Colville River Delta
2- and 10-Year Flood Models

Submitted to

PHILLIPS 66

PHILLIPS Alaska, Inc.
A Subsidiary of PHILLIPS PETROLEUM COMPANY

April 17, 2001

Baker

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For

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By

Baker

Michael Baker Jr., Inc.
4601 Business Park Blvd., # 42
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April 17, 2001
24307-MBJ-RPT-001

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April 16, 2001

Phillips Alaska, Inc.
700 G Street
Anchorage, AK 99501

Attn: Mr. Jeff Lipscomb

**RE: COLVILLE RIVER DELTA 2- AND 10-YEAR FLOOD MODELS
CONTRACT NO. AK990053, CRW NO. ANC012, AMENDMENT NO. 2**

Michael Baker Jr., Inc. (Baker) has completed the two-dimensional surface water analysis for the 2- and 10-year floods in the Colville River Delta. The purpose of this analysis was to provide water surface profiles suitable for addressing the requirements for floodwater monitoring specified in the U.S. Army Corps of Engineers (USACE) Permit 2-960874. The permit states:

> *The monitoring shall be done for the first five years after completion of construction, and for high water events greater than the 10-year predicted flood water surface elevation event.* [The permit goes on to say that]...*the annual report shall contain data and analysis related to ... the relationship of the observed peak flow with the predictive model...*

Under a separate scope of work, permanent staff gages were installed at 10 locations around the Alpine Facility to monitor water surface elevations during spring floods. The results of our analysis, combined with the permanent staff gages, provide Alpine personnel a means to monitor flood water levels that will satisfy the USACE permit requirements.

Tables and figures presenting the analysis results are included as Attachment 1 and Attachment 2. Descriptions of each permanent staff gage and design details are outlined in Attachment 3[1]. Attachment 4[2] presents the permanent staff gage as-built information.

1. *Typical Drawing and Suggested Locations for Permanent Staff Gages.* Letter to Mr. William Fowler, ARCO Alaska, Inc. from Michael Baker Jr., Inc., March 24, 2000.
2 *Alpine Facility Staff Gage Location.* Transmittal to Michael Baker Jr., Inc. from Kuupik/LCMF, May 18, 2000.

Background

The original Colville River Delta two-dimensional surface water model[3] developed by Shannon & Wilson was created to provide peak water surface elevations and velocities for design of the Alpine facilities and pipeline. In addition to providing design values, the model was used to estimate the impact the facilities would have on the environment with respect to large spring floods. The original model was developed to predict peak water surface elevations and velocities for the 50-, 100-, and 200-year flood events.

In the fall of 1997, field surveys around the proposed facilities showed that a portion of the ground surface elevations used to develop the original finite element mesh did not match the project datum (British Petroleum Mean Sea Level (BPMSL)) particularly well. Consequently, the ground surface elevations of the finite element mesh were improved to match the field surveys. In addition to the revised topography, the finite element mesh along the proposed facility road was updated to reflect the March 1998 proposed alignment. This included the addition of the proposed 440-foot bridge with spill through abutments (only a single bridge was anticipated at that time). The model was rerun and the analysis presented in a report by Michael Baker Jr., Inc.[4] Culverts were not represented in either the original model or the revised model as they were expected (and still are) to have little impact on overall water surface elevations.

Methods

The finite element mesh that was developed in 1998 was used to initiate modeling for the 2- and 10-year flood events. The magnitude of the 2- and 10-year flood events are taken from the Colville River Flood-Frequency Analysis[5] and are 240,000 and 470,000 cubic feet per second, respectively. A two-stage approach was adopted for this modeling program. The first stage consisted of taking the finite mesh generated in 1998 and running the 2- and 10-year peak discharges until the convergence tolerances of the model were satisfied. The second stage was to input the as-built bridge configurations at Alpine and rerun the simulations. Modifications made to the mesh were the addition of a smaller bridge (which was added to the design after the original model was run) and the widening of the larger bridge to account for its vertical abutments.

Results

Peak water surface elevations for the 2- and 10-year floods across the Colville River Delta as a whole are presented in Figures 1 and 5, respectively. Peak water surface elevations at selected

3 *Colville River Two-Dimensional Surface Water Model.* Shannon & Wilson, 1997. Prepared for Michael Baker Jr., Inc., Anchorage, Alaska.
4 *Colville River Delta Two-Dimensional Surface Water Model Project Update.* Michael Baker Jr., Inc., 1998. Prepared for ARCO Alaska, Inc., Anchorage, Alaska
5 *Colville River Flood-Frequency Analysis.* Michael Baker Jr., Inc. and Shannon & Wilson, Inc., 1998. Prepared for ARCO Alaska, Inc., Anchorage, Alaska

locations in the main channels (the same locations as presented in previous reports) are presented in Table 1.

Near the Alpine facilities, peak water surface elevations, water depths, and depth averaged velocities for the 2-year flood are presented in Figures 2, 3, and 4, respectively. Similarly, peak water surface elevations, water depths, and depth-averaged velocities for the 10-year flood are presented in Figures 6, 7, and 8, respectively.

Peak water surface elevations and water depths at the permanent staff gages are presented in Table 2. During the 2-year flood, the majority of the gravel structures are dry. During the 10-year flood, the average water surface elevation on the upstream side of the facilities is calculated to be 8.6 feet BPMSL. Since the model does not contain culverts along the road from the Alpine main facilities to CD-2, it is indicating that the area downstream of the road is dry. In actuality, there will be some flow through the culverts during a 10-year flood event, however, the volume of water through the culverts is expected to be low and should not cause significant amounts of flow or water velocities in the area.

Ice Jamming

A secondary objective of this report is to discuss the probable effects of a partial ice cover or ice jams on water surface elevations due to floods smaller than the 10-year event. While it is impossible to predict where and to what extent ice jams will occur, a general description and some hypotheses to the effects on water surface elevations are possible.

During smaller floods, ice jams can have a fairly significant effect on water surface elevations when breakup discharges remain within the channel banks. Ice jams also play a significant role as to which channels and tributaries the discharge may pass through. Observations made in 1998 and 1999 at Monument 22 illustrate this point (Monument 22 is located in the Nechelik Channel to the west of CD-2). In 1998, the peak water surface elevation at Monument 22 was recorded as 10.2 feet[6] and in 1999 was recorded as 5.9 feet[7]. While there is more than a 4 foot difference in peak water surface elevation, the peak discharges estimated at the head of the delta for 1998 and 1999 were very similar in magnitude at 213,000 cfs and 203,000 cfs, respectively. In addition, the local channel ice conditions at the time of the peak water surface elevation were similar for both years. It is hypothesized that the quantity of water flowing in the Nechelik Channel in 1999 was considerably lower than in 1998 and was probably due to the ice conditions that governed flow at the mouth of the Nechelik Channel.

A more localized consequence on water surface elevations can be from the ice cover remaining in a particular channel when the peak flows occur. This ice cover is not deposited from ice floes

6 *1998 Spring Breakup and Hydrologic Assessment, Colville River Delta* Michael Baker Jr., Inc., 1998. Prepared for ARCO Alaska, Inc. Anchorage, Alaska
7 *1999 Spring Breakup and Hydrologic Assessment, Colville River Delta* Michael Baker Jr., Inc., 1999. Prepared for ARCO Alaska, Inc. Anchorage, Alaska

that may cause an ice jam to occur, but is a result of the channel ice that was frozen in place and has yet to thaw or breakup. Again, Monument 22 will be used to illustrate this point. In 2000, the peak water surface elevation at Monument 22 was recorded as 9.6 feet, and the peak discharge at the head of the delta was estimated at 580,000 cfs[8]. It can be seen that the peak discharge in 2000 was considerably higher than in 1998 (an estimated 25-year return period vs. a 2-year return period), however, the peak water surface elevation at Monument 22 was lower. During 2000, the low water channel ice at Monument 22 had cleared, but it had not cleared in 1998. From the available data, it cannot be shown that the channel ice was entirely responsible for the increased water surface elevations, however, is felt that the channel ice was a contributing factor and at least partly responsible.

The ability of ice jams to effect water surface elevations will usually be less severe during large flood events. The floodplain of the delta is generally flat and once water breaches the channel banks, it has many places to spread out and flow. Consequently, localized channel ice jams and ice jams that occur on the floodplain usually have little effects on water surface elevations once flow is out of bank.

Please call if you have any questions or comments.

Sincerely,

MICHAEL BAKER JR., INC.

Jeffrey A. Baker, PE
Senior Engineer

Attachments

1. Tables
2. Figures
3. Letter Report, Typical Drawing and Suggested Locations for Permanent Staff Gages
4. Transmittal, Alpine Facility Staff Gage Locations, As-Built

8 *Spring 2000 Breakup Monitoring, Colville River Delta* Michael Baker Jr., Inc., 2000. Prepared for Phillips Alaska, Inc. Anchorage, Alaska

Attachment 1 - Tables

Table 1	Predicted Water Surface Elevations Within the Channels During the 2- and 10-Year Floods
Table 2	Predicted Water Surface Elevations at Permanent Staff gage Locations During the 2- and 10-Year Floods

Baker

Table 1: Predicted Water Surface Elevations Within the Channels During The 2- And 10-Year Floods

Location	State Plan Coordinates (ft)		Predicted Water Surface Elevation (ft)	
	Northing	Easting	2-Year Flood	10-Year Flood
East Channel				
Near E27.09	5,909,644	385,761	13.8	19.4
Near E24.92	5,919,492	390,811	12.8	18.2
Near E22.75	5,929,386	397,802	12.4	17.2
Near E20.56	5,940,315	396,669	10.9	15.7
Near E18.47	5,949,082	400,872	10.0	14.5
Near E16.32	5,959,033	406,361	9.0	13.2
Near E14.32	5,969,545	410,047	8.1	11.8
Near E09.76	5,984,872	427,058	6.4	9.0
Near E03.00	6,007,417	456,601	3.5	4.3
Kupigrual Channel				
Near K11.65	5,988,634	414,617	6.7	9.5
Nechelik Channel				
Near N22.65	5,922,041	385,366	12.4	17.5
Near N19.95	5,933,329	386,019	11.3	16.5
Near N17.8	5,934,291	377,889	9.8	14.4
Near N15.07	5,941,514	373,720	8.6	12.2
Near N12.88	5,952,813	375,779	7.3	10.7
Near N09.47	5,968,025	370,955	5.9	8.6
Near N07.47	5,976,223	368,261	5.1	7.2
Near N05.42	5,987,622	367,793	4.3	5.8
Near N02.03	6,006,506	368,960	3.2	3.4
Sakoonang Channel				
Near S16.52	5,946,219	393,958	10.7	15.3
Near S13.07	5,957,945	385,965	7.6	11.5
Near S09.80	5,968,672	390,519	6.2	9.8
Near S05.07	5,985,818	384,698	5.0	8.2
Near S01.38	5,991,840	377,691	4.5	7.1
Tamayayak Channel				
Near T12.62	5,972,400	397,793	7.7	11.3
Near T08.20	5,992,255	391,674	6.1	8.9

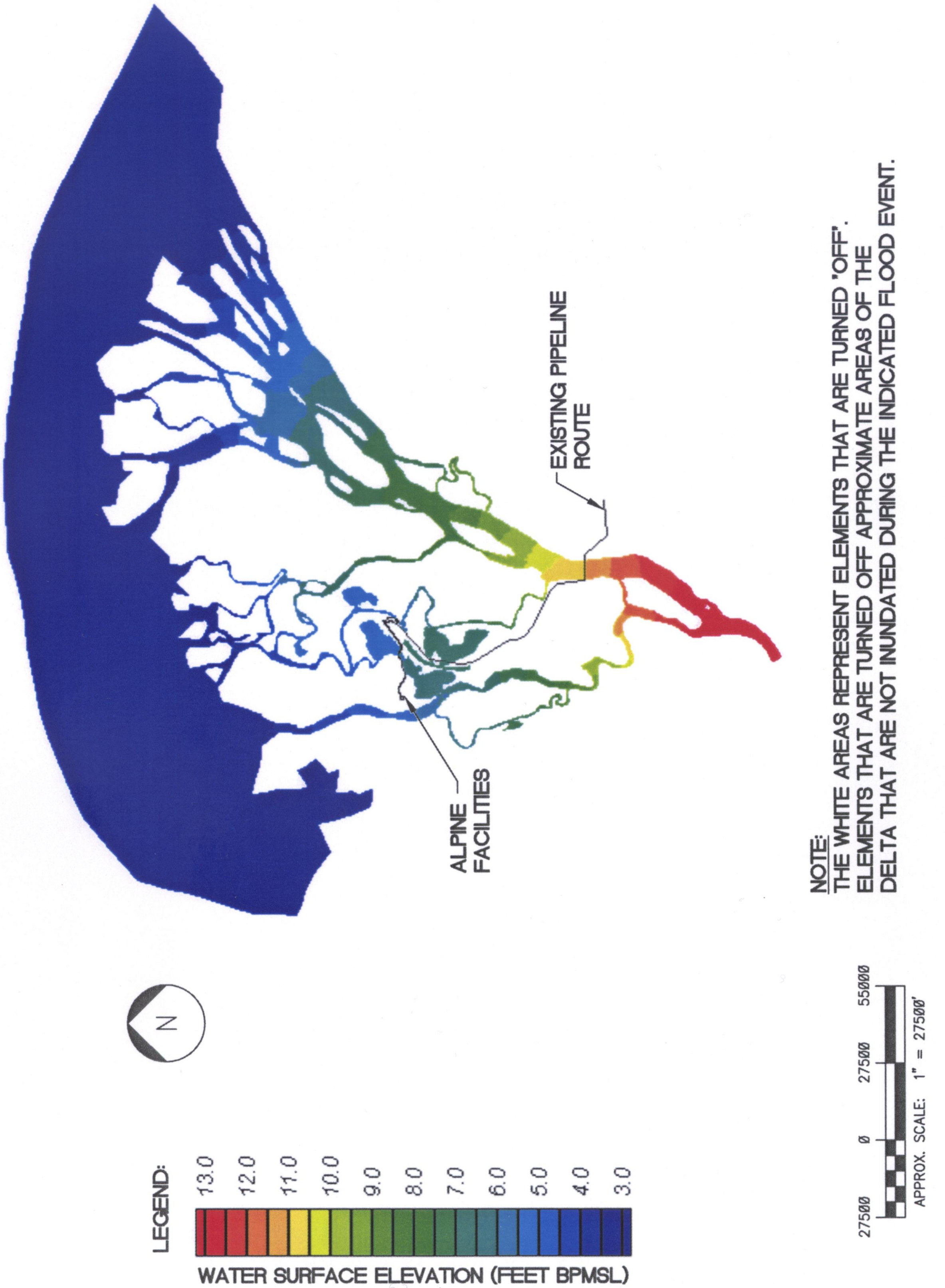
Notes:
1. All elevations are reported in BPMSL.

Table 2: Predicted Water Surface Elevations At Permanent Staff Gage Locations During The 2- And 10-Year Floods

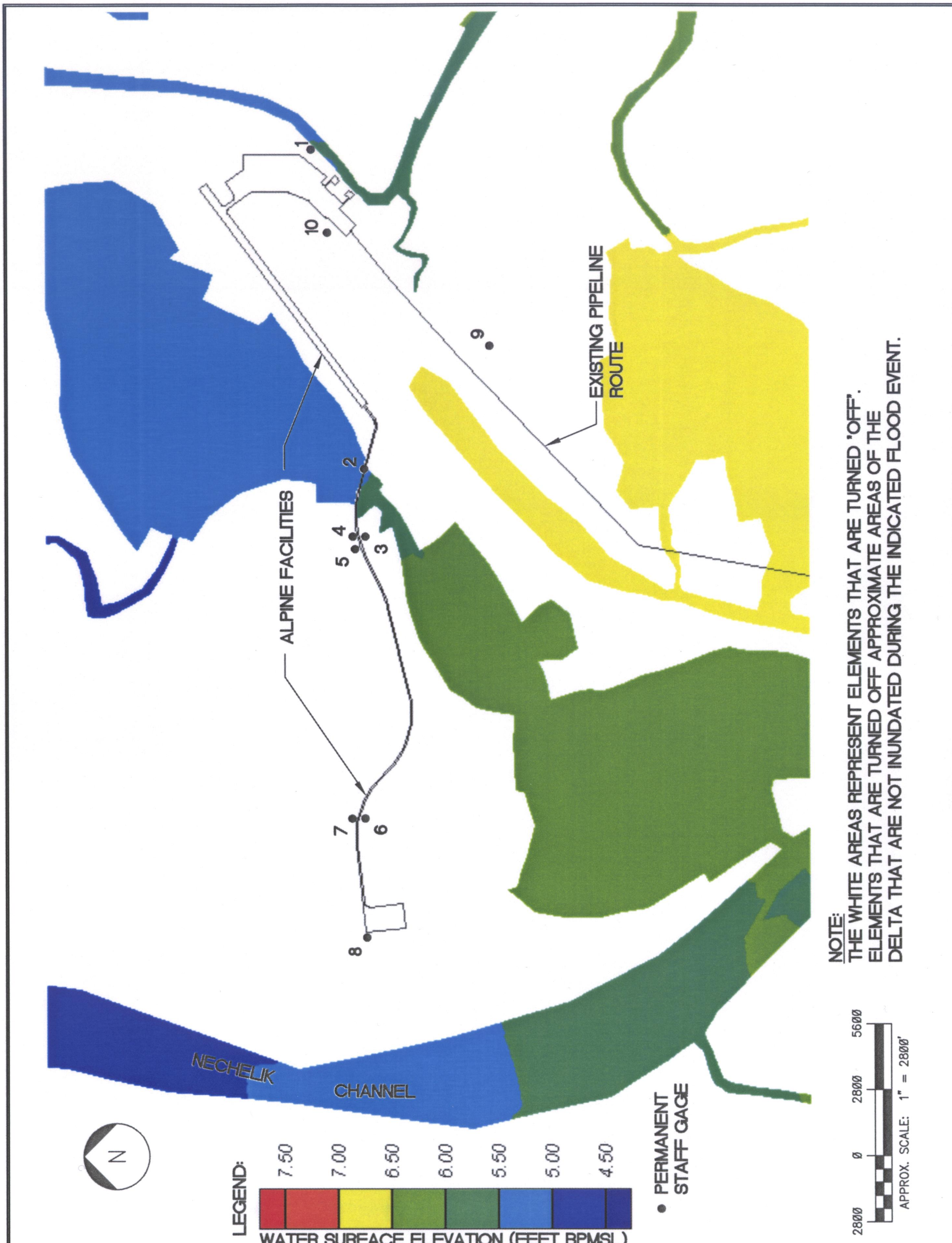
Permanent Staff Gage Number	State Plan Coordinates (ft)		Ground Surface Elevation	Model Results for 2-Year Flood [5]		Model Results for 10-Year Flood [5]	
	Northing	Easting		Water Surface Elevation	Water Depth	Water Surface Elevation	Water Depth
1	5975948	386920	1.9 [3]	5.5	3.6	9.0	7.1
2	5974961	380306	3.7 [4]	5.3	1.6	8.2	4.5
3	5975040	379259	5.9 [3]	----	----	8.7	2.8
4	5975173	379222	5.0 [4]	----	----	8.1	3.1
5	5975031	379071	5.2 [4]	----	----	8.4	3.2
6	5974982	373555	6.3 [4]	----	----	8.9	2.6
7	5975132	373586	7.5 [3]	----	----	----	----
8	5974855	371261	8.2 [3]	----	----	8.9	0.7
9	5972643	383030	8.0 [3]	----	----	10.0	2.0
10	5975797	385464	6.7 [3]	----	----	----	----

Notes:
1. All elevations are reported in BPMSL.
2. Coordinates are shown Alaska State Plane, Zone 4, NAD 27 and were surveyed by LCMF Inc., (Doc. LCMF-018, 5/17/00)
3. Ground surface elevations survey by LCMF Inc., (Doc. LCMF-018, 5/17/00).
4. Ground surface elevations are from finite element mesh dated 4/27/98.
5. Empty cells are areas where the two dimensional surface water model indicated dry ground.

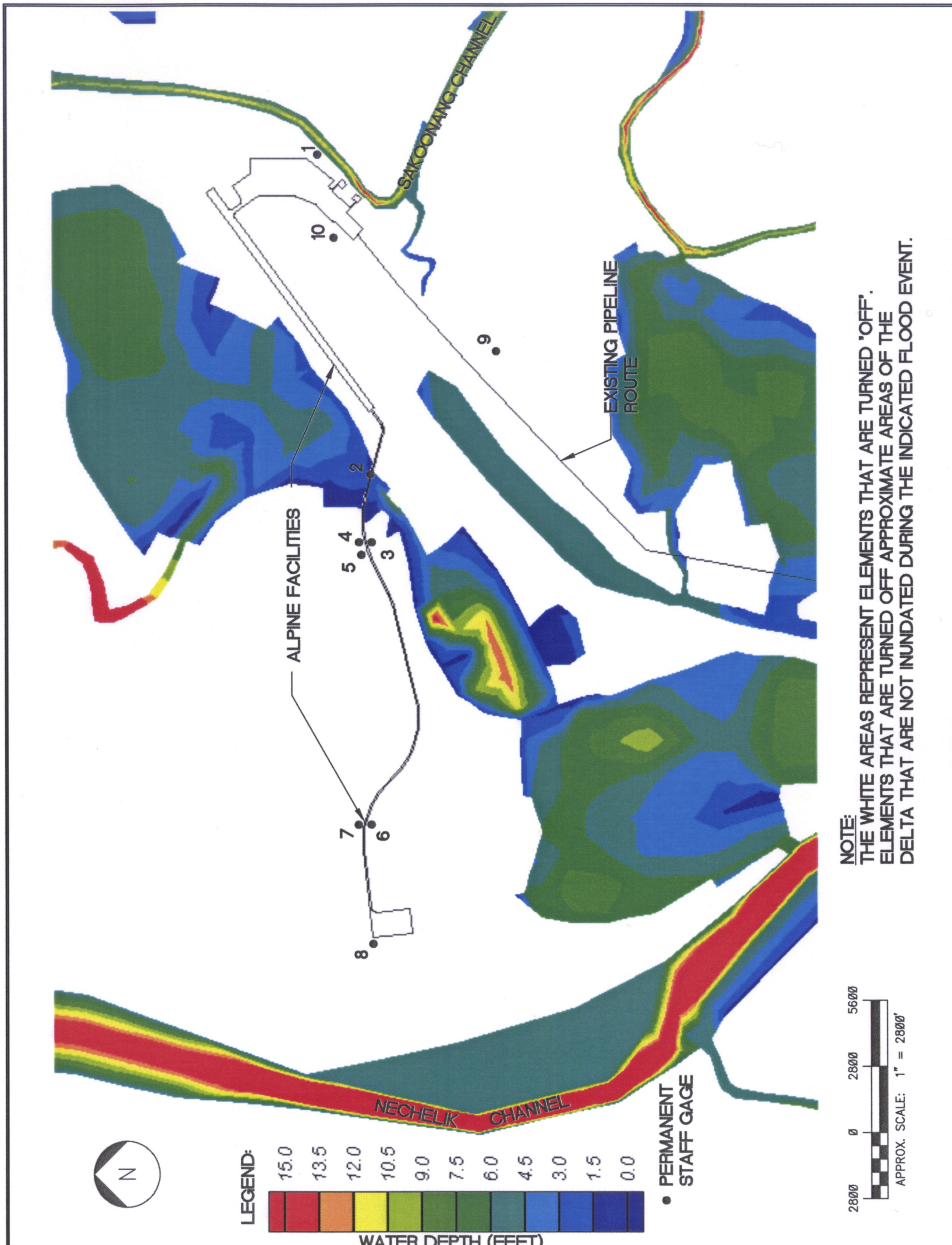
Attachment 2 - Figures



PHILLIPS 66 — **PHILLIPS Alaska, Inc.** A Subsidiary of PHILLIPS PETROLEUM COMPANY		TITLE: PREDICTED 2-YEAR FLOOD, WATER SURFACE ELEVATIONS ACROSS THE COLVILLE DELTA	FIGURE: 1
Baker — Michael Baker Jr., Inc.	DRAWING NO: 24307G005	PAGE: 1 OF 1	REV: A



PHILLIPS 66 — **PHILLIPS Alaska, Inc.** A Subsidiary of PHILLIPS PETROLEUM COMPANY	TITLE: PREDICTED 2-YEAR FLOOD, WATER SURFACES ELEVATIONS AT THE ALPINE FACILITY		FIGURE: 2
Baker — Michael Baker Jr., Inc. — DRAWING NO: 24307G006	PAGE: 1 OF 1	REV: A	



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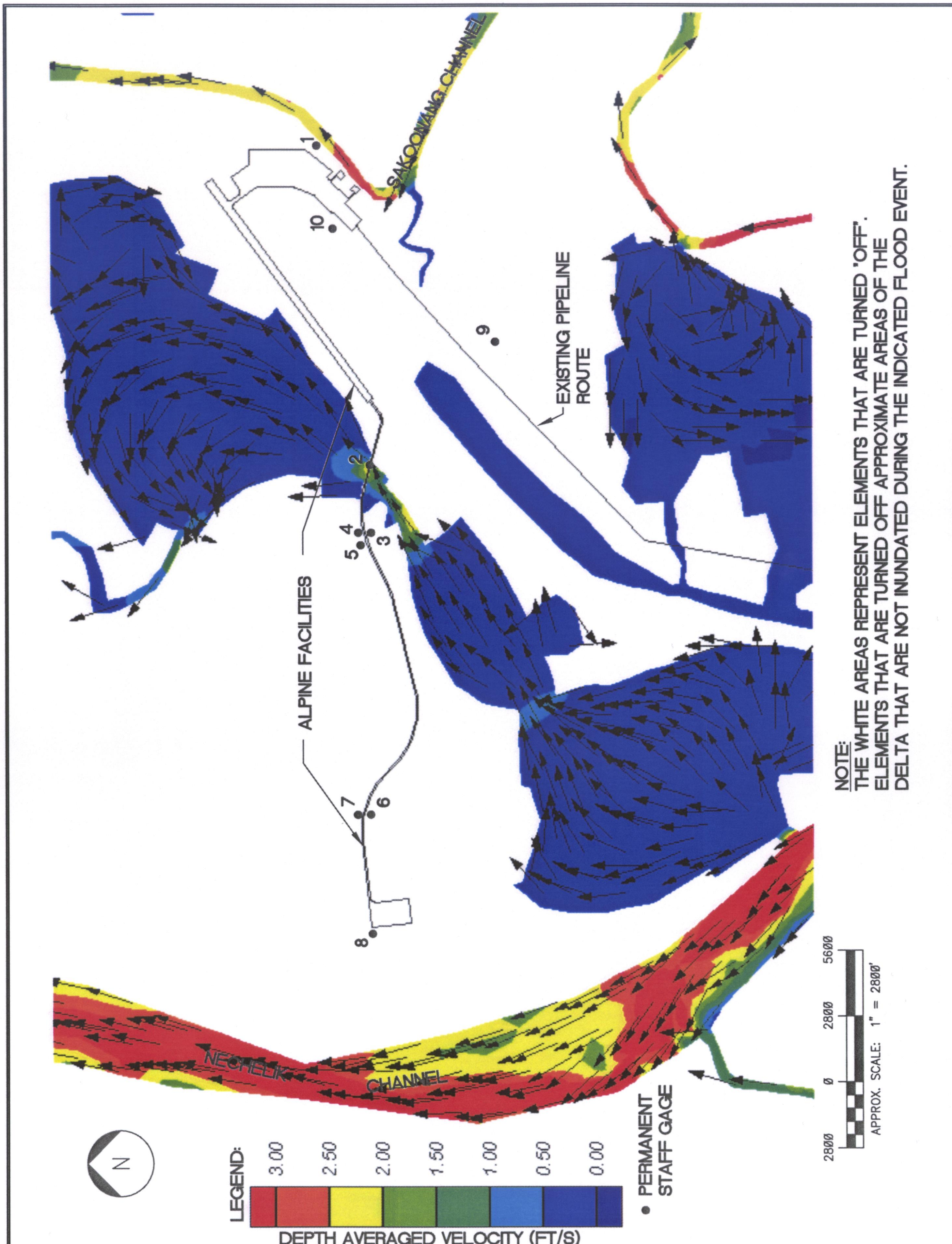
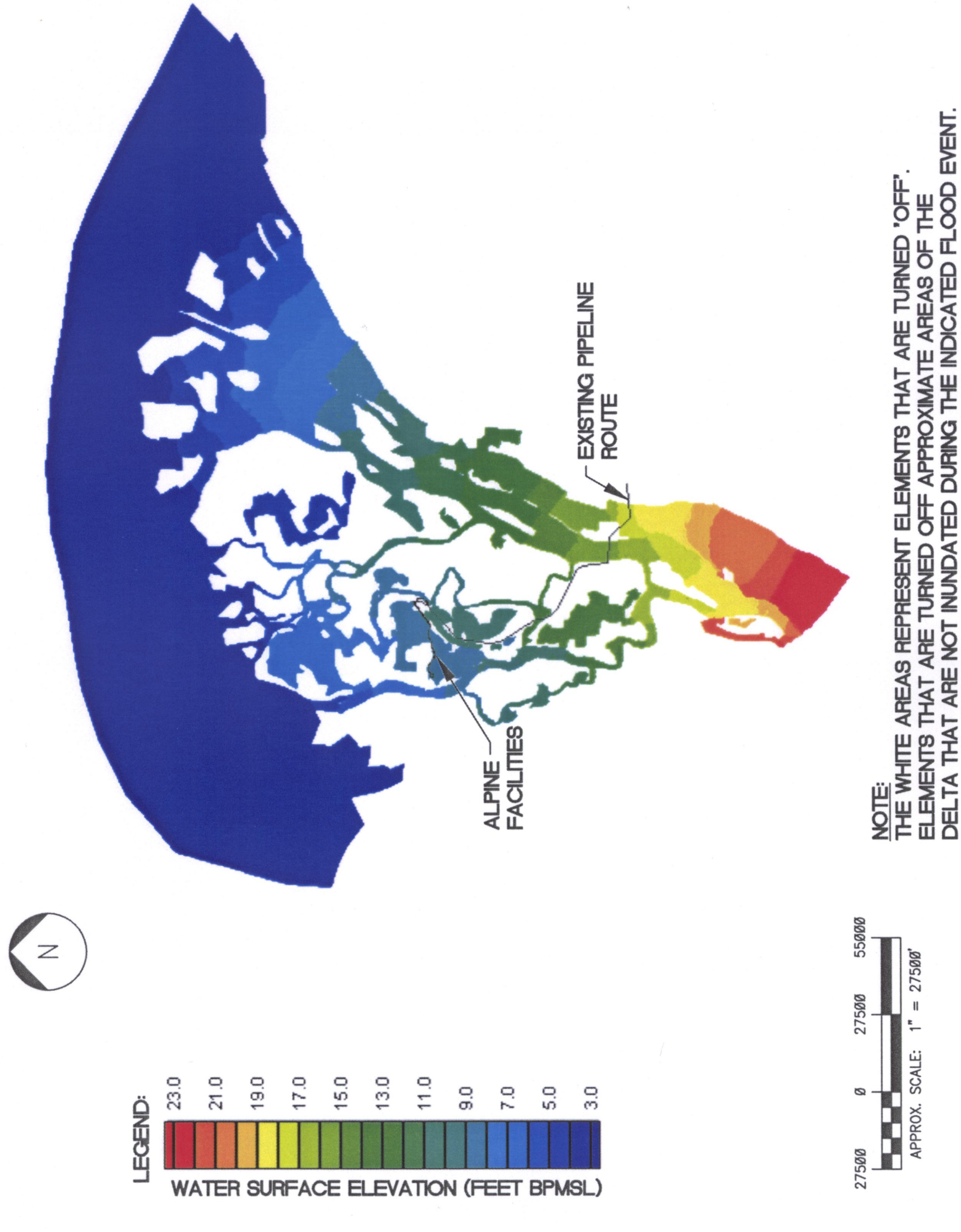
TITLE: PREDICTED 2-YEAR FLOOD, WATER DEPTHS AT THE ALPINE FACILITY

FIGURE: 3

Baker Michael Baker Jr., Inc.	DRAWING NO: 24307G007	PAGE: 1 OF 1	REV: A



PHILLIPS 66 — PHILLIPS Alaska, Inc. A Subsidiary of PHILLIPS PETROLEUM COMPANY	TITLE: PREDICTED 2-YEAR FLOOD, DEPTH AVERAGED VELOCITY AT THE ALPINE FACILITY		FIGURE: 4
Baker — Michael Baker Jr., Inc. — DRAWING NO: 24307G008	PAGE: 1 OF 1	REV: A	



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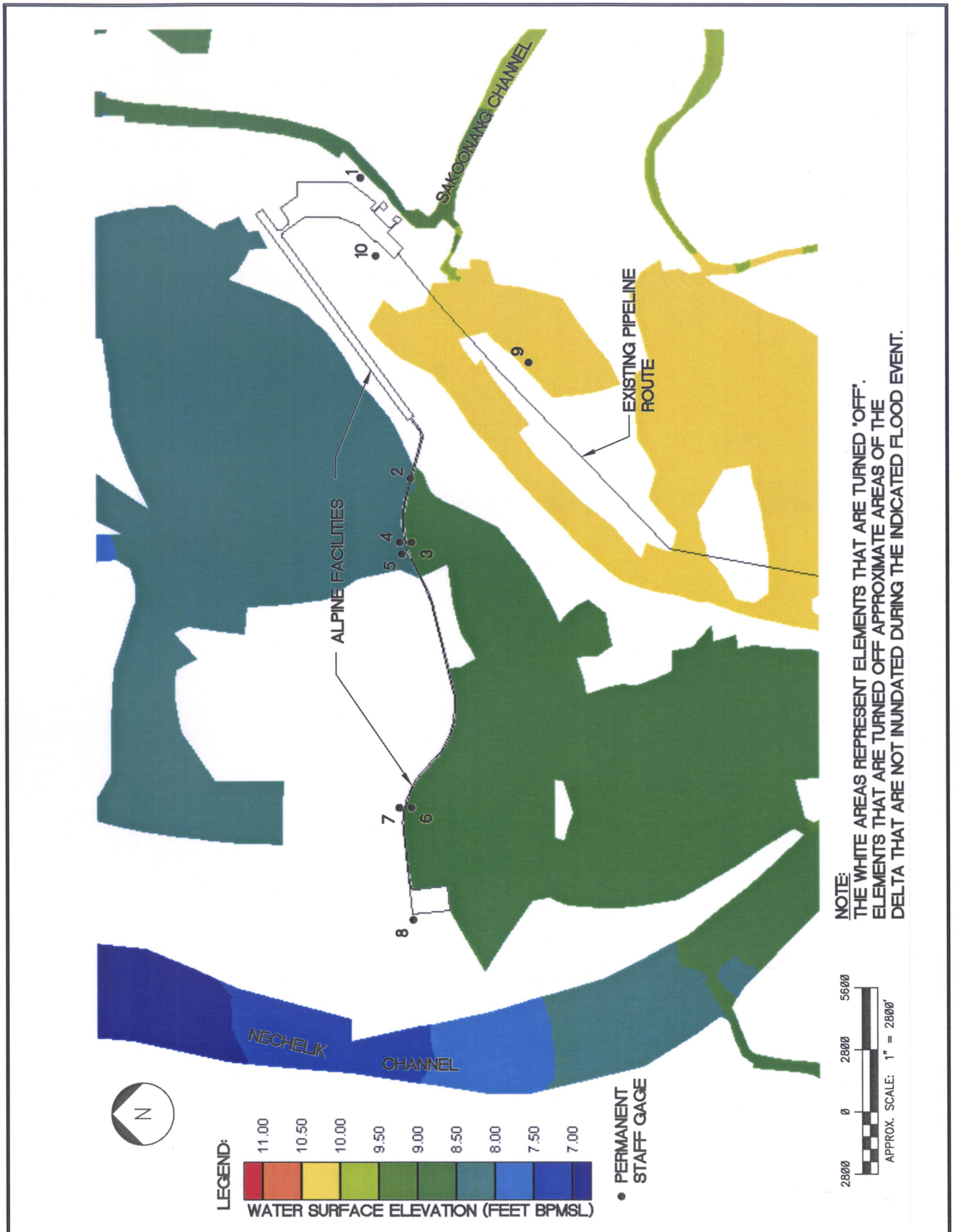
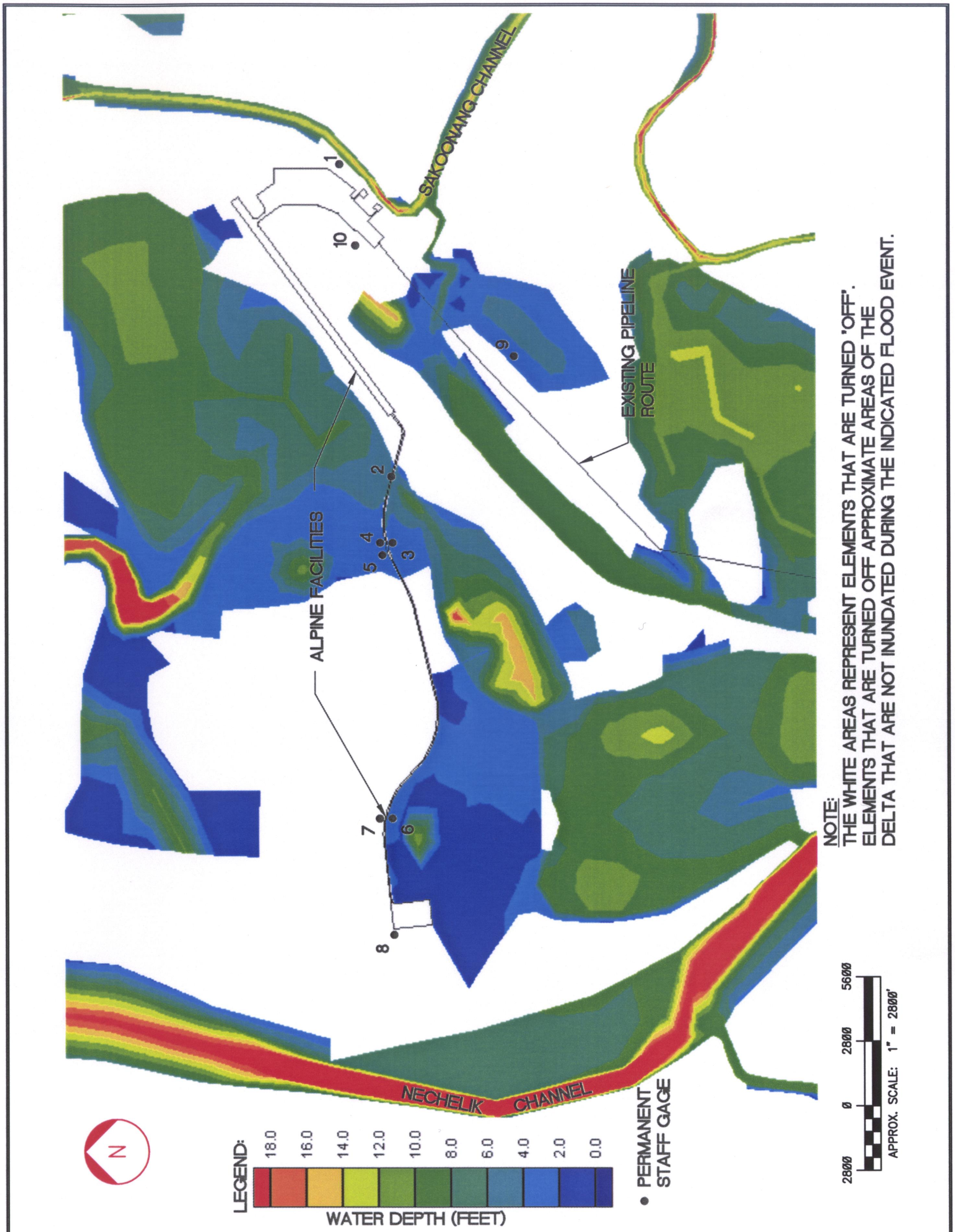
TITLE: PREDICTED 10-YEAR FLOOD, WATER SURFACE ELEVATIONS ACROSS THE COLVILLE DELTA		FIGURE: 5
Baker Michael Baker Jr., Inc.	DRAWING NO: 24307G001	
PAGE: 1 OF 1	REV: A	



PHILLIPS 66 — **PHILLIPS Alaska, Inc.** A Subsidiary of PHILLIPS PETROLEUM COMPANY		TITLE: PREDICTED 10–YEAR FLOOD, WATER SURFACES ELEVATIONS AT THE ALPINE FACILITY	FIGURE: 6
Baker — Michael Baker Jr., Inc.	DRAWING NO: 24307G002	PAGE: 1 OF 1	REV: A

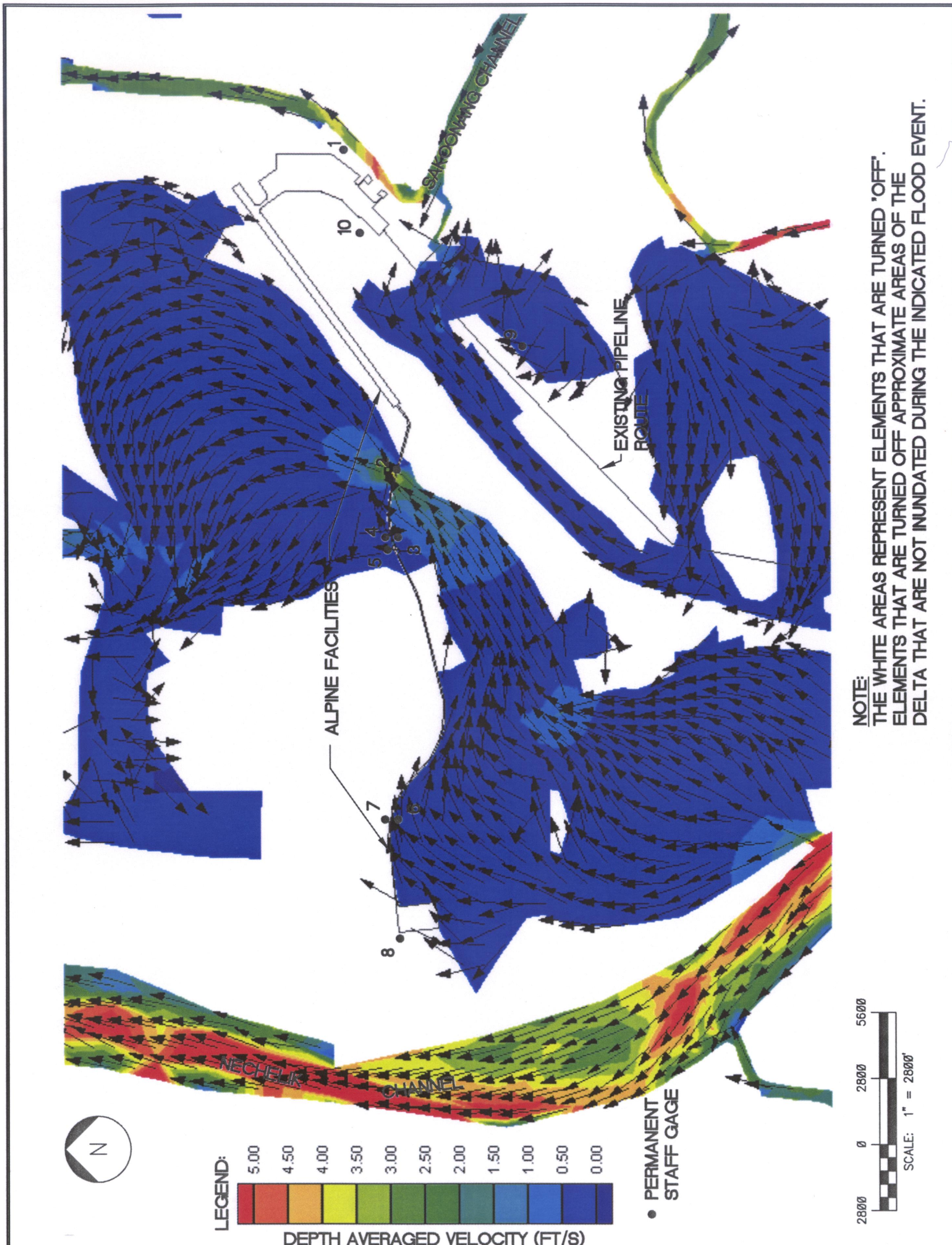


PHILLIPS Alaska, Inc.
A Subsidiary of PHILLIPS PETROLEUM COMPANY

TITLE: PREDICTED 10-YEAR FLOOD, WATER DEPTHS AT THE ALPINE FACILITY

FIGURE: 7

Baker | Michael Baker Jr., Inc. | DRAWING NO: 24307G003 | PAGE: 1 OF 1 | REV: A



PHILLIPS 66 **PHILLIPS Alaska, Inc.** A Subsidiary of PHILLIPS PETROLEUM COMPANY		TITLE: PREDICTED 10-YEAR FLOOD, DEPTH AVERAGED VELOCITY AT THE ALPINE FACILITY	FIGURE: 8
Baker Michael Baker Jr., Inc.	DRAWING NO: 24307G004	PAGE: 1 OF 1	REV: A

Attachment 3 – Letter Report

Typical Drawing and Suggested Locations for Permanent Staff Gages

Baker

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Fairbanks, AK 99701

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FAX (907) 457-2795

March 24, 2000

ARCO Alaska, Inc.
Post Office Box 100360
Anchorage, Alaska 99510-0360

Attn: Mr. William Fowler

RE: TYPICAL DRAWING AND SUGGESTED LOCATIONS FOR PERMANENT STAFF GAGES.

We have identified eight locations at which flood monitoring staff gages should be located within the immediate vicinity of the Alpine Facility, and developed a typical design for the staff gages. By monitoring water surface elevation at the staff gage locations suggested in this letter, a minimum of information can be obtained from which to assess the flooding conditions at the facility. Depending upon the locations of ice jams and snow blockage within the channels and floodplains, which change from one year to the next, it may occasionally be necessary to monitor water surface elevations at a few other locations. However, the permanent staff gage locations suggested herein will provide a reasonable starting position from which to monitor flooding at the facility.

Proposed Location of Permanent Staff Gages For Floodwater Monitoring
To assist with floodwater monitoring at the Alpine Facility, permanent staff gages should be located at the following eight locations (see Drawing 1).

- **On the Sakoonang River near Drill Site 1 (Staff Gage #1).** This staff gage should be located near Drill Site 1, at a location with a ground elevation between 1.0 and 2.0 feet (British Petroleum Mean Seal Level, BPMSL), and within the Sakoonang Channel. The location at which this staff gage is placed should also be somewhat protected from ice movement while still allowing the gage to be read without the reader having to enter the water, if possible. Based on the available mapping, such a location should be found near Northing 5975948.08 and Easting 386920.29. If the ground elevation at the staff gage is between 1.0 and 2.0 feet (BPMSL), it will be possible to read the staff gage at an open water discharge of less than 110,000 cfs (about half the size of the 2-year flood) at the head of the delta.
- **Bridge in vicinity of Road Centerline Station 105+00 (Staff Gage # 2).** A staff gage should probably be fastened to the bridge pier (pile) with the lowest ground elevation, on the south side of the bridge. However, consideration should be given to the desirability of reading the staff gage without having to enter the water, or cross snow that is saturated with water. This staff gage will provide information on water flowing within the swale during years when there is little or no backwater created by the bridge, and prior to the bridge deck being constructed. Once the bridge is constructed, a permanent monument, with a known elevation, should be set on the bridge. The monument should be set in a location convenient for measuring the water

surface elevation with a hand line. The hand line will be used to measure the vertical distance between the monument and the water surface.

- **Road Centerline Station 94+00, south side of road (Staff Gage #3).** A staff gage should be located on the upstream side of the road, near road centerline station 94+00 (± 50 feet). The location at which the staff gage is placed should be 40 feet (± 10 feet) from the toe of the road embankment and at a ground elevation as low as practical. However. there is no advantage to placing the staff gage in a hole, as the staff gage will not be useful for recording water surface elevations until water can freely flow past it. It is expected that the ground elevation will be between 4 and 5 feet (BPMSL). The location should not be directly upstream (along the flow path) of a culvert or bridge, but rather, should be offset to the side by at least one (and preferably two) culvert diameter(s) or bridge width(s). This staff gage should provide accurate water surface elevations during large floods when there is a significant backwater created by the bridges at centerline stations 105+00 and 92+00. If the ground elevation at the staff gage is between 4 and 5 feet (BPMSL), it will be possible to read the staff gage at an open water discharge of somewhat less than the peak discharge of the 2-year flood.
- **Road Centerline Station 94+00, north side of road (Staff Gage # 4).** A staff gage should be located on the downstream side of the road, near road centerline station 94+00 (± 50 feet). The location at which the staff gage is placed should be 30 feet (± 10 feet) from the toe of the road embankment and at a ground elevation as low as practical. However, there is no advantage to placing the staff gage in a hole, as the staff gage will not be useful for recording water surface elevations until water can freely flow past it. It is expected that the ground elevation will be between 4 and 5 feet (BPMSL). The location should not be directly downstream (along the flow path) of a culvert or a bridge, but rather, should be offset to the side by at least two-culvert diameter(s) or bridge width(s). This staff gage should provide accurate water surface elevations during large floods when there is a significant backwater created by the bridges at centerline stations 105+00 and 92+00. If the ground elevation at the staff gage is between 4 and 5 feet (BPMSL), it will be possible to read the staff gage at an open water discharge of somewhat less than the peak discharge of the 2-year flood.
- **Bridge ~~in~~ vicinity of Road Station 92+00 (Staff Gage # 5).** A staff gage should probably be fastened to the center bridge pier (pile), on the south side of the bridge. This staff gage will provide information on flow within the swale during years when there is little or no backwater created by the bridge and prior to the bridge deck being constructed. Once the bridge deck is construction, a permanent monument should be set with a known elevation on the bridge deck. The monument should be set in a location convenient for measuring the water surface elevation with a hand line. The hand line will be used to measure the vertical distance between the monument and the water surface.
- **Road Station 32+16, south side of road (Staff Gage #6).** A staff gage should be located on the upstream side of the road, near road centerline station 32+16 (± 100 feet). The location at which the staff gage is placed should be 40 feet (± 10 feet) from the toe of the road embankment and at a ground elevation as low as practical. However, there is no advantage to placing the staff gage in a hole, as the staff gage will not be useful for recording water surface elevations until water can freely flow past it. It is expected that the ground elevation will be

between 6 and 7 feet (BPMSL). The staff gage should be located such that as soon as water begins to flow through the culverts located in the vicinity of road centerline station 32+16, the water surface elevation controlling the flow through the culverts can be accurately determined. Ideally, the location should not be directly upstream (along the flow path) of the culverts, but rather, should be offset to the side by at least one (and preferably two) culvert diameter(s). If the ground elevation at the staff gage is between 6 and 7 feet (BPMSL), it will probably be possible to read the staff gage at an open water discharge of somewhat less than the peak discharge of the 10-year flood.

- **Road Station 32+16, north side of road (Staff Gage #7).** A staff gage should be located on the downstream side of the road, near road centerline station 32+16 (± 100 feet). The location at which the staff gage is placed should be 40 feet (± 10 feet) from the toe of the road embankment and at a ground elevation as low as practical. However, there is no advantage to placing the staff gage in a hole, as the staff gage will not be useful for recording water surface elevations until water can freely flow past it. It is expected that the ground elevation will be between 6 and 7 feet (BPMSL). Preferably, the location of the staff gage should not be directly downstream of the culverts (along the flow path), but rather, should be offset to the side by at least two-culvert diameter(s). However, in order to locate the staff gage at a location that will have water passing by it as soon as water starts flowing in the culverts, it may be necessary to locate it directly downstream of the culverts. In this case the staff gage should be placed 40 to 50 feet from the toe of the road embankment. If the staff gage can be located at least two culvert diameters to the side of the culvert battery, the staff gage can be located 30 to 40 feet from the toe of the road embankment. The closer the staff gage is to the road embankment, the easier it will be to read the staff gage from the road embankment. If the ground elevation at the staff gage is between 6 and 7 feet (BPMSL), it will probably be possible to read the staff gage at an open water discharge of somewhat less than the peak discharge of the 10-year flood.
- **On Nechelik Channel near Drill Site 2 (Staff Gage #8).** This site should be located on the Nechelik Channel side of Drill Site 2, at a location where the water from the Nechelik Channel will inundate the staff gage at as low an elevation as practical. However, there is no advantage to placing the staff gage in a hole, as the staff gage will not be useful for recording water surface elevations until water can freely flow past it. In order to read the staff gage from the embankment, the staff gage should be located about 50 feet (± 10 feet) from the toe of the gravel embankment. It is expected that the ground elevation will be between 7 and 8 feet (BPMSL). Note that when the gravel-filled geotextile bags (used to protect the embankment from erosion) are placed on the slope, the staff gage will be 40 to 45 feet from the toe of the gravel bags. If the ground elevation at the staff gage is between 7 and 8 feet (BPMSL), it will probably require an open water discharge approximately equal to the 10-year flood to inundate the ground around the staff gage.

Typical Design for Permanent Staff Gages

A typical design for the permanent staff gages is presented in Drawing 2.

Staff Gages at Existing Bridges

At the two bridges located on the road between Drill Sites 1 and 2, the staff gages should be attached to the existing bridge pile as shown in Drawing 2, Assembly Detail 1. However, the stainless steel banding will need to be sized to accommodate the diameter of the bridge piles.

Staff Gages at Lakes

It might be desirable to locate staff gages in Lake 93-12 and 93-13, the two lakes being used to supply water to the Alpine Facility on a regular basis. Ideally the staff gages should be place at a location where the ground surface is about 1 foot below the water surface elevation, when the water surface elevation of the lake is about average. The typical design presented in Drawing 2 will provide an adequate installation if the depth of water at the staff gage is no more than 2 feet. Thus, the staff gage should be located in about 1.0 to 1.5 feet of water.

Direction the Staff Gages Should Face

The staff gages should be mounted on the piles such that they provide an accurate measurement of the water surface elevation in the vicinity of the pile. Often the water surface elevation will rise above the average on the upstream side of the pile and drop below the average on the downstream side of the pile. The magnitude of the drop across the pile increases as the water velocity in the vicinity of the pile and the diameter of the pile increases. In such situations it is generally desirable to have the faceplate located parallel to the direction of flow (see Drawing 2, Assembly Detail 1). Thus, for each staff gage, the approximate side of the pile on which the faceplate should be located is presented below.

Table 1: Location of Faceplate on Staff Gages

Staff Gage	Location of Faceplate
S.G. #1	Faceplate should face approximately west (toward the west bank).
S.G. #2	Faceplate should face approximately east or west (toward the nearest abutment).
S.G. #3	Faceplate should face approximately east or west if direction of flow is likely to be into the embankment (as through a culvert). The flow velocity may be low enough that the faceplate can be placed on the north side of the pile. This would make it easier to read the faceplate and protect it from ice. Consider the ease of reading the faceplate as well as the possible drop in the water surface elevation across the pile when locating the faceplate.
S.G. #4	Faceplate should face approximately east or west if direction of flow is likely to be away from the embankment (as out of a culvert). The flow velocity may be low enough that the faceplate can be placed on the south side of the pile. This would make it easier to read the faceplate and protect it from ice. Consider the ease of reading the faceplate as well as the possible drop in the water surface elevation across the pile when locating the faceplate.
S.G. #5	Faceplate should face approximately east or west (toward one of the abutments).

Table 1: Continued

S.G. #6	Faceplate should face approximately east or west if direction of flow is likely to be into the embankment (as through a culvert). The flow velocity may be low enough that the faceplate can be placed on the north side of the pile. This would make it easier to read the faceplate and protect it from ice. Consider the ease of reading the faceplate as well as the possible drop in the water surface elevation across the pile when locating the faceplate.
S.G. #7	Faceplate should face approximately east or west if direction of flow is likely to be away from the embankment (as out of a culvert). The flow velocity may be low enough that the faceplate can be placed on the south side of the pile. This would make it easier to read the faceplate and protect it from ice. Consider the ease of reading the faceplate as well as the possible drop in the water surface elevation across the pile when locating the faceplate.
S.G. #8	Faceplate should face approximately east (toward Drill Site 2).

Staff Gage Datum

In order to provide water surface elevations that are relative to the same datum as the Alpine Facilities, it will be necessary to tie the staff gages to BPMSL. The numbers on the staff gage may be set to read directly in feet above BPMSL or an equation can be used to convert the reading on the staff gage to BPMSL. For ease of operation and to reduce confusion, the following procedures are recommended.

- A reference point should be selected on the pile. The reference point can be the head of a bolt placed in the pile, a lip welded on the pile or possibly the top of the pile. It must be a point that will move with the pile (if the pile moves) and constructed such that a survey rod can be held vertically on it. The location of the reference point should be clearly marked on the pile.
- The reference point should be surveyed and tied to BPMSL.
- The staff gage should be attached to the pile such that the numbers on the staff gage represent feet above BPMSL.
- Periodically, the reference point on the pile should be checked to make sure the pile has not moved with regard to BPMSL.
- Periodically, the staff gage should be checked to make sure that it has not moved with regard to the reference point.

Baker

I trust that this will be sufficient for your purposes at this time. If you have any questions, please do not hesitate to call.

Sincerely,

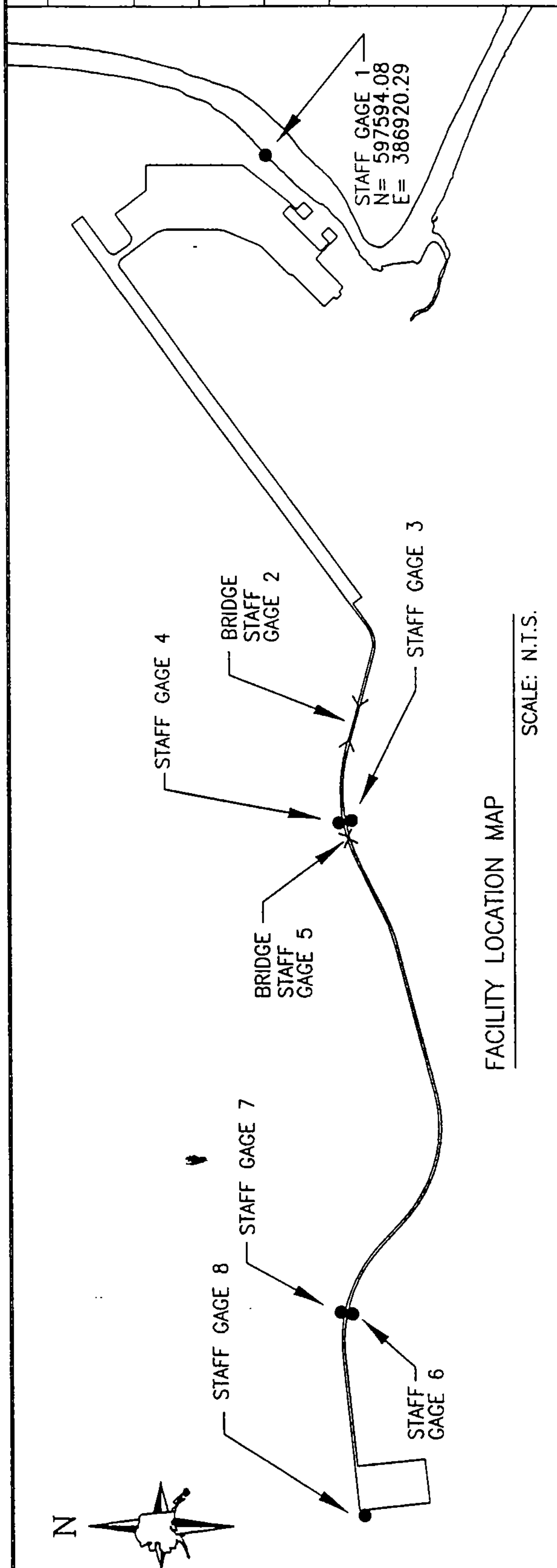
MICHAEL BAKER JR. INC.

James W. Aldrich

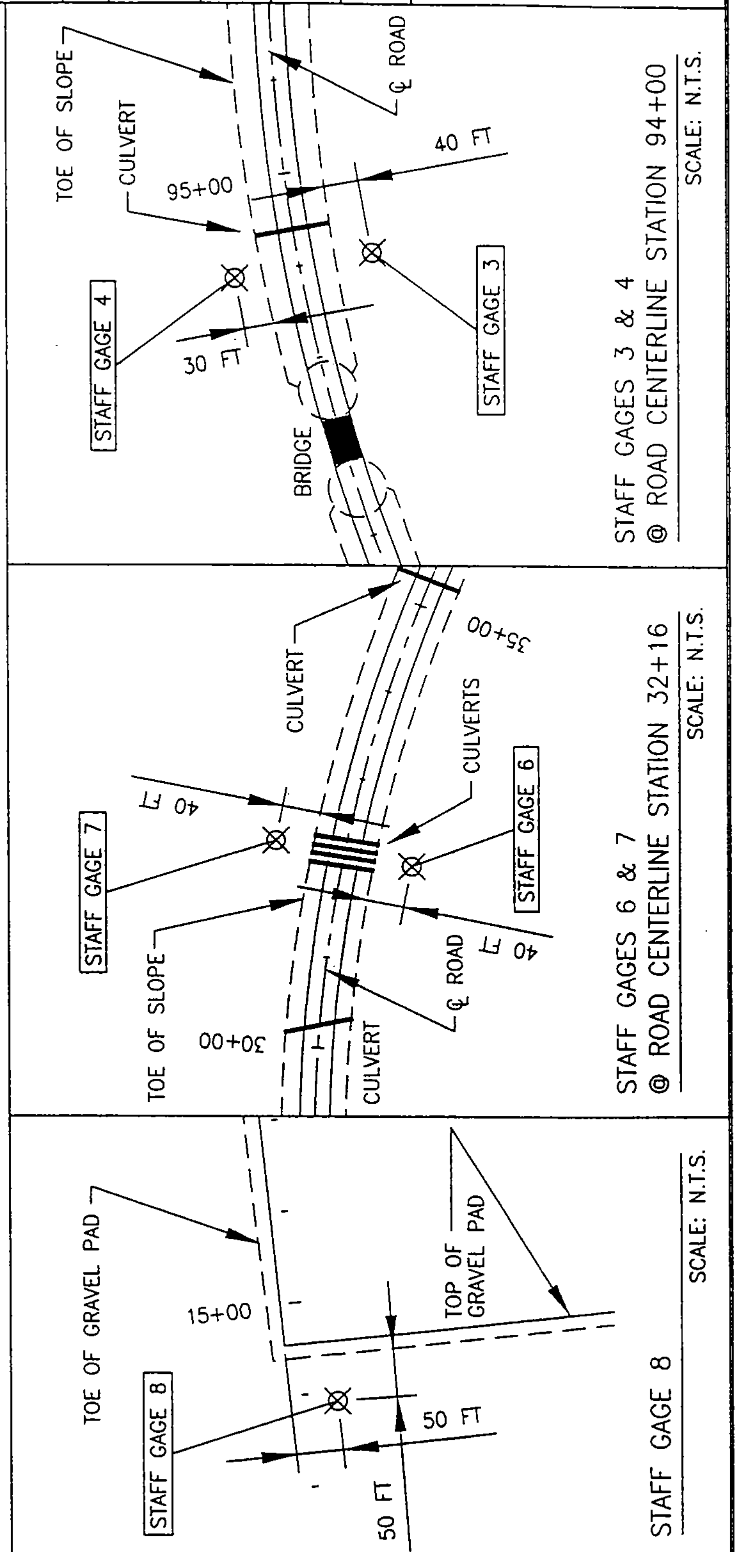
James W. Aldrich, P.E., P.H.
Assistant Chief Engineer

cc: Mr. Steve Geddes

REV	DATE	BY	CK	APP	DESCRIPTION	REV	DATE	BY	CK	APP	DESCRIPTION



NOTES:
1. SEE LETTER REPORT FOR ADDITIONAL DETAILS REGARDING THE FINAL LOCATION OF THE STAFF GAGES BASED ON SITE SPECIFIC CONSIDERATIONS.



Baker Michael Baker Jr., Inc.

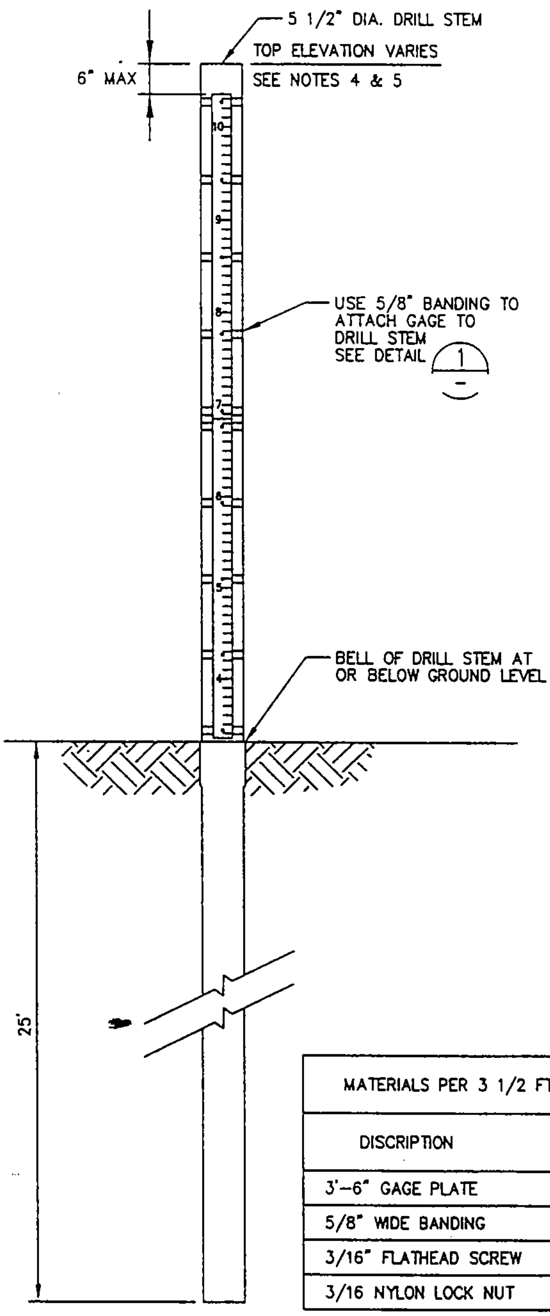
ARCO Alaska, Inc.

MODULE: UNIT:

ALPINE FACILITIES
APPROXIMATE LOCATION OF
PERMANENT STAFF GAGES

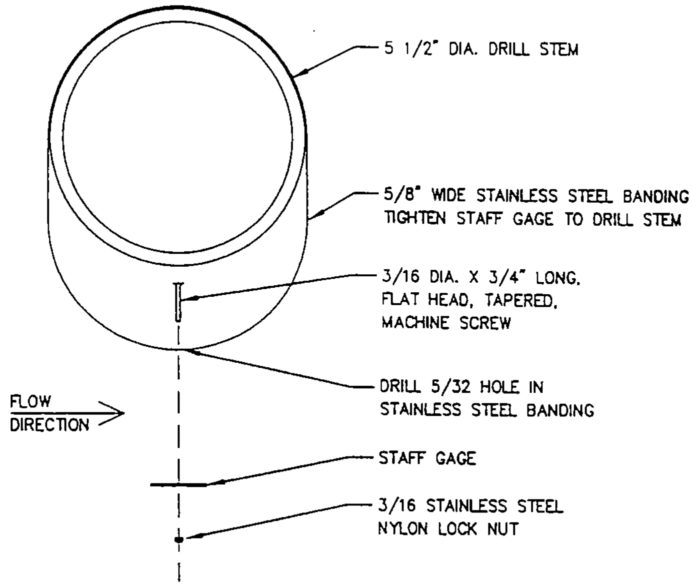
CADD FILE NO.		DRAWING NO:	SHEET:	REV:
StaffG.DWG	3/23/00	1	1 OF 1	A

REV	DATE	BY	CK	APP	DESCRIPTION	REV	DATE	BY	CK	APP	DESCRIPTION



ELEVATION VIEW

SCALE: NOT TO SCALE



1 ASSEMBLY DETAIL

NOT TO SCALE

MATERIALS PER 3 1/2 FT SECTION	
DISCRIPTION	QNTY
3'-6" GAGE PLATE	1
5/8" WIDE BANDING	5
3/16" FLATHEAD SCREW	5
3/16 NYLON LOCK NUT	5

NOTES:

1. HOLES FOR DRILL STEM SHALL BE PREPARED BY DRY DRILLING OR AUGERING.
2. DRILL STEMS SHALL BE PLACED VERTICAL, VARYING NO MORE THAN ± 0.5% (1/16-INCH IN 12 INCHES) IN ANY DIRECTION.
3. DRILL STEMS SHALL BE PLACED AT THE DESIGN LOCATION ± 1 INCH (0.08').
4. SEE DRAWING 1 FOR APPROXIMATE LOCATION OF STAFF GAGES.
5. THE TOP ELEVATION OF THE STAFF GAGES SHALL BE AS FOLLOWS.

   STAFF GAGE 1: 15.0 FEET
   STAFF GAGE 3: 15.0 FEET
   STAFF GAGE 4: 13.0 FEET
   STAFF GAGE 6: 15.0 FEET
   STAFF GAGE 7: 13.0 FEET
   STAFF GAGE 8: 15.0 FEET

Baker Michael Baker Jr., Inc.

ARCO Alaska, Inc.

MODULE: ALPINE FACILITIES

UNIT:

PERMANENT STAFF GAGE (TYPICAL)

CADD FILE NO. 24381001 03/23/00

DRAWING NO: 2

SHEET: 1 OF 1

REV: A

Attachment 4 - Transmittal

Alpine Facility Staff Gage Locations, As-Built

Kuukpik / LCMF TRANSMITTAL

Alpine Facility Staff Gage Locations

To: Tyde Riopelle
Michael Baker

From: J. Breese & J. Zilko
Alpine Survey Office
Kuukpik / LCMF

We are herewith transmitting the following:

- [x] Document(s)
- [x] Drawing(s)
- [ ] Disk
- [ ] Per Your Request
- [ ] For Your Use
- [x] For Your Information

Alpine Survey Office - Phone: 670-4739 Fax: 670-4731

Drawing No.	Sht.	Rev.	Qty.	Description
00-03-29-1B	1 of 1	0	1	Alpine Facility Staff Gage Locations As Built
Doc. LCMF-018	1 of 1	0	1	Alpine Facility Staff Gage Locations As Built

cc: Julene Abrams

SWR #: 00-03-29-1R1
AFC#: 998906

File: 10.0, 00-03-29-1

DATE: May 18, 2000

Calc'. JB
Date: 5-17-00
Ck'd. By:
Date:

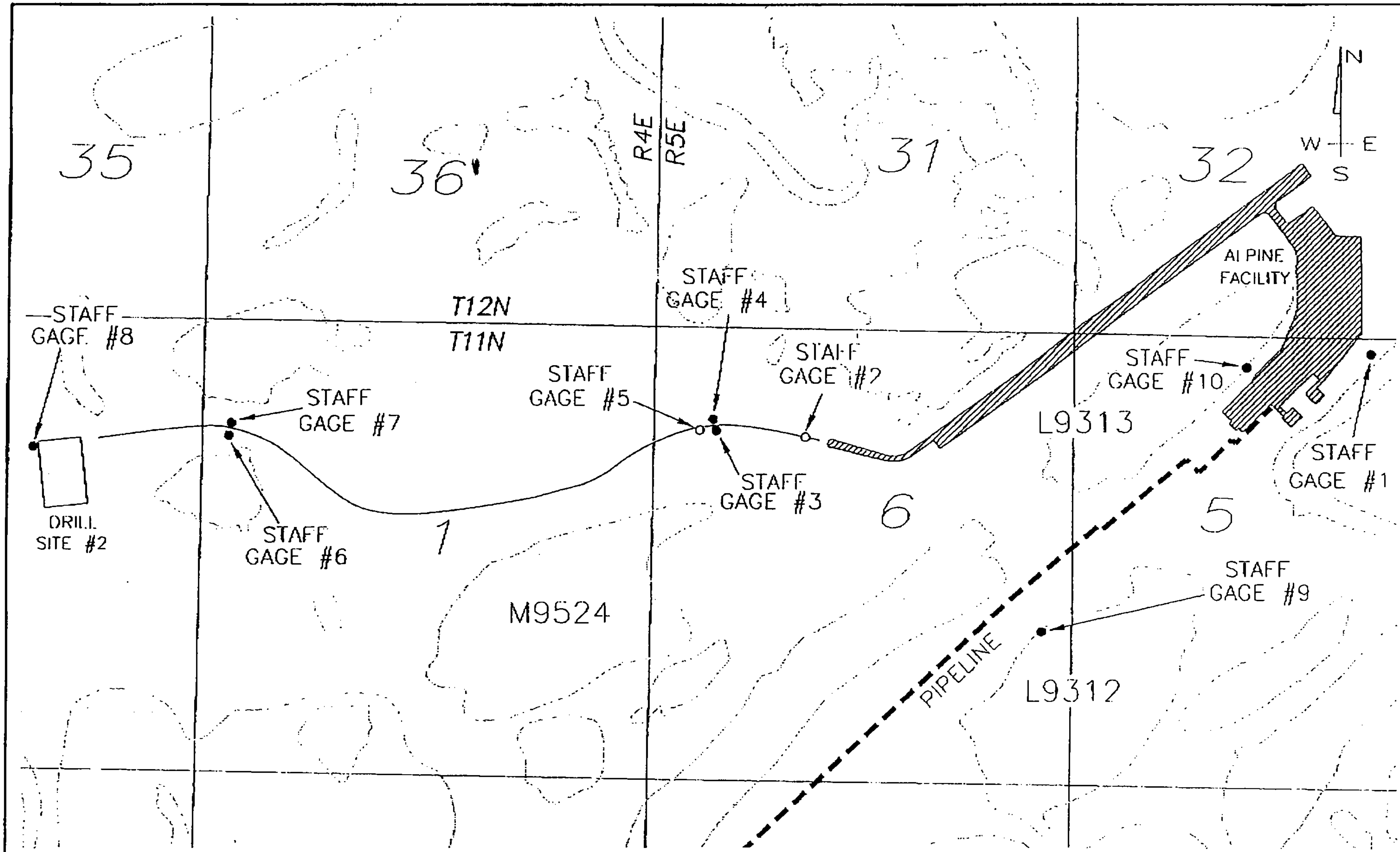
Alpin. acility
Staff Gage Locations
As Built

Kuukp CMF
Alpine Construction
Doc. LCMF-018

Staff Gage	Y	X	Ref. Elev.	Gnd. Elev.	Remarks
1	5975948.0	386920.3	2.16	1.9	Punch mark at Elev. 8.00
2	5974961.4	380306.0	13.11	not noted	Punch marks at elev. 9.00 on piling E2-A, E9-A, and E15-A. PK in S. side timber decking at elev. 13.00. Ref. Elev. noted is top of wood decking at Bent E6.
3	5975040.8	379259.2	6.00	5.9	Punch mark at elev. 12.00
4	5975173.9	379222.5	6.47	not noted	Punch mark at elev. 12.00
5	5975031.5	379071.5	13.11	not noted	PK in S. side timber decking at elev. 13.00. Ref. Elev. noted is top of wood decking at Bent W2.
6	5974982.6	373555.5	7.30	not noted	Punch mark at elev. 14.00
7	5975132.9	373586.4	7.81	7.5	Punch mark at elev. 13.00
8	5974854.9	371261.2	8.76	8.2	Punch mark at elev. 15.00
9	5972643.8	383030.4	8.96	8.0	Punch mark at elev. 14.00 Top of Ice elev. = 7.8; Water elev. = 7.7; Ice thickness = 6.6'
10	5975797.3	385464.0	-	6.7	No angle iron reference point found. Punch mark at elev. 13.00 Top of Ice elev. = 5.2; Water elev. = 4.2; Ice thickness = 5.3'

Notes:

1.) Coordinates shown are Alaska State Plane, Zone 4, NAD '27.
2.) Elevations shown are BPMSL datum.
3.) Reference elevations are to top of 1" angle iron welded on 5" drill stem staff gage, generally 1 ft. or less above existing ground. Additional reference elevation marks were punched in the drill stem at approximately head height.
4.) No angle iron was found on gage 10. It may be buried.
5.) Gages 2 and 5 are referenced to top of wooden bridge decking.
6.) Ground elevations are approximate as some materials adjacent to the gages appear to be drill tailings.



LEGEND

- ● STAFF GAGE – 5" DRILL STEM
- o STAFF GAGE – SET ON BRIDGE PILE

Kuukpik/LCMF

A subsidiary of Ukpeaġvik Iñupiat Corporation

Alpine Office (907) 670-4739
Anchorage, Alaska (907) 273-1830

Alpine Survey Office

AS-BUILT SURVEY

STAFF GAGE LOCATIONS

ALPINE FACILITY

DATE: 5/18/00	DRAWN BY: LAG	SHEET: 1/1
SCALE: 1"=1600'	CHECKED BY: JB	SWR: 00-03-29-1REV1

DWG NO.: 00-03-29-1B