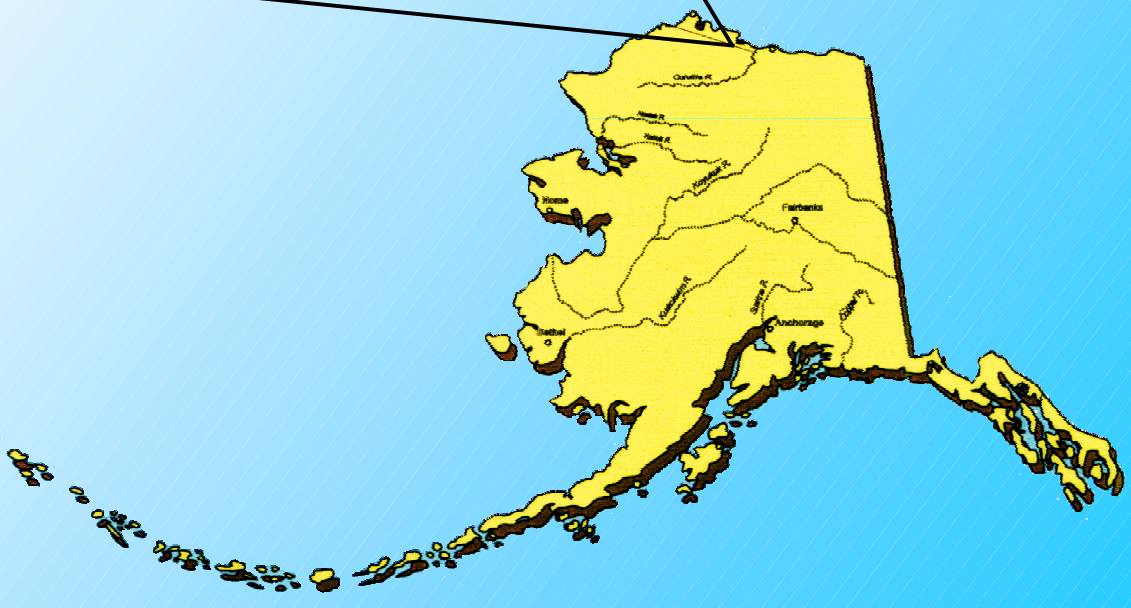
2000 SPRING BREAKUP AND HYDROLOGIC ASSESSMENT

NECHELIK CHANNEL, COLVILLE RIVER DELTA, ALASKA

for

CD-SOUTH DEVELOPMENT PROJECT

February 2001



PHILLIPS Alaska, Inc.
A Subsidiary of PHILLIPS PETROLEUM COMPANY

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24531-MBJ-DOC-001

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For

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By

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1.0 Introduction

This report summarizes the observations and measurements made during the 2000 Spring breakup of the Colville River in and around the proposed CD-South Development. The CD-South Development is located in the southwest portion of the Colville River Delta approximately 60 miles west of Prudhoe Bay and approximately 3 miles south of the Alpine Development, on the North Slope of Alaska (see Figure 1-1).

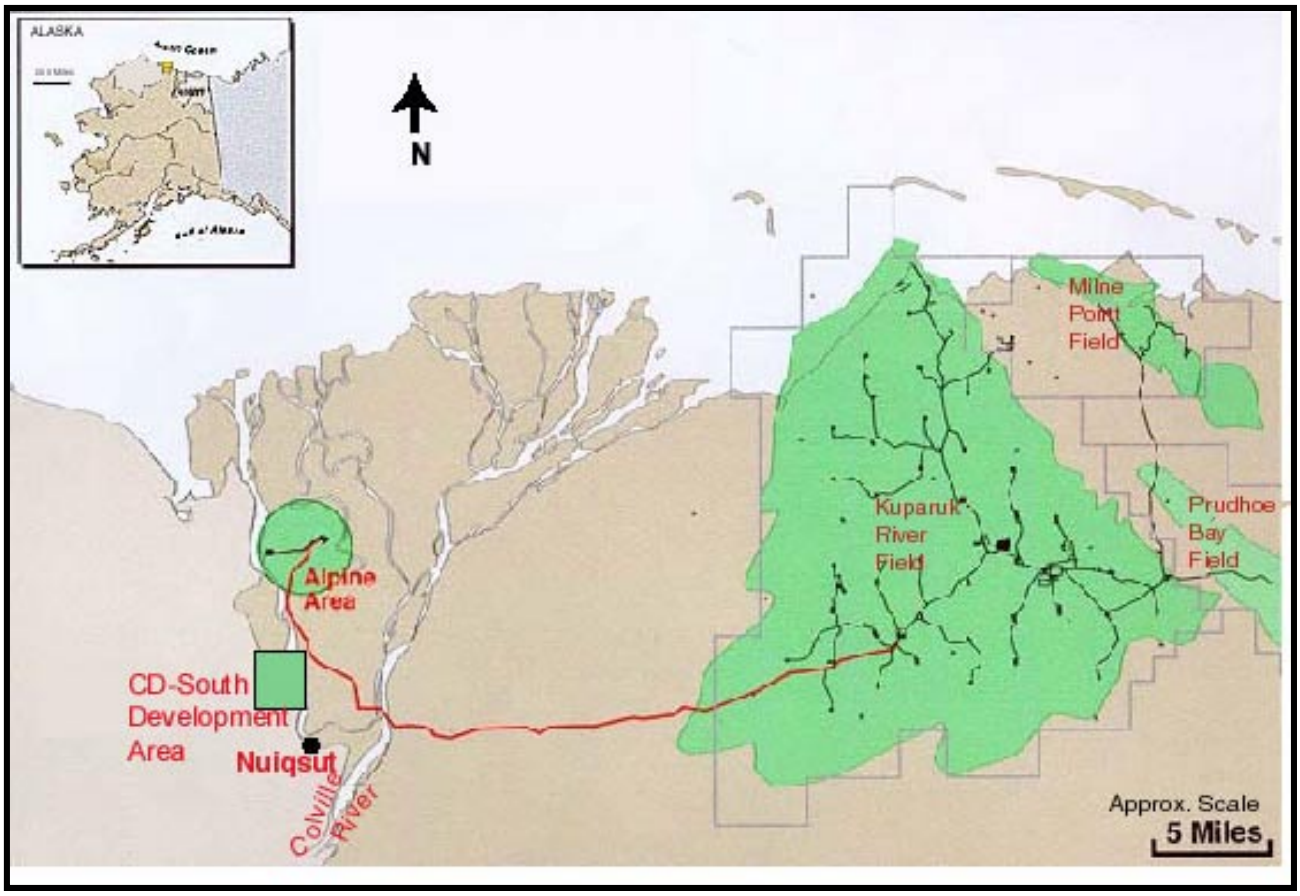


Figure 1-1 Project Location Map

Fieldwork for the 2000 breakup was performed between 28 May and 22 June 2000. Water surface elevations were monitored at three locations near the project development and at other specific locations in the Colville River Delta. Channel ice observations were made on the main channels of the delta to document the clearing of the low water channel ice sheet and the location of ice-jams. Photo documentation of the flooding around the project area was also obtained.

All of the elevations presented in this report are in feet and are based on the British Petroleum mean sea level (BPMSL) datum unless otherwise noted.

2.0 Field Observations and Breakup Summary

2.1 Water Surface Elevations and Observations

Water surface elevations were monitored in the Nechelik Channel at Survey Monuments 12 and 22, and at Permanent Staff Gage # 8 (Figure 2-1 to 2-5). Water surface elevations were also monitored at the permanent staff gages on the upstream side of the Alpine Development (Staff Gages #3 and #6), and in the Sakoonang Channel at Permanent Staff Gage #1. At the head of the delta, water surface elevations were monitored near Survey Monument #1. All of the staff gages were in-place prior to flow in the river, and water-surface elevation measurements began on 8 June 2000. The water surface elevation and observation records are presented in Appendix A.

2.2 Channel Ice Observations

Ice observations were begun on 6 June 2000 when the ice cover within the Colville River Delta began to break up. By 12 June 2000, all of the major channels of the Colville River Delta were clear of channel ice and ice jams, with the exception of the Nechelik Channel. The Nechelik had cleared to approximately river mile N7, about one mile north of CD-2. The progression of the channel ice clearing and ice jamming is shown on a series of figures presented in Appendix B.

The winter ice road constructed across the Nechelik Channel near Monument 12 did not appear to have hindered breakup or caused ice jamming. A “break through” channel was excavated prior to abandonment of the ice road. It is believed that this was a significant factor in preventing breakup ice jamming problems due to the ice road (see Figure 2-2 and Figure C-1, Appendix C). In contrast, an ice jam was observed in the Tamayayak Channel (near Monument 25) where a “break-through” channel was not excavated in the ice road. The practice of excavating break-through channels should be encouraged.

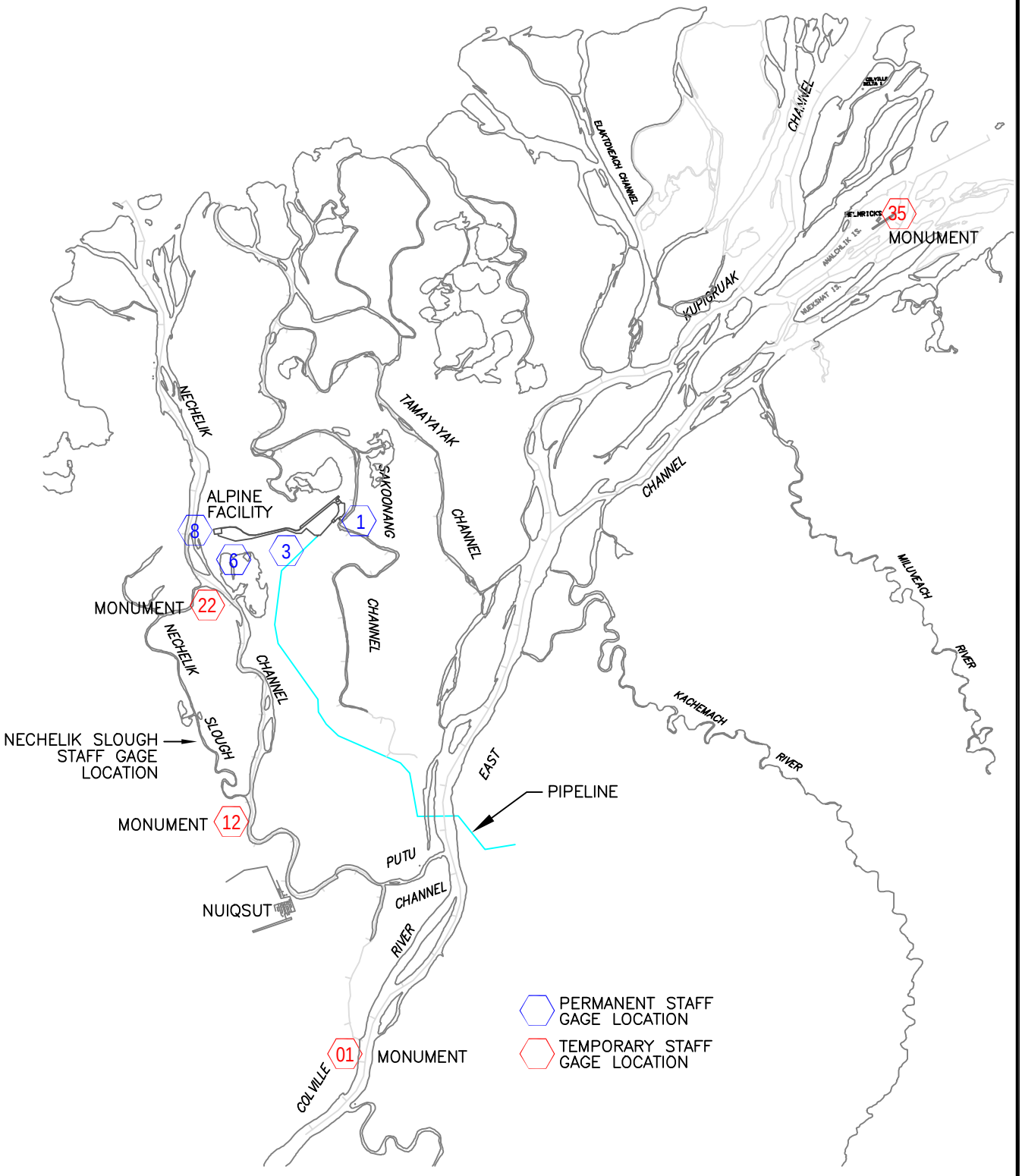


FIGURE 2–1A.dwg

Baker — Michael Baker Jr., Inc.			
DATE: 01\16\01	PROJECT: 24531	2000 SPRING BREAKUP COLVILLE RIVER DELTA	FIGURE: 2-1
DRAWN: WAE	FILE:	TEMPORARY STAFF GAGE LOCATIONS	
CHECKED: TAR	SCALE: NOT TO SCALE		

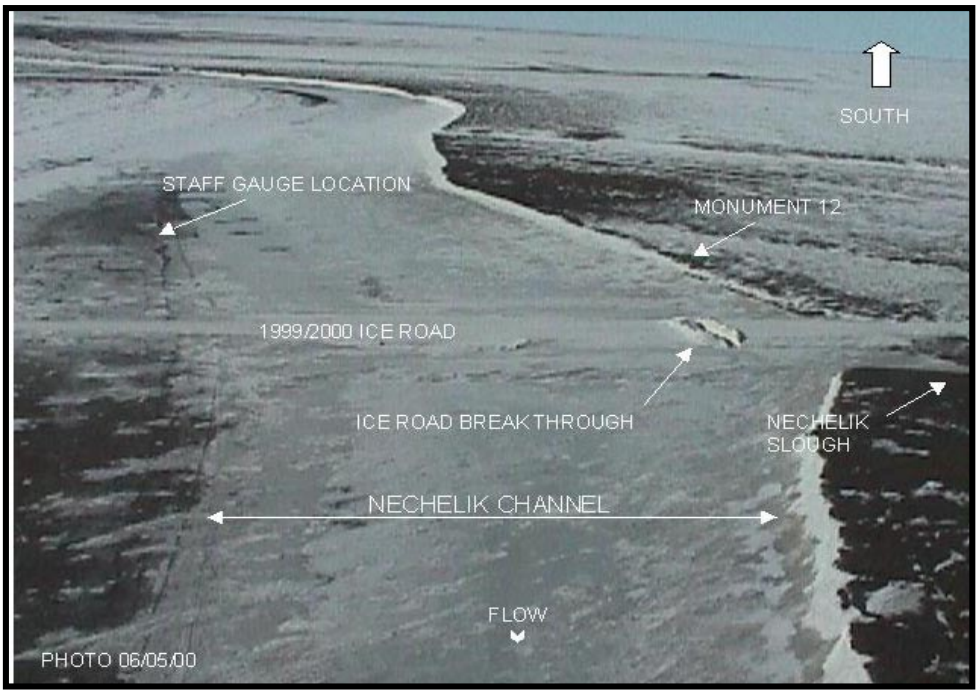


Figure 2-2 **Nechelik Channel Aerial View at Monument 12**

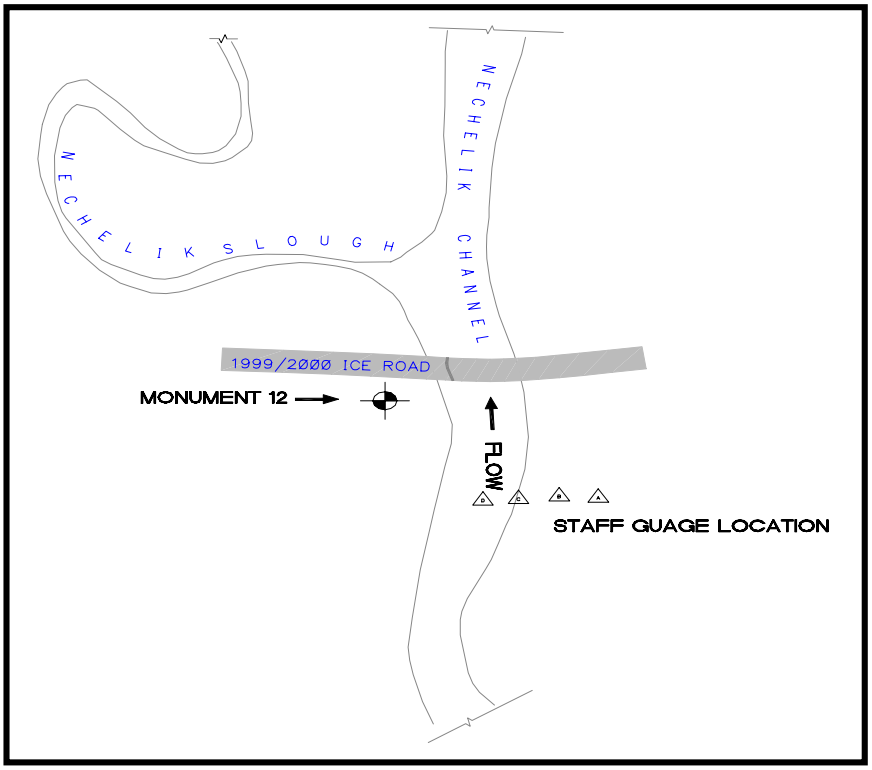


Figure 2-3 **Nechelik Channel – Monument 12 Schematic Site Plan**

Figure 2-4 Monument 22 Staff Gage Layout

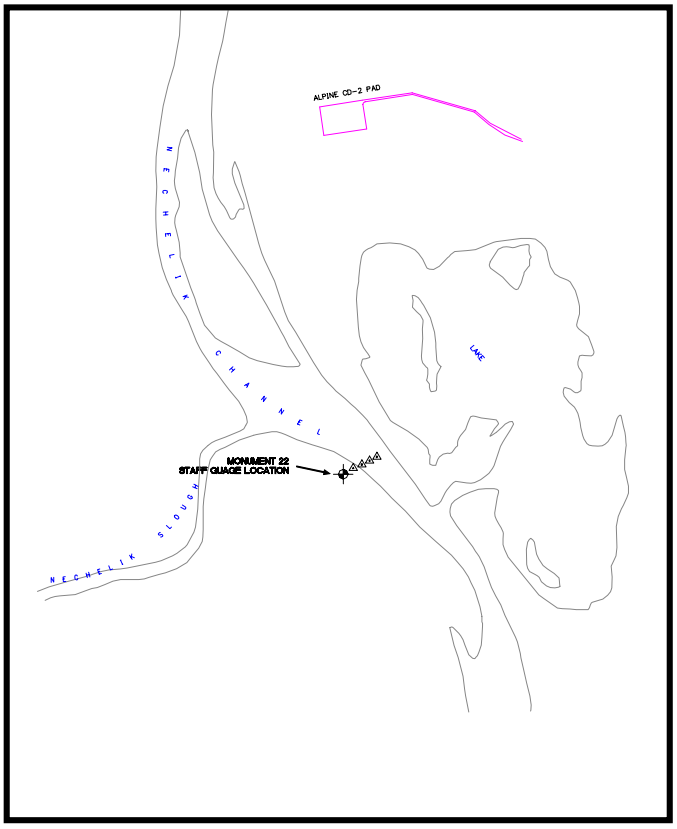


Figure 2-5 Schematic Site Plan, Monument 22

2.3 Peak Discharge at the Head of the Colville River Delta

The peak discharge at the head of the Colville River Delta was approximately 580,000 cubic feet per second (cfs). It is estimated that at the head of the delta this discharge will be equaled or exceeded, on average, approximately once every 25 years (Michael Baker Jr., Inc. et. al, 1998). The discharge, during at least a portion of the day, on 9 June, 11 June, and 12 June 2000 was probably within 5 to 10 percent of the estimated peak discharge. The available data does not support a quantitative estimate of the discharge on 10 June 2000. A summary of the flood peak estimates from previous years is presented in Table A-10 in Appendix A.

2.4 Peak Water Surface Elevations

In the Nechelik Channel, the water surface elevation peaked between 9:00 am on 12 June and 8:00 am on 13 June 2000. The peak water-surface elevations recorded at Survey Monuments 12 and 22, the two closest monitoring locations to CD-South, were 13.26 and 9.58 feet, respectively. Based on these measurements it is estimated that the peak water-surface elevation near CD-south was approximately 10.6 feet. In the swale on the upstream side of the Drill Site 2 access road (Permanent Staff Gage #3), the peak water-surface elevation was 9.48 feet. In the Sakoonang Channel at the Alpine Development (Permanent Staff Gage #1), the peak water-surface elevation was 9.10 feet. The peak water-surface elevation at the swale and in the Sakoonang Channel occurred during the same 24-hour period that it did on the Nechelik Channel.

A linear interpolation between the water surface elevations predicted for the 10- and 30-year open water floods (Michael Baker Jr., Inc., 1998 and Shannon & Wilson, Inc., 1997) was used to estimate the likely frequency of occurrence of this years peak water surface. Based on this analysis, it is estimated that the peak water-surface elevation observed near CD-South will be equaled or exceeded on average about once every 20 years. At the Alpine Development and at the head of the delta, it is estimated that the peak water-surface elevation during this years flood will be equaled or exceeded on average about once every 19 and 25 years, respectively.

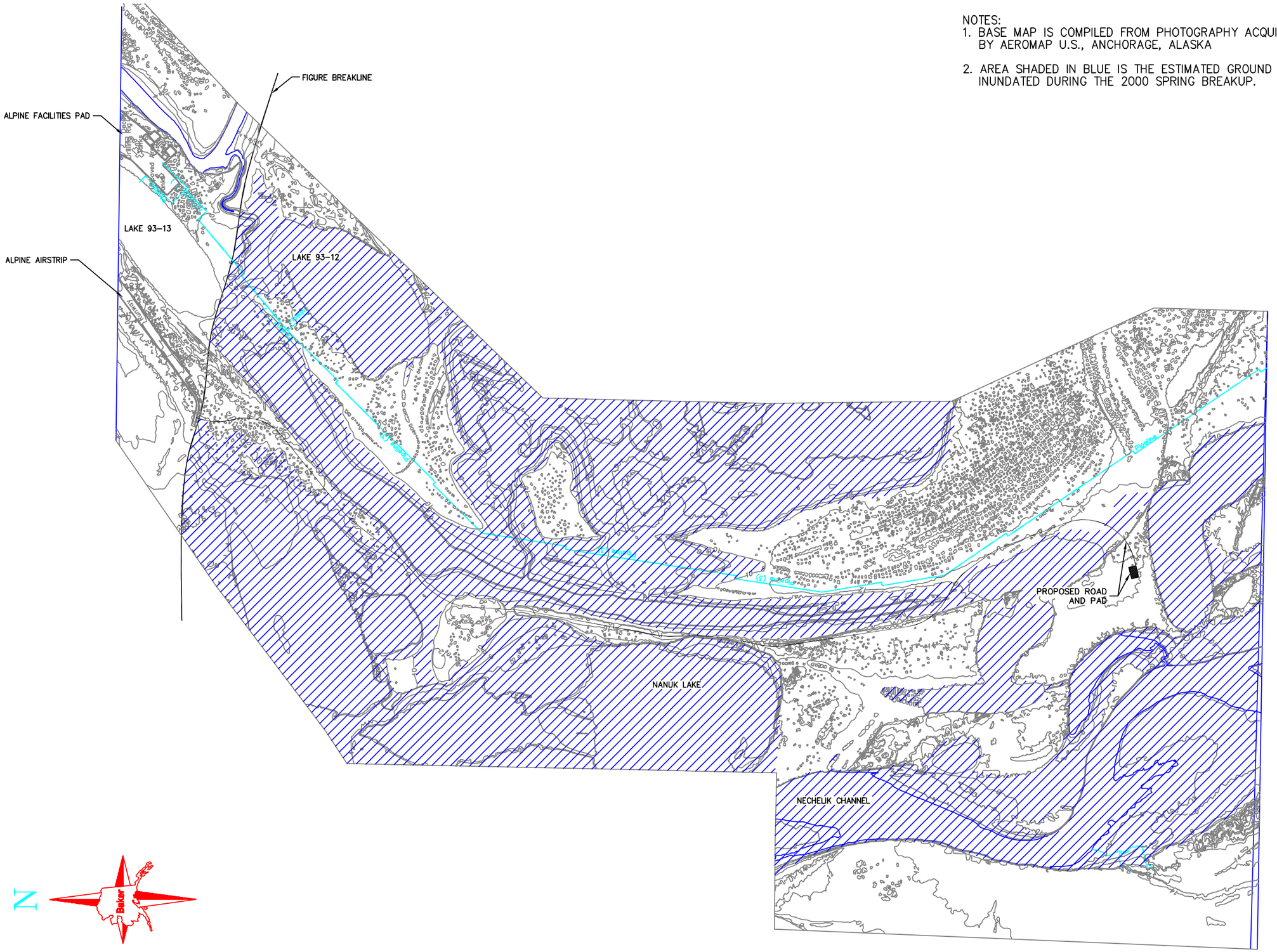
One reason the estimated recurrence interval is higher at the head of the delta than at CD-South, might be the temporary storage of floodwater within the delta. As a flood moves through the delta, the peak is attenuated due to the filling of depressions and backwater areas (i.e. temporary

floodwater storage). However, the results from the two-dimensional surface water model are based on steady state conditions and the actual recurrence interval at locations lower in the delta may be closer to 25-years. Another explanation is that the difference in the 19 and 25-year water surface elevations is small and thus, minor inaccuracies in the model may explain the differences in the recurrence interval estimate. In either case, the peak water-surface elevation during the 2000 spring breakup at CD-South can be expected to occur at least once every 19 to 25 years on average.

The ground surface in the CD-South area inundated by the 2000 peak water surface elevation was estimated and is presented in Figure 2-6. The estimate is based on the water-surface elevation measurements at Survey Monuments 12 and 22, and the two-dimensional surface water model developed for the Colville River Delta (Michael Baker Jr., 1998; and Shannon & Wilson, Inc., 1997). Specifically, the water-surface profile developed for the 30-year peak discharge was adjusted using the peak water-surface elevations observed during the 2000 spring breakup. The resulting water surface, in conjunction with topographic mapping was used to estimate the ground surface inundated near CD-South.

NOTES:
1. BASE MAP IS COMPILED FROM PHOTOGRAPHY ACQUIRED 6/30/99 BY AEROMAP U.S., ANCHORAGE, ALASKA

2. AREA SHADED IN BLUE IS THE ESTIMATED GROUND SURFACE INUNDATED DURING THE 2000 SPRING BREAKUP.



REVISION	NO.:	DATE:	BY:

2000 SPRING BREAKUP
COLVILLE RIVER DELTA

CD-SOUTH PROJECT AREA
ESTIMATED FLOODWATER INUNDATION

Baker

Michael Baker Jr., Inc.

DATE:	12/20/00	PROJECT:	24531
DRAWN:	TKM	FILE:	HYDRO1
CHECKED:	JAB	SCALE:	1"=800'

FIGURE:
2-6

2.5 Historic Water Surface Elevations

Spring peak water-surface elevations and discharge were also recorded at Monument 22 during 1998 and 1999. The following discussion compares the peak water surface elevations and discharge that occurred in 1998 and 1999 with that which occurred in 2000, and discusses the affect of ice on the water surface elevations observed in each of the years.

In 1998, the peak water-surface elevation at Monument 22 was 10.20 feet and the discharge at the head of the delta on the day of the peak stage was approximately 175,000 cfs (Michael Baker Jr., Inc., 1998). The peak discharge at the head of the delta was approximately 213,000 cfs and was estimated to have an average recurrence interval of less than 2 years. Based on other measurements made in 1998, and assuming that CD-South will be located adjacent to river mile N11.0 in the Nechelik Channel, it is estimated that the peak water surface elevation at CD-South was between 11.1 and 11.6 feet.

In 1999, the peak water-surface elevation at Monument 22 was 5.89 feet and the discharge at the head of the delta on the day of the peak stage was approximately 168,000 cfs (Michael Baker Jr., Inc., 1999). The peak discharge at the head of the delta was approximately 203,000 cfs and was estimated to have an average recurrence interval of less than 2 years. Based on other measurements made in 1999, it is estimated that the peak water-surface elevation at CD-South was between 6.3 and 6.8 feet.

In 2000, the peak water-surface elevation at Monument 22 was 9.58 feet and the discharge at the head of the delta on the day of the peak stage was approximately 580,000 cfs. The peak discharge at the head of the delta was also about 580,000 cfs and was estimated to have an average recurrence interval of about 25 years. Based on other measurements made in 2000, it is estimated that the peak water-surface elevation at CD-South was about 10.6 feet.

In reviewing the water-surface elevation measurements from 1998, 1999 and 2000, it will be noted that the peak water-surface elevation was probably higher at CD-South in 1998 than it was in 2000, although the discharge was less. In 1998, the low-water-channel ice sheet remained in-place throughout the 1998 breakup event. In 2000 however, the low-water-channel ice sheet had cleared the channel at CD-South by the time the peak stage occurred. The added resistance of the ice sheet

is undoubtedly at least partially responsible for the relatively high water-surface elevation. However, there is probably another reason, as explained below.

The discharge at the head of the delta in 1998 is only about 7,000 to 10,000 cfs higher than the discharge in 1999. Given the similarity in the discharge, it is interesting to note that at CD-South the 1998 peak stage is 4 to 5 feet higher than the 1999 peak stage. During both years, the low-flow-channel ice sheet remained in-place until after the peak discharge had passed. At discharges that are contained within the banks of the channels, the low-water-channel ice sheet and surface ice jams can have a significant effect on water surface elevations. They can also impact the amount of water that passes down a particular distributary in any given year. Thus, it is hypothesized that the difference in the 1998 and 1999 water surface elevations is due to the difference in the quantity of water that was passing through the Nechelik Channel at the peak stage.

The floodplain of the delta is large and relatively flat. For this reason, the effect of the low-water-channel ice sheet and ice jams on water surface elevations will be much smaller during out-of-bank floods than during floods that are contained within the channels.

2.6 Photographic Documentation

Photographic documentation of the Nechelik Channel, Nechelik Slough and the CD-South monitoring sites are presented in Appendix C.

3.0 References

Michael Baker Jr., Inc. 2000. *Alpine Facilities Spring 2000 Breakup Monitoring.* Prepared for: Phillips Alaska, Inc., Anchorage.

Michael Baker Jr., Inc. 1999. *1999 Spring Breakup And Hydrologic Assessment, Colville River Delta, North Slope, Alaska.* Prepared for: ARCO Alaska, Inc. Anchorage, Alaska.

Michael Baker Jr., Inc., and Shannon & Wilson, Inc. 1998. *Colville River Flood-Frequency Analysis, North Slope, Alaska.* Prepared for: ARCO Alaska, Inc., Anchorage.

Michael Baker Jr., Inc. 1998. *1998 Spring Breakup And Hydrologic Assessment, Colville River Delta, North Slope, Alaska.* Prepared for: ARCO Alaska, Inc. Anchorage, Alaska.

Shannon & Wilson, Inc. 1997. *Colville River Two-Dimensional Surface Water Model.* Prepared for: Michael Baker Jr., Inc., Anchorage, Alaska.

Appendix A.

Water Surface Elevations and Observations

List of Tables:

Table A-1: Water Surface Elevations and Observation at Survey Monument #12

Date	Time	Water Surface Elevation (feet)	Observations
6-8-00	08:32 09:50 12:06	7.02 7.31 7.62	Ice sheet over the channel is continuous and about 600' across. Ice sheet over the channel is continuous and about 600' across. Ice sheet over the channel is continuous and about 600' across.
6-9-00	07:29 14:49	9.64 10.24	Ice sheet over the channel is continuous and about 500' across. Ice sheet over the channel is continuous and about 500' across.
6-10-00	15:41	10.68	Ice sheet over the channel is continuous and about 200' across.
6-11-00	11:07	10.82	
6-12-00 High Water Mark 6-15-00		13.26	The peak water surface elevation probably occurred between the morning of 6/12 – 6/13 based on local observations.

Notes:

1. Elevations are based on an elevation of 10.13 feet (BPMSL) for Monument 12, which was established by Lounsbury & Associates in 1996
2. GPS coordinates for Monument 12 are N 70º 14' 58.3" W 150º 01' 23.5" (NAD 27) which were surveyed by Lounsbury and Associates.

Table A-2: Water Surface Elevation and Observations at Survey Monument #22

Date	Time	Water Surface Elevation (feet)	Observations
6-8-00	08:40	4.08	Ice sheet over the channel is continuous and about 300' across.
	09:50	4.26	± 0.02 ft. Ice sheet over the channel is continuous and about 300' across.
	12:11	4.54	± 0.02 ft. Ice sheet over the channel is continuous and about 300' across.
6-9-00	07:41	6.79	± 0.02 ft. Ice sheet over the channel is continuous and about 200' across.
	15.06	7.47	± 0.05ft. Ice sheet over the channel is continuous and about 200' across.
6-10-00	15:58	7.94	± 0.05 ft. Ice sheet over the channel is continuous and about 175' across.
6-11-00	11:30	7.85	
6-12-00 High Water Mark 6-15-00		9.58	The peak water surface elevation probably occurred between the morning of 6/12 – 6/13 based on local observations.

Notes:

1. Elevations are based on an elevation of 10.13 feet (BPMSL) for Monument 22, which was established by Lounsbury & Associates in 1996.
2. GPS coordinates for Monument 22 are N 70º 19' 06.3" W 151º 03' 10.4" (NAD 27) which were surveyed by Lounsbury and Associates.

Table A-3: Water Surface Elevations and Observations at Permanent Staff Gage #1

Date	Time	Water Surface Elevation (feet)	Observations
06-02-00			Set faceplate on Staff Gage #1 from 1.48 to approximately 15.00 feet.
06-03-00	10:11	1.49	
06-08-00	13:40	~1.00	Water does not quite touch staff gage at this point. No continuous ice either upstream or downstream of gage.
06-09-00	11:18	3.22	± 0.02 feet
	18:08	3.47	± 0.02 feet
06-10-00	08:35	5.80	± 0.03 feet
	18:20	7.05	± 0.05 feet
06-11-00	08:24	7.95	± 0.01 feet
	20:58	8.31	± 0.02 feet. Ice floes are present in channel. Intermediate high water mark of 8.46 recorded.
06-12-00	07:23	8.80	± 0.05 feet. Ice floe 6 inches upstream of gage. Could not see chalk line due to ice floe. Ice floes still present, with some beached about 300 feet downstream of gage on left bank.
High Water Mark		9.10	± 0.05 feet
06-13-00	09:25	7.00	± 0.03 feet
	17:25	6.36	± 0.01 feet
06-14-00	09:05	5.32	± 0.01 feet. Ice floes still present in channel.
	20:05	4.80	± 0.01 feet
06-15-00	08:37	4.19	± 0.03 feet
	21:27	3.77	± 0.01 feet
06-16-00	08:14	3.40	± 0.05 feet. Faceplate is slightly bent between 3.0 and 5.0 feet.
	17:55	3.05	± 0.05 feet
06-17-00	08:07	2.62	
	20:07	2.24	± 0.02 feet
06-18-00	10:39	1.83	± 0.02 feet
06-19-00	16:20	1.29	± 0.02 feet. Straightened staff gage faceplate.

Notes: 1. Coordinates for Staff Gage #1 are longitude 5975948.0, latitude 386920.3 and are Alaska State Plane, Zone 4, NAD 27.

2. Elevations are based on an elevation of 2.16 feet (BPMSL) located at the top of the 1-inch angle iron welded on the 5-inch drill stem staff gage support which was surveyed by LCMF Incorporated.

Table A-4: Water Surface Elevations and Observations at Permanent Staff Gage #3

Date	Time	Water Surface Elevation (feet)	Observations
06-03-00	14:12	5.39	Placed staff gage faceplate from 6.67 to 15.07 feet. Standing water in hole at staff gage
06-04-00	14:39	5.37	Standing water around staff gage
06-08-00	10:59	5.34	Intermediate high water mark of 5.40 feet recorded
06-09-00	09:33	6.70	± 0.01 feet
	13:27	7.21	± 0.02 feet
	17:09	7.20	± 0.02 feet
	23:08	7.38	± 0.03 feet
06-10-00	10:40	7.61	± 0.02 feet
	14:23	7.77	± 0.03 feet
	15:34	7.87	± 0.04 feet
	17:20	7.87	± 0.03 feet
	18:45	7.89	± 0.02 fee.
06-11-00	08:57	7.87	Intermediate high water mark of 7.96 feet recorded
	12:08	7.92	± 0.01 feet
	14:26	7.97	± 0.02 feet
	15:42	7.96	± 0.02 feet.
06-12-00	08:00	9.18	± 0.02 feet
High Water Mark		9.48	± 0.02 feet
06-13-00	07:59	6.57	± 0.03 feet
	14:50	6.00	± 0.02 feet
06-14-00	09:48	5.36	Standing water. No flow.
	17:54		No flow.

Notes:

1. Coordinates for Staff Gage #3 are longitude 5975040.8, latitude 379259.2 and are Alaska State Plane, Zone 4, NAD 27.
2. Elevations are based on an elevation of 6.00 feet (BPMSL) located at the top of the 1-inch angle iron welded on the 5-inch drill stem staff gage support which was surveyed by LCMF Incorporated.

Table A-5: Water Surface Elevations and Observations at Permanent Staff Gage #6

Date	Time	Water Surface Elevation (feet)	Observations
06-03-00	15:24	7.20	Placed staff gage face plates from 9.99 to 15.0 feet. Standing water at staff gage.
06-04-00	15:29	7.20	Standing water at gage.
06-08-00	10:06	7.24	Standing water at staff gage. Intermediate high water mark of 7.27 recorded.
06-09-00	08:59	7.26	
	17:23	7.37	± 0.02 feet. There is water flowing, but it is not passing through the road at this location due to snow/ice blocked culverts.
06-10-00	10:19	7.84	± 0.02 feet. There is water flowing, but it is not passing through the road at this location due to snow/ice blocked culverts.
	19:11	8.07	± 0.03 feet
06-11-00	09:15	7.89	Intermediate high water mark of 8.16 recorded.
	17:11	8.00	± 0.02 feet
06-12-00	08:35	9.25	± 0.04 feet
High Water Mark		9.64	± 0.02 feet
06-13-00	08:18	7.47	± 0.01 feet
	15:07	7.38	± 0.01 feet
06-14-00	10:30	7.22	Standing water. No flow.
	17:45		No flow.

Notes:

1. Coordinates for Staff Gage #6 are longitude 5974982.6, latitude 373555.5 and are Alaska State Plane, Zone 4, NAD 27.
2. Elevations are based on an elevation of 7.30 feet (BPMSL) located at the top of the 1-inch angle iron welded on the 5-inch drill stem staff gage support which was surveyed by LCMF Incorporated.

Table A-6: Water Surface Elevations and Observations at Permanent Staff Gage #8

Date	Time	Water Surface Elevation (feet)	Observations
06-03-00			Placed staff gage faceplate from 9.99 to 15.07 feet.
06-08-00	09:40	8.06	Standing water at staff gage. Intermediate high water mark of 8.12 recorded.
06-09-00	08:43	8.06	Standing water at staff gage.
	17:30		Standing water at staff gage.
06-10-00	10:14		Standing water at staff gage.
06-11-00	09:26		Standing water at staff gage.
06-12-00	08:45	8.84	Water flowing around CD-2 pad. No high water mark at this time.
High Water Mark		9.11	
06-13-00	08:32		Standing water at staff gage.
06-14-00	10:48	8.06	Standing water at staff gage.
	15:48		Standing water at staff gage.

Notes:

1. Coordinates for Staff Gage #8 are longitude 5974854.9, latitude 371261.2 and are Alaska State Plane, Zone 4, NAD 27.
2. Elevations are based on an elevation of 8.76 feet (BPMSL) located at the top of the 1-inch angle iron welded on the 5-inch drill stem staff gage support which was surveyed by LCMF Incorporated.

Table A-7: Water Surface Elevations and Observations at Survey Monument #1

Date	Time	Water Surface Elevation (feet)	Observations
6-8-00	08:23	11.26	Ice sheet over the channel is continuous and about 1000' across.
	09:42	11.64	Ice sheet over the channel is continuous and about 1000' across.
	11:51	11.75	Ice sheet over the channel is continuous and about 1000' across.
	15:40	12.24	Ice sheet over the channel is continuous and about 1000' across.
6-9-00	06:50	15.68	Ice sheet over the channel is continuous and about 1000' across. Non-moving ice rubble exists for the other 2000'.
	14:37	18.98	Ice sheet over the channel is only along the east bank and about 35' across.
High Water Mark		19.33	
6-10-00	15:20	18.61	Ice sheet over the channel is only along the east bank and about 35' across.
	19:20	18.18	
6-11-00	10:57	15.94	
6-12-00		15.54	
6-13-00		13.21	

Notes:
1. Elevations are based on an elevation of 27.74 feet (BPMSL) for Monument 1, which was established by Lounsbury & Associates in 1996.
2. GPS coordinates for Monument 1 are N 70º 09' 58.3" W 150º 56' 12.6" (NAD 27). The GPS coordinates were obtained with a Garmin GPS II global positioning system.
3. The distance along the flow path from Monument 1 to TBM01D is approximately 2134 feet.
4. The distance along the flow path from Monument 1 to TBM01U is approximately 2010 feet.

Table A-8: Water Surface Elevations and Observations at Temporary Bench Mark 01D

Date	Time	Water Surface Elevation (feet)	Observations
6-8-00	08:27	N/A	Water level had not reached first gauge. Ice sheet over the channel is continuous and about 1000' across.
	09:45	N/A	Water level had not reached first gauge. Ice sheet over the channel is continuous and about 1000' across.
	11:53	N/A	Water level had not reached first gauge. Ice sheet over the channel is continuous and about 1000' across.
6-9-00	07:21	15.49	Ice sheet over the channel is continuous and about 1000' across. Non-moving ice rubble exists for the other 2000'.
	00:29	15.82	Ice sheet over the channel is continuous and about 1000' across. Non-moving ice rubble exists for the other 2000'.
	14:40	18.87	Ice sheet over the channel is only along the east bank and about 35' across.
High Water Mark		18.87	
6-10-00	15:23	18.43	Ice sheet over the channel is only along the east bank and about 35' across.
6-11-00	11:00	N/A	All gages are dry or destroyed.

Notes:
1. The elevations are based on an elevation of 28.62 feet (BPMSL) for TBM01D, which was established by Michael Baker Jr., Inc. in 2000. The elevation of TBM01D was based on an elevation of 27.74 feet (BPMSL) for Monument 1, which was established by Lounsbury and Associates in 1996.
2. The distance along the flow path from Monument 1 to TBM01D is approximately 2134 feet.
3. The distance along the flow path from Monument 1 to TBM01U is approximately 2010 feet.

Table A-9: Water Surface Elevations and Observations at Temporary Bench Mark 01U

Date	Time	Water Surface Elevation (feet)	Observations
6-8-00	08:21	11.46	Ice sheet over the channel is continuous and about 1000' across.
	09:40	11.88	Ice sheet over the channel is continuous and about 1000' across.
	11:45	11.97	Ice sheet over the channel is continuous and about 1000' across.
6-9-00	06:46	16.61	Ice sheet over the channel is continuous and about 1000' across. Non-moving ice rubble exists for the other 2000'.
	09:21	17.56	Ice sheet over the channel is continuous and about 1000' across. Non-moving ice rubble exists for the other 2000'.
	14:34	19.23	Ice sheet over the channel is only along the east bank and about 35' across.
High Water Mark		19.88	
6-10-00	15:15	18.53	Ice sheet over the channel is only along the east bank and about 35' across.
6-11-00	10:55	17.51	
6-12-00	17:15	16.38	

Notes:
1. The elevations are based on an elevation of 28.03 feet (BPMSL) for TBM01U, which was established by Michael Baker Jr., Inc. in 2000. The elevation of TBM01U was based on an elevation of 27.74 feet (BPMSL) for Monument 1, which was established by Lounsbury and Associates in 1996.
2. The distance along the flow path from Monument 1 to TBM01D is approximately 2134 feet.
3. The distance along the flow path from Monument 1 to TBM01U is approximately 2010 feet.

Table A-10: Summary of Breakup Data Obtained at the Head of the Colville River Delta, 1962 – 2000

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

Notes:

1. Water surface elevations are based on monuments set by Lounsbury & Associates in 1996 and are based on British Petroleum mean sea level (BPMSL).
2. The peak breakup discharge was estimated to range between 570,000 to 590,000 cfs.
3. Data from Michael Baker Jr., Inc., 1999, *1999 Spring Breakup and Hydrologic Assessment, Colville River Delta, North Slope, Alaska*. Prepared for ARCO Alaska, Inc., Anchorage, Alaska.
4. 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.
5. Data from Michael Baker Jr., Inc., 1998, *1998 Spring Breakup and Hydrologic Assessment, Colville River Delta, North Slope, Alaska*. Prepared for ARCO Alaska, Inc., Anchorage, Alaska.
6. Data from Shannon & Wilson, Inc., 1996, *1996 Spring Breakup and Hydrologic Assessment, Colville River Delta, North Slope, Alaska.* Prepared for Michael Baker Jr., Inc., Anchorage, Alaska.
7. Data from Jorgenson et al., 1996, *Geomorphology and Hydrology of the Colville River Delta, Alaska, 1995.* Prepared for ARCO Alaska, Inc., and Kuukpik Unit Owners, Anchorage, Alaska. 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.

Table A-11: Comparison of Observed and Predicted Water Surface Elevations

Observation Site	Observed Peak Water Surface Elev. (ft)	Predicted 10-yr Water Surface Elev. (ft)	Predicted 30-yr Water Surface Elev. (ft)	Predicted 50-yr Water Surface Elev. (ft)	Approximate Recurrence Interval of Observed Peak Water Surface Elevation (1) (yrs)
Staff G. 1	9.1	8.4	10.2	11.2	18
Staff G. 3	9.48	8.6	10.8	11.8	18
Staff G. 6	9.64	8.8	10.9	11.9	18
Staff G. 8	9.11	8.8	9.9	10.7	16
Mon 01	19.33	19	21.7	23	25
Mon 12	13.26	12	14	14.9	23
Mon 22	9.58	8.6	10.7	11.8	19

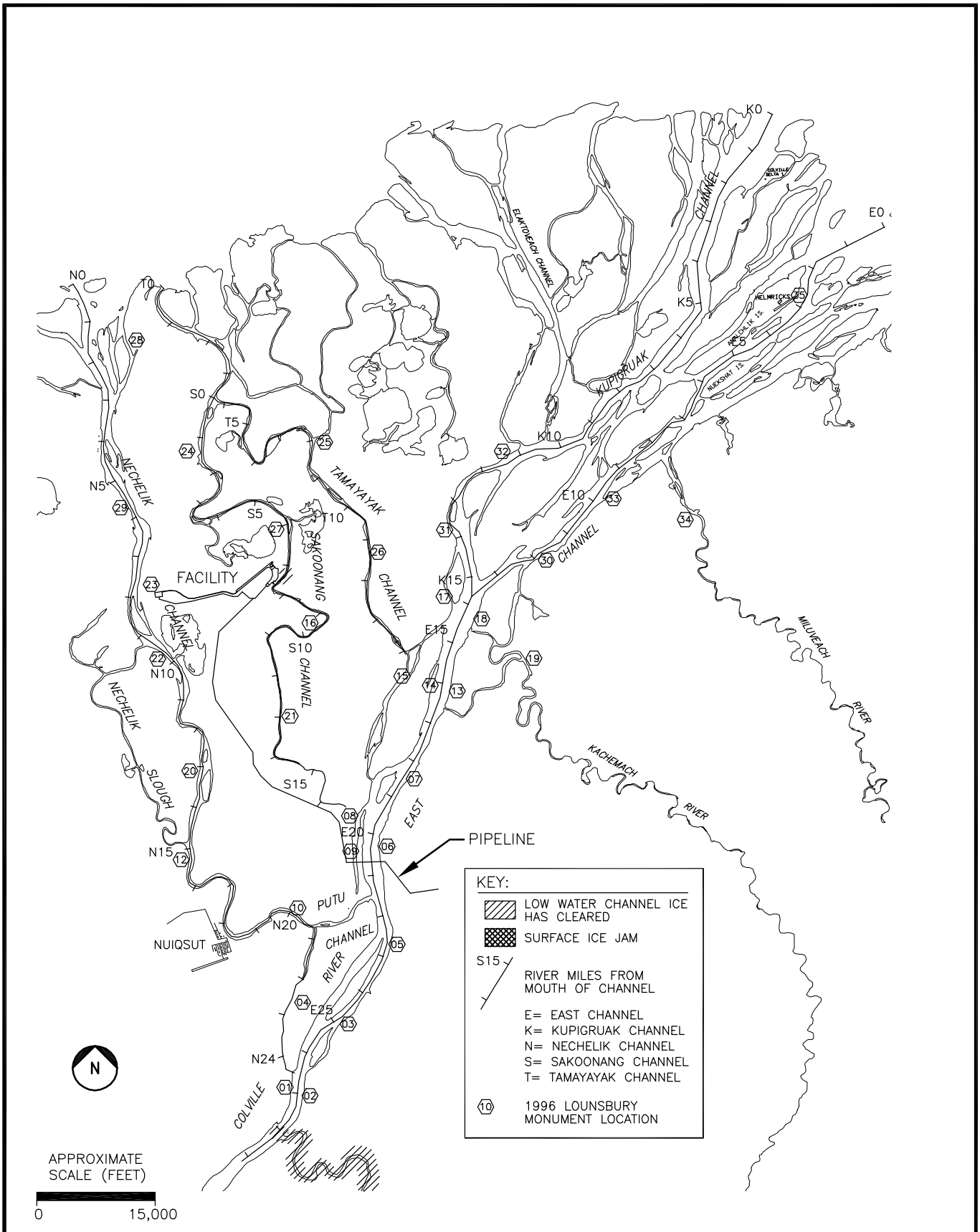
Notes:

1. The recurrence interval was estimated based on water surface elevations predicted with a two-dimensional open-water surface-water model of the Colville River Delta (Michael Baker Jr., Inc., 1998 and Shannon & Wilson, Inc., 1997). Thus, the impact on the recurrence interval of an ice cover and/or ice jams has not been considered. The larger the recurrence interval, the less likely it will be that an ice cover and/or ice jams will significantly affect the recurrence interval associated with a particular water surface elevation.
2. The peak water surface elevation was caused by a downstream ice-jam.
3. The locations of the monuments and staff gages are shown in Figure 2-1.

Appendix B

Channel Ice Observations

List of Figures:



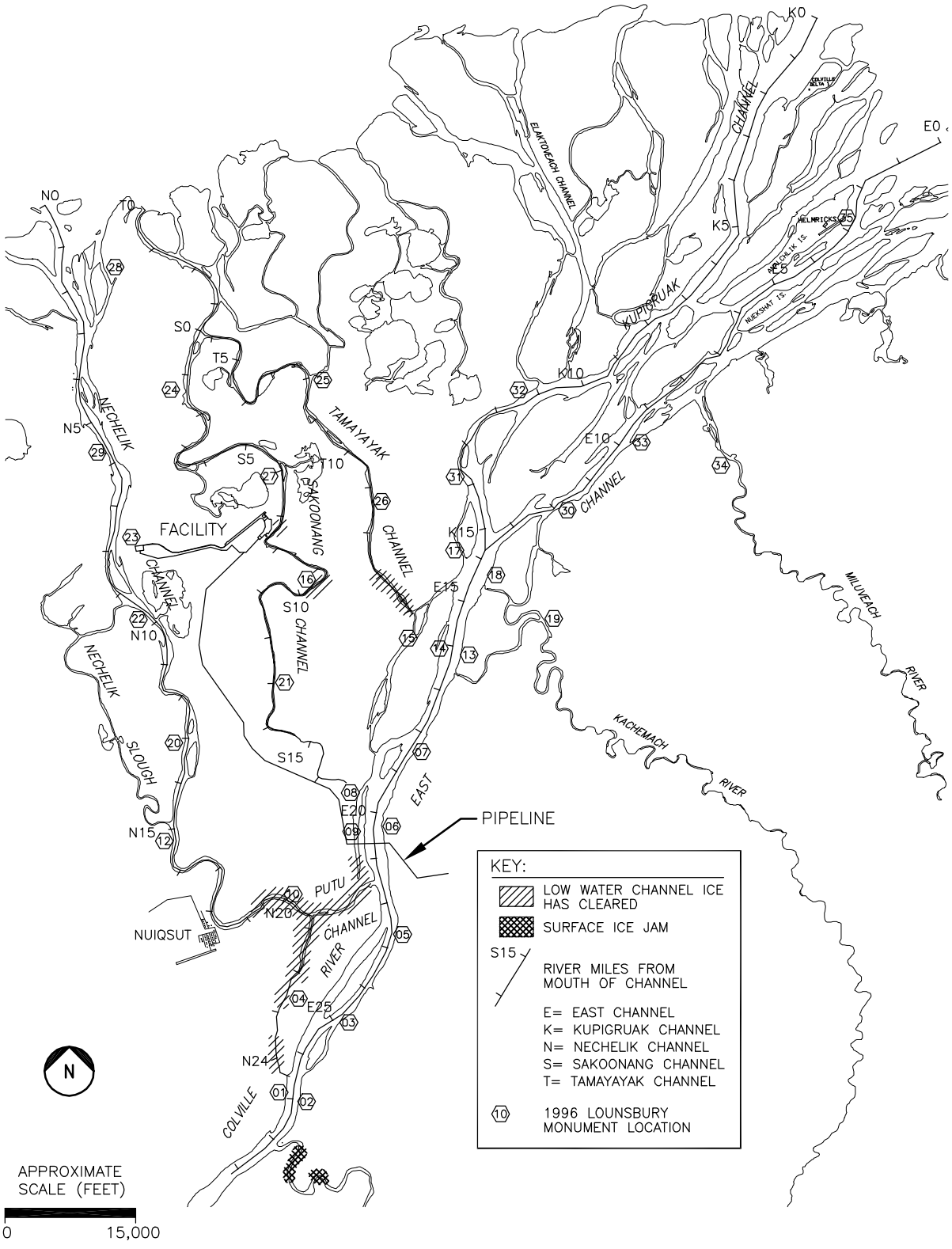
24531M01.dwg

Baker	Michael Baker Jr., Inc.		
DATE: 12/26/00		PROJECT: 24531-164-0000	
DRAWN: TM		FILE:	
CHECKED: JWA		SCALE: AS NOTED	

2000 SPRING BREAKUP
COLVILLE RIVER DELTA

LOW WATER CHANNEL ICE SURVEY
JUNE 6, 2000 AT 15:00 HOURS

FIGURE:
B-1



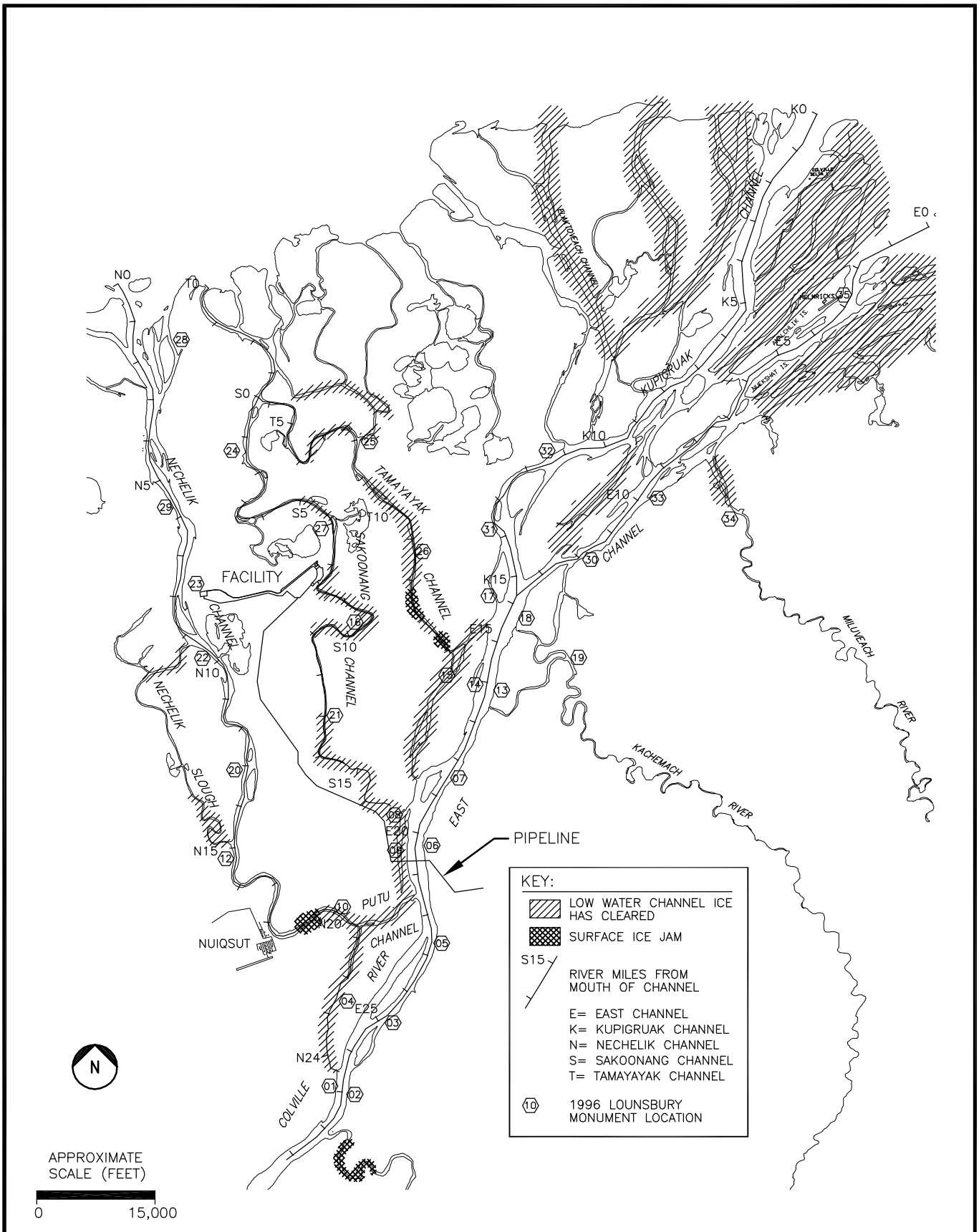
24531M02.dwg

Baker	Michael Baker Jr., Inc.		
DATE: 12/26/00		PROJECT: 24531-164-0000	
DRAWN: TM		FILE:	
CHECKED: JWA		SCALE: AS NOTED	

2000 SPRING BREAKUP
COLVILLE RIVER DELTA

LOW WATER CHANNEL ICE SURVEY
JUNE 7, 2000 AT 10:00 HOURS

FIGURE:
B-2



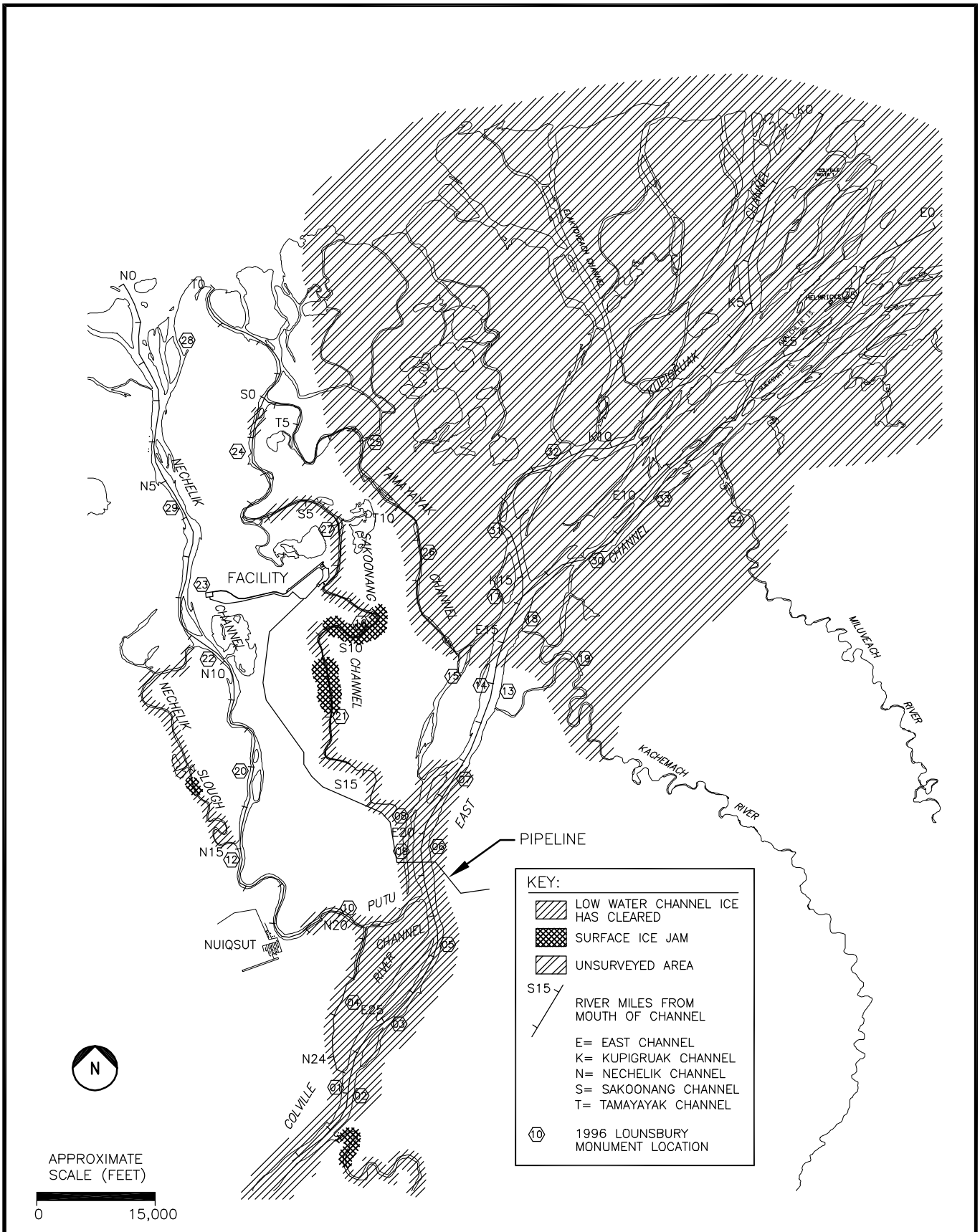
24531M03.dwg

Baker	Michael Baker Jr., Inc.		
DATE:	12/26/00	PROJECT:	24531-164-0000
DRAWN:	TM	FILE:	
CHECKED:	JWA	SCALE:	AS NOTED

2000 SPRING BREAKUP
COLVILLE RIVER DELTA

LOW WATER CHANNEL ICE SURVEY
JUNE 8, 2000 AT 15:43 HOURS

FIGURE:
B-3



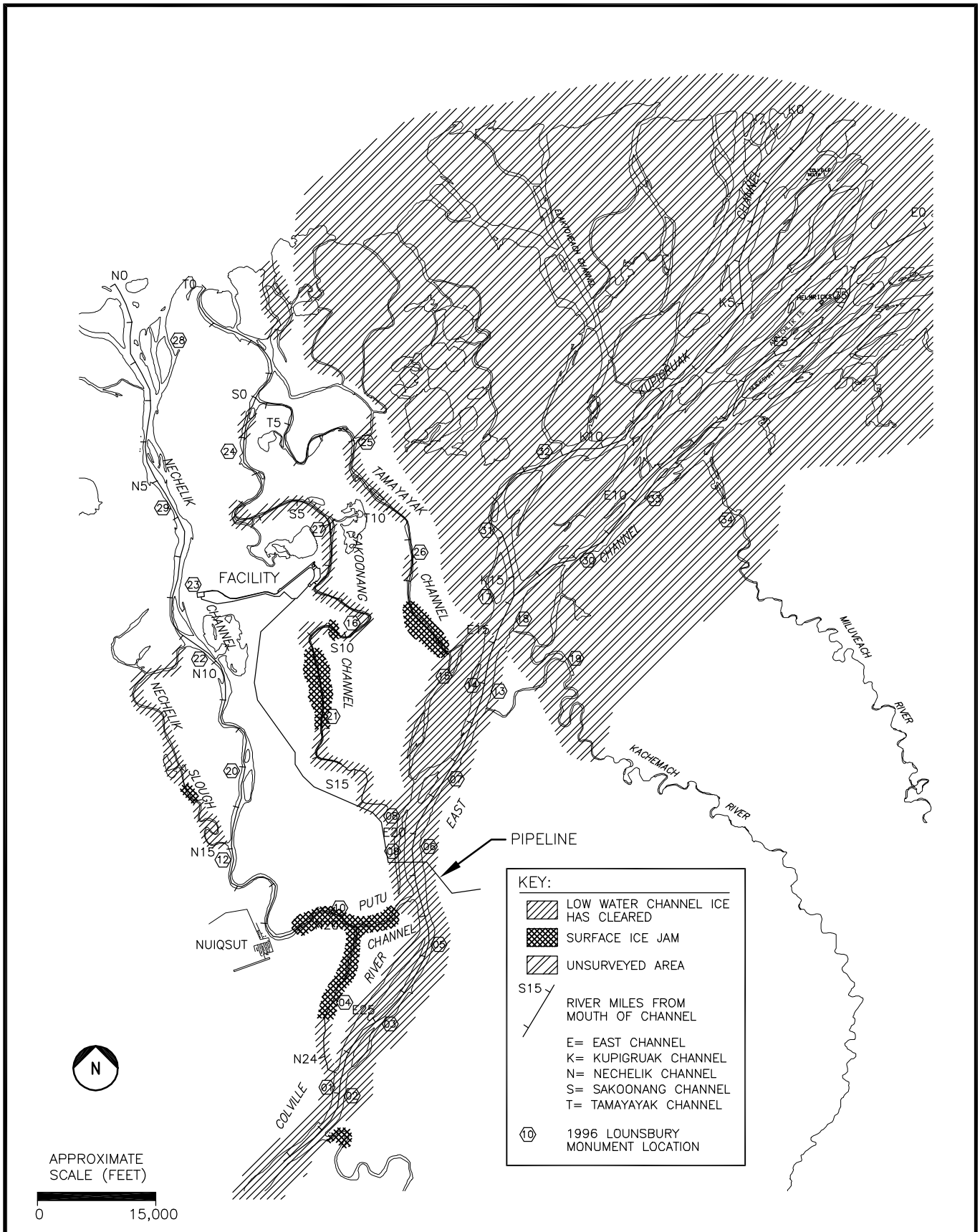
24531M04.dwg

Baker	Michael Baker Jr., Inc.		
DATE:	12/26/00	PROJECT:	24531-164-0000
DRAWN:	TM	FILE:	
CHECKED:	JWA	SCALE:	AS NOTED

2000 SPRING BREAKUP
COLVILLE RIVER DELTA

LOW WATER CHANNEL ICE SURVEY
JUNE 9, 2000

FIGURE:
B-4



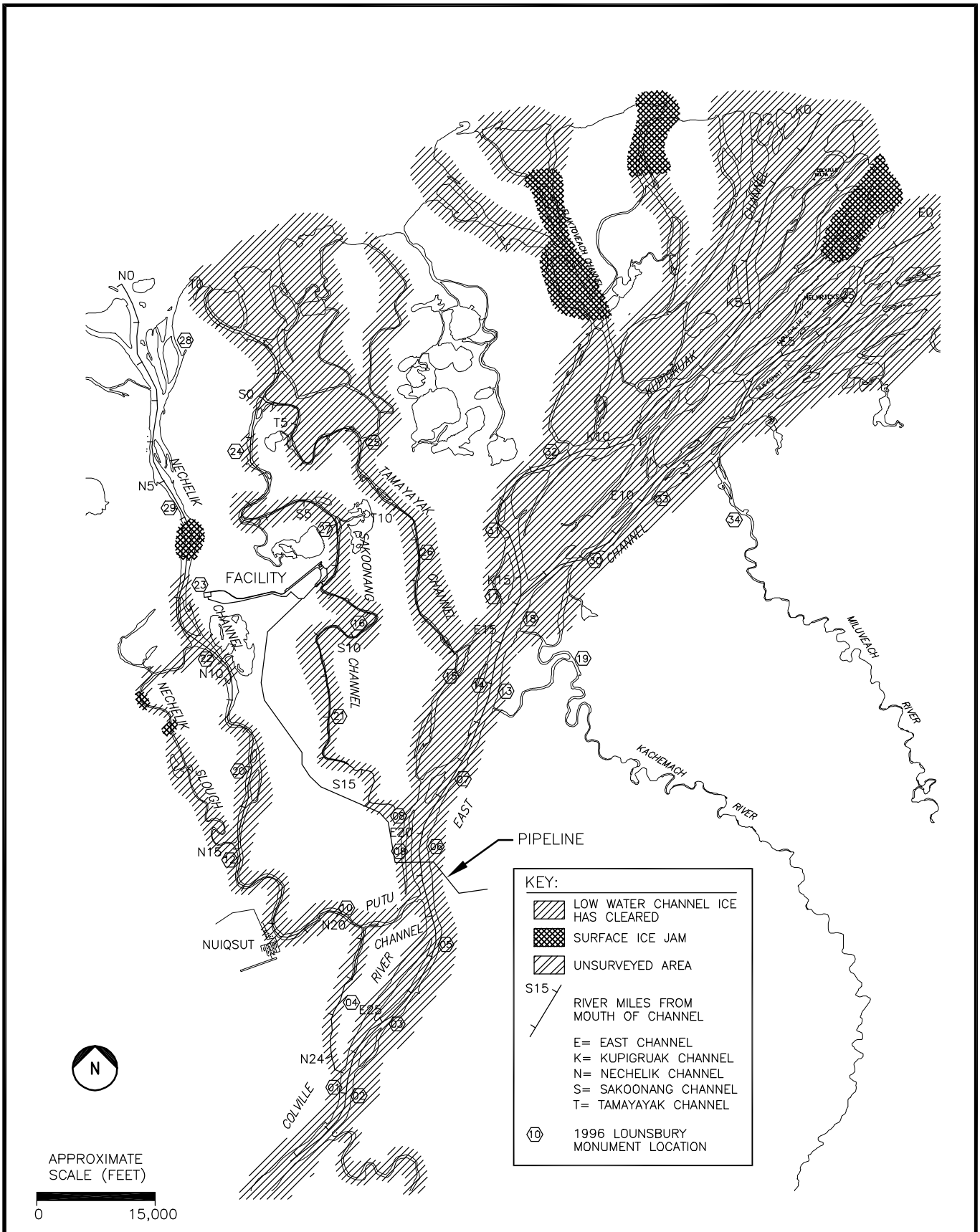
24531M05.dwg

Baker	Michael Baker Jr., Inc.		
DATE:	12/26/00	PROJECT:	24531-164-0000
DRAWN:	TM	FILE:	
CHECKED:	JWA	SCALE:	AS NOTED

2000 SPRING BREAKUP
COLVILLE RIVER DELTA

LOW WATER CHANNEL ICE SURVEY
JUNE 10, 2000 AT 18:00 HOURS

FIGURE:
B-5



24531M07.dwg

Baker	Michael Baker Jr., Inc.		
DATE:	12/26/00	PROJECT:	24531-164-0000
DRAWN:	TM	FILE:	
CHECKED:	JWA	SCALE:	AS NOTED

2000 SPRING BREAKUP
COLVILLE RIVER DELTA

LOW WATER CHANNEL ICE SURVEY
JUNE 12, 2000 AT 15:30 HOURS

FIGURE:
B-6

Appendix C. Photographs

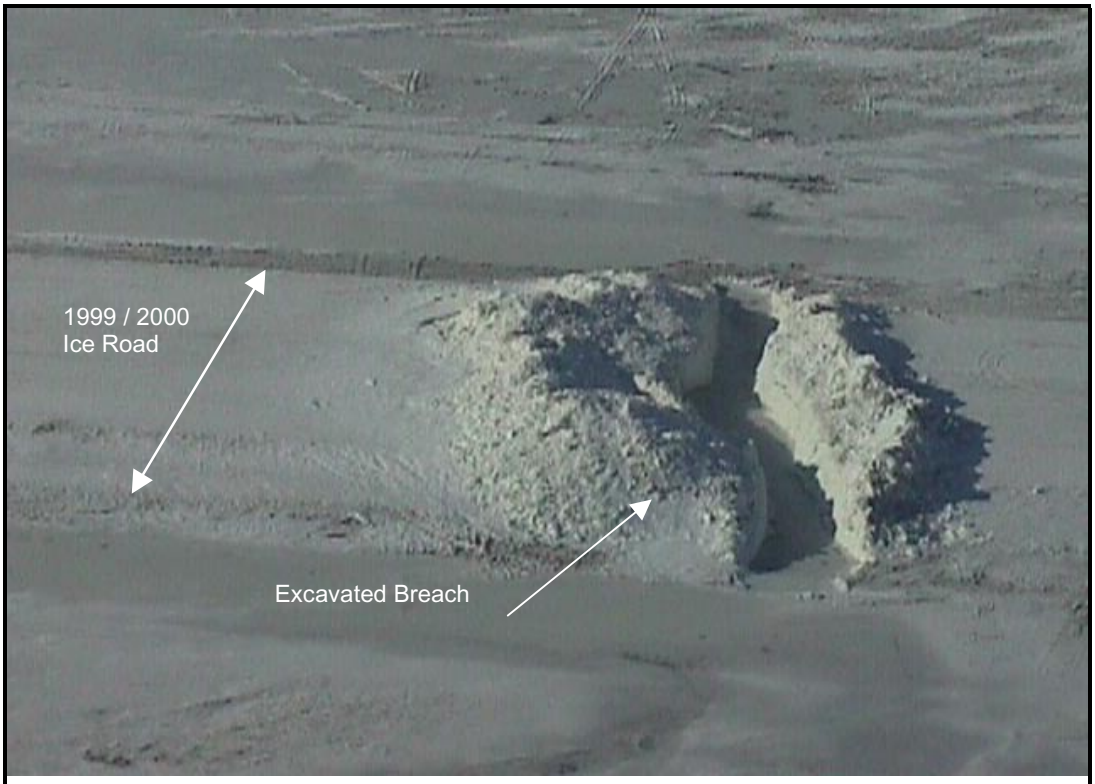


Figure C- 1 Breach in Ice Bridge Across Nechelik Channel

Figure C- 2 Staff Gage at Monument 12 Monitoring Site

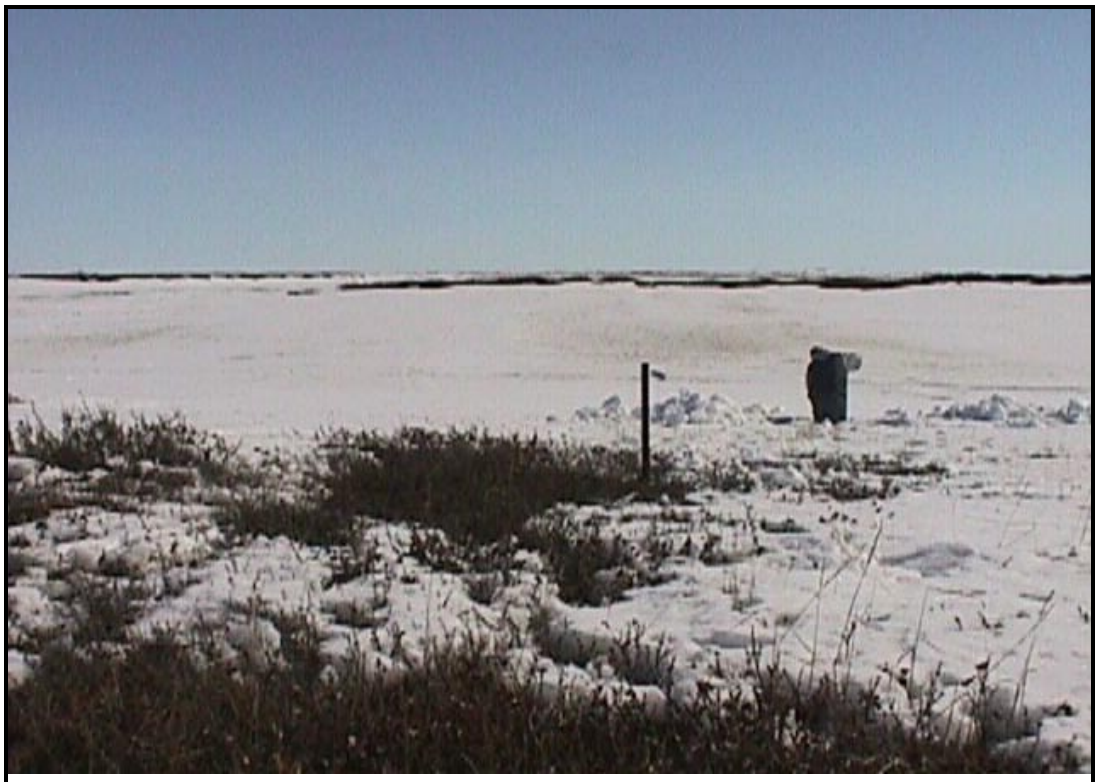


Photo 06/05/00 00060513.jpg

Figure C- 3 Nechelik Slough, Downstream Monitoring Site

Photo 06/08/00 00060802.jpg

Figure C- 4 Nechelik Slough Looking Northeast, Photo Taken Just North Monument 12

Photo 06/08/00 00060808.jpg

Figure C- 5 Looking South at Monument 22 Monitoring Site

Photo 06/09/00 00060908.jpg

Figure C- 6 Looking West at Monument 12 Monitoring Site

Photo 06/09/00 00060910.jpg

Figure C- 7 Looking West From Nechelik Slough Upstream Monitoring Site

Photo 06/09/00 00060912.jpg

Figure C- 8 Looking Southeast From Nechelik Slough Monitoring Site

Photo 06/09/00 00060914.jpg

Figure C- 9 Looking Northeast From Monument 22 Monitoring Site

Photo 06/09/00 00060915.jpg

Figure C- 10 Looking Northeast From Monument 22 Monitoring Site

Photo 06/10/00 00061014.jpg

Figure C- 11 Looking West From Monument 12 Monitoring Site

Photo 06/10/00 00061016.jpg

Figure C- 12 Looking West From Nechelik Slough Upstream Monitoring Site

Photo 06/10/00 00061017.jpg

Figure C- 13 Looking North From Nechelik Slough Upstream Monitoring Site

Photo 06/10/00 00061020.jpg

Figure C- 14 Looking East From Nechelik Slough Downstream Monitoring Site

Photo 06/10/00 00061022.jpg

Figure C- 15 Looking Northeast From Monument 22 Monitoring Site

Photo 06/11/00 00061110.jpg

Figure C- 16 Looking West From Monument 12 Monitoring Site

Photo 06/110// 00061112.jpg

Figure C- 17 Looking West From Nechelik Slough Upstream Monitoring Site

Photo 06/11/00 00061113.jpg

Figure C- 18 Looking North From Nechelik Slough Upstream Monitoring Site

Figure C- 19 Looking East From Nechelik Slough Downstream Monitoring Site

Figure C- 20 Looking Northeast From Monument 22 Monitoring Site

Photo 06/11/00 00061118r1.jpg

Figure C- 21 Looking Northeast From Monument 22 Monitoring Site. Note Staff Gage A Submerged.

Photo 06/11/00 00061119.jpg

Figure C- 22 Looking North From CD-2 Pad at Nechelik Channel Low Water Channel Ice. Photo From Helicopter.