# FLOOD-PRONE AREA MAPS AT THREE SITES ALONG THE TRANS-ALASKA PIPELINE, ALASKA

Prepared by the U.S. Geological Survey

in cooperation with the Bureau of Land Management



OPEN-FILE REPORT 80-209

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY



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by

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Anchorage, Alaska
1980

UNITED STATES DEPARTMENT OF THE INTERIOR

CECIL D. ANDRUS, Secretary

GEOLOGICAL SURVEY

H. William Menard, Director

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## INTRODUCTION

The Bureau of Land Management requested on May 3, 1979 that the U.S. Geological Survey determine the base (100-year) flood-plain limits at three sites (fig. 1) along the Trans-Alaska Pipeline System Highway (Haul Road) between the Yukon River and Prudhoe Bay in order to issue land-use permits. The Alaska Department of Transportation and Public Facilities (ADOT) has constructed maintenance camps at Coldfoot and adjacent to the Jim River near Pump Station 5. The site along the Sagavanirktok River near Pump Station 3 is under consideration as a site for potential development.

An analysis of the flood data available at nearby gaging stations, at prior flood-survey sites, and from regional flood analyses was made. The discharge of the 100-year flood was calculated for the three sites using methods described by U.S. Water Resources Council (WRC, 1977) and given in Lamke (1979). Next field examination was made of the sites. Flood-deposited debris upon the overbank floodways was used to determine elevations of the maximum evident flood at the three flood-prone sites mapped. The maximum evident floodmarks for these floods were at elevations and locations which indicated that they were independent of ice scars. Ice scars higher than the highest flood debris were found at the Jim River site. Flood evidence of recent peaks was also used as an aid in determining the base flood boundaries. These limits have been delineated on aerial photographs of the sites. Surveying was limited to that necessary to adequately define the base flood boundaries; step-backwater computations were not made. Although some additional pertinent information is shown on the photographs, no attempt was made to delineate areas of inadequate local drainage or seasonal problems of high ground-water tables.

Aerial photographs of the three sites were obtained from North Pacific Aerial Survey, Inc., with the permission of Alaskan Natural Gas Transportation Co. One photograph was obtained from Air Photo Tech, Inc., with the permission of Aleyska Pipeline Service Co.

## SITE ANALYSES

### Sagavanirktok River near Pump Station 3

The Sagavanirktok River borders the trans-Alaskan pipeline and Pump Station 3 to the east of the area proposed for potential development (fig. 2) on the west bank. Gaging station flood information is available for 10 years, 1969-78, at a site 19 mi (miles) downstream from Pump Station 3. The maximum evident flood at the gage has a discharge of 62,000 $ft^3/s$ (cubic feet per second) (table 1). The maximum observed discharge for the period of record was 34,900 $ft^3/s$ in August 1969. The log-Pearson Type III distribution of the annual series of flood events at the gage was computed using the maximum evident flood of 62,000 $ft^3/s$ as the highest since 1961. This resulted in a 100-year flood discharge of 76,400 $ft^3/s$ (WRC, 1977). An analysis using regional flood frequency techniques (Lamke, 1979) and the above value resulted in an estimated 100-year flood discharge at the gage of 76,000 $ft^3/s$. The drainage area at the site near Pump Station 3 is 1,691 $mi^2$ (square miles) as compared to the drainage area at the gage of 2,208 $mi^2$. The

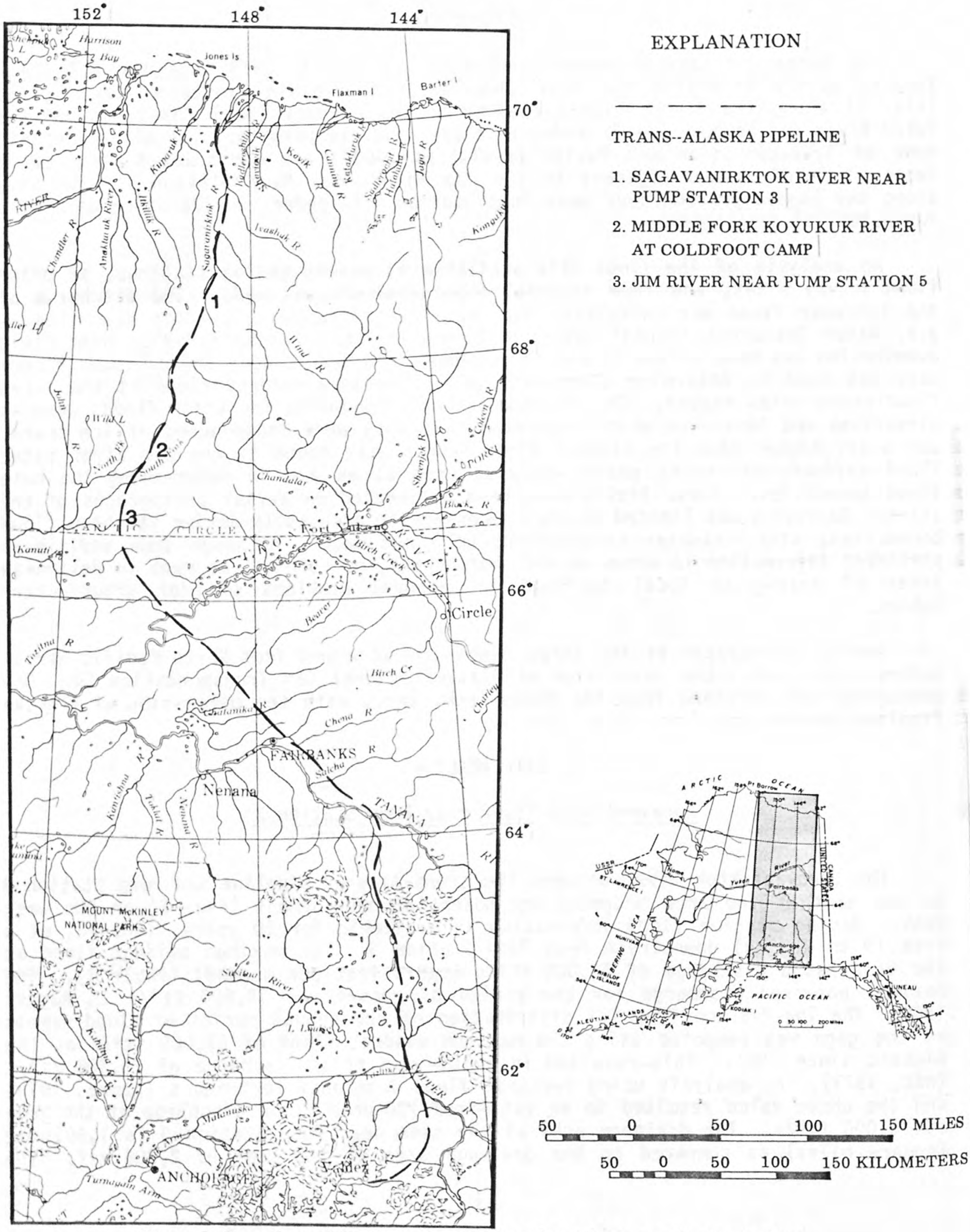



Figure 1.--Location of flood-prone area sites along the trans-Alaska pipeline.

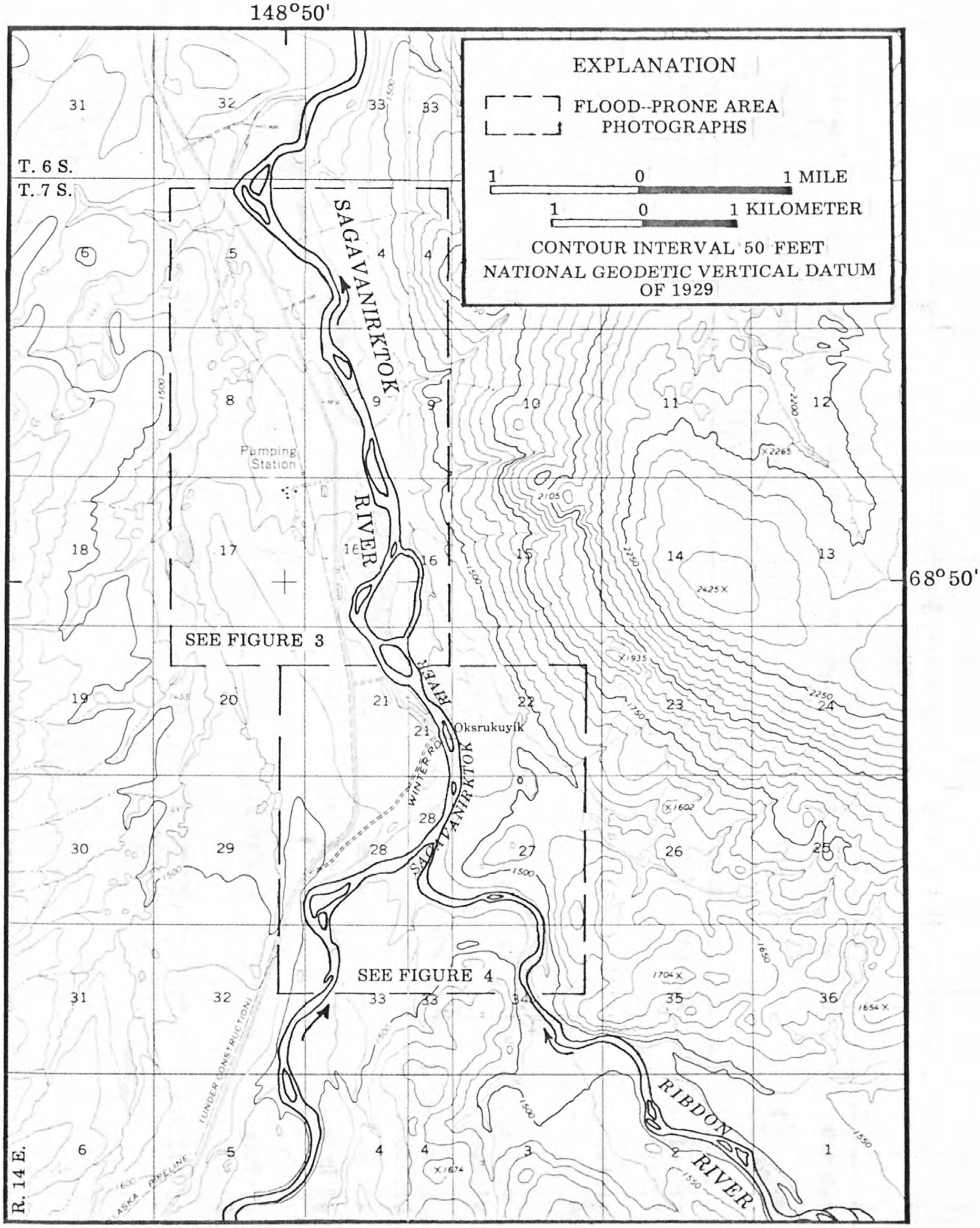



Figure 2.--Location of flood-prone area photograph for Sagavanirktok River near Pump Station 3.

Table 1.--Summary of data for surface-water gaging stations, partial-record stations, and flood-prone mapping sites.

| Site no. | Stream name | Latitude | Longitude | Drainage area (mi²) | Period of record | Maximum for period of record (ft³/s) | Maximum evident flood (ft³/s) | 100-year flood Q 100 (ft³/s) | Aerial photography Date | Aerial photography Scale |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Sagavanirktok R nr Pump Station 3 | 68°50'38" | 148°48'43" | 1,691 | -- | -- | -- | 63,000 | 7-12-77<br>8-30-78 | 1:2,000<br>1:24,000 |
| | Sagavanirktok R nr Sagwon | 69°05'24" | 148°45'34" | 2,208 | 1969-78 | 34,900 | 62,000 | 76,000 | | |
| | Middle Fork Koyukuk R nr Wiseman | 67°27'18" | 150°04'30" | 1,426 | 1968, 1970-78 | 19,100 | 33,000 | 39,000 | | |
| 2 | Middle Fork Koyukuk R at Coldfoot Camp | 67°16'26" | 150°11'48" | 1,650 | -- | -- | -- | 43,800 | 9-13-78 | 1:24,000 |
| | Jim R at Bridge No. 3 | 66°53'05" | 150°31'18" | 223 | -- | -- | 13,000 | 16,500 | | |
| 3 | Jim R nr Pump Station 5 | 66°49'37" | 150°40'20" | 306 | -- | -- | -- | 19,000 | 9- 3-78 | 1:24,000 |
| | Jim R nr Bettles | 66°47'10" | 150°52'23" | 465 | 1970-77 | 12,800 | 21,000 | 26,000 | | |

100-year flood discharge at Pump Station 3 was calculated as 63,000 ft³/s using techniques given in Lamke (1979).

The 100-year flood elevation at the gage would be more than 3 ft higher than the peak of 1977. This flood-elevation relationship was transferred to the Pump Station 3 site where the 100-year flood elevation was assumed to be 4 ft higher than the floodmarks of the 1977 peak. The flood evidence left by the 1977 peak was the most readily identifiable evidence found at the site and was about at the top of the channel bank.

During a flood survey made in 1972 on the Sagavanirktok River at Franklin Bluffs downstream from the gage, good high-water marks were found 2-3 ft above the tops of the main channel banks at elevations documented by photographs in July 1961 (Childers, Sloan, and Meckel, 1973) of an extreme flood caused by intense rainfall. The level of the 100-year flood at the flood-prone area site near Pump Station 3 was estimated as 3-4 ft above the top of the channel bank.

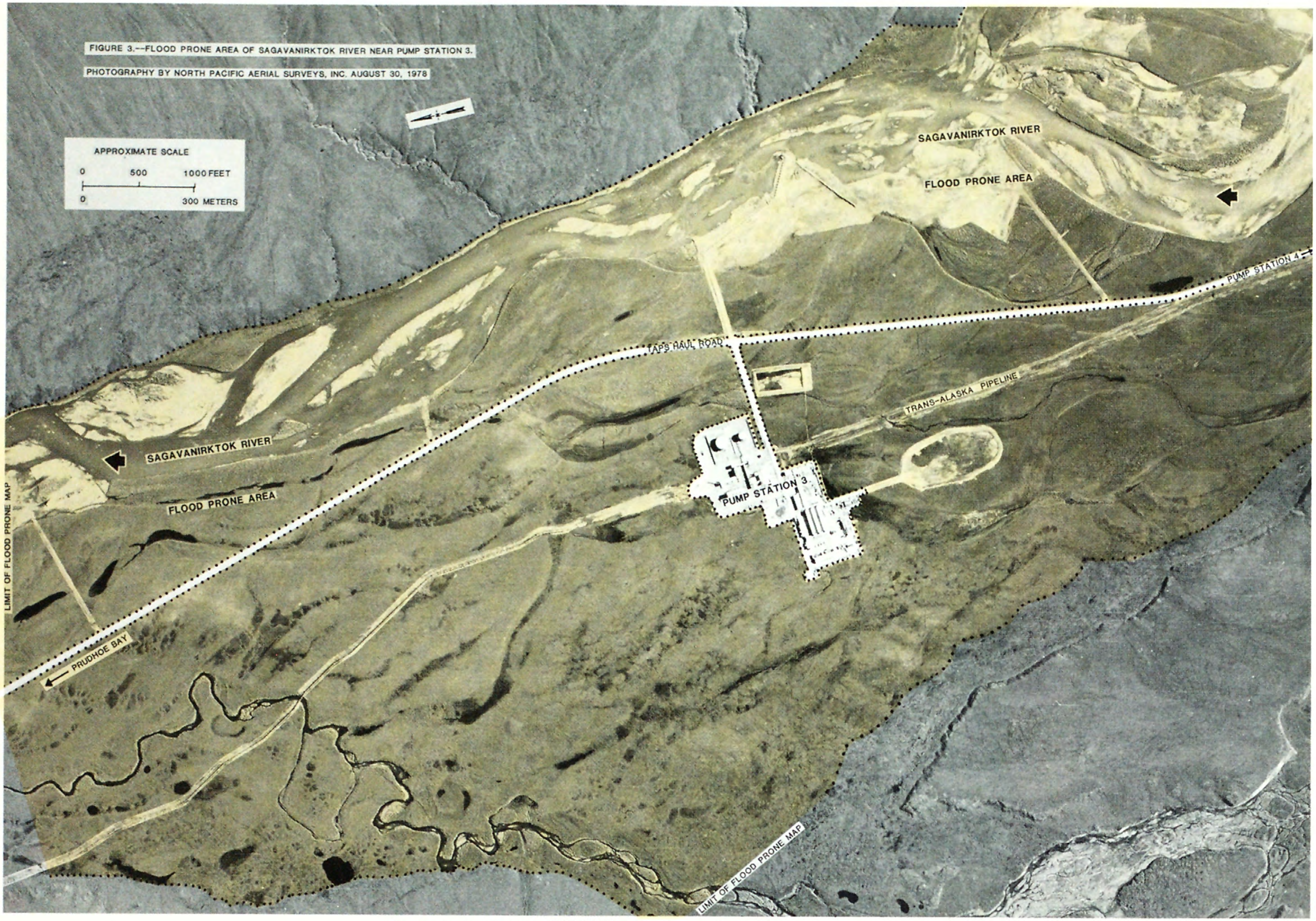
A flood and channel overbank survey of the Sagavanirktok River site was made June 25-27, 1979, by the authors. The east streambank of the Sagavanirktok River in the vicinity of Pump Station 3 is steep and well defined and is not subject to overbank flooding. Evidence of the 1977 flood peak was found along the west bank of the main channel. Evidence of the 1979 peak was found also at levels about 3 ft lower than the 1977 peak. Several cross sections were surveyed perpendicular to the river. They were used to estimate the 100-year flood elevations on the ground and also were used to delineate the flood-prone boundaries shown on the aerial photography (figs. 3 and 4).

The Sagavanirktok River maintains its split-channel character even a[illegible] flows. The photos show overflow channels within the vegetated flood plain [illegible] areas). These channels can carry flows down the flood plain from overflow [illegible]nts far upstream. Structures such as road fills or pads that encroach on these over-flow channels can cause local flood levels several feet higher than the base (100-year) flood level for the main channel. The gradient (slope=.0035 foot per foot) of the Sagavanirktok River and the ponding effect of structures which dam the overflow streams can back water up to the point where overflow occurs (Loeffler and Childers, 1977).

Extensive icings have occurred in the main channel of the Sagavanirktok and Ribdon Rivers in the vicinity of Pump Station 3. Although the maximum known flood discharge and stage was caused by rain during open-water channel conditions, flood stages can also occur when the main channel is ice covered.

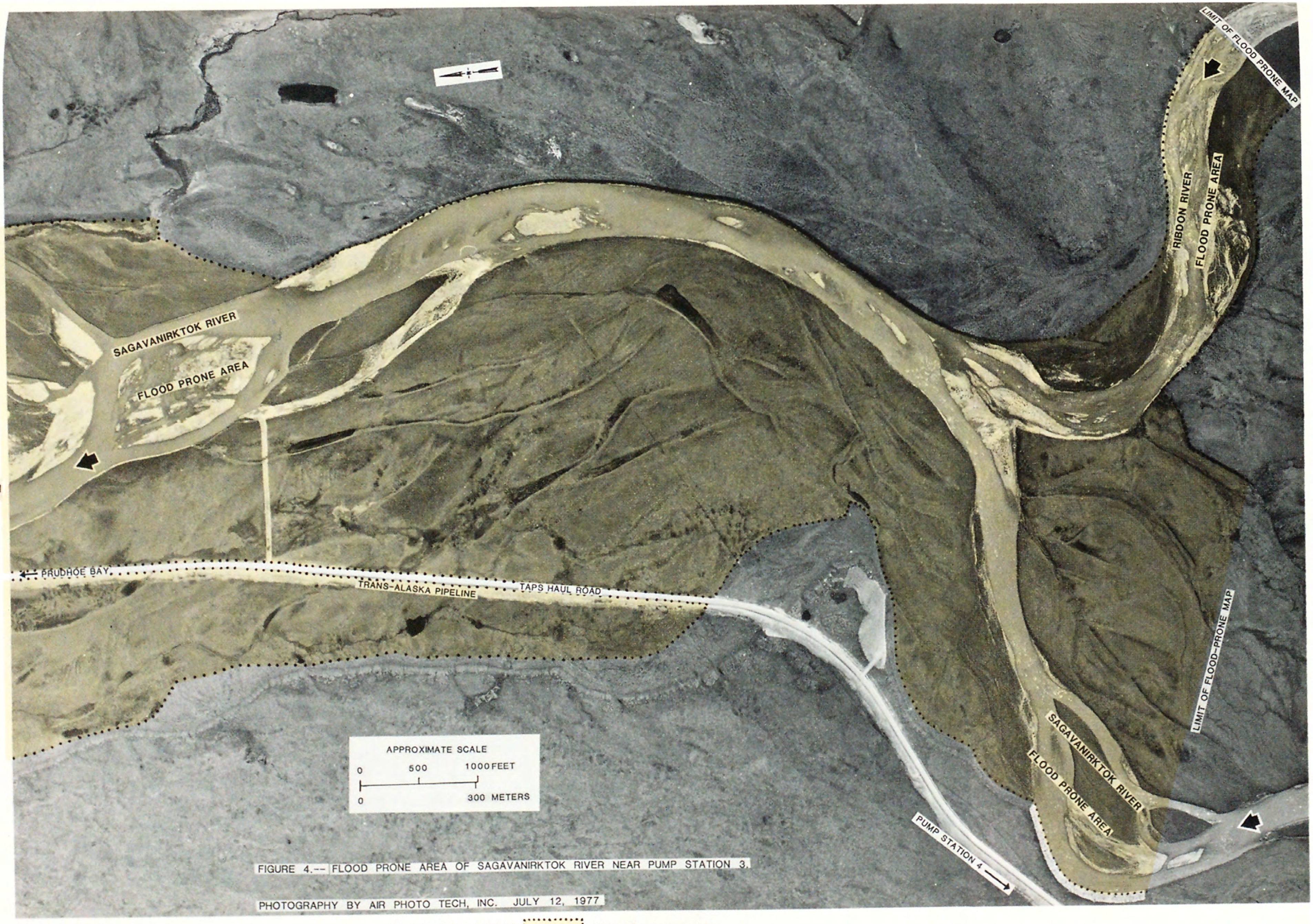
## Middle Fork Koyukuk River at Coldfoot Camp

The Middle Fork Koyukuk River and its tributary, Slate Creek, border west and north, respectively, the vacant Alyeska Pipeline Camp and the site ADOT maintenance camp (fig. 5) at Coldfoot. Gaging station flood inform[illegible] available for 9 years, 1968 and 1971-78, at the Haul Road bridge across the Middle Fork Koyukuk River near Wiseman, 13 mi upstream from Coldfoot. The maximum evident flood at the gage, for which the date is unknown, was about one-half foot higher




EXPLANATION Flood-prone area

Figure 3.--Flood-prone area of Sagavanirktok River near Pump Station 3.




EXPLANATION Flood-prone area

Figure 4.--Flood-prone area of Sagavanirktok River near Pump Station 3.

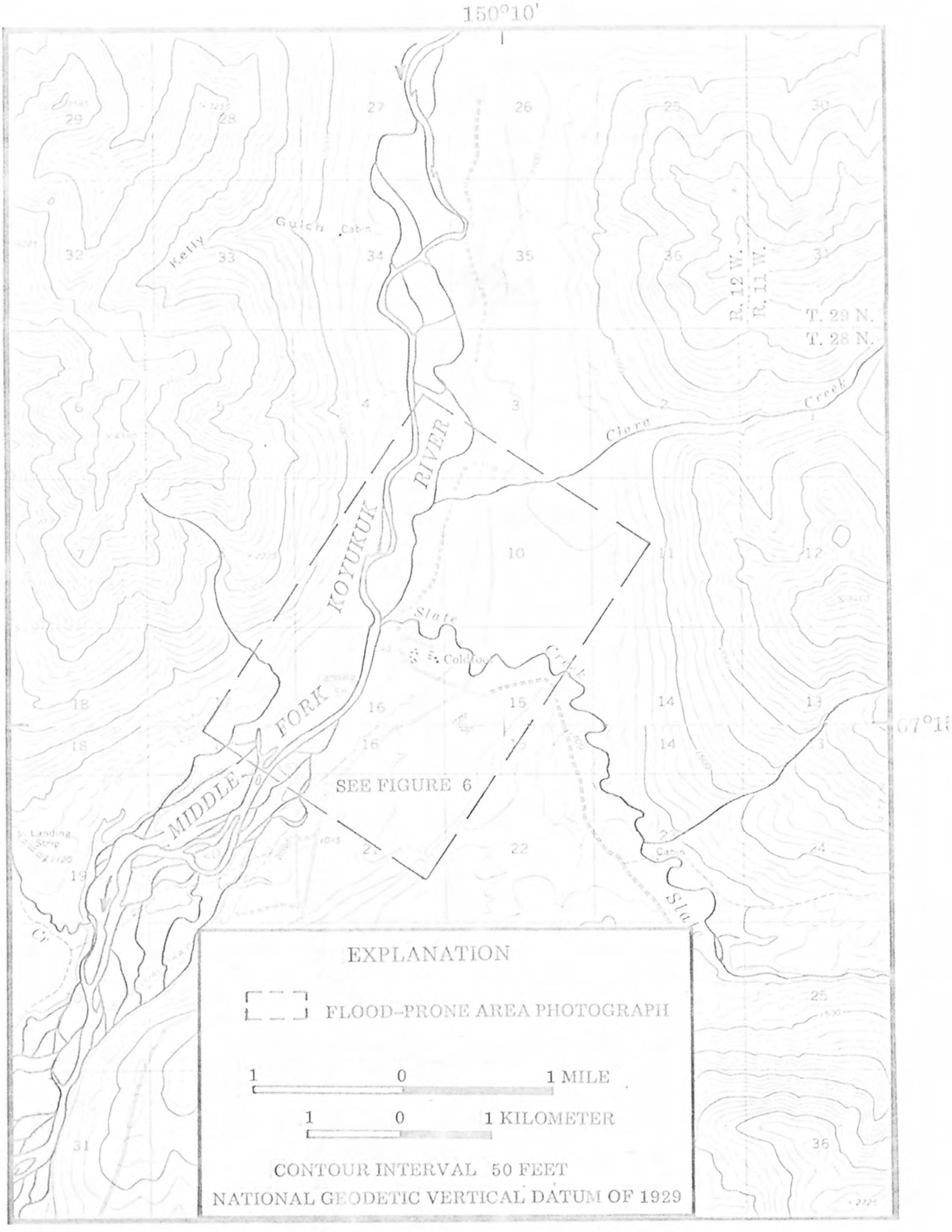



Figure 5.--Location of flood-prone area photograph for Middle Fork Koyukuk River at Coldfoot Camp.

than the flood of 1977, which was the highest flood experienced during the period of gaging station operation. The log-Pearson Type III distribution of the annual series of flood events at the station resulted in a 100-year flood of 38,400 $ft^3/s$ (WRC, 1977). An independent analysis using regional flood frequency techniques resulted in a 100-year discharge at the gage of 39,000 $ft^3/s$ (Lamke, 1979). The drainage area of the Middle Fork at Coldfoot is 1,650 $mi^2$ as compared to the drainage area at the gage of 1,426 $mi^2$. The 100-year flood discharge at Coldfoot was calculated as 43,800 $ft^3/s$ using techniques given in Lamke (1979). The 100-year flood elevation at the gage is about 1.4 ft higher than the most recent high peak (1977). These flood-elevation relationships were transferred to the Coldfoot site; the 100-year flood elevation used was 1 ft higher than the maximum evident flood and 1.5 ft higher than the 1977 peak. Channel characteristics were considered to be similar at both sites. No hydraulic analysis was prepared for Slate Creek.

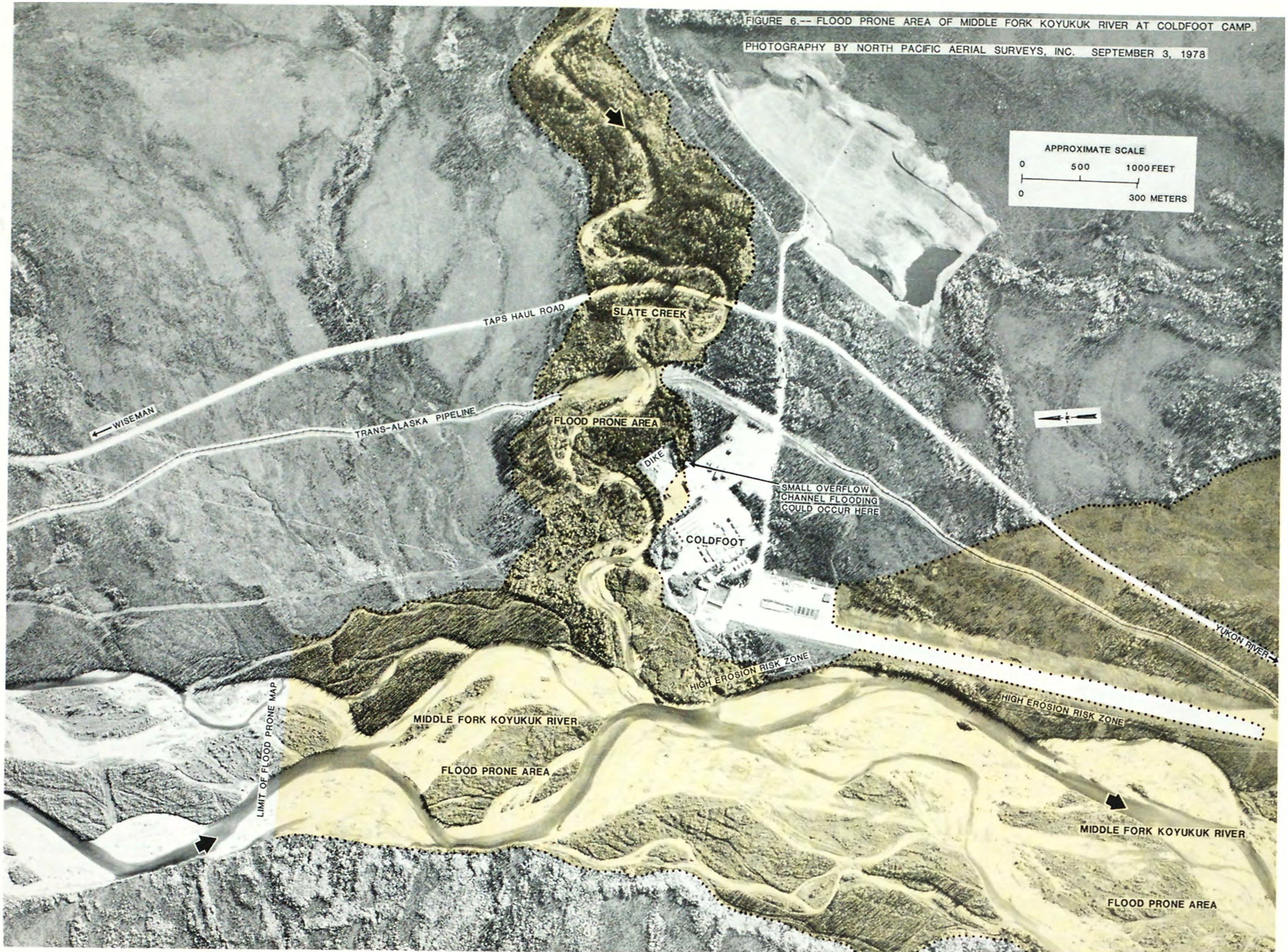
On June 29, 1979, a flood and channel survey of the Middle Fork Koyukuk River and Slate Creek was made by the authors. M. H. Kahler (ADOT), in the company of the authors and using the field-marked aerial photograph, re-examined the area on June 30.

The channel bank on the east (Coldfoot) side of the Middle Fork is a steep cut bank. However, floodmarks of the maximum evident flood were found on the vegetated flood-plain terraces. Evidence of the 1977 flood was sparse, but it was generally 0.5 to 1 ft lower than the maximum evident flood. The elevations of the 100-year flood on the ground and locations of the boundaries of the base flood could be adequately estimated from this flood evidence. The authors determined that water would flow in the low spots along the streamward side of the airstrip during the base flood. Therefore, the built-up streamward side of the lower end of the airstrip is shown on the aerial photograph as the flood-plain limit. Several high spots between the airstrip and the river would remain above the water during the 100-year flood. No attempt was made to show these "islands"; they are usually the areas with the more luxuriant growths of spruce.

The Middle Fork Koyukuk River bank is actively eroding at two locations. These high erosion risk zones are noted on the aerial photograph (fig. 6). Lateral bank erosion along the Middle Fork Koyukuk River is highly unpredictable and can be significant during a flood or as a result of ice jamming. As much as 180 ft of lateral bank erosion occurred between 1971 and 1974 at a site 6 mi downstream from Coldfoot (Doyle and Childers, 1975).

Flood evidence on Slate Creek and Middle Fork Koyukuk River indicated that maximum flood stages occur during open-water periods. Long-term local residents reported that channel icings and ice-jam flooding were not significant on Slate Creek. However, log jamming during floods on Slate Creek can cause rapid channel changes and accelerated bank erosion throughout the flood-prone area.

Slate Creek is a meandering stream with a well-defined channel. Floodmarks indicated that the 1979 peak came within 0.3 to 1 ft of over-topping the vegetated flood plain at the outside of the meander bends at several places. There is some older evidence that the maximum evident flood had been in the vegetated overbanks. Well-developed flood-plain terraces parallel the general direction of the stream.




EXPLANATION [dotted box] Flood-prone area

Figure 6.--Flood-prone area of Middle Fork Koyukuk River at Coldfoot Camp.

The boundaries of the base flood could be marked on the aerial photograph along much of the reach studied by using the demarcation line between heavily vegetated areas and areas of more widely scattered spruce and underbrush.

An earth and rock dike has been constructed across an overbank area on Slate Creek upstream from the former pipeline camp to prevent flooding. Advantage had been taken also of a natural high ridge at the dike and downstream from the dike, paralleling Slate Creek, to protect an area that probably would have been flooded during extreme floods. A small channel (fig. 6) between the man-made dike and the natural high ridge may carry water during extreme floods.

The swampy area east of the airstrip is shown as being in the flood-prone area. This area probably would not be flooded at flood flows much lower than the base flood. However, high ground-water table levels could occur during floods on Middle Fork or Slate Creek and could result in an increase in the size of the water-covered portions of this swampy area.

## Jim River near Pump Station 5

The Jim River is west of the site of the ADOT maintenance camp (fig. 7). Gaging station flood information is available for seven years, 1971-77, at a site 8.5 mi downstream from the maintenance camp. The maximum observed discharge for the period of gage record was 12,800 $ft^3/s$ on June 1, 1977. The maximum evident flood discharge determined at the gage was 21,000 $ft^3/s$ (Childers, 1974). The log-Pearson Type III distribution of the annual series of flood events at the gage was computed using the maximum evident flood of 21,000 $ft^3/s$ as the highest since 1966 or 1967. This resulted in a 100-year flood discharge of 26,000 $ft^3/s$ at the gage. The drainage area of the Jim River at the maintenance camp is 306 $mi^2$ as compared to the drainage area at the gage of 465 $mi^2$. The 100-year flood discharge at the maintenance camp was calculated as 19,000 $ft^3/s$ using the above value at the gage and techniques given in Lamke (1979).

The maximum evident flood discharge at Jim River bridge number 3, which is 7.7 mi upstream from the maintenance camp, was determined to be 13,000 $ft^3/s$ (Childers, 1972). The drainage area upstream from the bridge is 223 $mi^2$.

Large flood-plain icings form throughout the meandering and braided channels of the Jim River from about 1 mi downstream from Jim River bridge number 3 and extend downstream to the gage site in the canyon. Ice-jam flooding occurs frequently during spring breakup throughout this reach and is evidenced by the ice scars on the trees in the flood plain. Also, ice-rafted boulders and large deposits of gravel can be found resting on small trees and brush along the overbank flood plain. Channel bank erosion is evident in the study area and is caused by diversion of flows during ice and log jams.

Recent highwater marks, maximum evident floodmarks, and ice-jam scars in the study area were examined on July 2, 1979, by the authors and M. H. Kahler (ADOT). Ice scars were found on trees at elevations 2-3 ft higher than maximum evident floodmarks. Maximum evident floodmarks and ice scars of good quality were found along the overflow channels and upon the overbank floodways. The elevation of the

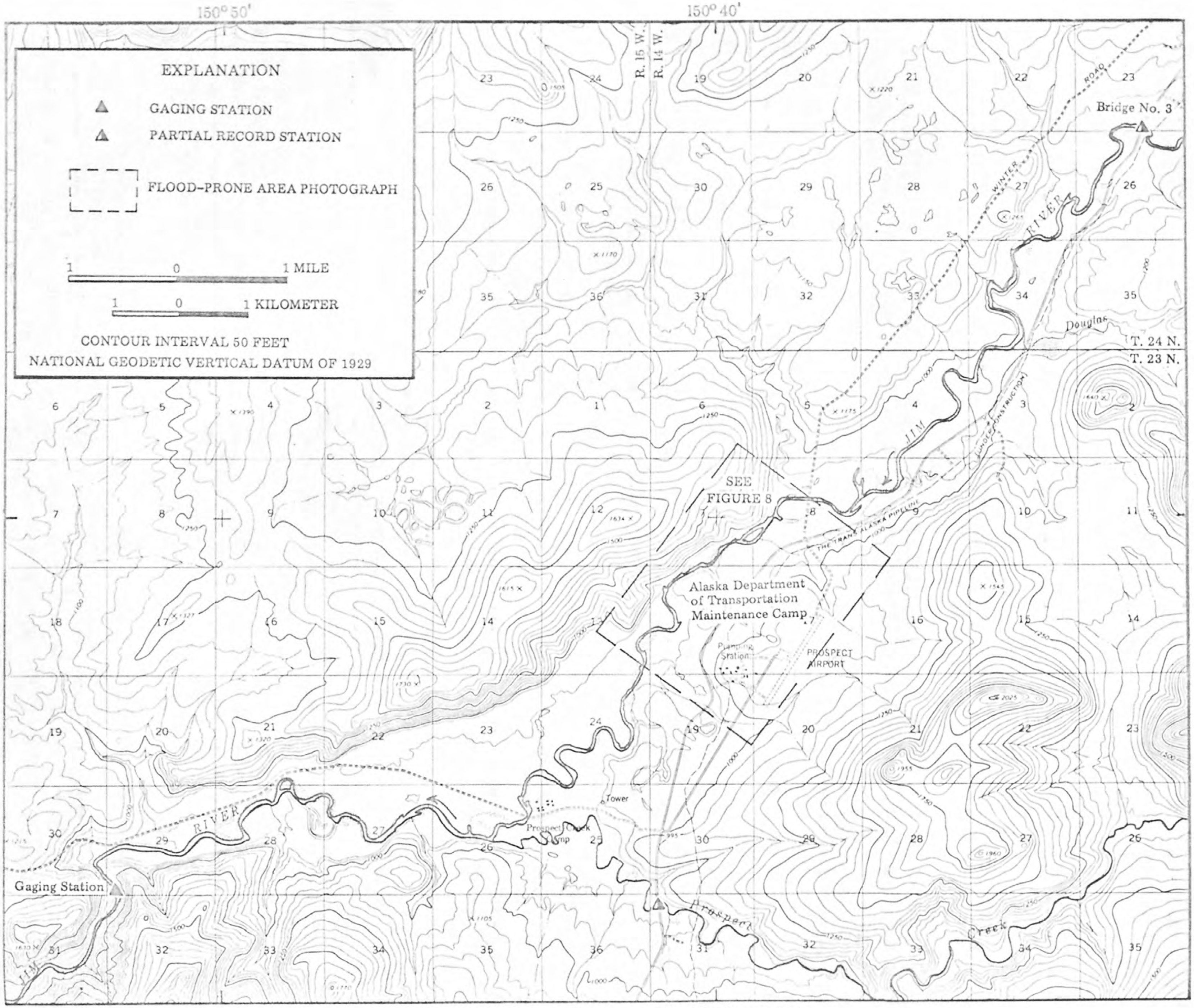



Figure 7.--Location of flood-prone area photograph for Jim River near Pump Station 5.

100-year flood discharge would be at about the level of the highest ice-jam scars. The flood-prone area for the Jim River site was delineated from maximum ice-jam flood evidence throughout the reach of the river studied (fig. 8).

The frequency of occurrence of an ice-jam flood comparable to the one that probably occurred in 1966 or 1967 is unknown. However, the maintenance camp would be flooded even at the lower stage of the maximum evident flood. Local flooding at the maintenance camp occurred in 1979 from a small-stream overflow. High ground-water table levels are likely to occur at the camp when the Jim River is at flood stage.

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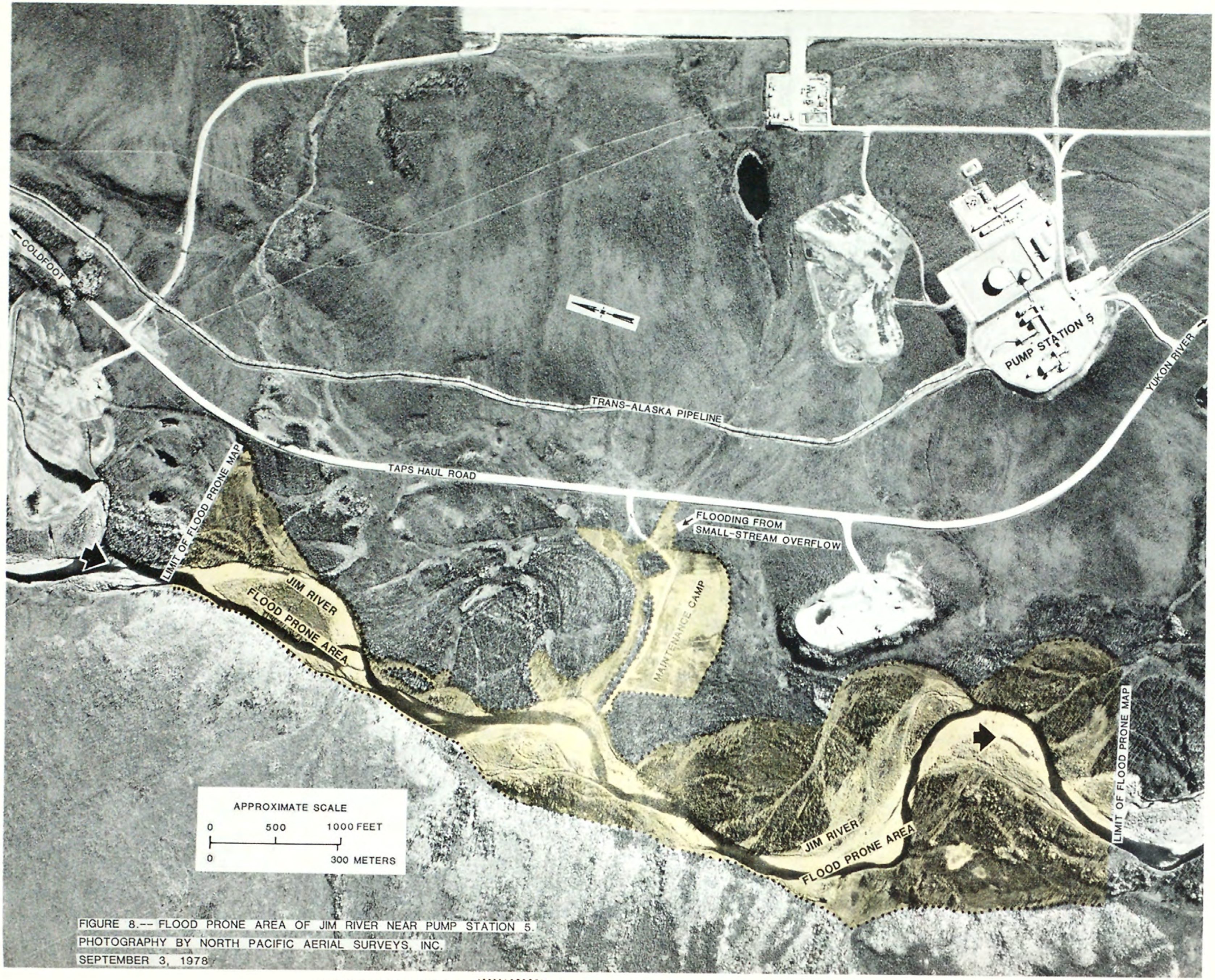


EXPLANATION Flood-prone area

Figure 8.--Flood-prone area of Jim River near Pump Station 5.