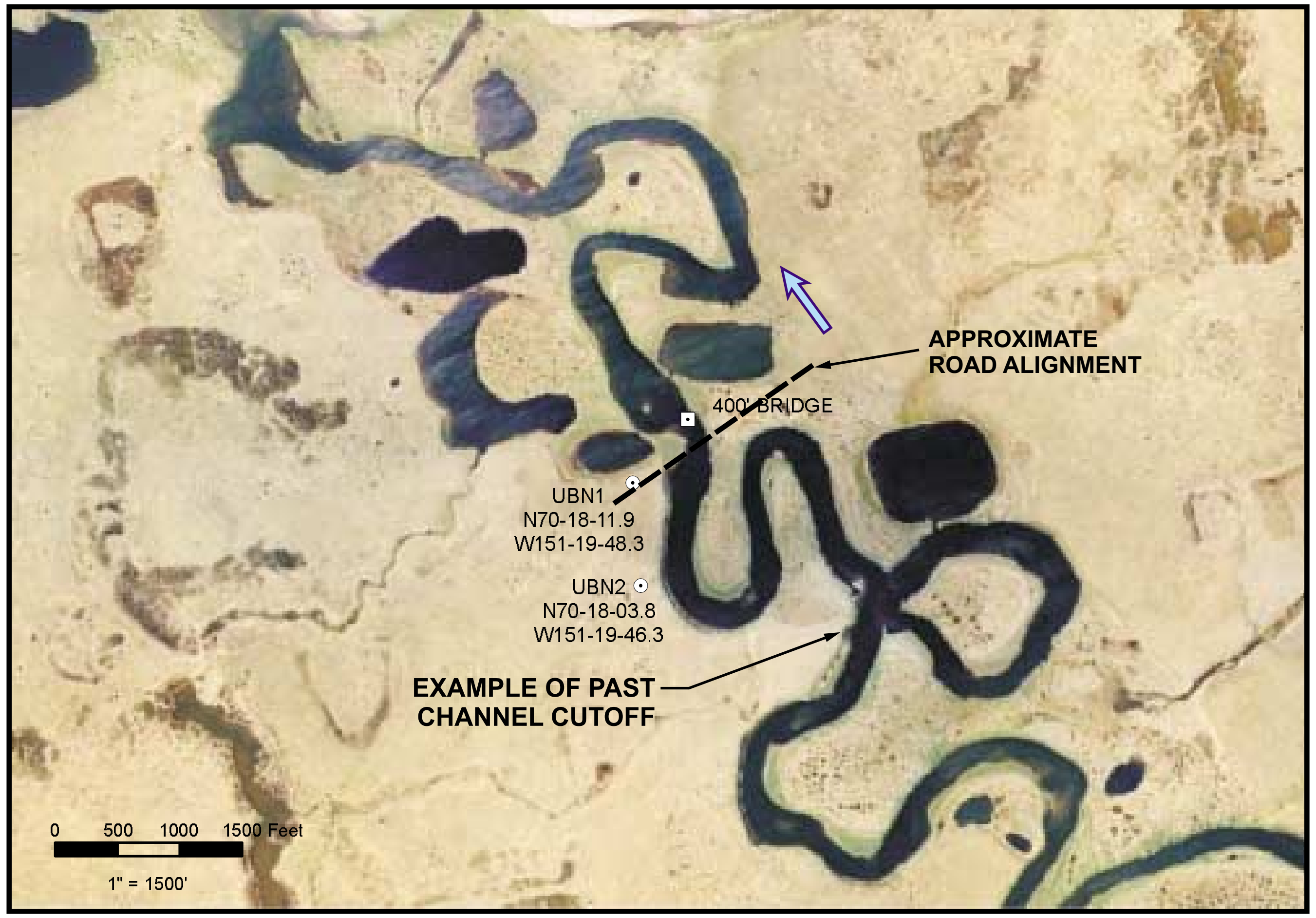
NO.	DATE	REVISION	BY
2	Dec. 2/03	Finalized following Baker's review	WMV
1	Oct. 24/03	Minor edits	WMV

DRAWN Gary Evenson
DESIGN Wim Veldman
APP Wim Veldman
SCALE As shown
DATE 03/10/08

ALPINE SATELLITE DEVELOPMENT PLAN

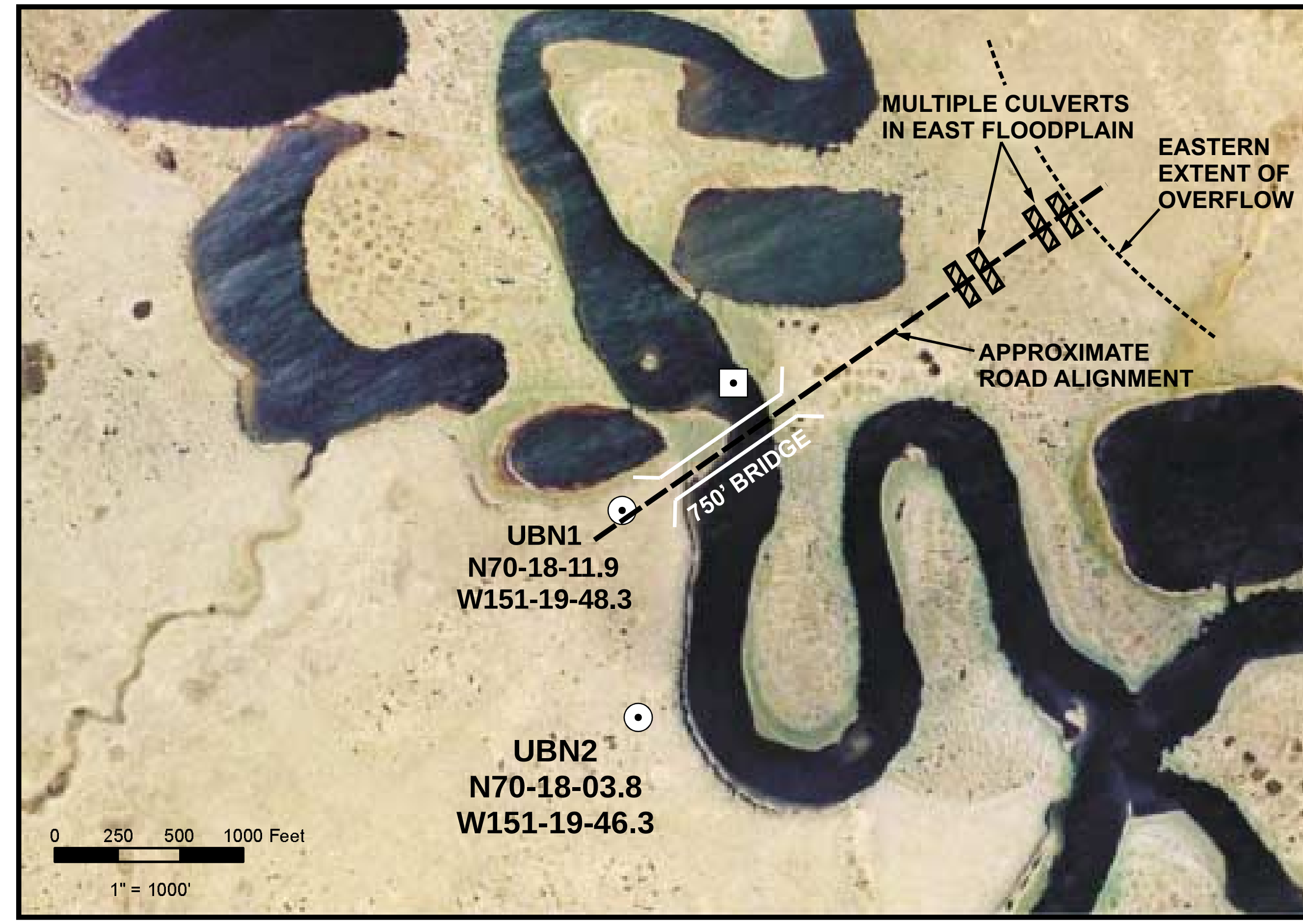
NIGLIQ CHANNEL
SITE PHOTOS OF ICE IN DELTA

FILE (CDR) 782-03-07-18-A1 | JOB NO. 782 | **FIGURE 3**



1. Large Scale

N



2. Local Scale

1.0 SCOPE OF HYDROCONSULT'S ASSESSMENT

1.1 A general assessment of river engineering considerations and factors in the preliminary design of a bridge crossing. Based on Wim Veldman's site evaluation June 3 - 5, 2003, his long term experience on the North Slope of Alaska and Baker's field photos.

2.0 CONSIDERATIONS

2.1 Water Level

2.1.1 A slow-moving relatively wide channel. The low flow winter channel, which determines the extent and location of the ice cover, is almost the same as the normal bank-to-bank width of the channel .

2.1.2 No west bank floodplain. The east bank area is fully inundated, see photos on Figure 6.

2.1.3 Maximum water level likely corresponds to the late breakup flow with the winter ice cover still in place, see Figure 6 photos. As per Baker's observations, peak flow in the last several years has occurred with the ice still in place.

2.2 Ice

2.2.1 See photos on Figure 5 and 6.

3.0 RECOMMENDATIONS FOR PRELIMINARY DESIGN

3.1 Design Water Level - Extrapolate the flow measurement vs. water level up to the design flow assuming the winter ice is still in place. This assumes the design flow occurs during breakup with the ice in place - confirm this from other similar sized existing crossings in the Colville River and Kuparuk areas.

3.2 Criticality of Design Water Level - The road profile approaching the crossing from the west bank, typically 3-5 feet of granular fill over the natural ground, will likely govern the bridge deck and thus the bridge's low chord elevation. Consequently the low chord level could be above the top of the west bank height (Photos 5 & 6, Figure 5) and thus well above the design water level. If this is the case, the precise computed flow and water level may not need to be refined.

3.3 Ice - Design values, thickness, strength and size as observed in the field. Ice movement is limited due to low velocities. Ice jams are not expected at this location under high flow conditions, see notes on Figure 6. Ice strengths expected to be low - significant deterioration has occurred by the time the ground-fast ice lifts and the peak flow, based on several years of measurements, has passed by the time the ice lifts.

3.4 Bridge Length - As necessary to span from top of west bank to the east floodplain, about 750 feet, plus multiple culverts in the east floodplain. If abutments are not designed for main channel scour, due to bank erosion or thermal degradation (natural or construction induced), locate about 50 feet back from the top of the bank. A sheet-pile cellular abutment designed for the flow could likely be located partially in the channel.

Airphoto, road alignments and bridge notations on the airphotos as per Baker.

Hydroconsult

Baker

ConocoPhillips

NO.	DATE	REVISION	BY
1	Dec. 5/03	Finalized following Baker's review	WMV

DRAWN Gary Evenson
DESIGN Wim Veldman
APP Wim Veldman
SCALE As shown
DATE 03/10/08

ALPINE SATELLITE DEVELOPMENT PLAN

UBLUTUOCH RIVER, MP 1.9
AIRPHOTOS AND ASSESSMENT

FILE (CDR) 782-03-07-18-A1
JOB NO. 782
FIGURE 4

1. Long range view illustrating the sharp meander bends.

2.

3. Width of ice is indicative of the width and location of the winter low flow channel. At the crossing, maximum velocities and bank erosion potential expected to occur along the right (east) bank.

4.

5. Looking upstream along the left (west) bank.

6. Looking downstream towards the crossing along the left (west) bank.

1. Photos by Wim Veldman, Hydroconsult, June 4 & 5, 2003.
2. Bridge location shown is approximate.

Hydroconsult

Baker

ConocoPhillips

NO.	DATE	REVISION	BY
1	Dec. 2/03	Finalized following Baker's review	WMV

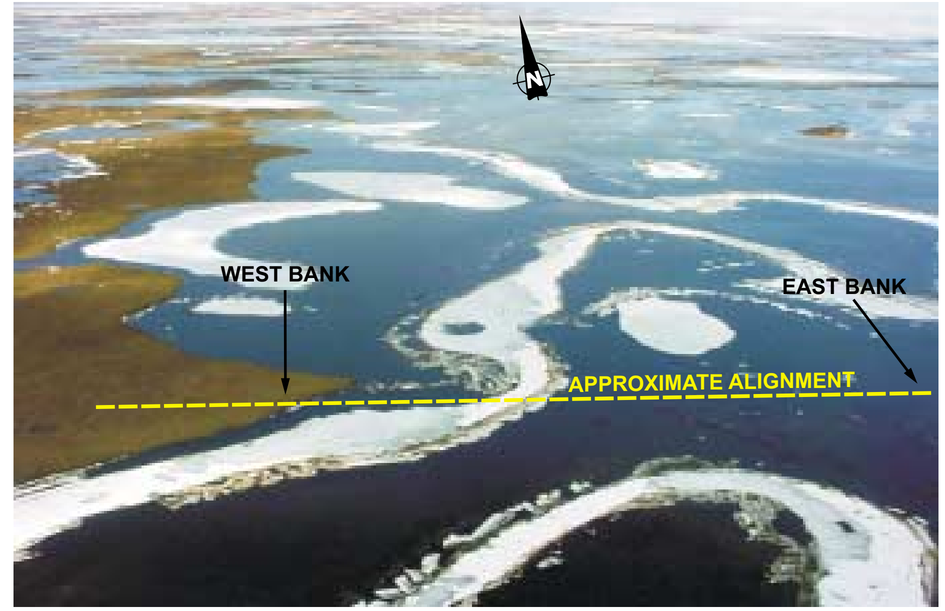
DRAWN Gary Evenson
DESIGN Wim Veldman
APP Wim Veldman
SCALE As shown
DATE 03/10/08

ALPINE SATELLITE DEVELOPMENT PLAN

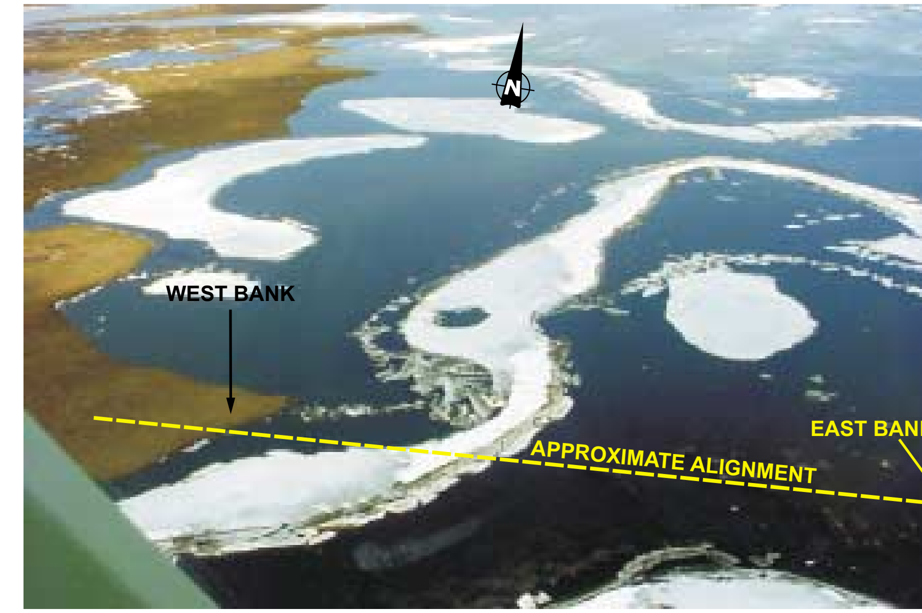
UBLUTUOCH RIVER, MP 1.9
SITE PHOTOS
JUNE 4 - 5, 2003

FILE (CDR) 782-03-07-18-A1 | JOB NO. 782 | **FIGURE 5**

1. Water level increase and/or deterioration of the ice sufficient to lift the winter ice which was likely ground-fast in some areas. Velocities are relatively low in the main channel thus ice movement is very limited. Floodplain depths and velocities are expected to be even lower as evidenced by the lack of ice movement across the floodplains. The wide east floodplain offers an "escape route" in the event of an ice jam, therefore the likelihood and magnitude of ice jams will be low at this crossing.



2. The west bank appears to have experienced little inundation in the past - no evidence of overflow. Considering the minimum thickness of roadfill on the crossing (3' - 5' depending on utilization of insulation), the resulting minimum bridge grade is expected to be well above the anticipated design water level.



3. If a bridge crossing was contemplated at this location, the flow across the wide inundated east floodplain could be estimated from the cross-sectional area and water level slope to determine the need for and size of additional openings across the east floodplain embankment. As a minimum, some culverts would be required to drain the inundated areas after passage of the floodplain (see Figure 4).

Photos by Baker staff, June 8, 2003

Hydroconsult

Baker

ConocoPhillips

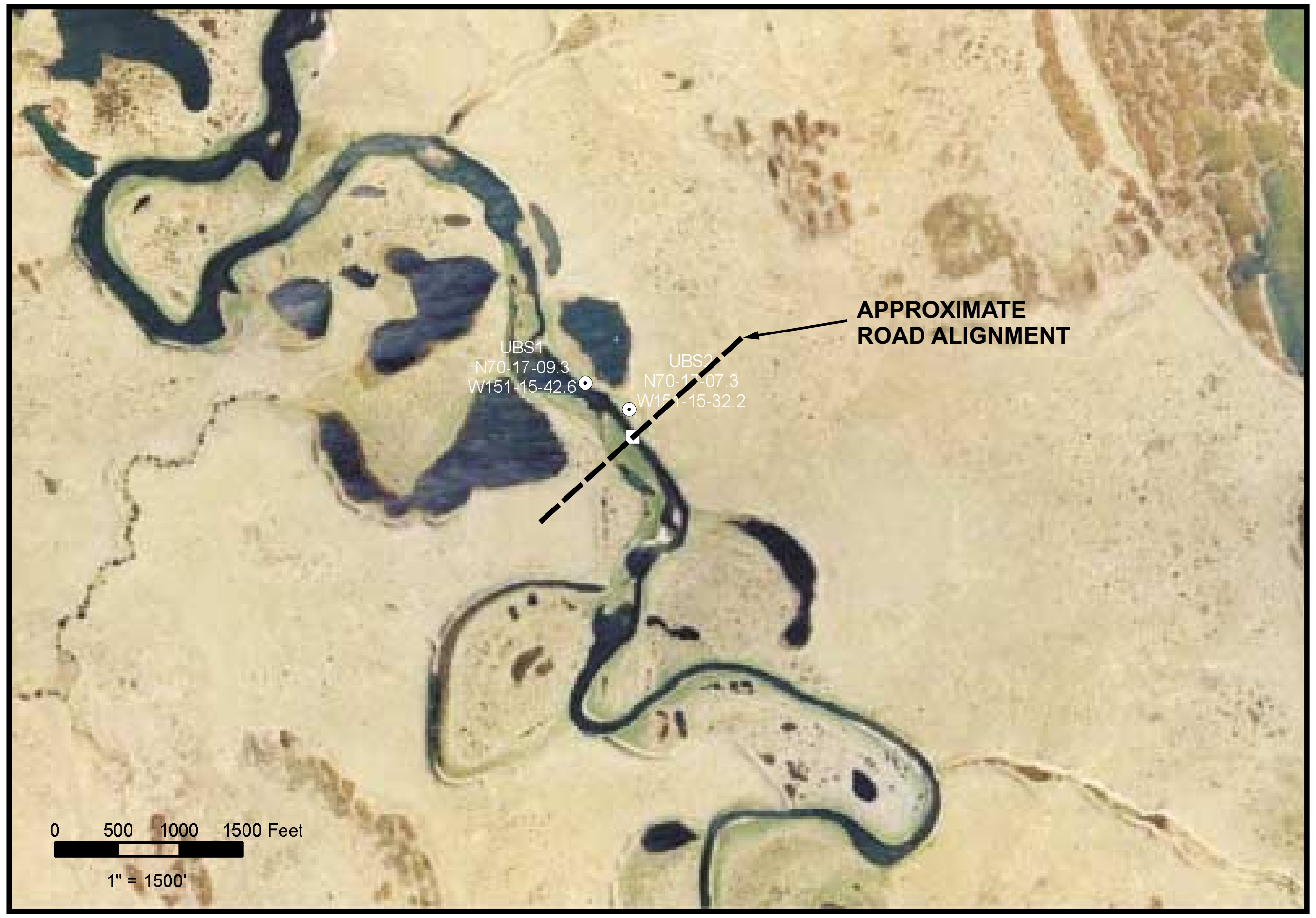
NO.	DATE	REVISION	BY
1	Dec. 2/03	Finalized following Baker's review	WMV

DRAWN Gary Evenson
DESIGN Wim Veldman
APP Wim Veldman
SCALE As shown
DATE 03/10/24

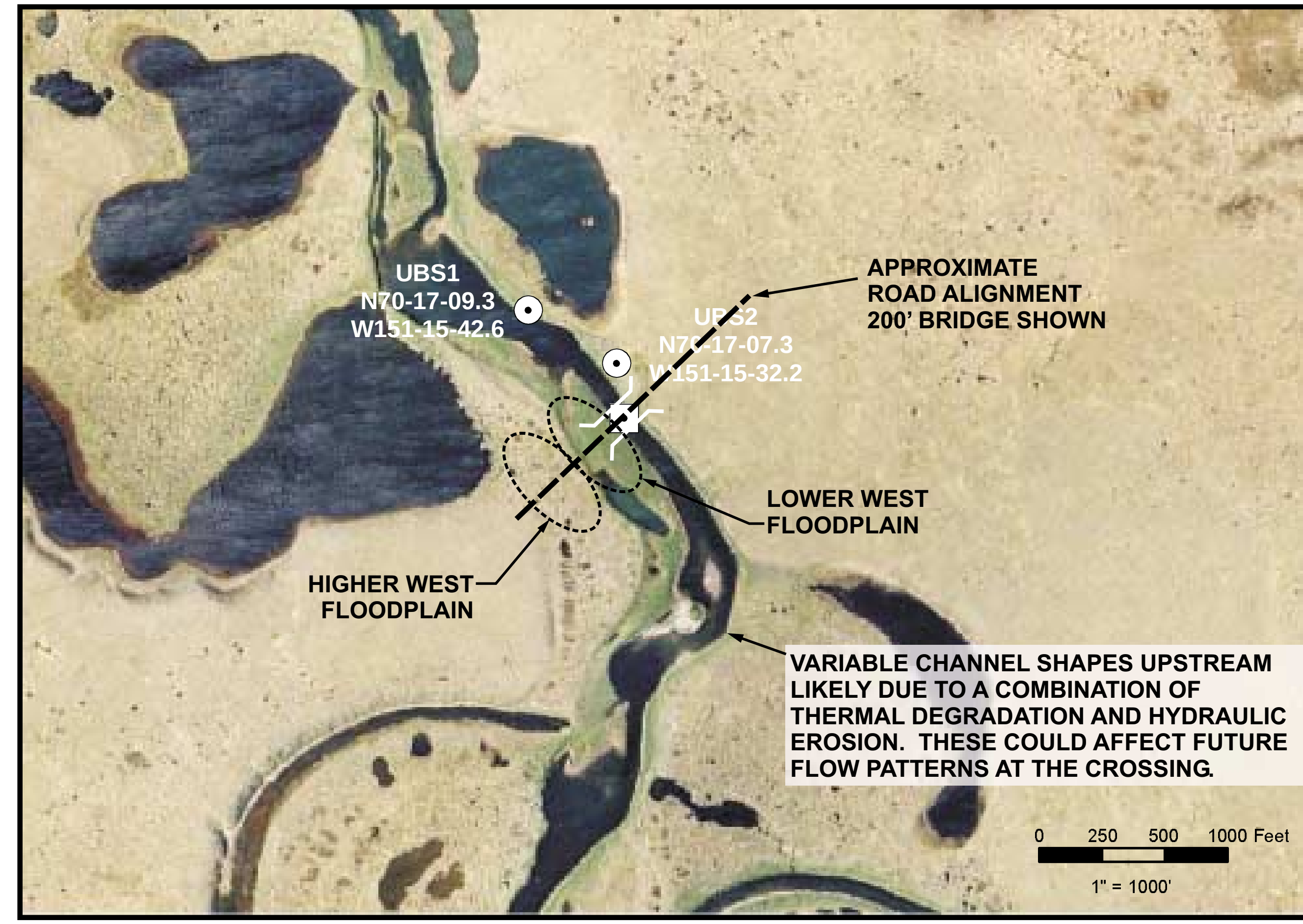
ALPINE SATELLITE DEVELOPMENT PLAN

UBLUTUOCH RIVER, MP 1.9
SITE PHOTOS
JUNE 8, 2003

FILE (CDR) 782-03-07-18-A1 JOB NO. 782 **FIGURE 6**



1. Overall Airphoto.



2. Local Airphoto.

1.0 SCOPE OF HYDROCONSULT'S ASSESSMENT

1.1 A general assessment of river engineering considerations and factors in the preliminary design of a bridge crossing. Based on Wim Veldman's site evaluation June 3 - 5, 2003, his long term experience on the North Slope of Alaska and Baker's field photos.

2.0 CONSIDERATIONS

2.1 Water Level

2.1.1 Initial breakup flow is over the ground-fast ice. From other experience on the North Slope, flow over ground-fast ice usually occurs for 3 - 5 days before the ice deteriorates sufficiently and lifts. With a relatively small watershed and a rapid breakup as occurred in 2003, peak flow can occur with the ice still in place. Thus the computed design discharge with the winter ice still in place will likely govern the design water level.

2.1.2 The lower west floodplain is fully inundated and provides considerable conveyance for high flows. Spanning this floodplain with the bridge will thus likely be necessary to avoid excessive backwater and velocities at the crossing. The higher west floodplain conveys relatively little flow.

2.2 Ice

2.2.1 Ice conditions at different stages of the breakup are as illustrated on the site photos, Figures 8 and 9. At the latter stages of breakup, some ice flows occur primarily in the main east channel.

2.2.2 Significant ice jamming, a design consideration for the piles, abutment and height of the bridge, is not anticipated as the lower west floodplain, if spanned, in part or in whole by the bridge structure, will provide an "escape flow route" if an ice jam occurs.

3.0 RECOMMENDATIONS FOR PRELIMINARY DESIGN

3.1 Bridge Length - The total width of the east main channel and the entire west floodplain is about 450 feet whereas the main channel is only about 100 feet wide. The higher west floodplain, although inundated during high flow conditions, does not carry a significant percentage of the total flow due to its elevation, especially upstream from the proposed crossing, and the orientation of flow approaching the crossing - the flow and main are deflected to the east bank.

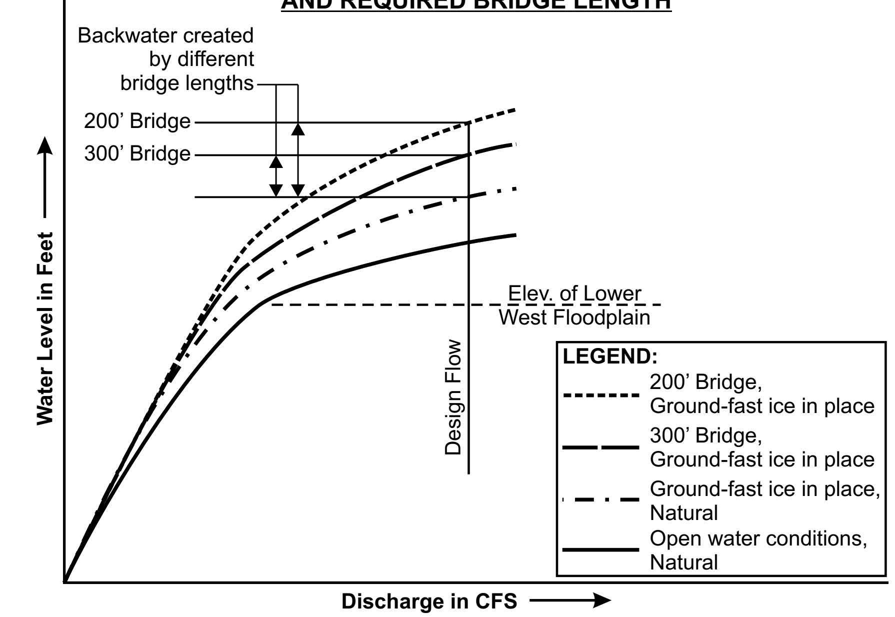
Thus spanning the entire west floodplain is not deemed necessary at this time. Detailed hydraulic analysis will be required to assess backwater conditions for various bridge lengths in order to refine the 200 foot long bridge as shown on the airphoto.

3.2 Design Water Level - As per the computed design flow with the ground-fast ice in place in the main east channel. Use field - measured relationships between flow and water level to calibrate the calculations. Compute different rating curves (see example) to establish the design water level.

3.3 Criticality of Design Water Level re: the Elevation of the Bridge - Depends primarily on the height of the east bank and thickness of road gravel used approaching the bridge. With 3 - 5 feet of gravel, depending on whether insulation is used, the resulting bridge elevation could provide more than adequate clearance. If this is the case, detailed refinement of the design water level is not necessary. If this is not the case, refinement of the design flood and water levels (including impact of ice), is important.

3.4 Ice - Design values, thickness, strength and size as observed in the field. Ice strengths expected to be moderate to low - significant deterioration has occurred by the time the ground-fast ice lifts.

HYDRAULIC EVALUATION TO DETERMINE DESIGN WATER LEVEL AND REQUIRED BRIDGE LENGTH



Airphoto and road alignments as per Baker.

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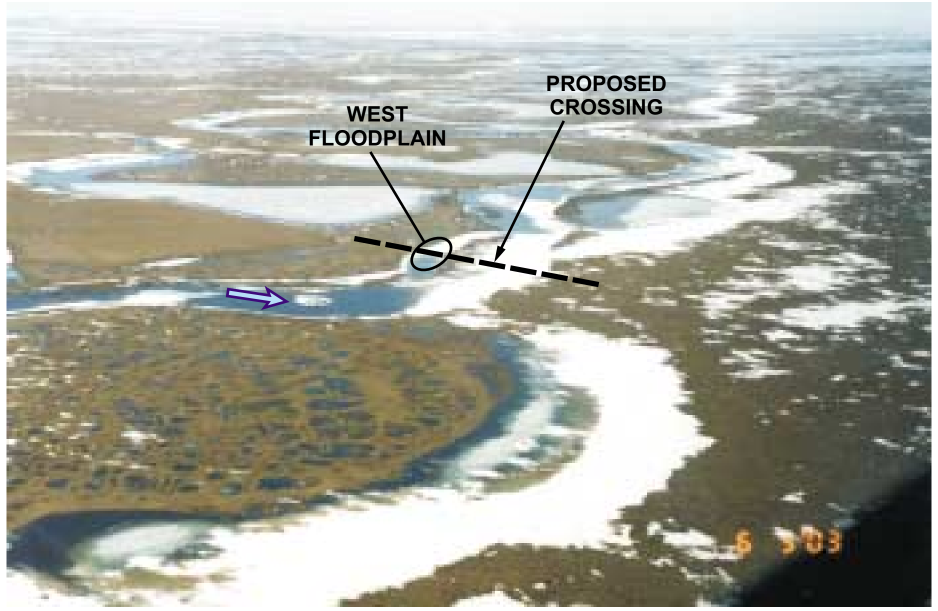
NO.	DATE	REVISION	BY
1	Dec. 2/03	Finalized following Baker's review	WMV

DRAWN: Gary Evenson
DESIGN: Wim Veldman
APP: Wim Veldman
SCALE: As shown
DATE: 03/10/08

ALPINE SATELLITE DEVELOPMENT PLAN

UBLUTUOCH RIVER, MP 6.8
AIRPHOTOS AND ASSESSMENT

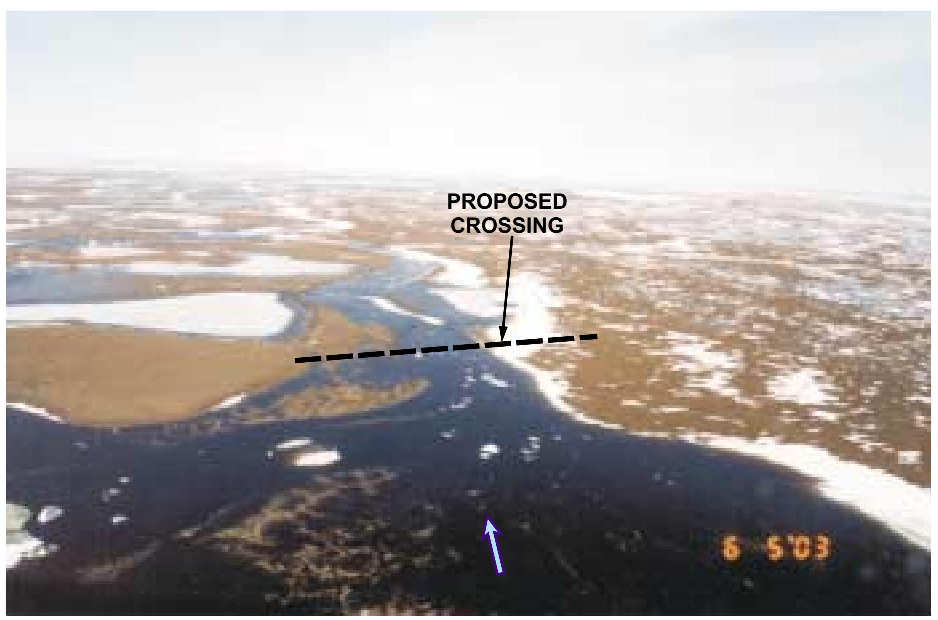
FILE (CDR): 782-03-07-18-A1
JOB NO.: 782
FIGURE 7



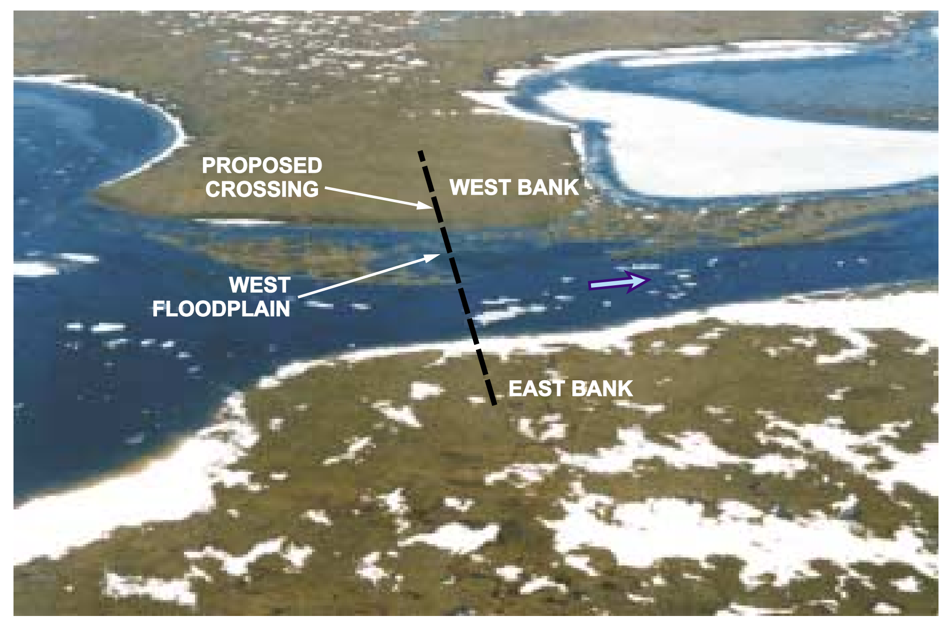
1. Flow commencing at this time.

2.

3.



4.



5. From discharge measurements data by Baker, channel bottom ice was still in place at least through the 10th. Design water level is thus likely with the ice in place.

6. Low level view to the east (right) bank from the west side. Winter ice about to lift and move downstream.

1. Photos by Wim Veldman, Hydroconsult, June 4 & 5, 2003.
2. Bridge location shown is approximate.

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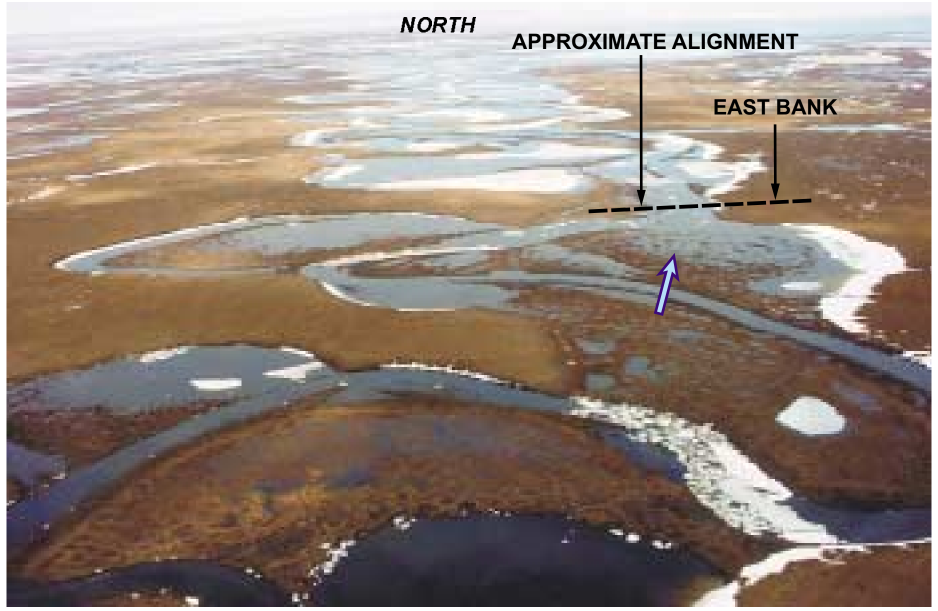
DATE 03/10/08

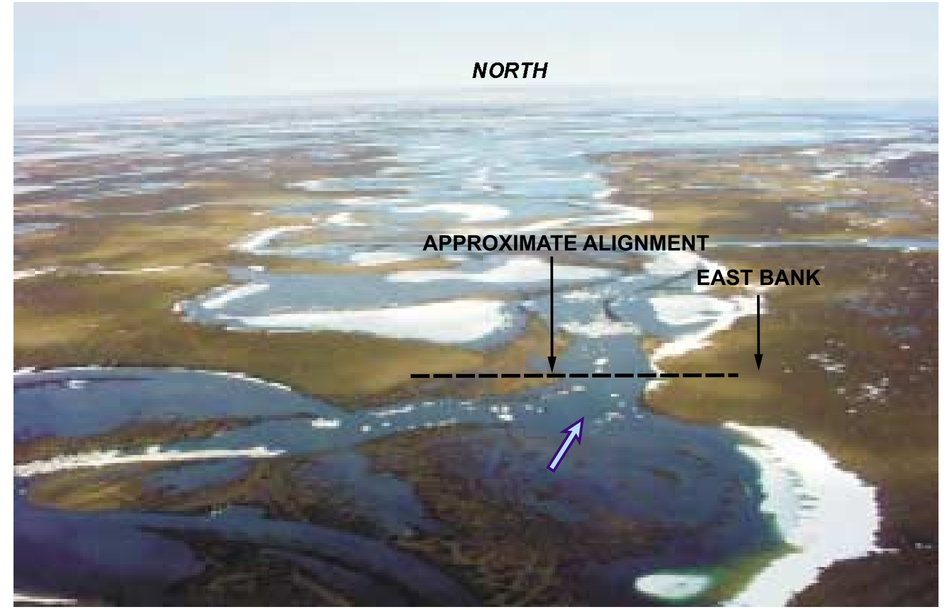
ALPINE SATELLITE DEVELOPMENT PLAN

UBLUTUOCH RIVER, MP 6.8
SITE PHOTOS
JUNE 5, 2003

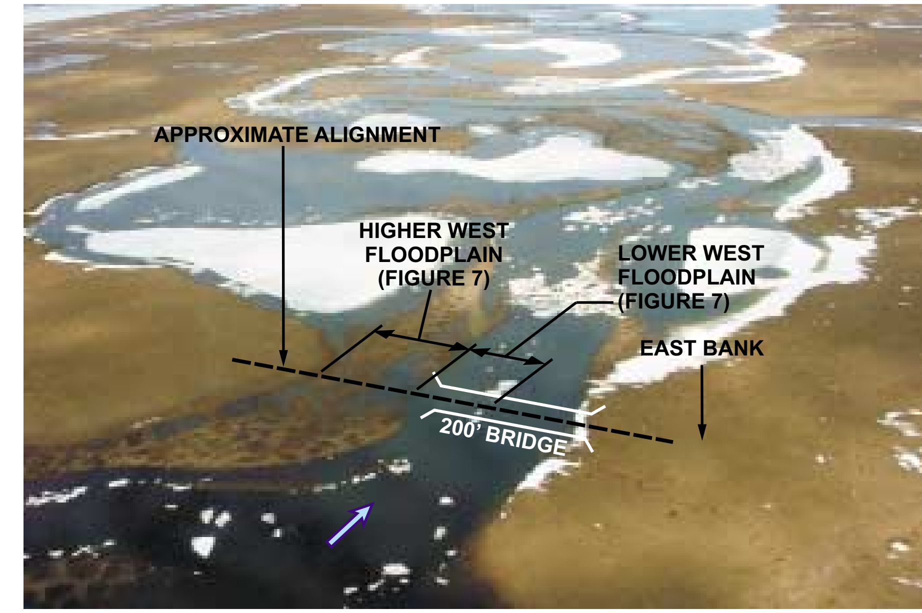
FILE (CDR) 782-03-07-18-A1
JOB NO. 782
FIGURE 8



1. A long range view looking downstream. Main channel is very tortuous throughout this reach.



2. Large floodplain areas next to the main channel become inundated during spring breakup but convey little flow. The flow patterns at the bridge crossing are therefore dependent on the orientation of the main channel and the characteristics of the floodplain at the crossing.



3. The east main channel and the higher west floodplain are very apparent in this photo. At high flows and/or ice conditions in the main channel the lower west floodplain is fully inundated and conveys flow (Photo 6, Figure 8).

Photos by Baker staff, June 8, 2003

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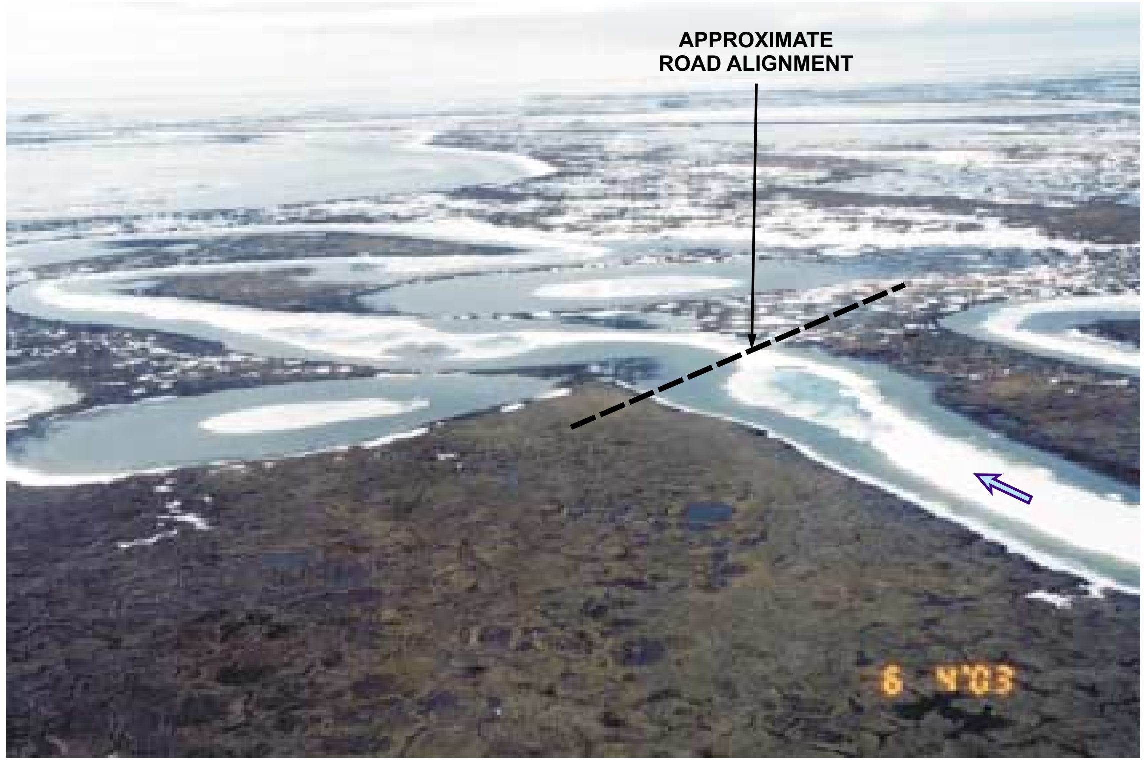
DESIGN Wim Veldman
APP Wim Veldman
SCALE As shown
DATE 03/10/24

ALPINE SATELLITE DEVELOPMENT PLAN

UBLUTUOCH RIVER, MP 6.8
SITE PHOTOS
JUNE 8, 2003

FILE (CDR) 782-03-07-18-A1 | JOB NO. 782 | FIGURE 9



1. Ublutuoch, MP 1.9.

2. Ublutuoch, MP 6.8.

COMPARISON	MP 1.9	MP 6.8
1. BRIDGE LENGTH	• 750' - to span the main channel plus 50' setback of the abutments on each bank. East of the bridge, a 1500' wide zone of inundation would require a number of post-flood drainage culverts.	• 200' - to span the main east channel and part of the lower west floodplain. The higher west floodplain, about 300' in total width, is relatively high and is not expected to convey significant flow. Thus a significant portion of the floodplain could be closed with fill and several post flood "drainage" culverts rather than a much longer bridge.
2. DESIGN WATER LEVEL	• West bank does not appear to overtop. The east side is a 1500' wide floodplain which, combined with the wide river cross-section, limits the increase in water level in response to flow and/or ice conditions. Road fill blocking the majority of the east floodplain would slightly increase water levels about natural levels.	• The east bank does not appear to overtop. The west bank, beyond the west floodplain, does not appear to overtop. With the vast majority of the flow in the main channel, partial blockage of the lower west floodplain is not expected to significantly raise the design water levels.
3. ICE CONDITIONS	• Likely primarily ground-fast ice in the winter. Low ice forces on instream structures due to degree of deterioration of the ice by the time it moves out downstream and low velocities.	• Slightly higher forces likely than at MP 1.9.

HYDRAULIC CONCLUSIONS

- The MP 6.8 location is considerably more favorable than MP 1.9 primarily as the upstream location is significantly shorter. The wide east floodplain at MP 1.9 would, as a minimum, require a number of large post-flood drainage culverts or, at the most, another bridge span east of the main crossing
- Unless other considerations outweigh the hydraulic considerations, it is recommended that MP 6.8 be the selected crossing location and that hydraulic analysis and additional field work be undertaken to refine the location, length and design parameters for the bridge and west floodplain culverts.

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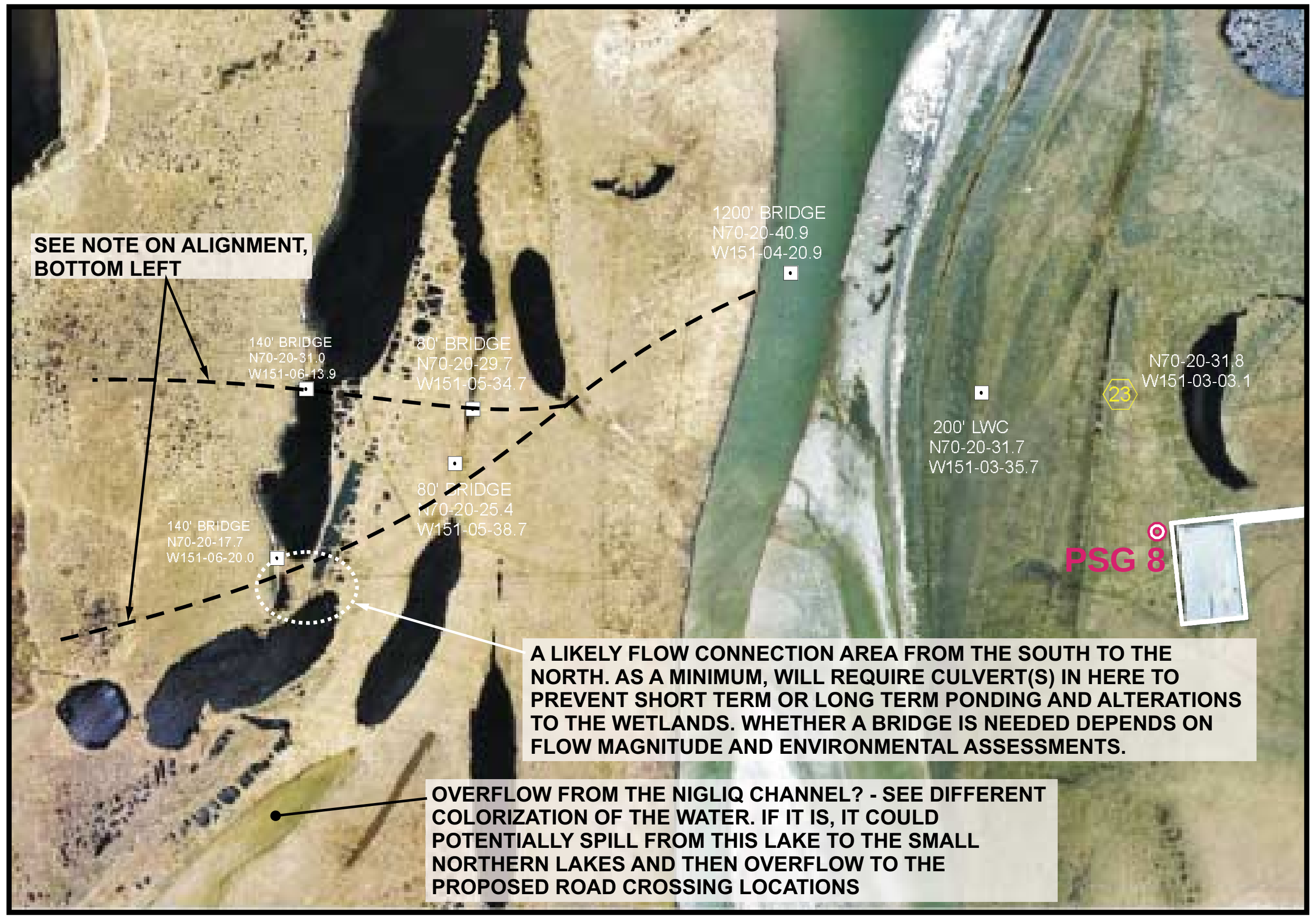
DATE 03/10/08

ALPINE SATELLITE DEVELOPMENT PLAN

UBLUTUOCH RIVER
HYDRAULIC COMPARISON OF MP 1.9 AND MP 6.8 CROSSINGS

FILE (CDR) 782-03-07-18-A1 | JOB NO. **782** | **FIGURE 10**



0 500 1000 1500 Feet

1" = 1500'

N

0 250 500 1000 Feet

1" = 1000'

1.0 SCOPE OF HYDROCONSULT'S ASSESSMENT

1.1 A general assessment of river engineering considerations and factors in the preliminary design of a bridge crossing. Based on Wim Veldman's site evaluation June 3 to 5, 2003 and his long term experience on the North Slope of Alaska, which included field assessments on the Colville River in June 2001.

2.0 CONSIDERATIONS

2.1 Water Level:

- No flow in the area during the June 3 - 5, 2003 field observations by Wim Veldman thus observation, notes and recommendations herein should be considered very preliminary.

2.2 For general comments on flow, see notes on the Airphotos.

3.0 RECOMMENDATIONS FOR PRELIMINARY DESIGN

3.1 From topographic maps, field observations and the 2D model, determine likelihood of overflow from the Nigliq Channel into this area. If low to none, crossings need be designed for local runoff only.

3.2 From this assessment as well as potential environment considerations, determine whether a bridge or culvert is required.

3.3 From a hydraulic viewpoint only, the southern alignment is favoured as it avoids the west lake in the northern route.

Airphoto and alignment information supplied by Baker.
Alignment options "roughed" in by Hydroconsult.

Hydroconsult

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APP Wim Veldman
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DATE 03/10/08

ALPINE SATELLITE DEVELOPMENT PLAN

PALEO CHANNELS WEST OF NIGLIQ AIRPHOTOS AND ASSESSMENT

FILE (CDR) 782-03-07-18-A1
JOB NO. **782**
FIGURE 11