SUS 423

ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

POSITION PAPER

FISHERIES ISSUE F-5

EXECUTIVE SUMMARY

Issue

Significance of impoundment effects on resident fish habitats and populations upstream of the dams.

Position

The position of the Alaska Power Authority is that arctic grayling habitats in tributaries of the Susitna River will be inundated by the proposed reservoirs and lost, and therefore, should be mitigated. The loss will be mitigated through:

1. Recontouring of borrow sites to develop ponds for planting of arctic grayling.

2. Supplementation and expansion of arctic grayling populations in appropriate sites near Fairbanks with provision for public access.

3. Supplementation of the existing rainbow trout planting programs in the Anchorage area.

Present Knowledge

The Watana and Devil Canyon dams will create two major impoundments on the Susitna River. Seven species of resident fish are known to inhabit the Susitna River and tributaries, and lakes and ponds within the area to be inundated. These species are: arctic grayling and slimy sculpin which inhabit the river, tributaries and lakes; burbot, longnose sucker and round and humpback whitefish in the river; Dolly Varden in the tributaries; and lake trout, which inhabit only one lake which will be inundated.

The Watana Dam will impound a reservoir approximately 48 miles long. The water surface elevation in the reservoir will fluctuate seasonally with the normal maximum operating elevation (2185) in August and minimum operating elevation (070) during April. The reservoir will remain turbid throughout the year, due to the input of glacial flour (less than 4-micron diameter suspended sediments) during the summer. Water temperatures in the reservoir will range from 4 to 10°C during the summer months and 0-4°C during the winter. The combination of fluctuating water surface elevations, high turbidity and lower water temperatures during the summer will result in the loss of suitable resident fish habitat and loss of the populations. The loss of arctic grayling is potentially substantial.

The Devil Canyon Dam will impound a reservoir approximately 28 miles long. Habitat conditions in the reservoir will be similar to those in the Watana Reservoir with the exception that reservoir water surface elevation changes will be less than the Watana Reservoir and short-term drawdowns will occur in the fall rather than in the spring. Habitats in the reservoir will not be suitable for resident species and it is expected that resident fish populations will be lost. Additionally, some anadromous fish, specifically chinook salmon, currently utilize the reach to be impounded by the Devil Canyon Dam for spawning. Since only 25 to 75 salmon have been observed in this reach in each study year, the loss of these spawning areas is not considered significant.

Mitigation Measures Endorsed by the Alaska Power Authority

The loss of resident fish habitats and populations will be mitigated through recontouring of borrow sites used for materials to construct the dam and access road. The recontouring will consist of providing suitable habitat for arctic grayling and planting of arctic grayling in the borrow sites. In addition, arctic grayling populations and habitats will be supplemented in the Fairbanks area and the rainbow trout stocking program in the Anchorage area will be supplemented.

ALASKA POWER AUTHORITY
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INTRODUCTION

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Significance of impoundment effects on resident fish habitats and populations upstream of the dams.

Position

The position of the Alaska Power Authority is that arctic grayling habitats in tributaries of the Susitna River will be inundated by the proposed reservoirs and lost, and therefore, should be mitigated. This loss will be mitigated through the following compensatory measures:

1. Recontouring of borrow sites to develop ponds for planting of arctic grayling.

2. Supplementation and expansion of arctic grayling populations in appropriate sites near Fairbanks with provision for public access.

3. Supplementation of the existing rainbow trout planting program in the Anchorage area.

DISCUSSION

The Watana and Devil Canyon Dams will create two reservoirs which will inundate approximately 88 miles of the Susitna River, the lower reaches of

11 named and numerous unnamed tributaries, and 31 lakes and ponds. The river, tributaries, lakes and ponds are inhabited by seven species of fish which will be directly affected by the reservoirs. The purpose of this paper is to discuss the effects of the reservoirs on the fish habitats and populations and to describe how adverse effects should be mitigated by the Power Authority.

Baseline Conditions

Susitna River and Peripheral Habitats. The reach of the Susitna River which will be inundated by the Watana and Devil Canyon Reservoirs extends from the Devil Canyon damsite at River Mile (RM) 152 upstream to the upper end of the Watana Reservoir at approximately RM 240. The Watana and Devil Canyon Reservoir areas are depicted in Figures 1 and 2, respectively. Within this reach, the Susitna River flows generally to the west in a relatively confined valley. The Susitna River valley in this area ranges from V-shaped to somewhat U-shaped, with little flood plain or alluvial deposits. The river channel is relatively distinct, with few peripheral side channels or sloughs. In general, the river is relatively narrow and is characteristically deep with high water velocities. Major rapids occur in Vee Canyon and Devil Canyon.

Eleven named and numerous unnamed tributaries enter the Susitna River within the reach to be inundated by the reservoirs. The eleven named tributaries and the location of their confluences with the Susitna River are presented in Table 1 and are identified in Figures 1 and 2. With the exception of the Oshetna River, they contain clear water, since they are fed primarily by snowmelt, surface runoff and groundwater. The Oshetna River is fed by glacier melt during the summer months and, therefore, is quite turbid. During the winter months, the Oshetna River contains clear water.

Thirty-one lakes and ponds occur within the area to be affected by the reservoirs. Nearly all of the lakes and ponds are relatively small and shallow. Only four of the lakes are sufficiently deep to contain free water

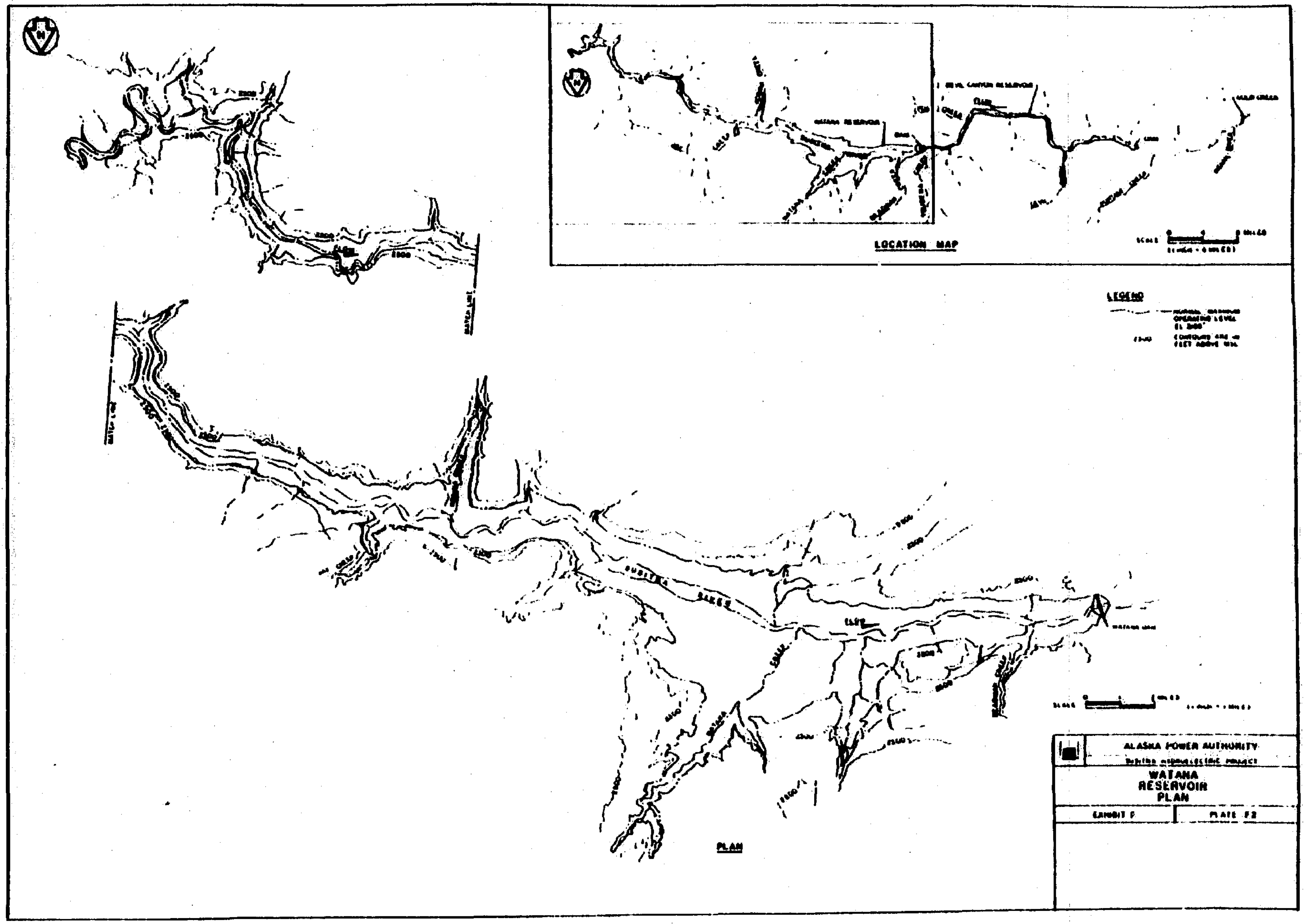
Table 1

SUSITNA HYDROELECTRIC PROJECT
LOCATIONS OF NAMED TRIBUTARIES OF THE
SUSITNA RIVER IN THE RESERVOIR AREA

Tributary	Susitna River Confluence (River Mile)
Oshetna River	233.4
Goose Creek	231.3
Jay Creek	208.5
Kosina Creek	206.8
Watana Creek	194.1
Deadman Creek	186.7
Tsusena Creek	181.3
Fog Creek	176.7
Devil Creek	161.4
Chinook Creek	157.0
Cheechako Creek	152.4

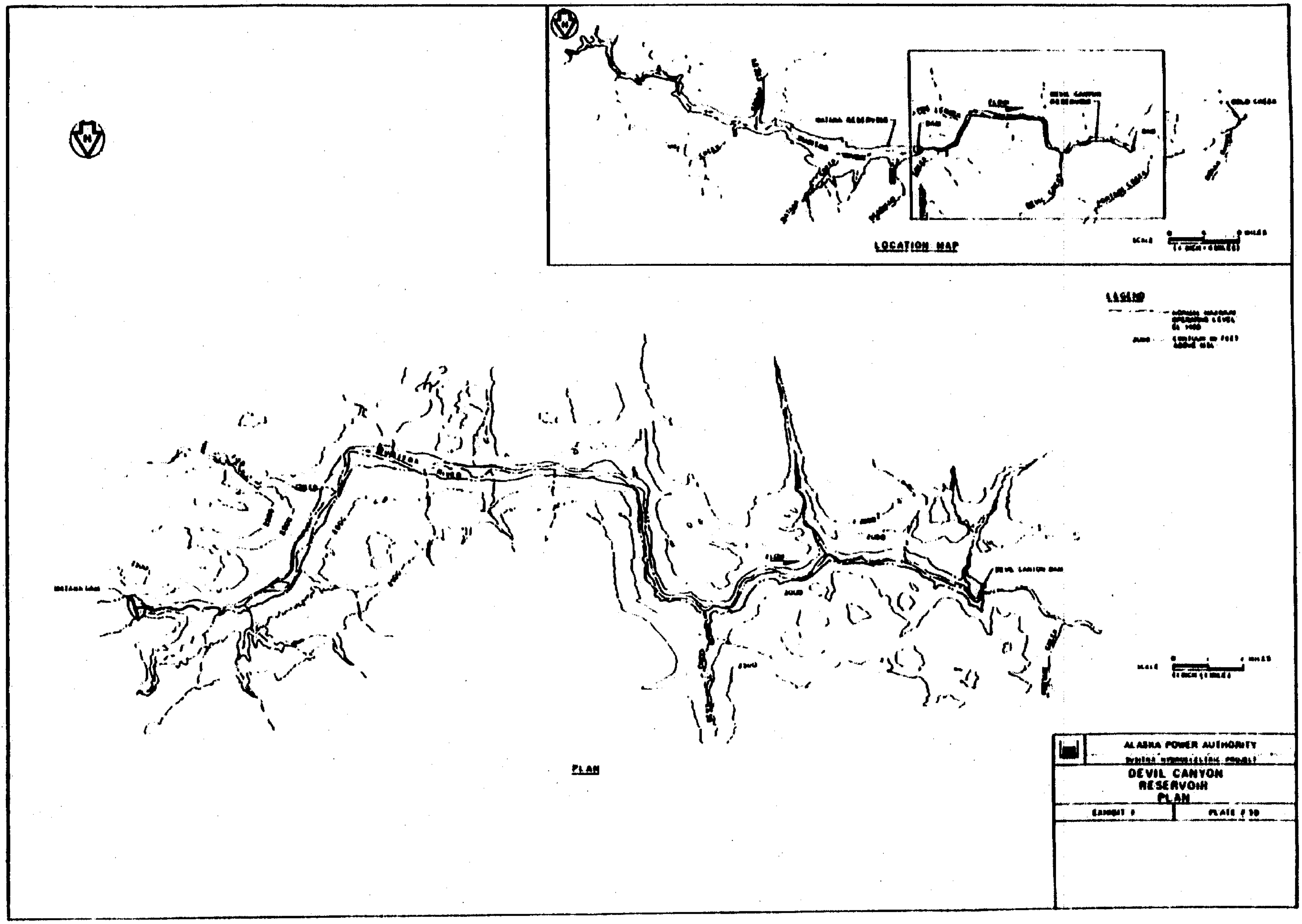
Source: ADF&G 1983a (Tables 5-3-1 and 5-3-2)

Figure 1
SUSITNA HYDROELECTRIC PROJECT



Source: APA 1983, Exhibit F.

Figure 2
SUSITNA HYDROELECTRIC PROJECT



Source: APA 1983, Exhibit F.

under the ice cover in winter. The largest lake to be affected by the reservoirs is Sally Lake, which is located near the confluence of Watana Creek with the Susitna River (See Figure 1). The lakes and ponds range in size from less than one acre to approximately 55 acres.

The Susitna River is glacially fed and exhibits extreme annual cycles in discharge, suspended sediment concentrations, and to a lesser extent, temperature. Discharge is generally highest during the summer months as a result of snowmelt, surface runoff and glacier melt. Concurrently, suspended sediment concentrations are highest during the summer months, frequently exceeding 1000 mg/l (APA 1983, Table E-2.20). The high concentrations of suspended sediments are generated primarily from the melting glaciers. Water temperatures in the river range between 10-15°C during the summer months.

As air temperature begins to decline in the fall, discharge in the Susitna River decreases. This is due primarily to the reduction in surface runoff, snow and glacier melt. The principle sources of water in the river during the winter months are groundwater and outflow from lakes in the upper portion of the basin. The shift in the principle sources of water also results in a dramatic reduction of the suspended sediment concentrations in the river. The concentration of suspended sediments generally is less than 10 mg/l during the winter months. Water temperature during the winter is 0°C with an ice cover forming throughout the reach of river which will be inundated. However, in Vee Canyon and Devil Canyon, the ice cover forms in the rapids reaches only under extremely cold, heavy ice production conditions and is, therefore, quite unstable (R&M 1984).

<u>Fish Species Inhabiting the Inundated Zones</u>. Five resident fish species have been collected in the mainstem and peripheral habitats of the Susitna river (ADF&G 1981, 1983a). These were:

1. Arctic Grayling, <u>Thymallus arcticus</u>
2. Burbot, <u>Lota lota</u>
3. Longnose Sucker, <u>Catostomus catostomus</u>

4. **Round Whitefish, Prosopium cylindraceum**
5. **Humpback Whitefish, Coregonus pidschian**

With the exception of burbot, these species were collected primarily from clearwater, peripheral habitats of the mainstem, such as sloughs and tributary mouths (ADF&G 1983a). Burbot were collected from turbid waters in the mainstem upstream of Tsusena Creek. In addition to the resident fish, two to 30 Chinook salmon (Oncorhynchus tshawytscha) were observed at the mouths of each of four tributaries within the Devil Canyon reach of the Susitna River: Cheechako Creek, Chinook Creek, Devil Creek and Fog Creek (ADF&G 1984a and Wick pers. comm. 1985).

Three species of resident fish were collected in the tributaries within the impoundment zones (ADF&G 1984a). These were arctic grayling, Dolly Varden (Salvelinus malma) and slimy sculpin (Cottus cognatus). The arctic grayling population in the tributaries consists of two subpopulations: those which remain in the tributaries throughout the year, and those which migrate to the mainstem during the fall and return to the tributaries in the spring. The former subpopulations inhabit only a few tributaries which have impassable barriers (e.g. waterfalls) that prevent upstream migration.

Two species of fish were collected in lakes within the impoundment zone: arctic grayling and lake trout (Salvelinus namaycush). Arctic grayling were collected from four of 31 lakes and ponds and lake trout were collected only from Sally Lake, where they occur with arctic grayling.

Arctic Grayling. Arctic grayling occur in most of the clear water habitats within the impoundment zone. Estimates of grayling populations based on mark-recapture ratios were obtained for tributary reaches that will be affected by the reservoirs (ADF&G 1981, 1983a). Results obtained in 1981 were refined in 1982 and are summarized in Table 2.

1/ Scientific names of fish species follow Morrow (1980).

Table 2

SUSITNA HYDROELECTRIC PROJECT
ARCTIC GRAYLING POPULATION
ESTIMATES BY TRIBUTARY

Location	Population Estimate	Grayling Per Mile
Oshetna River	2,426	1,103
Goose Creek	949	791
Jay Creek	1,592	455
Kosina Creek	5,544	1,232
Watana Creek	3,925	324
Deadman Creek[a/]	734	1,835
Tsusena Creek[b/]	1,000	440
Fog Creek[b/]	176	664
Total	16,346	

Source: ADF&G 1983a (Table 5-3-13)

a/ Includes only the part of Deadman Creek below falls.
b/ 1981 estimates.

Very few grayling were collected in the mainstem. However, the locations of recaptured fish relative to the locations at which they were marked indicate that populations inhabiting the lower reaches of the tributaries migrate to and overwinter in mainstem habitats and return to the tributaries in the spring (ADF&G 1983a).

Movement of adult arctic grayling into the tributaries in the spring apparently occurs during breakup of the ice cover. Spawning occurs in the early spring, as evidenced by the collection of spent males and females in the tributaries immediately after the open water season begins (ADF&G 1983a).

In addition to the tributary populations, arctic grayling populations were sampled in two lakes within the Watana Reservoir area. One population was identified from Sally Lake, near the confluence of Watana Creek and the Susitna River. A second population was identified in an unnamed lake across the Susitna River from the mouth of Watana Creek (D. Schmidt, pers. comm. 1984).

Burbot. Seven mainstem locations within the Watana impoundment zone were sampled monthly for burbot in 1982. Based on the number of burbot collected at each location through the summer, it appears that they have a relatively even distribution throughout the reach of the river in the impoundment zone. Although no estimate of the population size can be made in general, the population density of burbot is quite low (ADF&G 1983a). Captures of burbot are summarized by sampling location and by month in Table 3.

Only three individuals marked in 1982 and two individuals marked in 1981 were recaptured in 1982. All recaptures were collected at the locations where they were originally captured and marked (ADF&G 1983a). This suggests that burbot in this reach of the river do not move up- or downstream to any great extent.

Table 3

**SUSITNA HYDROELECTRIC PROJECT
NUMBER OF BURBOT CAPTURED IN 1982
BY MAINSTEM SITE AND MONTH**

Mainstem Site	Catch[1/] May	June	July	August	September	Total
No. 1, RM 189.0	-0-	-0-	3	6	7	16
No. 2, RM 191.5	-0-	-0-	3	1	-0-	4
No. 3, RM 197.8	-0-	8	3	-0-	-0-	11
No. 3A, RM 201.6	-0-	-0-	-0-	6	7	13
No. 4, RM 201.2	-0-	5	10	7	2	24
No. 5, RM 208.1	-0-	4	2	4	2	12
Watana Creek Mouth, RM 194.1	7	17	9	13	9	55
Total	7	34	30	37	27	135

Source: ADF&G 1983a (Table 5-3-16)

[1/] Burbot populations were sampled using trot lines.

Dolly Varden. Dolly Varden populations are limited in their distribution within the upper Susitna basin, as shown by their having been collected at only a few sampling locations. Small populations have been identified in Cheechako, Devil, Watana, Jay and Upper Deadman Creeks. It was noted, that all captured Dolly Varden were of a dwarf or stunted variety with total lengths of the fish varying from 120 to 205 mm (ADF&G 1983a).

Longnose Sucker. Although longnose suckers were collected at four of seven mainstem sampling sites, most (80 percent) were collected near the mouth of Watana Creek. Marked fish were recaptured at the same locations at which they were originally marked. This indicates that the sucker populations tend to remain relatively localized with little instream movement.

Round Whitefish. Five round whitefish were collected in the mainstem of the Susitna River near the mouth of Watana Creek. Other than identifying the presence of this species, nothing further can be stated regarding its abundance or distribution in the impoundment zones except that the population densities are quite low.

Humpback Whitefish. Only one individual of this species was collected (ADF&G 1983a). Therefore, it can be stated only that the species is present in the mainstem and the population is at quite low densities.

Lake Trout. A small population of lake trout was identified in Sally Lake. This is the only population known to exist in the impoundment zone (ADF&G 1983a). Due to insufficient recaptures of marked fish, the population size could not be estimated.

Evaluation Species. Arctic grayling is the primary evaluation species for assessing the effects of the reservoirs on aquatic resources (APA 1983a). Therefore, this species will be the focus of the remaining discussion. However, since Dolly Varden and burbot are also project evaluation species, some discussion of the effects of the reservoirs on these species will be presented. A short discussion will also be presented regarding the possible effects on salmon which occasionally occur within the reach to be impounded by the Devil Canyon reservoir.

Effects of the Watana Reservoir

Inundation Area. Closure of the Watana Dam will result in the inundation of approximately 48 miles of the Susitna River, the lower reaches of six named tributaries (approximately 26 miles total), and 31 lakes and ponds (ranging in size from less than one acre to approximately 55 acres). At the normal operating water surface elevation of the reservoir, the Susitna River will be converted from riverine habitat types to a relatively uniform lake-like habitat. The reservoir will extend into the tributaries various distances depending upon the locations of the tributary confluences with the river or reservoir (Table 1) and the gradients of the streambed. The lengths and gradients of the tributaries affected by the Watana Reservoir are summarized in Table 4.

Drawdown Zone. Seasonal variations in the lengths of the tributary reaches affected by the reservoir will occur as a result of project operation. In general, the reservoir will be filled by the end of the summer (approximately the end of August) and drawn down through the winter beginning approximately October 1. The reservoir will usually be drawn down about 100 ft, with a maximum drawdown of 120 ft. Refilling will begin at the onset of the open water season, approximately May 1. This translates to a daily average rate of drawdown of approximately 0.5 ft/day during the winter (Oct. 1 - May 1) and a rise in surface elevation of approximately 1.0 ft/day during the summer refilling period (May 1 - Sept. 1). A schematic of the drawdown-refill cycle is presented on Figure 3.

Because of the drawdown-refill cycle, tributary reaches within the drawdown zone will alternately exhibit tributary or reservoir characteristics. Reaches of the tributaries below the minimum water surface elevation (El. 2,065) will be permanently inundated (Table 4). Assuming a maximum annual drawdown of 120 ft, the approximate lengths of the Susitna River tributaries

Table 4

SUSITNA HYDROELECTRIC PROJECT
FEATURES OF SELECTED TRIBUTARIES WITHIN
THE PROPOSED WATANA IMPOUNDMENT

Tributary	Susitna River Confluence (River Mile)	Total Length Affected (mi)	Stream Gradient (ft/mi)	Approximate Length in Drawdown Zone (mi)	Approximate Length Permanently Inundated (mi)
Deadman Creek	186.7	2.7	253	.5	2.2
Watana Creek	194.1	8.5[a]	60[a]	0.0	8.5
East Fork	N/A	1.2[b]	113[b]	1.1	0.1
West Fork	N/A	2.1[b]	67[b]	1.8	0.3
Kosina Creek	206.8	4.5	118	1.0	3.5
Jay Creek	208.5	3.5	143	.8	2.7
Goose Creek	231.3	1.2	114	1.1	0.1
Oshetna River	233.4	2.2	41	2.2	0.0

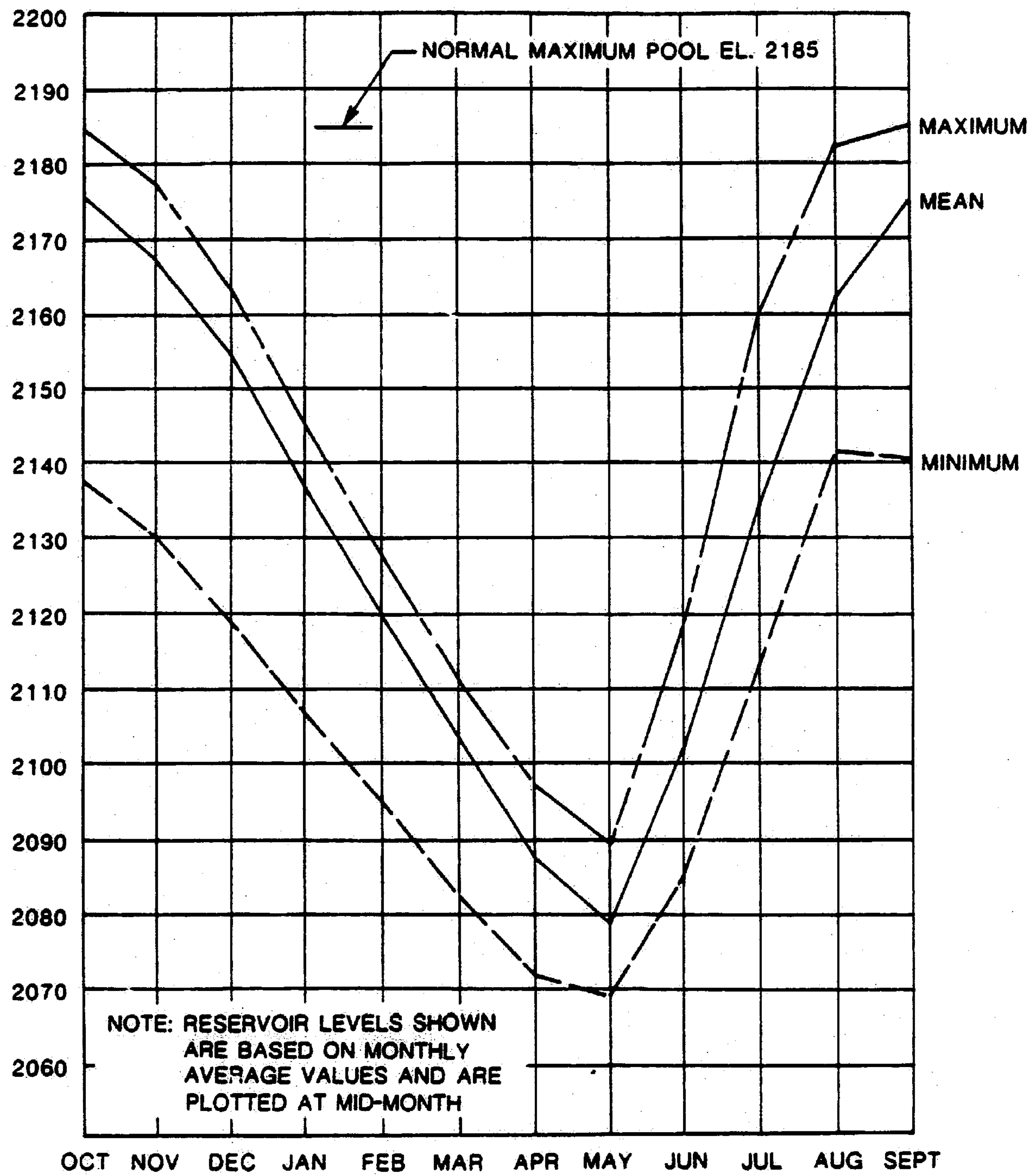
Source: Adapted from ADF&G 1983a (Table 5-3-2)

a/ Watana Creek below forks.
b/ Watana Creek above fork.

Figure 3

SUSITNA HYDROELECTRIC PROJECT

WATANA RESERVOIR WATER LEVELS
WATANA AND DEVIL CANYON OPERATING
2020 SIMULATION CASE E-VI



which will be in the drawdown zone are presented in Table 4. Lengths of tributaries within the drawdown zone are generally two miles or less.

<u>Suspended Sediment and Turbidity</u>. During the summer months, the Susitna River upstream of the proposed reservoir normally carries a heavy suspended sediment load. Under project conditions, the majority of the suspended sediments will be deposited in the upper end of the reservoir (APA 1983, 1984a). The deposited material will consist of some gravel (bed load), sand, silt and glacial flour (suspended sediments). Suspended particles less than 4 microns in diameter (the glacial flour component) will probably remain in suspension and cause the reservoir to remain turbid (APA 1983, 1984b; Peratrovitch, Nottingham and Drage, Inc. 1982). In addition, the Oshetna River, a glacially-fed river which enters the Susitna at RM 233.4, will contribute a considerable amount of sediment to the reservoir. The deposition of the suspended sediments will cover the river bed throughout the upper end of the reservoir including the lower reaches of some tributaries. The sediments will likely be graded from the upper end of the reservoir with the smaller materials deposited further into the reservoir.

As the reservoir is drawn down in the winter, the inflow from the upper Susitna River and the tributaries will cut through the deposited sediments to some extent and carry them farther into the reservoir. However, larger materials will remain in the stream bed since the discharge during the winter will be less than that required to transport them. The accumulation of sediments in the stream beds of the inundated tributary reaches will be considerably less than at the inflow of the Susitna and Oshetna Rivers. This is primarily due to the fact that most of the tributaries are clear water streams and do not convey excessive amounts of suspended sediments. They can, however, convey considerable bed materials, which will be deposited near the mouth of the tributary. As a result, small deltas will form at the mouths of the tributaries.

Although the reservoir in general will remain quite turbid (Peratrovich, Nottingham, and Drage, Inc. 1982) it is expected that clear water plumes will extend from the tributary mouths into the reservoir. The extent and nature of these plumes will depend upon the morphology of the inundated tributary valley, the discharge from the tributary, the mixing action of prevailing winds, the surface elevation of the reservoir, and the relative temperatures of the reservoir and the tributary water. These clearwater plumes will provide some habitat diversity in an otherwise uniformly turbid-water reservoir.

Temperature. During the summer months, the Watana reservoir will become thermally stratified. The strength and depth of the stratification will gradually change through the summer months as the surface water warms and density differences between the surface and bottom water increase. This stratification is due in part to the inflow of warmer water from the upper Susitna River and the warming of the reservoir surface water by solar radiation. The process will reverse during the late summer as the surface water cools. Maximum surface water temperature will be 8-10°C whereas bottom water will be 4°C (APA 1984b).

During the winter months, the temperature relationships will be reversed. The bottom waters will remain at 4°C, with the surface water temperature approaching 0°C. An ice cover will form on the reservoir. As the reservoir is drawn down through the winter, it is likely that the ice along the edge of the reservoir will break off and remain on the bank as large blocks.

The major change in the overall temperature regime in the reservoir area is that water temperature will, on the average, be cooler in the summer and warmer in the winter than under natural conditions. Warming of the water will occur at a slower rate in the spring and cooling will occur at a slower rate in the fall. The overall effect is that the warm-to-cool cycle will be somewhat retarded from pre-project regimes and will have a somewhat smaller amplitude. The cycle will be similar to temperature cycles observed in other lakes in southcentral Alaska (e.g. Eklutna Lake).

Effects on Resident Fish Species

Arctic grayling. Arctic grayling are relatively adaptable in their habitat requirements and are found in both river and lake habitats. However, it is likely that most of the reservoir area will not provide suitable habitat for grayling since it will be turbid. The most likely areas within the impoundment zone which will support grayling populations will be the clear-water plumes at the mouths of the tributaries.

Although it is likely that some small populations will be maintained in the reservoir area, the arctic grayling populations will be substantially affected. This loss is considered to be significant and, therefore, requires mitigative actions.

Burbot. Burbot are found throughout interior Alaska and inhabit both rivers and lakes. They generally prefer low light conditions and are often associated with turbid water environments. The Watana Reservoir should offer suitable habitat for burbot. However, burbot spawn in relatively shallow water (1-5 ft) over sand, gravel and stone substrates. Eggs settle to the bottom where they develop (Morrow 1980). Since spawning occurs in January and February, it is likely that some burbot will spawn in shallow areas of the reservoir at a time when the reservoir is being drawn down. As the reservoir is drawn down further, the eggs may become dewatered and either desiccate or freeze. This will result in a reduced recruitment rate to the population. A few burbot may move into the upper Susitna or Oshetna River to spawn (Morrow 1980); however, mark-recapture studies indicate that burbot are rather sedentary (ADF&G 1983a, Morrow 1980).

A burbot population is expected to remain in the reservoir area, and could expand over existing populations. However, the densities are expected to remain low due to reduced recruitment and reduced food supplies. Because this species is not highly sought by fishermen, any reduction in population density is not considered significant and, therefore, does not warrant mitigative action.

Dolly Varden. Small populations of Dolly Varden were found in Watana, Deadman and Jay Creeks within the Watana impoundment zone (ADF&G 1983a). Since this species is found in a wide range of habitat types, it is expected that the populations will inhabit the reservoir area. It is possible that the population will expand in the reservoir, but the individuals probably will not grow to large size (Morrow 1980) and, therefore, will not induce a significant sport fishery.

Effects of Watana Releases on the Devil Canyon Reach

Baseline conditions in the reach of the Susitna River within the Devil Canyon impoundment zone will be altered as a result of the Watana facilities. The principal physical changes will be the alteration of the flow regime, reduction in the total suspended sediment loads, moderation of the temperature regime, and increase in the turbidity of the discharge during the winter months. In general, all of these regimes will be changed from exhibiting considerable extremes in magnitude between summer and winter conditions to remaining relatively constant throughout the year.

Adult salmon generally do not use this reach of the Susitna River for spawning; however, a few chinook salmon are able to negotiate the rapids within Devil Canyon and up to 20 spawning pairs have been observed in both Cheechako and Chinook Creeks (ADF&G 1983b, 1984). In addition, five to 10 individuals have been observed in Devil's Creek and one spawning pair has been observed as far upstream as Fog Creek (Wick pers. comm. 1985).

The absence of the other salmon species in the Devil Canyon impoundment zone and upstream is apparently due to velocity barriers at the rapids within Devil Canyon. This is supported by radio telemetry tracking results of chinook and chum salmon adults and gill net captures of coho (O. kisutch), chum (O. keta) and pink (O. gorbuscha) salmon adults in the lower portion of Devil Canyon. Radio tagged chinook and chum salmon were tracked into the Devil Canyon reach (ADF&G 1983b). These individuals subsequently returned downstream to spawn. Movement of coho, chum and pink salmon into the Devil Canyon reach was demonstrated by the capture of adults of each species at RM 150.2 and 150.4 (ADF&G 1983b). Presumably, these fish would have returned downstream to spawn, since none has been observed upstream of the lower rapids area at the Devil Canyon dam site. It can be inferred from these results that farther upstream movements of adult coho, pink, and chum salmon are blocked by the rapids.

Effects of the Devil Canyon Reservoir

Inundation. Closure of the Devil Canyon Dam and filling of the reservoir will result in the inundation of approximately 35 miles of the Susitna River and a total of approximately six miles of the lower reaches of five named tributaries (Figure 2). The lower reaches of several unnamed tributaries will also be inundated, but the lengths of these tributaries have not been determined. The only lake to be affected by the Project will be a shallow, five-acre pond at the damsite, which will be filled by the saddle dam associated with the main, concrete arch Devil Canyon Dam.

As with the tributaries that flow into the Watana impoundment, the lengths of the tributaries to be affected by the Devil Canyon impoundment will vary according to their gradients and location within the impoundment. The locations of the tributaries, the stream gradients and lengths of affected reaches are summarized in Table 5.

Drawdown Zone. The Devil Canyon Reservoir water surface elevation will remain stable at near maximum operating levels most of the time. No drawdown of the Devil Canyon Reservoir is anticipated during wet years. A drawdown of approximately 50 feet may occur in median flow years during the August to September period, with refilling occurring in October (Figure 4). A drawdown of approximately 50 ft is anticipated for dry years, similar to that occurring in median flow years. Periodic smaller drawdowns may occur during the early spring months as the amount of water available in Watana Reservoir for power production becomes limiting. The lengths of tributaries to the Devil Canyon Reservoir within the drawdown zone are provided in Table 5.

Table 5

SUSITNA HYDROELECTRIC PROJECT
TOPOGRAPHICAL FEATURES OF SELECTED TRIBUTARIES OF
THE PROPOSED DEVIL CANYON IMPOUNDMENT[a/], 1982.

Tributary	Susitna River Confluence (River Mile)	Total Length Affected (mi)	Stream Gradient (ft/mi)	Approximate Length in Drawdown Zone (mi)	Approximate Length Permanently Inundated (mi)
Cheechako Creek	152.4	1.7	321	0.4	1.3
Chinook Creek	157.0	1.3	308	0.4	0.9
Devil Creek	161.4	1.5	176	0.7	0.8
Fog Creek	176.7	1.3	72	1.3	0.0
Tsusena Creek	181.3	0.4	82	0.4	0.0

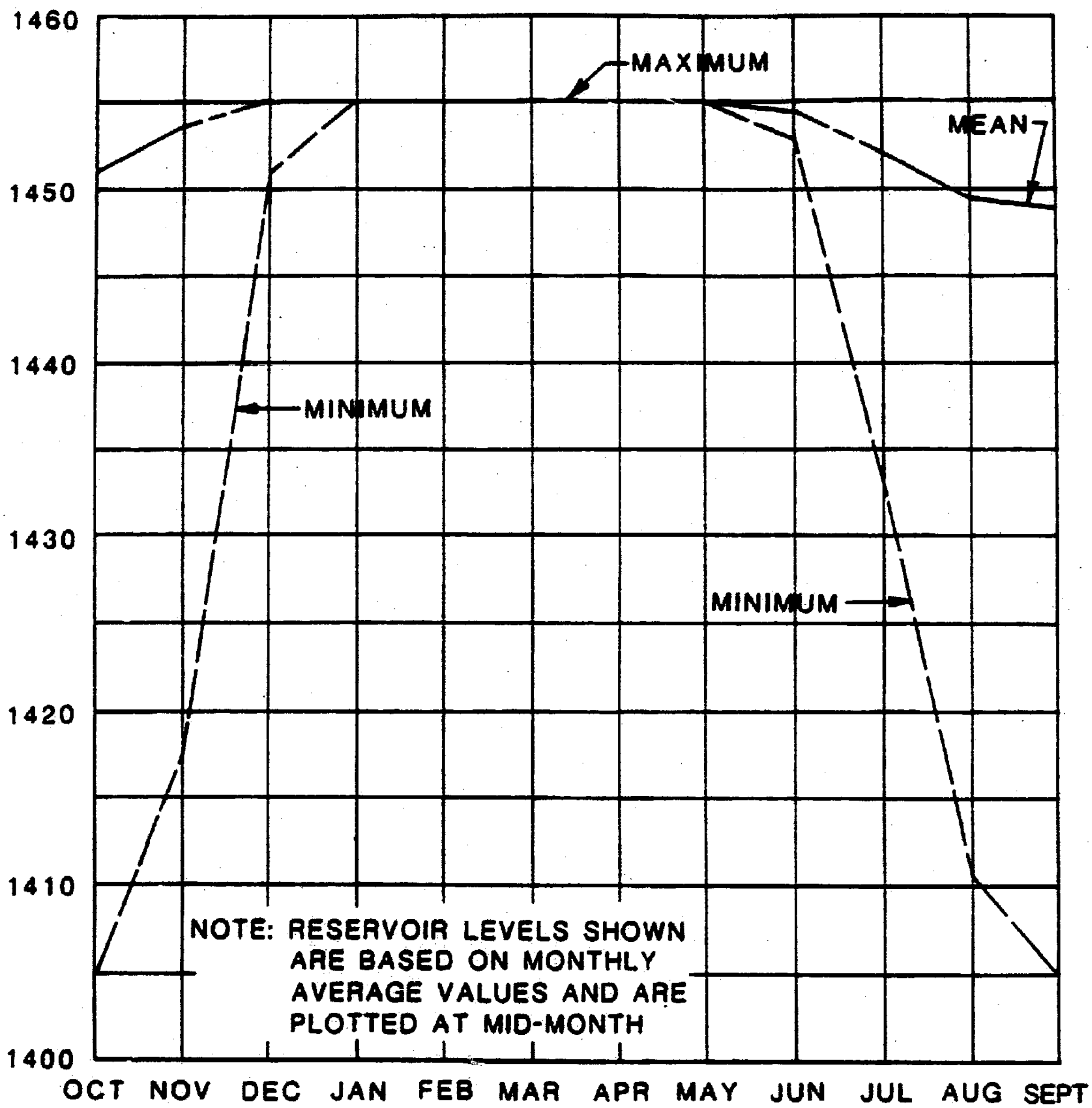
Source: ADF&G 1983a (Table 5-3-1)

a/ proposed Impoundment Elevation: 1455 Feet MSL.

Figure 4

SUSITNA HYDROELECTRIC PROJECT

DEVIL CANYON WATER LEVELS
2020 SIMULATION CASE E-VI



Suspended Sediment and Turbidity. The suspended sediments transported to the Devil Canyon Reservoir will consist almost entirely of particles less than 4 microns in diameter. Larger particles will be trapped in the Watana Reservoir and the source of larger sized suspended sediments will be from the tributaries. Some of the smaller particles will settle in the Devil Canyon reservoir, but the majority will pass through contributing to its turbidity. Small deltas will likely form at the mouths of the tributaries. However, these are not expected to significantly alter fish habitats.

Temperature. Temperature regimes in Devil Canyon Reservoir will be highly dependent upon the temperature of the water released from Watana Reservoir. The Devil Canyon Reservoir will stratify during June and July each year as warmer water from Watana enters the reservoir and remains at the surface. Maximum temperatures will range between 8 and 10°C (APA 1982, 1984b). Beginning August 1 in most years, the cone valves in Devil Canyon Dam will be operated to release water in excess of that required for generation. This excess water will result because the Watana Reservoir will have reached full storage capacity. Once the cone valves are operating, the cold, deeper water (4°C) will be evacuated from the reservoir and replaced by warmer Watana water (APA 1984b). The reservoir will become uniformly mixed at about 8-10°C by mid-August and will remain relatively warm through September (APA 1984b). The reservoir will then cool until it becomes isothermal at 4°C in October. After that time the surface water will cool to 0°C and an ice cover will form. In general, the seasonal temperature regime in Devil Canyon Reservoir will closely follow that of Watana.

Effects on Resident Fish Species

The Devil Canyon Reservoir will affect resident fish populations in much the same way as Watana Reservoir. Arctic grayling, burbot and Dolly Varden will have slightly better conditions in Devil Canyon than in Watana, since the drawdown of the Devil Canyon Reservoir will be less severe and will occur at a time not critical to the spawning of adults and the incubation of the embryos. Despite the possibility that somewhat larger populations may be maintained in Devil Canyon Reservoir, it is not likely that a significant sport fishery will develop in the reservoir.

Mitigation Measures Endorsed by The Alaska Power Authority

In selecting the measures for mitigating the loss of arctic grayling in the reservoirs, the Power Authority has attempted to follow, as closely as possible, the mitigation planning policy set forth in the License Application (APA 1983). Since the Project cannot avoid or minimize the effects, the preferred options are to replace and compensate for the loss of grayling populations. Specifically, the preferred mitigation plan consists of the following elements:

1. Recontouring of access road borrow sites to provide grayling habitat and planting grayling in the new ponds.

   The only in-kind, in-basin option for mitigating the loss of arctic grayling is to provide for planting of arctic grayling in the reservoirs or lakes, ponds and streams in the Susitna Basin. Since the reservoirs are not expected to provide suitable habitat for grayling, this option is not satisfactory. Planting of grayling in streams, lakes and ponds, however, could be implemented. Suitable streams for planting of grayling include those which presently do not contain grayling populations because there is some barrier (e.g. a waterfall) which prevents grayling from entering the system. Planting of grayling in lakes or ponds is possible. However, the lakes and ponds would need to be deep enough to prevent freezing to the bottom during winter months. One further option for planting arctic grayling within the Susitna Basin is to recontour the borrow pits used during construction of the dam and access road in a manner which will provide suitable grayling habitat. These recontoured borrow sites would provide considerable new grayling habitat and would also be accessible to fishermen.

2. Supplementation and expansion of arctic grayling populations within the Fairbanks area with provision for public access to the enhanced fisheries.

   In-kind, out-of-basin options include planting of grayling into sites outside of the Susitna River Basin. These options would require identification of potential sites to provide suitable conditions and provision for public access to the sites. Although such habitat could be identified throughout Alaska, it would be preferred to limit the location of the sites to areas within easy access from the major population centers of Anchorage and Fairbanks. Since a rainbow trout (Salmo gairdneri) planting program already exists in Anchorage, the preferred mitigation is to develop a program for the Fairbanks area.

   In order to implement this mitigation, it will probably be necessary to increase the size or number of facilities available for artificial propagation of grayling. One possible facility which could be expanded is the Clear Hatchery near Nenana. In addition, it may be necessary to improve existing technology for grayling propagation.

3. Supplementation of the existing rainbow trout planting program in the Anchorage area.

   A rainbow trout planting program currently exists in the lakes and streams of the Anchorage area. This program could be expanded by providing public access to additional lakes and streams which currently do not have trout populations and which do not have public access. Additionally, the existing program could be supplemented by providing more frequent plantings in the lakes and streams currently heavily used by area fishermen.

Implementation of these elements of the mitigation plan will require examination of existing hatchery facilities and possible expansion of hatchery capacity. Detailed procedures for implementing these elements will be developed in close consultation with the Alaska Department of Fish and Game.

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