# SUSITNA HYDROELECTRIC PROJECT

FEDERAL ENERGY REGULATORY COMMISSION
PROJECT No. 7114



# CASE E-VI ALTERNATIVE FLOW REGIME

VOLUME 2 - APPENDICES A THROUGH D

Final Report

February 1985
Document No. 2601



HARZA-EBASCO
SUSITNA JOINT VENTURE

ALASKA POWER AUTHORITY

Document No. 2601
Susitna File No. 6.18.7.5



# SUSITNA HYDROELECTRIC PROJECT

## CASE E-VI
## ALTERNATIVE FLOW REGIME

## VOLUME 2
## APPENDICES A THROUGH D

Report By
Harza-Ebasco Susitna Joint Venture



Prepared for
Alaska Power Authority

Final Report
February 1985

**Appendix A**

SUSITNA HYDROELECTRIC PROJECT

Summary of Resource Agency Meeting Minutes

November, December 1984

Note: Detailed copies of the minutes of these minutes are being sent to participant Agencies for review. An addendum to this Appendix will be issued if Agency representatives request changes.

Between 20 November, 1984 and 20 December, 1984 the Alaska Power Authority held a series of meetings with representatives from the state and federal resource agencies as well as project intervenors from the private sector. The purpose of these meetings was to present the rationale utilized in refining the flow regime, to compare and contrast the refined E-VI regime with both Case C and other regimes developed more recently, and to present, for agency and intervenor comment, the Power Authority's assessment of Case E-VI as its selected Project flow regime.

Minutes of these four meetings have been prepared and are being sent out for review and correction by those in attendance. In the absence of these final detailed minutes the following summary information is provided.

Meetings of November 20 and 27, 1984

A meeting was held on 20 November, 1984 for the purpose of discussing the process by which the Power Authority had arrived at Case E-VI as its preferred case. A second meeting was held on 27 November, 1984 to discuss the same topic with agency representatives unable to attend the earlier meeting. Attendees for the two meetings are listed below.

For the 20 November Meeting:

H. Hosking, USFWS
B. Smith, NMFS
D. Pruitt, USGS
D. Rosenberg, ADF&G
L. Latta, ADNR
C. Gorbics, USACE
J. Thrall, Harza-Ebasco
L. Gilbertson, Harza-Ebasco
W. Dyok, Harza-Ebasco
L. Polivka, Harza-Ebasco
H. Teas, Harza-Ebasco
E. Marchegiani, Power Authority

M. Granata, ADNR
G. Prokosch, ADNR
D. Wilkerson, ADEC
J. Lowenfels, BHBP&A
E. Myers
R. Fleming, Power Authority
T. Arminski, Power Authority

For the 27 November Meeting:

C. Yanagawa, ADF&G
D. McKay, ADF&G
D. Rosenberg, ADF&G
H. Hosking, USFWS
B. Bowker, USFWS
K. Middleton
W. Dyok, Harza-Ebasco
L. Gilbertson, Harza-Ebasco
J. Thrall, Harza-Ebasco
E. Marchegiani, Power Authority
R. Fleming, Power Authority

Materials presented and discussions were similar at both meetings. Therefore, the following are combined notes for the two meetings.

Dr. Fleming briefly explained the distinction between environmental flow requirements and project operation. Environmental requirements establish maximum and minimum flow limits for each week of the year within which project operation flows are constrained. Project operation flows are also guided by power and energy criteria and the volume of water available to the project.

Dr. Gilbertson presented information regarding development of alternative environmental flow requirements. Chum salmon spawning in side sloughs and chinook salmon rearing in side channels are considered the most critical and sensitive (re. project related changes) habitat utilization combinations for development of flow requirements. The other evaluation species and their habitats are less sensitive to flow changes and their needs would be protected by requirements based on chum spawning or chinook rearing. Further, the other evaluation species and their habitat utilizations will be included for detailed impact assessment and flow refinement during the general process of flow negotiations.

Eight sets of environmental requirements (flow cases) were developed based on habitat needs for chum spawning in side sloughs and chinook rearing in side channels. These flow cases are in addition to those presented in the License Application, and represent a refinement based on more complete information and better understanding of the Susitna River and its aquatic resources.

Dr. Gilbertson presented each of the eight flow cases and discussed their important characteristics. The eight cases were grouped into three categories as follows:

1. Cases to mitigate with flow for potential loss of chinook rearing in side channels.

2. Cases to mitigate with flow for potential loss of chum spawning in side sloughs.

3. Cases to mitigate with flow for both 1 and 2, above.

Primary characteristics of category 1 (above) are minimum flow requirements during the summer to maintain a desired quantity of rearing habitat, flow stability to improve habitat quality and maximum winter requirements for protection and stability of over-wintering sites in side sloughs.

Primary characteristics of category 2 are increased minimum flows during August and September to improve access conditions at slough mouths, spiking flows in August and/or September to improve slough access conditions, spiking flows in June to clear sediment and debris out of spawning sites, and maximum winter flows to protect spawning sites in sloughs.

The primary characteristics of category 3 are combinations of those for categories 1 and 2. Details presented for each flow case can be found in the Power Authority document, Evaluation of Alternative Flow Requirements (APA, November, 1984).

There was a general discussion of the flow cases by the meeting participants. The more important subjects are outlined below.

Mr. Dyok then presented the economic basis for the selection of Case E-VI. He explained that given the energy demand pattern and the annual hydroelectric energy potential from the Susitna project, a potential savings can be realized if energy can be stored and transferred from summer to winter. This occurs because additional winter energy generation allows for a reduction in required thermal generation capacity and for the displacement of thermal generation units that have higher fuel and operating costs per MWh of generation. Therefore, the operational strategy is to increase winter energy generation from the project until the same amount of thermal energy is produced each week of the year. However, if winter energy production is limited by the available Watana reservoir storage volume, more thermal energy will be produced in winter (October-April) than in summer (May-September). Since Susitna and other hydro projects would provide the difference between the system energy demand and the thermally supplied energy, more energy would be supplied by the Susitna project in winter than in summer.

Mr. Dyok discussed how the reservoir operations program attempts to satisfy the operational strategy while maintaining the Susitna River discharge at Gold Creek discharge within established environmental flow constraints. The reservoir operations program produces a time series of weekly flows and energies for a 34 year duration. The flows are analyzed for their environmental suitability and the average monthly and firm energies are input in the General Electric Optimized Generation Planning (OGP) model. The OGP model determines annual costs and the present worth of these annual costs for the life of the project.

Mr. Dyok presented graphs for a number of cases illustrating the discharges at which the flow for each week of the year would be exceeded 9-, 50-, and 94- percent of the time. He noted that the governing flow constraints on power production were generally the minimum summer flows and the maximum winter flows. Project winter flows will normally be less than the maximum flow constraint. Maximum power output and, consequently, maximum winter flows will only occur when Watana is operating alone and there is an emergency situation such as a sudden power outage from the loss of other generation units in the system.

Mr. Dyok next presented energy data for average and low flow conditions for Watana operation and Watana/Devil Canyon operation. He then described the generation capacity requirements and the present worth of the long term costs of the alternatives.

Following some discussion of Mr. Dyok's presentation, Dr. Gilbertson then discussed mitigation costs associated with representative flow cases for the Middle River reach. Flow cases designed to mitigate for chum spawning and flow regimes based only on power production would require a hatchery to replace chinook rearing habitat and various levels of slough modification for chum spawning. Flow cases designed to mitigate for chinook rearing would require slough modification for chum spawning. Flow cases designed to mitigate for both chinook rearing and chum spawning would require either no further mitigation or some slough modification depending on the flow requirements of each particular case.

Total project costs, including mitigation, were compared and Case E-VI was found to be the least-cost alternative. Case E-VI was selected by the Power Authority as the preferred alternative based on its total cost, including mitigation, and compatibility with mitigation policies.

A final discussion was held concerning the refinement process followed by the Power Authority in arriving at Case E-VI. It was agreed that additional documentation and/or explanation would be highly valuable to explain how the evaluation species (chum and chinook salmon) and critical habitats (chum spawning in sloughs and chinook rearing in side channels) were selected.

The Power Authority promised to provide this documentation in a follow-up meeting to be scheduled as soon as feasible.

Meeting of December 18, 1984

The meeting was held with representatives from various State and Federal agencies to discuss the Power Authority's selection of chum and chinook salmon as critical evaluation species for the project as requested during the November 20 and 27, 1984 presentations.

Those in attendance were:

Richard Fleming, APA
Jim Thrall, Harza-Ebasco
Hank Hosking, Fish and Wildlife Service
Tom Arminski, APA
Chris Godfrey, EPA
Brad Smith, NMFS
Dan Rosenburg, ADF&G
Gary Prokosch, ADNR
Leroy Latta, ADNR
Jeff Lowenfels, BHB
Larry Gilbertson, Harza-Ebasco
Phil Scordelis, Harza-Ebasco
Ben Rosenthal, NOAA.

Tom Arminski opened the meeting with a brief discussion of the process to reach negotiated settlement of a project flow regime. Mr. Arminski described the original process schedule and components (Figure 1a). Under this schedule the Instream Flow Relationships Report (IFRR) would provide the necessary framework and technical information to assess the aquatic habitat consequences of various project operation scenarios. This information would be used in the economic and environmental comparisons process to develop an "optimized" flow regime that provides a balance between economic and environmental objectives. The Power Authority would

Figure 1a

SUSITNA HYDROELECTRIC PROJECT

ORIGINAL FLOW REGIME SETTLEMENT PROCESS

**IFRR**

↓

**COMPARISONS** — **MARCH**

↓

**RFR** — **APRIL**

↓

**FLOW NEGOTIATIONS**

↓

**SETTLEMENT** — **AUGUST**

use this process to select a preferred flow regime and present it in a Recommended Flow Regime (RFR) report as their initial position to begin flow negotiations.

Mr. Arminski then described a revised process and schedule that the Power Authority intends to follow for flow negotiations (Figure 1b). The original and revised processes were contrasted by Mr. Arminski and Dr. Gilbertson. A major difference is the level of anticipated agency involvement prior to and during the economic and environmental comparisons process. A major reason for revising the flow negotiation process was to increase agency consultation. The Power Authority encourages agency participation in all steps leading toward a negotiated flow regime. Information, data and analyses will be incorporated into the process as they become available.

Dr. Gilbertson explained the rationale leading to the selection of chinook salmon rearing in side channels and chum salmon spawning in side sloughs as the most critical (most sensitive to mainstem flow) species/habitat combinations for initial evaluation of flow regimes. Alteration of mainstem flow will not effect all habitats equally. The degree of effect will depend on the level of influence mainstem flow has on characteristics of the habitats. Seven aquatic habitat types were evaluated for the effects of mainstem flow on five physical characteristics of the habitats (Table 1). Mainstem influence is minor for three habitat types. The remaining four, mainstem, side channel, tributary mouth and side slough were evaluated further.

Dr. Gilbertson continued his explanation by describing how the habitat types are utilized by the evaluation species. The evaluation species are listed in the left column of Table 2. The habitat uses noted in Table 2 are the dominant uses by each species. For example, chinook salmon juveniles may be found rearing in upland sloughs and at tributary mouths but this habitat use is minor and transient compared to the rearing habitats in side channels and side sloughs marked (x) in Table 2.

Figure 1b

SUSITNA HYDROELECTRIC PROJECT

REVISED FLOW REGIME SETTLEMENT PROCESS

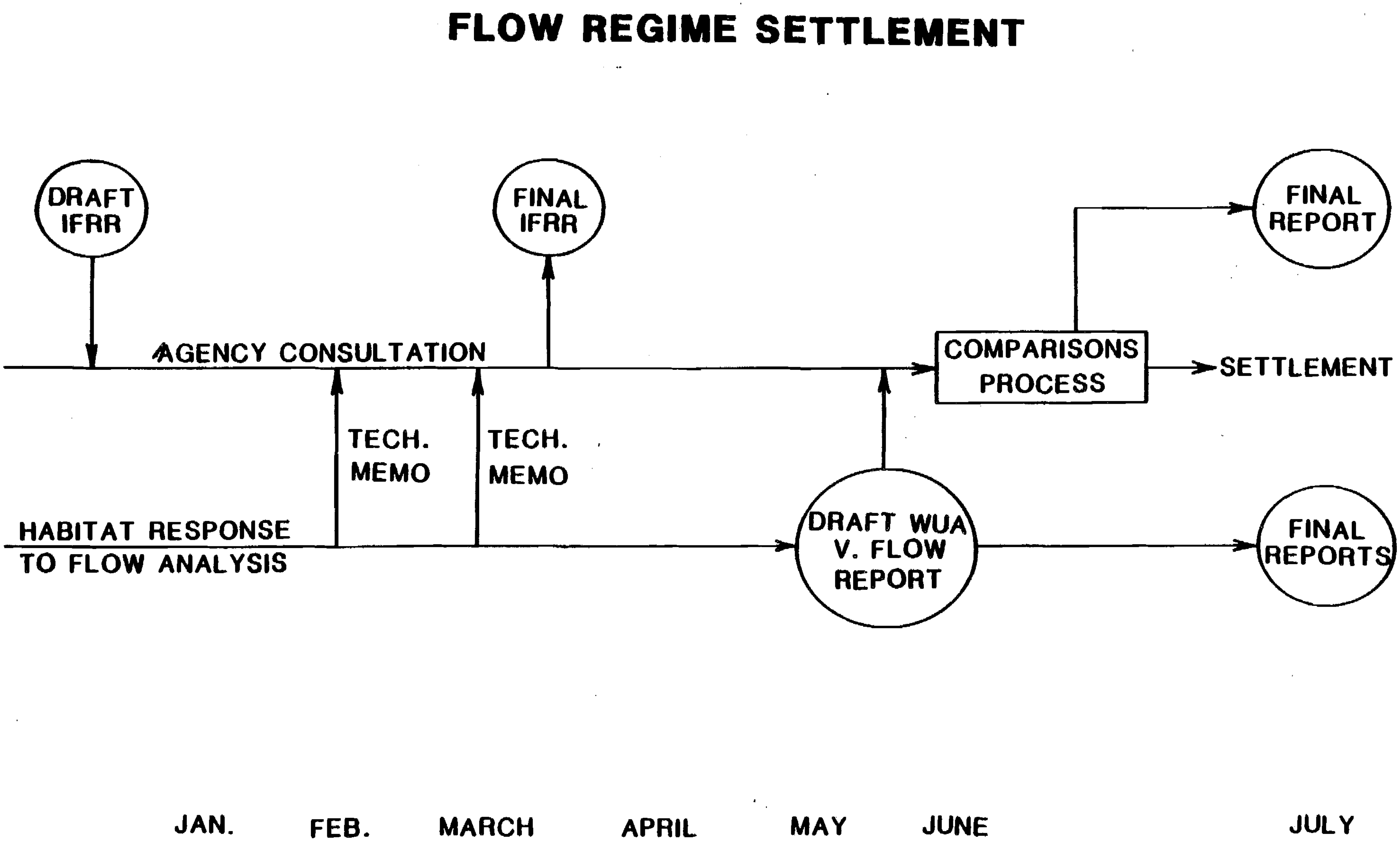


**Table 1**

SUSITNA HYDROELECTRIC PROJECT
INFLUENCE OF MAINSTEM FLOW ON SEVERAL
PARAMETERS OF ASSOCIATED HABITAT TYPES

| | Hydraulics | Hydrology | Temp. | Turbidity | Ice | Total |
|---|---|---|---|---|---|---|
| Mainstem (MS) | 4 | 4 | 4 | 4 | 4 | 20 |
| Side Channel (SC) | 3 | 4 | 4 | 3 | 4 | 18 |
| Tributary Mouth (TM) | 3 | 3 | 2 | 2 | 3 | 13 |
| Side Slough (SS) | 2 | 2 | 2 | 2 | 2 | 10 |
| Upland Slough (US) | 1 | 1 | 0 | 0 | 0 | 2 |
| Tributary (T) | 0 | 0 | 0 | 0 | 0 | 0 |
| Lake (L) | 0 | 0 | 0 | 0 | 0 | 0 |

0 - no influence
1 - small, limited influence
2 - moderate, occasional influence
3 - moderate, frequent influence
4 - direct, extensive, exclusive influence

## Table 2

SUSITNA HYDROELECTRIC PROJECT
USES OF SUSITNA RIVER HABITAT TYPES BY INDIGENOUS FISH SPECIES

| | MS | SC | TM | SS | US | T | L |
|---|---|---|---|---|---|---|---|
| **Chinook Salmon** | | | | | | | |
| Migrate | X | | X | | | X | |
| Spawn-incubate | | | | | | X | |
| Rear | | X | | X | | X | |
| **Coho Salmon** | | | | | | | |
| Migrate | X | | X | | | X | |
| Spawn-incubate | | | | | | X | |
| Rear | | | | | X | X | |
| **Chum Salmon** | | | | | | | |
| Migrate | X | X | X | X | | X | |
| Spawn-incubate | | X | | X | | X | |
| Rear | X | | | X | | X | |
| **Sockeye Salmon** | | | | | | | |
| Migrate | X | | | X | | | |
| Spawn-incubate | | | | X | | | |
| Rear | | | | X | X | | |
| **Pink Salmon** | | | | | | | |
| Migrate | X | | X | | | X | |
| Spawn-incubate | | | | | | X | |
| Rear | | | | | | | |
| **Arctic Grayling** | | | | | | | |
| Migrate | X | | | | | X | |
| Spawn-incubate | | | | | | X | |
| Rear | X | | X | | | X | |
| **Rainbow Trout** | | | | | | | |
| Migrate | X | | | | | X | |
| Spawn-incubate | | | | | | X | |
| Rear | X | | X | | | X | |
| **Burbot** | | | | | | | |
| Migrate | X | | | | | | |
| Spawn-incubate | X | | | | | | |
| Rear | X | | | | | | |
| **Dolly Varden** | | | | | | | |
| Migrate | X | | X | | | X | |
| Spawn-incubate | | | | | | X | |
| Rear | X | | | | | X | |

Habitat requirements for migration and movement are not as restrictive as for rearing or spawning/incubation. Depth and velocity requirements for migration and movement are provided over a wide range of mainstem flows and would be restrictive only at extreme low and high flows. Habitat requirements for rearing and spawning/incubation are more restrictive, and flows intended to provide for these uses would provide adequate conditions for migration and movement. Therefore, habitat utilization for rearing and spawning/incubation were focused on for further evaluation.

The four most sensitive habitat types were then compared as to their use by the evaluation species for rearing and spawning/incubation (Table 3). Use of the sensitive habitats for spawning/incubation is limited to chum and sockeye salmon, and burbot. Burbot populations in the Middle River are of low density and of lesser importance than chum and sockeye salmon. Sockeye salmon spawning in the Middle River is essentially limited to a few side sloughs that are also utilized by chum salmon for spawning. Approximately 1,500-2,000 sockeye spawn in the middle river side sloughs each year. Chum salmon utilize side slough sites more extensively. Approximately 3,000-5,000 spawn in the middle river side sloughs each year. Therefore, sockeye spawning sites, timing and habitat needs are so similar to the more abundant chum salmon that efforts to mitigate impacts for chum spawning/incubation would effectively mitigate impacts on sockeye. Thus, the most important use of the sensitive habitat types for spawning/incubation is by chum salmon.

The sensitive habitat types are used for rearing more commonly than for spawning/incubation (Table 3). However, the extent or importance of this utilization varies. Rearing in the sensitive habitat types by the resident species is mostly for overwintering. Use during the open water season is limited to tributary mouths and other clear water habitats, and appears to be associated with the presence of spawning salmon (salmon eggs are a food source for the resident species). The exception to this is burbot, which remain in the mainstem throughout the year. However, all the resident fish populations in the Middle River are characterized as small, low density

**Table 3**

SUSITNA HYDROELECTRIC PROJECT
PRIMARY UTILIZATION OF SENSITIVE HABITAT TYPES
BY EVALUATION SPECIES

| Evaluation Species | Habitat Types: Mainstem | Side Channel | Side Slough | Tributary Mouth |
|---|---|---|---|---|
| Chinook Salmon | | r | r | |
| Chum Salmon | r | s | s,r | |
| Coho Salmon | | | | |
| Sockeye Salmon | | | s,r | |
| Pink Salmon | | | | |
| Arctic Grayling | r | | | r |
| Rainbow Trout | r | | | r |
| Dolly Varden | r | | | |
| Burbot | s,r | | | |

s - spawning/incubation
r - rearing

69274/TBL
850124

populations that, with the exception of burbot, rely on tributary and lake habitats within the Susitna Basin for their major production.

Chum and sockeye salmon utilize side sloughs for initial, short-term rearing after emerging from spawning sites in the late spring. Sockeye gradually leave their natal side sloughs and move into upland sloughs for further rearing and overwintering. Most of this movement has occurred by early July. Chum salmon rear in their natal side sloughs prior to starting a general downstream movement to Cook Inlet. The chum begin moving out of the sloughs in May and are essentially out by July. The chum juveniles also utilize slack water (low velocity, moderate depth) areas during their downstream movement to Cook Inlet. This habitat use is limited to approximately June to mid-July , after which time they are essentially out of the Susitna system and into Cook Inlet.

Chinook salmon juveniles use side channels and side sloughs throughout the year for rearing and overwintering. Side sloughs are used most extensively during the winter, whereas side channels are used mostly during the open water months. The chinook juveniles are found in higher densities in side channels than side sloughs during July through mid-October. Habitat conditions in the side channels are directly influenced by mainstem flows, whereas side slough habitat is determined mostly by local and regional groundwater infiltration. Based on these considerations, chinook rearing in side channels was selected as the most critical use of the sensitive habitats for rearing.

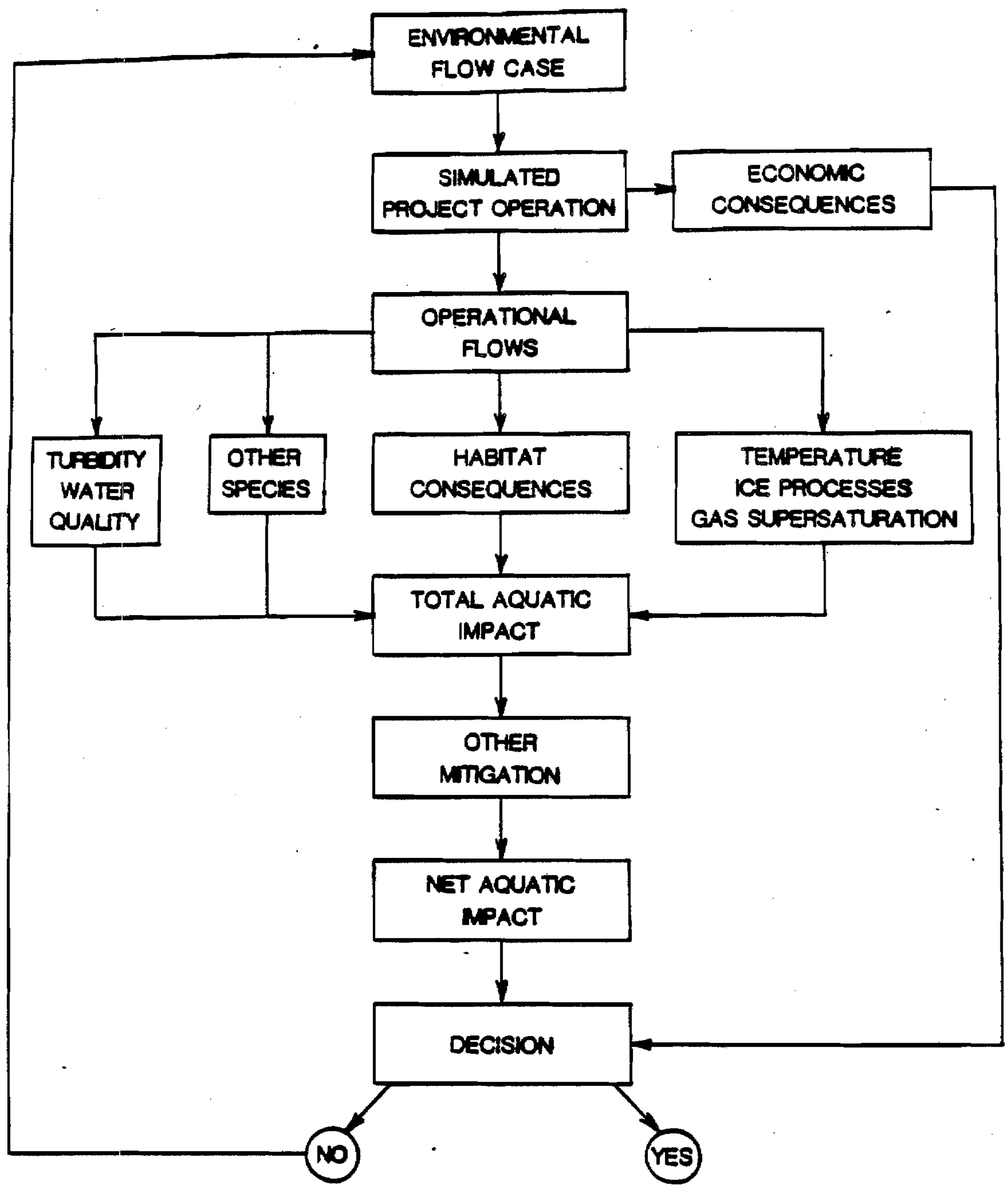
Chum salmon spawning in side sloughs and chinook salmon rearing in side channels were selected as the primary evaluation species/habitat combinations for initial designs and assessment of environmental flow requirements. The other evaluation species will be included in the overall process of flow regime refinement, impact assessment and mitigation planning.

Dr. Gilbertson then handed out a flow chart on the proposed process for flow regime refinement and selection (Figure 2). It describes how a simulation

Figure 2

SUSITNA HYDROELECTRIC PROJECT

FLOW REGIME COMPARISON PROCESS



of project operation under a particular set of environmental constraints leads to the production of a range of operational flows and how the habitat consequences of these flows are derived. This leads to the total aquatic impact, which is then mitigated through the use of other mitigation measures. The result is a net aquatic impact, which is used with other input to decide what flow regime is optimal for the project.

Dr. Gilbertson went on to discuss Figure 2. The water quality variables on the left side of the figure are not affected by operational flows, whereas those on the right (i.e. temperature, ice processes and gas supersaturation) are affected to some degree by the flow level. It was suggested that this flow chart be handed out to policy and decision makers so that they have a better understanding of how the process works. Hank Hosking commented that it seemed to be a very useful diagram and he recommended that this be done.

A general discussion of Dr. Gilbertson's presentation then followed. It was agreed that the material presented would be appropriate for the meeting scheduled for 20 December, 1984 at which upper level management personnel from both the agencies and the Power Authority would be in attendance.

Meeting of December 20, 1984

Those in attendance were:

| | |
|---|---|
| John C. Stafford | Alaska Power Authority |
| Bob Martin | ADEC/Anchorage |
| Dan Wilkerson | ADEC/Anchorage |
| Don McKay | ADF&G/Habitat |
| Carl Yanagawa | ADF&G/Habitat |
| Norman Cohen | ADF&G/Commissioner's Office |
| Dan Rosenberg | ADF&G |
| Ben Rosenthal | NOAA - Office of General Counsel, Alaska |
| Ted F. Meyers | NMFS/Juneau |
| Brad K. Smith | NMFS/Anchorage |
| Jim Thrall | Harza-Ebasco |
| Richard Fleming | Alaska Power Authority |
| Tom Arminski | Alaska Power Authority |
| Jeff Lowenfels | Alaska Power Authority |
| Gary Stackhouse | FWS/Anchorage |
| Keith Bayha | FWS/Anchorage |
| Carol Gorbics | Corps of Engineers |
| Hank Hosking | FWS |
| Chris Godfrey | EPA |
| Leroy Latta | DNW/DLWM/SCRO |
| Esther Wunnicke | DNR Commissioner |
| Jon Ferguson | Alaska Power Authority |
| Wayne Dyok | Harza-Ebasco |
| Joe Perkins | Alaska Power Authority |
| Charlotte Thomas | Harza-Ebasco |

Mr. Joe Perkins opened the meeting. He gave a brief history of the Susitna Project, including a description of the site. Conditional power sales agreements are planned to be signed by June 1985. The Power Authority considers a flow regime the most important variable in the project for two reasons: 1) it dictates how the project will be operated and thus is important to the financial feasibility of the project; and 2) it is the major environmental concern identified for the project. The final flow regime will incorporate the optimum balance of environmental and economic factors and considerations. The Power Authority wants the licensed flow regime to be one developed in Alaska.

The purpose of the meeting was to inform the agencies of the Power Authority's proposed flow regime and to invite comments, input and discussion of the proposed regime. Mr. Perkins emphasized the Power Authority's expectation of cooperation and the importance of an Alaskan flow regime decision.

Jeff Lowenfels outlined the FERC process and reminded those attending that the FERC decision will be based on 1) need for power and 2) environmental impacts.

Dr. Gilbertson presented a brief overview of the rationale and criteria used to develop and evaluate alternative environmental flow requirements. He discussed the three criteria used in developing flow requirements: 1) objective oriented; 2) emphasis on critical/sensitive habitats; and 3) compatibility with mitigation policy.

Dr. Gilbertson reminded those attending that the Susitna Project will have both the most impact and the most control in the Devil Canyon to Talkeetna (Middle River) reach of the Susitna River. He reviewed the middle river habitats and evaluation species and presented alternative flow cases, including Case E-VI which is the Power Authority's recommended case.

Case E-VI is recommended because:

1. It mitigates impacts on rearing habitats of chinook salmon and other species.

2. It is compatible with mitigation policies.

3. It retains the economic viability of the project.

Dr. Richard Fleming emphasized that other factors in addition to aquatic habitats (such as navigation and water quality) would be included in the development of a final flow regime.

Tom Arminski reviewed the following goals for an aquatic settlement:

1. agency consultation and endorsement

2. adoption of a balanced flow regime

3. resolution of non-flow-related aquatic issues

4. possible reduction of scope of FERC hearings

He presented an economic analysis of different flow cases indicating the economic effects of the various flow regimes. Case E-VI strikes an equitable balance between the use of the water for fisheries and for power generation.

Mr. Arminski outlined the flow refinement/adoption process and described the process for resolution of non-flow issues, e.g. effects of transmission lines on fisheries.

Ben Rosenthal of the National Marine Fisheries Service presented a proposed framework and procedures for settlement of issues (letter attached). Jeff Lowenfels responded that the Power Authority's goal is the same as that proposed by NMFS.

Bob Martin of ADEC asked which flow case the Power Authority was using in its negotiations with utilities. Wayne Dyok answered that Case E-VI was being used.

Norm Cohen asked how the flow regime issue would fit into the position papers process. Tom Arminski answered that position papers and the flow case refinement process were parallel.

A discussion followed regarding the process to be used in determining the flow regime to be proposed to FERC. The discussion centered around what agreement on one issue meant and how final would agreement on one issue be. It was agreed that sign off on one issue did not constitute final and complete agreement by an agency or intervenor. At the end of the process, the total picture would be considered, with a view of how all the issues fit together. The Power Authority expressed the confidence that only minor revisions would be needed at the end of the process.

Keith Bayha complimented the Power Authority on its consultation with agencies, noting the improvement over the past few years. He noted the workability of the process.

Norm Cohen of ADF&G asked when an agreement on the flow regime would take place in the process. The response was that it would be at the end rather than mid-process.

Richard Fleming commented that there was a difference between sufficient data for a decision and perfect information. He asked for the flexibility of the agencies regarding requests for data, keeping the difference in mind. Ben Rosenthal assured him that his agency was not asking for perfect data but rather was asking for data the Power Authority has so that the agency would understand how the Power Authority had arrived at its position.

Brad Smith, NMFS, assured the Power Authority that NMFS was not going to make unreasonable data requests, but would be asking for information the Power Authority already has.

Gary Stackhouse of FWS asked for consideration for agencies involved in the total project, including non-fisheries aspects. He would like to have information on that. Ted Meyers of NMFS asked for a written document of the procedures and process to be used in developing the flow regime to be submitted to FERC. The Power Authority committed themselves to providing that written information on the consultation process.

The meeting was adjourned by Joe Perkins at 11:30 a.m.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
*National Marine Fisheries Service*
*P.O. Box 1668*
*Juneau, Alaska 99802*

December 19, 1984

Larry Crawford
Executive Director
Alaska Power Authority
334 West 5th Avenue
Anchorage, Alaska 99501

Dear Mr. Crawford:

Staff of the NMFS have recently met with your staff to discuss the initiation of the issues resolution process for the Susitna Hydroelectric Project. Settlement discussions and inter-agency working group efforts are underway which are intended to meet the goal of no net loss of existing habitat value. Specific position papers are being developed for aquatic issues identified by your staff during 1983 and recently we have received a schedule indicating the release of those papers to the intervening groups.

Our agency acknowledges the desirability of resolving these issues outside of the formal hearing process prescribed by the FERC and will continue to work towards this goal. To accomplish this, a framework is necessary under which each issue could be effectively addressed and, whenever possible, resolved. We suggest that the following procedures might be adopted to achieve this purpose.

A. Issue Papers

Since meaningful discussion is dependant upon informed participants, it is necessary that any attempts at resolving issues not precede the release of the resolution papers. These papers should present the scope of impacts associated with each issue, describe the available data from research efforts, present practicable alternatives for minimizing impacts, and identify data gaps or additional data sources that will become available in the future. In the least, the issue paper should state the position of the applicant relative to the issue.

B. Initial Meeting

The APA will notify the interveners and concerned groups of the date of the initial meeting for each discrete issue. The interveners must be provided with the applicable issue papers and all necessary background reports at least two weeks prior to the initial meeting. In general, the purpose of this meeting will be to jointly review the issue paper in order to:

- scope the issue in question;
- identify data gaps (i.e. information unavailable to the interveners);
- review methodologies and all available information;
- when sufficient information exists to achieve resolution, agree on the format for and scope of resolution (i.e. discuss the interrelationship of the subject issue to the other remaining issues and limit the scope of its coverage so that it would not substantively impact the other respective issues).

C. Follow Up Meeting

Follow up meetings would be held as necessary to review iterations of the issue paper, discuss additional pertinent data or issues and incorporate recommended changes developed during the initial meeting. Such a meeting could be scheduled to allow the interveners and concerned groups sufficient time to review any new material. In general, one purpose for such a meeting would be to assure that integration of intervener and concerned group comment was occurring. Draft language will be developed reflecting the resolution of each specific issue and the concurrence of participants. Such language will later be incorporated into a proposed offer of settlement, discussed below.

D. Actual Resolution

Actual resolution will occur after discussion of all issue papers. Aquatic resolutions will be embodied in a proposed offer of settlement which will be negotiated among the APA and the concerned interveners in additional meetings. The proposed offer of settlement will contain the draft provisions which were elicited from those concerned in earlier discussions. Since one draft provision may affect the total agreement and additional issues not addressed earlier may develop during the settlement process, this draft language will be subject to revision at such meetings if necessary. The proposed offer of settlement as we envision it will contain monitoring language, be contingent on FERC incorporating it into its license as conditions to the license, and submitted to FERC as provided in 18 CFR § 385.602. No participant will be precluded from presenting before FERC its views concerning any matters not discussed or agreed to in the settlement process including but not limited to any impasses reached, any issues unforeseen during negotiation or any new data or information developed.

This suggested framework is presented in the spirit of cooperation and hopefully it will inspire the same from all concerned.

Sincerely,

Robert W. McVey
Director, Alaska Region
National Marine Fisheries Service

# Appendix B

## SUSITNA HYDROELECTRIC PROJECT

Resource Agency Comments

on

"Evaluation of Alterntive Flow Requirements"

(Harza-Ebasco 1984)

# United States Department of the Interior

FISH AND WILDLIFE SERVICE
Western Alaska Ecological Services
Sunshine Plaza, Suite 2B
411 W. 4th Avenue
Anchorage, AK 99501


IN REPLY REFER TO:
WAES


RECEIVED
JAN 4 1985
ALASKA POWER AUTHORITY


02 JAN 1985

Mr. Jon S. Ferguson, Project Manager
Susitna Hydroelectric Project
Alaska Power Authority
334 West 5th Avenue
Anchorage, AK 99501

Re: Susitna Hydroelectric Project
Alternative Flow Requirements Report

Dear Mr. Ferguson:

This responds to the Alaska Power Authority (APA) letter of 7 December 1984, and transmits U. S. Fish and Wildlife Service (FWS) comments pertaining to the subject report, dated 12 November 1984.

Operation of this project will seasonally alter water flows in the Susitna River and could adversely impact fish populations. Winter flows will be higher than natural flows as electrical demands increase during the winter. Summer discharges will be lower than natural flows as power demands decrease and runoff water is stored. The APA has the objective of balancing water releases with demands for electricity and the biological requirements of anadromous and resident fish species in the Susitna River.

In the mainstem flow evaluation process, the APA has relied upon field observations and computer modeling to determine the habitat requirements of indigenous species by phenological parameters. Although the data submitted are incomplete, the FWS supports the intent of the APA to mitigate fishery impacts through water releases and side slough habitat modifications. However, it is the intention of the FWS to withhold final approval of a flow regime and mitigation plan until all currently scheduled data reports are received and reviewed, and all agencies' concerns are successfully resolved.

Sincerely,

Robert Bowker

Field Supervisor

cc: NMFS, ADF&G, ADNR, ~~ADEG~~, ~~Anchorage~~

File No. 6.18.4.9
Resp. [illegible]
Keywords FWS
Aquatic
mitigation

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, ALASKA
POUCH 898
ANCHORAGE, ALASKA 99506-0898

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RECEIVED
JAN 11 1985
ALASKA POWER AUTHORITY

REPLY TO ATTENTION OF
Regulatory Branch
Special Actions Section

RECEIVED
JAN 14 1985
ALASKA POWER AUTHORITY

Larry D. Crawford
Executive Director
Alaska Power Authority
334 West 5th Avenue
Anchorage, Alaska 99501

Dear Mr. Crawford:

This is in reference to your December 20, 1984 meeting and report, "Evaluation of Alternative Flow Requirements," on the Susitna Hydroelectric project. Although I could not attend the meeting, my staff found it informative and helpful.

The process you have used to develop your flow regime appears to be thorough, and the strategy you have developed for finalizing the fisheries/management mitigation and impact assessment should be effective.

As you know, I will be making a permit decision on this project subsequent to the release of the final Environmental Impact Statement and the appropriate permit review. That decision will be based on a review of public and agency comments, as well as an internal review of your project. Although our internal review of your project has been ongoing through the past year, through our review of your various documents, attendance at workshops, and review of your staff application, the final position on your proposed project will be my permit decision. That decision cannot be made until the appropriate public notice and review process has been completed.

Although I am supportive of your strategy for settling the various issues over the next year, I am not in a position to make a formal commitment on any particular item. I will, however, continue to provide my staff's involvement in that process to raise concerns and/or issues which would involve the Corps responsibilities and our permitting authority.

File No. 6.18.4.15
Resp. TJM
Keywords Aquatic
Flow
Settlement

DEPARTMENT OF ENVIRONMENTAL CONSERVATION

# MEMORANDUM State of Alaska

OFFICE OF THE COMMISSIONER

TO: Larry Crawford
Executive Director
Alaska Power Authority

DATE: December 26, 1984

DEC 2 : 1984
ALASKA POWER AUTHORITY

FILE NO:

TELEPHONE NO:

FROM: Bob Martin, P.E.
Special Assistant to
the Commissioner

SUBJECT: Evaluation of Alternative Flow Requirements

In reviewing the "Evaluation of Alternative Flow Requirements" report prepared by Harza-Ebasco, Dated October 1984, the Department commends the Alaska Power Authority for accomplishing an evaluation of alternative flow regimes. Although the Alaska Power Authority has chosen the alternative flow strategy E-6 as the preferred management scheme, the Department is not prepared at this time to recommend any of the alternatives as presented. There are a number of other issues related to water quality which have yet to be fully addressed by the Alaska Power Authority. These were identified in an issues list prepared by the A.P.A., March 6, 1984, and include concerns such as temperature changes, turbidity, gas supersaturation and pH. However, anticipated position papers reviewing these issues have not yet been made available for review.

We believe that the flow regulation regime that is adopted can have substantial impact on downstream water quality conditions. Before the Department can advise on a preferred flow regime, the resource agencies need the opportunity to clarify the various water quality issues in conjunction with instream flow strategies. We anticipate that these concerns will be addressed in the near future by the A.P.A. in concert with the respective resuorce agency technical staff representatives. We will be happy to work with the Power Authority and other affected resource agencies in resolving these concerns.

BM/DW/dd

cc: Richard A. Neve, Commissioner, ADEC, Juneau
Chris Noah, Deputy Commissioner, ADEC, Juneau
Keith Kelton, Director ADEC-EQ, Juneau
Carl Yanagawa, ADF&G, Anchorage

XC: J. Perkins
J. Ferguson
B. Pethie

Should you have any questions concerning this information, please feel free to contact me. Should your staff have any questions, please contact Ms. Carol Gorbics of my Regulatory Branch, Special Actions Section at (907) 753-2724.

Sincerely,

Leroy L. Saage
Lieutenant Colonel, Corps of Engineers
Acting District Engineer

# Appendix C

## SUSITNA HYDROELECTRIC PROJECT

Status of License Application Figures and Tables

Related to Case E-VI

- Table C-1 . . . Figures
- Table C-2 . . . Tables
- References

APPENDIX C

TABLE C-1

STATUS OF LICENSE APPLICATION FIGURES AND TABLES RELATED TO CASE E-VI

NOTE: Exhibit E, Chapter 2 of the FERC License Application (February, 1983) contained 222 Figures numbered E.2.1 through E.2.222. The following list presents the status of those figures that have been affected since the original License Application, by the Case E-VI flow regime refinement; additional data; and by refined river-, reservoir-, and ice-temperature analyses.

| Original Figure Number | Current Status | Table or Figure No. This Report | Related Text This Report | Other Comments (Reference List pp. C-7, C-8) |
|---|---|---|---|---|
| E.2.7 | Superseded | | | Ref. No. 2,3 |
| E.2.8 | Superseded | | | Ref. No. 2,3 |
| E.2.10 | Superseded | | | Ref. No. 2,3 |
| E.2.39 | No Change | Tables E-11, E-12<br>Figures E-2, E-3 | 3.3.1 | Additional Data Provided |
| E.2.40 | No Change | Tables E-13, E-14<br>Figures E-4, E-5 | 3.3.1 | Additional Data Provided |
| E.2.130 | Revised | Figures 2.3-1, 2.3-2, 2.3-3 | 2.3 | Same as Table E.2.34 |
| E.2.136 | Revised | Table 4.1-1 | 4.1/4.2 | Same as Table E.2.36 |
| E.2.138 | Revised | Figure 4.1-1 | 4.1 | Same as Table E.2.37 |
| E.2.139 | Not Applicable to E-VI | | 4.1 | Applies Only to Case C |
| E.2.141 | Superseded | | 3.4 | Ref. No. 9 |
| E.2.142 | Superseded | | 3.4 | Ref. No. 9 |

Table C-1 (Cont'd)

| Original Figure Number | Current Status | Table or Figure No. This Report | Related Text This Report | Other Comments (Reference List pp. C-7, C-8) |
|---|---|---|---|---|
| E.2.143 | Superseded | | 3.4 | Ref. No. 9 |
| E.2.144 | Superseded | | 3.4 | Ref. No. 9 |
| E.2.145 | Superseded | | 3.4 | Ref. No. 9 |
| E.2.146 | Superseded | | 3.4 | Ref. No. 9 |
| E.2.149 | Revised | Figure 3.3-6 | 3.3.1 | |
| E.2.150 | Revised | Figure 3.3-7, 3.3-8, 3.3-9 | 3.3.1 | |
| E.2.151 | Revised | Exhibit E-18 | | Ref No. 2, 3 |
| E.2.152 | Revised | Exhibit E-19 | | Ref No. 2, 3 |
| E.2.153 | Revised | Exhibit E-20 | | Ref No. 2, 3 |
| E.2.156 | Revised | Tables E-1, E-5, E-8 | 3.3.1 | |
| E.2.157 | Revised | Tables E-1, E-5, E-8 | 3.3.1 | |
| E.2.158 | Revised | Tables E-1, E-5, E-8 | 3.3.1 | |
| E.2.159 | Revised | Exhibit E-2, E-6 | 3.3.1 | |
| E.2.160 | Revised | Exhibit E-3, E-7 | 3.3.1 | |
| E.2.161 | Revised | Exhibit E-4, E-8 | 3.3.1 | |
| E.2.162 | Revised | Exhibit E-5, E-9 | 3.3.1 | |
| E.2.163 | Not applicable to Case E-VI | | 3.3.1 | Applies only to Case C |
| E.2.165 | Superseded | | | Ref. No. 4,5 |
| E.2.166 | Superseded | | | Ref. No. 4,5 |
| E.2.167 | Superseded | | | Ref. No. 4,5 |
| E.2.170 | Superseded | | | Ref. No. 4,5 |
| E.2.171 | Superseded | | | Ref. No. 4,5 |

Table C-1 (Cont'd)

| Original Figure Number | Current Status | Table or Figure No. This Report | Related Text This Report | Other Comments (Reference List pp. C-7, C-8) |
|---|---|---|---|---|
| E.2.172 | Superseded | Exhibits G-1, G-2 | 3.4.1 | Ref. No. 8 also new data this report |
| E.2.173 | Superseded | Exhibit G-1 | 3.4.1 | " " " |
| E.2.174 | Superseded | Exhibit G-1 | 3.4.1 | " " " |
| E.2.175 | Superseded | Exhibit G-1 | 3.4.1 | " " " |
| E.2.176 | Superseded | Exhibits G-3, G-5 | 3.4.1 | Ref. No. 9 also new data this report |
| E.2.177 | Superseded | Exhibits G-3, G-5 | 3.4.1 | " " " |
| E.2.178 | Superseded | Exhibits G-3, G-5 | 3.4.1 | " " " |
| E.2.179 | Superseded | Exhibits G-3, G-5 | 3.4.1 | " " " |
| E.2.180 | Obsolete | | 3.4.1 | Not to be replaced |
| E.2.181 | Obsolete | | 3.4.1 | Not to be replaced |
| E.2.182 | Obsolete | | 3.4.1 | Not to be replaced |
| E.2.183 | Obsolete | | 3.4.1 | Not to be replaced |
| E.2.184 | Superseded | Exhibits G-6, G-8 | 3.4.1 | Ref. No. 10 |
| E.2.185 | Superseded | Exhibits G-6, G-8 | 3.4.1 | Ref. No. 10 |
| E.2.191 | Revised | Figures 3.3-20, 3.3-23 | 3.3.2 | |
| E.2.192 | Revised | Figures 3.3-21, 3.3-24 | 3.3.2 | |
| E.2.193 | Revised | Figures 3.3-7, 3.3-25, 3.3-26, 3.3-28 | 3.3.2 | |
| E.2.194 | Revised | Figures 3.3-27, 3.3-29 | 3.3.2 | |
| E.2.195 | Revised | Exhibits F-22, F-25 | 3.3.2 | |
| E.2.196 | Revised | Exhibits F-23, F-26 | 3.3.2 | |
| E.2.197 | Revised | Exhibits F-24, F-27 | 3.3.2 | |
| E.2.200 | Revised | Tables F-1, F-7 | 3.3.2 | |
| E.2.201 | Revised | Tables F-1, F-7 | 3.3.2 | |
| E.2.202 | Revised | Tables F-1, F-7 | 3.3.2 | |

Table C-1 (Cont'd)

| Original Figure Number | Current Status | Table or Figure No. This Report | Related Text This Report | Other Comments (Reference List pp. C-7, C-8) |
|---|---|---|---|---|
| E.2.203 | Revised | Tables F-1, F-10 | 3.3.2 | |
| E.2.204 | Revised | Tables F-1, F-10 | 3.3.2 | |
| E.2.205 | Revised | Tables F-1, F-10 | 3.3.2 | |
| E.2.206 | Revised | Exhibits F-2, F-7 | 3.3.2 | |
| E.2.207 | Revised | Exhibits F-3, F-8 | 3.3.2 | |
| E.2.208 | Revised | Exhibits F-4, F-9 | 3.3.2 | |
| E.2.209 | Revised | Exhibits F-5, F-10 | 3.3.2 | |
| E.2.210 | Revised | Exhibits F-6, F-11 | 3.3.2 | |
| E.2.211 | Not Applicable to Case E-VI | | 3.3.2 | Applies Only to Case C |
| E.2.212 | Revised | Figures 3.3-15, 3.3-22 | 3.3.2 | |
| E.2.213 | Superseded | Exhibit H-1 | 3.4.2 | Ref. No. 8 |
| E.2.214 | Superseded | Exhibit H-1 | 3.4.2 | Ref. No. 8 |
| E.2.215 | Superseded | Exhibit H-1 | 3.4.2 | Ref. No. 8 |
| E.2.216 | Superseded | Exhibit H-1 | 3.4.2 | Ref. No. 8 |
| E.2.217 | Superseded | Exhibits H-3, H-5 | 3.4.2 | Ref. No. 9 |
| E.2.218 | Superseded | Exhibits H-3, H-5 | 3.4.2 | Ref. No. 9 |
| E.2.219 | Obsolete | | 3.4.1 | Not to be replaced |
| E.2.220 | Obsolete | | 3.4.1 | Not to be replaced |
| E.2.221 | Obsolete | | 3.4.1 | Not to be replaced |
| E.2.222 | Obsolete | | 3.4.1 | Not to be replaced |

APPENDIX C

TABLE C-2

STATUS OF LICENSE APPLICATION TABLES RELATED

TO CASE E-VI

NOTE: Exhibit E, Chapter 2 of the FERC License Application (February, 1983) contained 58 Tables of data, numbered E.2.1 through E.2.58. The following list presents the status of those tables that have been affected since the original License Application, by the Case E-VI flow regime refinement; additional data; and by refined river-, reservoir-, and ice-temperature analyses.

| Original Table Number | Current Status | Table or Figure No. This Report | Related Text This Report | Other Comments (Reference List pp. C-7, C-8) |
|---|---|---|---|---|
| E.2.5 | Obsolete | | 3.2.1 | |
| E.2.6 | Superseded | Table D-1 | 3.2.1 | |
| E.2.7 | Superseded | Table D-2 | 3.2.1 | |
| E.2.8 | Superseded | Table D-6 | 3.2.1 | |
| E.2.9 | Superseded | Table E-2 | 3.2.1 | |
| E.2.10 | Superseded | Table E-3 | 3.2.1 | |
| E.2.15 | Superseded | | | Ref. No. 2,3,7 (AQR067) |
| E.2.27 | Revised | | | Ref. No. 6,7 (AQR025 and AQR026) |
| E.2.34 | Revised | Table 3.1-1 | 2.3/3.1 | Table B.54 Ref. No. 1 |
| E.2.36 | Revised | Table 4.1-1 | 4.0 | |
| E.2.37 | Revised | Table 4.1-3 | 4.1 | |
| E.2.38 | Revised | Table 4.1-4 | 4.1 | |
| E.2.39 | Revised | Table 4.1-2 | 4.1 | |
| E.2.40 | Revised | | 3.2 | |

Table C-2 (Cont'd)

| Original Table Number | Current Status | Table or Figure No. This Report | Related Text This Report | Other Comments (Reference List pp. C-7, C-8) |
|---|---|---|---|---|
| E.2.41 | Revised | | 3.2 | |
| E.2.42 | Revised | Tables E-5, E-8 | 3.3.1 | |
| E.2.43 | Revised | Tables E-15, E-19 F-17, F-22 | 3.3.1/3.3.2 | |
| E.2.44 | Revised | Tables E-5, E-8 | 3.3.1 | |
| E.2.45 | Revised | Tables E-16, E-20 F-19, F-24 | 3.3.1/3.3.2 | |
| E.2.46 | Revised | Tables E-6, E-9 | 3.3.1 | |
| E.2.47 | Revised | Tables E-17, E-21 F-20, F-25 | 3.3.1/3.3.2 | |
| E.2.48 | Revised | Tables E-7, E-10 | 3.3.1 | |
| E.2.49 | Revised | Tables E-18, E-22 F-21, F-29 | 3.3.1/3.3.2 | |
| E.2.50 | Revised | Tables 3.3-1, 3.4-1 3.4-2, E-5, E-8 | 3.3.1/3.4 | |
| E.2.51 | Revised | | 3.2.3 | |
| E.2.52 | Revised | Tables F-6, F-9 | 3.3.2 | |
| E.2.53 | Revised | Tables F-7, F-10 | 3.3.2 | |
| E.2.54 | Revised | Tables F-7, F-10 | 3.3.2 | |
| E.2.55 | Revised | Tables F-18, F-23 | 3.3.2 | |
| E.2.56 | Revised | Tables F-8, F-11 | 3.3.2 | |
| E.2.57 | Revised | Tables F-8, F-11 | 3.3.2 | |
| E.2.58 | Revised | Tables 3.3-2, 3.4-3 3.4-4, F-6, F-7, F-9, F-10 | 3.3.2 | |

APPENDIX C

LIST OF REFERENCES

No. 1 Acres American, Inc., 1983 (February). Susitna Hydroelectric Project, Application for License for Major Project, Vol. 2, Exhibit B, prepared for the Alaska Power Authority.

No. 2 Harza-Ebasco Susitna Joint Venture. 1984 (January). Water Surface Profiles and Discharge Rating Curves for Middle and Lower Susitna River, Volume 1, Draft Report to Alaska Power Authority.

No. 3 Harza-Ebasco Susitna Joint Venture. 1984 (January). Water Surface Profiles and Discharge Rating Curves for Middle and Lower Susitna River, Volume 2, Draft Report to Alaska Power Authority.

No. 4 Harza-Ebasco Susitna Joint Venture. 1984 (January). Eklutna Lake Temperature and Ice Study (With Six Months Simulation for Watana Reservoir), prepared for the Alaska Power Authority.

No. 5 Harza-Ebasco Susitna Joint Venture. 1984 (April). Eklutna Lake Temperature and Ice Study (With Six Months Simulation for Watana Reservoir), Final Report to Alaska Power Authority.

No. 6 Harza-Ebasco Susitna Joint Venture. 1984 (April). Reservoir and River Sedimentation, Final Report to Alaska Power Authority.

No. 7 Alaska Power Authority. 1984 (August). Alaska Power Authority Comments on the Federal Energy Regulatory Commission Draft Environmental Impact Statement of May 1984; Volume 2B, Technical Comments - Aquatic Resources.

No. 8 Alaska Power Authority. 1984 (August). Alaska Power Authority Comments on the Federal Energy Regulatory Commission Draft Environmental Impact Statement of May 1984; Volume 6, Appendix IV - Temperature Simulations, Watana and Devil Canyon Reservoirs.

No. 9 Alaska Power Authority. 1984 (August). Alaska Power Authority Comments on the Federal Energy Regulatory Commission Draft Environmental Impact Statement of May 1984; Volume 7, Appendix V - Temperature Simulations, Susitna River Watana Dam to Sunshine Gaging Station, Open Water.

No. 10 Alaska Power Authority. 1984 (August). Alaska Power Authority Comments on the Federal Energy Regulatory Commission Draft Environmental Impact Statement of May 1984; Volume 8, Appendix VI - River Ice Simulations, Susitna River, Watana Dam to Confluence of Susitna and Chulitna Rivers.

## Appendix D

**SUSITNA HYDROELECTRIC PROJECT**

STREAM FLOW TIME SERIES

Susitna River at

Watana and Devil Canyon

(Harza-Ebasco 1985)

SUSITNA HYDROELECTRIC PROJECT

SUSITNA RIVER AT WATANA AND DEVIL CANYON
STREAMFLOW TIME SERIES

Report by
Harza-Ebasco Susitna Joint Venture

Prepared for
Alaska Power Authority

February, 1985

# TABLE OF CONTENTS

## LIST OF TABLES

## LIST OF EXHIBITS

.REAMFLOW TIME SERIES
SUSITNA RIVER AT WATANA AND DEVIL CANYON

## 1.0 SUMMARY

This report presents the results of a study made to update the monthly and 7-day streamflow sequences at the Watana and Devil Canyon dam sites. The updated steamflow series are given in Tables 1 through 4.

## 2.0 BACKGROUND

Acres American Incorporated (ACRES) generated 32 years (1950-1981) of monthly and 7-day streamflow series at the Watana and Devil Canyon sites (Acres, 1982). The monthly streamflow series were derived using the streamflow data of the Susitna River at Gold Creek and at Cantwell. The resulting monthly series averages 7955 and 9056 cubic feet per second (cfs) at Watana and Devil Canyon respectively. The 7-day series were based on data at Gold Creek Station. The resulting 7-day series averages 8201 and 9198 cfs at Watana and Devil Canyon respectively.

R&M Consultants, Incorporated (R&M) and Dr. W.D. Harrison of the University of Alaska, have investigated probable monthly contributions of glaciers to the recorded streamflow at Gold Creek for the months of June through September. They constructed five scenarios of monthly streamflows for Watana based on different assumptions of glacier contributions.

## 3.0 SCOPE OF THE STUDY

The major work items of the present study include:

1. Review ACRES' procedures used for generation of streamflow series at the two dam sites and modify these procedures, if necessary;

2. Review the study made by R&M and Dr. Harrison on the contribution to streamflow by glaciers, and adopt the most appropriate estimates for possible use in analyzing sensitivity of glacier waste on energy production;

3. Add flow data for the water years 1982 through 1984; and

4. Estimate net reservoir evaporation for use in the reservoir operation study.

## 4.0 REVIEW OF ACRES STUDY

Streamflow series generated by ACRES at the two dam sites are discussed below. Comments and necessary improvements to these time series also are discussed.

### 4.1 STREAMFLOW EXTENSION

ACRES selected a common base period of 30 years (1950 to 1979) for the monthly streamflow series and used the available streamflow data at eight stream gaging stations (Exhibit 1) to estimate missing monthly flows at each station. An in-house computer program, based on the program FILL-IN developed by the Texas Water Development Board (1970) was used in estimating the data. The periods for which observed data were available and the periods for which the data were estimated are shown on Exhibit 1.

The FILL-IN computer program is based on a multi-site regression technique which analyzes monthly streamflow series and estimates missing data. The program evaluates statistical parmeters (means, standard deviations, lag one auto-correlation coefficients and multi-site spatial correlation coefficients) and estimates missing data in which the statistical parameters are preserved.

The primary objective of ACRES' analysis was to generate 30 years of monthly streamflow sequences at the Cantwell stream gaging station. These data were used with those at the Gold Creek stream gaging station to estimate flows at the two dam sites. A comparison of the statistical parameters of recorded and filled-in data series at Cantwell, provided by ACRES (1982), indicates nearly the same statistical parameters in both cases. Therefore, the 30-year streamflow series at Cantwell is considered acceptable. The monthly streamflows at Cantwell and at Gold Creek are given in Tables 5 and 6.

## 4.2 STREAMFLOW TRANSPOSITION

ACRES derived the monthly streamflow series at the two dam sites using the following relationships:

$$Q_{DC} = 0.827\ (Q_G - Q_C) + Q_C \qquad \text{I}$$

$$Q_W = 0.515\ (Q_G - Q_C) + Q_C \qquad \text{II}$$

in which

$Q_{DC}$ = Monthly flow at Devil Canyon

$Q_W$ = Monthly flow at Watana

$Q_G$ = Monthly flow at Gold Creek;

$Q_C$ = Monthly flow at Cantwell

The coefficient of 0.827 is the ratio of the drainage areas between Cantwell and Devil Canyon to that between Cantwell and Gold Creek. Similarly, the coefficient of 0.515 is the ratio of the drainage areas between Cantwell and Watana to that between Cantwell and Gold Creek.

Transposition of flows by drainage area ratios is acceptable if there is no significant variation in seasonal or annual precipitation amounts over the two areas. This was examined by using a mean annual precipitation map (Exhibit 2) developed by the Soil Conservation Service (SCS 1981). The mean-annual precipitation amounts (MAP) upstream of Watana and Devil Cayon are about 37.4 and 36.8 inches, respectively. The MAP upstream of Gold Creek is about 36.6 inches. The differences in the MAPs upstream of the three locations are insignificant. Therefore, no adjustments to the estimated streamflows for differences in precipitation are required.

The relationships given in equations I and II were not used to generate 7-day flow sequences. Instead, ACRES computed the 7-day streamflow series at each site by multiplying the observed 7-day flows at Gold Creek with the ratio between the drainage areas upstream of the site and that upstream of Gold Creek. The flows at Cantwell were not used because the 7-day flows were not generated at Cantwell for the missing period of record at the station.

Since ACRES used different methods to generate the monthly and 7-day streamflow series, a check was made to evaluate the differences in the streamflow data if the monthly flows also were generated by using the method adopted for the 7-day flows.

For a few selected years, the flows transposed by this method are about 3 to 10 percent higher than those generated by using equations I and II. The accuracy of streamflow records at the two gaging stations is fair to good with a probable error of $\pm 5$ to $\pm 10$ percent (USGS). Since the difference in the monthly and 7-day flow series are within this accuracy, both series would normally be considered acceptable for reservoir operation studies.

However, reservoir operating guidelines are now being refined to optimize project economic feasibility and to establish environmental flow constraints at Gold Creek under various power demand scenarios. Total energy production is being estimated for both monthly and weekly reservoir operation studies. The previous streamflow sequences give inconsistent results in energy production because of the discrepancies in the intervening[1/] flows derived from monthly and 7-day flow sequences. Therefore, computations were made to revise the 7-day flow sequences at the two damsites to provide consistent energy production between the weekly and monthly operation studies. The monthly flow sequences were assumed to be correct.

## 4.3 PROCEDURE FOR REVISING 7-DAY FLOW SEQUENCES

The 7-day flow sequences at Cantwell, Gold Creek and the other six stations used by ACRES (Acres, 1982) to estimate missing monthly flows at Cantwell, were reviewed. The purpose was to ascertain whether the computer program FILL-IN could be used to generate the missing weekly data at Cantwell and whether the generated data would produce consistent intervening flows with 7-day flows generated using equations I and II. It was concluded that, because of poor correlation among various stream gaging stations based on 7-day flow sequences, the estimated flows at Cantwell and consequently at the two damsites were unlikely to provide the same intervening flows as derived from monthly flow sequences. Therefore, the following procedure was used to revise 7-day streamflow sequences.

1. Assume monthly streamflow sequences derived for the Watana and Devil Canyon damsites using equations I and II are correct;

2. Compute intervening flows for each month;

3. Compute 7-day intervening flow sequences from the monthly intervening flow sequences using the pattern of observed 7-day flow sequences at Gold Creek;

---

[1/] The term intervening flows means the flow coming solely from the drainage basin between the dams and Gold Creek.

4. Compute 7-day flow sequences at the damsites by subtracting the intervening flows, computed in step 3 above, from the observed 7-day flow sequence at Gold Creek;

5. Compute monthly flow sequences at the damsites using 7-day flow sequences derived in step 4 above;

6. Compare the monthly flow sequences derived in step 5 above with those derived by using equations I and II. Some discrepancies were noticed;

7. Adjust 7-day flow sequences derived in step 4 above until the monthly flow sequences based on 7-day flow sequences match with the monthly flow sequences based on equations I and II.

The above procedure provided the same intervening flows from the monthly and 7-day flow sequences when compared on a monthly basis. In each water year, the 7-day flow sequence starts from the first of October. The flow for the last 7-day period of September is the sum of 8-day flows divided by 7. In leap years, the flow on the 29th of February was neglected since it is generally insignificant. To compute monthly flows from 7-day flows, the flow for a part of a week falling in a given month was prorated according to the number of days falling in that month.

## 4.4 ADJUSTMENT TO 1969 STREAMFLOW

For the period from 1950 to 1979, the lowest mean annual flow occurred in 1969. ACRES made a frequency analysis of mean annual flows at Gold Creek and estimated a return period of more than 1,000 years for the 1969 (water year) flows. Since ACRES accepted a return period of 30 years for the selection of allowable reservoir drawdown and firm energy, the observed 1969 mean annual flow of 5,561 cubic feet per second (cfs) was replaced by a 30-year low flow estimated to be about 7,200 cfs. The monthly flows were then derived using this value and the ratios of long term mean monthly and annual flows. The recorded monthly streamflows at Cantwell also were replaced by a 30-year low flow. The resulting 1969 streamflows at Gold Creek and Cantwell were used to compute the corresponding flows at the two dam sites.

The 1969 streamflows included in Tables 1 through 4 of this report are those based on observed records to preserve the sample distribution of historical data.

## 5.0 GLACIER CONTRIBUTION

Dr. W.D. Harrison and R&M have made a preliminary study of glacier contributions to streamflows at Gold Creek. The study resulted in five scenarios of streamflows at Gold Creek each corresponding to one of the following assumptions.

1. Glaciers were assumed to have net zero loss during the 1949-80 period, but there were annual variations in the waste. Annual contributions during the period were estimated using the Tangborn runoff-precipitation model (Tangborn, 1980, 1983) and used to adjust the recorded flows. The resulting flow series represents the conditions of zero contributions from the glaciers in each year.

2. Glaciers were assumed to have wasted 25 meters (82 feet) during the 1949-80 period. Annual contributions were estimated using the Tangborn model, and used to adjust the recorded flows.

3. Glaciers were assumed to have wasted 45 meters (148 feet) during the 1949-80 period. Annual contributions were estimated using the Tangborn model, and used to adjust the recorded flows.

4. Glaciers were assumed to have wasted 25 meters (82 feet) during the 1949-80 period. Annual contributions were estimated using the Tangborn model, and used to adjust the flow series resulting from Case 1.

5. Glaciers were assumed to have wasted 45 meters (148 feet) during the 1949-1980 period. Annual contributions were estimated using the Tangborn model, and used to adjust the flow series resulting from Case 1.

The Tangborn model computes annual glacier balances by relating measured precipitation amounts and annual mass balance of glacier with differences in runoff between a glacierized basin and a nearby non-glacierized basin. R&M computed the model parameters using data for one glacierized basin, Phelan Creek draining Gulkana Glacier, and two non-glacierized basins listed below:

| Non-glacierized Basin | Index Precipitation Station |
|---|---|
| Ship Creek | Talkeetna |
| Ship Creek | Gulkana |
| Caribou Creek | Talkeetna |
| Caribou Creek | Gulkana |

The resulting estimate of annual contribution by the glaciers was distributed in the months of June through September based on average monthly temperatures at Talkeetna and a base temperature of 43°F for thawing degree days, allowing for a lapse rate of about 3°F per 1000 feet between Talkeetna and the glaciers. The differences in monthly contributions between Cases 1 and 2 (scenario 4) and Cases 1 and 3 (scenario 5) for the period 1950-79 are given in Table 8. The values in this table can be subtracted from those in Table 1 to obtain adjusted streamflows for Watana reflecting, respectively, 25 and 45 meters (82 and 148 feet) of net glacial waste during the 1949-80 period.

The estimate of 45 meters (148 feet) of glacial waste during the 1949-80 period was based on two sets of photos taken in 1949 and 1980. Since the photos were taken without vertical and horizontal controls and the analysis was made only for East Fork Glacier which constitutes only five percent of glaciers in the basin, the estimate of 45-meters (148 feet) waste is uncertain. In view of this, R&M made another assumption of 25-meter (82 feet) waste in the computation. A brief water balance analysis based on available mean annual isohyetal maps of the basin and streamflows records at the Susitna River near Denali and the MacLaren River near Paxson indicated that the glacial waste during the 1949-80 period is more likely to be in the order of 22 meters (72 feet).

Currently, pertinent data are not available to verify the estimated historic waste or mass balance of the Susitna glaciers. Regardless of how much effort is made to reconstitute historical wastes of the glaciers, the resulting estimates would be highly uncertain. However, in the absence of any better information, the glacier contributions as estimated by R&M and Dr. Harrison (Table 8) could be used through a sensitivity analysis to evaluate their effects on power production. The streamflow series at Watana adjusted for these contributions are given in Table 9. However, the contribution from the glaciers has been completely removed or greatly reduced in the adjusted series shown in this table. There is no established evidence that such a situation will occur when the Susitna project is placed in operation.

## 6.0 RESERVOIR EVAPORATION

Net evaporation from the Watana and Devil Canyon reservoirs is estimated to be negligible. The procedures used in the estimation are discussed below. Pan evaporation data near the Susitna River basin are available at McKinley Park, elevation 2,070 feet above mean sea level (ft, msl) and the Matanuska Agricultural Experiment Station, elevation 150 ft, msl. These data are given in Tables 10 and 11, respectively.

Based on normal pool elevation of the Watana reservoir (about 2,185 ft, msl) and a comparison of monthly temperatures at Watana and McKinley Park (Table 12), the pan evaporation data at McKinley Park is considered applicable for Watana. The mean monthly evaporations for June and July at this station are about 82 percent of those at Matanuska. Using this as an adjustment factor, the long term mean monthly pan evaporation for Watana was computed as shown in Table 13.

R&M measured pan evaporation at Watana from May 8 through August 31, 1981. The June through August evaporation was about 9.42 inches (R&M, 1982a). The long term evaporation for the corresponding period is 9.5 inches (Table 13). Table 14 indicates sub-freezing temperatures at Watana for the months of October through April. Because of ice cover over the reservoir, evaporation during these months would be negligible. The mean annual pan evaporation is, therefore, about 14.7 inches (Table 13).

Lake evaporation for the months of May through September was computed using a pan coefficient of 0.7 (see Table 13). This gives May through September lake evaporation of about 10.4 inches. This value is close to the R&M's estimate of 10 inches of reservoir evaporation at Watana (R&M, 1982a).

Precipitation data at Watana are available since May 1980 (Table 14). This period is too short to compute long-term mean precipitation and mean net reservoir evaporation. The mean annual precipitation at Watana was estimated to be about 30 inches from Exhibit 2.

Monthly distribution of precipitation at Matanuska and McKinley Park are given in Table 15. The May through September precipitation is 63 and 67 percent of the annual precipitation. Other precipitation stations near the Susitna basin also show percentages close to these values.

Using McKinley percentages and 30 inches of annual precipitation at Watana, the monthly precipitation at Watana was estimated as given in Table 13.

E cept for the month of May, the monthly precipitation amounts are significantly higher than the estimated lake evaporation.

Net evaporation from a reservoir can be estimated by the difference between evaporation from the reservoir surface and evapotranspiration from the same area prior to construction of the dam. A comparison of the estimated annual reservoir evaporation with annual evapotranspiration as represented by the difference between precipitation and runoff (in depth of water) indicated that net reservoir evaporation loss for Watana would be in the order of one to two inches which represents a reduction of 4 to 8 cfs from the mean annual flow. This is negligible compared to the mean annual flow of about 8,000 cfs.

Devil Canyon reservoir is located under the same general climatic conditions as Watana, except at lower elevations. Therefore, net reservoir evaporation at this site also can be assumed to be negligible.

TABLE 1

MONTHLY STREAMFLOW AT WATANA

(CFS)

| | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1950 | 4719.9 | 2083.6 | 1168.9 | 815.1 | 641.7 | 569.1 | 680.1 | 8655.9 | 16432.1 | 19193.4 | 16913.6 | 7320.4 |
| 1951 | 3299.1 | 1107.3 | 906.2 | 808.0 | 673.0 | 619.8 | 1302.2 | 11649.8 | 18517.9 | 19786.6 | 16478.0 | 17205.5 |
| 1952 | 4592.9 | 2170.1 | 1501.0 | 1274.5 | 841.0 | 735.0 | 803.9 | 4216.5 | 25773.4 | 22110.9 | 17356.3 | 11571.0 |
| 1953 | 6285.7 | 2756.8 | 1281.2 | 818.9 | 611.7 | 670.7 | 1382.0 | 15037.2 | 21469.8 | 17355.3 | 16681.6 | 11513.5 |
| 1954 | 4218.9 | 1599.6 | 1183.8 | 1087.8 | 803.1 | 638.2 | 942.6 | 11696.8 | 19476.7 | 16983.6 | 20420.6 | 9165.5 |
| 1955 | 3859.2 | 2051.1 | 1549.5 | 1388.3 | 1050.5 | 886.1 | 940.8 | 6718.1 | 24881.4 | 23787.9 | 23537.0 | 13447.8 |
| 1956 | 4120.3 | 1588.1 | 1038.6 | 816.9 | 754.8 | 694.4 | 718.3 | 12953.3 | 27171.8 | 25831.3 | 19153.4 | 13194.4 |
| 1957 | 4208.0 | 2276.6 | 1707.0 | 1373.0 | 1189.0 | 935.0 | 945.1 | 10176.2 | 25275.0 | 19948.9 | 17317.7 | 14841.1 |
| 1958 | 6034.9 | 2935.9 | 2258.5 | 1480.6 | 1041.7 | 973.5 | 1265.4 | 9957.8 | 22097.8 | 19752.7 | 18843.4 | 5978.7 |
| 1959 | 3668.0 | 1729.5 | 1115.1 | 1081.0 | 949.0 | 694.0 | 885.7 | 10140.6 | 18329.6 | 20493.1 | 23940.4 | 12466.9 |
| 1960 | 5165.5 | 2213.5 | 1672.3 | 1400.4 | 1138.9 | 961.1 | 1069.9 | 13044.2 | 13233.4 | 19506.1 | 19323.1 | 16085.6 |
| 1961 | 6049.3 | 2327.8 | 1973.2 | 1779.9 | 1304.8 | 1331.0 | 1965.0 | 13637.9 | 22784.1 | 19839.8 | 19480.2 | 10146.2 |
| 1962 | 4637.6 | 2263.4 | 1760.4 | 1608.9 | 1257.4 | 1176.8 | 1457.4 | 11333.5 | 36017.1 | 23443.7 | 19887.1 | 12746.2 |
| 1963 | 5560.1 | 2508.9 | 1708.9 | 1308.9 | 1184.7 | 883.6 | 776.6 | 15299.2 | 20663.4 | 28767.4 | 21011.4 | 10800.0 |
| 1964 | 5187.1 | 1789.1 | 1194.7 | 852.0 | 781.6 | 575.2 | 609.2 | 3578.8 | 42841.9 | 20082.8 | 14048.2 | 7524.2 |
| 1965 | 4759.4 | 2369.2 | 1070.3 | 863.0 | 772.7 | 807.3 | 1232.4 | 10966.0 | 21213.0 | 23235.9 | 17394.1 | 16225.6 |
| 1966 | 5221.2 | 1565.3 | 1203.6 | 1060.4 | 984.7 | 984.7 | 1338.4 | 7094.1 | 25939.6 | 16153.5 | 17390.9 | 9214.1 |
| 1967 | 3269.8 | 1202.2 | 1121.6 | 1102.2 | 1031.3 | 889.5 | 849.7 | 12555.5 | 24711.9 | 21987.3 | 26104.5 | 13672.9 |
| 1968 | 4019.0 | 1934.3 | 1704.2 | 1617.6 | 1560.4 | 1560.4 | 1576.7 | 12826.7 | 25704.0 | 22082.8 | 14147.5 | 7163.6 |
| 1969 | 3135.0 | 1354.9 | 753.9 | 619.2 | 607.5 | 686.0 | 1261.6 | 9313.7 | 13962.1 | 14843.5 | 7771.9 | 4260.0 |
| 1970 | 2403.1 | 1020.9 | 709.3 | 636.2 | 602.1 | 624.1 | 986.4 | 9536.4 | 14399.0 | 18410.1 | 16263.8 | 7224.1 |
| 1971 | 3768.0 | 2496.4 | 1687.4 | 1097.1 | 777.4 | 717.1 | 813.7 | 2857.2 | 27612.8 | 21126.4 | 27446.6 | 12188.9 |
| 1972 | 4979.1 | 2587.0 | 1957.4 | 1670.9 | 1491.4 | 1366.0 | 1305.4 | 15973.1 | 27429.3 | 19820.3 | 17509.5 | 10955.7 |
| 1973 | 4301.2 | 1977.9 | 1246.5 | 1031.5 | 1000.2 | 873.9 | 914.1 | 7287.0 | 23859.3 | 16351.1 | 18016.7 | 8099.7 |
| 1974 | 3056.5 | 1354.7 | 931.6 | 786.4 | 689.9 | 627.3 | 871.9 | 12889.0 | 14780.6 | 15971.9 | 13523.7 | 9786.2 |
| 1975 | 3088.8 | 1474.4 | 1276.7 | 1215.8 | 1110.3 | 1041.4 | 1211.2 | 11672.2 | 26689.2 | 23430.4 | 15126.6 | 13075.3 |
| 1976 | 5679.1 | 1601.1 | 876.2 | 757.8 | 743.2 | 690.7 | 1059.8 | 8938.8 | 19994.0 | 17015.3 | 18393.5 | 5711.5 |
| 1977 | 2973.5 | 1926.7 | 1687.5 | 1348.7 | 1202.9 | 1110.8 | 1203.4 | 8569.4 | 32352.8 | 19707.3 | 16807.3 | 10613.1 |
| 1978 | 5793.9 | 2645.3 | 1979.7 | 1577.9 | 1267.7 | 1256.7 | 1408.4 | 11231.5 | 17277.2 | 18385.2 | 13412.1 | 7132.6 |
| 1979 | 3773.9 | 1944.9 | 1312.6 | 1136.8 | 1055.4 | 1101.2 | 1317.9 | 12369.3 | 22904.8 | 24911.7 | 16670.7 | 9096.7 |
| 1980 | 6150.0 | 3525.0 | 2032.0 | 1470.0 | 1233.0 | 1177.0 | 1404.0 | 10140.0 | 23400.0 | 26740.0 | 18000.0 | 11000.0 |
| 1981 | 6632.0 | 3044.0 | 1790.0 | 1858.0 | 1592.0 | 1262.0 | 1641.0 | 14416.0 | 16739.0 | 27601.0 | 30542.0 | 11669.0 |
| 1982 | 5700.0 | 2650.0 | 1863.0 | 1700.0 | 1234.0 | 898.0 | 1190.0 | 10879.0 | 21444.0 | 20445.0 | 13206.0 | 13890.0 |
| 1983 | 5154.0 | 2132.0 | 1893.0 | 1797.0 | 1610.0 | 1427.0 | 1565.0 | 11672.0 | 20401.0 | 18761.0 | 20863.0 | 11192.0 |
| 1984 | 6821.0 | 2657.0 | 1939.0 | 1782.0 | 1742.0 | 1697.0 | 1654.0 | 10937.0 | 22958.0 | | | |

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TABLE 2

MONTHLY STREAMFLOW AT DEVIL CANYON

(CFS)

| | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1950 | 5758.2 | 2404.7 | 1342.5 | 951.3 | 735.7 | 670.0 | 802.2 | 10490.7 | 18468.6 | 21383.4 | 18820.6 | 7950.8 |
| 1951 | 3652.0 | 1231.2 | 1030.8 | 905.7 | 767.5 | 697.1 | 1504.6 | 13218.5 | 19978.5 | 21575.9 | 18530.0 | 19799.1 |
| 1952 | 5221.7 | 2539.0 | 1757.5 | 1483.7 | 943.2 | 828.2 | 878.5 | 4989.5 | 30014.2 | 24861.7 | 19647.2 | 13441.1 |
| 1953 | 7517.6 | 3232.6 | 1550.4 | 999.6 | 745.6 | 766.7 | 1531.8 | 17758.3 | 25230.7 | 19184.0 | 19207.0 | 13928.4 |
| 1954 | 5109.3 | 1921.3 | 1387.1 | 1224.2 | 929.7 | 729.4 | 1130.6 | 15286.0 | 23188.1 | 19154.1 | 24071.6 | 11579.1 |
| 1955 | 4830.4 | 2506.8 | 1868.0 | 1649.1 | 1275.2 | 1023.6 | 1107.4 | 8390.1 | 28081.9 | 26212.8 | 24959.6 | 13989.2 |
| 1956 | 4647.9 | 1788.6 | 1206.6 | 921.7 | 893.1 | 852.3 | 867.3 | 15979.0 | 31137.1 | 29212.0 | 22609.8 | 16495.8 |
| 1957 | 5235.3 | 2773.8 | 1986.6 | 1583.2 | 1388.9 | 1105.4 | 1109.0 | 12473.6 | 28415.4 | 22109.6 | 19389.2 | 18029.0 |
| 1958 | 7434.5 | 3590.4 | 2904.9 | 1792.0 | 1212.2 | 1085.7 | 1437.4 | 11849.2 | 24413.5 | 21763.1 | 21219.8 | 6988.8 |
| 1959 | 4402.8 | 1999.8 | 1370.9 | 1316.9 | 1179.1 | 877.9 | 1119.9 | 13900.9 | 21537.7 | 23390.4 | 28594.4 | 15329.6 |
| 1960 | 6060.7 | 2622.7 | 2011.5 | 1686.2 | 1340.2 | 1112.8 | 1217.8 | 14802.9 | 14709.8 | 21739.3 | 22066.1 | 18929.9 |
| 1961 | 7170.9 | 2759.9 | 2436.6 | 2212.0 | 1593.6 | 1638.9 | 2405.4 | 16030.7 | 27069.3 | 22880.6 | 21164.4 | 12218.6 |
| 1962 | 5459.4 | 2544.1 | 1978.7 | 1796.0 | 1413.4 | 1320.3 | 1613.4 | 12141.2 | 40679.7 | 24990.6 | 22241.8 | 14767.2 |
| 1963 | 6307.7 | 2696.0 | 1896.0 | 1496.0 | 1387.4 | 958.4 | 810.9 | 17697.7 | 24094.1 | 32388.4 | 22720.5 | 11777.2 |
| 1964 | 5998.3 | 2085.4 | 1387.1 | 978.0 | 900.2 | 663.8 | 696.5 | 4046.9 | 47816.4 | 21926.0 | 15585.8 | 8840.0 |
| 1965 | 5744.0 | 2645.1 | 1160.8 | 925.3 | 828.8 | 866.9 | 1314.4 | 12267.1 | 24110.3 | 26195.7 | 19789.3 | 18234.2 |
| 1966 | 6496.5 | 1907.8 | 1478.4 | 1278.7 | 1187.4 | 1187.4 | 1619.1 | 8734.0 | 30446.4 | 18536.2 | 20244.6 | 10844.3 |
| 1967 | 3844.0 | 1457.9 | 1364.9 | 1357.9 | 1268.3 | 1089.1 | 1053.7 | 14435.5 | 27796.4 | 25081.2 | 30293.0 | 15728.2 |
| 1968 | 4585.3 | 2203.5 | 1929.7 | 1851.2 | 1778.7 | 1778.7 | 1791.0 | 14982.4 | 29462.1 | 24871.0 | 16090.5 | 8225.9 |
| 1969 | 3576.7 | 1531.8 | 836.3 | 686.6 | 681.8 | 769.6 | 1421.3 | 10429.9 | 14950.7 | 15651.2 | 8483.6 | 4795.5 |
| 1970 | 2866.5 | 1145.7 | 810.0 | 756.9 | 708.7 | 721.8 | 1046.6 | 10721.6 | 17118.9 | 21142.2 | 18652.8 | 8443.5 |
| 1971 | 4745.2 | 3081.8 | 2074.8 | 1318.8 | 943.6 | 866.8 | 986.2 | 3427.9 | 31031.0 | 22941.6 | 30315.9 | 13636.0 |
| 1972 | 5537.0 | 2912.3 | 2312.6 | 2036.1 | 1836.4 | 1659.8 | 1565.5 | 19776.8 | 31929.8 | 21716.5 | 18654.1 | 11884.2 |
| 1973 | 4638.6 | 2154.8 | 1387.0 | 1139.8 | 1128.6 | 955.0 | 986.7 | 7896.4 | 26392.6 | 17571.8 | 19478.1 | 8726.0 |
| 1974 | 3491.4 | 1462.9 | 997.4 | 842.7 | 745.9 | 689.5 | 949.1 | 15004.6 | 16766.7 | 17790.0 | 15257.0 | 11370.1 |
| 1975 | 3506.8 | 1619.4 | 1486.5 | 1408.8 | 1342.2 | 1271.9 | 1456.7 | 14036.5 | 30302.6 | 26188.0 | 17031.6 | 15154.7 |
| 1976 | 7003.3 | 1853.0 | 1007.9 | 896.8 | 876.2 | 825.2 | 1262.2 | 11305.3 | 22813.6 | 18252.6 | 19297.7 | 6463.3 |
| 1977 | 3552.4 | 2391.7 | 2147.5 | 1657.4 | 1469.7 | 1361.0 | 1509.8 | 11211.9 | 35606.7 | 21740.5 | 18371.2 | 11916.1 |
| 1978 | 6936.3 | 3210.8 | 2371.4 | 1867.9 | 1525.0 | 1480.6 | 1597.1 | 11693.4 | 18416.8 | 20079.0 | 15326.5 | 8080.4 |
| 1979 | 4502.3 | 2324.3 | 1549.4 | 1304.1 | 1203.6 | 1164.7 | 1402.8 | 13334.0 | 24052.4 | 27462.8 | 19106.7 | 10172.4 |
| 1980 | 6900.0 | 3955.0 | 2279.0 | 1640.0 | 1383.0 | 1321.00 | 1575.0 | 11377.0 | 26255.0 | 30002.0 | 20196.0 | 12342.0 |
| 1981 | 7335.0 | 3382.0 | 1841.0 | 1958.0 | 1839.0 | 1470.0 | 1898.0 | 15789.0 | 18387.0 | 31679.0 | 35256.0 | 13033.0 |
| 1982 | 6384.0 | 3270.0 | 2207.0 | 2086.0 | 1559.0 | 1094.0 | 1574.0 | 12490.0 | 24439.0 | 22877.0 | 14535.0 | 16427.0 |
| 1983 | 6272.0 | 2454.0 | 2192.0 | 2098.0 | 1858.0 | 1596.0 | 1781.0 | 13777.0 | 22789.0 | 20295.0 | 23203.0 | 12731.0 |
| 1984 | 7696.0 | 2976.0 | 2144.0 | 1953.0 | 1888.0 | 1828.0 | 1772.0 | 12425.0 | 25410.0 | | | |

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TABLE 3

7-DAY STREAMFLOW AT WATANA

(CFS)

| YEAR | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1950 | 10810. | 4827. | 3532. | 3195. | 2811. | 2511. | 2114. | 2078. | 1430. | 1430. | 1333. | 1105. | 949. |
| | 853. | 823. | 829. | 925. | 925. | 817. | 577. | 529. | 597. | 598. | 560. | 605. | 674. |
| | 651. | 658. | 714. | 848. | 1946. | 6733. | 11496. | 11941. | 15064. | 14379. | 13935. | 22008. | 16265. |
| | 16782. | 17851. | 19521. | 21227. | 21107. | 19449. | 17791. | 14668. | 11076. | 7789. | 8830. | 5970. | 6043. |
| 1951 | 4421. | 3940. | 3441. | 1963. | 1237. | 1165. | 1093. | 1033. | 985. | 925. | 925. | 925. | 925. |
| | 824. | 807. | 807. | 807. | 757. | 690. | 690. | 690. | 661. | 622. | 622. | 622. | 622. |
| | 651. | 839. | 1265. | 2234. | 5178. | 14572. | 16205. | 8045. | 14019. | 24843. | 17911. | 11388. | 16037. |
| | 17431. | 20470. | 19581. | 18007. | 18019. | 14812. | 15737. | 15401. | 21527. | 25275. | 15701. | 16217. | 15689. |
| 1952 | 7760. | 5190. | 3772. | 2931. | 2943. | 2695. | 1992. | 1970. | 1838. | 1598. | 1598. | 1598. | 1598. |
| | 1382. | 1345. | 1345. | 1345. | 1129. | 841. | 841. | 841. | 798. | 740. | 740. | 740. | 740. |
| | 774. | 774. | 774. | 774. | 1002. | 1273. | 1742. | 3772. | 18440. | 20866. | 29552. | 32050. | 28362. |
| | 23233. | 16546. | 21095. | 22861. | 31318. | 21083. | 16554. | 12566. | 14572. | 15881. | 10740. | 9274. | 12686. |
| 1953 | 9370. | 6737. | 6082. | 4433. | 4205. | 3580. | 2295. | 2811. | 2042. | 1430. | 1430. | 1430. | 1430. |
| | 997. | 925. | 925. | 925. | 824. | 690. | 690. | 690. | 690. | 690. | 690. | 690. | 690. |
| | 782. | 782. | 1265. | 2102. | 11881. | 14139. | 12866. | 22188. | 17443. | 29528. | 22800. | 18560. | 21719. |
| | 17010. | 15364. | 16710. | 17371. | 21563. | 18380. | 14728. | 15160. | 18079. | 15797. | 14391. | 12001. | 10449. |
| 1954 | 6827. | 5662. | 4154. | 3311. | 2019. | 1910. | 1766. | 1646. | 1502. | 1261. | 1261. | 1261. | 1261. |
| | 1117. | 1093. | 1093. | 1093. | 985. | 841. | 841. | 841. | 762. | 656. | 656. | 656. | 656. |
| | 732. | 732. | 1258. | 1345. | 5670. | 10331. | 16734. | 19185. | 18139. | 21407. | 20566. | 19725. | 23978. |
| | 20590. | 16422. | 15977. | 15977. | 26188. | 20182. | 20182. | 20182. | 19341. | 13695. | 11773. | 10980. | 8057. |
| 1955 | 5466. | 5137. | 3868. | 3868. | 3099. | 2523. | 2379. | 2102. | 2030. | 1850. | 1814. | 1598. | 1598. |
| | 1670. | 1682. | 1442. | 1345. | 1273. | 1177. | 1177. | 1177. | 1069. | 925. | 925. | 925. | 925. |
| | 1009. | 1009. | 1009. | 1009. | 2991. | 3784. | 4421. | 13238. | 14656. | 17094. | 27870. | 30236. | 28314. |
| | 28747. | 24014. | 16536. | 22164. | 19016. | 17575. | 18031. | 21923. | 31318. | 16542. | 12638. | 10271. | 9244. |
| 1956 | 6085. | 4480. | 3648. | 3143. | 2090. | 1766. | 1622. | 1430. | 1333. | 1093. | 1093. | 1093. | 1093. |
| | 863. | 824. | 824. | 824. | 821. | 816. | 816. | 816. | 805. | 790. | 790. | 790. | 790. |
| | 799. | 799. | 799. | 799. | 2114. | 9586. | 13683. | 27221. | 18236. | 28134. | 36615. | 26885. | 23701. |
| | 24434. | 26645. | 26909. | 26260. | 26428. | 24194. | 21863. | 17431. | 14896. | 13454. | 18860. | 16380. | 13454. |
| 1957 | 6055. | 6055. | 4108. | 3784. | 3159. | 2691. | 2563. | 2439. | 2318. | 2018. | 1958. | 1598. | 1598. |
| | 1454. | 1430. | 1430. | 1430. | 1358. | 1261. | 1261. | 1261. | 1153. | 1009. | 1009. | 1009. | 1009. |
| | 1009. | 1009. | 1009. | 1009. | 2871. | 4841. | 7905. | 17707. | 25996. | 31486. | 27822. | 24686. | 16902. |
| | 19521. | 17935. | 20110. | 21815. | 17623. | 17611. | 17515. | 16061. | 17779. | 15905. | 17359. | 16878. | 16524. |
| 1958 | 8689. | 7454. | 6080. | 6268. | 4565. | 3802. | 3254. | 2675. | 3015. | 3628. | 3095. | 2308. | 1874. |
| | 2042. | 1790. | 1562. | 1478. | 1225. | 1213. | 1093. | 1009. | 1009. | 1009. | 985. | 925. | 925. |
| | 1009. | 1129. | 1225. | 1485. | 3355. | 6629. | 9262. | 17635. | 18548. | 23545. | 23545. | 20302. | 16500. |
| | 16500. | 16500. | 16500. | 18139. | 32531. | 23149. | 17190. | 13935. | 9718. | 7148. | 7148. | 5550. | 6343. |
| 1959 | 5038. | 4433. | 4241. | 2943. | 2511. | 2186. | 1862. | 1430. | 1285. | 925. | 1021. | 1598. | 1598. |
| | 1309. | 1201. | 1201. | 1177. | 1177. | 1177. | 1129. | 1009. | 930. | 824. | 824. | 824. | 824. |
| | 841. | 841. | 1201. | 1261. | 2403. | 3820. | 16314. | 23113. | 18776. | 21887. | 16350. | 19485. | 21803. |
| | 22200. | 21311. | 25069. | 18236. | 20086. | 15665. | 20110. | 37144. | 36303. | 24134. | 12469. | 9365. | 10097. |
| 1960 | 9010. | 6223. | 3424. | 4277. | 2931. | 2523. | 2415. | 2270. | 2150. | 1850. | 1850. | 1850. | 1850. |
| | 1706. | 1682. | 1502. | 1430. | 1358. | 1261. | 1237. | 1177. | 1141. | 1093. | 1045. | 925. | 925. |
| | 925. | 925. | 1213. | 1261. | 4925. | 6391. | 12349. | 19221. | 20422. | 12073. | 12517. | 12962. | 14247. |
| | 19281. | 14295. | 16446. | 22548. | 26945. | 21363. | 18896. | 18260. | 17539. | 15401. | 24338. | 17251. | 14764. |
| 1961 | 10535. | 7652. | 3442. | 3964. | 3015. | 2775. | 2559. | 2270. | 2318. | 2439. | 2391. | 2102. | 2102. |
| | 2030. | 2018. | 2078. | 2102. | 1850. | 1514. | 1490. | 1430. | 1358. | 1261. | 1406. | 1766. | 1766. |
| | 2102. | 2102. | 2318. | 2355. | 6079. | 10692. | 16500. | 17623. | 16662. | 15953. | 26056. | 32555. | 27353. |
| | 19341. | 20302. | 21023. | 21779. | 21563. | 21863. | 18668. | 17719. | 13166. | 10451. | 11857. | 11292. | 12998. |
| 1962 | 6769. | 3868. | 3868. | 3868. | 2955. | 2270. | 2270. | 2270. | 2126. | 1766. | 1766. | 1766. | 1766. |
| | 1622. | 1598. | 1598. | 1598. | 1454. | 1261. | 1261. | 1261. | 1225. | 1177. | 1177. | 1177. | 1177. |
| | 1430. | 1430. | 1430. | 1430. | 3111. | 3784. | 10271. | 15136. | 23942. | 25467. | 49397. | 42237. | 29900. |
| | 22861. | 22320. | 19449. | 22861. | 21911. | 19341. | 19341. | 19341. | 19701. | 19821. | 12517. | 10139. | 11665. |

TABLE 3 (CONTINUED)

7-DAY STREAMFLOW AT WATANA

(CFS)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1963 | 7694. | 5859. | 5105. | 4613. | 3111. | 2355. | 2355. | 2355. | 2162. | 1682. | 1682. | 1682. | 1682. |
| | 1394. | 1345. | 1345. | 1345. | 1309. | 1261. | 1261. | 1261. | 1081. | 841. | 841. | 841. | 841. |
| | 698. | 698. | 698. | 698. | 2242. | 2859. | 16121. | 26068. | 30008. | 21863. | 21863. | 21863. | 21863. |
| | 26188. | 33852. | 32074. | 27389. | 23377. | 21143. | 18344. | 19401. | 16434. | 12734. | 11388. | 9106. | 9232. |
| 1964 | 7462. | 6300. | 5154. | 3904. | 2427. | 2186. | 1934. | 1598. | 1550. | 1430. | 1382. | 1093. | 1093. |
| | 949. | 925. | 865. | 841. | 841. | 841. | 824. | 782. | 724. | 648. | 621. | 555. | 555. |
| | 597. | 597. | 648. | 656. | 728. | 877. | 1177. | 2606. | 24378. | 63092. | 43330. | 36159. | 26152. |
| | 21335. | 21984. | 20746. | 14235. | 16614. | 15749. | 12698. | 13539. | 11436. | 9548. | 7781. | 7824. | 7657. |
| 1965 | 6456. | 7225. | 4728. | 3761. | 2590. | 2385. | 2361. | 2631. | 1710. | 1152. | 1027. | 933. | 933. |
| | 825. | 807. | 807. | 807. | 771. | 723. | 723. | 723. | 738. | 757. | 757. | 757. | 757. |
| | 992. | 992. | 1252. | 1295. | 1691. | 4529. | 7880. | 14199. | 28290. | 18476. | 19737. | 16860. | 27762. |
| | 25527. | 25744. | 23978. | 20794. | 18692. | 16542. | 25551. | 17130. | 9538. | 14168. | 17407. | 15929. | 21059. |
| 1966 | 12686. | 7053. | 3304. | 2733. | 2325. | 1904. | 1682. | 1604. | 1538. | 1442. | 1394. | 1337. | 1287. |
| | 1193. | 1177. | 1177. | 1177. | 1141. | 1093. | 1093. | 1093. | 1093. | 1093. | 1093. | 1093. | 1093. |
| | 1261. | 1261. | 1658. | 1724. | 2535. | 3268. | 6055. | 11604. | 18212. | 40099. | 28699. | 24242. | 20458. |
| | 15677. | 14932. | 15629. | 17683. | 23557. | 19269. | 15845. | 19197. | 15389. | 10836. | 10523. | 10403. | 8673. |
| 1967 | 5878. | 3941. | 2960. | 2018. | 1454. | 1345. | 1345. | 1345. | 1321. | 1261. | 1261. | 1261. | 1261. |
| | 1261. | 1261. | 1261. | 1261. | 1225. | 1177. | 1177. | 1177. | 1105. | 1009. | 1009. | 1009. | 1009. |
| | 925. | 925. | 949. | 1093. | 1466. | 4145. | 14416. | 20170. | 24242. | 22344. | 29275. | 24398. | 23870. |
| | 18127. | 18055. | 25107. | 29263. | 22788. | 21059. | 46141. | 25732. | 17335. | 24446. | 14427. | 10487. | 9108. |
| 1968 | 5761. | 4796. | 3750. | 2859. | 2403. | 2042. | 1934. | 1862. | 1826. | 1766. | 1766. | 1694. | 1682. |
| | 1682. | 1682. | 1682. | 1658. | 1598. | 1598. | 1598. | 1598. | 1598. | 1598. | 1598. | 1598. | 1598. |
| | 1574. | 1514. | 1566. | 1694. | 1886. | 2475. | 11004. | 28459. | 23161. | 22248. | 30969. | 31402. | 22861. |
| | 24747. | 22524. | 21743. | 21011. | 18680. | 16938. | 14091. | 12734. | 11292. | 9478. | 9495. | 6063. | 5305. |
| 1969 | 4256. | 3675. | 2830. | 2512. | 2138. | 1658. | 1261. | 1105. | 913. | 799. | 757. | 715. | 679. |
| | 649. | 631. | 589. | 589. | 589. | 589. | 601. | 631. | 631. | 655. | 673. | 709. | 733. |
| | 805. | 949. | 1237. | 1754. | 2859. | 5056. | 9615. | 16866. | 10149. | 10764. | 13719. | 15028. | 13647. |
| | 11713. | 14824. | 15232. | 12734. | 11256. | 12013. | 6222. | 5047. | 4703. | 5300. | 4635. | 3974. | 3814. |
| 1970 | 3313. | 3119. | 2732. | 1844. | 1442. | 1201. | 949. | 841. | 787. | 757. | 721. | 715. | 715. |
| | 715. | 715. | 685. | 673. | 673. | 673. | 631. | 631. | 631. | 631. | 643. | 673. | 673. |
| | 715. | 787. | 901. | 1093. | 1634. | 3880. | 13743. | 12409. | 15244. | 14271. | 13767. | 13034. | 21948. |
| | 21047. | 17659. | 16920. | 18091. | 22224. | 19233. | 14860. | 16794. | 11592. | 10004. | 7960. | 8109. | 5166. |
| 1971 | 5901. | 4925. | 4012. | 3412. | 3364. | 3195. | 2907. | 2571. | 2307. | 2162. | 2018. | 1850. | 1658. |
| | 1466. | 1309. | 1169. | 1045. | 973. | 925. | 841. | 841. | 823. | 799. | 799. | 799. | 799. |
| | 811. | 841. | 913. | 1021. | 1225. | 1598. | 2355. | 4157. | 7328. | 19221. | 39679. | 24098. | 33288. |
| | 20578. | 20938. | 24134. | 15701. | 20482. | 37624. | 33636. | 20626. | 16374. | 19221. | 12265. | 9274. | 9198. |
| 1972 | 6512. | 5835. | 4429. | 3652. | 3027. | 2739. | 2595. | 2451. | 2331. | 2186. | 2186. | 2018. | 2018. |
| | 2018. | 1850. | 1850. | 1850. | 1850. | 1754. | 1682. | 1682. | 1610. | 1586. | 1514. | 1514. | 1490. |
| | 1430. | 1430. | 1370. | 1430. | 2847. | 16458. | 16217. | 22608. | 37204. | 20578. | 36543. | 32002. | 21635. |
| | 21335. | 21323. | 19004. | 15497. | 17022. | 18272. | 16758. | 17323. | 11592. | 11088. | 15160. | 11172. | 5766. |
| 1973 | 4024. | 3724. | 5166. | 3832. | 2619. | 2138. | 1826. | 1682. | 1466. | 1345. | 1201. | 1177. | 1177. |
| | 1033. | 1009. | 1009. | 1009. | 1009. | 1009. | 1009. | 1009. | 937. | 841. | 841. | 841. | 841. |
| | 841. | 841. | 841. | 889. | 1177. | 2258. | 7736. | 10655. | 13214. | 16998. | 28338. | 30645. | 20134. |
| | 17707. | 16926. | 12806. | 13815. | 14848. | 17683. | 14091. | 18332. | 19485. | 10776. | 7519. | 6350. | 5895. |
| 1974 | 4739. | 3817. | 2632. | 1994. | 1610. | 1382. | 1273. | 1165. | 1069. | 961. | 865. | 823. | 799. |
| | 763. | 757. | 727. | 715. | 697. | 673. | 661. | 631. | 631. | 631. | 619. | 589. | 589. |
| | 589. | 613. | 739. | 1177. | 2162. | 5538. | 10331. | 23065. | 26368. | 16446. | 14043. | 13130. | 14019. |
| | 14247. | 17707. | 16241. | 15617. | 14896. | 15713. | 13442. | 10639. | 14405. | 13971. | 7832. | 7915. | 11902. |
| 1975 | 4627. | 4599. | 2451. | 1634. | 1430. | 1430. | 1430. | 1430. | 1418. | 1345. | 1345. | 1345. | 1345. |
| | 1333. | 1261. | 1261. | 1261. | 1261. | 1261. | 1261. | 1213. | 1177. | 1177. | 1177. | 1177. | 1177. |
| | 1177. | 1169. | 1297. | 1538. | 2391. | 5766. | 12674. | 19365. | 25647. | 30609. | 22993. | 28891. | 25828. |
| | 23125. | 25143. | 23834. | 21803. | 20350. | 16386. | 15653. | 13815. | 11905. | 9875. | 16722. | 15665. | 15088. |

TABLE 3 (CONTINUED)

7-DAY STREAMFLOW AT WATANA

(CFS)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1976 | 8649. | 7628. | 7028. | 4145. | 2883. | 2066. | 1574. | 1249. | 1069. | 961. | 925. | 889. | 841. |
| | 841. | 841. | 811. | 799. | 799. | 799. | 799. | 799. | 781. | 757. | 757. | 757. | 757. |
| | 757. | 793. | 985. | 1646. | 4168. | 11725. | 11268. | 11785. | 13563. | 23293. | 25095. | 17671. | 17070. |
| | 16253. | 16217. | 15461. | 15857. | 18260. | 23305. | 17299. | 13286. | 9404. | 6499. | 5323. | 5354. | 6517. |
| 1977 | 4063. | 3316. | 3162. | 2806. | 2475. | 2283. | 2138. | 2018. | 2427. | 2283. | 2066. | 1898. | 1754. |
| | 1646. | 1598. | 1514. | 1478. | 1430. | 1370. | 1345. | 1345. | 1309. | 1261. | 1261. | 1261. | 1261. |
| | 1345. | 1345. | 1418. | 1490. | 1658. | 2907. | 10523. | 16145. | 24554. | 29395. | 38934. | 31906. | 28470. |
| | 18260. | 20302. | 21455. | 17851. | 18740. | 17935. | 16410. | 16590. | 10523. | 8714. | 12337. | 11833. | 11381. |
| 1978 | 7424. | 7532. | 6619. | 4937. | 3772. | 3220. | 2901. | 2691. | 2493. | 2318. | 2216. | 2150. | 1988. |
| | 1880. | 1772. | 1682. | 1616. | 1520. | 1430. | 1388. | 1388. | 1345. | 1345. | 1345. | 1345. | 1363. |
| | 1388. | 1388. | 1388. | 1466. | 3063. | 10559. | 14416. | 9754. | 10403. | 12938. | 17971. | 15376. | 19161. |
| | 18764. | 17431. | 17623. | 17286. | 16998. | 16073. | 14944. | 12469. | 8986. | 9430. | 8500. | 6390. | 5450. |
| 1979 | 4554. | 5103. | 4122. | 3093. | 3008. | 2628. | 1970. | 1730. | 1658. | 1598. | 1454. | 1309. | 1261. |
| | 1225. | 1177. | 1177. | 1177. | 1093. | 1093. | 1093. | 1093. | 1009. | 1009. | 1009. | 1009. | 1009. |
| | 1009. | 1057. | 1165. | 1466. | 2307. | 4325. | 10091. | 16097. | 26633. | 23113. | 19401. | 17515. | 21671. |
| | 22176. | 21936. | 26705. | 27293. | 22296. | 20854. | 16842. | 14343. | 12758. | 7944. | 7739. | 11388. | 10305. |
| 1980 | 6635. | 8421. | 5915. | 4370. | 4096. | 3720. | 4145. | 2967. | 2823. | 2307. | 2078. | 1898. | 1718. |
| | 1610. | 1538. | 1454. | 1382. | 1345. | 1285. | 1225. | 1177. | 1177. | 1177. | 1177. | 1177. | 1177. |
| | 1177. | 1177. | 1237. | 1682. | 3484. | 8169. | 11701. | 10463. | 16686. | 27029. | 21299. | 27582. | 24062. |
| | 26356. | 26741. | 28218. | 25347. | 27762. | 19509. | 18440. | 16722. | 12157. | 8888. | 9506. | 15977. | 11929. |
| 1981 | 8282. | 7382. | 6141. | 5061. | 3916. | 3541. | 2643. | 2691. | 2691. | 1946. | 1502. | 1412. | 1358. |
| | 1321. | 1538. | 1790. | 1934. | 1958. | 2030. | 1694. | 1345. | 1261. | 1261. | 1345. | 1370. | 1388. |
| | 1430. | 1490. | 1586. | 2054. | 4728. | 17154. | 17226. | 11352. | 18452. | 15665. | 14223. | 15304. | 17875. |
| | 14992. | 35390. | 34597. | 30861. | 32459. | 30405. | 39294. | 31137. | 20999. | 15124. | 12193. | 10175. | 9465. |
| 1982 | 6425. | 6054. | 6222. | 7216. | 3878. | 3316. | 3243. | 2727. | 2378. | 2127. | 2006. | 1934. | 1934. |
| | 1934. | 1934. | 1934. | 1934. | 1945. | 1982. | 1447. | 1051. | 925. | 925. | 925. | 979. | 1255. |
| | 1261. | 1261. | 1393. | 1850. | 2842. | 6811. | 12614. | 16938. | 19100. | 21989. | 18380. | 24266. | 23545. |
| | 16398. | 20277. | 20614. | 23125. | 19893. | 13983. | 12169. | 10620. | 11784. | 11340. | 14199. | 22332. | 14069. |

TABLE 4

7-DAY STREAMFLOW AT DEVIL CANYON

(CFS)

| YEAR | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1950 | 12126. | 5414. | 3961. | 3584. | 3153. | 2816. | 2372. | 2331. | 1603. | 1603. | 1496. | 1240. | 1065. |
| | 957. | 923. | 930. | 1038. | 1038. | 916. | 647. | 593. | 670. | 671. | 628. | 679. | 756. |
| | 730. | 738. | 800. | 951. | 2183. | 7552. | 12895. | 13393. | 16897. | 16129. | 15630. | 24685. | 18244. |
| | 18824. | 20023. | 21896. | 23809. | 23674. | 21815. | 19955. | 16452. | 12423. | 8737. | 9904. | 6697. | 6778. |
| 1951 | 4959. | 4420. | 3859. | 2202. | 1388. | 1307. | 1226. | 1159. | 1105. | 1038. | 1038. | 1038. | 1038. |
| | 924. | 906. | 906. | 906. | 849. | 773. | 773. | 773. | 741. | 698. | 698. | 698. | 698. |
| | 730. | 941. | 1442. | 2506. | 5807. | 16344. | 18177. | 9024. | 15725. | 27865. | 20090. | 12774. | 17988. |
| | 19551. | 22960. | 21963. | 20198. | 20212. | 16614. | 17651. | 17274. | 24146. | 28350. | 17611. | 18190. | 17597. |
| 1952 | 8704. | 5821. | 4231. | 3268. | 3301. | 3022. | 2234. | 2210. | 2062. | 1792. | 1792. | 1792. | 1792. |
| | 1550. | 1509. | 1509. | 1509. | 1267. | 943. | 943. | 943. | 895. | 830. | 830. | 830. | 830. |
| | 868. | 868. | 868. | 868. | 1124. | 1428. | 1954. | 4231. | 20683. | 23405. | 33147. | 35949. | 31813. |
| | 26059. | 16514. | 23661. | 25642. | 35128. | 23647. | 18568. | 14094. | 16344. | 17813. | 12046. | 10402. | 14229. |
| 1953 | 10510. | 9800. | 6822. | 4972. | 4716. | 4015. | 2574. | 3153. | 2291. | 1603. | 1603. | 1603. | 1603. |
| | 1118. | 1038. | 1038. | 1038. | 924. | 773. | 773. | 773. | 773. | 773. | 773. | 773. | 773. |
| | 877. | 877. | 1419. | 2358. | 13326. | 15859. | 14431. | 24887. | 19565. | 33120. | 25574. | 20818. | 24362. |
| | 19080. | 17234. | 18743. | 19484. | 24186. | 20616. | 16520. | 17005. | 20279. | 17719. | 16142. | 13461. | 11720. |
| 1954 | 7658. | 6350. | 4659. | 3714. | 2265. | 2142. | 1981. | 1846. | 1684. | 1415. | 1415. | 1415. | 1415. |
| | 1253. | 1226. | 1226. | 1226. | 1105. | 943. | 943. | 943. | 854. | 736. | 736. | 736. | 736. |
| | 821. | 821. | 1411. | 1509. | 6360. | 11568. | 18770. | 21518. | 20346. | 24011. | 23068. | 22125. | 26895. |
| | 23095. | 18419. | 17921. | 17921. | 29374. | 22637. | 22637. | 22637. | 21694. | 15361. | 13205. | 12316. | 9037. |
| 1955 | 6131. | 5762. | 4339. | 4339. | 3476. | 2830. | 2668. | 2358. | 2277. | 2075. | 2035. | 1792. | 1792. |
| | 1873. | 1886. | 1617. | 1509. | 1428. | 1321. | 1321. | 1321. | 1199. | 1038. | 1038. | 1038. | 1038. |
| | 1132. | 1132. | 1132. | 1132. | 3355. | 4244. | 4959. | 14849. | 16439. | 19174. | 31260. | 33915. | 31759. |
| | 32244. | 26935. | 20791. | 24860. | 21330. | 19713. | 20225. | 24591. | 35128. | 18554. | 14175. | 11521. | 10369. |
| 1956 | 6825. | 5025. | 4092. | 3525. | 2345. | 1981. | 1819. | 1603. | 1496. | 1226. | 1226. | 1226. | 1226. |
| | 967. | 924. | 924. | 924. | 920. | 915. | 915. | 915. | 903. | 887. | 887. | 887. | 887. |
| | 896. | 896. | 896. | 896. | 2372. | 10753. | 15347. | 30533. | 20454. | 31557. | 41070. | 30155. | 26585. |
| | 27407. | 29886. | 30162. | 29455. | 29644. | 27137. | 24523. | 19551. | 16708. | 15091. | 21155. | 20616. | 15091. |
| 1957 | 6791. | 6791. | 4608. | 4244. | 3544. | 3018. | 2897. | 2735. | 2601. | 2264. | 2196. | 1792. | 1792. |
| | 1630. | 1603. | 1603. | 1603. | 1523. | 1415. | 1415. | 1415. | 1294. | 1132. | 1132. | 1132. | 1132. |
| | 1132. | 1132. | 1132. | 1132. | 3220. | 5430. | 8866. | 19861. | 29158. | 35316. | 31206. | 27690. | 18958. |
| | 21896. | 20117. | 22556. | 24469. | 19767. | 19753. | 19646. | 18015. | 19942. | 17840. | 19470. | 18931. | 20777. |
| 1958 | 9746. | 6361. | 6819. | 7031. | 5120. | 4265. | 3650. | 3001. | 3382. | 4069. | 3471. | 2588. | 2102. |
| | 2291. | 2008. | 1752. | 1657. | 1374. | 1361. | 1226. | 1132. | 1132. | 1132. | 1105. | 1038. | 1038. |
| | 1132. | 1267. | 1374. | 1665. | 3763. | 7435. | 10389. | 19780. | 20804. | 26410. | 26410. | 22772. | 20750. |
| | 20750. | 20750. | 20750. | 20346. | 36468. | 25965. | 19282. | 15630. | 10901. | 8017. | 8017. | 6225. | 7115. |
| 1959 | 5651. | 4972. | 4757. | 3301. | 2816. | 2452. | 2069. | 1603. | 1442. | 1038. | 1145. | 1792. | 1792. |
| | 1469. | 1415. | 1348. | 1321. | 1321. | 1321. | 1267. | 1132. | 1043. | 924. | 924. | 924. | 924. |
| | 943. | 943. | 1348. | 1415. | 2695. | 4285. | 18298. | 25925. | 21060. | 24550. | 18339. | 21855. | 24456. |
| | 24901. | 23903. | 25898. | 20454. | 22529. | 17571. | 22556. | 41663. | 40719. | 27070. | 13986. | 10505. | 11325. |
| 1960 | 10106. | 6980. | 5840. | 4797. | 3288. | 2830. | 2708. | 2547. | 2412. | 2075. | 2075. | 2075. | 2075. |
| | 1913. | 1866. | 1684. | 1603. | 1523. | 1415. | 1388. | 1321. | 1280. | 1226. | 1172. | 1038. | 1038. |
| | 1038. | 1038. | 1361. | 1415. | 5524. | 7168. | 13852. | 21559. | 22906. | 13542. | 14040. | 14539. | 15961. |
| | 21626. | 16034. | 16446. | 25291. | 30223. | 23984. | 21195. | 20481. | 19672. | 17274. | 27299. | 19349. | 16560. |
| 1961 | 11817. | 8583. | 6104. | 4447. | 3382. | 3113. | 2870. | 2547. | 2601. | 2735. | 2681. | 2358. | 2358. |
| | 2277. | 2264. | 2331. | 2358. | 2075. | 1698. | 1671. | 1603. | 1523. | 1415. | 1577. | 1981. | 1981. |
| | 2358. | 2358. | 2601. | 2641. | 6818. | 11992. | 20750. | 19767. | 18689. | 17894. | 29226. | 36515. | 30681. |
| | 21694. | 22772. | 23560. | 24429. | 24186. | 24523. | 20939. | 19875. | 14768. | 11723. | 13299. | 12606. | 14579. |
| 1962 | 9836. | 4339. | 4339. | 4339. | 3315. | 2547. | 2547. | 2547. | 2385. | 1981. | 1981. | 1981. | 1981. |
| | 1819. | 1792. | 1792. | 1792. | 1630. | 1415. | 1415. | 1415. | 1374. | 1321. | 1321. | 1321. | 1321. |
| | 1603. | 1603. | 1603. | 1603. | 3490. | 4244. | 11521. | 16978. | 26854. | 28566. | 55406. | 47376. | 33538. |
| | 25642. | 25035. | 21815. | 25642. | 24577. | 21694. | 21694. | 21694. | 22098. | 22233. | 14040. | 11372. | 13084. |

# TABLE 4 (CONTINUED)

## 7-DAY STREAMFLOW AT DEVIL CANYON

(CFS)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1963 | 8630. | 6571. | 5727. | 5174. | 3490. | 2641. | 2641. | 2641. | 2425. | 1886. | 1886. | 1886. | 1886. |
| | 1563. | 1509. | 1509. | 1509. | 1469. | 1415. | 1415. | 1415. | 1213. | 943. | 943. | 943. | 943. |
| | 783. | 783. | 783. | 783. | 2514. | 3207. | 18083. | 29239. | 33659. | 24523. | 24523. | 24523. | 24523. |
| | 29374. | 37971. | 35976. | 30721. | 26221. | 23715. | 20575. | 21761. | 18433. | 14283. | 12774. | 10214. | 10355. |
| 1964 | 8392. | 7066. | 5781. | 4379. | 2722. | 2452. | 2169. | 1792. | 1738. | 1603. | 1550. | 1226. | 1226. |
| | 1065. | 1038. | 970. | 943. | 943. | 943. | 924. | 877. | 813. | 726. | 697. | 623. | 623. |
| | 670. | 670. | 726. | 736. | 817. | 984. | 1321. | 2923. | 27343. | 70767. | 48602. | 40558. | 29334. |
| | 23930. | 24658. | 25270. | 15967. | 18635. | 17665. | 14242. | 15186. | 12828. | 10709. | 8727. | 8776. | 8589. |
| 1965 | 7241. | 8103. | 5304. | 4219. | 2905. | 2675. | 2648. | 2951. | 1917. | 1292. | 1152. | 1047. | 1047. |
| | 926. | 906. | 906. | 906. | 865. | 811. | 811. | 811. | 827. | 849. | 849. | 849. | 849. |
| | 1113. | 1113. | 1404. | 1453. | 1897. | 5080. | 8839. | 15927. | 31732. | 20723. | 22138. | 21155. | 31139. |
| | 26633. | 28875. | 26895. | 23324. | 20966. | 18554. | 28660. | 19214. | 10699. | 15892. | 19524. | 17867. | 23621. |
| 1966 | 14229. | 7911. | 3706. | 3065. | 2607. | 2136. | 1886. | 1799. | 1725. | 1617. | 1563. | 1500. | 1443. |
| | 1338. | 1321. | 1321. | 1321. | 1280. | 1226. | 1226. | 1226. | 1226. | 1226. | 1226. | 1226. | 1226. |
| | 1415. | 1415. | 1859. | 1934. | 2843. | 3665. | 6791. | 13016. | 20427. | 44977. | 32190. | 27191. | 22947. |
| | 17584. | 16749. | 17530. | 19834. | 26423. | 21613. | 17773. | 21532. | 17261. | 12154. | 11804. | 11669. | 9728. |
| 1967 | 6593. | 4421. | 3343. | 2264. | 1630. | 1509. | 1509. | 1509. | 1482. | 1415. | 1415. | 1415. | 1415. |
| | 1415. | 1415. | 1415. | 1415. | 1374. | 1321. | 1321. | 1321. | 1240. | 1132. | 1132. | 1132. | 1132. |
| | 1038. | 1038. | 1065. | 1226. | 1644. | 4649. | 16169. | 22623. | 27191. | 25062. | 32837. | 27366. | 26773. |
| | 20333. | 20252. | 26161. | 32823. | 25561. | 23621. | 51755. | 28862. | 19443. | 27420. | 16183. | 11763. | 10216. |
| 1968 | 6462. | 5379. | 4207. | 3207. | 2695. | 2291. | 2169. | 2089. | 2048. | 1981. | 1981. | 1900. | 1886. |
| | 1886. | 1886. | 1886. | 1859. | 1792. | 1792. | 1792. | 1792. | 1792. | 1792. | 1792. | 1792. | 1792. |
| | 1765. | 1698. | 1779. | 1900. | 2116. | 2776. | 12342. | 31921. | 25979. | 24954. | 34737. | 35222. | 25642. |
| | 27757. | 25264. | 24388. | 23567. | 20953. | 18999. | 15805. | 14283. | 12666. | 10631. | 10650. | 6801. | 5950. |
| 1969 | 4774. | 4122. | 3175. | 2817. | 2399. | 1859. | 1415. | 1240. | 1024. | 896. | 849. | 802. | 761. |
| | 728. | 707. | 660. | 660. | 660. | 660. | 674. | 707. | 707. | 734. | 755. | 795. | 822. |
| | 903. | 1065. | 1388. | 1967. | 3207. | 5671. | 10785. | 18918. | 11383. | 12073. | 15388. | 16856. | 15307. |
| | 13138. | 16627. | 17085. | 14283. | 12625. | 13474. | 6978. | 5661. | 5275. | 5945. | 5198. | 4457. | 4278. |
| 1970 | 3716. | 3498. | 3064. | 2068. | 1617. | 1348. | 1065. | 943. | 883. | 849. | 808. | 802. | 802. |
| | 802. | 802. | 768. | 755. | 755. | 755. | 707. | 707. | 707. | 707. | 721. | 755. | 755. |
| | 802. | 883. | 1011. | 1226. | 1833. | 4352. | 15415. | 13919. | 17099. | 16007. | 15442. | 14620. | 24618. |
| | 23607. | 19807. | 21222. | 20292. | 24928. | 21572. | 16668. | 18837. | 13003. | 11221. | 8928. | 9095. | 5794. |
| 1971 | 6619. | 5524. | 4500. | 3827. | 3773. | 3584. | 3261. | 2884. | 2587. | 2425. | 2264. | 2075. | 1859. |
| | 1644. | 1469. | 1334. | 1172. | 1091. | 1038. | 943. | 943. | 923. | 896. | 896. | 896. | 896. |
| | 910. | 943. | 1024. | 1145. | 1374. | 1792. | 2641. | 4662. | 8219. | 21559. | 44506. | 27029. | 37337. |
| | 23081. | 23486. | 27070. | 17611. | 22974. | 42202. | 37728. | 23135. | 18365. | 21559. | 13757. | 10402. | 10317. |
| 1972 | 7304. | 6545. | 4968. | 4096. | 3396. | 3072. | 2910. | 2749. | 2614. | 2452. | 2452. | 2264. | 2264. |
| | 2264. | 2075. | 2075. | 2075. | 2075. | 1967. | 1886. | 1886. | 1806. | 1779. | 1698. | 1698. | 1671. |
| | 1603. | 1603. | 1536. | 1603. | 3193. | 18460. | 18190. | 25359. | 41730. | 23081. | 40989. | 35896. | 24267. |
| | 23930. | 23917. | 21316. | 17382. | 19093. | 20494. | 18797. | 19430. | 13003. | 12437. | 17005. | 12531. | 6468. |
| 1973 | 4514. | 4177. | 5794. | 4298. | 2937. | 2399. | 2048. | 1886. | 1644. | 1509. | 1348. | 1321. | 1321. |
| | 1159. | 1132. | 1132. | 1132. | 1132. | 1132. | 1132. | 1132. | 1051. | 943. | 943. | 943. | 943. |
| | 943. | 943. | 943. | 997. | 1321. | 2533. | 8677. | 11952. | 14822. | 19066. | 31786. | 34373. | 22583. |
| | 19861. | 16985. | 14364. | 15496. | 16654. | 19834. | 15805. | 20562. | 21855. | 12086. | 8434. | 7123. | 6612. |
| 1974 | 5316. | 4281. | 2952. | 2237. | 1806. | 1550. | 1428. | 1307. | 1199. | 1078. | 970. | 923. | 896. |
| | 856. | 849. | 815. | 802. | 782. | 755. | 741. | 707. | 707. | 707. | 694. | 660. | 660. |
| | 660. | 687. | 829. | 1321. | 2425. | 6212. | 11588. | 25871. | 29576. | 18446. | 15751. | 14727. | 15725. |
| | 15981. | 19861. | 18217. | 17517. | 16708. | 17624. | 15078. | 11933. | 16157. | 15671. | 8785. | 8878. | 13350. |
| 1975 | 5190. | 5158. | 2749. | 1833. | 1603. | 1603. | 1603. | 1603. | 1590. | 1509. | 1509. | 1509. | 1509. |
| | 1496. | 1415. | 1415. | 1415. | 1415. | 1415. | 1415. | 1361. | 1321. | 1321. | 1321. | 1321. | 1321. |
| | 1321. | 1334. | 1455. | 1725. | 2681. | 6468. | 14215. | 21721. | 28768. | 34333. | 25790. | 32406. | 28970. |
| | 25938. | 28202. | 26733. | 24456. | 22825. | 18379. | 17557. | 15496. | 13353. | 11076. | 18756. | 17571. | 16924. |

TABLE 4 (CONTINUED)

7-DAY STREAMFLOW AT DEVIL CANYON

(CFS)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1976 | 9702. | 6556. | 7882. | 4649. | 3234. | 2318. | 1765. | 1401. | 1199. | 1078. | 1038. | 997. | 943. |
| | 943. | 943. | 910. | 896. | 896. | 896. | 896. | 896. | 876. | 849. | 849. | 849. | 849. |
| | 849. | 889. | 1105. | 1846. | 4676. | 13151. | 12639. | 13218. | 15213. | 26127. | 28148. | 19821. | 19147. |
| | 18231. | 18190. | 17341. | 17786. | 20481. | 26140. | 19403. | 14903. | 10548. | 7290. | 5971. | 6005. | 7310. |
| 1977 | 4557. | 3719. | 3546. | 3148. | 2776. | 2560. | 2399. | 2264. | 2722. | 2560. | 2318. | 2129. | 1967. |
| | 1846. | 1792. | 1698. | 1657. | 1603. | 1536. | 1509. | 1509. | 1469. | 1415. | 1415. | 1415. | 1415. |
| | 1509. | 1509. | 1590. | 1671. | 1859. | 3261. | 11804. | 18109. | 27541. | 32972. | 43670. | 35788. | 31934. |
| | 20481. | 22772. | 24065. | 20023. | 21020. | 20117. | 18406. | 18608. | 11804. | 9774. | 13838. | 13272. | 12766. |
| 1978 | 8327. | 8448. | 7424. | 5538. | 4231. | 3611. | 3254. | 3018. | 2796. | 2601. | 2486. | 2412. | 2230. |
| | 2109. | 1987. | 1886. | 1812. | 1705. | 1603. | 1556. | 1556. | 1509. | 1509. | 1509. | 1509. | 1529. |
| | 1556. | 1556. | 1556. | 1644. | 3436. | 11844. | 16169. | 10941. | 11669. | 14512. | 20158. | 17247. | 21492. |
| | 21047. | 19551. | 19767. | 19390. | 19066. | 18029. | 16762. | 13986. | 10079. | 10577. | 9534. | 7167. | 6113. |
| 1979 | 5108. | 5724. | 4623. | 3470. | 3374. | 2948. | 2210. | 1940. | 1859. | 1792. | 1630. | 1469. | 1415. |
| | 1374. | 1321. | 1321. | 1321. | 1226. | 1226. | 1226. | 1226. | 1132. | 1132. | 1132. | 1132. | 1132. |
| | 1132. | 1186. | 1307. | 1644. | 2587. | 4851. | 11318. | 18056. | 29873. | 25925. | 21761. | 19646. | 24308. |
| | 24874. | 24604. | 29953. | 30614. | 25008. | 23391. | 18891. | 16088. | 14310. | 8911. | 8680. | 12774. | 11558. |
| 1980 | 7442. | 9446. | 6635. | 4902. | 4595. | 4173. | 4649. | 3328. | 3166. | 2587. | 2331. | 2129. | 1927. |
| | 1806. | 1725. | 1630. | 1550. | 1509. | 1442. | 1374. | 1321. | 1321. | 1321. | 1321. | 1321. | 1321. |
| | 1321. | 1321. | 1368. | 1886. | 3908. | 9163. | 13124. | 11736. | 18716. | 30317. | 23890. | 30937. | 26989. |
| | 29563. | 29994. | 31651. | 28431. | 31139. | 21882. | 20683. | 18756. | 13636. | 9970. | 10662. | 17921. | 13380. |
| 1981 | 9289. | 6280. | 6888. | 5677. | 4393. | 3972. | 2964. | 3018. | 3018. | 2183. | 1684. | 1583. | 1523. |
| | 1482. | 1725. | 2008. | 2169. | 2196. | 2277. | 1900. | 1509. | 1415. | 1415. | 1509. | 1536. | 1556. |
| | 1603. | 1671. | 1779. | 2304. | 5304. | 19241. | 19322. | 12733. | 20697. | 17571. | 15954. | 17166. | 20050. |
| | 16816. | 39695. | 36806. | 34615. | 36408. | 34103. | 44074. | 34925. | 23553. | 16964. | 13676. | 11413. | 10616. |
| 1982 | 7207. | 6791. | 6979. | 8094. | 4350. | 3719. | 3638. | 3059. | 2667. | 2384. | 2250. | 2170. | 2170. |
| | 2170. | 2170. | 2170. | 2170. | 2183. | 2223. | 1623. | 1179. | 1038. | 1038. | 1038. | 1098. | 1408. |
| | 1415. | 1415. | 1563. | 2075. | 3194. | 7640. | 14148. | 18999. | 21424. | 24658. | 20616. | 27218. | 26410. |
| | 18392. | 22744. | 23122. | 25938. | 22313. | 15684. | 13649. | 11912. | 13218. | 12720. | 15927. | 25048. | 15779. |

TABLE 5
MONTHLY STREAMFLOW AT CANTWELL*
(CFS)

| YR | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | SUMYR | CALYR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 4218.3 | 1824.1 | 924.6 | 838.3 | 662.6 | 562.7 | 618.3 | 7827.5 | 15670.4 | 16690.4 | 13901.9 | 5631.6 | 69360.7 | 1950 |
| 2 | 2710.0 | 889.0 | 710.7 | 556.2 | 494.8 | 409.5 | 999.4 | 6194.6 | 12003.0 | 14652.4 | 11642.8 | 11693.5 | 62955.8 | 1951 |
| 3 | 3255.8 | 1575.1 | 956.5 | 740.4 | 492.3 | 560.5 | 639.3 | 2642.7 | 16465.7 | 17394.7 | 13705.1 | 8185.0 | 66613.1 | 1952 |
| 4 | 3431.2 | 1668.6 | 932.4 | 731.2 | 511.6 | 476.7 | 833.7 | 5960.2 | 13671.0 | 13140.8 | 11158.3 | 5876.8 | 58392.4 | 1953 |
| 5 | 2334.1 | 916.8 | 794.1 | 708.4 | 482.6 | 443.3 | 638.4 | 7852.1 | 16795.4 | 16371.9 | 19033.7 | 9832.6 | 76203.3 | 1954 |
| 6 | 3293.4 | 1784.7 | 1105.3 | 930.6 | 797.6 | 491.0 | 563.2 | 3014.7 | 14675.8 | 16621.7 | 12900.7 | 6064.7 | 62243.4 | 1955 |
| 7 | 2465.1 | 1075.3 | 855.2 | 684.3 | 727.2 | 614.7 | 569.2 | 8231.9 | 20082.3 | 18916.4 | 14164.8 | 8487.2 | 76873.6 | 1956 |
| 8 | 2547.4 | 1279.1 | 902.1 | 888.4 | 843.4 | 851.3 | 802.6 | 8230.5 | 19438.8 | 16361.0 | 13422.6 | 8899.4 | 74466.8 | 1957 |
| 9 | 3410.4 | 2051.9 | 1096.8 | 876.9 | 592.2 | 454.1 | 689.9 | 3004.9 | 13973.2 | 15743.3 | 12723.2 | 4464.4 | 59081.3 | 1958 |
| 10 | 2690.1 | 969.6 | 733.6 | 661.7 | 644.9 | 501.2 | 671.2 | 7894.5 | 16362.3 | 15620.2 | 16790.6 | 8063.5 | 71603.4 | 1959 |
| 11 | 3711.0 | 1718.7 | 1187.7 | 1042.0 | 826.4 | 695.6 | 785.6 | 13750.5 | 11108.1 | 16291.3 | 17056.1 | 12704.7 | 80877.7 | 1960 |
| 12 | 4625.6 | 2012.7 | 1534.8 | 1207.4 | 984.7 | 1056.1 | 1701.7 | 9688.0 | 15710.0 | 14820.0 | 16700.0 | 6725.0 | 76766.0 | 1961 |
| 13 | 3281.0 | 1800.0 | 1400.0 | 1300.0 | 1000.0 | 940.0 | 1200.0 | 10000.0 | 28320.1 | 20890.0 | 16000.0 | 9410.0 | 95541.1 | 1962 |
| 14 | 4326.0 | 2200.0 | 1400.0 | 1000.0 | 850.0 | 760.0 | 720.0 | 11340.0 | 15000.0 | 22790.0 | 18190.0 | 9187.0 | 87763.1 | 1963 |
| 15 | 3848.0 | 1300.0 | 877.0 | 644.0 | 586.0 | 429.0 | 465.0 | 2806.0 | 34630.0 | 17040.0 | 11510.0 | 5352.0 | 79487.0 | 1964 |
| 16 | 3134.0 | 1911.0 | 921.0 | 760.0 | 680.0 | 709.0 | 1097.0 | 8818.0 | 16430.0 | 18350.0 | 13440.0 | 12910.0 | 79160.1 | 1965 |
| 17 | 3116.0 | 1000.0 | 750.0 | 700.0 | 650.0 | 650.0 | 875.0 | 4387.0 | 18500.0 | 12220.0 | 12680.0 | 6523.0 | 62051.0 | 1966 |
| 18 | 2322.0 | 780.0 | 720.0 | 680.0 | 640.0 | 560.0 | 513.0 | 9452.0 | 19620.0 | 16880.0 | 19190.0 | 10280.0 | 81637.1 | 1967 |
| 19 | 3084.0 | 1490.0 | 1332.0 | 1232.0 | 1200.0 | 1200.0 | 1223.0 | 9268.0 | 19500.0 | 17480.0 | 10940.0 | 5410.0 | 73359.1 | 1968 |
| 20 | 2406.0 | 1063.0 | 618.0 | 508.0 | 485.0 | 548.0 | 998.0 | 7471.0 | 12330.0 | 13510.0 | 6597.0 | 3376.0 | 49910.0 | 1969 |
| 21 | 1638.0 | 815.0 | 543.0 | 437.0 | 426.0 | 463.0 | 887.0 | 7580.0 | 9909.0 | 13900.0 | 12320.0 | 5211.0 | 54129.0 | 1970 |
| 22 | 2155.0 | 1530.0 | 1048.0 | 731.0 | 503.0 | 470.0 | 529.0 | 1915.0 | 21970.0 | 18130.0 | 22710.0 | 9800.0 | 81491.1 | 1971 |
| 23 | 4058.0 | 2050.0 | 1371.0 | 1068.0 | 922.0 | 881.0 | 876.0 | 9694.0 | 20000.0 | 16690.0 | 15620.0 | 9243.0 | 82653.0 | 1972 |
| 24 | 3619.2 | 1962.0 | 1138.5 | 895.6 | 778.9 | 638.9 | 723.2 | 4763.6 | 16762.6 | 12619.1 | 12379.8 | 5037.5 | 61318.9 | 1973 |
| 25 | 2037.4 | 929.4 | 651.2 | 583.7 | 467.7 | 407.8 | 553.0 | 9163.1 | 12544.9 | 13434.2 | 11833.3 | 7888.1 | 60493.8 | 1974 |
| 26 | 2108.9 | 1191.4 | 929.8 | 812.5 | 779.6 | 669.5 | 807.2 | 5583.5 | 19277.4 | 20812.1 | 14871.9 | 10648.4 | 78492.2 | 1975 |
| 27 | 3879.3 | 1052.1 | 564.4 | 549.6 | 529.7 | 496.4 | 628.4 | 4788.3 | 16571.4 | 14057.3 | 14468.0 | 4585.6 | 62170.6 | 1976 |
| 28 | 2198.5 | 1195.9 | 1150.1 | 848.6 | 689.9 | 777.8 | 996.2 | 9619.2 | 30705.6 | 16666.4 | 12242.6 | 7420.0 | 84510.7 | 1977 |
| 29 | 3968.8 | 1833.7 | 1263.7 | 1192.1 | 1034.4 | 1272.7 | 1368.8 | 7819.4 | 15655.3 | 16812.8 | 10181.5 | 5488.6 | 67891.8 | 1978 |
| 30 | 2345.0 | 1288.6 | 1032.3 | 878.5 | 808.3 | 746.7 | 870.6 | 6209.9 | 15598.4 | 18493.7 | 12750.7 | 7320.9 | 68343.7 | 1979 |
| 31 | | | | | | | | | 17370.0 | 20460.0 | 14870.0 | 8570.0 | | 1980 |
| 32 | 5472.0 | 2487.0 | 1658.0 | 1694.0 | 1186.0 | 919.0 | 1218.0 | 12150.0 | 14020.0 | 20870.0 | 22760.0 | 9417.0 | 93851.0 | 1981 |
| 33 | 3829.0 | 1627.0 | 1297.0 | 1061.0 | 698.0 | 573.0 | 573.0 | 8219.0 | 16500.0 | 16540.0 | 11010.0 | 9942.0 | 71869.0 | 1982 |
| 34 | 3309.0 | 1600.0 | 1400.0 | 1300.0 | 1200.0 | 1148.0 | 1210.0 | 8196.0 | 16460.0 | 16230.0 | 17000.0 | 8650.0 | 77703.0 | 1983** |
| 35 | 5377.0 | 2130.0 | 1600.0 | 1500.0 | 1500.0 | 1481.0 | 1460.0 | 8481.0 | 18910.0 | | | | | 1984** |

* The Cantwell gage became operational in June, 1980. Flows for the period Oct. 1949 to Sept. 1979 were generated by Acres American, Inc. using a multi-site regression model. Flows have not been generated for the period Oct. 1979 to May 1980.

** Preliminary data obtained from USGS

421493/TBL
850116

TABLE 6

MONTHLY STREAMFLOW AT GOLD CREEK

(CFS)

| YR | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | SUMYR | CALYR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 6335.0 | 2583.0 | 1439.0 | 1027.0 | 788.0 | 726.0 | 870.0 | 11510.0 | 19600.0 | 22600.0 | 19880.0 | 8301.0 | 95659.1 | 1950 |
| 2 | 3848.0 | 1300.0 | 1100.0 | 960.0 | 820.0 | 740.0 | 1617.0 | 14090.0 | 20790.0 | 22570.0 | 19670.0 | 21240.0 | 108745.1 | 1951 |
| 3 | 5571.0 | 2744.0 | 1900.0 | 1600.0 | 1000.0 | 880.0 | 920.0 | 5419.0 | 32370.1 | 26390.0 | 20920.0 | 14480.0 | 114194.1 | 1952 |
| 4 | 8202.0 | 3497.0 | 1700.0 | 1100.0 | 820.0 | 820.0 | 1615.0 | 19270.0 | 27320.1 | 20200.0 | 20610.0 | 15270.0 | 120424.1 | 1953 |
| 5 | 5604.0 | 2100.0 | 1500.0 | 1300.0 | 1000.0 | 780.0 | 1235.0 | 17280.0 | 25250.0 | 20360.0 | 26100.0 | 17920.0 | 115429.1 | 1954 |
| 6 | 5370.0 | 2760.0 | 2045.0 | 1794.0 | 1400.0 | 1100.0 | 1200.0 | 9319.0 | 29860.0 | 27560.0 | 27550.0 | 14290.0 | 122448.1 | 1955 |
| 7 | 4951.0 | 1900.0 | 1300.0 | 980.0 | 970.0 | 940.0 | 950.0 | 17660.0 | 33340.0 | 31090.1 | 24530.0 | 18330.0 | 136941.2 | 1956 |
| 8 | 5806.0 | 3050.0 | 2142.0 | 1700.0 | 1500.0 | 1200.0 | 1200.0 | 13750.0 | 30160.0 | 23310.0 | 20540.0 | 19800.0 | 124158.1 | 1957 |
| 9 | 8212.0 | 3954.0 | 3264.0 | 1965.0 | 1307.0 | 1148.0 | 1533.0 | 12900.0 | 25700.0 | 22880.0 | 22540.0 | 7550.0 | 112953.1 | 1958 |
| 10 | 4811.0 | 2150.0 | 1513.0 | 1448.0 | 1307.0 | 980.0 | 1250.0 | 15990.0 | 23320.0 | 25000.0 | 31180.0 | 16920.0 | 125869.1 | 1959 |
| 11 | 6558.0 | 2850.0 | 2200.0 | 1845.0 | 1452.0 | 1197.0 | 1300.0 | 15780.0 | 15530.0 | 22980.0 | 23590.0 | 20510.0 | 115792.1 | 1960 |
| 12 | 7794.0 | 3000.0 | 2694.0 | 2452.0 | 1754.0 | 1810.0 | 2650.0 | 17360.0 | 29450.0 | 24570.0 | 22100.0 | 13370.0 | 129004.1 | 1961 |
| 13 | 5916.0 | 2700.0 | 2100.0 | 1900.0 | 1500.0 | 1400.0 | 1700.0 | 12590.0 | 43270.0 | 25850.0 | 23550.0 | 15890.0 | 138366.0 | 1962 |
| 14 | 6723.0 | 2800.0 | 2000.0 | 1600.0 | 1500.0 | 1000.0 | 830.0 | 19030.0 | 26000.0 | 34400.0 | 23670.0 | 12320.0 | 131873.0 | 1963 |
| 15 | 6449.0 | 2250.0 | 1494.0 | 1048.0 | 966.0 | 713.0 | 745.0 | 4307.0 | 50580.0 | 22950.0 | 16440.0 | 9571.0 | 117571.1 | 1964 |
| 16 | 6291.0 | 2799.0 | 1211.0 | 960.0 | 860.0 | 900.0 | 1360.0 | 12990.0 | 25720.0 | 27840.0 | 21120.0 | 19350.0 | 121401.1 | 1965 |
| 17 | 7205.0 | 2098.0 | 1631.0 | 1400.0 | 1300.0 | 1300.0 | 1775.0 | 9645.0 | 32950.0 | 19860.0 | 21830.0 | 11750.0 | 112744.1 | 1966 |
| 18 | 4163.0 | 1600.0 | 1500.0 | 1500.0 | 1400.0 | 1200.0 | 1167.0 | 15480.0 | 29510.0 | 26800.0 | 32620.0 | 16870.0 | 133810.1 | 1967 |
| 19 | 4900.0 | 2353.0 | 2055.0 | 1981.0 | 1900.0 | 1900.0 | 1910.0 | 16180.0 | 31550.0 | 26420.0 | 17170.0 | 8816.0 | 117513.1 | 1968 |
| 20 | 3822.0 | 1630.0 | 882.0 | 724.0 | 723.0 | 816.0 | 1510.0 | 11050.0 | 15500.0 | 16100.0 | 8879.0 | 5093.0 | 66729.0 | 1969 |
| 21 | 3124.0 | 1215.0 | 866.0 | 824.0 | 768.0 | 776.0 | 1080.0 | 11380.0 | 18630.0 | 22660.0 | 19980.0 | 9121.9 | 90424.1 | 1970 |
| 22 | 5288.0 | 3407.0 | 2290.0 | 1442.0 | 1036.0 | 950.0 | 1082.0 | 3745.0 | 32930.0 | 23950.0 | 31910.0 | 14440.0 | 122470.1 | 1971 |
| 23 | 5847.0 | 3093.0 | 2510.0 | 2239.0 | 2028.0 | 1823.0 | 1710.0 | 21890.0 | 34430.0 | 22770.0 | 19290.0 | 12400.0 | 130030.1 | 1972 |
| 24 | 4826.0 | 2253.0 | 1465.0 | 1200.0 | 1200.0 | 1000.0 | 1027.0 | 8235.0 | 27800.0 | 18250.0 | 20290.0 | 9074.0 | 96620.1 | 1973 |
| 25 | 3733.0 | 1523.0 | 1034.0 | 874.0 | 777.0 | 724.0 | 992.0 | 16180.0 | 17870.0 | 18800.0 | 16220.0 | 12250.0 | 90977.1 | 1974 |
| 26 | 3739.0 | 1700.0 | 1603.0 | 1516.0 | 1471.0 | 1400.0 | 1593.0 | 15350.0 | 32310.0 | 27720.0 | 18090.0 | 16310.0 | 122802.1 | 1975 |
| 27 | 7739.0 | 1993.0 | 1081.0 | 974.0 | 950.0 | 900.0 | 1373.0 | 12620.0 | 24380.0 | 18940.0 | 19800.0 | 6881.0 | 97631.1 | 1976 |
| 28 | 3874.0 | 2650.0 | 2403.0 | 1829.0 | 1618.0 | 1500.0 | 1680.0 | 12680.0 | 37970.0 | 22870.0 | 19240.0 | 12640.0 | 120954.1 | 1977 |
| 29 | 7571.0 | 3525.0 | 2589.0 | 2029.0 | 1668.0 | 1605.0 | 1702.0 | 11950.0 | 19050.0 | 21020.0 | 16390.0 | 8607.0 | 97706.1 | 1978 |
| 30 | 4907.0 | 2535.0 | 1681.0 | 1397.0 | 1286.0 | 1200.0 | 1450.0 | 13870.0 | 24690.0 | 28880.1 | 20460.0 | 10770.0 | 113126.1 | 1979 |
| 31 | 7311.0 | 4192.0 | 2416.0 | 1748.0 | 1466.0 | 1400.0 | 1670.0 | 12060.0 | 29080.0 | 32660.0 | 20960.0 | 13280.0 | 128243.0 | 1980 |
| 32 | 7725.0 | 3569.0 | 1915.0 | 2013.0 | 1975.0 | 1585.0 | 2040.0 | 16550.0 | 19300.0 | 33940.0 | 37870.0 | 13790.0 | 142272.0 | 1981 |
| 33 | 7463.0 | 3613.0 | 2397.0 | 2300.0 | 1739.0 | 1203.0 | 1783.0 | 13384.0 | 26100.0 | 24123.0 | 15274.0 | 17783.0 | 117162.0 | 1982 |
| 34 | 6892.0 | 2633.0 | 2358.0 | 2265.0 | 1996.0 | 1690.0 | 1900.0 | 14945.0 | 24113.0 | 21145.0 | 24500.0 | 13585.0 | 118022.0 | 1983* |
| 35 | 8181.0 | 3153.0 | 2258.0 | 2048.0 | 1969.0 | 1900.0 | 1837.0 | 13250.0 | 26770.0 | | | | | 1984* |

* Preliminary data obtained from USGS.

421493/TBL
850116

TABLE 7

7-DAY STREAMFLOWS AT GOLD CREEK

(CFS)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1950 | 12856. | 5740. | 4200. | 3800. | 3343. | 2986. | 2514. | 2471. | 1700. | 1700. | 1586. | 1314. | 1129. |
| | 1014. | 979. | 966. | 1100. | 1100. | 971. | 686. | 629. | 710. | 711. | 666. | 720. | 801. |
| | 774. | 783. | 849. | 1009. | 2314. | 8007. | 13671. | 14200. | 17914. | 17100. | 16571. | 26171. | 19343. |
| | 19957. | 21229. | 23214. | 25243. | 25100. | 23129. | 21157. | 17443. | 13171. | 9263. | 10500. | 7100. | 7186. |
| 1951 | 5257. | 4686. | 4091. | 2334. | 1471. | 1386. | 1300. | 1229. | 1171. | 1100. | 1100. | 1100. | 1100. |
| | 980. | 960. | 960. | 960. | 900. | 820. | 820. | 820. | 786. | 740. | 740. | 740. | 740. |
| | 774. | 997. | 1529. | 2657. | 6157. | 17329. | 19271. | 9567. | 16671. | 29543. | 21300. | 13543. | 19071. |
| | 20729. | 24343. | 23286. | 21414. | 21429. | 17614. | 18714. | 18314. | 25600. | 30057. | 18671. | 19286. | 18657. |
| 1952 | 9229. | 6171. | 4486. | 3486. | 3500. | 3204. | 2369. | 2343. | 2186. | 1900. | 1900. | 1900. | 1900. |
| | 1643. | 1600. | 1600. | 1600. | 1343. | 1000. | 1000. | 1000. | 949. | 880. | 880. | 880. | 880. |
| | 920. | 920. | 920. | 920. | 1191. | 1514. | 2071. | 4486. | 21929. | 24814. | 35143. | 38114. | 33729. |
| | 27629. | 19629. | 25086. | 27186. | 37243. | 25071. | 19686. | 14943. | 17329. | 18886. | 12771. | 11029. | 15086. |
| 1953 | 11143. | 10340. | 7233. | 5271. | 5000. | 4257. | 2729. | 3343. | 2429. | 1700. | 1700. | 1700. | 1700. |
| | 1186. | 1100. | 1100. | 1100. | 980. | 820. | 820. | 820. | 820. | 820. | 820. | 820. | 820. |
| | 930. | 930. | 1504. | 2500. | 14129. | 16814. | 15300. | 26386. | 20743. | 35114. | 27114. | 22071. | 25829. |
| | 20229. | 16271. | 19871. | 20657. | 25643. | 21857. | 17514. | 18029. | 21500. | 18786. | 17114. | 14271. | 12426. |
| 1954 | 8119. | 6733. | 4940. | 3937. | 2401. | 2271. | 2100. | 1957. | 1786. | 1500. | 1500. | 1500. | 1500. |
| | 1329. | 1300. | 1300. | 1300. | 1171. | 1000. | 1000. | 1000. | 906. | 780. | 780. | 780. | 780. |
| | 870. | 870. | 1496. | 1600. | 6743. | 12286. | 19900. | 22814. | 21571. | 25457. | 24457. | 23457. | 28514. |
| | 24486. | 19529. | 19000. | 19000. | 31143. | 24000. | 24000. | 24000. | 23000. | 16286. | 14000. | 13057. | 9561. |
| 1955 | 6500. | 6109. | 4600. | 4600. | 3686. | 3000. | 2829. | 2500. | 2414. | 2200. | 2157. | 1900. | 1900. |
| | 1986. | 2000. | 1714. | 1600. | 1514. | 1400. | 1400. | 1400. | 1271. | 1100. | 1100. | 1100. | 1100. |
| | 1200. | 1200. | 1200. | 1200. | 3557. | 4500. | 5257. | 15743. | 17429. | 20329. | 33143. | 35957. | 33671. |
| | 34186. | 28557. | 22043. | 26357. | 22614. | 20900. | 21443. | 26071. | 37243. | 19671. | 15029. | 12214. | 10993. |
| 1956 | 7236. | 5327. | 4359. | 3737. | 2486. | 2100. | 1929. | 1700. | 1586. | 1300. | 1300. | 1300. | 1300. |
| | 1026. | 980. | 980. | 980. | 976. | 970. | 970. | 970. | 957. | 940. | 940. | 940. | 940. |
| | 950. | 950. | 950. | 950. | 2514. | 11400. | 16271. | 32371. | 21686. | 33457. | 43543. | 31971. | 28186. |
| | 29057. | 31686. | 32000. | 31229. | 31429. | 28771. | 26000. | 20729. | 17714. | 16000. | 22429. | 21857. | 16000. |
| 1957 | 7200. | 7200. | 4886. | 4500. | 3757. | 3200. | 3071. | 2900. | 2757. | 2400. | 2329. | 1900. | 1900. |
| | 1729. | 1700. | 1700. | 1700. | 1614. | 1500. | 1500. | 1500. | 1371. | 1200. | 1200. | 1200. | 1200. |
| | 1200. | 1200. | 1200. | 1200. | 3414. | 5757. | 9400. | 21057. | 30914. | 37443. | 33086. | 29357. | 20100. |
| | 23214. | 21329. | 23914. | 25943. | 20957. | 20943. | 20829. | 19100. | 21143. | 18914. | 20643. | 20071. | 22029. |
| 1958 | 10333. | 6864. | 7230. | 7454. | 5429. | 4521. | 3870. | 3181. | 3586. | 4314. | 3680. | 2744. | 2229. |
| | 2429. | 2129. | 1857. | 1757. | 1457. | 1443. | 1300. | 1200. | 1200. | 1200. | 1171. | 1100. | 1100. |
| | 1200. | 1343. | 1457. | 1766. | 3990. | 7883. | 11014. | 20971. | 22057. | 28000. | 28000. | 24143. | 22000. |
| | 22000. | 22000. | 22000. | 21571. | 38686. | 27529. | 20443. | 16571. | 11557. | 8500. | 8500. | 6600. | 7543. |
| 1959 | 5991. | 5271. | 5043. | 3500. | 2986. | 2600. | 2214. | 1700. | 1529. | 1100. | 1214. | 1900. | 1900. |
| | 1557. | 1500. | 1429. | 1400. | 1400. | 1400. | 1343. | 1200. | 1106. | 980. | 980. | 980. | 980. |
| | 1000. | 1000. | 1429. | 1500. | 2857. | 4543. | 19400. | 27486. | 22329. | 26029. | 19443. | 23171. | 25929. |
| | 26400. | 25343. | 27457. | 21686. | 23886. | 18629. | 23914. | 44171. | 43171. | 28700. | 14829. | 11137. | 12007. |
| 1960 | 10714. | 7400. | 4071. | 5086. | 3486. | 3000. | 2871. | 2700. | 2557. | 2200. | 2200. | 2200. | 2200. |
| | 2029. | 2000. | 1786. | 1700. | 1614. | 1500. | 1471. | 1400. | 1357. | 1300. | 1243. | 1100. | 1100. |
| | 1100. | 1100. | 1443. | 1500. | 5857. | 7600. | 14686. | 22857. | 24286. | 14357. | 14886. | 15414. | 16943. |
| | 22929. | 17000. | 19557. | 26814. | 32043. | 25429. | 22471. | 21714. | 20857. | 18314. | 28943. | 20514. | 17557. |
| 1961 | 12529. | 9100. | 6471. | 4714. | 3586. | 3300. | 3043. | 2700. | 2757. | 2900. | 2843. | 2500. | 2500. |
| | 2414. | 2400. | 2471. | 2500. | 2200. | 1800. | 1771. | 1700. | 1614. | 1500. | 1671. | 2100. | 2100. |
| | 2500. | 2500. | 2757. | 2800. | 7229. | 12714. | 22000. | 20957. | 19814. | 18971. | 30986. | 38714. | 32529. |
| | 23000. | 24143. | 25000. | 25900. | 25643. | 26000. | 22200. | 21071. | 15657. | 12429. | 14100. | 13429. | 15457. |
| 1962 | 10429. | 4600. | 4600. | 4600. | 3514. | 2700. | 2700. | 2700. | 2529. | 2100. | 2100. | 2100. | 2100. |
| | 1929. | 1900. | 1900. | 1900. | 1729. | 1500. | 1500. | 1500. | 1457. | 1400. | 1400. | 1400. | 1400. |
| | 1700. | 1700. | 1700. | 1700. | 3700. | 4500. | 12214. | 18000. | 28471. | 30286. | 58743. | 50229. | 35557. |
| | 27186. | 26543. | 23129. | 27186. | 26057. | 23000. | 23000. | 23000. | 23429. | 23571. | 14886. | 12057. | 13871. |

TABLE 7 (continued)

7-DAY STREAMFLOWS AT GOLD CREEK

(CFS)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1963 | 9150. | 6967. | 6071. | 5486. | 3700. | 2800. | 2800. | 2800. | 2571. | 2000. | 2000. | 2000. | 2000. |
| | 1657. | 1600. | 1600. | 1600. | 1557. | 1500. | 1500. | 1500. | 1286. | 1000. | 1000. | 1000. | 1000. |
| | 830. | 830. | 830. | 830. | 2666. | 3400. | 19171. | 31000. | 35686. | 26000. | 26000. | 26000. | 26000. |
| | 31143. | 40257. | 38143. | 32571. | 27800. | 25143. | 21814. | 23071. | 19543. | 15143. | 13543. | 10829. | 10979. |
| 1964 | 8897. | 7491. | 6129. | 4643. | 2886. | 2600. | 2300. | 1900. | 1843. | 1700. | 1643. | 1300. | 1300. |
| | 1129. | 1100. | 1029. | 1000. | 1000. | 1000. | 980. | 930. | 861. | 770. | 739. | 660. | 660. |
| | 710. | 710. | 770. | 780. | 866. | 1043. | 1400. | 3099. | 28990. | 75029. | 51529. | 43000. | 31100. |
| | 25371. | 28143. | 24671. | 16929. | 19757. | 18729. | 15100. | 16100. | 13600. | 11354. | 9253. | 9304. | 9106. |
| 1965 | 7677. | 8591. | 5623. | 4473. | 3080. | 2836. | 2807. | 3129. | 2033. | 1370. | 1221. | 1110. | 1110. |
| | 981. | 960. | 960. | 960. | 917. | 860. | 860. | 860. | 877. | 900. | 900. | 900. | 900. |
| | 1180. | 1180. | 1469. | 1540. | 2011. | 5386. | 9371. | 16886. | 33643. | 21971. | 23471. | 22429. | 33014. |
| | 30357. | 30614. | 28514. | 24729. | 22229. | 19671. | 30386. | 20371. | 11343. | 16849. | 20700. | 18943. | 25043. |
| 1966 | 15066. | 6387. | 5929. | 3250. | 2764. | 2264. | 2000. | 1907. | 1829. | 1714. | 1657. | 1590. | 1530. |
| | 1419. | 1400. | 1400. | 1400. | 1357. | 1300. | 1300. | 1300. | 1300. | 1300. | 1300. | 1300. | 1300. |
| | 1500. | 1500. | 1971. | 2050. | 3014. | 3886. | 7200. | 13800. | 21657. | 47686. | 34129. | 28829. | 24329. |
| | 18643. | 17757. | 18586. | 21029. | 28014. | 22914. | 18843. | 22829. | 18300. | 12886. | 12514. | 12371. | 10314. |
| 1967 | 6990. | 4687. | 3544. | 2400. | 1729. | 1600. | 1600. | 1600. | 1571. | 1500. | 1500. | 1500. | 1500. |
| | 1500. | 1500. | 1500. | 1500. | 1457. | 1400. | 1400. | 1400. | 1314. | 1200. | 1200. | 1200. | 1200. |
| | 1100. | 1100. | 1129. | 1300. | 1743. | 4929. | 17143. | 23986. | 28829. | 26571. | 34814. | 29014. | 28386. |
| | 21557. | 21471. | 29857. | 34800. | 27100. | 25043. | 54871. | 30600. | 20614. | 29071. | 17157. | 12471. | 10831. |
| 1968 | 6851. | 5703. | 4460. | 3400. | 2857. | 2429. | 2300. | 2214. | 2171. | 2100. | 2100. | 2014. | 2000. |
| | 2000. | 2000. | 2000. | 1971. | 1900. | 1900. | 1900. | 1900. | 1900. | 1900. | 1900. | 1900. | 1900. |
| | 1871. | 1800. | 1886. | 2014. | 2243. | 2943. | 13086. | 33843. | 27543. | 26457. | 36829. | 37343. | 27186. |
| | 29429. | 26786. | 25857. | 24986. | 22214. | 20143. | 16757. | 15143. | 13429. | 11271. | 11291. | 7210. | 6309. |
| 1969 | 5061 | 4370 | 3366 | 2987 | 2543 | 1971 | 1500 | 1314 | 1086 | 950 | 900 | 850 | 807 |
| | 771 | 750 | 700 | 700 | 700 | 700 | 714 | 750 | 750 | 779 | 800 | 843 | 871 |
| | 957 | 1129 | 1471 | 2086 | 3400 | 6013 | 11434 | 20057 | 12069 | 12800 | 16314 | 17871 | 16229 |
| | 13929 | 17629 | 18114 | 15143 | 13386 | 14286 | 7399 | 6001 | 5593 | 6303 | 5511 | 4726 | 4536 |
| 1970 | 3940. | 3709. | 3249. | 2193. | 1714. | 1429. | 1129. | 1000. | 956. | 900. | 857. | 850. | 850. |
| | 850. | 850. | 814. | 800. | 800. | 800. | 750. | 750. | 750. | 750. | 764. | 800. | 800. |
| | 850. | 936. | 1071. | 1300. | 1943. | 4614. | 16343. | 14757. | 18129. | 16971. | 16371. | 15500. | 26100. |
| | 25029. | 21000. | 22500. | 21514. | 26429. | 22871. | 17671. | 19971. | 13786. | 11897. | 9466. | 9643. | 6143. |
| 1971 | 7017. | 5857. | 4771. | 4057. | 4000. | 3800. | 3457. | 3057. | 2743. | 2571. | 2400. | 2200. | 1971. |
| | 1743. | 1557. | 1414. | 1243. | 1157. | 1100. | 1000. | 1000. | 979. | 950. | 950. | 950. | 950. |
| | 964. | 1000. | 1086. | 1214. | 1457. | 1900. | 2800. | 4943. | 8714. | 22857. | 47186. | 28657. | 39586. |
| | 24471. | 24900. | 28700. | 18671. | 24357. | 44743. | 40000. | 24529. | 19471. | 22857. | 14586. | 11029. | 10939. |
| 1972 | 7744. | 6939. | 5267. | 4343. | 3600. | 3257. | 3086. | 2914. | 2771. | 2600. | 2600. | 2400. | 2400. |
| | 2400. | 2200. | 2200. | 2200. | 2200. | 2086. | 2000. | 2000. | 1914. | 1886. | 1800. | 1800. | 1771. |
| | 1700. | 1700. | 1629. | 1700. | 3386. | 19571. | 19286. | 26886. | 44243. | 24471. | 43457. | 36057. | 25729. |
| | 25371. | 25357. | 22600. | 18429. | 20243. | 21729. | 19929. | 20600. | 13786. | 13186. | 18029. | 13286. | 6857. |
| 1973 | 4786. | 4429. | 6143. | 4557. | 3114. | 2543. | 2171. | 2000. | 1743. | 1600. | 1429. | 1400. | 1400. |
| | 1229. | 1200. | 1200. | 1200. | 1200. | 1200. | 1200. | 1200. | 1114. | 1000. | 1000. | 1000. | 1000. |
| | 1000. | 1000. | 1000. | 1057. | 1400. | 2686. | 9200. | 12671. | 15714. | 20214. | 33700. | 36443. | 23943. |
| | 21057. | 20129. | 15229. | 16429. | 17657. | 21029. | 16757. | 21800. | 23171. | 12814. | 8942. | 7551. | 7010. |
| 1974 | 5656. | 4539. | 3130. | 2371. | 1914. | 1643. | 1514. | 1366. | 1271. | 1143. | 1029. | 979. | 950. |
| | 907. | 900. | 864. | 850. | 829. | 800. | 786. | 750. | 750. | 750. | 736. | 700. | 700. |
| | 700. | 729. | 879. | 1400. | 2571. | 6586. | 12286. | 27429. | 31357. | 19557. | 16700. | 15614. | 16671. |
| | 16943. | 21057. | 19314. | 18571. | 17714. | 18686. | 15986. | 12651. | 17130. | 16614. | 9314. | 9413. | 14154. |
| 1975 | 5503. | 5469. | 2914. | 1943. | 1700. | 1700. | 1700. | 1700. | 1686. | 1600. | 1600. | 1600. | 1600. |
| | 1586. | 1500. | 1500. | 1500. | 1500. | 1500. | 1500. | 1443. | 1400. | 1400. | 1400. | 1400. | 1400. |
| | 1400. | 1414. | 1543. | 1829. | 2843. | 6857. | 15071. | 23029. | 30500. | 36400. | 27343. | 34357. | 30714. |
| | 27500. | 29900. | 28343. | 25929. | 24200. | 19486. | 18614. | 16429. | 14157. | 11743. | 19886. | 18629. | 17943. |

TABLE 7 (continued)

7-DAY STREAMFLOWS AT GOLD CREEK

(CFS)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1976 | 10286. | 9071. | 6357. | 4929. | 3429. | 2457. | 1871. | 1486. | 1271. | 1143. | 1100. | 1057. | 1000. |
| | 1000. | 1000. | 964. | 950. | 950. | 950. | 950. | 950. | 929. | 900. | 900. | 900. | 900. |
| | 900. | 943. | 1171. | 1957. | 4957. | 13943. | 13400. | 14014. | 16129. | 27700. | 29843. | 21014. | 20300. |
| | 19329. | 19286. | 18386. | 18857. | 21714. | 27714. | 20571. | 15800. | 11183. | 7729. | 6330. | 6367. | 7750. |
| 1977 | 4831. | 3943. | 3700. | 3357. | 2943. | 2714. | 2543. | 2400. | 2886. | 2714. | 2457. | 2257. | 2086. |
| | 1957. | 1900. | 1800. | 1757. | 1700. | 1629. | 1600. | 1600. | 1557. | 1500. | 1500. | 1500. | 1500. |
| | 1600. | 1600. | 1686. | 1771. | 1971. | 3457. | 12514. | 19200. | 29200. | 34957. | 46300. | 37943. | 33857. |
| | 21714. | 24143. | 25514. | 21229. | 22286. | 21329. | 19514. | 19729. | 12514. | 10363. | 14671. | 14071. | 13534. |
| 1978 | 8829. | 6957. | 7871. | 5871. | 4886. | 3829. | 3450. | 3200. | 2968. | 2757. | 2636. | 2557. | 2364. |
| | 2236. | 2107. | 2000. | 1921. | 1807. | 1700. | 1650. | 1650. | 1600. | 1600. | 1600. | 1600. | 1621. |
| | 1650. | 1650. | 1650. | 1743. | 3643. | 12557. | 17143. | 11600. | 12371. | 15386. | 21371. | 18286. | 22786. |
| | 22314. | 20729. | 20957. | 20557. | 20214. | 19114. | 17771. | 14829. | 10686. | 11214. | 10109. | 7599. | 6481. |
| 1979 | 5416. | 6069. | 4901. | 3679. | 3577. | 3126. | 2343. | 2057. | 1971. | 1900. | 1729. | 1557. | 1500. |
| | 1457. | 1400. | 1400. | 1400. | 1300. | 1300. | 1300. | 1300. | 1200. | 1200. | 1200. | 1200. | 1200. |
| | 1200. | 1257. | 1386. | 1743. | 2743. | 5143. | 12000. | 19143. | 31671. | 27486. | 23071. | 20829. | 25771. |
| | 26371. | 26086. | 31757. | 32457. | 26514. | 24800. | 20029. | 17057. | 15171. | 9447. | 9203. | 13543. | 12254. |
| 1980 | 7890. | 10014. | 7034. | 5197. | 4871. | 4424. | 4929. | 3529. | 3357. | 2743. | 2471. | 2257. | 2043. |
| | 1914. | 1829. | 1729. | 1643. | 1600. | 1529. | 1457. | 1400. | 1400. | 1400. | 1400. | 1400. | 1400. |
| | 1400. | 1400. | 1471. | 2000. | 4143. | 9714. | 13914. | 12443. | 19843. | 32143. | 25329. | 32800. | 28614. |
| | 31343. | 31800. | 33557. | 30143. | 33014. | 23200. | 21929. | 19886. | 14457. | 10570. | 11304. | 19000. | 14186. |
| 1981 | 9849. | 6779. | 7303. | 6019. | 4657. | 4211. | 3143. | 3200. | 3200. | 2314. | 1786. | 1679. | 1614. |
| | 1571. | 1829. | 2129. | 2300. | 2329. | 2414. | 2014. | 1600. | 1500. | 1500. | 1600. | 1629. | 1650. |
| | 1700. | 1771. | 1886. | 2443. | 5623. | 20400. | 20486. | 13500. | 21943. | 18629. | 16914. | 18200. | 21257. |
| | 17829. | 42086. | 41143. | 30700. | 38600. | 36157. | 46729. | 37029. | 24971. | 17986. | 14500. | 12100. | 11256. |
| 1982 | 7641 | 7200 | 7399 | 8581 | 4612 | 3943 | 3857 | 3243 | 2828 | 2529 | 2385 | 2300 | 2300 |
| | 2300 | 2300 | 2300 | 2300 | 2314 | 2357 | 1721 | 1250 | 1100 | 1100 | 1100 | 1164 | 1497 |
| | 1500 | 1500 | 1657 | 2200 | 3386 | 8100 | 15000 | 20143 | 22714 | 26143 | 21857 | 28857 | 28000 |
| | 19500 | 24114 | 24514 | 27500 | 23657 | 16629 | 14471 | 12629 | 14014 | 13486 | 16886 | 26557 | 16729 |
| 1983 | 10429 | 8201 | 6677 | 3914 | 2971 | 2786 | 2643 | 2471 | 2400 | 2300 | 2300 | 2300 | 2443 |
| | 2771 | 2400 | 2129 | 2000 | 1957 | 1900 | 2043 | 2086 | 1957 | 1814 | 1700 | 1643 | 1514 |
| | 1500 | 1529 | 1786 | 2414 | 4586 | 11086 | 19143 | 17000 | 24143 | 27343 | 19586 | 23886 | 23671 |
| | 25371 | 21857 | 18243 | 19686 | 21014 | 26586 | 24629 | 21757 | 26529 | 18957 | 11729 | 10334 | 13574 |
| 1984 | 11283 | 9373 | 7946 | 5457 | 4843 | 3386 | 2943 | 2700 | 2514 | 2386 | 2286 | 2200 | 2129 |
| | 2100 | 2100 | 2029 | 2000 | 2000 | 2000 | 2000 | 1943 | 1900 | 1900 | 1900 | 1900 | 1900 |
| | 1800 | 1800 | 1800 | 1857 | 2800 | 6400 | 15643 | 23543 | 14543 | 18457 | 27700 | 25871 | 29100 |

NOTE: Streamflows for the water years 1983 and 1984 are the preliminary data obtained from USGS.

Table 8

ADJUSTMENTS FOR GLACIERS WASTE
(CFS)

| | Scenario 4 | | | | Scenario 5 | | | |
|---|---|---|---|---|---|---|---|---|
| Year | June | July | Aug | Sept | June | July | Aug | Sept |
| 1950 | 1,632 | 2,244 | 2,376 | 612 | 2,952 | 4,068 | 4,308 | 1,104 |
| 1951 | 2,388 | 4,260 | 2,808 | 1,044 | 4,320 | 7,704 | 5,076 | 1,884 |
| 1952 | 2,208 | 3,072 | 2,280 | 312 | 3,996 | 5,568 | 4,140 | 576 |
| 1953 | 912 | 984 | 636 | 216 | 4,860 | 5,304 | 3,384 | 1,176 |
| 1954 | 2,263 | 2,496 | 2,184 | 780 | 4,116 | 4,548 | 3,972 | 1,416 |
| 1955 | 1,860 | 3,936 | 2,316 | 516 | 3,264 | 7,140 | 4,188 | 936 |
| 1956 | 2,436 | 3,360 | 2,988 | 276 | 4,368 | 6,024 | 5,376 | 216 |
| 1957 | 3,288 | 3,084 | 2,880 | 696 | 5,940 | 5,580 | 5,220 | 1,260 |
| 1958 | 2,412 | 2,628 | 2,124 | 144 | 4,380 | 4,776 | 3,840 | 264 |
| 1959 | 3,144 | 2,364 | 2,616 | 612 | 5,712 | 4,284 | 4,764 | 1,116 |
| 1960 | 3,252 | 3,852 | 3,048 | 408 | 5,904 | 7.008 | 5,532 | 180 |
| 1961 | 2,832 | 3,384 | 2,556 | 360 | 5,124 | 6,120 | 4,632 | 660 |
| 1962 | 2,868 | 3,960 | 2,976 | 0 | 5,208 | 7,176 | 5,388 | 0 |
| 1963 | 1,704 | 3,708 | 2,904 | 1,704 | 3,084 | 6,720 | 5,268 | 3,084 |
| 1964 | 2,244 | 2,880 | 2,076 | 804 | 4,056 | 5,208 | 3,768 | 1,452 |
| 1965 | 1,992 | 3,984 | 2,832 | 1,680 | 3,624 | 7,260 | 5,160 | 3,060 |
| 1966 | 2,712 | 2,964 | 2,280 | 924 | 4,920 | 5,376 | 4,152 | 504 |
| 1967 | 2,604 | 3,180 | 2,988 | 864 | 4,716 | 5,760 | 5,412 | 1,572 |
| 1968 | 2,292 | 3,312 | 2,712 | 168 | 4,140 | 5,988 | 4,908 | 312 |
| 1969 | 1,680 | 1,728 | 888 | 324 | 3,048 | 3,312 | 1,704 | 624 |
| 1970 | 2,448 | 3,816 | 2,820 | 0 | 4,440 | 6,900 | 5,100 | 0 |
| 1971 | 2,436 | 3,564 | 3,312 | 492 | 4,380 | 6,312 | 5,952 | 876 |
| 1972 | 2,196 | 4,500 | 3,300 | 0 | 3,996 | 8,172 | 5,988 | 0 |
| 1973 | 2,292 | 3,324 | 2,052 | 240 | 4,152 | 6,012 | 3,720 | 432 |
| 1974 | 1,896 | 1,968 | 1,896 | 792 | 3,444 | 3,552 | 3,444 | 1,428 |
| 1975 | 2,280 | 3,672 | 2,976 | 996 | 4,128 | 6,636 | 5,376 | 1,788 |
| 1976 | 1,416 | 1,824 | 1,524 | 300 | 2,568 | 3,300 | 2,748 | 552 |
| 1977 | 2,772 | 3,516 | 3,720 | 744 | 5,616 | 6,744 | 6,360 | 1,344 |
| 1978 | 1,200 | 1,872 | 1,992 | 564 | 2,160 | 3,396 | 3,612 | 1,032 |
| 1979 | 2,028 | 3,228 | 2,856 | 1,104 | 3,672 | 5,844 | 5,184 | 2,004 |

Source: R&M

Table 9

MONTHLY STREAMFLOWS ADJUSTED FOR GLACIERS WASTE
SUSITNA RIVER AT WATANA
(CFS)

| | Scenario 4 | | | | Scenario 5 | | | |
|---|---|---|---|---|---|---|---|---|
| Year | June | July | Aug | Sept | June | July | Aug | Sept |
| 1950 | 14,800 | 16,949 | 14,538 | 6,708 | 13,480 | 15,125 | 12,666 | 6,216 |
| 1951 | 16,130 | 18,527 | 13,670 | 16,162 | 14,198 | 12,083 | 11,462 | 15,322 |
| 1952 | 23,565 | 19,039 | 15,076 | 11,259 | 21,777 | 16,543 | 13,216 | 10,995 |
| 1953 | 22,381 | 18,339 | 17,318 | 11,730 | 16,610 | 12,051 | 13,298 | 10,338 |
| 1954 | 17,209 | 14,488 | 18,237 | 8,386 | 15,361 | 12,436 | 16,449 | 7,750 |
| 1955 | 23,081 | 19,852 | 21,221 | 12,932 | 21,617 | 16,648 | 19,349 | 12,511 |
| 1956 | 24,736 | 22,471 | 16,165 | 12,911 | 22,804 | 19,807 | 13,777 | 12,978 |
| 1957 | 21,987 | 16,865 | 14,438 | 14,145 | 19,335 | 14,369 | 12,098 | 13,581 |
| 1958 | 19,686 | 17,125 | 16,719 | 5,835 | 17,718 | 14,977 | 15,003 | 5,715 |
| 1959 | 15,186 | 18,129 | 2,324 | 11,855 | 12,618 | 16,209 | 19,176 | 11,351 |
| 1960 | 9,981 | 15,654 | 16,275 | 15,678 | 7,329 | 12,498 | 13,791 | 15,906 |
| 1961 | 19,952 | 16,456 | 16,924 | 9,786 | 17,660 | 13,720 | 14,848 | 9,486 |
| 1962 | 33,149 | 19,489 | 16,911 | 12,746 | 30,809 | 16,268 | 14,489 | 12,746 |
| 1963 | 18,959 | 25,059 | 18,107 | 9,096 | 17,579 | 22,097 | 15,743 | 7,716 |
| 1964 | 40,598 | 17,703 | 11,972 | 6,220 | 38,786 | 14,875 | 16,284 | 6,072 |
| 1965 | 19,221 | 19,252 | 14,562 | 14,546 | 17,584 | 15,776 | 12,234 | 13,166 |
| 1966 | 23,228 | 13,190 | 15,111 | 8,710 | 21,020 | 10,778 | 13,239 | 8,290 |
| 1967 | 22,108 | 18,807 | 23,117 | 12,809 | 19,006 | 16,227 | 20,693 | 12,101 |
| 1968 | 23,412 | 18,771 | 11,456 | 6,996 | 21,564 | 16,095 | 9,239 | 6,852 |
| 1969 | 12,282 | 13,116 | 6,884 | 3,936 | 10,914 | 11,532 | 6,068 | 3,636 |
| 1970 | 11,951 | 14,594 | 13,444 | 7,224 | 9,959 | 11,510 | 11,164 | 7,224 |
| 1971 | 25,177 | 17,622 | 24,135 | 11,607 | 23,233 | 14,814 | 21,995 | 11,313 |
| 1972 | 25,233 | 15,320 | 14,210 | 10,956 | 23,433 | 11,648 | 11,522 | 10,956 |
| 1973 | 21,567 | 13,027 | 15,965 | 7,866 | 19,707 | 10,339 | 14,297 | 7,668 |
| 1974 | 12,885 | 14,004 | 11,628 | 8,704 | 11,337 | 12,420 | 10,080 | 8,358 |
| 1975 | 24,409 | 19,758 | 12,151 | 12,077 | 22,561 | 16,794 | 9,751 | 11,287 |
| 1976 | 18,528 | 15,191 | 16,870 | 5,412 | 17,426 | 13,715 | 15,646 | 5,160 |
| 1977 | 28,581 | 16,191 | 13,087 | 7,867 | 26,337 | 12,163 | 15,447 | 9,269 |
| 1978 | 16,077 | 16,513 | 11,429 | 6,569 | 15,117 | 14,989 | 9,800 | 6,101 |
| 1979 | 20,877 | 21,684 | 13,815 | 7,993 | 19,233 | 14,068 | 11,487 | 7,093 |

Source: R&M

Table 10

PAN EVAPORATION (INCHES)
McKINLEY PARK

| Year | May | Jun | Jul | Aug | Sep |
|---|---|---|---|---|---|
| | Months | | | | |
| 1967 | | 3.97 | 3.20 | 2.42 | |
| 1968 | | 3.31 | 3.67 | 2.25 | |
| 1969 | | | 3.48 | 2.39 | |
| 1970 | | | 3.35 | 2.20 | |
| 1971 | | 6.38 | 3.75 | 2.06 | |
| 1972 | | 3.97 | 4.10 | 2.61 | |
| 1973 | | 3.37 | 3.25 | 1.55 | |
| 1974 | | | | | |
| 1975 | | | | | |
| 1976 | | | | | |
| 1977 | | 3.77 | 4.02 | 3.37 | |
| 1978 | | 3.02 | 3.46 | 3.31 | |
| 1979 | | 2.81 | 2.97 | 2.73 | |
| 1980 | | 4.04 | 2.92 | 1.88 | |
| 1981 | | 3.24 | 1.89 | 2.18 | |
| Average | | 3.78 | 3.35 | 2.41 | |

Table 11

PAN EVAPORATION (INCHES)
MATANUSKA AGRICULTURAL EXPERIMENTAL STATION

| Year | May | Jun | Jul | Aug | Sep |
|---|---|---|---|---|---|
| | Months | | | | |
| 1951 | | | 4.16 | 2.21 | 1.79 |
| 1952 | | 4.45 | | 2.98 | 1.64 |
| 1953 | 3.99 | 4.96 | 4.88 | 2.58 | 1.71 |
| 1954 | 4.74 | 4.80 | 4.10 | 3.03 | 2.23 |
| 1955 | | 3.48 | 4.91 | 3.96 | 2.50 |
| 1956 | 4.83 | 4.32 | 4.44 | | 1.47 |
| 1957 | 6.41 | 5.45 | 4.80 | 3.59 | 2.03 |
| 1958 | 4.35 | 5.00 | 3.97 | 3.53 | 2.00 |
| 1959 | 4.76 | 5.23 | 2.79 | 2.82 | 1.46 |
| 1960 | 3.76 | 4.44 | 3.59 | 2.47 | 1.08 |
| 1961 | 5.18 | 4.17 | 3.40 | 2.41 | 1.62 |
| 1962 | 3.66 | 4.09 | 3.85 | 2.81 | 1.66 |
| 1963 | | 3.56 | 3.42 | 2.50 | 1.48 |
| 1964 | | 4.04 | | 3.06 | 1.60 |
| 1965 | | 4.18 | 7.19 | 4.34 | |
| 1966 | 3.56 | 4.08 | 4.36 | 2.60 | 2.25 |
| 1967 | 4.35 | 3.07 | 3.99 | 2.91 | 1.76 |
| 1968 | | 4.57 | 3.56 | 3.30 | 1.66 |
| 1969 | | 5.42 | 4.38 | 3.53 | 2.07 |
| 1970 | | | 5.03 | 3.13 | 2.36 |
| 1971 | 5.34 | 4.93 | 4.90 | 2.69 | 1.57 |
| 1972 | 3.43 | 4.06 | 4.90 | 3.79 | 2.63 |
| 1973 | 5.05 | 3.56 | 4.38 | 3.52 | |
| 1974 | 5.06 | 4.96 | 3.96 | 3.79 | 2.20 |
| 1975 | 4.20 | 3.56 | 3.16 | 3.17 | 1.73 |
| 1976 | 4.22 | 5.34 | 4.55 | 3.21 | 2.13 |
| 1977 | 4.11 | 5.20 | 5.24 | 3.18 | 1.84 |
| 1978 | 4.60 | 3.01 | 3.33 | 3.23 | 1.70 |
| 1979 | 4.84 | 3.90 | 4.01 | 3.73 | 2.54 |
| 1980 | 3.72 | 2.98 | 3.27 | 2.74 | |
| 1981 | 4.41 | 3.98 | 2.82 | 2.25 | |
| Average | 4.48 | 4.30 | 4.18 | 3.10 | 1.88 |

Table 12

COMPARISON OF MONTHLY TEMPERATURES (°F)

| Month | Watana 1/ | McKinley Park 2/ |
|---|---|---|
| May | 41 | 41 |
| June | 48 | 52 |
| July | 51 | 54 |
| August | 43 | 50 |
| September | 40 | 41 |

1/ Based on the data collected by R&M (Susitna Hydroelectric Project, Processed Climatological data, April 1980 through September 1982, volume 5, Watana Stations, two volumes) for the years 1981, 82 and 83.

2/ For the period 1951-75, taken from NOAA Climatography of the United States No. 60, Climate of Alaska.

Table 13

NET RESERVOIR EVAPORATION
WATANA RESERVOIR

| Month | Average Pan Evaporation (in) | Lake Evaporation (in) | Average Precipitation (in) |
|---|---|---|---|
| Jan | 0 | 0 | 1.20 |
| Feb | 0 | 0 | 1.20 |
| Mar | 0 | 0 | 1.20 |
| Apr | 0 | 0 | 0.60 |
| May | 3.67 | 2.67 | 1.50 |
| Jun | 3.53 | 2.47 | 4.80 |
| Jul | 3.43 | 2.40 | 6.30 |
| Aug | 2.54 | 1.78 | 4.80 |
| Sep | 1.54 | 1.08 | 2.70 |
| Oct | 0 | 0 | 1.80 |
| Nov | 0 | 0 | 1.80 |
| Dec | 0 | 0 | 2.10 |
| Total | 14.71 | 10.40 | 30.0 |

Table 14

CLIMATOLOGICAL DATA

| | | Watana | | Devil Canyon | |
|---|---|---|---|---|---|
| Year | Month | Temperature (°C) | Precipitation (mm) | Temperature (°C) | Precipitation (mm) |
| 1980 | May | 4.6 | 14.6 | | |
| | Jun | 9.1 | 55.0 | | |
| | Jul | 11.9 | 107.6 | | |
| | Aug | | | | |
| | Sep | | | | |
| | Oct | | | 0.2 | |
| | Nov | -7.2 | 2.0 | -5.1 | |
| | Dec | -21.1 | 0.2 | -17.9 | |
| 1981 | Jan | -4.5 | 1.6 | -2.5 | |
| | Feb | | | -7.3 | |
| | Mar | -4.3 | 18.4 | -1.8 | |
| | Apr | -4.3 | 1.2 | -1.8 | 1.2 |
| | May | 7.6 | 44.0 | 8.7 | 39.0 |
| | Jun | 9.3 | 129.8 | 10.0 | 166.4 |
| | Jul | 9.3 | 170.6 | 9.3 | 176.6 |
| | Aug | 2.0 | 165.6 | | |
| | Sep | 4.0 | 77.2 | | |
| | Oct | -2.1 | 25.0 | -.4 | |
| | Nov | -10.4 | 5.6 | -8.3 | |
| | Dec | -13.7 | 7.0 | -11.6 | |
| 1982 | Jan | -19.6 | 0.0 | -17.0 | |
| | Feb | | | | |
| | Mar | | | -7.1 | |
| | Apr | -4.5 | 7.2 | -2.7 | 21.0 |
| | May | 2.3 | 25.8 | 4.4 | 22.0 |
| | Jun | 8.6 | 87.4 | 9.9 | 85.2 |
| | Jul | 10.8 | 109.2 | 11.7 | 106.4 |
| | Aug | 10.0 | 58.2 | 10.8 | 35.0 |
| | Sep | 5.0 | 100.8 | 6.0 | 156.6 |

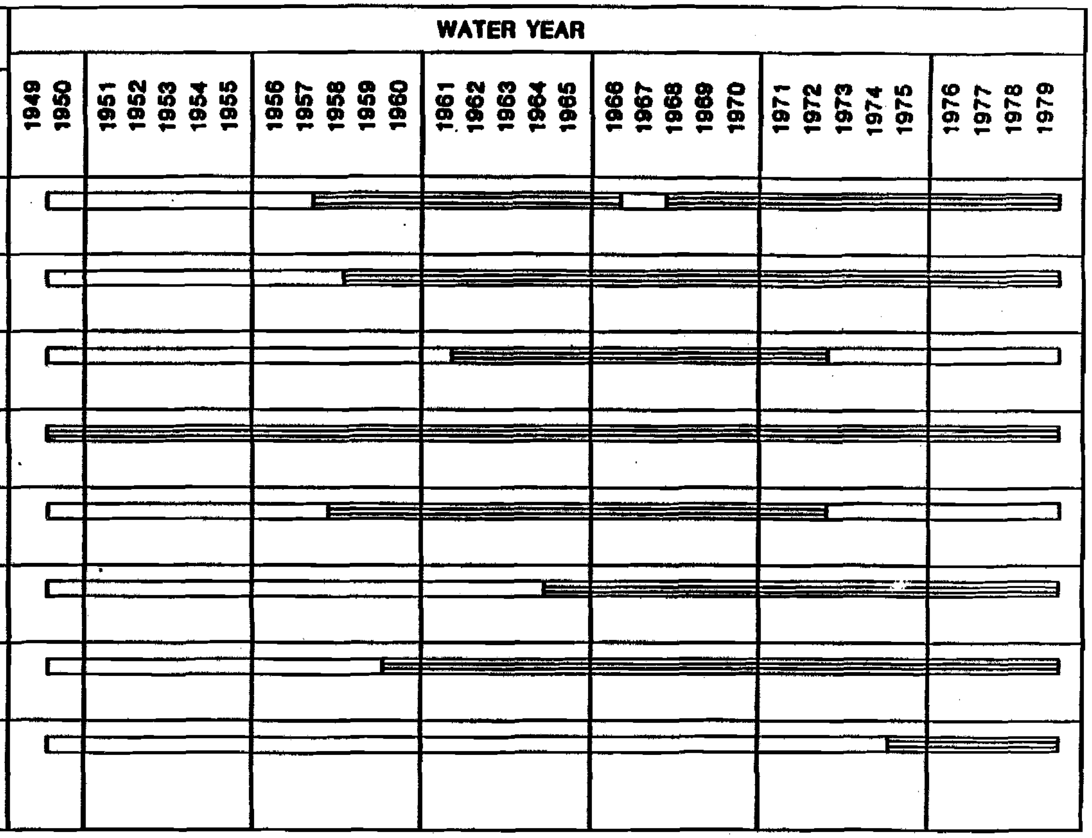
Table 15

MONTHLY PERCENTAGES OF PRECIPITATION

| | Matanuska | | McKinley Park | |
|---|---|---|---|---|
| Month | Precipitation (in) | Percent of Annual | Precipitation (in) | Percent of Annual |
| Jan | 0.79 | 5 | 0.68 | 4 |
| Feb | 0.63 | 4 | 0.61 | 4 |
| Mar | 0.52 | 3 | 0.60 | 4 |
| Apr | 0.62 | 4 | 0.38 | 2 |
| May | 0.75 | 5 | 0.82 | 5 |
| Jun | 1.61 | 10 | 2.51 | 16 |
| Jul | 2.40 | 15 | 3.25 | 21 |
| Aug | 2.61 | 18 | 2.48 | 16 |
| Sep | 2.31 | 15 | 1.43 | 9 |
| Oct | 1.39 | 9 | 0.92 | 6 |
| Nov | 0.93 | 6 | 0.90 | 6 |
| Dec | 0.93 | 6 | 0.96 | 7 |

EXHIBIT 1

| STREAM GAGING STATION | | | |
|---|---|---|---|
| SERIAL NO. | USGS NO. | DRAINAGE AREA $MI^2$ | NAME |
| 1. | 15291000 | 950 | SUSITNA RIVER NR. DENALI |
| 2. | 15291200 | 280 | MACLAREN RIVER NR. PAXSON |
| 3. | 15291500 | 4,140 | SUSITNA RIVER AT CANTWELL |
| 4. | 15292000 | 6,160 | SUSITNA RIVER AT GOLD CREEK |
| 5. | 15292400 | 2,570 | CHULITNA RIVER NR. TALKEETNA |
| 6. | 15292700 | 2,006 | TALKEETNA RIVER NR. TALKEETNA |
| 7. | 15294300 | 2,250 | SKWENTNA RIVER NR. SKWENTNA |
| 8. | 15294350 | 19,400 | SUSITNA RIVER AT SUSITNA STATION |




OBSERVED DATA

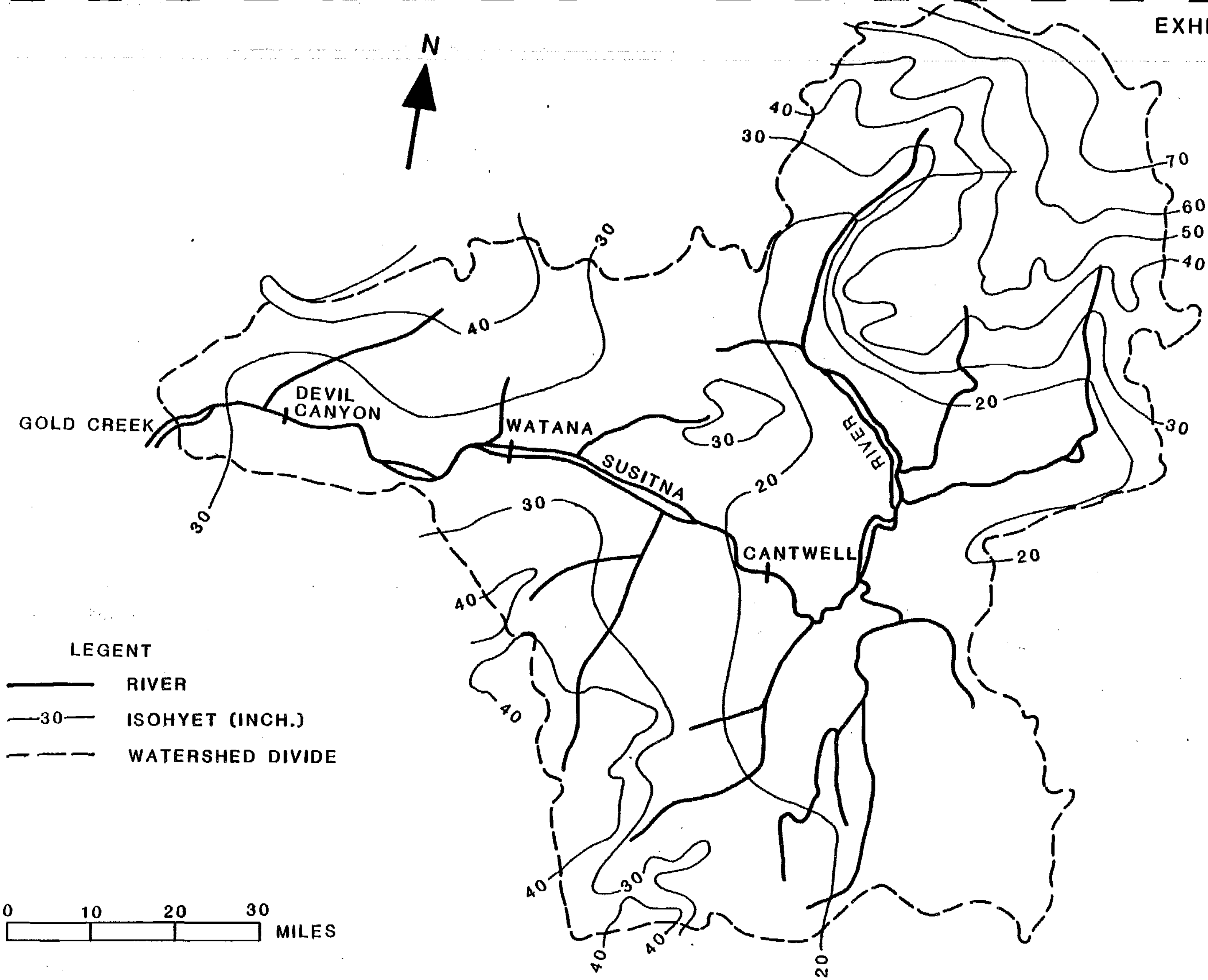
FILLED - IN DATA

SUSITNA HYDROELECTRIC PROJECT

STREAMFLOW DATA USED IN TIME SERIES ANALYSIS

HARZA-EBASCO SUSITNA JOINT VENTURE

EXHIBIT 2




HARZA-EBASCO SUSITNA JOINT VENTURE

SUSITNS HYDROELECTRIC PROJECT
**MEAN ANNUAL PRECIPITATION MAP**