ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT
POSITION PAPER
FISHERIES ISSUE F-2.5

EXECUTIVE SUMMARY

Issue

Significance of changes in water temperature on salmon and resident fish habitats and populations downstream of the dams.

Position

The Alaska Power Authority endorses the mitigation measures presented in this paper. It is our position that, by employing these measures, potential impacts of the Project on downstream fisheries resources resulting from changes in water temperatures will be insignificant.

Present Knowledge

Middle River (Talkeetna to Devil Canyon). Results of extensive field and laboratory studies, temperature modeling and simulations, and literature review have shown that under operational conditions:

1. The cooler water temperatures in summer will not significantly impact salmon inmigration or spawning, with the possible exception of a short delay in chinook inmigration to Middle River tributaries during June.

2. Mainstem winter water temperatures, which may be a limiting factor for salmon incubation under natural conditions, will be warmer, which could allow increased mainstem spawning.

3. Operation temperatures predicted by computer simulation are within the established range of tolerance for mainstem-rearing juvenile salmon.

4. Salmon outmigrants from tributaries and sloughs upstream of river mile 131 will encounter mainstem temperatures cooler than natural during late May and early June. However, these temperatures are within the range of tolerance for these species.

5. Round whitefish are the only resident species in the Middle River that might be significantly affected by project operation. Predicted temperatures could hinder successful reproduction of these species in the Middle River.

6. Simulation studies show that reservoir levels may be sufficiently high during the latter part of the second year of filling to allow operation of the cone valves for temperature control. If so, reservoir outlet temperatures during this period would be similar to those to be found subsequently during project operation (APA 1984a). If the reservoir level is not sufficiently high, the cone valves could not be used. In this situation, temperatures would be cooler than natural during the second year of filling because water would be withdrawn from the colder, lower levels of the reservoir.

Lower River (Cook Inlet to Talkeetna). The differences between natural and with-project temperatures will decrease with increasing distance downstream from the dams. At Sunshine Station (RM 83.8), with project water temperatures are predicted to be generally within the natural range. Temperatures downstream of the confluences of the Chulitna and Talkeetna Rivers with the Susitna are expected either to approach natural conditions or be within the tolerance ranges of the various life stages of salmon.

Mitigation Measures Endorsed by Alaska Power Authority

Multilevel intakes will be included in both dams to allow control of outlet temperatures to approximate natural water temperatures. If the Watana Reservoir reaches a sufficiently high water level during the latter part of

the second year of filling, the cone valves could be operated so as to make discharge temperatures similar to those anticipated during project operation.

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INTRODUCTION

Issue

Significance of changes in water temperature on salmon and resident fish habitats and populations downstream of the dams.

Position

The Alaska Power Authority endorses the mitigation measures presented in this paper. It is our position that, by employing these measures, potential impacts of the Project on downstream fisheries resources resulting from changes in water temperatures will be insignificant.

DISCUSSION

Construction and subsequent operation of the Susitna dams are expected to alter the natural thermal regime of the river. In general, mainstem water temperatures downstream from the dams will be cooler in the summer and warmer in the winter than under natural conditions. A change in the ice regime downstream of the project is also expected, due to altered temperatures and increased winter flows.

At issue is the potential for impacts of these temperature changes on fisheries resources downstream of the dams. The principal concerns have focused on timing and success of upstream migration and spawning of adult salmon, egg incubation, and juvenile rearing and outmigration.

Area of Potential Impact

The most apparent project-induced changes in Susitna water temperature will occur in the mainstem and side channels of the Middle River (Talkeetna to Devil Canyon) since these habitats will be directly affected by change in river discharge. With increasing distance downstream of the project, the extent of change from existing conditions will decrease. Downstream from the confluences of the Chulitna, Talkeetna, and Susitna Rivers, the changes will be even further diminished as a result of the moderating effect of the Chulitna and Talkeetna Rivers. Therefore, the primary emphasis of impact assessment has been on fisheries resources of the Middle River.

Studies Conducted

The Power Authority has conducted extensive studies designed to assess the potential effects of project-induced temperature changes on Susitna River fishery resources. Information for these studies has been derived from:

- Field investigations on the Susitna River by the Alaska Department of Fish and Game that have been ongoing since the 1970's.
- Field investigations (meteorological and riverine conditions) by R&M Consultants, the U.S. National Weather Service, and the U.S. Geological Survey.
- Laboratory investigations on Susitna sockeye and chum salmon egg development under simulated natural and with-project temperature regimes (Wangaard and Burger 1983).
- Reservoir temperature and operations simulation modeling (APA 1984b).
- Ice modeling studies (Harza-Ebasco 1984a) supported by field observations (R&M Consultants 1984).

- Temperature simulation and modeling studies (Arctic Environmental Information and Data Center (AEIDC 1984).

- Comprehensive literature review and impact assessment on instream temperature and fishery resources in the Middle River (AEIDC 1984).

These sources served as input to the instream temperature model SYNTEMP. Simulations from this model were run using average weekly time steps. The output provided predictions of natural and with-project instream temperature conditions, primarily for the river reach from the Watana damsite to the Parks Highway at Sunshine.

To evaluate the potential effects of the simulated with-project temperature conditions on fish, the results of field studies were combined with available literature and laboratory investigations to develop temperature criteria for the various life stages of fish found in the Susitna. These criteria were then used in combination with the temperature simulations to prepare descriptions of project effects on downstream fishery resources (AEIDC 1984).

The instream temperature studies also included predictions of natural and with-project downstream ice conditions resulting from various project operations. These predictions were made using the instream ice simultion model ICECAL (Harza-Ebasco 1984a).

Cases Studied. Detailed information for input to SYNTEMP was available for water years 1968 through 1983. These years were examined for seasonal variations in meteorologic and hydrologic conditions. From these, four summer and five winters were selected to represent normal and extreme conditions. Fifty temperature simulation cases were studied, 9 natural and 41 with-project, considering the various meteorologic/hydrologic conditions

as well as reservoir filling and one- and two-dam scenarios (Tables 1a and 1b).[1/] The simulations for operation were based primarily on the Case C, instream flow requirements presented in the License Application for the Susitna Project (APA 1983). Additional simulations and refinements are being performed to examine proposed instream flow requirement cases P-1 and E-1 through E-6 (APA 1984c).

Fish Resources in the Middle River. Seven anadromous and twelve resident fish species are known to inhabit the Susitna drainage. From the Watana Dam site to Talkeetna, six anadromous and ten resident species are found (Table 2). Of these, the five species of Pacific salmon[2/] (chinook, chum, pink, coho, and sockeye) were examined in detail for potential effects of the with-project temperature changes. The sixth species is the Bering cisco. Resident species were evaluated to the extent that information was available about their thermal requirements (AEIDC 1984).

Fishwheels, downstream migrant traps, and stream survey data were used to determine the timing patterns of salmon into and through the mainstem, as well as into the various sloughs and tributaries. This timing varies among species, but in general, the peak inmigration and spawning time for salmon upstream of Talkeetna is between late June and September. Most salmon use the tributaries for spawning. Next in importance are the sloughs, with only a small number of fish spawning in mainstem habitats (ADF&G 1984a).

Juvenile chinook salmon are distributed mostly in tributaries and side channels throughout the entire May-to-October rearing season. Coho are mostly rearing in tributaries and upland sloughs during this time. Sockeye are found evenly distributed between upland and side sloughs from May through early September. Chum are mainly distributed between side sloughs and tributaries from May through July (ADF&G 1984b).

1/ All tables are found at the end of this paper.

2/ Scientific names (from Morrow 1980): chinook salmon, Oncorhynchus tshawytscha; chum, O. keta; pink, O. gorbuscha; coho, O. kisutch; sockeye, O. nerka; Bering cisco, Coregonus laurettae.

Juvenile outmigration occurs throughout the open water season for sockeye, chinook and coho salmon. Pink salmon are believed to outmigrate immediately after emergence and chum salmon have mostly outmigrated by mid-July (ADF&G 1984b).

Of the ten resident fish species found between Talkeetna and Devil Canyon, only rainbow trout, Arctic grayling, round whitefish, longnose sucker, and slimy sculpin are abundant in the area. Dolly Varden, burbot, humpback whitefish, threespine stickleback, and Arctic lamprey[3/] occur throughout the river below Devil Canyon but appear to be more abundant below the Chulitna River Susitna River confluence. Rainbow trout and Arctic grayling provide sport fishing, especially near tributary mouths.

Rainbow trout and Arctic grayling spend most of the open water season in tributaries, using the mainstem more as a migration and overwintering area. Burbot generally occupy the mainstem waters throughout the year, while whitefish and longnose suckers can be found in both mainstem and tributaries during the open water season.

Analysis

Temperature regimes in the reach from Devil Canyon to Talkeetna were evaluated with respect to the various life stage temperature tolerances. In order to facilitate this evaluation, temperature tolerances were developed for a one-year time frame by fish life stage for the five species of Pacific salmon. These tolerances were then compared to simulated temperature profiles from river miles 100, 130, and 150 for the years 1971-72, 1974-75, 1981-82 and 1982-83 (Tables 1a and 1b). Three scenarios were examined for each profile:

3/ Scientific names: rainbow trout, Salmo gairdneri; Arctic grayling, Thymallus arcticus; burbot, Lota lota, round whitefish, Prosopium cylindraceum; longnose sucker, Catostomus catostomus; slimy sculpin, Cottus cognatus; Dolly Varden, Salvelinus malma; humpback whitefish, Coregonus pidschian; threespine stickleback, Gasterosteus aculeatus; Arctic lamprey, Lampetra japonica.

1. Natural versus Watana Dam operation.

2. Natural versus combined operation of the Watana and Devil Canyon Dams.

3. Natural versus Watana Reservoir filling.

Results

Tables 3 through 6 show mainstem and side-channel natural and simulated with-project temperature ranges for the May to October periods for the cases examined. In general, these indicate that operation of either a single- or two-dam project would dampen the natural variation in river temperatures. Mean summer river temperatures under a Watana-only scheme would be approximately 1.0°C cooler than natural at river miles 150 and 130, and 0.6°C cooler at RM 100. Addition of the Devil Canyon Dam, 33 miles downstream from Watana, would increase this mean seasonal temperature deviation to approximately 2.0, 1.7, and 1.2°C cooler at RM 150, 130, and 100, respectively. Under either project configuration, downstream temperatures would peak later in the summer than at present, with the greatest deviation from natural temperature occurring in September - October.

Table 7 shows the mainstem and side-channel temperatures for the four winter periods that were simulated. These results showed that winter reservoir releases would range from 0.4 to 6.4°C in waters normally at 0°C from approximately October to April. Consequently, ice formation on the river would be somewhat delayed and, in some cases, might not reach as far upstream as under natural conditions.

Salmon. When information from the simulations was compared to the temperature tolerance information for various salmon life stages, it was found that the cooler summer temperatures would not significantly impact salmon inmigration or spawning (AEIDC 1984). An exception was that under the two-dam scenarios, chinook adults migrating to Middle River tributaries

such as Portage Creek during June might encounter temperatures that approach the known tolerance range for a short period. This might result in a slight delay in migration until mainstem water warms in July. Because the temperature is within the tolerance range, this impact is considered insignificant.

Mainstem winter water temperatures, which under natural conditions may be limiting for salmon incubation, could be improved under project operation. Some reduction of juvenile growth may occur due to cooler summer temperatures, even though the simulations indicate that operational temperatures will be within the established range of tolerance (AEIDC 1984).

Outmigrants from tributaries and sloughs upstream of RM 131 during late May and early June may encounter mainstem temperatures cooler than natural. As this delay would be two weeks or less in duration and occur only during the coldest scenarios, it should not noticeably affect the timing of outmigration (AEIDC 1984). Temperature is not the only factor affecting migration timing, however; photoperiod, water currents, magnetic fields, and lunar phases all are believed to influence migration timing (Groot 1982, Godin 1980).

Salmon egg incubation in side-slough habitats have temperature regimes generally controlled by groundwater inflow. Under project conditions these habitats could be significantly affected by mainstem temperatures only during periods of overtopping, when mainstem flows breach the upstream head of the slough.

Such overtoppings could occur due to high mainstem discharge, ice jams that divert water, or staging that occurs due to ice. However, protective berms on the upper ends of the side sloughs will be used to prevent such overtopping during winter periods.

Burbot and Round Whitefish. These species are the only resident species above Talkeetna expected to be affected by project operation. Burbot spawn in winter under the ice at water temperatures usually less than 3°C. In the Susitna drainage, this normally takes place in January and February,

downstream of the confluence of the Susitna and Chulitna Rivers 1/. Because temperatures in these downstream areas are predicted to be near 0°C in January and February, it is predicted that no significant impact to Susitna burbot populations will occur as a result of the with project temperature regime.

Whitefish in general, spawn in October under conditions of rapidly decreasing water temperatures. October temperatures would be 2.1°C to 4.1°C warmer between Whiskers and Portage Creeks under the one-dam project scenario, and 3.1° to 6.2°C warmer under the two-dam scenario. These warmer temperatures could result in a change in the incubation timing for whitefish in this section of the river. The warmer water temperatures would accelerate the development rates of the incubating embryos, resulting in early emerging fry. The whitefish fry would emerge sometime before normal and could have reduced survival due to their encounter with a generally colder environment. Instead of changing the incubation time, the warmer October temperatures could delay the whitefish spawning until the temperatures drop in November. The effect of this delay cannot now be quantified.

Side Sloughs. The temperature of the groundwater discharge to the side sloughs appears to remain relatively constant at a value approximately equal to the mean annual (time-weighted) river temperature. Changes in mean annual mainstem river temperatures resulting from project operation may be reflected in the temperature of the groundwater upwelling component. For example, the temperature simulations (AEIDC 1984), indicate that the mean annual temperature of the Susitna River at Slough 9 was approximately 3.9°C under natural conditions in the period May 1982 - April 1983. With Watana in operation, the mean annual temperature would have been 4.1°C. Such results suggest that the temperature of groundwater upwelling could increase slightly with project implementation. However, these differences in estimated mean annual temperatures are small enough that they do not represent significant changes (Harza-Ebasco 1984b).

1/ Catch data (ADF&G 1984b) supports the belief that little spawning occurs above the confluence.

MITIGATION

Mitigation Measures Endorsed by Alaska Power Authority

Impacts associated with an altered temperature regime during reservoir operation will be minimized by incorporating multilevel gates in the power intakes of both the Watana and Devil Canyon Dams. By utilizing the thermal stratification that is predicted for the reservoirs, it is anticipated that outlet temperatures can be controlled to approximate existing baseline water temperatures.

Simulation studies have shown that the reservoir level during the latter part of the second year of filling may be high enough to allow operation of the multilevel intake works or the cone valves for temperature control. In this case, reservoir outlet temperatures would be the same as those expected during project operation. If the reservoir level is not sufficiently high, the cone valves would not be used. In this situation, temperatures would be cooler than natural during the filling period because water would be withdrawn from the colder, lower levels of the resevoir.

Overtopping of the upstream end of productive side-sloughs during winter periods would be prevented by development of a protective berm. This would maintain the stability of the side-sloughs (APA 1982, Ch. 2, pp. E-2-181 to 189, Ch. 3, pp. E-3-169 to 171).

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Table 1a
SUSITNA HYDROELECTRIC PROJECT
TEMPERATURE SIMULATIONS SELECTED FOR DETAILED STUDY

	Natural Conditions	Watana Only 1996 Demand	Watana Only 2001 Demand	Watana/ Devil Canyon 2002 Demand	Watana/ Devil Canyon 2020 Demand	Watana Filling
Summer Season:						
1971	X[1/]	X	X	X	X	X
1974	X	X	X	X	X	
1981	X	X	X	X	X	X
1982	X	X	X	X	X	X
Winter Season:						
1971-72	X	X	X	X	X	X
1974-75	X	X	X	X	X	
1976-77	X	X		X	X	
1981-82	X	X	X	X	X	X
1982-83	X	X	X	X	X	X

1/ X denotes that scheme has been simulated

Source: AEIDC 1984.

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Table 1b
SUSITNA HYDROELECTRIC PROJECT
CLASSIFICATION OF SEASONS SIMULATED

Summer	Air Temperature	Available Runoff
1971	Cold	Wet
1974	Warm	Dry
1981	Average	Wet
1982	Average	Average

Winter	Air Temperature	Available Runoff
1971-72	Cold	Wet
1974-75	Average	Dry
1976-77	Warm	Dry
1981-82	Average	Wet
1982-83	Average	Average

Source: AEIDC 1984.

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Table 2

LIST OF FISH SPECIES FOUND TO DATE IN THE SUSITNA RIVER BETWEEN RIVER MILE 100 AND DEVIL CANYON

Common Name	Scientific Name
Pink (humpback)salmon	Oncorhynchus gorbuscha (Walbaum)
Sockeye (red) salmon	Oncorhynchus nerka (Walbaum)
Chinook (king) salmon	Oncorhynchus tshawytscha (Walbaum)
Coho (silver) salmon	Oncorhynchus kisutch (Walbaum)
Chum (dog) salmon	Oncorhynchus keta (Walbaum)
Arctic lamprey	Lampetra japonica (Martens)
Bering cisco	Coregonus laurettae (Bean)
Round whitefish	Prosopium cylindraceum (Pallas)
Humpback whitefish	Coregonus pidschian (Gmelin)
Arctic grayling	Thymallus arcticus (Pallas)
Rainbow trout	Salmo gairdneri (Richardson)
Dolly Varden	Salvelinus malma (Walbaum)
Longnose sucker	Catostomus catostomus (Forster)
Threespine stickleback	Gasterosteus aculeatus (Linnaeus)
Burbot	Lota lota (Linnaeus)
Slimy sculpin	Cottus cognatus (Richardson)

Source: Morrow (1980)

Table 3

SUSITNA HYDROELECTRIC PROJECT
1971 WEEKLY TEMPERATURE RANGES FOR MAINSTEM SUSITNA RIVER, DEVIL CANYON TO SUNSHINE, FOR NATURAL CONDITIONS AND PROJECT-RELATED SCENARIOS.

Simulated Weekly Temperatures (C), May

Location (River Mile)	Natural		Watana Filling		Watana Operation 1996		Watana Operation 2001		Devil Canyon Operation 2002		Devil Canyon Operation 2020	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean
Portage Creek (148.9)	0.6-4.5	3.3	1.5-2.7	2.3	2.4-3.1	2.9	2.4-3.1	2.9	2.2-2.5	2.3	2.0-2.4	2.2
Sherman (130.8)	0.9-4.6	3.5	1.5-3.1	2.6	2.3-3.5	3.1	2.4-3.5	3.1	2.2-3.0	2.7	2.1-2.9	2.6
Whiskers Creek (101.4)	1.3-5.4	4.1	1.7-4.2	3.3	2.4-4.1	3.5	2.4-4.4	3.7	2.2-4.0	3.3	2.1-3.6	3.3
Sunshine (83.8)	2.0-5.2	4.1	2.1-4.8	3.8	2.4-4.8	4.0	2.4-4.8	4.0	2.3-4.7	3.8	2.3-4.6	3.8

Simulated Weekly Temperatures (C), June

Location (River Mile)	Natural		Watana Filling		Watana Operation 1996		Watana Operation 2001		Devil Canyon Operation 2002		Devil Canyon Operation 2020	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean
Portage Creek (148.9)	7.8-11.3	9.7	4.7-8.4	6.2	4.5-7.6	5.7	4.5-7.6	5.7	3.2-6.3	4.4	3.0-6.5	4.4
Sherman (130.8)	7.7-11.2	9.6	5.1-8.1	6.3	4.9-7.8	6.1	4.9-7.8	6.1	4.2-7.0	5.3	4.2-7.2	5.4
Whiskers Creek (101.4)	8.0-11.7	10.0	6.0-9.9	7.9	5.4-8.9	7.1	5.7-9.5	7.6	5.4-9.0	6.9	5.4-9.3	7.1
Sunshine (83.8)	7.7-10.6	9.3	7.1-9.6	8.4	7.0-9.6	8.4	7.0-9.6	8.4	7.0-9.5	8.3	7.0-9.6	8.3

Source: AEIDC 1984.

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Table 3 (continued)

SUSITNA HYDROELECTRIC PROJECT
1971 WEEKLY TEMPERATURE RANGES FOR MAINSTEM SUSITNA RIVER, DEVIL CANYON TO SUNSHINE, FOR NATURAL CONDITIONS AND PROJECT-RELATED SCENARIOS.

Simulated Weekly Temperatures (C), July

Location (River Mile)	Natural		Watana Filling		Watana Operation 1996		Watana Operation 2001		Devil Canyon Operation 2002		Devil Canyon Operation 2020	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean
Portage Creek (148.9)	8.7-13.0	10.6	6.3-8.1	7.1	7.9-9.4	8.7	7.9-9.5	8.6	6.5-8.1	7.6	6.6-8.1	7.6
Sherman (130.8)	8.8-13.0	10.6	6.9-8.8	7.6	8.0-9.7	8.7	8.1-9.7	8.6	7.1-8.5	8.0	7.2-8.5	8.0
Whiskers Creek (101.4)	9.2-13.6	11.1	7.9-11.1	9.1	8.9-11.0	9.6	9.2-11.7	9.9	8.6-10.6	9.4	8.9-10.9	9.5
Sunshine (83.8)	8.1-11.5	9.7	7.5-10.3	8.7	7.7-10.4	8.9	7.7-10.4	8.8	7.6-10.3	8.8	7.6-10.3	8.7

Simulated Weekly Temperatures (C), August

Location (River Mile)	Natural		Watana Filling		Watana Operation 1996		Watana Operation 2001		Devil Canyon Operation 2002		Devil Canyon Operation 2020	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean
Portage Creek (148.9)	9.0-10.9	10.1	6.0-9.3	7.1	8.7-8.9	8.8	8.7-9.2	8.9	6.3-8.4	7.4	6.4-8.5	7.4
Sherman (130.8)	9.0-10.9	10.1	6.8-9.2	7.6	8.0	8.9	8.9-9.3	9.0	6.8-8.6	7.7	7.0-8.6	7.8
Whiskers Creek (101.4)	9.5-11.3	10.6	8.1-9.7	8.6	9.2-9.5	9.3	9.4-10.6	9.7	7.9-9.1	8.6	8.0-9.6	8.8
Sunshine (83.8)	8.5-10.4	9.6	8.2-9.5	8.8	8.5-9.7	9.1	8.5-9.2	9.1	8.3-9.4	8.8	8.2-9.4	8.8

Source: AEIDC 1984.

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Table 3 (continued)

SUSITNA HYDROELECTRIC PROJECT
1971 WEEKLY TEMPERATURE RANGES FOR MAINSTEM SUSITNA RIVER, DEVIL CANYON TO SUNSHINE,
FOR NATURAL CONDITIONS AND PROJECT-RELATED SCENARIOS.

Simulated Weekly Temperatures (C), September

Location (River Mile)	Natural		Watana Filling		Watana Operation 1996		Watana Operation 2001		Devil Canyon Operation 2002		Devil Canyon Operation 2020	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean
Portage Creek (148.9)	3.1-6.7	5.3	6.1-8.5	7.6	6.5-8.4	7.6	6.5-8.4	7.6	7.3-8.4	7.9	7.3-8.4	7.9
Sherman (130.8)	3.3-6.9	5.5	5.6-8.2	7.3	6.2-8.3	7.4	6.2-8.3	7.4	7.0-8.4	7.8	7.0-8.3	7.8
Whiskers Creek (101.4)	3.5-7.1	5.8	5.3-8.3	7.3	6.1-8.4	7.5	6.0-8.5	7.5	6.7-8.5	7.8	6.7-8.5	7.8
Sunshine (83.8)	3.6-6.6	5.5	4.3-6.8	5.9	4.8-7.2	6.2	4.8-7.2	6.2	5.2-7.2	6.4	5.2-7.2	6.4

Simulated Weekly Temperatures (C), October

Location (River Mile)	Natural		Watana Filling		Watana Operation 1996		Watana Operation 2001		Devil Canyon Operation 2002		Devil Canyon Operation 2020	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean
Portage Creek (148.9)	0-1.5	0.5	0-2.5	1.1	2.3-5.1	3.9	2.2-5.1	3.9	3.1-6.4	4.9	3.1-6.4	4.9
Sherman (130.8)	0.1.7	0.6	0-2.4	1.0	1.5-4.8	3.4	1.4-4.8	3.4	2.0-5.9	4.2	2.4-6.0	4.4
Whiskers Creek (101.4)	0.18	0.6	0-2.2	0.8	0-4.5	2.7	0-4.5	2.7	0.3-5.4	3.2	1.1-5.6	3.7
Sunshine (83.8)	0-2.4	1.2	0-2.7	1.5	0-3.7	2.1	0-3.7	2.1	0-3.9	2.2	0.2-4.2	2.5

Source: AEIDC 1984.

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Table 4

SUSITNA HYDROELECTRIC PROJECT
1974 WEEKLY TEMPERATURE RANGES FOR MAINSTEM SUSITNA RIVER, DEVIL CANYON TO SUNSHINE, FOR NATURAL CONDITIONS AND PROJECT-RELATED SCENARIOS.

Simulated Weekly Temperatures (C), May

Location (River Mile)	Natural		Watana Filling		Watana Operation				Devil Canyon Operation			
					1996		2001		2002		2020	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean
Portage Creek (148.9)	5.2-9.6	7.2	Not Simulated		2.7-4.6	3.2	2.5-4.7	3.1	1.5-3.4	2.2	1.8-3.3	2.2
Sherman (130.8)	5.6-9.4	7.2	Not Simulated		3.2-5.2	3.8	3.1-5.2	3.7	2.4-4.6	3.2	2.7-4.6	3.3
Whiskers Creek (101.4)	6.1-9.9	7.6	Not Simulated		4.0-6.5	4.7	4.3-7.1	5.2	3.8-6.7	4.8	4.0-6.9	5.0
Sunshine (83.8)	5.7-9.2	7.2	Not Simulated		5-8.3	6.3	4.7-8.3	6.1	4.7-8.2	6.1	4.7-8.3	6.2

Simulated Weekly Temperatures (C), June

Location (River Mile)	Natural		Watana Filling		Watana Operation				Devil Canyon Operation			
					1996		2001		2002		2020	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean
Portage Creek (148.9)	8.3-1.9	9.7	Not Simulated		5.2-8.9	7	5.3-8.8	7.0	3.9-7.2	5.5	3.8-7.2	5.4
Sherman (130.8)	8.3-10.9	9.7	Not Simulated		5.7-9.2	7.5	5.7-9.2	7.5	4.9-8.2	6.5	4.9-8.2	6.5
Whiskers Creek (101.4)	8.7-11.6	10.3	Not Simulated		6.7-10.5	8.7	7.2-11.1	9.2	6.5-10.3	8.4	6.7-10.5	8.6
Sunshine (83.8)	8.0-10.1	9.1	Not Simulated		7.3-9.3	8.4	7.3-9.3	8.4	7.2-9.1	8.2	7-3-9.1	8.2

Source: AEIDC 1984.

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Table 4 (Continued)

SUSITNA HYDROELECTRIC PROJECT
1974 WEEKLY TEMPERATURE RANGES FOR MAINSTEM SUSITNA RIVER, DEVIL CANYON TO SUNSHINE, FOR NATURAL CONDITIONS AND PROJECT-RELATED SCENARIOS.

Simulated Weekly Temperatures (C), July

Location (River Mile)	Natural		Watana Filling		Watana Operation 1996		Watana Operation 2001		Devil Canyon Operation 2002		Devil Canyon Operation 2020	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean
Portage Creek (148.9)	10.3-10.8	10.6	Not Simulated		8.2-9.5	9.0	8.3-9.5	9.1	7.3-8.8	8.1	7.4-8.9	8.2
Sherman (130.8)	10.3-10.8	10.6	Not Simulated		8.5-9.5	9.2	8.5-9.5	9.2	7.8-9.1	8.6	7.9-9.2	8.6
Whiskers Creek (101.4)	10.7-11.4	11.1	Not Simulated		9.4-10.5	10.1	9.8-11.0	10.6	9.4-10.5	10.2	9.6-10.7	10.4
Sunshine (83.8)	9.4-9.8	9.6	Not Simulated		8.7-9.1	9.0	8.7-9.1	9.0	8.6-9.0	8.9	8.6-9.0	8.9

Simulated Weekly Temperatures (C), August

Location (River Mile)	Natural		Watana Filling		Watana Operation 1996		Watana Operation 2001		Devil Canyon Operation 2002		Devil Canyon Operation 2020	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean
Portage Creek (148.9)	7.7-10.6	9.7	Not Simulated		8.8-10.4	9.6	9.0-10.5	9.7	8.2-9.6	9.0	9.5-10.2	9.9
Sherman (130.8)	7.9-10.7	9.8	Not Simulated		8.8-10.4	9.7	9.0-10.4	9.7	8.6-9.9	9.2	9.5-10.3	10.0
Whiskers Creek (101.4)	8.2-11.2	10.2	Not Simulated		9.1-11.0	10.2	9.4-11.2	10.5	9.5-11.1	10.1	10.2-11.2	10.7
Sunshine (83.8)	7.4-9.8	9.0	Not Simulated		7.6-9.4	8.9	7.6-9.4	8.9	7.6-9.2	8.7	7.9-9.3	8.9

Source: AEIDC 1984.

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Table 4 (Continued)

SUSITNA HYDROELECTRIC PROJECT
1974 WEEKLY TEMPERATURE RANGES FOR MAINSTEM SUSITNA RIVER, DEVIL CANYON TO SUNSHINE, FOR NATURAL CONDITIONS AND PROJECT-RELATED SCENARIOS.

Simulated Weekly Temperatures (C), September

Location (River Mile)	Natural		Watana Filling		Watana Operation 1996		Watana Operation 2001		Devil Canyon Operation 2002		Devil Canyon Operation 2020	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean
Portage Creek (148.9)	3.9-8.5	6.2	Not Simulated		6.3-9.8	8.1	6.4-9.8	8.3	8.8-9.4	9.2	8.4-10.0	9.3
Sherman (130.8)	4.1-8.6	6.4	Not Simulated		5.8-9.6	7.9	5.8-9.6	8.0	8.0-9.4	8.9	7.5-9.9	9.0
Whiskers Creek (101.4)	4.2-8.9	6.7	Not Simulated		5.7-9.9	8.0	5.8-10.0	8.2	7.5-9.9	9.0	7.1-10.3	9.0
Sunshine (83.8)	4.4-8.1	6.3	Not Simulated		4.7-8.2	6.7	4.7-8.2	6.7	5.3-8.1	7.0	5.0-8.3	6.9

Simulated Weekly Temperatures (C), October

Location (River Mile)	Natural		Watana Filling		Watana Operation 1996		Watana Operation 2001		Devil Canyon Operation 2002		Devil Canyon Operation 2020	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean
Portage Creek (148.9)	0-0.1	0	Not Simulated		3.6-4.5	4.1	3.6-4.6	4.1	4.1-7.3	5.7	3.7-6.8	5.3
Sherman (130.8)	0-0.2	0.1	Not Simulated		3.1-3.7	3.4	3.1-3.7	3.4	3.7-6.1	5.0	3.2-5.4	4.4
Whiskers Creek (101.4)	0-0.1	0	Not Simulated		2.2-2.9	2.5	2.5-2.9	2.5	3.0-4.5	3.9	2.5-3.8	3.2
Sunshine (83.8)	0.7-1.3	1.0	Not Simulated		1.5-2.2	1.9	1.5-2.2	1.9	2.2-2.9	2.5	1.8-2.5	2.1

Source: AEIDC 1984.

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Table 5

SUSITNA HYDROELECTRIC PROJECT
1974 WEEKLY TEMPERATURE RANGES FOR MAINSTEM SUSITNA RIVER, DEVIL CANYON TO SUNSHINE, FOR NATURAL CONDITIONS AND PROJECT-RELATED SCENARIOS.

Simulated Weekly Temperatures (C), May

Location (River Mile)	Natural		Watana Filling		Watana Operation 1996		Watana Operation 2001		Devil Canyon Operation 2002		Devil Canyon Operation 2020	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean
Portage Creek (148.9)	5.0-9.3	7.7	3.8-5.7	4.5	3.6-7.1	4.9	3.6-7.2	5.0	2.5-4.9	3.8	2.6-5.1	3.9
Sherman (130.8)	5.1-9.4	7.7	4.2-6.3	5.0	3.9-7.2	5.3	3.9-7.3	5.3	3.0-6.0	4.6	3.1-6.2	4.8
Whiskers Creek (101.4)	5.7-10.1	8.3	5.0-8.4	6.6	4.7-9.2	6.8	4.7-9.2	6.8	4.0-8.1	6.2	4.0-8.5	6.5
Sunshine (83.8)	5.2-9.4	7.7	4.9-8.4	6.8	4.8-8.5	6.9	4.8-8.5	6.9	4.5-8.3	6.7	4.5-8.4	6.8

Simulated Weekly Temperatures (C), June

Location (River Mile)	Natural		Watana Filling		Watana Operation 1996		Watana Operation 2001		Devil Canyon Operation 2002		Devil Canyon Operation 2020	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean
Portage Creek (148.9)	8.9-12.4	10.5	5.4-7.0	6.5	7.1-10.6	8.8	7.4-11.1	9.1	6.1-7.9	7.2	6.1-8.8	7.5
Sherman (130.8)	8.8-12.3	10.4	5.8-7.9	7.1	6.9-10.3	8.7	7.1-10.7	8.9	6.5-8.7	7.8	6.5-9.4	8.0
Whiskers Creek (101.4)	9.3-13.1	11.1	7.2-10.1	8.9	8.1-12.1	10.2	8.3-12.3	10.3	7.7-10.8	9.4	7.8-11.3	9.7
Sunshine (83.8)	8.0-10.7	9.4	7.1-9.3	8.4	7.2-9.6	8.6	7.2-9.6	8.6	7.2-9.4	8.5	7.2-9.5	8.5

Source: AEIDC 1984.

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Table 5 (Continued)

SUSITNA HYDROELECTRIC PROJECT
1974 WEEKLY TEMPERATURE RANGES FOR MAINSTEM SUSITNA RIVER, DEVIL CANYON TO SUNSHINE, FOR NATURAL CONDITIONS AND PROJECT-RELATED SCENARIOS.

Simulated Weekly Temperatures (C), July

Location (River Mile)	Natural		Watana Filling		Watana Operation				Devil Canyon Operation			
					1996		2001		2002		2020	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean
Portage Creek (148.9)	8.9-10.2	9.6	6.2-7.4	6.8	8.0-11.1	9.4	8.2-11.0	9.5	4.5-7.0	5.8	6.4-10.7	8.2
Sherman (130.8)	9.0-10.3	9.7	6.9-7.7	7.4	8.2-10.7	9.3	8.2-10.7	9.3	5.1-7.6	6.4	6.9-10.4	8.4
Whiskers Creek (101.4)	9.7-10.9	10.2	7.9-9.0	8.6	9.1-11.5	10.2	9.1-11.4	10.2	6.1-9.0	7.5	8.3-11.4	9.7
Sunshine (83.8)	9.1-9.9	9.4	8.4-8.9	8.6	8.5-9.5	9.0	8.5-9.5	9.0	7.8-8.6	8.3	8.3-9.3	8.8

Simulated Weekly Temperatures (C), August

Location (River Mile)	Natural		Watana Filling		Watana Operation				Devil Canyon Operation			
					1996		2001		2002		2020	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean
Portage Creek (148.9)	7.5-10.1	9.1	6.3-10.6	9.3	7.7-10.3	8.7	8.0-10.5	8.8	7.1-7.6	7.4	5.1-11.2	7.5
Sherman (130.8)	7.6-10.1	9.2	7.0-10.4	9.3	7.9-10.1	8.8	7.8-10.3	8.8	7.5-7.9	7.7	5.5-10.8	7.7
Whiskers Creek (101.4)	8.0-10.7	9.7	8.1-11.0	9.9	8.4-10.9	9.4	8.3-11.0	9.4	8.0-8.6	8.3	6.0-11.6	8.4
Sunshine (83.8)	7.7-9.8	9.0	8.4-9.4	9.0	7.9-9.6	8.8	7.8-9.6	8.8	7.6-8.9	8.4	6.9-9.5	8.3

Source: AEIDC 1984.

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Table 5 (Continued)

SUSITNA HYDROELECTRIC PROJECT
1974 WEEKLY TEMPERATURE RANGES FOR MAINSTEM SUSITNA RIVER, DEVIL CANYON TO SUNSHINE, FOR NATURAL CONDITIONS AND PROJECT-RELATED SCENARIOS.

Simulated Weekly Temperatures (C), September

Location (River Mile)	Natural		Watana Filling		Watana Operation 1996		Watana Operation 2001		Devil Canyon Operation 2002		Devil Canyon Operation 2020	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean
Portage Creek (148.9)	2.0-7.7	5.8	6.2-10.4	8.6	6.5-9.1	8.0	6.4-9.0	7.9	8.0-8.5	8.2	8.4-8.6	8.5
Sherman (130.8)	2.2-7.9	6.0	5.5-10.2	8.2	6.1-9-1	7.9	6.0-9.0	7.8	7.6-8.2	8.1	7.8-8.5	8.3
Whiskers Creek (101.4)	2.2-8.4	6.3	4.8-10.5	8.2	5.7-9.5	7.9	5.5-9.4	7.8	6.9-8.6	8.1	7.1-9.0	8.3
Sunshine (83.8)	2.3-7.8	5.8	3.2-8.5	6.5	4.0-8.2	6.6	3.9-8.2	6.6	4.5-8.1	6.7	4.6-8.0	6.8

Simulated Weekly Temperatures (C), October

Location (River Mile)	Natural		Watana Filling		Watana Operation 1996		Watana Operation 2001		Devil Canyon Operation 2002		Devil Canyon Operation 2020	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean
Portage Creek (148.9)	0.5-1.3	0.8	0-1.6	0.8	3.9-5.6	4.8	3.8-5.6	4.7	6.3-7.6	7.0	6.3-7.6	7.0
Sherman (130.8)	0.5-1.4	1.0	0.1-1.6	0.9	3.5-5.2	4.4	3.4-5.1	4.3	5.4-6.8	6.2	5.7-7.0	6.5
Whiskers Creek (101.4)	0.5-1.4	10	0-1.5	0.8	3.2-4.7	4.1	3.1-4.6	4.0	4.5-5.8	5.3	5.0-6.2	5.8
Sunshine (83.8)	1.1-1.9	1.6	1.3-2.3	1.9	2.5-3.6	3.3	2.4-3.4	2.9	3.0-4.0	3.7	3.5-4.6	4.2

Source: AEIDC 1984.

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Table 6

SUSITNA HYDROELECTRIC PROJECT
1974 WEEKLY TEMPERATURE RANGES FOR MAINSTEM SUSITNA RIVER, DEVIL CANYON TO SUNSHINE, FOR NATURAL CONDITIONS AND PROJECT-RELATED SCENARIOS.

Simulated Weekly Temperatures (C), May

Location (River Mile)	Natural		Watana Filling		Watana Operation				Devil Canyon Operation			
					1996		2001		2002		2020	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean
Portage Creek (148.9)	4.7-8.6	6.5	2.8-4.5	3.5	3.3-4.7	3.8	3.4-4.7	3.9	3.7-4.5	4.1	3.6-4.6	4.1
Sherman (130.8)	4.7-8.4	6.4	3.2-4.9	3.9	3.5-5.0	4.1	3.6-5.0	4.2	4.2-5.2	4.6	4.1-5.3	4.6
Whiskers Creek (101.4)	5.3-9.0	7.1	4.1-6.5	5.3	4.4-6.6	5.3	4.4-6.6	5.4	4.9-6.7	5.7	4.9-7.0	5.8
Sunshine (83.8)	5.2-8.4	6.7	4.6-7.3	5.9	4.7-7.3	5.8	4.7-7.3	5.8	4.9-7.3	6.0	4.9-7.4	6.0

Simulated Weekly Temperatures (C), June

Location (River Mile)	Natural		Watana Filling		Watana Operation				Devil Canyon Operation			
					1996		2001		2002		2020	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean
Portage Creek (148.9)	8.1-11.9	9.7	5.0-7.0	6.0	5.7-8.9	7.1	5.7-8.2	6.9	4.7-6.9	5.8	4.7-6.8	5.6
Sherman (130.8)	8.0-11.8	9.6	5.3-7.6	6.4	5.8-9.0	7.1	5.8-8.5	7.0	5.3-7.8	6.4	5.3-7.8	6.3
Whiskers Creek (101.4)	8.5-12.5	10.1	6.5-9.0	7.5	7.1-10.8	8.5	7.1-10.4	8.4	6.7-9.9	8.0	6.8-10.1	8.1
Sunshine (83.8)	7.6-11.0	9.1	6.7-9.6	7.9	6.9-9.9	8.1	6.9-9.8	8.1	6.8-9.7	8.0	6.7-9.7	8.0

Source: AEIDC 1984.

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Table 6 (Continued)

SUSITNA HYDROELECTRIC PROJECT
1974 WEEKLY TEMPERATURE RANGES FOR MAINSTEM SUSITNA RIVER, DEVIL CANYON TO SUNSHINE, FOR NATURAL CONDITIONS AND PROJECT-RELATED SCENARIOS.

Simulated Weekly Temperatures (C), July

Location (River Mile)	Natural		Watana Filling		Watana Operation 1996		Watana Operation 2001		Devil Canyon Operation 2002		Devil Canyon Operation 2020	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean
Portage Creek (148.9)	10.1-11.1	10.7	7.0-9.6	8.5	9.4-10.9	10.2	9.3-10.7	10.1	5.1-10.2	7.3	7.3-8.9	8.2
Sherman (130.8)	10.0-11.2	10.7	7.3-9.9	8.8	9.3-10.5	10.1	9.2-10.3	10.0	5.6-10.2	7.8	8.2-9.4	8.7
Whiskers Creek (101.4)	10.6-12.0	11.4	8.8-10.9	9.8	10.1-11.7	11.2	10.1-11.6	11.2	6.7-11.5	9.2	10.1-11.3	10.5
Sunshine (83.8)	9.3-10.5	9.9	8.8-9.9	9.2	8.8-9.7	9.3	8.9-9.7	9.3	8.0-9.1	8.8	8.6-9.5	9.0

Simulated Weekly Temperatures (C), August

Location (River Mile)	Natural		Watana Filling		Watana Operation 1996		Watana Operation 2001		Devil Canyon Operation 2002		Devil Canyon Operation 2020	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean
Portage Creek (148.9)	9.4-11.1	10.7	9.2-9.8	9.5	9.0-10.2	9.7	8.9-10.3	9.6	5.5-8.5	7.4	7.3-10.2	8.1
Sherman (130.8)	9.5-11.2	10.7	9.5-10.1	9.7	9.1-10.4	9.9	9.0-10.5	9.8	6.2-9.0	7.9	7.8-10.3	8.5
Whiskers Creek (101.4)	10.1-12.0	11.4	10.1-11.1	10.6	9.8-11.3	10.8	9.8-11.4	10.8	7.4-10.0	9.0	8.7-11.1	9.7
Sunshine (83.8)	8.5-10.2	9.7	8.4-9.8	9.4	8.3-9.7	9.3	8.3-9.7	9.3	8.2-9.3	8.8	7.9-9.4	9.0

Source: AEIDC 1984.

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Table 6 (Continued)

SUSITNA HYDROELECTRIC PROJECT
1974 WEEKLY TEMPERATURE RANGES FOR MAINSTEM SUSITNA RIVER, DEVIL CANYON TO SUNSHINE, FOR NATURAL CONDITIONS AND PROJECT-RELATED SCENARIOS.

Simulated Weekly Temperatures (C), September

Location (River Mile)	Natural		Watana Filling		Watana Operation 1996		Watana Operation 2001		Devil Canyon Operation 2002		Devil Canyon Operation 2020	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean
Portage Creek (148.9)	4.3-7.9	6.3	5.4-9.2	7.5	7.5-9.0	8.3	7.6-9.0	8.3	8.4-8.6	8.5	7.2-9.1	8.4
Sherman (130.8)	4.4-8.0	6.4	5.0-9.0	7.2	7.2-8.9	8.0	7.2-8.9	8.1	8.0-8.6	8.4	6.9-9.0	8.1
Whiskers Creek (101.4)	4.6-8.4	6.7	5.0-9.3	7.4	7.1-9.2	8.2	7.1-9.2	8.2	7.7-8.9	8.4	6.7-9.3	8.2
Sunshine (83.8)	4.5-7.6	6.1	4.5-7.9	6.2	5.5-7.8	6.6	5.5-7.8	6.6	5.6-7.8	6.7	5.1-7.8	6.4

Simulated Weekly Temperatures (C), October

Location (River Mile)	Natural		Watana Filling		Watana Operation 1996		Watana Operation 2001		Devil Canyon Operation 2002		Devil Canyon Operation 2020	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean
Portage Creek (148.9)	0-2.2	0.6	0-2.2	0.8	2.2-6.5	4.6	2.3-6.7	4.8	6.3-8.3	7.5	4.6-7.7	6.4
Sherman (130.8)	0-2.3	0.7	0-2.4	0.8	1.1-6.0	3.9	1.2-6.2	4.0	4.3-7.6	6.2	3.4-7.2	5.6
Whiskers Creek (101.4)	0-2.3	0.6	0-2.2	0.6	0-5.7	3.1	0-5.8	3.2	1.5-6.9	4.5	1.4-6.6	4.4
Sunshine (83.8)	0-2.6	0.9	0.3-1.8	1.1	0-4.1	2.1	0-3.6	3.1	0.8-3.8	2.6	0.7-3.7	2.6

Source: AEIDC 1984.

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Table 7

SUSITNA HYDROELECTRIC PROJECT
SUSITNA RIVER TEMPERATURE RANGES (C)
UNDER FOUR METEOROLOGICAL SCENARIOS
FOR THE PERIOD SEPTEMBER THROUGH APRIL

1971-72

	Natural		Watana Operational 1996[1/]		2001		Devil Canyon Operational 2002		2020	
RM	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean
150	0-6.8	0.7	0-8.4	1.9	0-8.4	1.7	0.7-8.4	2.3	0.6-8.4	2.5
130	0-6.9	0.8	0-8.3	1.5	0-8.3	1.5	0-8.4	1.6	0-8.3	2.0
100	0-7.1	0.8	0-8.5	1.4	0-8.5	1.3	0-8.5	1.4	0-8.5	1.6

1974-75

	Natural		Watana Operational 1996		2001		Devil Canyon Operational 2002		2020	
RM	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean
150	0-8.5	0.9	0-9.8	2.0	0-9.8	2.2	1.2-9.4	3.0	0.5-10.0	3.0
130	0-8.6	1.0	0-9.6	1.7	0-9.6	1.8	0-9.4	2.3	0-9.9	2.3
100	0-9.1	1.1	0-10.0	1.5	0-10.0	1.6	0-9.9	1.9	0-10.3	1.9

1981-82

	Natural		Watana Operational 1996		2001		Devil Canyon Operational 2002		2020	
RM	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean
150	0-7.7	1.1	0-9.1	2.8	0.4-9.0	3.0	1.8-8.3	4.0	0.8-8.6	3.9
130	0-7.9	1.1	0-9.1	2.4	0-9.0	2.5	0.7-8.2	3.2	0-8.5	3.4
100	0-8.4	1.3	0-9.5	2.1	0-9.4	2.1	0-8.6	2.4	0-9.0	2.7

1982-83

	Natural		Watana Operational 1996		2001		Devil Canyon Operational 2002		2020	
RM	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean
150	0-7.9	1.1	0.1-9.0	2.7	0-9.0	2.9	0.9-8.6	3.5	0.6-9.1	3.2
130	0-8.0	1.2	0-8.9	2.3	0-8.8	2.4	0-8.6	2.8	0-9.0	2.7
100	0-8.4	1.3	0-9.2	2.0	0-9.1	2.1	0-8.9	2.2	0-9.3	3.1

[1/] Year for which the estimated power demand was simulated.

Source: AEIDC 1984.

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