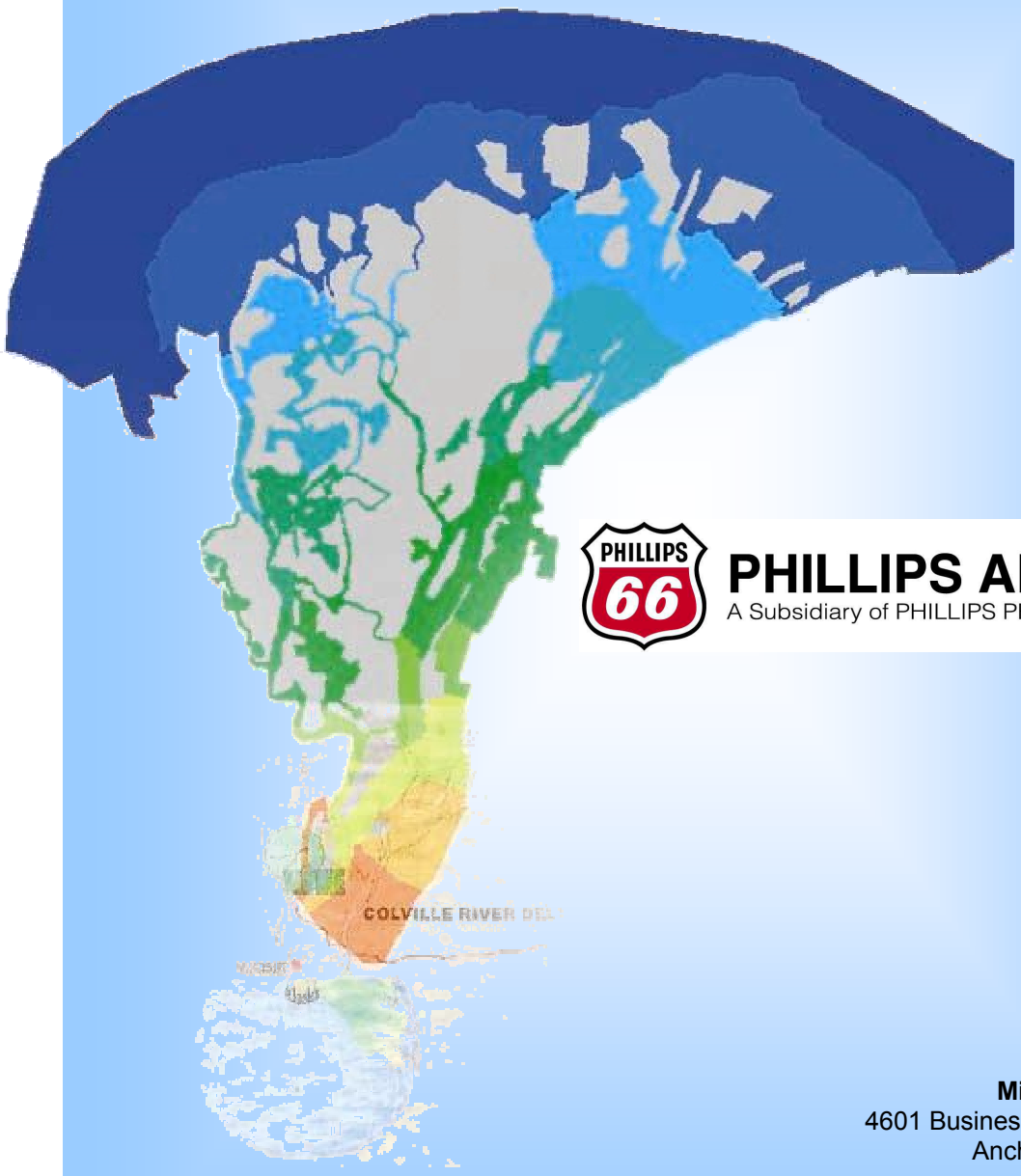
Colville River Delta
Two-Dimensional Surface Water Model
CD-Satellite Project Update



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By

Michael Baker Jr., Inc.
4601 Business Park Blvd., Suite 42
Anchorage, Alaska 99503
907-273-1600
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Section 1. Introduction

The original Colville River Delta two-dimensional surface water model (Shannon & Wilson, 1997) was created to provide peak water surface elevations and velocities for the 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.

This report presents an update of the Colville River Delta, two-dimensional surface water model with the inclusion of two proposed Colville Delta satellite developments.

- The first proposed development is identified as CD-South (Colville Delta South) and is located approximately 3.5 miles south of Alpine. This development consists of a typical satellite gravel drill pad with a conventional gravel access road.

- The second proposed satellite development is identified as CD-North (Colville Delta North) and is located approximately 5 miles north of Alpine. CD-North is being proposed as a road-less development. It contains typical satellite gravel drill pad with a gravel airstrip and a short access road connecting the pad to the airstrip. The locations of the proposed developments and their locations with respect to Alpine are shown on Figure 1.

The updated model was used to estimate water surface elevations and water velocities for 10-, 50-, and 200-year floods. Two conditions were evaluated for each flood event.

- The first condition represents the existing conditions on the delta, including the Alpine and CD-2 facilities, the CD-2 access road, and the two access road bridges.

- The second condition represents post-satellite construction conditions, which includes both the CD-North and CD-South facilities.

The 50- and 200-year flood models will be used to set design criteria for the minimum elevation of the proposed gravel facilities and pipelines with respect to floodwaters. The 10-year flood

model will be used to evaluate potential hydrologic changes at lower than design flood magnitudes.

The intent of this report is to provide the reader with an understanding of how the model was updated and what the general results are. Selected output (generally the design conditions) have been compiled into tables that present water surface elevations, depth averaged water velocities, and water depths at selected locations near the proposed and existing facilities. Figures of the water surface profiles and depth averaged velocity vectors for the modeled flood events are also presented.

The results discussion, tables, and figures have been divided into four groups. The first, Colville River Delta, shows water surface elevation profiles across the delta as a whole, and the tables specifically compare water surface elevations around the delta from the 1998 model results to the 2002 model results. The Alpine pipeline and facilities tables compare the predicted water surface elevations in 1998 with the predicted water surface elevation after construction of the proposed satellite developments. The CD-South and CD-North sections address the model results in the vicinity of the proposed facilities and compare the pre- and post-construction conditions for each development.

All elevations presented in this report are in feet and are referenced to the British Petroleum Mean Sea Level (BPMSL) datum unless otherwise noted.

Section 2. Background

The original two-dimensional surface water model developed in 1997 was used to predict peak water surface elevations and velocities for 50-, 100-, and 200-year flood events as part of the original Alpine facilities design.

In the fall of 1997, field surveys conducted in the area of the proposed Alpine facilities showed that a portion of the ground surface elevations used to develop the original finite element mesh did not match the project datum (BPMSL) particularly well. Consequently, the ground surface elevations of the finite element mesh were improved to match the 1997 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 project update report (Michael Baker Jr., Inc, 1998).

Model runs for the 2- and 10-year floods were completed in the spring of 2001 (Michael Baker Jr., Inc., 2001). The purpose of this analysis was not for design, but rather for addressing permit stipulations required by the U.S. Army Corps of Engineers for floodwater monitoring in and around the Alpine facilities. The finite element mesh that was developed in 1998 was used to initiate modeling for the 2- and 10-year flood events. A two-stage approach was adopted for this modeling program. The first stage consisted of taking the finite element 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 included the addition of a second 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.

Section 3. Model Update and Enhancements

3.1. Modeling Software

The two-dimensional surface water model is the product of two computer programs. The finite element mesh was developed using a pre- and post-processing software titled Surface Water Modeling System (SMS) developed by Brigham Young University. The original model was developed using version 4.1. Subsequent analyses were developed using version 6.0. The current project update used the most recent update to SMS, version 7.0. SMS is used to not only create the finite element mesh, but also to analyze the modeling results and generate output graphics. The computer program developed by the U.S. Geological Survey, Finite Element Surface-Water Modeling System: Two-Dimensional Flow in a Horizontal Plane (FESWMS), performs the numerical computation of the modeling system. FESWMS version 2 (modified by David Froehlich, one of the original authors, to handle a greater number of elements) was used in the original analysis and subsequent analyses through April 2001 (Froehlich 1996). Version 3 of FESWMS supplied by EMS-I (also the suppliers of SMS) was used for the current project update.

3.2. Topographic Base Map

The topographic base map used for the development of the current project update was based on the finite element mesh developed as part of the 1998 project update (Michael Baker Jr., Inc., 1998). Enhancements to the floodplain topography were made in the areas of the CD-South and CD-North project development sites. None of the channels within the model were modified except for the West Ulamnigiaq Channel; see discussion in Section 3.2.2 CD-North Enhancements.

Updated floodplain topography for the western Colville Delta was supplied by Peratrovich, Nottingham, & Drage, Inc. (PN&D) (2001a). This survey data was compiled from a combination of 2-foot contour mapping developed from aerial photography collected in 1999 by Aeromap U.S., Inc., ground truthing surveys conducted in 2000, and Western Geophysical Co. data collected in 1999. The data were provided in the vertical datum BPMSL and the NAD 83, Alaska

State Plane, Zone 4 horizontal datum. The model is in the NAD 27, Alaska State Plane, Zone 4 horizontal datum, and the topography data were converted to this datum with the use of Tralaine Coordinate Conversion Software, Version 3.23. The vertical datum was unchanged.

3.2.1. Topographic Base Map Enhancements in the CD-South Vicinity

The floodplain topography in the CD-South project area was updated with the survey data provided by PN&D (2001a). The portion of this data that was used to enhance the floodplain at CD-South was from the aerial photography and the ground truthing surveys. The area of floodplain topography that was updated for CD-South is presented on Figure 2. These data were collected during the snow-free season as opposed to the Western Geophysical data that were collected during the winter. The original topography used in the model for this area was developed from data obtained from Western Geophysical Co. that were collected during the winters of 1995 and 1996. Comparisons of the ground surface elevations provided by PN&D and the original Western Geophysical data to aerial photography (AeroMap U.S., Inc., 1999) showed that the PN&D survey data has a better correlation to the natural features depicted in the photography and thus, were adopted as the new floodplain data.

3.2.2. Topographic Base Map Enhancements in the CD-North Vicinity

A similar process was used to update the floodplain topography in the area of CD-North as was done for CD-South. The topography was again updated with survey information provided by PN&D, however, all of the data used to update the CD-North floodplain were developed from aerial photography as no ground truthing of this data has been performed. Since the updated topography was developed from data collected in the snow-free season and was developed using the same procedures as the updated CD-South topography (which had a better correlation to the natural features), it was adopted as the new floodplain data. The area of floodplain topography that was updated for CD-North is presented in Figure 2.

3.3. Finite Element Mesh

The original two-dimensional surface water model (Shannon & Wilson, 1997) as well as the subsequent project update (Michael Baker Jr., Inc., 1998) was developed as part of the Alpine

Development Project. Consequently, the modeling focused on the area around the Alpine Development. The entire Colville River Delta was represented in the original model runs; however, the finite element mesh is less dense in areas away from Alpine. The lower density mesh limited the number of elements which in turn made the model more manageable to use, i.e., simplifying calculations and keeping run times reasonable. With the current interest in the proposed CD-South and CD-North project sites and advances in computing speeds, it was felt prudent to increase the level of detail of the finite element mesh and topography in these areas.

3.3.1. Finite Element Mesh Enhancements in the CD-South Vicinity

The finite element mesh was enhanced to provide greater definition of the floodplain ground surface in the project area. Elements along the CD-South access corridor that are contained within the enhanced topography (Figure 2) were refined and relaxed (each selected element was split into smaller elements and the shape adjusted) using functions within the SMS program to optimize the mesh. Element material properties (hydraulic roughness and kinematic eddy viscosity) and material boundaries were not changed during the relaxing process, however, nodes were allowed to slide along material boundaries to optimize element shaping. Lakes in the vicinity of CD-South were represented by changing the elements' material type to "Lake" as defined in the 1998 project update (Baker 1998). In addition, minor modifications were made to better represent local topographical features. Changes were made to the mesh on the floodplain only. No changes to the mesh representing the Nechelik or Sakoonang Channels were made.

3.3.2. Finite Element Mesh Enhancements in the CD-North Vicinity

A similar process was used to update the floodplain topography and finite element mesh in the area of CD-North as was done for CD-South. The finite element mesh was refined and relaxed using the procedures previously described and lakes were represented by modifying element material properties.

Finite element mesh nodes defining the West Ulamnigiaq Channel in the area to the south and west of the proposed CD-North pad were shifted approximately 100-300 feet to match up with the channel as depicted in the aerial photography. The channel width and channel elevations

were not changed. Since all other channels in the vicinity closely matched the aerial photography, no other channel modifications were made.

3.3.3. Finite Element Mesh Enhancements in the Alpine Roadway

The finite element mesh representing the road from Alpine to CD-2 was modified to reflect the geometry of the two existing bridges as part of the 2- and 10-year modeling completed in 2001 (Baker 2001). This included adding the smaller bridge (which was added to the design after the original model runs) and widening the larger bridge to account for its vertical abutments (the conceptual bridge design included sloping abutments). Bridge dimensions and locations were taken from the bridge design drawings (PN&D 2000). Culverts were not represented in either the original or revised models since they are expected to have little effect on overall water surface elevations.

3.3.4. Other Finite Element Mesh Enhancements

The only area (other than the immediate CD-South and CD-North project areas) that was modified to improve the mesh characteristics is located between the Tamayayak and Kupigruak Channels directly to the east of the proposed CD-North site (see Figure 2). In this location, the element coverage was enhanced to represent a denser coverage over the area. The same Western Geophysical data used for the original model runs was again used to interpolate ground surface elevations to the new nodes. Improving the mesh density in this area helped the model to converge.

3.4. Boundary Conditions

Downstream and upstream boundary conditions were unchanged for the current project update. The following sections summarize the boundary conditions.

3.4.1. Downstream Boundary

The downstream boundary condition was set at a constant water surface elevation of 3 feet (BPMSL). The water surface elevation of 3 feet was based on conditions observed during the

1996 breakup and thought to be relatively conservative. Water surface elevation measurements made near the coast since 1996 suggest that a downstream boundary of 3 feet is still reasonable.

3.4.2. Upstream Boundary

The upstream boundary condition is based on a steady state discharge. Discharge values are based on design flood frequency estimates for the Colville River and are presented in the report *Colville River Flood Frequency Update, March 2002*, (Baker and Hydroconsult, 2002). A summary of design flood frequency estimates is presented in Table 1. Discharge due to spring flooding is generally not a steady state condition and flood peaks are attenuated by natural features of the delta (i.e. temporary floodwater storage). Thus, the steady state conditions of the two-dimensional model are thought to be somewhat conservative.

3.5. Element Status

The tolerance limits set to define when an element turns "on" or "off" was unchanged for the current project update. An element that is turned "on" is considered in the numerical computations while an element that is turned "off" is not. The tolerance limit remains set at one foot. Thus, if an element was already considered "on" it would be turned "off" when the water surface elevation fell one foot below the elevation of the highest node on that element. If an element were considered "off" it would be turned "on" when the water surface elevation was one foot higher than the highest node on that element.

Elements that are turned "off" are generally those that are dry or only partially covered with water. In some cases, an element that is considered "off" may in fact be completely covered with water, however, the water surface elevation is below the depth tolerance to turn the element on. For example, the elements on the north side of the CD-North airstrip are turned "off" during the 200-year post CD-Satellite construction condition. By examining ground and water surface elevations in this area, it can be seen that most of these elements are inundated with water but to depths below the 1-foot depth tolerance.

Section 4. Results and Discussion

Model runs for the 10-, 50-, and 200-year flood events were completed for both existing conditions and post-CD-Satellite construction conditions. To simulate the proposed facilities, the finite element mesh (enhanced with the most recent topography) was modified to include the proposed gravel structures. The height of the gravel structures was set so that water was prevented from flowing across or over them. Culverts and bridge openings in the proposed gravel structures are expected to have little effect on overall water surface elevations and were not represented.

The results of the updated modeling are divided into four groups. Discussions of each are presented in the following sections as well as in the tables and figures.

4.1. Colville River Delta

Peak water surface elevations for the 10-, 50-, and 200-year floods are presented on Tables 2 through 4 and on Figures 3 through 8. In addition to presenting the current modeling results, these tables present a comparison of the water surface elevations between the 1998 model runs (2001 for the 10-year model), the pre-CD-Satellite (existing conditions), and post-CD-Satellite construction conditions.

4.2. Alpine Pipeline and Facilities

The differences in peak water surface elevations between the 1998 model results and the post-CD-Satellite construction conditions along the Alpine pipeline for the 50- and 200-year floods are presented in Tables 5 and 6, respectively. The locations of the Alpine facilities and pipeline are shown on Figures 9 and 10. Water surface elevation increases north of PI 13 are predicted for the 200-year flood event and north of PI 07 for the 50-year flood event. The maximum water surface elevation increase is 1.3 feet at PI 04 and occurs during the 200-year event. The water surface elevation increases are primarily due to the addition of the CD-South access road. Further discussion of the CD-South access road and its hydraulic effects are presented below.

The differences in peak water surface elevations between the 2001 model results and the post-CD-Satellite construction conditions for the 10-year flood event at the Alpine permanent staff gage locations are presented in Table 7. These permanent staff gages were installed to monitor water surface elevations during spring floods. No significant changes are noted between the two conditions. Locations of the permanent staff gages can be found in Appendix A.

The differences in peak water surface elevations between the 1998 model results and the post-CD-Satellite construction conditions along the Alpine gravel facilities for the 50- and 200-year floods are presented in Tables 8 and 9, respectively. Water surface elevation increases on the order of 1 foot are predicted on the upstream side of the facilities to the east of the proposed CD-South access road during the 200-year event. Water surface elevation decreases on the order of 0.3 feet are predicted on the upstream side of the facilities to the west of the proposed CD-South access road during the 200-year event. These changes are primarily due to the addition of the CD-South access road. Water surface elevation increases on the order of 0.1 to 0.2 feet are predicted to occur on the downstream side of the facilities during the 200-year event.

Changes on the downstream side of the facilities are primarily a result of the enhanced topography and not due to the CD-South access road. Similar but smaller magnitude changes are predicted for the 50-year event.

The CD-South access road follows a natural ridge from the end of the Alpine runway to the south. During large flood events, i.e. the 50- and 200- year events, floodwaters are predicted to pass over certain portions of this ridge from east to west. The addition of the gravel road will divert these floodwaters back to the northeast and around the east end of the Alpine pad. During lower magnitude flood events (i.e., the 10-year event and under), the CD-South access road is not predicted to cause significant changes to the hydrologic flow patterns around the Alpine facilities since very little flow passes over this natural ridge. This is illustrated on the depth averaged velocity Figures 19 through 22.

Water surface elevation profiles and depth averaged velocities vectors in the Alpine vicinity are presented on Figures 11 through 22.

4.3. CD-South Facilities

The peak water surface elevations, water velocities, and water depths for the 50- and 200-year flood events for both the pre- and post-CD-Satellite construction conditions along the CD-South access corridor are presented in Tables 10 and 11, respectively. The peak water surface elevations, water velocities, and water depths for the 200-year flood event for both the pre- and post-CD-Satellite construction conditions along the CD-South pipeline are presented in Table 12. The location and stationing of the CD-South access road and pipeline are presented on Figure 23. Water surface elevations for the 10-, 50-, and 200-year flood events for both the pre- and post-CD-Satellite construction conditions are shown on Figures 24 through 29 and depth averaged water velocities for the same flood events are shown on Figures 30 through 35.

The average water surface elevation during the 200-year flood event (the design event for the pad) in the vicinity of the proposed pad location is 16.1 feet and the maximum predicted water surface elevation is 16.4 feet. The maximum water velocity predicted is 1.4 feet per second at the southwest corner of the pad during the same 200-year flood event.

Water surface elevations along the east side of the CD-South access road during the 50-year flood event (the design event for the road) range from 16.1 feet at the southern end to 15.7 feet at the junction with the existing CD-2 access road to the north. Water surface elevations along the west side of the road range from 15.9 feet at the southern end to 14.0 feet at the northern end. The maximum predicted water velocity along the road during the 50-year flood event is 2.1 feet per second at station 175+00 with the average velocity along the road being 0.9 feet per second.

The majority of the proposed access road and pad is situated on relatively high ground that will not be inundated during the 10-year and smaller flood events, even though both sides of the road will see inundation. The high ridge that the access road follows is a natural barrier between the floodplain on the east and west sides of the road. Recharge to the east is from the Sakoonang Channel while recharge to the west is from the Nechelik Channel.

During large flood events, the proposed CD-South access road is hydraulically fundamentally different from the existing Alpine/CD2 access road in that it is located on a high ridge that is

aligned parallel to flow patterns while the Alpine/CD2 access road is aligned perpendicularly. This is illustrated on the depth-averaged velocity Figures 30 through 35.

4.4. CD-North Facilities

The peak water surface elevations, water velocities, and water depths for the 200-year flood event for both the pre- and post-CD-Satellite construction conditions along the CD-North gravel facilities are presented in Table 13. The peak water surface elevations, water velocities, and water depths for the 200-year flood event for both the pre- and post-CD-Satellite construction conditions along the CD-North pipeline are presented in Table 14. The location of and stationing along the CD-North pipeline is presented on Figure 36. Water surface elevations for the 10-, 50-, and 200-year flood events for both the pre- and post-CD-Satellite conditions are shown on Figures 37 through 42 and depth-averaged water velocities for the same flood events are shown on Figures 43 through 48.

The average water surface elevation during the 200-year flood event (the design event for the pad and airstrip) in the vicinity of the proposed pad location is 7.7 feet and the maximum predicted water surface elevation is 8.0 feet for the pre-CD-Satellite construction condition. The average predicted water surface elevation on the upstream (southern) side of the pad and airstrip is 7.8 feet and the maximum is 8.3 feet for the post-CD-Satellite construction condition. The average water surface elevation on the downstream (northern) side of the facilities is 7.0 feet during the 200-year flood event for the post-CD-Satellite construction condition. The maximum predicted water velocity predicted is 2.4 feet per second at the northwest corner of the pad during the same 200-year flood event.

The proposed CD-North pad and airstrip sit on the floodplain between the West Ulamnigiaq and East Ulamnigiaq Channels. This area is not predicted to be inundated during lower magnitude flood events (10-year and smaller). During the 200-year flood event, a water surface elevation increase of 0.1 to 0.3 feet is expected on the upstream side of the facilities and a water surface elevation decrease of 0.6 to 0.7 feet is expected on the downstream side. Water depths in this area are generally less than 2.0 feet during the 200-year flood event. Recharge to the floodplain on the northern side of the facilities is expected during large flood events due to the floodplain

proximity with the surrounding channels and the local topography; however, floodwater north of the proposed airstrip is expected to be shallow (see Section 3.5 for explanation of element status).

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Tables

Table 1: Design Flood Frequency Estimates at the Head of Delta

Return Period	Design Flood-Peak Discharge (cfs)
2-Year	240,000
5-Year	370,000
10-Year	470,000
25-Year	610,000
50-Year	730,000
100Year	860,000
200-Year	1,000,000
500-Year	1,300,000

Table 2: Comparison of the 10-Year Flood Water Surface Elevations Within the Channels

Location	State Plane Coordinates (1)		Peak Water Surface Elevation (ft)			Difference in Peak Water Surface	
	Northing	Easting	March 2001 with Facilities (2)	Existing Conditions 2002 (3)	With Proposed CD-Satellite Facilities (4)	Jul-98 vs Existing Conditions	Existing Conditions vs Proposed CD-Satellite
East Channel							
Near E27.09	5,909,644	385,761	19.4	19.4	19.4	0.0	0.0
Near E24.92	5,919,492	390,811	18.2	18.3	18.3	0.1	0.0
Near E22.75	5,929,386	397,802	17.2	17.3	17.3	0.1	0.0
Near E20.56	5,940,315	396,669	15.7	15.7	15.7	0.1	0.0
Near E18.47	5,949,082	400,872	14.5	14.6	14.6	0.1	0.0
Near E16.32	5,959,033	406,361	13.2	13.3	13.3	0.1	0.0
Near E14.32	5,969,545	410,047	11.8	11.9	11.9	0.1	0.0
Near E09.76	5,984,872	427,058	9.0	9.0	9.0	0.0	0.0
Near E03.00	6,007,417	456,601	4.3	4.3	4.3	0.0	0.0
Kupigruik Channel							
Near K11.65	5,988,634	414,617	9.5	9.5	9.5	0.0	0.0
Nechelik Channel							
Near N22.65	5,922,041	385,366	17.5	17.5	17.5	0.0	0.0
Near N19.95	5,933,329	386,019	16.5	16.6	16.6	0.1	0.0
Near N17.8	5,934,291	377,889	14.4	14.4	14.4	0.0	0.0
Near N15.07	5,941,514	373,720	12.2	12.3	12.3	0.1	0.0
Near N12.88	5,952,813	375,779	10.7	10.9	10.9	0.2	0.0
Near N09.47	5,968,025	370,955	8.6	8.6	8.6	0.0	0.0
Near N07.47	5,976,223	368,261	7.2	7.2	7.2	0.0	0.0
Near N05.42	5,987,622	367,793	5.8	5.8	5.8	0.0	0.0
Near N02.03	6,006,506	368,960	3.4	3.4	3.4	0.0	0.0
Sakoonang Channel							
Near S16.52	5,946,219	393,958	15.3	15.3	15.3	0.0	0.0
Near S13.07	5,957,945	385,965	11.5	11.1	11.2	-0.4	0.1
Near S09.80	5,968,672	390,519	9.8	9.5	9.6	-0.3	0.1
Near S05.07	5,985,818	384,698	8.2	8.2	8.2	0.0	0.0
Near S01.38	5,991,840	377,691	7.1	7.1	7.1	0.0	0.0
Tamayayak Channel							
Near T12.62	5,972,400	397,793	11.3	11.3	11.3	0.0	0.0
Near T08.20	5,992,255	391,674	8.9	8.9	8.9	0.0	0.0

Notes:
1. All elevations are reported in BPMSL, and coordinates are reported in Alaska State Plane, Zone 4, NAD27.
2. Water surface elevations from the report: Michael Baker Jr., Inc., 2001. *Colville River Delta, 2- and 10-Year Flood Models*, Prepared for Phillips Alaska, Inc., Anchorage, Alaska.
3. Existing condition 2002 water surface elevations based on model output: 10_New_Alpine_e(4).flo.
4. Proposed CD-Satellite Facilities water surface elevations based on model output: 10_New_Facilities_d(2).flo.

Table 3: Comparison of the 50-Year Flood Water Surface Elevations Within the Channels

Location	State Plane Coordinates (1)		Peak Water Surface Elevation (ft)			Difference in Peak Water Surface	
	Northing	Easting	July 1998 with Facilities (2)	Existing Conditions 2002 (3)	With Proposed CD Satellite Facilities (4)	Jul-98 vs Existing Conditions	Existing Conditions vs Proposed CD-Satellite
East Channel							
Near E27.09	5,909,644	385,761	23.4	23.4	23.4	0.0	0.0
Near E24.92	5,919,492	390,811	22.1	22.1	22.1	0.0	0.0
Near E22.75	5,929,386	397,802	20.8	20.8	20.8	0.0	0.0
Near E20.56	5,940,315	396,669	18.8	18.8	18.8	0.0	0.0
Near E18.47	5,949,082	400,872	17.6	17.5	17.5	-0.1	0.0
Near E16.32	5,959,033	406,361	16.0	15.9	15.9	-0.1	0.0
Near E14.32	5,969,545	410,047	14.1	14.1	14.1	0.0	0.0
Near E09.76	5,984,872	427,058	10.7	10.6	10.6	-0.1	0.0
Near E03.00	6,007,417	456,601	4.9	4.8	4.8	-0.1	0.0
Kupigruik Channel							
Near K11.65	5,988,634	414,617	11.3	11.2	11.2	-0.1	0.0
Nechelik Channel							
Near N22.65	5,922,041	385,366	21.5	21.5	21.5	0.0	0.0
Near N19.95	5,933,329	386,019	19.7	19.7	19.7	0.0	0.0
Near N17.8	5,934,291	377,889	17.4	17.5	17.5	0.1	0.0
Near N15.07	5,941,514	373,720	15.0	15.1	15.1	0.1	0.0
Near N12.88	5,952,813	375,779	14.0	14.2	14.2	0.2	0.0
Near N09.47	5,968,025	370,955	11.8	11.9	11.8	0.1	-0.1
Near N07.47	5,976,223	368,261	10.3	10.4	10.3	0.1	-0.1
Near N05.42	5,987,622	367,793	8.1	8.3	8.2	0.2	-0.1
Near N02.03	6,006,506	368,960	3.9	3.9	4.0	0.0	0.1
Sakoonang Channel							
Near S16.52	5,946,219	393,958	18.3	18.3	18.3	0.0	0.0
Near S13.07	5,957,945	385,965	14.3	14.8	14.9	0.5	0.1
Near S09.80	5,968,672	390,519	12.2	12.5	13.2	0.3	0.7
Near S05.07	5,985,818	384,698	10.2	10.3	10.7	0.1	0.4
Near S01.38	5,991,840	377,691	8.1	8.2	8.3	0.1	0.1
Tamayayak Channel							
Near T12.62	5,972,400	397,793	13.2	13.1	13.1	-0.1	0.0
Near T08.20	5,992,255	391,674	10.1	10.0	10.0	-0.1	0.0

Notes:
1. All elevations are reported in BPMSL, and coordinates are reported in Alaska State Plane, Zone 4, NAD27.
2. Water surface elevations from the report: Michael Baker Jr., Inc., 1998. *Colville River Delta, Two-Dimensional Surface Water Model, Project Update* , Prepared for ARCO Alaska, Inc., Anchorage, Alaska.
3. Existing condition 2002 water surface elevations based on model output: 50_New_Alpine_f(2).flo.
4. Proposed CD-Satellite Facilities water surface elevations based on model output: 50_New_Facilities_c(1).flo.

Table 4: Comparison of the 200-Year Flood Water Surface Elevations Within the Channels

Location	State Plane Coordinates (1)		Peak Water Surface Elevation (ft)			Difference in Peak Water Surface Elevation	
	Northing	Easting	July 1998 with Facilities (2)	Existing Conditions 2002 (3)	With Proposed CD-Satellite Facilities (4)	Jul-98 vs Existing Conditions	Existing Conditions vs Proposed CD-Satellite
East Channel							
Near E27.09	5,909,644	385,761	26.4	26.4	26.4	0.0	0.0
Near E24.92	5,919,492	390,811	24.9	24.9	24.9	0.0	0.0
Near E22.75	5,929,386	397,802	23.4	23.4	23.4	0.0	0.0
Near E20.56	5,940,315	396,669	21.0	21.0	21.0	0.0	0.0
Near E18.47	5,949,082	400,872	19.7	19.7	19.7	0.0	0.0
Near E16.32	5,959,033	406,361	17.8	17.8	17.9	0.0	0.1
Near E14.32	5,969,545	410,047	15.7	15.8	15.8	0.1	0.0
Near E09.76	5,984,872	427,058	11.8	11.9	11.9	0.1	0.0
Near E03.00	6,007,417	456,601	5.3	5.4	5.4	0.1	0.0
Kupigruik Channel							
Near K11.65	5,988,634	414,617	12.1	12.4	12.4	0.3	0.0
Nechelik Channel							
Near N22.65	5,922,041	385,366	24.3	24.3	24.3	0.0	0.0
Near N19.95	5,933,329	386,019	22.0	22.0	22.0	0.0	0.0
Near N17.8	5,934,291	377,889	19.7	19.7	19.7	0.0	0.0
Near N15.07	5,941,514	373,720	17.3	17.4	17.4	0.1	0.0
Near N12.88	5,952,813	375,779	16.4	16.4	16.4	0.0	0.0
Near N09.47	5,968,025	370,955	14.1	14.2	13.9	0.1	-0.3
Near N07.47	5,976,223	368,261	12.3	12.5	12.3	0.2	-0.2
Near N05.42	5,987,622	367,793	9.8	9.8	9.7	0.0	-0.1
Near N02.03	6,006,506	368,960	4.4	4.4	4.4	0.0	0.0
Sakoonang Channel							
Near S16.52	5,946,219	393,958	20.5	20.5	20.5	0.0	0.0
Near S13.07	5,957,945	385,965	16.4	16.8	16.9	0.4	0.1
Near S09.80	5,968,672	390,519	14.8	15.1	15.8	0.3	0.7
Near S05.07	5,985,818	384,698	11.9	12.1	12.4	0.2	0.3
Near S01.38	5,991,840	377,691	9.5	9.6	9.7	0.1	0.1
Tamayayak Channel							
Near T12.62	5,972,400	397,793	14.2	14.2	14.3	0.0	0.1
Near T08.20	5,992,255	391,674	10.8	10.8	10.9	0.0	0.1

Notes:
1. All elevations are reported in BPMSL, and coordinates are reported in Alaska State Plane, Zone 4, NAD27.
2. Water surface elevations from the report: Michael Baker Jr., Inc., 1998. *Colville River Delta, Two-Dimensional Surface Water Model, Project Update* , Prepared for ARCO Alaska, Inc., Anchorage, Alaska.
3. Existing condition 2002 water surface elevations based on model output: 200_New_Alpine_i(1).flo.
4. Proposed CD-Satellite Facilities water surface elevations based on model output: 200_New_Facilities_i(1).flo.

Table 5: Comparison of the 50-Year Flood Water Surface Elevations Along the Alpine Pipeline

Location	State Plane Coordinates (1)		July 1998 with Facilities (2)		2002 Proposed CD-Satellite Facilities (3)		Difference in Water Surface Elevation and Water Depth	
	Northing	Easting	Water Surface Elevation	Water Depth (ft) (2)	Water Surface Elevation	Water Depth (ft) (4)	Water Surface Elevation Difference (5)	Water Depth Difference (ft) (5)
PI 01B	5,977,102	385,426	12.1	-	13.0	3.5	0.9	-
PI 03	5,973,060	382,705	12.1	0.6	13.0	0.2	0.9	-0.4
PI 04	5,969,486	378,985	12.1	2.0	13.1	3.3	1.0	1.3
PI 05	5,963,244	377,899	12.5	0.5	13.1	0.8	0.6	0.3
PI 06	5,960,993	378,208	12.8	1.3	13.3	1.8	0.5	0.5
PI 07	5,954,169	382,629	14.7	2.3	14.6	2.1	-0.1	-0.2
PI 08	5,952,674	382,609	14.8	5.0	15.0	4.6	0.2	-0.4
PI 09	5,951,162	383,482	14.8	6.2	15.0	6.1	0.2	-0.1
PI 10	5,949,730	384,843	15.3	2.0	15.4	2.3	0.1	0.3
PI 11	5,946,188	392,113	15.9	0.0	15.9	0.0	0.0	0.0
PI 12A	5,944,918	393,140	15.9	0.0	15.9	0.0	0.0	0.0
PI 13A	5,939,750	393,804	18.9	0.0	19.0	0.2	0.1	0.2
PI 14A	5,939,641	398,674	18.8	1.0	18.6	1.3	-0.2	0.3
PI 15A	5,935,517	401,684	20.0	7.7	20.0	9.0	0.0	1.3

Notes:
1. All elevations are reported in BPMSL, and coordinates are reported in Alaska State Plane, Zone 4, NAD27.
2. Water surface elevations and depths from the report: Michael Baker Jr., Inc., 1998. *Colville River Delta, Two-Dimensional Surface Water Model, Project Update* , Prepared for ARCO Alaska, Inc., Anchorage, Alaska.
3. Proposed CD-Satellite Facilities water surface elevations based on model output: 50_New_Facilities_c(1).flo.
4. The water depth represents the difference between the predicted water surface elevation at the closest inundated point and the ground surface elevation at the PI. Ground surface elevations for 2002 taken from Alpine Pipeline As-Built Submittal to Joint Pipeline Office, September 28, 2001, prepared by Michael Baker Jr., Inc.
5. The difference in water surface elevation and depth is positive when the 2002 value is higher than the 1998 value and negative when the 2002 value is lower than the 1998 value.

Table 6: Comparison of the 200-Year Flood Water Surface Elevations Along the Alpine Pipeline

Location	State Plane Coordinates (1)		July 1998 with Facilities (2)		2002 Proposed CD-Satellite Facilities (3)		Difference in Water Surface Elevation and Water Depth	
	Northing	Easting	Water Surface Elevation	Water Depth (feet) (2)	Water Surface Elevation	Water Depth (feet) (4)	Water Surface Elevation Difference (5)	Water Depth Difference (feet) (5)
PI 01B	5,977,102	385,426	14.4	-	15.5	6.0	1.1	-
PI 03	5,973,060	382,705	14.4	2.9	15.6	2.8	1.2	-0.1
PI 04	5,969,486	378,985	14.4	4.3	15.7	5.9	1.3	1.6
PI 05	5,963,244	377,899	14.8	2.8	15.7	3.4	0.9	0.6
PI 06	5,960,993	378,208	15.2	3.7	15.8	4.3	0.6	0.6
PI 07	5,954,169	382,629	16.6	4.2	17.0	4.5	0.4	0.3
PI 08	5,952,674	382,609	16.6	6.8	17.0	6.6	0.4	-0.2
PI 09	5,951,162	383,482	16.6	8.0	17.0	8.1	0.4	0.1
PI 10	5,949,730	384,843	17.4	4.1	17.6	4.5	0.2	0.4
PI 11	5,946,188	392,113	18.3	0.0	18.5	0.0	0.2	0.0
PI 12A	5,944,918	393,140	18.3	0.0	18.5	0.0	0.2	0.0
PI 13A	5,939,750	393,804	21.2	2.2	21.3	2.5	0.1	0.3
PI 14A	5,939,641	398,674	21.0	3.2	20.9	3.6	-0.1	0.4
PI 15A	5,935,517	401,684	22.3	10.0	22.4	11.4	0.1	1.4

Notes:
1. All elevations are reported in BPMSL, and coordinates are reported in Alaska State Plane, Zone 4, NAD27.
2. Water surface elevations and depths from the report: Michael Baker Jr., Inc., 1998. *Colville River Delta, Two-Dimensional Surface Water Model, Project Update* , Prepared for ARCO Alaska, Inc., Anchorage, Alaska.
3. Proposed CD-Satellite Facilities water surface elevations based on model output: 200_New_Facilities_i(1).flo.
4. The water depth represents the difference between the predicted water surface elevation at the closest inundated point and the ground surface elevation at the PI. Ground surface elevations for 2002 taken from Alpine Pipeline As-Built Submittal to Joint Pipeline Office, September 28, 2001, prepared by Michael Baker Jr., Inc.
5. The difference in water surface elevation and depth is positive when the 2002 value is higher than the 1998 value and negative when the 2002 value is lower than the 1998 value.

Table 7: Comparison of the 10-Year Flood Water Surface Elevations At Permanent Staff Gage Locations

Permanent Staff Gage Number	State Plane Coordinates (1)(2)		Ground Surface Elevation	March 2001 with Alpine Facilities (5)		2002 Proposed CD-Satellite Facilities (6)		Difference in Water Surface Elevation and Depth
	Northing	Easting		Water Surface Elevation	Water Depth (ft)	Water Surface Elevation	Water Depth (ft)	
1	5,975,948	386,920	1.9 [3]	9.0	7.1	8.8	6.9	-0.1
2	5,974,961	380,306	3.7 [4]	8.2	4.5	8.2	4.5	0.0
3	5,975,040	379,259	5.9 [3]	8.7	2.8	8.7	2.8	0.0
4	5,975,173	379,222	5.0 [4]	8.1	3.1	8.1	3.1	0.0
5	5,975,031	379,071	5.2 [4]	8.4	3.2	8.4	3.2	0.0
6	5,974,982	373,555	6.3 [4]	8.9	2.6	8.9	2.6	0.0
7	5,975,132	373,586	7.5 [3]	-	-	8.6	1.1	-
8	5,974,855	371,261	8.2 [3]	8.9	0.7	8.7	0.5	-0.2
9	5,972,643	383,030	8.0 [3]	10.0	2.0	9.7	1.7	-0.3
10	5,975,797	385,464	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. Water surface elevations from the report: Michael Baker Jr., Inc., 2001. Colville River Delta, 2- and 10-Year Flood Models, Prepared for Phillips Alaska, Inc., Anchorage, Alaska.
6. Proposed CD-Satellite Facilities water surface elevations based on model output: 10_New_Facilities_d(3).flo.

Table 8: Comparison of the 50-Year Flood Water Surface Elevations Along the Alpine Facilities Road

Location	State Plane Coordinates (1)		July 1998 with Facilities - Water Surface Elevations (2)		2002 Proposed CD-Satellite Facilities - Water Surface Elevations (3)		Difference in Water Surface Elevation (4)	
	Northing	Easting	Upstream (South) Side of Facilities	Downstream (North) Side of Facilities	Upstream (South) Side of Facilities	Downstream (North) Side of Facilities	Upstream (South) Side of Facilities	Downstream (North) Side of Facilities
SW Corner CD2 Pad	5,974,116	371,389	11.5	-	11.5	-	0.0	-
SE Corner CD2 Pad	5,974,149	371,920	11.9	-	11.9	-	0.0	-
10+00	5,974,900	371,367	-	10.5	-	10.4	-	-0.1
20+00	5,975,006	372,362	11.9	9.9	11.9	10.0	0.0	0.1
30+00	5,975,087	373,357	11.9	9.8	11.9	9.9	0.0	0.1
40+00	5,974,720	374,270	11.9	9.8	11.9	9.9	0.0	0.1
50+00	5,974,119	375,062	12.0	9.8	11.9	9.9	-0.1	0.1
60+00	5,974,017	376,041	12.0	9.8	11.8	9.9	-0.2	0.1
70+00	5,974,256	377,012	12.0	9.9	11.8	10.0	-0.2	0.1
80+00	5,974,506	377,980	11.9	9.9	11.8	10.1	-0.1	0.2
90+00	5,974,938	378,881	11.9	9.9	11.7	10.1	-0.2	0.2
100+00	5,975,071	379,861	11.8	9.9	11.6	10.1	-0.2	0.2
103+00	5,975,010	380,154	11.3	9.8	11.1	10.0	-0.2	0.2
108+00	5,974,878	380,637	11.4	9.8	11.4	10.0	0.0	0.2
110+00	5,974,826	380,829	11.6	9.8	11.5	10.0	-0.1	0.2
120+00	5,974,848	381,741	11.6	9.9	13.0	10.1	1.4	0.2
130+00	5,975,442	382,545	12.1	9.9	13.0	10.1	0.9	0.2
140+00	5,976,036	383,350	12.1	9.9	13.0	10.1	0.9	0.2
150+00	5,976,630	384,154	12.1	9.9	13.0	10.1	0.9	0.2
160+00	5,977,223	384,959	12.1	9.9	13.0	10.1	0.9	0.2
170+00	5,977,817	385,763	-	9.9	-	10.1	-	0.2
NW Corner CD1 Pad	5,977,146	386,066	12.1	-	13.0	-	0.9	-
NE Corner CD1 Pad	5,977,312	386,800	11.0	-	11.8	-	0.8	-
SW Corner CD1 Pad	5,975,266	385,196	12.1	-	12.9	-	0.8	-
SE Corner CD1 Pad	5,975,054	385,408	11.9	-	12.8	-	0.9	-

Notes:
1. All elevations are reported in BPMSL, and coordinates are reported in Alaska State Plane, Zone 4, NAD27.
2. Water surface elevations from the report: Michael Baker Jr., Inc., 1998. *Colville River Delta, Two-Dimensional Surface Water Model, Project Update*, Prepared for ARCO Alaska, Inc., Anchorage, Alaska.
3. Proposed CD-Satellite Facilities water surface elevations based on model output: 50_New_Facilities_c(1).flo.
4. The difference in water surface elevation and depth is positive when the 2002 value is higher than the 1998 value and negative when the 2002 value is lower than the 1998 value.

Table 9: Comparison of the 200-Year Flood Water Surface Elevations Along the Alpine Facilities Road

Location	State Plane Coordinates (1)		July 1998 with Facilities - Water Surface Elevations (2)		2002 Proposed CD-Satellite Facilities - Water Surface Elevations (3)		Difference in Water Surface Elevation and Water Depth (4)	
	Northing	Easting	Upstream (South) Side of Facilities	Downstream (North) Side of Facilities	Upstream (South) Side of Facilities	Downstream (North) Side of Facilities	Upstream (South) Side of Facilities	Downstream (North) Side of Facilities
SW Corner CD2 Pad	5,974,116	371,389	13.5	-	13.3	-	-0.2	-
SE Corner CD2 Pad	5,974,149	371,920	14.1	-	13.9	-	-0.2	-
10+00	5,974,900	371,367	-	12.3	-	12.2	-	-0.1
20+00	5,975,006	372,362	14.2	11.7	13.9	11.8	-0.3	0.1
30+00	5,975,087	373,357	14.2	11.6	13.9	11.7	-0.3	0.1
40+00	5,974,720	374,270	14.2	11.6	13.9	11.7	-0.3	0.1
50+00	5,974,119	375,062	14.2	11.6	13.9	11.7	-0.3	0.1
60+00	5,974,017	376,041	14.2	11.6	13.9	11.7	-0.3	0.1
70+00	5,974,256	377,012	14.2	11.6	13.9	11.7	-0.3	0.1
80+00	5,974,506	377,980	14.2	11.6	13.9	11.8	-0.3	0.2
90+00	5,974,938	378,881	14.2	11.6	13.8	11.8	-0.4	0.2
100+00	5,975,071	379,861	14.1	11.6	13.7	11.7	-0.4	0.1
103+00	5,975,010	380,154	13.6	11.5	13.1	11.7	-0.5	0.2
108+00	5,974,878	380,637	13.7	11.5	13.4	11.7	-0.3	0.2
110+00	5,974,826	380,829	14.0	11.5	13.6	11.7	-0.4	0.2
120+00	5,974,848	381,741	14.2	11.6	15.6	11.8	1.4	0.2
130+00	5,975,442	382,545	14.3	11.6	15.5	11.8	1.2	0.2
140+00	5,976,036	383,350	14.4	11.7	15.5	11.8	1.1	0.1
150+00	5,976,630	384,154	14.4	11.7	15.5	11.8	1.1	0.1
160+00	5,977,223	384,959	14.4	11.7	15.5	11.8	1.1	0.1
170+00	5,977,817	385,763	-	11.7	-	11.8	-	0.1
NW Corner CD1 Pad	5,977,146	386,066	14.4	-	15.5	-	1.1	-
NE Corner CD1 Pad	5,977,312	386,800	13.2	-	14.0	-	0.8	-
SW Corner CD1 Pad	5,975,266	385,196	14.3	-	15.5	-	1.2	-
SE Corner CD1 Pad	5,975,054	385,408	14.2	-	15.3	-	1.1	-

Notes:
1. All elevations are reported in BPMSL, and coordinates are reported in Alaska State Plane, Zone 4, NAD27.
2. Water surface elevations from the report: Michael Baker Jr., Inc., 1998. *Colville River Delta, Two-Dimensional Surface Water Model, Project Update* , Prepared for ARCO Alaska, Inc., Anchorage, Alaska.
3. Proposed CD-Satellite Facilities water surface elevations based on model output: 200_New_Facilities_i(1).flo.
4. The difference in water surface elevation and depth is positive when the 2002 value is higher than the 1998 value and negative when the 2002 value is lower than the 1998 value.

Table 10: Water Surface Elevations, Water Velocities, and Water Depths along the CD-South Access Road During the 50-Year Flood

Location	State Plane Coordinates (1)			Water Surface Elevations Along the CD-South Road Corridor Without CD-Satellite Facilities (3,5)	Model Results With CD-Satellite Facilites Along the Western Side of CD-South Access Road (4,5)			Model Results With CD-Satellite Facilites Along the Eastern Side of CD-South Access Road (4,5)		
	Northing	Easting	Approximate Ground Elevation (2)		Water Surface Elevation	Water Velocity (ft/s)	Water Depth (feet)	Water Surface Elevation	Water Velocity (ft/s)	Water Depth (feet)
10+00	5,974,702	381,090	8.3	11.6	11.4	0.5	3.1	13.0	0.5	4.7
15+00	5,974,160	381,046	11.5	11.6	11.5	0.3	0.0	13.0	0.5	1.5
20+00	5,973,749	381,094	11.9	12.0	11.6*	-	-	13.0	0.5	1.1
25+00	5,973,297	380,896	11.4	12.0	11.7	0.3	0.3	13.0	0.5	1.6
30+00	5,972,966	380,522	10.9	12.0	11.8	0.2	0.9	13.0	0.3	2.1
35+00	5,972,649	380,132	9.9	12.0	11.8	0.3	1.9	13.0	0.4	3.1
40+00	5,972,333	379,742	8.8	12.0	11.8	0.3	3.0	13.0	0.4	4.2
45+00	5,972,017	379,355	8.8	12.0	11.8	0.2	3.0	13.0	0.4	4.2
50+00	5,971,637	379,025	9.6	12.1	11.8	0.2	2.2	13.0	0.3	3.4
55+00	5,971,242	378,717	9.0	12.1	11.8	0.2	2.8	13.0	0.3	4.0
60+00	5,970,858	378,392	8.8	12.1	11.8	0.1	3.0	13.0	0.3	4.2
65+00	5,970,533	378,019	9.1	12.0	11.8	0.1	2.7	13.1	0.2	4.0
70+00	5,970,133	377,741	10.0	12.0	11.8	0.1	1.8	13.0	0.1	3.0
75+00	5,969,650	377,622	14.6	12.1*	12.0*	-	-	13.1*	-	-
80+00	5,969,159	377,591	11.9	12.2	12.0	0.1	0.1	13.1	0.1	1.2
85+00	5,968,662	377,546	16.0	12.2*	12.0*	-	-	13.1*	-	-
90+00	5,968,164	377,456	16.7	12.2*	12.0*	-	-	13.1*	-	-
95+00	5,967,688	377,365	18.5	12.2*	12.0*	-	-	13.1*	-	-
100+00	5,967,177	377,272	16.0	12.2*	12.0*	-	-	13.1*	-	-
105+00	5,966,806	377,205	17.3	12.2*	12.0*	-	-	13.1*	-	-
110+00	5,966,134	377,085	16.6	12.2*	12.0*	-	-	13.1*	-	-
115+00	5,965,687	377,122	12.3	12.3*	12.0*	-	-	13.1	0.2	0.8

Table 10: Water Surface Elevations, Water Velocities, and Water Depths along the CD-South Access Road During the 50-Year Flood

Location	State Plane Coordinates (1)			Water Surface Elevations Along the CD-South Road Corridor Without CD-Satellite Facilities (3,5)	Model Results With CD-Satellite Facilites Along the Western Side of CD-South Access Road (4,5)			Model Results With CD-Satellite Facilites Along the Eastern Side of CD-South Access Road (4,5)		
	Northing	Easting	Approximate Ground Elevation (2)		Water Surface Elevation	Water Velocity (ft/s)	Water Depth (feet)	Water Surface Elevation	Water Velocity (ft/s)	Water Depth (feet)
120+00	5,965,095	377,077	10.6	12.3	12.0	0.2	1.4	13.1	0.4	2.5
125+00	5,964,720	377,037	15.2	12.3*	12.0	0.1	-3.2	13.1*	-	-
130+00	5,964,205	376,897	14.9	12.3*	12.0*	-	-	13.1*	-	-
135+00	5,963,708	376,949	15.1	12.3*	12.3*	-	-	13.1*	-	-
140+00	5,963,213	377,025	14.6	12.4*	12.4*	-	-	13.1*	-	-
145+00	5,962,812	377,088	14.1	12.4*	12.4*	-	-	13.2*	-	-
150+00	5,962,215	377,179	13.0	12.8*	12.4*	-	-	13.2*	-	-
155+00	5,961,723	377,256	12.7	12.8*	12.4*	-	-	13.3	0.7	0.6
160+00	5,961,299	377,314	13.5	13.0*	12.5*	-	-	13.3*	-	-
165+00	5,960,755	377,392	13.1	13.1*	12.6*	-	-	13.4	1.3	0.3
170+00	5,960,326	377,503	10.5	13.5	13.7	0.1	3.2	13.6	0.4	3.1
175+00	5,959,842	377,772	13.7	13.6*	13.7*	-	-	13.7*	-	-
179+00	5,959,513	377,848	lake	13.7	13.7	0.2	-	13.9	0.2	-
180+00	5,959,389	377,843	lake	13.7	13.7	0.1	-	13.9	0.8	-
185+00	5,958,843	377,812	12.1	13.8	13.7	0.5	1.6	13.9	0.8	1.8
190+00	5,958,411	377,922	11.8	13.8	13.7	0.3	1.9	13.9	0.4	2.1
195+00	5,957,937	378,063	12.7	13.8	13.8	0.1	1.1	13.9	0.1	1.2
NW Corner Pad	5,957,564	377,387	10.1	13.8	13.8	0.2	3.7	-	-	-
NE Corner Pad	5,957,816	378,483	15.0	13.9	-	-	-	14.0*	-	-

Table 10: Water Surface Elevations, Water Velocities, and Water Depths along the CD-South Access Road During the 50-Year Flood

Location	State Plane Coordinates (1)			Water Surface Elevations Along the CD-South Road Corridor Without CD-Satellite Facilities (3,5)	Model Results With CD-Satellite Facilites Along the Western Side of CD-South Access Road (4,5)			Model Results With CD-Satellite Facilites Along the Eastern Side of CD-South Access Road (4,5)		
	Northing	Easting	Approximate Ground Elevation (2)		Water Surface Elevation	Water Velocity (ft/s)	Water Depth (feet)	Water Surface Elevation	Water Velocity (ft/s)	Water Depth (feet)
SW Corner Pad	5,957,231	377,467	10.1	13.9	13.8	0.7	3.7	-	-	-
SE Corner Pad	5,957,400	378,591	13.2	14.1	-	-	-	14.2	0.3	1.0

Notes:
1. All elevations are reported in BPMSL. Horizontal coordinates are reported in Alaska State Plane, Zone 4, NAD27.
2. Ground elevations are based on the topographical base map used to define the finite element mesh, which are based on photogrammetric contour data by Aeromap U.S. 6/30/99.
3. Water surface elevations and velocities for model results without CD-Satellite Facilities based on model output: 50_New_Alpine_f(2).flo.
4. Water surface elevations and velocities for model results with CD-Satellite Facilities based on model output: 50_New_Facilities_c(1).flo.
5. Water Surface Elevations with an asterisk (*) represent water surface elevations in the vicinity of the identified location and are lower than the ground elevation at this location.
6. The water depth is the difference between the predicted water surface elevation and the ground surface elevation at the specific location.
7. Empty cells are areas where the model indicates dry ground.

Table 11: Water Surface Elevations, Water Velocities, and Water Depths along the CD-South Access Road During the 200-Year Flood

Location	State Plane Coordinates (1)			Water Surface Elevations Along the CD-South Road Corridor Without CD-Satellite Facilities (3,5)	Model Results With CD-Satellite Facilites Along the Western Side of CD-South Access Road (4,5)			Model Results With CD-Satellite Facilites Along the Eastern Side of CD-South Access Road (4,5)		
	Northing	Easting	Approximate Ground Elevation (2)		Water Surface Elevation	Water Velocity (ft/s)	Water Depth (feet)	Water Surface Elevation	Water Velocity (ft/s)	Water Depth (feet)
10+00	5,974,702	381,090	8.3	14.1	13.5	0.8	5.2	15.6	0.0	7.3
15+00	5,974,160	381,046	11.5	14.1	13.7	0.9	2.2	15.6	0.0	4.1
20+00	5,973,749	381,094	11.9	14.3	13.7	0.7	1.8	15.6	0.2	3.7
25+00	5,973,297	380,896	11.4	14.4	13.8	0.5	2.4	15.6	0.5	4.2
30+00	5,972,966	380,522	10.9	14.4	13.8	0.5	2.9	15.6	0.7	4.7
35+00	5,972,649	380,132	9.9	14.4	13.8	0.5	3.9	15.6	0.6	5.7
40+00	5,972,333	379,742	8.8	14.4	13.9	0.5	5.1	15.6	0.6	6.8
45+00	5,972,017	379,355	8.8	14.4	13.9	0.3	5.1	15.6	0.5	6.8
50+00	5,971,637	379,025	9.6	14.4	13.9	0.3	4.3	15.6	0.4	6
55+00	5,971,242	378,717	9.0	14.4	13.9	0.2	4.9	15.6	0.4	6.6
60+00	5,970,858	378,392	8.8	14.4	13.9	0.2	5.1	15.6	0.3	6.8
65+00	5,970,533	378,019	9.1	14.4	13.9	0.1	4.8	15.7	0.3	6.6
70+00	5,970,133	377,741	10.0	14.4	13.9	0.1	3.9	15.6	0.3	5.6
75+00	5,969,650	377,622	14.6	14.5*	14.0*	-	-	15.7	0.4	1.1
80+00	5,969,159	377,591	11.9	14.6	14.0	0.2	2.1	15.7	0.3	3.8
85+00	5,968,662	377,546	16.0	14.6*	14.0*	-	-	15.6*	-	-
90+00	5,968,164	377,456	16.7	14.6*	14.0*	-	-	15.7*	-	-
95+00	5,967,688	377,365	18.5	14.6*	14.0*	-	-	15.7*	-	-
100+00	5,967,177	377,272	16.0	14.6*	14.0*	-	-	15.7*	-	-
105+00	5,966,806	377,205	17.3	14.6*	14.0*	-	-	15.7*	-	-
110+00	5,966,134	377,085	16.6	14.6*	14.0*	-	-	15.7*	-	-
115+00	5,965,687	377,122	12.3	14.6	14.0	0.1	1.7	15.7	0.1	3.4

Table 11: Water Surface Elevations, Water Velocities, and Water Depths along the CD-South Access Road During the 200-Year Flood

Location	State Plane Coordinates (1)			Water Surface Elevations Along the CD-South Road Corridor Without CD-Satellite Facilities (3,5)	Model Results With CD-Satellite Facilites Along the Western Side of CD-South Access Road (4,5)			Model Results With CD-Satellite Facilites Along the Eastern Side of CD-South Access Road (4,5)		
	Northing	Easting	Approximate Ground Elevation (2)		Water Surface Elevation	Water Velocity (ft/s)	Water Depth (feet)	Water Surface Elevation	Water Velocity (ft/s)	Water Depth (feet)
120+00	5,965,095	377,077	10.6	14.6	14.0	0.1	3.4	15.7	0.5	5.1
125+00	5,964,720	377,037	15.2	14.6*	14.0*	-	-	15.7	0.5	0.5
130+00	5,964,205	376,897	14.9	14.7*	14.0*	-	-	15.7	0.6	0.8
135+00	5,963,708	376,949	15.1	14.7*	14.9*	-	-	15.7	0.8	0.6
140+00	5,963,213	377,025	14.6	14.8	14.9	0.2	0.3	15.7	0.9	1.1
145+00	5,962,812	377,088	14.1	14.9	15.0	0.9	0.9	15.7	0.9	1.6
150+00	5,962,215	377,179	13.0	15.1	15.2	0.8	2.2	15.7	1.1	2.7
155+00	5,961,723	377,256	12.7	15.2	15.3	1.0	2.6	15.8	1.0	3.1
160+00	5,961,299	377,314	13.5	15.3	15.5	1.3	2.0	15.8	1.0	2.3
165+00	5,960,755	377,392	13.1	15.4	15.6	1.2	2.5	15.8	1.2	2.7
170+00	5,960,326	377,503	10.5	15.6	15.7	0.9	5.2	15.9	1.3	5.4
175+00	5,959,842	377,772	13.7	15.6	15.7	1.2	2.0	15.9	2.1	2.2
179+00	5,959,513	377,848	lake	15.9	15.8	0.9	-	16.0	1.8	-
180+00	5,959,389	377,843	lake	15.9	15.7	1.0	-	16.1	1.8	-
185+00	5,958,843	377,812	12.1	15.9	15.8	1.5	3.7	16.1	1.2	4
190+00	5,958,411	377,922	11.8	15.9	15.8	0.8	4.0	16.2	0.7	4.4
195+00	5,957,937	378,063	12.7	16.0	15.9	0.3	3.2	16.1	0.2	3.4
NW Corner Pad	5,957,564	377,387	10.1	16.0	15.9	0.2	5.8	-	-	-
NE Corner Pad	5,957,816	378,483	15.0	16.1	-	-	-	16.2	0.4	1.2

Table 11: Water Surface Elevations, Water Velocities, and Water Depths along the CD-South Access Road During the 200-Year Flood

Location	State Plane Coordinates (1)			Water Surface Elevations Along the CD-South Road Corridor Without CD-Satellite Facilities (3,5)	Model Results With CD-Satellite Facilites Along the Western Side of CD-South Access Road (4,5)			Model Results With CD-Satellite Facilites Along the Eastern Side of CD-South Access Road (4,5)		
	Northing	Easting	Approximate Ground Elevation (2)		Water Surface Elevation	Water Velocity (ft/s)	Water Depth (feet)	Water Surface Elevation	Water Velocity (ft/s)	Water Depth (feet)
SW Coner Pad	5,957,231	377,467	10.1	16.1	15.9	1.6	5.8	-	-	-
SE Corner Pad	5,957,400	378,591	13.2	16.3	-	-	-	16.4	0.3	3.2

Notes:
1. All elevations are reported in BPMSL. Horizontal coordinates are reported in Alaska State Plane, Zone 4, NAD27.
2. Ground elevations are based on the topographical base map used to define the finite element mesh, which are based on photogrammetric contour date by Aeromap U.S. 6/30/99.
3. Water surface elevations and velocities for model results without CD-Satellite Facilities based on model output: 200_New_Alpine_h(1).flo.
4. Water surface elevations and velocities for model results with CD-Satellite Facilities based on model output: 200_New_Facilities_i(1).flo.
5. Water Surface Elevations with an asterisk (*) represent water surface elevations in the vicinity of the identified location and are lower than the ground elevation at this location.
6. The water depth is the difference between the predicted water surface elevation and the ground surface elevation at the specific location.
7. Empty cells are areas where the model indicates dry ground.

Table 12: Water Surface Elevations, Water Velocities, and Water Depths Along the CD-South Pipeline During the 200-Year Flood

Location	State Plan Coordinates (1)			Model Results Without CD-Satellite Facilities (3)			Model Results With CD-Satellite Facilities (4)		
	Northing	Easting	Ground Elevation (2)	Water Surface Elevation	Water Velocity (ft/s)	Water Depth (feet) (5)	Water Surface Elevation	Water Velocity (ft/s)	Water Depth (feet) (5)
10+00	5,957,272	378,347	11.8	16.3	1.3	4.5	16.4	1.1	4.6
20+00	5,957,514	379,372	9.6	16.3	1.4	6.7	16.4	1.2	6.8
30+00	5,957,989	380,128	11.7	16.3	0.7	4.6	16.3	0.6	4.6
40+00	5,958,811	379,570	13.9	16.0	1.2	2.1	16.2	0.8	2.3
50+00	5,959,691	378,971	12.5	15.8	1.1	3.3	16.1	0.9	3.6
60+00	5,960,436	378,535	11.6	15.5	1.2	3.9	15.9	1.1	4.3
70+00	5,960,987	378,166	10.8	15.4	1.5	4.6	15.8	0.8	5.0
80+00	5,962,260	378,017	12.0	15.1	1.2	3.1	15.7	0.6	3.7
90+00	5,963,309	377,848	10.7	14.8	1.3	4.1	15.7	0.6	5.0
100+00	5,964,256	377,993	11.7	14.6	0.6	2.9	15.7	0.3	4.0
110+00	5,965,156	378,189	8.5	14.6	0.5	6.1	15.7	0.3	7.2
120+00	5,966,192	378,348	3.2	14.6	0.4	11.4	15.7	0.2	12.5
130+00	5,967,156	378,504	4.3	14.6	0.5	10.3	15.7	0.2	11.4
140+00	5,968,083	378,707	8.0	14.6	0.6	6.6	15.7	0.2	7.7
150+00	5,969,068	378,853	8.3	14.6	0.9	6.3	15.7	0.2	7.4
160+00	5,969,934	379,340	10.1	14.5	1.1	4.4	15.7	0.4	5.6
170+00	5,970,554	380,040	10.1	14.5	0.8	4.4	15.6	0.4	5.5
180+00	5,971,251	380,734	10.8	14.5	0.5	3.7	15.6	0.3	4.8
190+00	5,971,958	381,441	10.4	14.4	0.6	4.0	15.6	0.4	5.2
200+00	5,972,584	382,145	10.3	14.4	0.6	4.1	15.6	0.5	5.3
210+00	5,973,291	382,873	9.2	14.4	0.4	5.2	15.6	0.6	6.4
220+00	5,973,924	383,631	5.7	14.4	0.3	8.7	15.5	0.7	9.8
230+00	5,974,499	384,399	8.5	14.4	0.4	5.9	15.5	0.9	7.0
240+00	5,974,858	385,123	10.0	14.4	0.8	4.4	15.4	1.4	5.4

Notes:
1. All elevations are reported in feet BPMSL. Horizontal coordinates are reported in Alaska State Plane, Zone 4, NAD27.
2. Ground elevations are based on the topographical base map used to define the finite element mesh.
3. Water surface elevations and velocities for model results without CD-Satellite Facilities based on model output: 200_New_Alpine_i(1).flo.
4. Water surface elevations and velocities for model results with CD-Satellite Facilities based on model output: 200_New_Facilities_i(1).flo.
5. The water depth is the difference between the predicted water surface elevation and the ground surface elevation at the specific location.

Table 13: Water Surface Elevations, Water Velocities, and Water Depths along the CD-North Pad, Road, and Runway During the 200-Year Flood

Location	State Plane Coordinates (1)			Water Surface Elevations Without CD-Satellite Facilities (3,5)	Model Results With CD-Satellite Facilites (4,5)		
	Northing	Easting	Approximate Ground Elevation (2)		Water Surface Elevation	Water Velocity (ft/s)	Water Depth (feet)
NW Corner of Pad	600,391	387,495	6.2	7.6	7.7	2.4	1.5
NE Corner of Pad	6,004,197	388,672	6.0	7.5	7.0	0.1	1.0
SW Corner of Pad	6,003,595	387,552	6.1	7.7	7.9	1.4	1.8
SE Corner of Pad	6,003,545	388,891	6.0	7.7	7.0	0.1	1.0
Mid-Point Access Road (south)	5,974,921	389,409	7.7	8.0	8.3	1.5	0.6
Mid-Point Access Road (north)	6,002,856	389,443	7.6	8.0	-	-	-
West End of Runway (south)	6,003,176	390,564	6.5	7.7	7.9	0.4	1.4
West End of Runway (north)	6,003,606	390,261	6.6	7.6	7.0	0.1	0.4
Mid-Point Runway (south)	6,004,323	391,635	6.0	7.6	7.8	0.4	1.8
Mid-Point Runway (north)	6,004,458	391,559	6.0	7.6	7.0	0.1	1.0
East End Runway (south)	6,005,402	393,244	6.0	7.5	7.7	0.5	1.7

Notes:
1. All elevations are reported in BPMSL. Horizontal coordinates are reported in Alaska State Plane, Zone 4, NAD27.
2. Ground elevations are from photogramic contour data provided by Aeromap U.S., 6/30/99.
3. Water surface elevations and velocities for model results without CD-Satellite Facilities based on model output: 200_New_Alpine_h(1).flo.
4. Water surface elevations and velocities for model results with CD-Satellite Facilities based on model output: 200_New_Facilities_i(1).flo.
5. The water depth is the difference between the predicted water surface elevation and the ground surface elevation at the specific location.
6. Empty cells are areas where the model indicates dry ground.

Table 14: Water Surface Elevations, Water Velocities, and Water Depths Along the CD-North Pipeline During the 200-Year Flood

Location	State Plan Coordinates (1)			Model Results Without CD-Satellite Facilities (3)			Model Results With CD-Satellite Facilities (4)		
	Northing	Easting	Ground Elevation (2)	Water Surface Elevation (5,6)	Water Velocity (ft/s) (6)	Water Depth (feet) (7)	Water Surface Elevation (5,6)	Water Velocity (ft/s) (6)	Water Depth (feet) (7)
10+00	6,003,675	388,518	6.7	7.8	0.4	1.1	8.1	0.4	1.4
20+00	6,002,868	389,005	7.3	7.9	1.6	0.6	8.3	1.5	1.0
30+00	6,002,373	389,781	7.9	8.0	2.0	0.1	8.3	1.6	0.4
40+00	6,001,801	390,524	6.7	8.2	2.6	1.5	8.5	2.0	1.8
50+00	6,001,096	391,247	6.7	8.4**	0.7**	1.7	8.6**	0.7**	1.9
60+00	6,000,238	391,659	8.1	8.4**	0.7**	0.3	8.6**	0.7**	0.5
70+00	5,999,455	392,049	5.5	8.6**	3.0**	3.1	8.8	3.0**	3.3
Crossing 5	-	-	-	8.6	4.3	-	8.8	4.3	-
80+00	5,998,615	391,684	7.8	8.7**	1.0**	0.9	8.9**	1.0**	1.1
90+00	5,998,335	390,779	7.4	8.7**	1.0**	1.3	8.9**	1.0**	1.5
100+00	5,998,012	389,898	13.3	9.2*	-	-	9.3*	-	-
110+00	5,997,408	389,181	8.4	9.3**	1.2**	0.9	9.4	1.3**	1.0
120+00	5,996,562	388,766	10.1	9.5*	-	-	9.5*	-	-
130+00	5,995,678	388,392	7.7	9.7	1.4	2.0	9.9	1.5	2.2
140+00	5,994,810	387,949	8.0	9.7	1.1	1.7	9.8	1.2	1.8
Crossing	-	-	-	10.0	5.2	-	10.1	5.0	-
160+00	5,993,131	387,832	7.4	10.1**	0.9**	2.7	10.3**	0.7**	2.9
170+00	5,992,216	387,612	8.8	10.1**	0.9**	1.3	10.3**	0.9**	1.5
180+00	5,991,222	387,773	9.1	10.0	0.1	0.9	10.2	0.1	1.1
190+00	5,990,326	387,980	9.5	10.0**	.1**	0.5	10.2**	0.1**	0.7
200+00	5,989,332	388,140	10.8	11.3**	.5**	0.5	10.7*	-	-
210+00	5,988,424	388,288	11.7	12.1**	.5**	0.4	12.1**	1.0**	0.4
220+00	5,987,468	388,496	12.6	12.2*	-	-	12.5*	-	-
230+00	5,986,521	388,653	11.8	12.6**	0.5**	0.8	13.1**	0.9**	1.3
240+00	5,985,716	388,304	9.5	12.5	0.9	3.0	13.0	1.2	3.5

Table 14: Water Surface Elevations, Water Velocities, and Water Depths Along the CD-North Pipeline During the 200-Year Flood

Location	State Plan Coordinates (1)			Model Results Without CD-Satellite Facilities (3)			Model Results With CD-Satellite Facilities (4)		
	Northing	Easting	Ground Elevation (2)	Water Surface Elevation (5,6)	Water Velocity (ft/s) (6)	Water Depth (feet) (7)	Water Surface Elevation (5,6)	Water Velocity (ft/s) (6)	Water Depth (feet) (7)
250+00	5,985,068	387,631	4.6	12.5	1.6	7.9	13.0	1.1	8.4
Crossing	-	-	-	12.6	3.7	-	13.1	4.6	-
270+00	5,983,229	387,096	10.1	12.6	0.9	2.5	13.2	1.1	3.1
280+00	5,982,304	387,112	10.0	12.7	0.6	2.7	13.3	0.8	3.3
290+00	5,981,317	387,191	10.5	12.8	0.5	2.3	13.5	0.7	3.0
300+00	5,980,348	387,206	11.6	12.9**	0.5	1.3	13.6	0.6	2.0
310+00	5,979,417	387,222	11.3	13.0	0.5	1.7	13.7	0.8	2.4
320+00	5,978,424	387,304	10.3	13.2	0.9	2.9	13.9	1.2	3.6
330+00	5,977,493	387,317	9.6	13.3	1.5	3.7	14.2	2.0	4.6
340+00	5,976,600	387,008	10.5	13.6	1.1	3.1	14.5	1.5	4.0

Notes:
1. All elevations are reported in feet BPMSL. Horizontal coordinates are reported in Alaska State Plane, Zone 4, NAD27.
2. Ground elevations are based on the topographical base map used to define the finite element mesh.
3. Water surface elevations and velocities for model results without CD-Satellite Facilities based on model output: 200_New_Alpine_h(1).flo.
4. Water surface elevations and velocities for model results with CD-Satellite Facilities based on model output: 200_New_Facilities_i(1).flo.
5. Water Surface Elevations with an asterisk (*) represent water surface elevations in the vicinity of the identified location and are lower than the ground elevation at this location.
6. Water surface elevations and velocities with a double asterisk (**) represent values in the vicinity of the identified location. The element at the specifiec location is considered turned off by the model, however the ground surface elvation is lower than the water surface elevation..
7. The water depth is the difference between the predicted water surface elevation and the ground surface elevation at the specific location.
8. Empty cells are areas where the model indicates dry ground.

Figures

Colville River Delta

Alpine Facilities

CD-South Figures

CD-North Figures

Appendix A Location of Alpine Permanent Staff Gages

Michael Baker Jr., Inc.
Anchorage, Alaska 99503
907-273-1600