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SUSITNA HYDROELECTRIC PROJECT

FIELD DATA COLLECTION AND PROCESSING VOLUME 1

FEBRUARY 1982

Prepared by:

R&M CONSULTANTS, INC.

Prepared for:

ACRES

ALASKA POWER AUTHORITY

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SUSITNA HYDROELECTRIC PROJECT

TASK 3 - HYDROLOGY

FIELD DATA COLLECTION AND PROCESSING
VOLUME 1

FEBRUARY 1982

Prepared for:

ACRES AMERICAN INCORPORATED
1000 Liberty Bank Building
Main at Court
Buffalo, New York 14202
Telephone: (716) 853-7525

Prepared by:

R&M CONSULTANTS, INC.
5024 Cordova
Anchorage, Alaska 99502
Telephone: (907) 279-0483

ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT

TASK 3 - HYDROLOGY

FIELD DATA COLLECTION AND PROCESSING

TABLE OF CONTENTS PAGE

s14/g1

LIST OF TABLES

LIST OF FIGURES

1 - INTRODUCTION

The objective of the Hydrologic Field Data Collection and Processing was to supplement available streamflow and climatologic data within the Susitna River Basin. Specifically, the existing data base was augmented to meet the requirements of the FERC license application and to fill other data gaps that were present in the flow forecasting network for future project operation.

Collection and processing of the field data was performed by R&M Consultants and reviewed by Acres American. Portions of the field effort were done cooperatively with other data collection agencies, such as the U.S. Geological Survey, the U.S. Soil Conservation Service, and the Alaska Geophysical Institute, as is detailed in the following sections.

This Closeout Report presents an overview of the data-collection program and a general description of the field work undertaken relative to each of the hydrologic parameters. Each section of the main report briefly discusses what was done and why with reference to each parameter. The five appendices detail the locations of the data collection sites (Attachment A), the equipment and techniques used (Attachment B), the dates of field observations (Attachment C), pertinent letters and comments received (Attachment D), and they also give summaries of the data collected (Attachment E). Attachment F presents summaries of historical data collected through the present by other agencies.

The numbering system used herein deserves some explanation. The main sections of the report are identified by Arabic numerals, 1 through 14. The attachments are named by letters, as described above. Ordering of figures and tables in Attachments A, C, and D is fairly straightforward, but figures, tables and subsections in Attachments B and E follow a specific system. The first letter of each (B or E) identifies the attachment, which is followed by a number to denote the applicable parameter. (The table of contents lists parameters and sections).

The final number is merely a sequence number. Thus, Table B.5.2 would be the second table for Section 5 (Climate) of Attachment B. Finally, Attachment F presenting historical data collected by other agencies proceeds sequentially, with no numbering relationship to Attachments B or E, as detailed in the contents.

2 - SUMMARY

The hydrologic field data collection and processing program consisted of observation, sampling, and measurement of eleven basic parameters: streamflow (continuous), streamflow (partial or miscellaneous), water quality, sediment discharge, climate, atmospheric icing, snow depth and density, glacial characteristics, snow creep, river ice processes, and evaporation. The purpose of the present effort was to add to the previous data that had been collected by the U.S. Geological Survey (USGS), the National Weather Service, the U.S. Soil Conservation Service (SCS), the U.S. Bureau of Reclamation, the U.S. Army Corps of Engineers, and various other state and federal agencies.

The extent of the data collection program under the present study is summarized below for each major hydrologic parameter.

Streamflow (Continuous). A continuously-recording manometer streamgage was installed in the Susitna River about two miles downstream from the proposed Watana Damsite. The installation was made after spring breakup in 1980, and the recorder was made operational in early July. Stage records were obtained through freeze-up in 1980 and again in 1981 for the open-water period. Eight discharge measurements were made at the site to permit construction of a stage-discharge rating curve.

Streamflow (Partial). Crest-stage recorders were established at seven sites in the Devil Canyon-Talkeetna reach, three in the Deadman Creek-Devil Creek reach, and one in between these two reaches. Water surface elevation data were needed to calibrate the HEC-2 hydraulic model for the two reaches, so sequential observations were made at various flow levels to determine stage-discharge relationships. Data were also collected at three staff gages along the river, one on the extreme upper river at the Denali Highway bridge and one downstream of each of the proposed damsites.

Water Quality. A water quality sampling and analysis program was initiated at two sites: the USGS gaging stations "Susitna River near Cantwell" and "Susitna River at Gold Creek". Some parameters were measured directly in the field, while most concentrations were determined on samples brought back to Anchorage for laboratory analysis. The sampling period extended from the summer of 1980 to the winter of 1981-82. Most sampling times were selected to coincide with certain hydrologic events (i.e. low flow, freeze-up, break-up, rising/falling limbs and peak of a flood hydrograph, and ice cover), in order to try to estimate these conditions' effects on the water chemistry.

In addition, a continuous monitor was installed in the fall of 1980 one mile downstream from the proposed Watana Damsite. Water quality parameters recorded were water temperature, pH, dissolved oxygen concentration, oxidation-reduction potential, conductivity, and temperature-corrected conductivity. The plan had been to observe changes in the parameters with time and with discharge level. Several operational problems were encountered with the equipment, primarily related to operation through the winter and break-up periods.

Sediment Discharge. Suspended sediment samples were collected at the same sites and times as were water quality samples. A depth-integrating sampler was used at several points across the cross-section at each of the two locations. In addition, a bedload-sampling program was begun in 1981 in cooperation with the USGS. Sampling was done at one site each on the Chulitna and Talkeetna Rivers and above and below the Chulitna-Susitna-Talkeetna confluence on the Susitna River. Each of the four sites was visited three times, at various flow levels, to estimate the ranges in bedload.

Climate. Recording climatic stations were installed in the spring and summer of 1980 at six sites throughout the Upper Susitna Basin. One was located in the midst of the upper glaciers, one somewhat downstream in the Denali Highway area, one in the southeast corner of the basin, one further west in the Kosina Creek drainage, and one near each of the proposed damsites. Data parameters recorded on magnetic tape at 15-minute intervals were air temperature, average wind speed, resultant wind direction, relative humidity, cumulative precipitation, solar radiation intensity, and peak wind gust speed.

Atmospheric Icing. Freezing rain and in-cloud icing data were sought for two locations near the proposed transmission line corridor to estimate the severity of icing conditions to be expected on the proposed line. Heavy-duty transmission cables and horizontal steel plates were installed near the proposed Watana Damsite and near Denali to permit measurement of accumulated ice on them. A recording icing detector was also installed near Watana to measure ice build-up in general.

Snow Depth and Density. Snow surveys were undertaken in the basin cooperatively with the SCS, who has been managing the program statewide for years. Existing aerial markers were observed jointly, new markers and snow courses were established and observed by R&M, and the data for all were assimilated and reported by SCS. The new markers were all primarily on and around the major basin glaciers - West Fork, East Fork, and Susitna Glaciers.

Glacial Characteristics. The contributions of the major glaciers in the basin was sought to be determined to evaluate their effect on the flow regime of the river. Mass balance, glacial velocity and dynamics, and sediment contribution were the chief parameters investigated. As noted previously, climate and snow data were also collected in close proximity to the glaciers.

Snow Creep. The importance of snow creep forces on transmission line towers in the region was investigated by installing two simulated transmission towers on movable plates on steep slopes. The maximum force of the snow on the towers was recorded by a maximum-reading indicator. Generally light snow conditions in the basin and late winter installation in the 1980-81 winter cause doubt as to the representativeness of the data obtained from that period.

River Ice Observations. Experience with hydroelectric projects elsewhere has emphasized the importance of careful study of ice conditions and processes for engineering works in arctic and subarctic climates. Field observations were made during freeze-up in the fall of 1980, during the continuous ice-covered period in the winter, and during break-up in the spring of 1981. Aerial photographs were taken to document ice accumulation locations and dates, progress of ice cover growth was recorded, and water levels and velocities were observed at selected sites at certain times.

Evaporation. An evaporation pan was installed near the proposed Watana Damsite in April of 1981. Observations were made of daily pan evaporation so that an estimate could be made of evaporation to be expected from the two proposed project reservoirs.

All the known existing hydrologic data (collection periods, locations, and specific parameters observed) are documented in the R&M Field Data Index (1982). The index has been updated twice annually - the most recent revision is dated January 1982.

Data collection sites are shown in Attachment A to this report. Locations of both active and historical sites are shown. Station names and other particulars may be found in the Field Data Index, referenced above.

Attachment B describes the specific equipment and measurement techniques used for field observations of each type of parameter. Laboratory methods and office methods for data reduction, where appropriate, are also given.

The record of site visits and periods of record for the continuous recorders are presented in Attachment C, the Field Observation Log.

Correspondence pertaining to instrument selection and data collection site locations, received from the Alaska Power Authority, Acres, other subcontractors, and other government agencies, are reproduced in Attachment D.

Attachment E contains summaries of all the field data collected by the current study effort, itemized by parameter type. Finally, Attachment F is a compilation of hydrologic and climatogic data collected by other agencies through the present date.

3 - STREAMFLOW (CONTINUOUS)

The U.S. Geological Survey has established three stream gaging stations on the Upper Susitna River (i.e. above Talkeetna). These are at Denali, Vee Canyon ("Susitna River near Cantwell") and Gold Creek. The latter two sites are separated by approximately 80 river miles, and it is between these two sites that the Devil Canyon and Watana projects are proposed. A new continuous streamgage was set up just downstream of the proposed Watana damsite. This site was chosen to provide a more precise estimate of discharge at the actual damsite. The station is also well-located to continue gaging of streamflow if the project is built (i.e. record discharge from the Watana Reservoir). The gaging methods used are described in Attachment B.1, and the streamflow data are contained in Attachment E.1.

4 - STREAMFLOW (PARTIAL)

Partial streamflow records consist of infrequent water surface elevation observations made at various locations. In the current program, data were obtained at two types of installation: crest-stage recorder (also called crest gage) sites and staff gages. The crest gages were devices designed to record the highest water level at a site since the gage was last reset. Staff gages consisted of calibrated marks where the water level at the time of reading could be observed. The crest gage installations and specific staff gages are described in Attachment B.2, and data are summarized in Attachment E.2.

Crest-stage recorder sites were selected primarily to provide water surface elevation data through two river reaches for use in calibration of the HEC-2 Water Surface Profiles computer program. One reach was from Devil Canyon to the Susitna-Chulitna confluence, and the other was from Devil Creek to Deadman Creek (around the Watana Damsite). The recorder called Devil Canyon Upper, located about two miles upstream of the proposed Devil Canyon Damsite and between these two reaches, was installed to provide site-specific information near the damsite for construction and cofferdam planning.

Staff gages were installed at three locations to provide information on stage-discharge relationships in the tailrace areas of the two proposed dams and to provide estimates of streamflow near the upstream end of the basin during the summer.

5 - WATER QUALITY

A water quality program was initiated by R&M Consultants in 1980 to define baseline parameters on the Susitna River. This basic information was to aid the reservoir, fisheries, and instream-flow studies for Phase I of the Susitna Hydroelectric Project.

The data collection program was established in conjunction with an environmental consultant, L.A. Peterson and Associates. The program consisted of a continuous water quality recorder situated about one mile below the proposed Watana Damsite and a sampling schedule at Gold Creek and Vee Canyon, designed to supplement the U.S. Geological Survey data acquisition program. This sampling schedule is based on specific streamflow events in order to determine the range of variations in water quality parameters.

The sampling sites were selected to represent water quality conditions flowing into (Vee Canyon) and out of (Gold Creek) the proposed reservoir system. The baseline data would be extended at each site since the U.S.G.S. had sampled historically.

Those parameters requiring instantaneous measurement were determined on site in the field. At the same time, samples were collected, preserved and shipped on ice to Anchorage for laboratory analysis.

A complete description of specific sampling events and procedures is included in Attachment B.3. Summarized data tables are presented in Attachment E.3.

6 - SEDIMENT DISCHARGE

A study was implemented to gain information on the sediment regime of the Susitna River in order to assess the impact of flow regulation and sediment trapping by the Susitna Hydroelectric Project. The sites sampled were near inflow and outflow points of the proposed project.

Suspended sediment samples were collected during each water quality sampling event. The sampling schedule was designed to include a wide range of discharges so that a discharge/sediment transport relationship could be established.

Depth-integrated samples were collected at Vee Canyon and Gold Creek. Suspended sediment analyses were conducted by a certified laboratory in Anchorage. For each sample the laboratory reported suspended sediment concentration in mg/l, and for three preselected samples, a particle distribution was analyzed and reported as a percentage by size.

Bedload samples were collected in 1981 to further define the coarse sediment transport. In cooperation with the U.S. Geological Survey, samples were obtained at the gaging stations at Sunshine and Gold Creek on the Susitna River. Additional samples were collected in the Talkeetna River and the Chulitna River. The U.S.G.S. was responsible for all sample analysis and reporting of data.

Detailed data collection procedures are outlined in Attachment B.4. Attachment E.4 contains data tables for suspended sediment and bedload discharges.

7 - CLIMATE

The Upper Susitna River basin contains over 6000 square miles of diverse climatic regions: high glaciated mountains; the flat-lying, poorly-drained terrain characteristic of the Tyone River Valley; and the high plateau area that makes up much of the basin. In this entire upper basin there existed no operating climatic stations. Outside of the upper basin a few climate stations exist from which a general climatic history of the basin can be approximated but none are truly representative of the basin.

In order to provide accurate meteorological data for hydrologic work, wildlife studies, and engineering design, six weather stations were installed in the Upper Susitna Basin during the spring and summer of 1980. Their locations, descriptions, and histories are given in Attachment B.5, and the recorded data from the stations are summarized in Attachment E.5.

8 - FREEZING RAIN AND ICING

Instrumentation for measuring freezing rain and in-cloud icing conditions was installed at two sites, Watana Camp and Denali. A set of cables was used to model icing on transmission lines, and horizontal steel plates were used to simulate conditions that could be expected for freezing rain accumulation on transmission line towers. An electronic ice detector was later added at Watana Camp to give a more accurate and continuous reading of icing condition occurrence.

The Watana Camp and Denali locations were chosen due to their proximity to proposed power transmission routes and also due to the convenient setting near climate stations. It was also intended that placing the instrumentation close to Watana Camp would permit more frequent observation by camp personnel.

The installations used for the measurements are described in Attachment B.6, and the observations are summarized in Attachment E.6.

9 - SNOW SURVEYS

Much of the water in the Susitna basin originates as snowfall. This snowfall is especially concentrated in the high mountains at the headwaters of the basin. Since the runoff from precipitation as snow does not normally occur until spring melt, knowledge of snow pack allows estimates of spring floods in advance of their occurrence.

The Soil Conservation Service administers the snow courses and snow surveys that are in the Susitna River Basin. Prior to the present study, there was a scarcity of data on many parts of the basin, including especially the high mountain areas, where large amounts of snowfall were expected. R&M Consultants, cooperating with the S.C.S., established 21 sites at various locations (described in Attachment E.7) and surveyed these each month between January and May to determine snow depth and water content. The sites were selected with field input from the S.C.S. Snow Survey Supervisor who offered advice on locations that would best fill gaps in the basin data, as well as site-specific suggestions to try to avoid installations in unrepresentative locations.

The field data collection techniques are described in Attachment B.7, and the data are summarized in Attachment E.7.

10 - GLACIAL OBSERVATIONS

The purpose of this study was to conduct a reconnaissance level investigation of the primary glaciers in the Upper Susitna Basin. Assessments were made to determine whether significant changes in water and sediment yield could occur, to determine if potential floods from glacier-dammed lakes were possible and to develop a long-term glacial observation and study program oriented toward hydropower development.

The Geophysical Institute of the University of Alaska provided consulting services for this study. The Geophysical Institute was responsible for all data reduction, analyses and reporting with respect to velocity surveys, sediment contribution analysis, mass balance studies, volume analysis and glacier temperature determinations. R&M Consultants provided logistic support, field support, suspended sediment data, and low-altitude snow survey data and conducted all velocity surveys and gradient determinations.

Procedures involved in these studies are described in Attachment B.8.

11 - SNOW CREEP

Instrumentation for measuring the effect of snow creep pressure on transmission line towers was installed by R&M Consultants during the winter of 1980-81. Two locations were chosen along the proposed transmission line route, a south-facing slope near Tsusena Butte above Watana Camp and a north-facing slope near Devil Canyon. The two sites were selected based on proximity to the proposed route, accessibility from the damsite areas for ease of measurement, location in expected heavy-snow areas, and location on creep-prone slopes.

The field installations are described in Attachment B.9, and the observations are summarized in Attachment E.9.

12 - RIVER ICE OBSERVATIONS

Observations were made at different times and locations of the various ice processes acting in the Susitna River. Freeze-up, the winter ice cover, and break-up were all documented in detail. Areas of primary interest were the vicinity of the two proposed damsites and the reach between Devil Canyon and Talkeetna, with less concern below the Talkeetna confluence and in the extreme upper basin.

The importance of ice observations (and analysis under subtask 3.06) was to assist with an assessment of post-project and during-construction effects on the ice regime and also effects of the ice on the project construction and operation. Thus, the damsite areas were studied carefully, as were developed areas downstream (i.e. Talkeetna, the Alaska Railroad, other small communities).

Attachments B.10 and E.10 give descriptions of the observation program itself and the general results of the observations, respectively.

13 - EVAPORATION

The evaporative losses from the proposed Watana and Devil Canyon reservoirs are influenced by several factors, primarily solar radiation, air temperature, relative humidity and wind. These same factors determine rate of evapotranspiration from land and evaporation from a pan. Thus, measurement of pan evaporation provides an index of the total effect of meteorological conditions on lake evaporation.

There are few evaporation pans in Alaska. The two closest to the Susitna watershed are at McKinley Park, with 14 years of data, and at Matanuska Agricultural Experiment Station, with 30 years of data. McKinley has an interior climate greatly influenced by the Alaska Range. The climate at the Matanuska station, located 40 miles northeast of Anchorage in Palmer, is influenced by the proximity of the Cook Inlet.

In order to obtain an estimate of actual evaporation in the Susitna watershed, an evaporation pan was installed near the proposed Watana damsite in May 1981. The data collection techniques are described in Attachment B.11, and the data are summarized in Attachment E.11.

14 - REFERENCES

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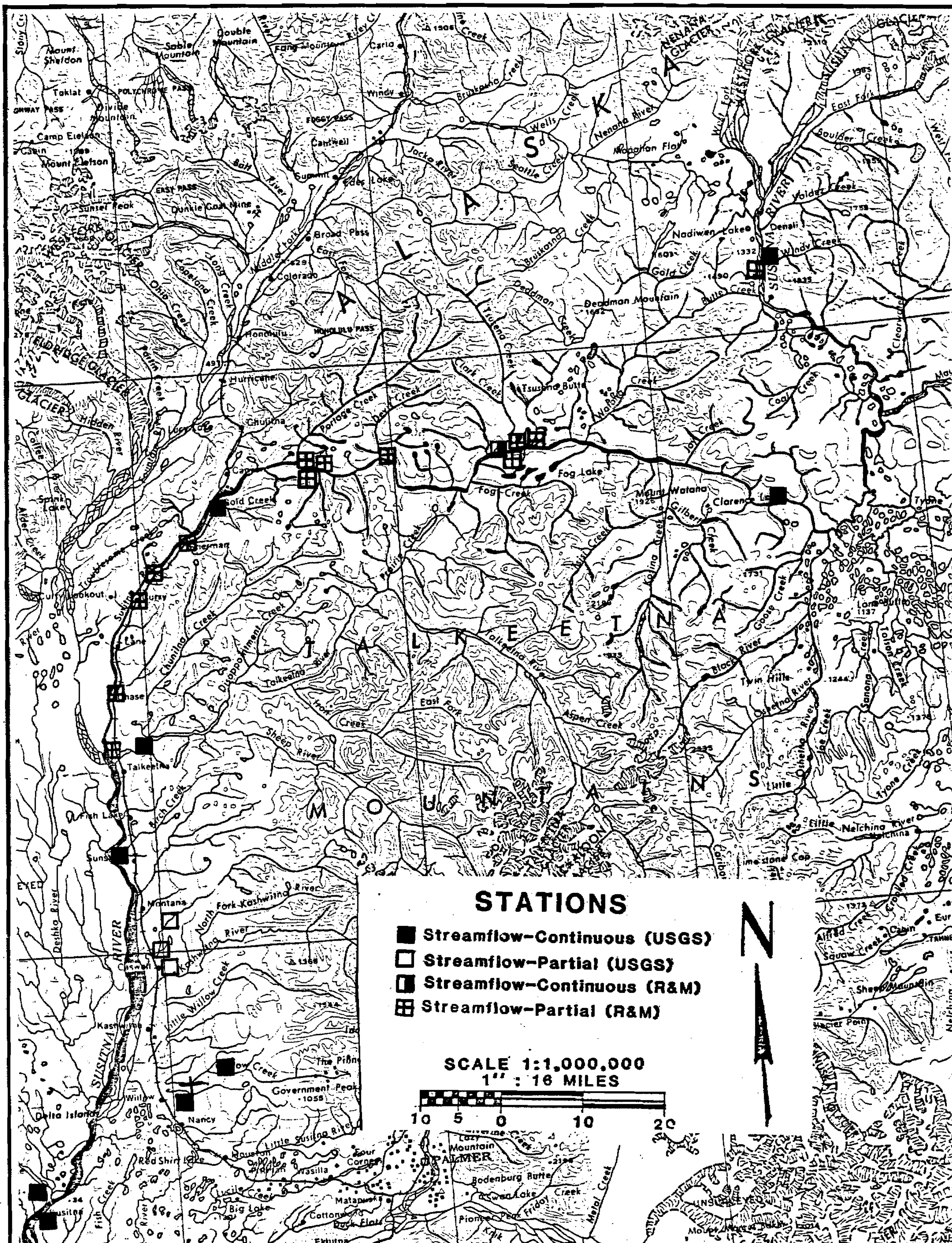
ATTACHMENT A

LOCATIONS OF DATA COLLECTION SITES



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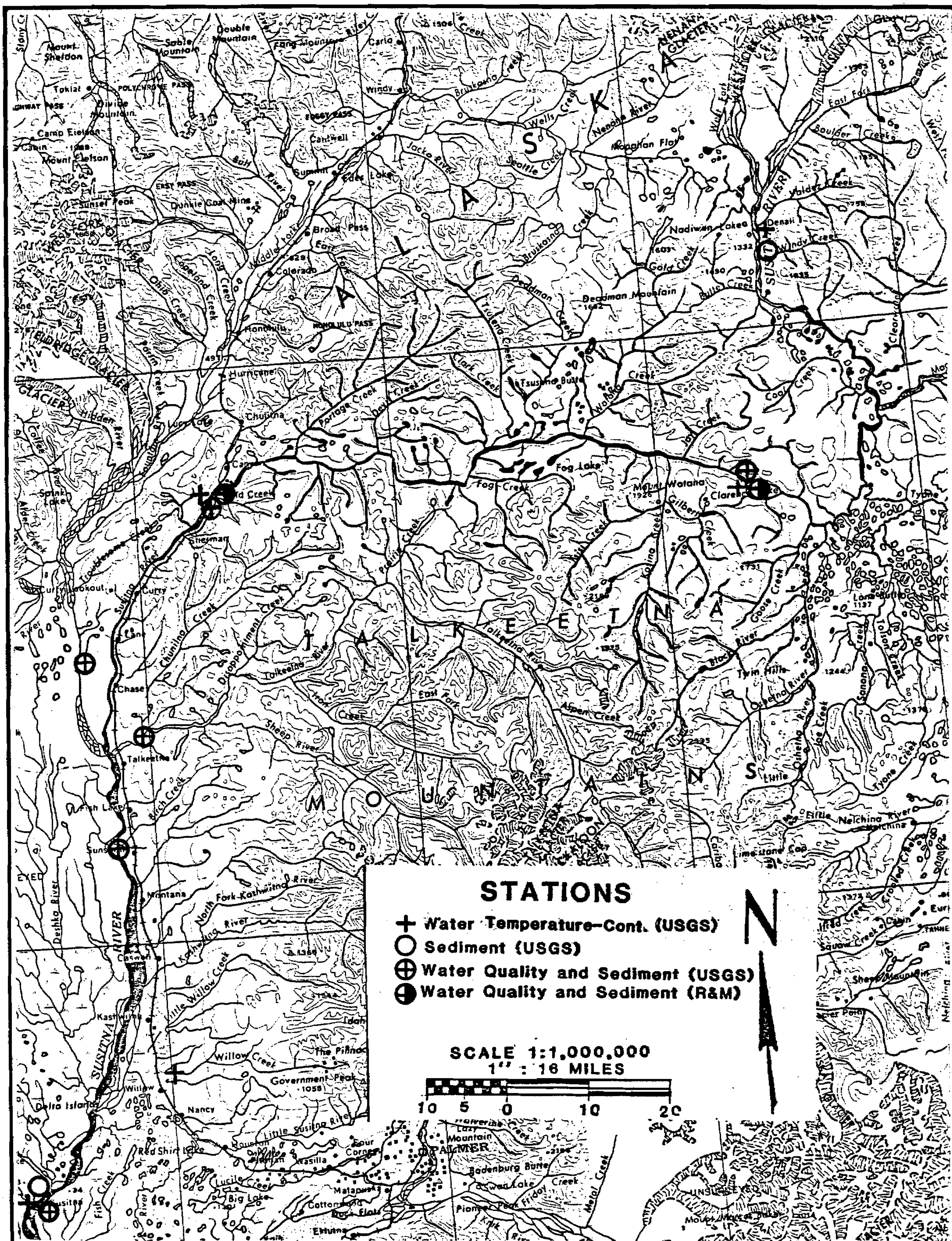
CURRENT DATA COLLECTION
STATION SITES

PREPARED FOR:

ACRES

FIGURE A.1



PREPARED BY:

R&M CONSULTANTS, INC.

CURRENT DATA COLLECTION
STATION SITES

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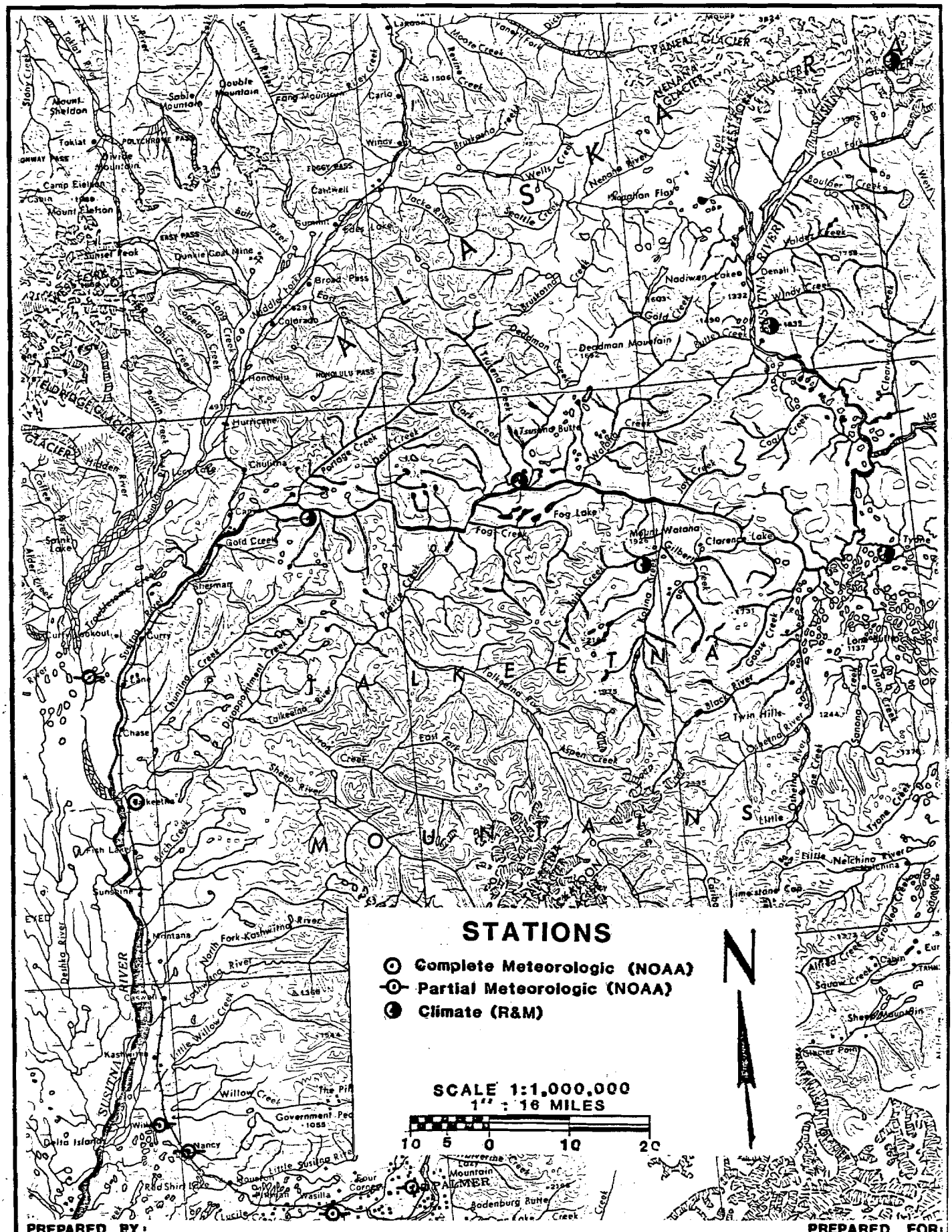
FIGURE A.2



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CURRENT DATA COLLECTION STATION SITES

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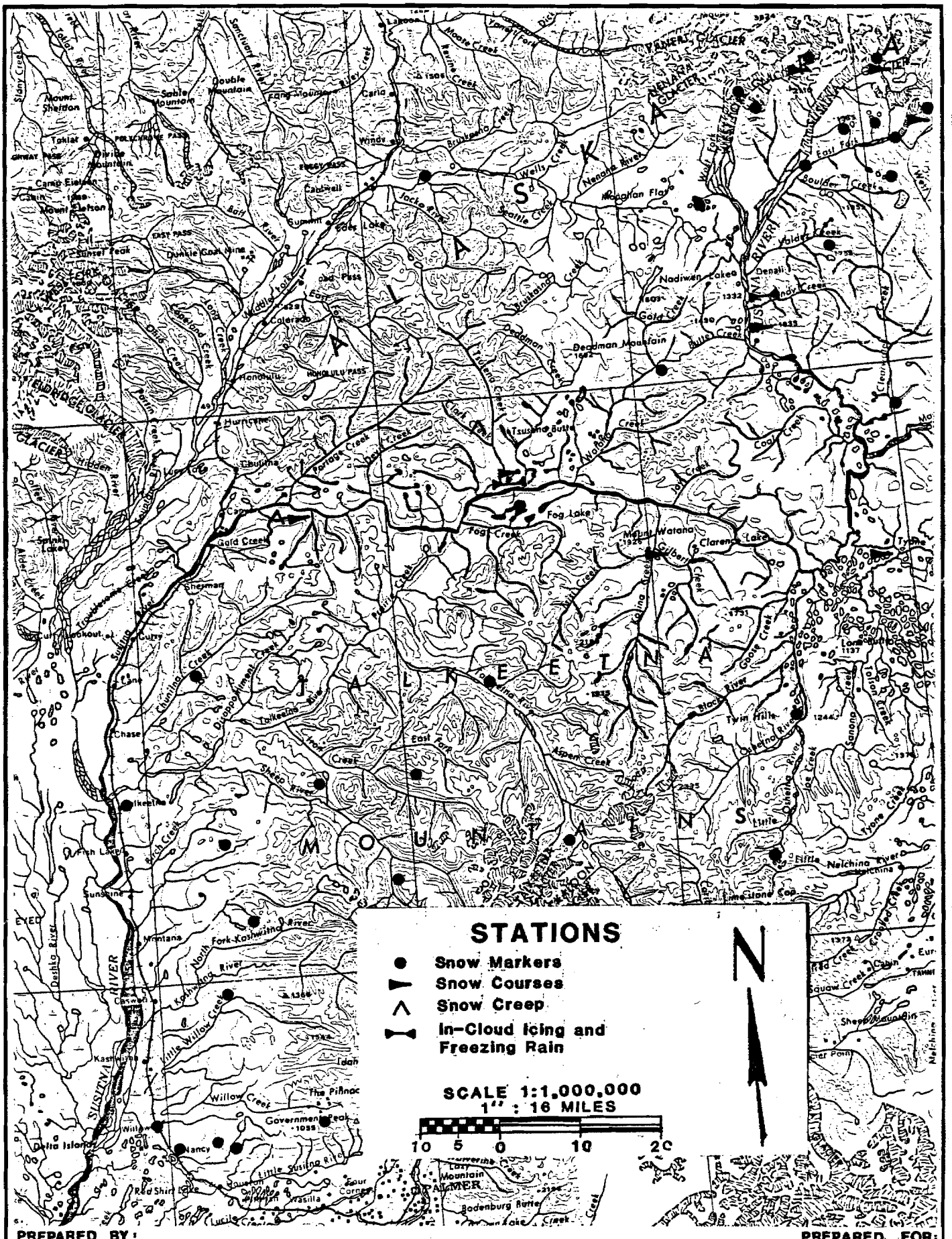
FIGURE A.3



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CURRENT DATA COLLECTION
STATION SITES

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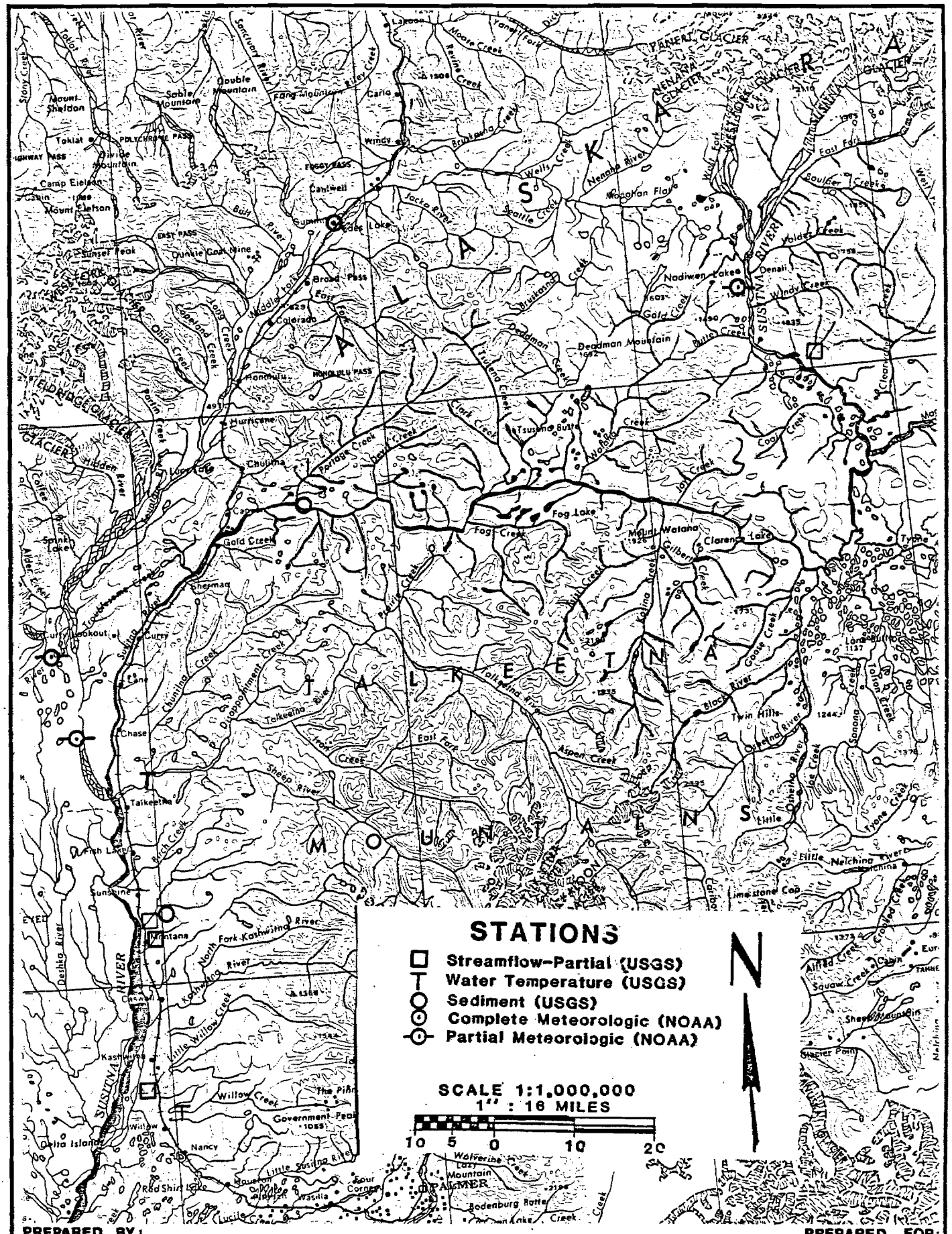
FIGURE A.4



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HISTORICAL DATA COLLECTION STATION SITES

(NO LONGER CURRENT)

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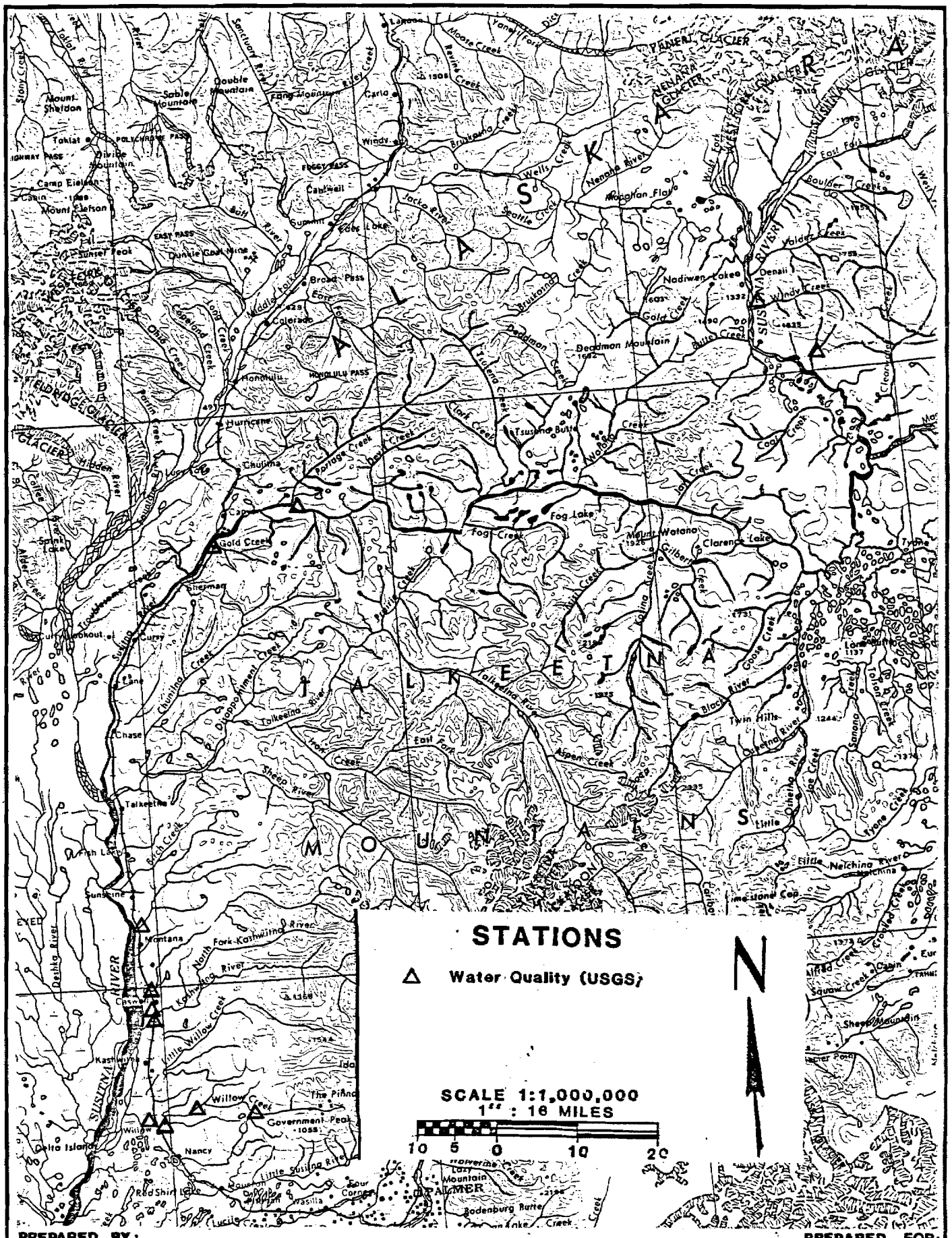
FIGURE A.5



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HISTORICAL DATA COLLECTION STATION SITES

(NO LONGER CURRENT)

ACRES

FIGURE A.6

ATTACHMENT B

DATA COLLECTION EQUIPMENT
AND TECHNIQUES

B.1 - Streamflow (Continous)

Susitna River near Watana Damsite.

Location - On right bank 0.3 miles upstream from Tsusena Creek, 4.3 miles downstream from Deadman Creek, and 2.0 miles downstream of the proposed Watana Dam centerline. Talkeetna Mountains (D-4) quad. map. Gage house is in trees just above vegetation line of bank.

Established - June 1980 by R&M Consultants.

Drainage Area - 5,180 square miles, from topographic map.

Gage - Leupold & Stevens A-71 Water Stage Recorder coupled to manometer gage. Housed in white 4 x 4 x 8-foot wooden shelter. Bubble tube is housed in 2-inch galvanized pipe.

Reference Marks - TBM-1 is paint mark at downstream corner of large rock at right bank of river 30 feet upstream from gagehouse. Elevation 1444.72 feet M.S.L.

TBM "LOST" is spike in upstream side of 14-inch spruce tree 50 feet upstream of gage house. Elevation 1445.41 feet M.S.L.

Channel - Channel is straight above and below gage site. Banks are gradually sloping on both sides of river. Bed material is gravel and cobbles.

Discharge Measurements - All open-water measurements are made at the gage site using a boat. A 1/4" cable tag line is strung across the river at this point. It is painted yellow at 10-foot intervals with white paint at the 100-foot points. River is 428 feet wide at high water.

Winter Flow - Flow drops off quickly in October or November. There is usually complete ice cover at the site during winter. Winter measurements are made at this site.

Accuracy of Records - Believed good, based on uniformity of cross-section and fairly consistent stage-discharge rating curve.

The Watana streamgage consists of a servo manometer assembly and a strip-chart recorder. In this system nitrogen gas is bubbled through a small tube and discharged through an orifice at a fixed elevation in the river. The pressure in the tube is equal to the head of the water above the orifice. This pressure is converted to a stage of the water which is recorded on the water stage recorder. The major advantage of this setup is that it allows the instrumentation to be safely located away from the river. The river stage was recorded in 1980 from July 11 to December 2, when the orifice was removed from the ice. An attempt was made to record 1981 breakup flows, but this resulted in the orifice being carried away by ice. No data were obtained until after breakup when a new orifice was replaced on May 21, 1981.

To convert stage data to discharge a rating curve was developed using eight measurements made during 1980 and 1981. These measurements ranged from 5820 to 39,725 c.f.s., producing a well-defined rating curve between these limits.

Open-water discharge measurements were made using a standard Price Type A current meter suspended from a boom fixed to the boat and operated by a B-56 reel. For winter stream gaging, a Marsh-McBirney current meter was used. The conventional current meter tend to ice up but the Marsh-McBirney meter has no moving parts, and thus eliminates this problem. Measurements were made through the ice at the same location as open-water measurements.

B.2 - Streamflow (Partial)

B.2.1 - Crest-Stage Recorders

Crest-stage recorders were established at ten sites on the Susitna River, six on the lower river below Devil Canyon, one in the reach between Devil Creek and Devil Canyon, and the remaining three on the upper river above Devil Creek. A crest stage recorder is normally used to determine the highest stage of the year but in our case was serviced periodically to determine maximum stages for separate storms. In addition, the sites were visited frequently at various flows and the water level surveyed to define a rating curve for each site as an aid in the calibration of the HEC-2 Water Surface Profiles Computer program.

The Crest Stage Recorders consisted of a pipe set vertically along the riverbank with an opening at the bottom to allow the inflow of water. The pipe contains a marked wooden staff and a quantity of powdered cork. When the water

rises during a flood the pipe fills to the level of the flood crest, the cork is floated to the top, and is left clinging to the wooden staff at the high-water mark. This mark can later be surveyed to determine the flood crest. Each installation consisted of a series of 7-foot pipes staggered up the bank to cover the full extent of expected flood crests. A sketch of a typical crest gage is detailed in Figure B.2.1.

The stage-discharge rating curves, contained in Attachment E.2, were constructed using stage data determined from surveys along with discharge data from the closest recording station (i.e. Gold Creek or Watana). These discharge data were multiplied by a factor for each station based on a drainage area comparison between the crest-stage recorder site and the recording station site (see Table B.2.1).

B.2.2 - Staff Gages

Staff gages were established for specific reasons at three sites.

(1) Denali - A gage was installed at the Denali Highway bridge over the Susitna River and its datum related to the existing U.S.G.S. recording stream gage. An observer from a local mining operation visited the station each day at 0800 during the months of July and August 1981. This information was used to anticipate timing of a flood peak for the water quality hydrograph sampling program. No data from this staff gage are included in this report as they were used solely for estimation purposes and are redundant with the data from the U.S.G.S. gage at the site.

(2) Watana Damsite - A staff gage was painted on a rock wall at the location of the continuous water quality monitor. This location was selected to provide stage information for the proposed Watana Dam tailrace.

(3) Devil Canyon - A staff gage was located at the downstream end of the canyon, about 1 mile upstream from Portage Creek. It consisted of a weighted rope marked at one-foot intervals and hung over a short cliff. Its purpose was to provide stage information on the tailwater from the proposed Devil Canyon Dam.

B.3 - Water Quality

Table B.3.1 lists the dates and hydrologic events of each of the water quality sampling times.

A complete discussion of equipment, calibration, sampling techniques and laboratory analysis methods is included in the R&M Consultants 1981 Water Quality Annual Report (R&M, 1981f).

B.4 - Sediment Discharge

A complete description of techniques and equipment has been presented in the R&M Consultants 1981 Water Quality Annual Report (R&M, 1981f).

B.5 - Climate

Six Meteorological Research, Inc. (MRI), Series 5100 "Weather Wizard" units were installed in the Upper Susitna basin. These instruments are continuous-recording and are located at the following sites:

Site 1 - Susitna Glacier: This site is located near the confluence of four major glaciers feeding the mainstem of the Susitna River . It is a fairly high-elevation station, located at the 4700-foot elevation.

Site 2 - Denali: This site is considered to represent the high plateau at the base of the Alaska Range. Data from this site will extend an existing partial climate record.

Site 3 - Tyone River: The Tyone drainage area is relatively large and is characterized by gently rolling or flat terrain with numerous lakes and poor drainage. Climatic data within this basin are important for runoff studies.

Site 4 - Kosina Creek: This station was selected to assist Alaska Department of Fish and Game caribou studies and satisfy hydrology data requirements for the area south of the Susitna River in the Talkeetna Mountain drainages.

Site 5 - Watana Camp: Represents conditions at the proposed Watana Damsite and impoundment, as well as being at a convenient location for servicing.

Site 6 - Devil Canyon: This site offers a good location for satisfying transmission line, environmental and hydrology requirements for this region. Data have also been obtained for use in access road and dam construction.

The instrument used for data collection was the MRI Model 5100, a continuous-recording, digital weather station that monitors temperature, windspeed and direction, wind gusts, precipitation, relative humidity and solar radiation. A description of the parameters recorded is located on Page B-7. This system was purchased because it was felt to offer cost-effective data collection and reduction. A number of problems were encountered which resulted in the loss of some data. A summary of the first year's experience is presented in Tables B.5.2 and B.5.3, describing

each site's problems and precentage of data recorvery. Problems of these sorts are fairly common at remote locations and with new equipment. The actual data are summarized in Attachment E.5.

Climatic stations are located at the following sites. One station (Watana Camp) has been recording data since April 8, 1980. The other five stations were installed during July and August 1980. Descriptions of the sites and their map locations are given below.

Site 1 - Susitna Glacier: Station is located in the headwaters of the Susitna River, adjacent to Susitna Glacier. The site is on a hillside to the north of the main glacier, at about the 4,700-foot elevation.
It is located on map Mt. Hayes (C-16).
Map location: NE¼ Sec. 14, R4E, T16S, Fairbanks Meridian.

Site 2 - Denali: Station is located about a mile east of the Susitna River on the left bank, near Susitna Lodge. The site is on a bluff west of the air strip next to the lodge.
It is located on map Healy (A-1).
Map location: SW¼ Sec. 13, R1E, T21S, Fairbanks Meridian.

Site 3 - Tyone River: Station is located about five miles east-southeast of the Susitna River on the left bank in the Tyone River drainage. The site is on a terrace between the Tyone River and a bluff above it, about 1.5 miles (straight line) downstream from the confluence of Tyone Creek and Tyone River.
It is located on map Talkeetna Mountains (C-1).
Map location: SE¼ Sec. 3, R10W, T10N, Copper River Meridian.

Site 4 - Kosina Creek: Station is located about six miles south of the Susitna River in the Kosina Creek drainage. The site is on a bluff about ½-mile upstream from the confluence of Tsisi and Gilbert Creeks and between the two creeks.
It is located on map Talkeetna Mountains (C-2).
Map location: NW¼ Sec. 16, R8E, T30N, Seward Meridian.

Site 5 - Watana Camp: Station is located about 100 yards NE of the base camp in a fairly open, gradually sloping area. No large trees are in the immediate vicinity. The site is about a mile north of the Susitna River on the right bank, about midway between Tsusena and Deadman Creeks.
It is located on map Talkeetna Mountains (D-4).
Map location: NW¼ Sec. 27, R5E, T32N, Seward Meridian.

Site 6 - Devils Canyon: Station is ½-mile downstream of the Devil Canyon damsite on a ridge on the south bank.
It is located on map Talkeetna Mountains (D-5).
Map location: SE¼ Sec. 32, R1E, T32N, Seward Meridian.

Seven climate parameters are measured at each station. These parameters are presently recorded at 15-minute intervals at all stations, although the Susitna Glacier station initially was setup to record at 30 minute intervals and was changed in June 1981.

The parameters measured are explained below:

Time	Data are recorded at 15 or 30 minute intervals, with time of day noted for each record.
Temperature	Air temperature at time of recording, in °C.
Windspeed	Average windspeed during preceding interval, in meters per second.
Wind direction	Average wind direction during preceding interval, in degrees true, with 000° being true north and 90° being east.
Relative humidity	Percentage of vapor saturation, in percent.
Precipitation	Cumulative precitation, in millimeters. Restarted at zero when total reaches 100 mm or when instrument is turned off.
Solar Radiation	Incident intensity at time of recording, in milliwatts per square centimeter.
Peak wind gust	Highest 15-second wind speed, in meters/second, during preceding interval.
Battery voltage	Power supply voltage.

B.6 - Freezing Rain and Icing

To determine the amount of icing that might affect transmission facilities in the Susitna Basin, three systems were used. The first two systems were both used at the Denali and Watana climate station sites, and the third was used at Watana only, where AC power was available. The first method was to install a sample section of transmission line between two upright posts. The cables were 12-foot lengths of one-inch diameter aluminum (steel core) transmission line suspended 8 to 10 feet above the ground. As in-cloud icing caused rime build-up on the cables, its thickness was to be measured by vernier caliper during visits to the site.

The second method used a horizontal, eight-inch square steel plate mounted six feet above the ground on a vertical steel pipe. It was designed to permit measurement of ice that accumulated during freezing-rain events. The thickness of ice buildup on the plate would again be measured by vernier caliper during site visits.

The third method to measure amount of atmospheric icing was an attempt to continuously record the occurrence of icings. The Rosemount ice detector is a device which senses the presence of ice (sensitivity = 0.025") and produces an output signal suitable for automatic control of de-icing equipment. The unit contains a built-in heater which automatically de-ices the detector each time an ice warning signal is produced, thus preparing the detector for another ice-sensing cycle. This device is designed for use as an automatic control mechanism to de-ice fixed antenna installations. For our purposes, the unit was connected to a counter which totaled the number of times that the detector indicated an occurrence of icing. The counter was then to be read during site visits.

Each of the three systems had problems associated with data collection. The first two both require fairly prompt site visits following the icing events. Since this is not always possible, some icings may have occurred and gone unrecorded. Ice was never observed on either the cables or the plates.

It had been planned that the electronic ice detector system would be able to automatically and accurately record occurrence of icing. However, the detector counts the number of times icings occur but also records power outages the same as icings*. The unit is located near Watana Camp and uses AC power from the camp's generators to operate. These outages occur frequently when the camp generators are switched off for daily servicing or changeover. Thus, a number of the recorded counts are due merely to power interruptions.

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* This is a safety feature designed into the device to permit the de-icing signal to be generated when the power supply is interrupted.

As a solution to this problem, an attempt was made to keep a count of the number of power interruptions at the camp. The intent was that these would then be subtracted from the counts recorded by the detector, with the balance of the counts being the number of icings occurring. The generator operator was enlisted to record the timing of each power outage.

Keeping accurate track of the number of power interruptions was a more difficult task than originally envisioned. Sometimes a shut-off might not be recorded, or during a shut-off the generator might kick on and off a few times, thus causing multiple icing counts to be recorded but not necessarily logged by the operator.

For this reason, the detector results are suspect. However, the winter of 1980-81 was a dry one, and judging by observation of the icing cable and plate, we suspect that little if any icing actually did occur during the winter at the observation sites. This suspicion is supported by discussion with long-term residents of Watana Camp. When the camp maintenance men and/or cooks were asked at frequent intervals during visits to the camp, none ever reported any freezing rain or icing conditions.

Attachment E.6 is a comparison of ice detector counts and recorded camp power outages for the period December 5, 1980 to April 17, 1981.

B.7 - Snow Surveys

The snow course is a permanently marked area where snow surveys are taken each year. The snow course measurement is obtained by sampling snow depth and water equivalent at these locations. Five to ten samples are taken at each location and the average of these are reported as snow depth and water equivalent for the area.

In the Susitna Basin 20 snow survey sites were established in 1980. Five of these sites were at the existing climate stations (all stations except Susitna Glacier). Of the other 15, 12 were located in the glaciated mountains at the headwaters of the basin, and 3 along the drainage of Butte Creek. See Map A.2 in Attachment A for exact locations.

The criteria used for selection of snow course sites were:

(a) The site should represent the snow conditions for the general area.

(b) The site should be open and large enough so it is not affected by interception, yet should be protected from high winds.

(c) Finally, the site should be accessible throughout the season (January 1 - May 1).

Due to the large size and the diversity of topographic conditions within the Susitna Basin, many snow courses were needed to accurately represent snowfall in the basin. Also, because of the relative inaccessibility of many of the sites, snow depth was found by aerial survey and snow density and water content were estimated from other measured sites.

Snow surveys were made monthly utilizing a helicopter and coordinating the snow survey with servicing of climate stations in the basin. Depth and water content were measured using an aluminum snow tube. This tube is cored into the snow. Depth of snow is read from the graduations on the tube and the tube full of snow is weighed to determine water content of the snow. Depth can also be estimated from the aerial markers. These markers are described Figure B.7.1. Data for all stations are listed in Attachment E.7.

During the first season of measurements five of the sites were found to be poorly located. The problem in each case was wind carrying away the snow. These markers were removed during the summer of 1981. Four new sites were also established in locations where it was felt additional data were needed. Two sites were added at higher elevations along East Fork Glacier so that an attempt could be made at correlating elevation to snowpack. Two sites were also added in the Clearwater Mountains slightly downstream of the glaciers. This left a total of 19 snow survey sites for the 1981-82 season.

B.8 - Glacial Observations

In May of 1981, R&M Consultants assisted personnel from the Geophysical Institute of the University of Alaska with the installation of snow markers, ablation stakes and with the digging of snow pits. Data were gathered on all major glaciers of the Upper Susitna Basin with the exception of the Eureka and Oshetna Glaciers. Study of the Eureka Glacier was limited to visual observations and aerial photography. The Oshetna Glacier was not considered a major contributor to the flow or sediment regime of the Susitna River and therefore was omitted from this study.

R&M conducted the control and velocity surveys on the West Fork Glacier, West Tributary of Susitna Glacier, Turkey Glacier and East Tributary of Susitna Glacier. The velocity surveys were repeated monthly through September to determine ice movement as an aid in mass balance and glacier dynamics analyses.

A thermocouple string was installed to a depth of 66 feet at an elevation of 7700 feet on the West Tributary of Susitna Glacier to determine the thermal regime of the ice.

The snow markers and ablation stake sites on all the glaciers were visited again in July 1981. The lower-altitude ablation stakes were found to have fallen over, signifying a total ablation at these points of more than 3 meters in 3 months. In August the holes for the velocity stakes had to be drilled deeper; otherwise, they also would have been lost. The locations of the stakes are shown in Figure B.8.1.

The results of this data gathering effort as well as a thorough description of field procedures and analytical methods are presented in a report by William Harrison of the Geophysical Institute (Harrison, 1981).

B.9 - Snow Creep

Snow Creep is the slow movement of a snowpack downhill. It is most prevalent on slopes of 25-35°. Above this angle the movement of snow will more likely occur as an avalanche.

In 1973 in Southeast Alaska several transmission line towers servicing the Snettisham Hydroelectric Project failed for a reason unknown but theorized to be caused by high winds or snow creep pushing the base of the tower off its base. In 1974 and 1975 the Corps of Engineers installed a system to evaluate the amount of force that snow creep could exert on a transmission line tower (Meyer, 1978). These tests measured a maximum pressure of 460 lbs/ft^2 with a 71-inch depth of 37%-density snow, but concluded that snow creep forces did not contribute to the failure of the tower.

Even though not judged to be a factor in the Snettisham failures, snow creep was considered to be a potentially large force in Alaska. To try to determine the magnitude for the transmission line servicing the Susitna Project, two installations were set up to measure snow creep forces. To simulate conditions at the actual transmission line towers as closely as possible, 24-inch diameter, 3/8" thick tubular steel sections were placed on the chosen slopes. These sections were allowed to slide over the ground and were held from sliding downhill by a cable attached to a dynamometer. The dynamometer measured the force in the cable which was needed to support the pipe section. If creep of the snowpack did occur, the force would have been transmitted to the pipe section, cable and dynamometer where its maximum would have been recorded by a maximum-recording gauge. (See sketch, Figure B.9.1).

The two setups were installed in January of 1981. During setup, the snowpack was unavoidably disturbed. Partly because of this and also due to the lack of abundant snow during the winter, no usable snow creep data were collected. Some readings were taken, however, which indicate the type of base readings that may occur on the instrument with no snow (due to thermal, wind, or other stresses).

The 1981 observations are summarized in Attachment E.9.

B.10 - River Ice Observations

Frazil ice first appeared in 1980 on October 11 and in 1981 on September 28 in the Susitna River. The ice cover was nearly complete over the whole river by mid-December though open water leads did persist in several turbulent reaches throughout the winter. The presence of a hydrographic survey crew in the Devil Canyon-Talkeetna reach during the fall of 1980 permitted extensive observation and photography of the freeze-up processes. Also, measurements were made at several ice accumulation sites to record the increase in water level at the upstream ends and to record the advance of the cover upstream with time.

Mid-winter observations consisted of taking photographs at areas of interest to record locations of open leads as well as ice cover characteristics. In addition, ice thicknesses and top-of-ice elevations were measured at several locations in February 1981, notably the crest gage sites.

Break-up on the Susitna was relatively mild in 1981, compared to a number of the historical records. Abundant spring sunshine and warm temperatures early on reduced the low-elevation snowpack, and a lack of significant precipitation kept the river level fairly low. Observations again consisted of aerial reconnaissance of the primary areas of interest and a few on-site measurements of water stage and velocity.

Freeze-up in 1981 was begun with an early appearance of frazil ice (September 28 at Gold Creek). Warmer temperatures in October, however, dissipated the frazil and delayed further freeze-up activity for several weeks. Observations were made periodically during the fall and early winter, primarily by means of aerial fixed-wing flights.

The full extent of the ice observation program through spring 1981 breakup is described in a separate R&M report, Ice Observations (R&M, 1981c). The report details descriptive observations made in the field and presents climatological, hydrologic, and ice-related data collected during the period. The dates of field observations are summarized in the Hydrology Field Observation Log, included as Appendix C to this report.

B.11 - Evaporation

A National Weather Service Type A evaporation pan was installed at the Watana Site on May 7, 1981. The location chosen was an open area 200 feet northeast of the camp buildings and near the Watana Climate Station. Observations of the change in water level and the minimum-maximum water temperatures during the preceeding 24 hours were made each morning at 0700.

One problem with this arrangement was the lack of responsible camp personnel to make the daily observations. Thus, there were frequent periods when readings were not taken for several days. This caused a loss of some daily data, but it does not affect the monthly evaporation totals which are cumulative.

To compute evaporation, precipitation amounts at the site during the same time period are needed. These were obtained from the precipitation gage at the weather station nearby.

TABLE B.2.1

Factors for Relating Recorded Streamflows
to Other Sites, Based on Drainage Area

Station	Cross-Section Number	Discharge Factor
Deadman Creek	URX-101	$0.969 \times Q_{Watana}$
Watana Dam	URX-106.3	$1.000 \times Q_{Watana}$
Devil Creek	URX-121	$1.079 \times Q_{Watana}$
Devil Canyon Upper	-	$0.933 \times Q_{G.C.}$
Portage Creek	LRX-62	$0.943 \times Q_{G.C.}$
Sherman	LRX-35	$1.000 \times Q_{G.C.}$
Section 25	LRX-28	$1.000 \times Q_{G.C.}$
Curry	LRX-24	$1.000 \times Q_{G.C.}$
Chase	LRX-9	$1.029 \times Q_{G.C.}$
Susitna-Chulitna Confl.	LRX-4	$1.029 \times Q_{G.C.}$

Note:

1. Discharges at crest stage recorder sites were estimated using flows from nearby continuous recorders (Gold Creek for LRX's , Watana for URX's) multiplied by a factor based on comparative drainage areas.

2. ($Q_{G.C.}$ = flow observed at Gold Creek).

TABLE B.3.1

WATER QUALITY SAMPLING SUMMARY

1980 WATER QUALITY SAMPLING
DATES AND EVENTS

Vee Canyon	Gold Creek	Event
6/19/80	-	Glacier runoff and snowmelt.
8/8/80	8/8/80	After heavy summer rain.
9/5/80	-	Low summer discharge.
9/17/80	-	After heavy rains.
10/17/80	10/14/80	Pre-freezeup.

1981 WATER QUALITY SAMPLING
DATES AND EVENTS

Vee Canyon	Gold Creek	Event
1/13/81	1/14/81	Winter, under ice cover.
5/20/81	5/27/81	Breakup.
6/18/81	6/17/81	Glacier runoff and snowmelt.
-	6/30/81	Heavy rains, hydrograph peak.
6/30/81	7/1/81	Descending limb of hydrograph.
8/2/81	-	Heavy rain, rising limb of hydrograph.
8/3/81	8/2/81	Heavy rain, hydrograph peak.
8/3/81	8/3/81	Descending limb of hydrograph.
9/15/81	9/14/81	Late summer, low discharge.
10/7/81	10/8/81	Pre-freezeup.

TABLE B.5.1
OPERATING HISTORY
SUSITNA GLACIER CLIMATE STATION
Prepared May 1981

7/20/80	Installed.
7/20/80 to 8/12/80	Good record RH very erratic suspect no-good.
8/12/80 to 8/28/80	Garbled data.
8/28/80 to 10/26/80	Good record RH very low suspect no good.
10/26/80 to 12/4/80	Garbage on tape due to high voltages approximately 1% loss.
12/4/80	Voltage limiter added. RH sensor replaced.
12/4/80 to 2/3/81	Good record.
2/3/81 to 4/2/81	Loss of some midday data due to high voltages approximately 2%.
4/2/81 to 4/22/81	Missing 20 days of data.
4/22/81 to 4/30/81	Still erratic garbage on tape, approximately 3% loss.

TABLE B.5.1 (Continued)
OPERATING HISTORY
DENALI CLIMATE STATION
Prepared May 1981

7/18/80	Installed.
8/29/80	Unit not working.
9/11/80	Unit started working. RH much too low.
9/18/80	Unit stopped again.
10/17/80	Unit started again.
10/17/80 to 10/30/80	Wind speed and gust no good. Garbage and spacing causing loss of approximately 5% of data.
10/30/80 to 12/4/80	No wind speed and wind gusts. Approximately 2% loss of data to garbage and spacing.
12/4/80 to 2/2/81	No wind speed and gusts. RH still too low.
2/2/81	Wind speed, gust, and RH fixed.
2/2/81 to 3/19/81	Losing some of mid-day readings due to high battery voltage, approximately 1%.
3/19/81	Solar collector hooked up correctly.
3/19/81 to 4/30/81	Good data.

TABLE B.5.1 (continued)
OPERATING HISTORY
TYONE CLIMATE STATION
Prepared May 1981

8/27/80	Installed.
8/30/80	Instrument stopped working. Faulty electronic chips
10/17/80	Monitor replaced - data erratic.
12/5/80	New monitor installed but did not operate till 1/9.
1/9/81	Monitor warmed up and started working. Slightly erratic.
2/11/81	Monitor stopped working.
3/4/81	Monitor replaced. Solar very high.
4/1/81	Solar connection repaired. Data looks good.

TABLE B.5.1 (continued)
OPERATING HISTORY
KOSINA CREEK CLIMATE STATION
Prepared May 1981

8/25/80	Installed.
10/17/80	Worked good until this date. Monitor replaced and then lots of garbage and spacing errors introduced. Useless without cleanup program but with cleanup program most of it becomes useful and losses occur mostly in temperature and wind speed, about 35%, and about 5% of the rest of the parameters. Data would not file 10/17 - 10/29.
1/8/81 to 1/15/81	No data. W.W. removed 1/8.
1/15/81	New W.W. installed. Recorded well for 2 days.
1/16/81	W.W. stopped working due either to recorder releasing tape or loose screws on display module.
2/3/81 to 3/6/81	Record good.
3/6/81 to 3/25/81	Garbage loss of about 5%. Reason unknown.
3/25/81 to 4/1/81	Good data.
4/1/81 to 4/5/81	5% loss of data.
4/5/81 to 4/30/81	Total loss of data.

TABLE B.5.1 (continued)
OPERATING HISTORY
WATANA CLIMATE STATION
Prepared May 1981

3/13/80	Installed.
4/8/80	First tape retrieved no data because head bar not depressed.
4/28/80	Second data tape retrieved, processed by MRI, record good.
5/8/80	Lighting strikes - time lag of 9 hours introduced.
5/28/80	New unit installed in place of Demo unit.
6/13/80	Tape removed - unit left off until 6/19/80 because of blown fuse.
6/19/80	New fuse. New tape.
6/21/80	Time messed up between 6/21 and 6/25.
6/21/80 to 7/30/80	Good Record.
7/30/80 to 8/14/80	No record. Faulty solar panel drained battery.
8/14/80 to 8/28/80	All garbage. Improper type cassette installed.
8/28/80 to 10/2/80	Some garbage causing loss after cleanup of approximately 2% of temperature and wind speed data.
10/2/80 to 10/17/80	No record. Electrical malfunction in W.W.
10/17/80 to 10/30/80	Good record.
10/30/80	Solar radiation became very high today - N.G.
10/30/80 to 12/5/80	Record okay except for solar. New power supply installed.
12/5/80 to 2/2/81	Good record. Solar still bad.

TABLE B.5.1 (continued)
OPERATING HISTORY
WATANA CLIMATE STATION
Prepared May 1981
(CONTINUED)

2/2/81	New solar sensor.
2/2/81 to 2/13/81	Good record.
2/13/81	High voltages causing loss of some data.
2/13/81 to 2/26/81	Loss of about 50% of data.
2/26/81	Power at station found turned off.
2/26/81 to 3/6/81	Data looks good.
3/6/81 to 3/16/81	Slight losses of data.
3/16/81 to 4/29/81	Good data.

TABLE B.5.1 (continued)
OPERATING HISTORY
DEVIL CANYON CLIMATE STATION
Prepared May 1981

7/17/80	Installed.
7/17/80 to 7/23/80	Some errors mostly in spacing.
7/23/80 to 8/13/80	Data good.
8/13/80 to 10/1/80	No data. Recorder did not advance. New unit installed 10/1.
10/1/80 to 10/4/80	Good data.
10/4/80	Some garbled data.
10/4/80 to 10/12/80	Good data.
10/12/80	Some spacing problems.
10/13/80	Solar suddenly gets very high.
10/12/80 to 10/16/80	Good data, except for solar.
10/16/80 to 10/30/80	Possible 2% loss due to spacing when voltage got too high. Solar very high.
10/30/80 to 12/3/80	Solar too high throughout. RH looks bad throughout. 50% okay the rest too high.
12/3/80 to 1/12/80	Voltage regulator battery installed.
1/12/80 to 2/25/81	Looks good. Solar all bad. RH seems high.
3/16/81	Changed solar panel connection.
3/16/81 to 4/30/81	Data good. Unlikely RH readings occur periodically throughout the record.

Table: B.5.2 R&M CONSULTANT, INC. SUSITNA HYDROELECTRIC PROJECT
PERCENTAGE OF USABLE (HOURLY DATA) FOR WEATHER WIZARD STATION ID: 610 NAME : GLACIER

MONTH	TEMP	WS	WD	RH	PRECIP.	SOLAR	PK-GUST	BATTERY	DEW POINT
JULY ,1980	91.5	91.5	91.5	0.0	91.5	91.5	91.5	91.5	0.0
AUGUST ,1980	49.6	49.7	49.7	0.0	49.7	49.7	49.7	49.7	0.0
SEPTEMBER ,1980	99.9	99.9	99.9	0.0	99.9	99.9	100.0	99.9	0.0
OCTOBER ,1980	93.0	94.2	98.9	0.0	.1	98.8	99.7	98.3	0.0
NOVEMBER ,1980	94.0	94.9	98.3	0.0	0.0	99.7	100.0	97.8	0.0
DECEMBER ,1981	99.9	99.9	99.9	79.0	0.0	99.9	100.0	99.9	79.0
JANUARY ,1981	99.9	99.9	96.0	90.9	0.0	100.0	100.0	100.0	90.7
FEBRUARY ,1981	96.4	96.6	52.4	63.2	0.0	98.5	99.9	98.2	61.0
MARCH ,1981	89.9	87.0	91.7	79.0	0.0	93.8	98.3	92.3	73.1
APRIL ,1981	28.3	27.4	29.4	17.5	31.0	30.0	31.7	30.1	15.1
MAY ,1981	99.6	99.6	99.5	88.8	99.5	99.6	99.7	99.6	88.8
JUNE ,1981	100.0	100.0	100.0	84.9	100.0	100.0	100.0	100.0	84.9
JULY ,1981	100.0	100.0	100.0	96.6	100.0	100.0	100.0	100.0	96.6
TOTAL	86.7	86.5	83.9	44.6	37.0	88.3	89.1	88.0	43.7

Table: B.5.2 (continued)

R&M CONSULTANT, INC. SUSITNA HYDROELECTRIC PROJECT
PERCENTAGE OF USABLE (HOURLY DATA) FOR WEATHER WIZARD STATION ID: 620 NAME : DENALI

MONTH	TEMP	WS	WD	RH	PRECIP.	SOLAR	PK-GUST	BATTERY	DEW POINT
JULY ,1980	100.0	100.0	100.0	92.9	100.0	100.0	100.0	100.0	92.9
AUGUST ,1980	92.7	92.7	92.7	83.2	92.7	92.7	92.7	92.7	83.2
SEPTEMBER ,1980	22.5	0.0	22.5	0.0	22.5	22.5	0.0	22.5	0.0
OCTOBER ,1980	46.9	0.0	46.9	0.0	0.0	46.8	0.0	46.6	0.0
NOVEMBER ,1980	99.9	0.0	100.0	0.0	0.0	99.7	0.0	99.6	0.0
DECEMBER ,1981	100.0	0.0	100.0	0.0	0.0	100.0	0.0	100.0	0.0
JANUARY ,1981	100.0	0.0	100.0	0.0	0.0	100.0	0.0	100.0	0.0
FEBRUARY ,1981	99.9	94.2	99.9	77.7	0.0	99.6	94.3	99.6	77.7
MARCH ,1981	99.2	99.1	99.2	89.2	0.0	99.2	99.2	99.2	89.2
APRIL ,1981	99.4	99.4	99.4	87.2	0.0	99.4	99.7	99.4	87.2
MAY ,1981	100.0	100.0	100.0	94.5	100.0	100.0	100.0	100.0	94.5
JUNE ,1981	100.0	100.0	100.0	96.7	100.0	100.0	100.0	100.0	96.7
JULY ,1981	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
TOTAL	87.9	55.0	87.9	49.9	32.1	87.8	55.1	87.8	49.9

Table: B.5.2
Continued R&M CONSULTANT, INC. SUSITNA HYDROELECTRIC PROJECT
PERCENTAGE OF USABLE (HOURLY DATA) FOR WEATHER WIZARD STATION ID: 630 NAME : TYONE

MONTH	TEMP	WS	WD	RH	PRECIP.	SOLAR	PK-GUST	BATTERY	DEW POINT
AUGUST ,1980	69.5	69.5	69.5	34.3	69.5	69.5	69.5	69.5	34.3
SEPTEMBER ,1980	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OCTOBER ,1980	25.3	25.0	24.3	7.3	0.0	25.3	26.2	25.4	6.7
NOVEMBER ,1980	95.0	95.7	95.3	24.0	0.0	96.8	97.6	96.0	22.5
DECEMBER ,1981	14.2	14.2	14.2	0.0	0.0	14.2	14.2	14.2	0.0
JANUARY ,1981	57.1	56.9	56.6	10.8	0.0	56.2	57.9	56.6	10.8
FEBRUARY ,1981	37.9	37.9	37.9	9.8	0.0	37.6	38.2	37.6	9.8
MARCH ,1981	59.4	59.4	59.4	26.5	0.0	0.0	59.7	59.4	26.5
APRIL ,1981	100.0	100.0	100.0	52.6	0.0	98.3	100.0	100.0	52.6
MAY ,1981	100.0	100.0	100.0	68.7	100.0	100.0	100.0	100.0	68.7
JUNE ,1981	100.0	100.0	100.0	73.1	100.0	100.0	100.0	100.0	73.1
JULY ,1981	98.4	98.4	98.4	62.3	98.4	98.4	100.0	98.4	62.3
TOTAL	59.4	59.4	59.3	27.7	21.5	53.3	59.9	59.4	27.5

Table: B.5.2 (continued)

R&M CONSULTANT, INC. SUSITNA HYDROELECTRIC PROJECT
PERCENTAGE OF USABLE (HOURLY DATA) FOR WEATHER WIZARD STATION ID: 640 NAME : KOSINA STATION

MONTH	TEMP	WS	WD	RH	PRECIP.	SOLAR	PK-GUST	BATTERY	DEW POINT
AUGUST ,1980	100.0	100.0	100.0	90.2	100.0	100.0	100.0	100.0	90.2
SEPTEMBER ,1980	100.0	100.0	100.0	80.1	100.0	100.0	100.0	100.0	80.1
OCTOBER ,1980	86.8	88.8	92.5	87.5	0.0	92.3	92.7	92.3	81.9
NOVEMBER ,1980	95.6	95.4	100.0	98.2	0.0	100.0	100.0	100.0	93.8
DECEMBER ,1981	97.0	97.6	100.0	99.1	0.0	100.0	100.0	100.0	96.1
JANUARY ,1981	28.9	28.5	29.0	28.8	0.0	29.0	29.2	29.0	28.6
FEBRUARY ,1981	91.2	91.2	91.2	87.1	0.0	91.2	91.4	91.2	87.1
MARCH ,1981	53.9	54.6	54.3	53.1	0.0	54.4	55.6	53.8	51.6
APRIL ,1981	16.0	16.0	15.7	14.7	0.0	14.2	16.1	16.0	14.7
MAY ,1981	45.0	45.0	45.0	44.0	45.0	39.0	45.3	45.0	44.0
JUNE ,1981	64.6	64.6	64.6	60.8	64.6	62.2	64.9	64.6	60.8
JULY ,1981	100.0	100.0	100.0	95.1	100.0	100.0	100.0	100.0	95.1
TOTAL	68.6	68.8	69.9	65.9	23.2	68.9	70.2	69.9	64.5

Table: B.5.2 (continued)

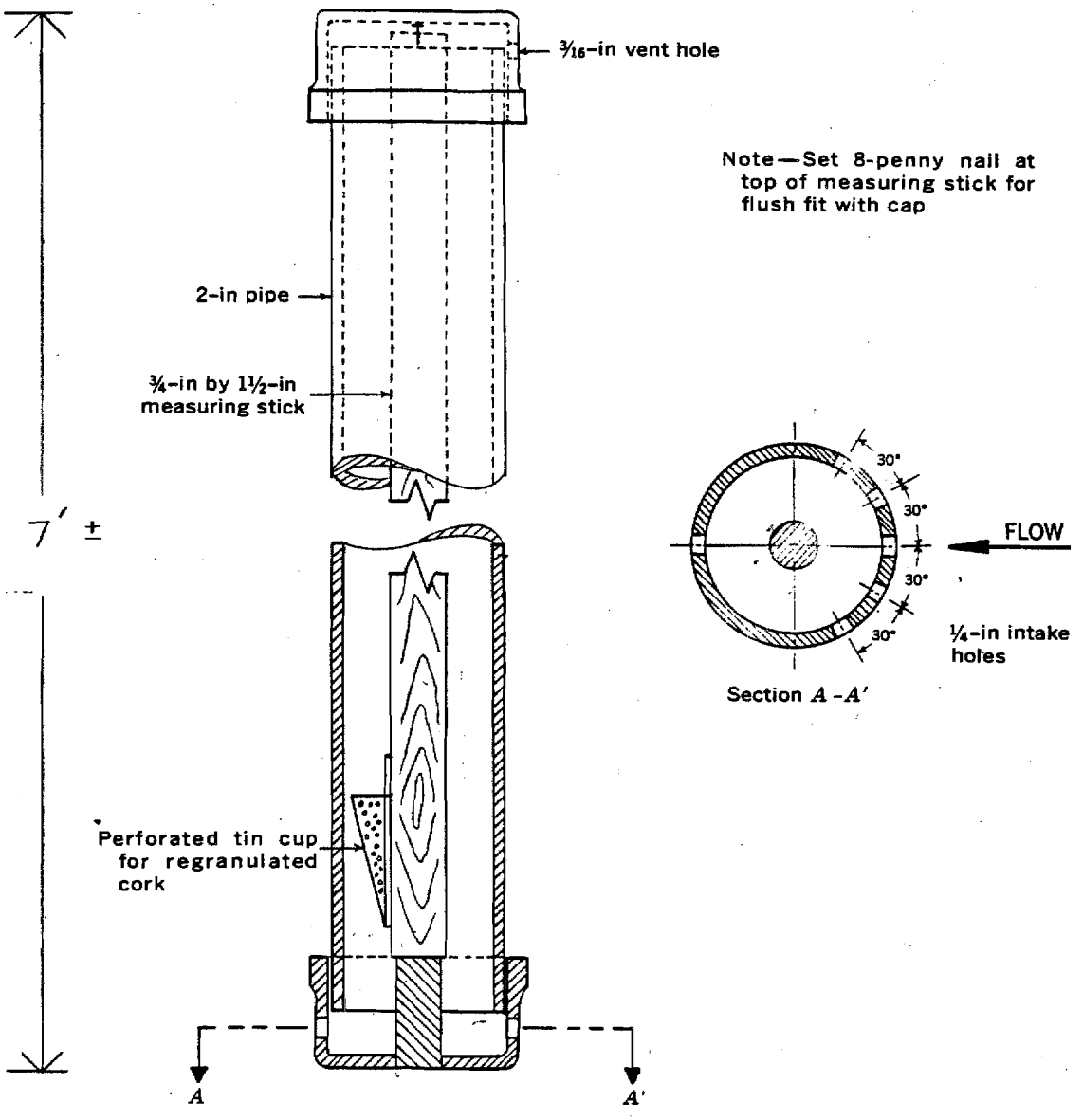
R&M CONSULTANT, INC. SUSITNA HYDROELECTRIC PROJECT
PERCENTAGE OF USABLE (HOURLY DATA) FOR WEATHER WIZARD STATION ID: 650 NAME : WATANA STATION

MONTH	TEMP	WS	WD	RH	PRECIP.	SOLAR	PK-GUST	BATTERY	DEW POINT
APRIL ,1980	99.8	99.8	99.8	93.3	99.8	99.8	100.0	99.8	93.3
MAY ,1980	98.7	98.7	98.7	90.1	98.7	98.7	98.7	98.7	90.1
JUNE ,1980	69.7	69.6	69.7	61.5	54.2	69.9	69.9	69.9	61.4
JULY ,1980	96.1	96.1	96.1	91.0	96.1	96.1	96.1	96.1	91.0
AUGUST ,1980	2.2	2.3	2.3	2.2	2.3	2.3	2.4	2.3	2.0
SEPTEMBER ,1980	58.2	58.2	58.3	55.4	58.3	58.3	58.6	58.3	55.3
OCTOBER ,1980	46.4	46.4	46.4	44.1	46.4	2.0	46.4	46.4	44.1
NOVEMBER ,1980	100.0	100.0	100.0	94.9	100.0	0.0	100.0	100.0	94.9
DECEMBER ,1981	100.0	100.0	100.0	99.5	100.0	0.0	100.0	100.0	99.5
JANUARY ,1981	100.0	100.0	100.0	98.0	100.0	0.0	100.0	100.0	98.0
FEBRUARY ,1981	52.7	52.7	52.7	41.1	52.7	46.6	53.0	52.7	41.1
MARCH ,1981	96.6	96.8	96.8	94.2	96.6	96.4	97.0	96.0	94.1
APRIL ,1981	100.0	100.0	100.0	95.3	100.0	100.0	100.0	100.0	95.3
MAY ,1981	100.0	100.0	100.0	94.8	100.0	100.0	100.0	100.0	94.8
JUNE ,1981	100.0	100.0	100.0	95.6	100.0	100.0	100.0	100.0	95.6
JULY ,1981	100.0	100.0	100.0	90.9	100.0	100.0	100.0	100.0	90.9
TOTAL	81.2	81.3	81.3	76.7	80.2	57.4	81.4	81.2	76.6

Table: B.5.2 (continued)

R&M CONSULTANT, INC. SUSITNA HYDROELECTRIC PROJECT
PERCENTAGE OF USABLE (HOURLY DATA) FOR WEATHER WIZARD STATION ID: 660 NAME : DEVIL CANYON

MONTH	TEMP	WS	WD	RH	PRECIP.	SOLAR	PK-GUST	BATTERY	DEW POINT
JULY ,1980	100.0	100.0	100.0	72.0	100.0	100.0	100.0	100.0	72.0
AUGUST ,1980	41.7	41.7	41.7	28.8	41.7	41.7	41.7	41.7	28.8
SEPTEMBER ,1980	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OCTOBER ,1980	98.8	98.8	98.8	74.9	0.0	39.7	98.9	98.8	74.9
NOVEMBER ,1980	100.0	82.6	82.6	90.3	0.0	0.0	100.0	100.0	90.3
DECEMBER ,1981	100.0	100.0	100.0	89.2	0.0	0.0	100.0	100.0	89.2
JANUARY ,1981	100.0	100.0	100.0	86.7	0.0	0.0	100.0	100.0	86.7
FEBRUARY ,1981	100.0	27.8	24.3	93.3	0.0	12.6	100.0	100.0	93.3
MARCH ,1981	99.6	99.6	100.0	89.4	0.0	99.9	100.0	99.7	89.0
APRIL ,1981	100.0	100.0	100.0	90.1	100.0	100.0	100.0	100.0	90.1
MAY ,1981	100.0	100.0	100.0	75.3	100.0	100.0	100.0	100.0	75.3
JUNE ,1981	100.0	100.0	100.0	77.6	100.0	100.0	100.0	100.0	77.6
JULY ,1981	98.4	98.4	98.4	92.1	98.4	98.4	100.0	98.4	92.1
TOTAL	86.1	78.9	78.7	72.4	34.4	47.8	84.2	86.2	72.3



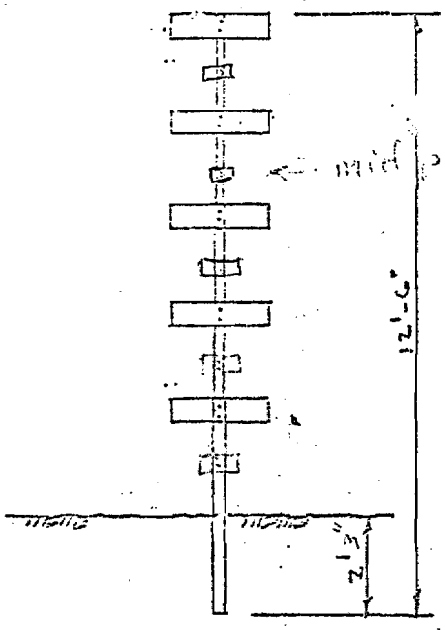
Crest Stage Recorder (typical)

Source: Discharge measurements at gaging stations, Techniques of Water - Resources Investigations. USGS, 1968, p. 28.

Figure B.2.1

SNOW SURVEY MARKER DETAIL

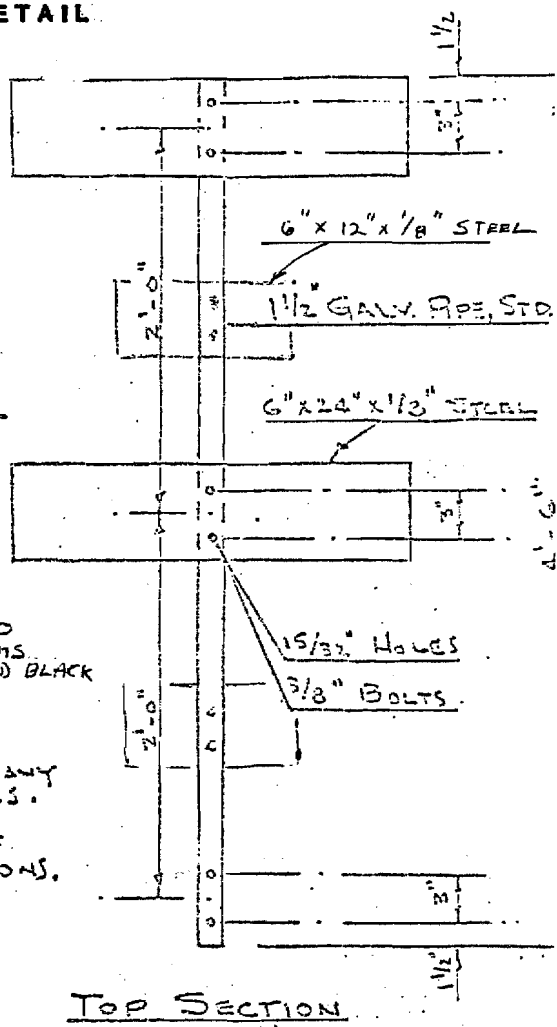
Figure B.7.1



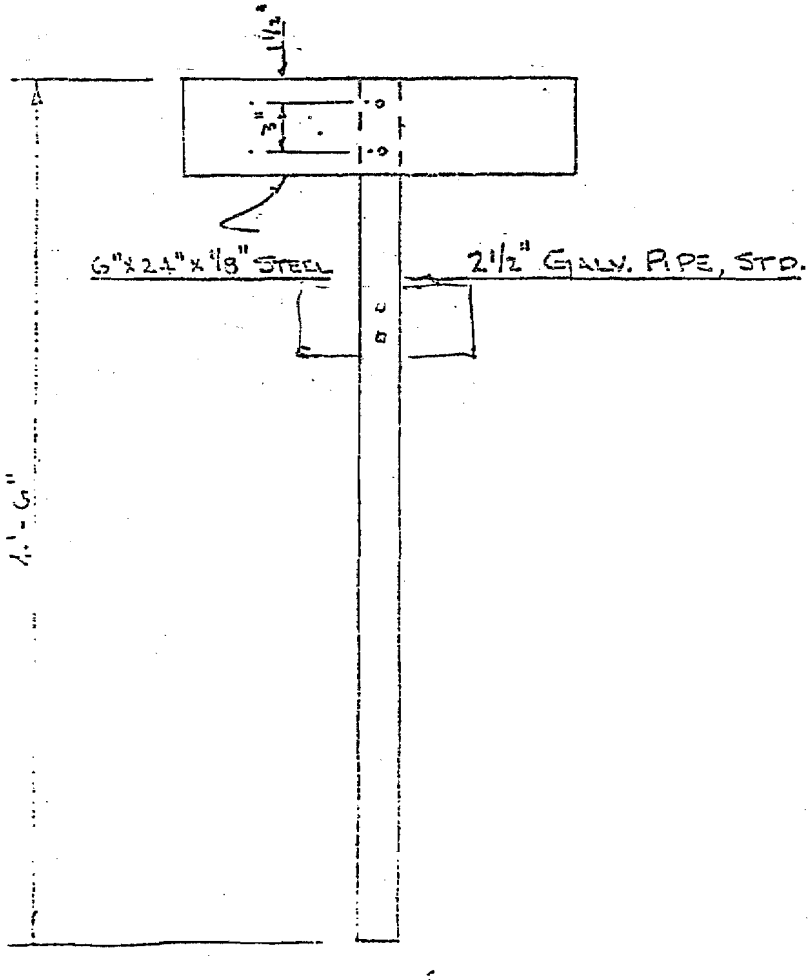
AERIAL SNOW MARKER

NOTES:

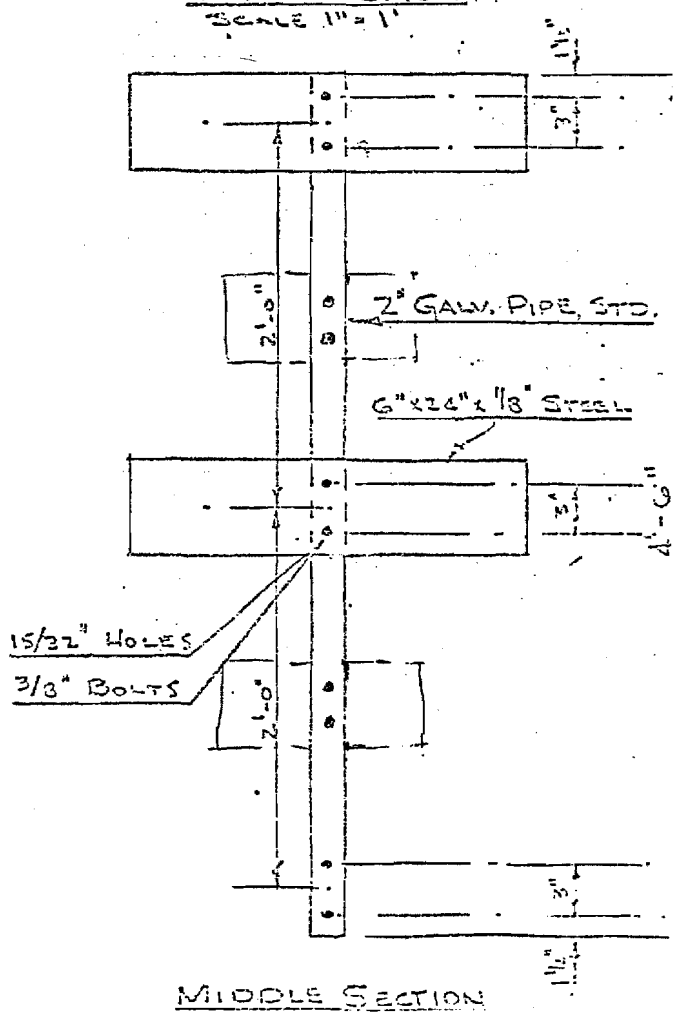
1. ~~All~~ 5 CROSS ARMS SHALL BE 6" X 24" X 1/8" STEEL. & 5 each 6" X 12" X 1/8" STEEL
2. ALL HOLES ARE 15/32".
3. ALL BOLTS ARE HEX. HEAD, 4" X 3/8".
4. 24" CROSS ARMS SHALL BE PRIMED & PAINTED ORANGE; 12" CROSS ARMS SHALL BE PRIMED & PAINTED BLACK
5. ALL HOLES SHALL BE IN ALIGNMENT.
6. REMOVE ALL BURRS & ANY OTHER DEFORMATIONS.
7. REAM TOP ENDS OF MIDDLE & BASE SECTIONS.
8. SHOP TEST FOR FIT.



TOP SECTION
SCALE 1" = 1'



BASE SECTION



MIDDLE SECTION

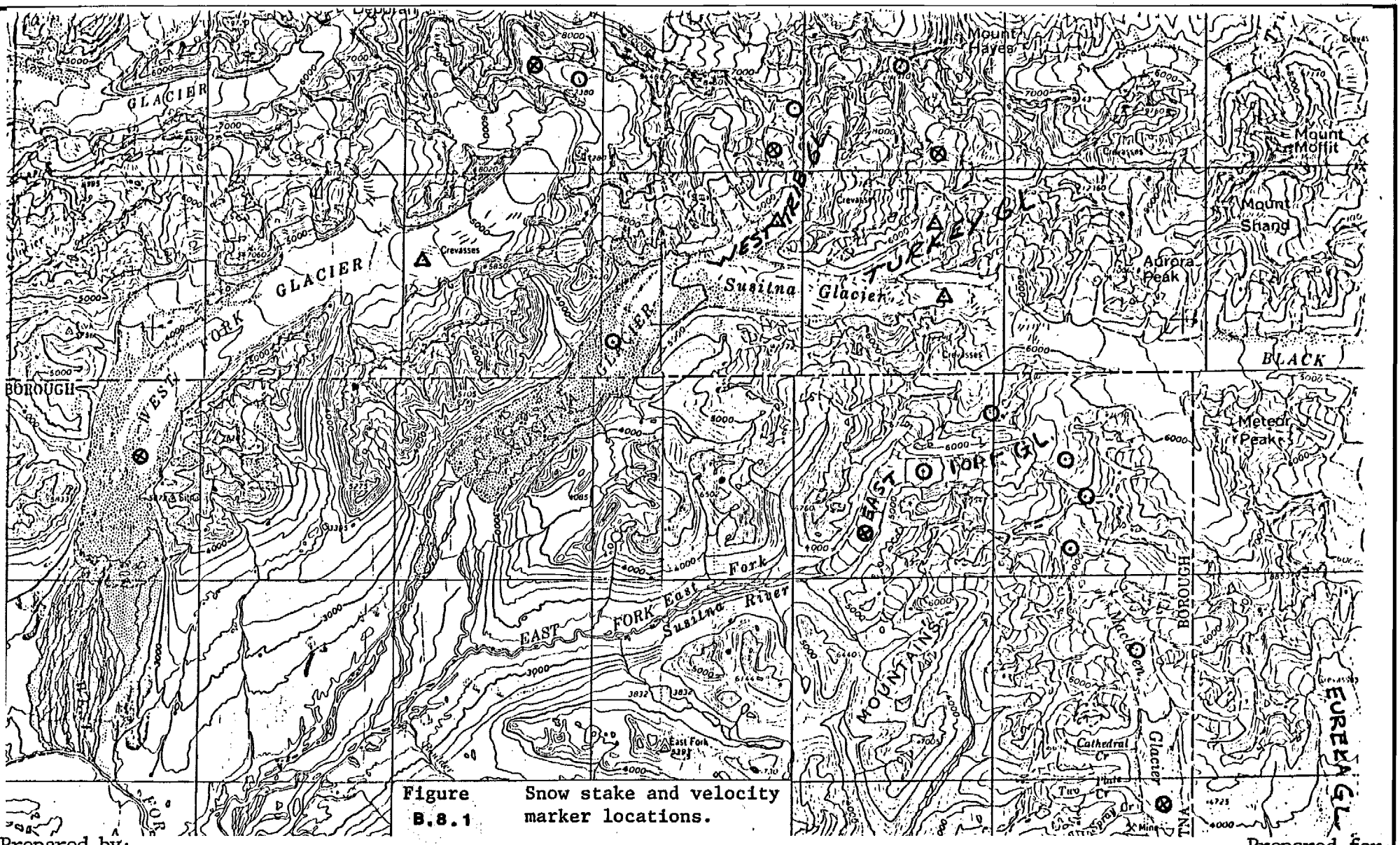


Figure B.8.1 Snow stake and velocity marker locations.

Prepared by:

R&M CONSULTANTS, INC.

Prepared for:

ACRES

○ snow stake

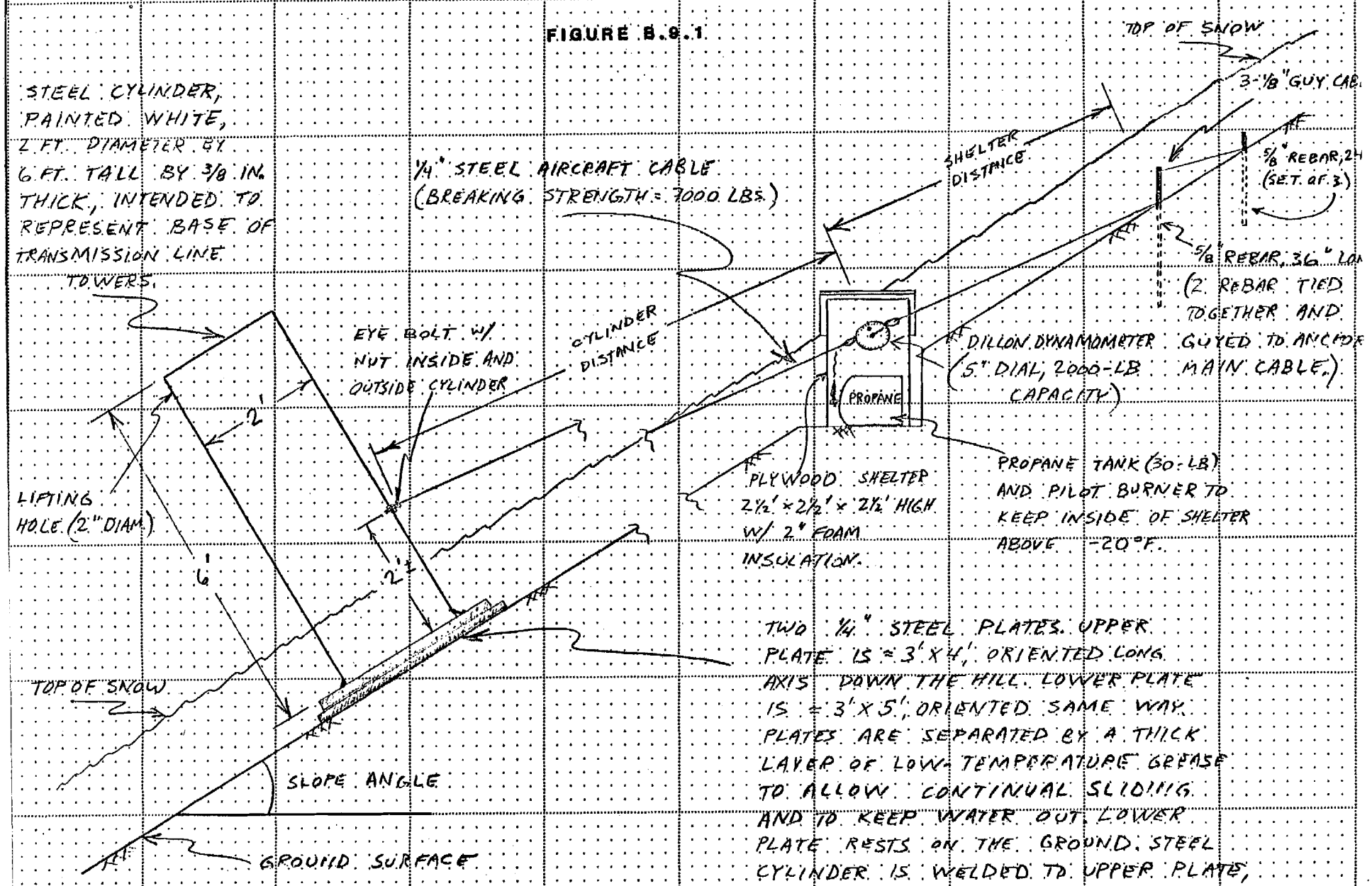
△ velocity marker

⊗ lost stake

SUSITNA HYDRO PROJECT

SNOW CREEP STATION (TYPICAL)

FIGURE B.9.1



SUSITNA HYDROELECTRIC PROJECT

TABLE B.9.1

Description of Snow Creep Station Installations

Site Name: Devils Canyon

Site Number: 0940

Date of Installation: February 25, 1981

Installation Crew: J. Coffin, C. Schoch, R. Butera

Site-Specific Information

1. Location: SW ¼, Sec. 32, T33N, R1E, Seward Meridian
2. U.S.G.S. Map: Talkeetna Mountains (D-5)
3. Elevation of Site: 1,500 ft. (from map)
4. Slope Aspect: Northeast
5. Slope Angle: 29°
6. Snow Depth @ Time of Installation: 20+ inches
7. Air Temperature @ Time of Installation: 32°F
8. Soil Material: Thick tundra, frozen
9. Shelter Distance (see sketch): 15 ft. (approx.)
10. Cylinder Distance (see sketch): 65 ft. (approx.)
11. Maximum Pretensioning Force Used: 1000 lbs.
12. Final Dynamometer Reading @ Time of Installation: 470 lbs.
13. Dynamometer Installed: W.C. Dillon Co., 2000-lb. (pound) Capacity, 5"dial S/N 10576
14. Notes: Pilot burner did not funtion properly at time of installation. Thus, it was not connected until the next visit to the station, March 15, 1981.

susit4/g2

SUSITNA HYDROELECTRIC PROJECT

TABLE B.9.2

Description of Snow Creep Station Installations

Site Name: Watana

Site Number: 0920

Date of Installation: February 26, 1981

Installation Crew: J. Coffin, C. Schoch, R. Butera

Site-Specific Information

1. Location: NW ¼, Sec. 30, T33N, R5E, Seward Meridian
2. U.S.G.S. Map: Talkeetna Mountains (D-4)
3. Elevation of Site: 3,200 ft. (from map)
4. Slope Aspect: Southwest
5. Slope Angle: 35°
6. Snow Depth @ Time of Installation: 24-30 inches
7. Air Temperature @ Time of Installation: 30°F
8. Soil Material: Broken rock and tundra, all frozen
9. Shelter Distance (see sketch): 20 ft. (approx.)
10. Cylinder Distance (see sketch) : 90 ft. (approx.)
11. Maximum Pretensioning Force Used: 900 lbs.
12. Final Dynamometer Reading @ Time of Installation: 440 lbs.
13. Dynamometer Installed: W.C. Dillon Co., 2000-lb. (pound) Capacity, 5"dial, S/N 10575
14. Notes: Pilot burner did not funtion properly at time of installation. Thus, it was not connected until the next visit to the station, March 16, 1981.

susit4/g1

ATTACHMENT C

FIELD OBSERVATION LOG

R&M FIELD DATA COLLECTION LOG AS OF DECEMBER 15, 1981

susi6/g Page 1

SUSITNA HYDROELECTRIC PROJECT
Subtask 3.03 - Hydrology Field Observation Log

Status As of: December 15, 1981

Parameter Measured	Station Location	Type of Instrument Used	Date of Installation	Observation Frequency	Dates of Observation	Type of Observation	Comments
(1) River Stage*	Susitna River near Watana Damsite	Scientific Instr. Co. Manometer Stevens Water Level Recorder	6/20/80	Continuous	7/10-12/1/80 4/15/81-12/2/81	Scheduled	Instrument functioning normally.
(2) River Discharge	Susitna River near Watana Damsite	Teledyne-Gurley Price Current Meter Marsh-McBirney Flow Meter	N/A	Unscheduled	8/20/80 8/21/80 9/3/80 9/18/80 10/20/80 4/01/81 5/24/81 6/2/81 7/3/81	Event Event Event Event Event Event Event Event Event	Stage-discharge rating curve and table have been prepared from field measurements.
(3) River Crest Stage* (Susitna River)	(a) Susitna-Chulitna Confluence (LRX-4)	Crest-stage recorder	6/26/80	Unscheduled	7/31/80 7/27/81 8/31/81 11/2/81	Event	Observations are made at recorder following flood events. Water surface elevations are recorded periodically at most of the crest gage sites.
	(b) Chase (LRX-9)	Crest-stage recorder	7/31/80	Unscheduled	12/2/80 7/27/81 11/2/81	Event	
	(c) Curry (LRX-24)	Crest-stage recorder	6/26/80	Unscheduled	7/31/80 7/27/81 8/31/81 11/2/81	Event	
	(d) Section 25 (LRX-28)	Crest-stage recorder	6/26/80	Unscheduled	7/31/80 7/27/81 8/31/81 11/2/81	Event	
	(e) Sherman (LRX-35)	Crest-stage recorder	6/26/80	Unscheduled	7/31/80 7/27/81 8/31/81 11/2/81	Event	
	(f) Portage Creek (LRX-62)	Crest-stage recorder	6/25/80	Unscheduled	9/6/80 11/11/80 7/27/81 11/2/81	Event	

SUSITNA HYDROELECTRIC PROJECT
Subtask 3.03 - Hydrology Field Observation Log

Status As of: December 15, 1981

Parameter Measured	Station Location	Type of Instrument Used	Date of Installation	Observation Frequency	Dates of Observation	Type of Observation	Comments
(3) River Crest Stage* (Susitna River) (Continued)	(g) Devil Canyon Upper	Crest-stage recorder	6/25/80	Unscheduled	7/31/80 5/24/81 5/31/81 7/31/81 9/3/81 9/17/81	Event	
	(h) Devil Creek (URX-121)	Crest-stage recorder	5/24/80	Unscheduled	7/81/81 9/3/81 11/2/81	Event	
	(i) Watana Dam (URX-106.3)	Crest-stage recorder	7/30/80 10/01/80	Unscheduled	7/28/81 9/3/81 11/2/81	Event	
	(j) Deadman Creek (URX-101)	Crest-stage recorder	7/30/80	Unscheduled	7/28/81 9/3/81 11/2/81	Event	
(4) River Stage (Susitna River)	(a) Devil Canyon	Staff Gauge	3/25/81	Unscheduled	3/30/81 4/14/81 5/1/81 5/8/81 5/14/81 5/24/81 5/31/81 6/2/81 6/6/81 7/27/81 7/31/81 8/5/81 8/6/81 8/10/81 8/12/81 9/3/81 9/4/81 9/17/81	Event	Observations are made periodically by field personnel.

SUSITNA HYDROELECTRIC PROJECT
Subtask 3.03 - Hydrology Field Observation Log

Status As of: December 15, 1981

Parameter Measured	Station Location	Type of Instrument Used	Date of Installation	Observation Frequency	Dates of Observation	Type of Observation	Comments
(4) River Stage (Susitna River) (Continued)	(b) Watana Damsite	Staff Gauge	4/16/81	Unscheduled	5/7/81 5/21/81 6/1/81 6/3/81 6/9/81 6/10/81 7/28/81 8/5/81 8/12/81	Event	
	(c) Denali Bridge	Staff Gauge	5/31/81	Daily	-	Scheduled	Daily observations by personnel of the Denali Mining Company.
(5) Water Quality (1,2)*	(a) Susitna River near Watana Damsite	Martek Water Quality Data Logger	10/23/80	Continuous	10/23/80-4/16/81, 5/21/81-7/2/81, 8/5/81-Present	Scheduled	Damage to cable caused loss of all but temperature data for period to 7/2/81. Instrument repaired and factory - calibrated in 7/81. Appears to be functioning normally at present. D.O. sensor not working properly from 10/?/81 to 11/3/81.
	(b) Susitna River near Cantwell (Vee Canyon Site)	VWR pH Meter YSI DO Meter YSI S-C-T Meter Van Dorn Sampler Imhoff Cones	N/A	Summer: monthly Winter: 2-3 months	6/19/80	Scheduled	Spring break-up.
					8/8/80	Scheduled	Summer high-flow period (sampled by helicopter).
					9/5/80	Scheduled	Summer low-flow period.
					9/17/80	Sched/Event	Right after heavy rainstorm (post-peak).
					10/17/80	Scheduled	During river freeze-up.
					1/13/81	Scheduled	Winter through-ice sampling.
					5/20/81	Scheduled	After ice breakup, spring.
					6/30/81	Sched/Event	Summer hydrograph - falling limb.

SUSITNA HYDROELECTRIC PROJECT
Subtask 3.03 - Hydrology Field Observation Log

Status As of: December 15, 1981

Parameter Measured	Station Location	Type of Instrument Used	Date of Installation	Observation Frequency	Dates of Observation	Type of Observation	Comments
(5) Water Quality (1,2)* (Continued)	(b) Susitna River near Cantwell (Vee Canyon Site)				8/2/81	Event	Summer hydrograph - - rising limb.
					8/3/81	Event	Summer hydrograph - peak.
					8/3/81	Event	Summer hydrograph - falling limb.
					9/15/81	Scheduled	Summer low-flow period.
					10/7/81	Scheduled	During river freeze-up.
	(c) Susitna River at Gold Creek	Same as at Vee Canyon	N/A	Summer: monthly Winter: 2-3 months	8/8/80	Scheduled	Summer high-flow period (sampled by helicopter).
					10/14/80	Scheduled	During river freeze-up.
					1/14/81	Scheduled	Winter through-ice sampling.
					5/27/81	Scheduled	After ice break-up, spring. (Sampled same day by USGS).
					6/30/81	Sched/Event	Summer hydrograph - peak.
					7/1/81	Sched/Event	Summer hydrograph - falling limb.
					8/2/81	Event	Summer hydrograph - peak.
					8/3/81	Event	Summer hydrograph - falling limb.
					9/14/81	Scheduled	Summer low-flow period.
					9/17/81	Scheduled	Samples taken for quality - control check of laboratory.
					10/8/81	Scheduled	During river freeze-up.
(6) Suspended Sediment Discharge	(a) Susitna River near Cantwell (Vee Canyon Site)	Point-integrating Suspended Sediment Sampler	N/A	Summer: monthly Winter: 2-3 months	9/5/80	Scheduled	Summer low-flow period.
					9/17/80	Sched/Event	Right after heavy rainstorm (post-peak).
					10/18/80	Scheduled	During river freeze-up.
					1/13/80	Scheduled	Winter through-ice sampling.
					5/20/81	Scheduled	After ice break-up, spring.

SUSITNA HYDROELECTRIC PROJECT
Subtask 3.03 - Hydrology Field Observation Log

Status As of: December 15, 1981

Parameter Measured	Station Location	Type of Instrument Used	Date of Installation	Observation Frequency	Dates of Observation	Type of Observation	Comments
(6) Suspended Sediment Discharge	(a) Susitna River near Cantwell (Vee Canyon Site)				6/30/81	Sched/Event	Summer hydrograph - falling limb.
					8/2/81	Event	Summer hydrograph - rising limb.
					8/3/81	Event	Summer hydrograph - peak.
					8/3/81	Event	Summer hydrograph - falling limb.
					9/15/81	Scheduled	Summer low-flow period.
	(b) Susitna River at Gold Creek	Same as at Vee Canyon	N/A	Summer: monthly Winter: 2-3 months	10/16/80	Scheduled	During river freeze-up.
					1/14/81	Scheduled	Winter through-ice sampling.
					5/27/81	Scheduled	After ice break-up, spring.
					6/30/81	Sched/Event	Summer hydrograph - peak.
					7/1/81	Sched/Event	Summer hydrograph - falling limb.
					8/2/81	Event	Summer hydrograph - peak.
					8/3/81	Event	Summer hydrograph - falling limb.
					9/14/81	Scheduled	Summer low-flow period.
(7) Climate (3)*	(a) Watana Camp	MRI Weather Wizard (WW)	3/13/80	Continuous (15-min.)	4/8/80-Present	Scheduled	**
	(b) Devil Canyon	MRI Weather Wizard	7/17/80	Continuous (15-min.)	7/17/80-Present	Scheduled	**
	(c) Kosina Creek	MRI Weather Wizard	8/25/80	Continuous (15-min.)	8/25/80-Present	Scheduled	**
	(d) Tyone River	MRI Weather Wizard	8/27/80	Continuous (15-min.)	8/27/80-Present	Scheduled	**
	(e) Denali (Susitna Lodge)	MRI Weather Wizard	7/18/80	Continuous(15-min.)	7/18/80-Present	Scheduled	**
	(f) Susitna Glacier	MRI Weather Wizard	7/20/80	Continuous (15-min. or 30-min.)	7/20/80-Present	Scheduled	**

** Occasional gaps in data records due to mechanical or electronic malfunctions or other field problems. Data summaries prepared by MRI for period to 7/1/81. Summaries for more recent data are being prepared by R&M.

SUSITNA HYDROELECTRIC PROJECT
Subtask 3.03 - Hydrology Field Observation Log

Status As of: December 15, 1981

Parameter Measured	Station Location	Type of Instrument Used	Date of Installation	Observation Frequency	Dates of Observation	Type of Observation	Comments
(8) Snow Density and Depth (4)*	(a) West Fork Glacier Snow Course	Carpenter Machine Works Snow Sampling Kit Aerial Snow Markers	8/26/80, 8/81	Winter: monthly	01/07/81 2/2-2/3/81 3/6/81 4/2/81 4/30/81	Scheduled	Three aerial markers on and around the glacier.
	(b) Susitna Glacier Snow Course	Same as at West Fork	8/28/80, 9/4/80, 8/81	Winter: monthly	1/7/81 2/2-2/3/81 3/6/81 4/2/81 4/30/81	Scheduled	Three aerial markers on and around the glacier (three of original six markers mov to better locations in 8/81).
	(c) East Fork Glacier Snow Course	Same as West Fork	9/4/80, 8/81	Winter: monthly	1/7/81 2/2-2/3/81 3/6/81 4/2/81 4/30/81	Scheduled	Five aerial markers on and around the glacier (including two additional markers placed on the ice in 8/81).
	(d) Butte Creek Pass	Aerial Snow Markers	9/11/80	Winter: monthly	2/2/81 3/6/81 4/1/81 4/30/81	Scheduled	One aerial marker in vicinity of Butte Creek Pass (two of original three markers removed and used elsewhere).
(9) Ice Buildup during Precipitation*	(a) Watana Camp	Steel Plate	11/80	Unscheduled	Same dates as any winter trip to Watana Camp	Event	Measurements to be made during or immediately al freezing rain. No observed freezing rain to date.
	(b) Denali (Susitna Lodge)	Steel Plate	11/80	Unscheduled	Same dates as Denali climate station runs	Event	Same as at Watana Camp.
(10) In-Cloud Icing (Ice Buildup on Transmission Line)*	(a) Watana Camp	Short Section of Transmission Line	9/10/80, 10/16/80	Unscheduled	Same dates as any winter trip to Watana Camp	Event	Measurements to be made during or immediately after icing conditions. No in-cloud icing has been observed to date.

SUSITNA HYDROELECTRIC PROJECT
Subtask 3.03 - Hydrology Field Observation Log

Status As of: December 15, 1981

Parameter Measured	Station Location	Type of Instrument Used	Date of Installation	Observation Frequency	Dates of Observation	Type of Observation	Comments
(10) In-Cloud Icing (Ice Buildup on Transmission Line)*	(b) Denali (Susitna Lodge)	Short Section of Transmission Line	9/11/80, 10/20/80	Unscheduled	Same dates as Denali climate station runs	Event	Same as at Watana Camp.
(11) Snow Creep*	(a) Watana Camp	Dillon Dynamometer Section of Transmission Line Tower	2/26/81	Winter: monthly	3/6/81 3/16/81 4/1/81 10/2/81 11/3/81 12/2/81	Scheduled	Installed on a north-facing slope about 2 miles west of Tsusena Butte.
	(b) Devil Canyon	Dillon Dynamometer Section of Transmission Line Tower	2/25/81	Winter: monthly	3/5/81 3/16/81 3/31/81 10/2/81 11/3/81 12/3/81	Scheduled	Installed on a north-facing slope near the Devil Canyon climate station.
(12) Ice Thickness and Competence*	Susitna River and Tributaries (5)	Ice Auger Measuring Tape	N/A	Winter	2/27/81	Scheduled	Ice thickness surveys were conducted at all CSR locations, except at Section 25 and the Susitna-Chulitna confluence. See parameter (3).
					4/1/81	Scheduled	Adjacent to Watana Strea... gauge and in conjunction with through-ice discharge measurements.
(13) Extent of Ice Cover, Locations of Ice Jams*	Susitna River	SLR Camera	N/A	Daily or weekly during Freeze-up and Break-up	10/80 11/80, 12/80 1/81, 2/81 3/81, 4/81 5/81 10/2/81, 10/6/81, 10/29/81, 11/6/81, 11/18/81, 12/14/81	Event	Black & white aerial photos taken 11/14/80, 12/5/80, 4/27/81, 5/6/81.

SUSITNA HYDROELECTRIC PROJECT
Subtask 3.03 - Hydrology Field Observation Log

Status As of: December 15, 1981

Parameter Measured	Station Location	Type of Instrument Used	Date of Installation	Observation Frequency	Dates of Observation	Type of Observation	Comments
(14) Glacial Composition and Movement (6)	Susitna Glacier, West Fork Glacier, Turkey Glacier, West Fork Susitna Glacier	Survey Equipment SLR Camera Aerial Photography	5/17-5/18/81 5/30/81	Monthly through July, August, September	5/81 7/30/81 8/11/81 9/2/81	Scheduled	Velocity points, camera mounts and thermocouple were installed. Horizontal control net establish and initial survey conducted. Extensive snow depth and density studies throughout glacier network were conducted.
(15) Evaporation	Watana Camp	Monel, Class A Standard Weather Bureau Evaporation Pan	5/7/81	Daily, May-Sept.		Scheduled	Daily observations recorded by camp personnel.
(16) Icing Detector*	Watana Camp	Rosemount Ice Detector with electronic counter	12/5/80	Continuous	1/7/81 2/3/81 3/6/81 3/31/81 4/30/81 6/1/81	Scheduled	Any interruption of AC power is recorded as one count. Counter observed during site visits. No significant amount of icing has been recorded to date.
(17) Bedload Transport*	(a) Susitna River @ Gold Creek	Helley-Smith Sampler	-	Unscheduled	7/22/81 8/26/81 9/28/81	Event	***
	(b) Talkeetna River near Talkeetna	Helley-Smith Sampler	-	Unscheduled	7/21/81 8/25/81 9/29/81	Event	***
	(c) Chulitna River near Talkeetna	Helley-Smith Sampler	-	Unscheduled	7/22/81 8/25/81 9/29/81	Event	***
	(d) Susitna River near Sunshine	Helley-Smith Sampler	-	Unscheduled	7/22/81 8/26/81 9/30/81	Event	***

*** Bedload sampling done jointly and in cooperation with the USGS. The July trip was done at a relatively high flow level, the August one at an intermediate of Susitna River flow level, and the September trip at a relatively low flow.

SUSITNA HYDROELECTRIC PROJECT
Subtask 3.03 - Hydrology Field Observation Log

Status As of: December 15, 1981

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(18) Sequential Aerial Photography of Susitna River*	N/A	Olympus OM-2 Camera (35-mm film)		Unscheduled	11/14/80	Event	Freeze-up, Delta Island to Watana Creek.
					12/5/80	Event	Freeze-up, Cook Inlet to Watana Creek.
					4/27/81	Event	Break-up, Bell Island to Watana Creek.
					5/6/81	Event	Break-up, Bell Island to Curry.
					8/24/81	Event	Medium flow. Cook Inlet to Devil Canyon, for Vegetation Studies.
					10/19/81	Event	Low flow, Cook Inlet to Talkeetna Confluences, for Morphology Studies.

SUSITNA HYDROELECTRIC PROJECT
Subtask 3.03 - Hydrology Field Observation Log

NOTES:

* An asterisk after a parameter in column one (1) indicates that the entry for that parameter has been altered from the last log's entry.

(1) WQ parameters measured by the continuous water quality monitor: water temperature, dissolved oxygen, conductivity, pH, and oxidation - reduction potential.

(2) WQ parameters measured in the field: dissolved oxygen, water temperature, conductivity, pH, alkalinity, settleable solids, and free carbon dioxide.

(3) Climate parameters measured at each station: air temperature, average wind speed, wind direction, peak wind gust, relative humidity, precipitation, and solar radiation. Snowfall amounts will be measured in heated precipitation bucket at Watana only. Prior to 4/30/81, data were recorded at thirty (30) minute intervals at the Susitna Glacier station and at fifteen (15) minute intervals at all the other stations. Since that date, a 15-minute interval has been used at all stations.

(4) Dates of installation refer to aerial snow survey markers. The actual snow courses are located at one of the markers at each of the three glaciers. There is no snow course at Butte Creek Pass, only an aerial marker. Snow surveys are conducted concurrently at all the climate monitor locations, with the exception of the Susitna Glacier Station, where the snow course is at a more suitable location nearby.

(5) Several sites along the main stem of the Susitna and a few sites on the larger tributaries are to be observed.

(6) Dates of installation refer to snow survey markers.

(7) Last log prepared was as of 10/2/81.