DRAFT

SUSITNA HYDROELECTRIC PROJECT

# ECONOMIC AND FINANCIAL UPDATE

## SUPPLEMENTAL REPORT

## ENVIRONMENTAL IMPLICATIONS OF SUSITNA PROJECT ALTERNATIVES

CONFIDENTIAL; PRIVILEGED WORK PRODUCT PREPARED IN ANTICIPATION OF LITIGATION; RESTRICTED DISTRIBUTION

SEPTEMBER 1983

HARZA-EBASCO
Susitna Joint Venture
Document Number

466

Please Return To
DOCUMENT CONTROL

HARZA-EBASCO
SUSITNA JOINT VENTURE

ALASKA POWER AUTHORITY

# SUSITNA HYDROEELECTRIC PROJECT

## ENVIRONMENTAL IMPLICATION
## OF
## SUSITNA PROJECT ALTERNATIVES

SEPTEMBER 1983

SUBMITTED BY

HARZA-EBASCO
SUSITNA JOINT VENTURE

TO THE

ALASKA POWER AUTHORITY

TABLE OF CONTENTS

# INTRODUCTION

ENVIRONMENTAL IMPLICATIONS
OF SUSITNA PROJECT ALTERNATIVES

September 1983

The objective of this report is to present the environmental implications and trade-offs of the alternative development concepts considered in the Susitna Project Economic and Financial Update Report and in the Review and Update of Conceptual Design Report. This report was prepared in response to an August 22, 1983 Power Authority directive regarding the need to "address the environmental trade-offs involved in the reservoir elevation and reregulation dam issues." The environmental implications of both the recommended design refinements to the Project as described in the License Application and the alternative reservoir elevation and reregulating dam issues are summarized in the Economic and Financial Update Report. This report provides a more detailed evaluation of the relative differences among the various alternatives, but is not intended to be a comprehensive analysis of all impacts of each of the alternatives.

Exhibit E of the FERC License Application considers all aspects of construction and operation of the Project as proposed in relation to probable impacts on the physical, biological and social resources of the affected region. The Project as described in Exhibit E consists of the initial construction of the Watana Development with normal maximum reservoir elevation of 2185, followed by construction of the Devil Canyon dam and reservoir with normal maximum reservoir elevation of 1455. The Watana Development would operate as a base load project until the Devil Canyon Development enters operation, at which time the Devil Canyon Development would operate on base and the Watana development would operate in the load following mode.

Chapter 7 of the September 1983 Update Report compares the Susitna Project as proposed in the FERC License Application with potential Susitna Projects that have lower Watana dams and smaller reservoirs by evaluating and comparing:

A. For the Susitna Project —

1. Sizing of the Watana Project including a range of reservoir elevations (1900 to 2185) and installations (4 units versus 6 units).
2. Load following (rather than base load) operation.

B. For Non-Susitna Projects —

1. Natural gas-fired combined cycle power plants.
2. Coal-fired steam plants at Beluga and/or near the community of Nenana with coal from the Nenana field.
3. Natural gas from the North Slope.
4. Chakachamna Hydroelectric Project.

Environmental implications among the Susitna and Non-Susitna alternatives are considered separately in Parts A and B, respectively, of this Report.

# ENVIRONMENTAL IMPLICATIONS
# OF
# SUSITNA PROJECT ALTERNATIVES

SEPTEMBER 1983

PART A

ALTERNATIVE SCHEMES FOR
HYDROELECTRIC DEVELOPMENT OF THE
SUSITNA RIVER BASIN

TABLE OF CONTENTS

TABLE OF CONTENTS (Cont')

## LIST OF TABLES

## LIST OF EXHIBITS

# 1.0 INTRODUCTION

Development of the hydroelectric potential of the Susitna River Basin has been studied, on an intermittent basis, since shortly after World War II. In February 1983 the Alaska Power Authority submitted an application to the Federal Energy Regulatory Commission (FERC) for license to construct and operate the Susitna Project.

Changes from the License Application in the size or configuration of project features would likely result in changes in project impacts from those discussed in Exhibit E. This portion of the Environmental Report on Project Alternatives presents a discussion of the relative impacts related to each of the design and operational alternatives considered in the Update Study. This discussion is designed to highlight the differential impacts of the alternatives and to assist in their overall evaluation. It is not intended to present a comprehensive discussion of all potential impacts of each of the alternatives. A comprehensive evaluation of the project as described in the License Application is contained in Exhibit E. Comparable detailed analyses will be made only for those alternatives or design modifications that may be selected for future detailed study. The presently recommended modifications to the Project (considered below) will not result in significant changes in project impacts. Further quantification of project effects due to changes in plant discharge is in progress.

The following questions have been examined in relation to their engineering, economic and environmental desirability.

- Should the maximum normal water surface elevation of the Watana Development be maintained at elevation 2185 or would a lower elevation (e.g., 2100, 2000 or 1900) be preferable?

- Should facilities for four, rather than six, generating units be constructed initially, with the fifth and sixth units constructed at some future date?

- Should the Devil Canyon Development be built prior to the Watana Development?

- Should both developments be constructed with no appreciable changes in the design of project features or in the timing of construction?

- Should the project be operated in the load following mode?

- Are there other viable alternatives to the proposed project?

Fourteen alternative concepts for the Watana Development and three for the Devil Canyon Development were evaluated in order to provide answers to these questions. The alternatives for Watana were differentiated by various combinations of:

- Normal maximum reservoir elevations of 2185, 2100, 2000 and 1900 feet.

- Fill versus arch dam.

- Four versus six generating units in initial construction.

- Underground versus surface powerhouse.

The three alternatives for Devil Canyon included:

- The development as described in the License Application, including a 50-foot drawdown and an underground powerhouse.

- The same configuration (with underground powerhouse) with minor modifications by Harza-Ebasco (basically the removal of the emergency spillway) and with 100-foot reservoir draw-down if necessary for power generation.

- An arch dam with surface powerhouse.

The characteristics of the alternative development concepts selected for consideration in the Economic and Financial Update Report are shown in Table A-1. The Watana Development, as described in the FERC License Application, is included for comparison.

For each development concept, alternative operational modes have been considered. These are:

a. operating the downstream development (Devil Canyon or Watana if Devil Canyon is not present) as base load as described in the license application;

b. operating the entire project in a load following mode with flows naturally attenuating as they proceed downstream.

In terms of anticipated environmental implications of the alternatives, the development concepts would differentially impact the region upstream of Devil Canyon through construction and inundation effects (e.g., size of reservoir, construction time, labor requirements, etc.) and will differentially affect the river downstream of Devil Canyon through different seasonal flow release, and possibly temperature, patterns.

In addition to the alternative development concepts for the Susitna Project listed above, seven potential design refinements to the Watana Development have also been evaluated from engineering, economic and

Table A-1

SUSTINA RIVER ALTERNATIVE DEVELOPMENTS

| Characteristic | WATANA 2185 FERC | WATANA 2185 Modified | WATANA 2100 | WATANA 2000 | WATANA 1900 | DEVIL CANYON 1455 |
|---|---|---|---|---|---|---|
| Type of Dam | Fill | Fill | Fill | Fill | Fill | Concrete Arch |
| No. of Units | 6 | 6 | 4 | 4 | 4 | 4 |
| Volume of Dam ($10^6$cy) | 62 | 55 | 41 | 25 | 16 | 1.3 (arch)<br>1.9 (fill) |
| Construction Period (Years) | 10 | 8 | 8 | 7 | 7 | 8 |
| Dam Location (RM) | 184 | 184 | 184 | 184 | 184 | 152 |
| Dam Height (ft.) | 885 | 885 | 800 | 700 | 600 | 646 |
| Reservoir Area (Acres) | 38,000 | 38,000 | 28,300 | 19,800 | 14,500 | 7,800 |
| Total Reservoir Volume ($10^3$AF) | 9,470 | 9,470 | 6,645 | 4,248 | 2,546 | 1,100 |
| Reservoir Volume ($10^3$AF) | 3,740 | 3,740 | 3,315 | 2,370 | 1,675 | 599 |
| River Length Inundated (miles) | 54 | 54 | 49 | 44 | 39 | 32 |
| Maximum Drawdown | 120 | 120 | 150 | 150 | 150 | 100 |
| Tailwater Elevation (at 12,000 cfs) | 1,455 | 1,455 | 1,455 | 1,455 | 1,455 | 890 |
| Approximate Water Retention Time (days) (Total Volume ÷ (1.9835 x average annual flow of 8023) | 595 | 595 | 420 | 265 | 160 | 60 |
| Inundation of Principal Clear-water Tributaries (steam miles) | 23.9 | 23.9 | 18.1 | 14.4 | 10.7 | 4.4 |
| Average August Flows (cfs)[a] | 12,600 | 12,700 | 13,500 | 17,400 | 20,400 | n/a |
| Average December Flows (cfs)[a] | 11,300 | 11,000 | 11,300 | 8,900 | 7,100 | n/a |
| Man-months to first power ($x10^3$) | 103 | 83 | 70 | 57 | 49 | 50 |
| Peak Work Force | 3,300 | 2,800 | 2,700 | 2,600 | 2,600 | 1,800 |

a/ At Gold Creek, assumes presence of Devil Canyon Development environmental viewpoints. These refinements (Category 1) have been incorporated into the Modified Watana 2185 Project and included in the study of the alternative development concepts. These refinements relate to:

- o Dam Foundation Excavation and Treatment
- o Dam Configuration and Composition
- o Cofferdam and Diversion Tunnels
- o Power Intake - Spillway Approach Channel
- o Underground Cavern Orientation
- o Power Conduits
- o Spillway Structures (at both Watana and Devil Canyon)

These refinements are discussed in the report "Review and Update of Conceptual Design" (draft dated September, 1983). All environmental implications of these refinements are discussed both in that report and in subsequent sections of this environmental report. Additional cost-saving design refinements (Category 2) still under consideration are also addressed in this report. These include:

- o Relict channel treatment
- o Outlet facilities
- o Emergency release facilities

Several of the design refinements (e.g., Cofferdam and Diversion Tunnel details, Underground Cavern Orientation, etc.) have no significant environmental implications and are therefore not further discussed in this report.

## 2.0 AREA UPSTREAM OF DEVIL CANYON

The dam and reservoir characteristics of the individual development alternatives considered (four Watana, and Devil Canyon) are shown in Table A-1. The four alternative heights for the Watana site are defined in terms of their normal maximum water surface elevation. The Watana Development as described in the FERC License Application is also shown for comparison. Individual reservoirs range in size from 38,000 acres for the Watana 2185 Development to 7,800 acres for the Devil Canyon Reservoir.

Exhibit E of the License Application considers all aspects of project construction and operation in relation to probable impacts on fish, vegetation, wildlife and other resources of the project area. That discussion is based on the Watana 2185 alternative combined with subsequent construction of the Devil Canyon dam and reservoir. The following sections compare the differences in impacts if a lower maximum normal water surface elevation is selected at the Watana site or if other development concepts are selected.

### 2.1 WATANA ALTERNATIVES

The majority of the anticipated impacts on terrestrial and aquatic resources resulting from the construction and operation of the two dam project, as described in the License Application, are related to the first phase of development, the Watana 2185 dam and reservoir. The relative impacts of the proposed Watana alternatives are therefore compared to those for the base case Watana 2185 development. Dams with lower normal maximum water surface elevations (2100, 2000 or 1900 feet) would result in:

1) less area inundated,
2) less borrow material needed,

3) 1 to 2 years shorter construction period,

4) more modest remedial measures to seal the relict channel, and;

5) less inherent capacity for flood control and less regulation of downstream flows.

These changes, in turn, will modify the impacts that are described in many sections of Exhibit E. Lower dam heights would be matched by a reduction in installed capacity (but not the turbine discharge capacity). Modified project operation schedules would, in turn, result in alterations in seasonal, and potentially weekly and daily, release patterns and therefore in downstream flow regimes.

### 2.1.1 Area of Inundation

Table A-1 and Exhibit A-1 show that at reservoir elevations of 2100, 2000 or 1900 feet, the length of the reservoir would be 5, 10 and 15 miles shorter, respectively, than at elevation 2185. Also the area inundated is 26, 48 and 62 percent less, respectively, and the active storage capacity is 11, 36 and 55 percent less, respectively, than for the reservoir at elevation 2185.

Exhibit E identifies the major impact issues directly related to the amount of area inundated by the Watana development as:

Loss of grayling spawning and rearing habitat
Removal of vegetation
Loss of winter/spring moose and spring bear habitat
Interference with big game movements and potential for accidents
Inundation of Jay Creek mineral lick
Inundation of raptor nests
Impacts on other wildlife
Impacts on existing archaeologic and aesthetic resources

2.1.1.1 Loss of grayling spawning and rearing habitat. The Watana 2185 reservoir will flood 54 miles of Susitna River mainstem habitat and 28 miles of tributary habitat, including ten miles along Watana Creek, as well as portions of other tributaries. The primary long-term impact is the reduction of clear water spawning habitat in the tributaries that currently supports a substantial population of grayling (estimated to be at least 15,000 in 1982). Future aquatic habitats within the reservoir area are not expected to support a significant grayling population (page E-3-121).[1/] In addition, some reduction of burbot and whitefish spawning area is expected in mainstream habitats.

Measures to minimize impoundment impacts would be to "substantially lower the surface elevation of the reservoir or to maintain surface level during the embryo incubation period" (page E-3-171). It will not be feasible to maintain constant reservoir elevations during the grayling incubation period (May and June) because of the need to refill the reservoir, but the alternative Watana developments would have substantially lower reservoir surface elevations and therefore the reservoir would inundate correspondingly fewer stream miles of tributary habitat than the 28 miles inundated by the elevation 2185 development (Table A-2). Deadman, Watana, Kosina and Jay Creeks would be impacted by a reservoir at elevation 1900, but to a considerably smaller extent than by reservoirs with higher maximum water surface elevations. The falls on Deadman Creek, with crest elevation of 1800 feet, would be inundated under all alternatives. The mouth of Goose Creek is at an elevation of approximately 2060 feet at its confluence with the Susitna River and would not be adversely affected by the two lower alternatives. The mouth of the Oshetna River would be inundated only by the Watana 2185 development.

---

1/ Unless otherwise identified, page references are to Exhibit E of the License Application as filed, February 28, 1983.

Table A-2

PRINCIPAL TRIBUTARY STREAMS a/
INUNDATED BY WATANA RESERVOIR

| Stream | Location: River Mile | Location: Elevation at Confluence (feet) | Length (miles) Inundated by Reservoir El.: 1900 | 2000 | 2100 | 2185 |
|---|---|---|---|---|---|---|
| Deadman Creek | 186.7 | 1,513 | 0.7 | 1.2 | 1.7 | 2.3 |
| Watana Creek | 194.1 | 1,552 | 6.1 | 7.7 | 9.2 | 10.4 |
| Kosina Creek | 106.9 | 1,670 | 2.2 | 3.2 | 3.9 | 4.6 |
| Jay Creek | 208.6 | 1,700 | 1.7 | 2.3 | 3.0 | 3.6 |
| Goose Creek | 231.2 | 2,060 | -- | -- | 0.3 | 1.1 |
| Oshetna River | 233.5 | 2,110 | -- | -- | -- | 1.9 |
| Total for six tributaries | | | 10.7 | 14.4 | 18.1 | 23.9 |
| Other minor tributaries inundated by Watana 2185 Development | | | b/ | b/ | b/ | 4.1 |
| | | | | | | 28.0 |

a/ In addition, the lower portions of 39 smaller, unnamed tributaries will be inundated, for 0.1 to 3.9 miles, by all four alternatives with an additional 4, 12 and 13 tributaries inundated by the elevation 2000, 2100 and 2185 alternatives respectively.

b/ Not determined at this time for smaller tributaries but expected to be proportionately less as reservoir elevation is lowered.

2.1.1.2 Removal of Vegetation. "Construction of the Watana Development will result in the direct removal of vegetation within an area of approximately 35,605 acres (14,409 ha) covering a range of elevations from 1400 to 2400 feet (430 to 730 m). In addition, about 5,258 acres (2128 ha) of unvegetated areas will be inundated or developed" (page E-3-225 as revised by supplemental information filed with FERC on July 11, 1983). The total reservoir areas associated with the smaller projects will require correspondingly less removal of vegetation. Table A-

3 shows the total reservoir area and the vegetated area of the reservoir for each of the Watana alternatives. At the present time, differences in the amount of required clearing for other project features for the four alternatives are not included in these calculations. The Watana 2100, 2000 and 1900 alternatives would result in preservation of about 9,000, 17,000 and 22,000 acres of natural vegetation, respectively, with corresponding reductions in impacts to wildlife resources and aesthetics. Natural vegetation that would be preserved by lower Watana dam heights primarily consists of black spruce, white spruce, and mixed forest types.

Table A-3

RESERVOIR AREA AND REQUIRED
CLEARING FOR WATANA ALTERNATIVES

| | | | | |
|---|---|---|---|---|
| Reservoir elevation (feet,msl) | 2,185 | 2,100 | 2,000 | 1,900 |
| Reservoir area (acres) | 38,000a/ | 28,300 | 19,800 | 14,500 |
| River length inundated (miles) | 54 | 49 | 44 | 39 |
| Unvegetated area | 5,400b/ | 4,900b/ | 4,400b/ | 3,900b/ |
| Vegetated area | 32,600 | 23,400 | 15,400 | 10,600 |
| Percent reduction in required clearing for reservoir | - | 28 | 53 | 67 |

---

a/ From Exhibit A, page A-2-1, and Exhibit E, Chapter 2, page E-2-55; based on R&M data in a letter dated May 7, 1981.

b/ Assumed to be proportional to river length inundated since this is predominately open water.

2.1.1.3 Loss of Moose and Bear Habitat. Removal of vegetation and filling of the reservoir for the Watana 2185 development will reduce the carrying capacity of the winter range by approximately 300 moose. Also, the impoundment zones, particularly the south-facing slopes, are important as a source of early spring foods and as calving areas for moose. These zones also contain several large areas of river valley bottomland with mixed spruce deciduous woodlands that may provide critical moose habitat during years with severe winters. Brown bears likewise make heavy spring use of the riparian vegetation and south-facing slope habitat where they prey on moose calves and forage on new spring vegetation and overwintered berries. The permanent loss of habitat and early spring foods in the impoundment area may cause a decrease in the carrying capacity of the area for brown bears. Loss of habitat will be most significant for black bears. A large proportion of the acceptable black bear habitat in the middle basin will be eliminated. Whereas no brown bear denning habitat will be affected by the Watana 2185 reservoir, 9 of 13 identified black bear den sites in the Watana impoundment area will apparently be flooded. Lower reservoir surface elevations would impact moose and bears to a correspondingly lesser extent for each of the smaller reservoir alternatives. For examples, 8 of the 9 black bear dens potentially flooded by Watana 2185 occur within an elevation range of 1900 to 2100 feet. Therefore, the number of den sites actually flooded could vary from 1 to 8 depending on the dam height and the exact elevation of the dens.

2.1.1.4 Interference with Big Game Movements. Reduction of reservoir area, particularly in the length of mainstem and tributary stream inundated and the narrower reservoir width associated with the lower Watana developments, will reduce the magnitude of impacts on the carrying capacity of the area for big game species. Such a reduction would also reduce the potential for interference with movements and the possibility for big game fatalities during river crossing attempts. Moose, caribou, brown and black bears, and possibly Dall sheep cross the river in the project area. Barriers and potential for accidents would be less at lower Watana elevations, and would not be present at some key crossing areas due to the shorter reservoir lengths (e.g., in the vicinity of Goose Creek, the Oshetna River, and along a portion of Watana Creek).

2.1.1.5 Inundation of Jay Creek Mineral Lick. Partial inundation of the Jay Creek mineral lick may negatively impact the Watana Hills Dall sheep population. With the reservoir at elevation 2185, up to 42 percent of the surface area of the mineral lick would be inundated by the Watana impoundment (page E-3-512). This lick appears to be an important nutrient source for the Watana Hills Dall Sheep population. The lick extends from elevation 2000 to 2450, so lower elevations of the reservoir will inundate less of the lick area or may totally avoid it (e.g., at elevation 1900).

2.1.1.6 Inundation of Raptor Nests. Reduction of reservoir elevation may also be significant for raptors. Lowering the elevation of the Watana reservoir would reduce or eliminate impacts to as many as two bald eagle nests, one golden eagle nest, one gyrfalcon nest, and six raven nests, depending on the alternative selected and the exact nest elevations. Two bald eagle, five golden eagle, one goshawk, and five raven nests would be inundated regardless of the alternative selected.

2.1.1.7 Impacts on Other Wildlife. Reservoir clearing and general ground disturbance associated with the Watana development will have adverse impacts on the other species of wildlife present in the area (pages E-3-512 to 517 and Tables E.3.149 to 158). Lower reservoir elevations with less needed clearing and general ground disturbance would reduce construction and inundation impacts on all wildlife species in the area, especially forest-inhabiting species such as many birds, small mammals, and certain furbearers. The impact reduction would be especially significant for marten which is dependent on forest habitat and is the most economically important furbearer in the reservoir vicinity. A reservoir elevation of 1900 feet would reduce marten impacts substantially because only about half of the forest habitat lost with the Watana 2185 project would be inundated by the lower dam height. Areas of stream habitat utilized by mink and otter (both moderately abundant furbearers in the Watana reservoir vicinity) would also be significantly less-affected by lower reservoir elevations.

2.1.1.8 Other Impacts of Inundation. A total of 167 historic and archaeological sites are discussed in the License Application. Of these, 30 are identified as being directly affected by the Watana Dam and impoundment (at El. 2185). Three additional sites may be affected (one site directly and two potentially) by borrow area activities. The remaining 134 sites would be unaffected by possible changes in normal maximum reservoir elevations at the Watana development. Since preparation of Exhibit E, 26 additional sites have been identified from the Watana area.

Three of these sites appear to be in the construction area and will likely be impacted regardless of elevation selected. One site is located upstream of the Oshetna River and would only be affected by the elevation 2185 development. The relative elevations of the remaining 52 sites are shown in Table A-4.

Table A-4

ELEVATIONS OF IDENTIFIED ARCHAEOLOGICAL
SITES IN THE WATANA RESERVOIR AREA

| Elevation (ft.) | No. of Sites |
|---|---|
| 1540 - 1900 | 20 |
| 1920 - 2000 | 6 |
| 2050 - 2100 | 10 |
| 2133 - 2185 | 2 |
| 2200 - 2300 | 14 |
| | 52 |

Thus, lowering the normal maximum reservoir elevation from 2185 to 2100, 2000 or 1900 would reduce the number of sites directly affected by 2, 12, and 18 respectively. These sites would remain subject to indirect impacts during both project construction and operation, however, as discussed in Exhibit E of the License Application.

The License Application also indicates that the Watana 2185 dam and reservoir will inundate six structures, of which one, a lean-to for hunting and fishing, is presently maintained for temporary use. These six structures are located close to the river and will be affected by the Watana Development, regardless of selected reservoir elevation.

Since the lower alternative reservoir elevations would inundate significantly fewer acres and stream miles than the reservoir as described in the License Application, the lower elevation developments would progressively reduce the total magnitude of changes in land use and related land use activities. Although development would increase the potential for access to the area, the lower alternatives would result in larger areas remaining in primitive "before project" condition for recreational activities including boating, fishing, hunting, and hiking. It is not anticipated that changes in the dam height or reservoir level would result in any significant modifications to the project related facilities proposed in the Recreation Plan.

Differences in alternative Watana developments will not change impacts to the exceptional Natural Features in the project area as identified in Chapter 8 of the License Application. For example, Deadman Creek Falls, which is located approximately 0.5 miles north of the Susitna River-Deadman Creek confluence and rises to 1800 feet in elevation, will still be inundated. In terms of the aesthetic quality of the reservoir and the adjacent area, as the reservoir is lowered and the total number of river and tributary miles are reduced and the total size of the reservoir and borrow sites decreases, increasingly larger areas will retain their natural landscape characteristics. In particular, as the reservoir size decreases, the size of the project-created mudflats (located principally east of Deadman Creek and in the area centered around Watana Creek) will be significantly reduced, thereby diminishing potentially negative aesthetic effects including those related to blowing dust. Sally Lake near the mouth of Watana Creek has a surface elevation of approximately 2050 feet and would be affected only by the 2100 and 2185 dam alternatives.

### 2.1.2 Borrow Material

"Removal of floodplain gravel can cause erosion, siltation, increased turbidity, increased ice buildup caused by ground water overflow, fish entrapment, and alteration of fish habitat" (page E-3-155). Borrow material requirements for the Watana dam are shown in Table A-5.

Table A-5

DAM FILL VOLUMES
(Thousand cubic yards)

| Development/ Nature of Fill | Borrow Area | 2185 FERC a/ | 2185 Modified b/ | 2100 | 2000 | 1900 |
|---|---|---|---|---|---|---|
| Total Volume | - | 61,800 | 55,100 | 40,600 | 24,900 | 16,400 |
| Percent Reduction | - | - | 11c/ | 26d/ | 55d/ | 70d/ |
| Impervious Fill | D | 8,300 | 7,250 | 5,160 | 3,370 | 2,230 |
| Sand & Gravel/ Filters | E | 42,300 | 26,300 | 18,500 | 11,460 | 7,640 |
| Rockfill from Quarry | A | 1,600 | 16,000 | 10,900 | 3,210 | 580 |
| Total Rockfill from Excavation | - | 9,600 | 5,550 | 6,040 | 6,880 | 5,990 |

a/ Project as described in the License Application.
b/ Project as modified by Harza-Ebasco.
c/ As compared to the project as described in the License Application.
d/ As compared to the modified project.

The Harza-Ebasco modified design for the El. 2185 dam requires ten percent less fill material than that described in the License Application. This is mainly because of reduced foundation excavation and revised design of the fill dam. Approximately 75 percent of the material excavated from the dam foundation could eventually be utilized in dam construction. The remainder would be spoiled in the future reservoir area. Since spoil material will be placed in the dead storage portion of the reservoir, no aesthetic or other impacts are anticipated from this disposal.

A project at elevation 2100 reduces the total volume of the dam by 26 percent as compared with the modified El. 2185 design. A development at elevation 2000 reduces the volume by 55 percent and a development at elevation 1900 reduces the volume by 70 percent as compared with the modified El. 2185 design.

Borrow areas for the Watana dam are shown in Figure E.2.131 of the License Application. Borrow area E is a large alluvial fan deposit at the confluence of Tsusena Creek with the surface of the deposit ranging in elevation from a low of 1410 feet near the river to 1700 feet against the valley walls. Although the mined area will be rehabilitated to provide feeding and overwintering fish habitat following construction, some increased turbidity will doubtless occur from the mining activities. The reduced volume of material needed from borrow area E will tend to reduce the extent and duration of turbidity and sedimentation in the river downstream during construction. Also, reducing the volume needed from this area may reduce impacts on the existing riparian habitat for moose and other species.

Borrow areas A and D are located in upland areas away from the reservoir. The volume of material needed for impervious fill (area D) is progressively less at lower dam heights than that for the dam as described in the License Application.

The volume of material needed from the rock quarry (area A) is also considerably less at lower dam heights but, except for the El. 1900 alternative, is greater than that for the project described in the License Application. This is due to a redistribution in the proportion of the types of materials used in dam construction under the modified design. The project modifications result in a reduction in material extracted from the river (area E) and a smaller increase in material excavated from the rock quarry (area A). This results in a trade-off between less disturbance to aquatic and riparian habitats through removal of the sand and gravel sustrate and less turbidity downstream and increased disturbance to the area around the rock quarrry with increased blasting and resultant dust and increased aesthetic impact in the quarry area.

### 2.1.3 Shorter Construction Period

Many project impacts discussed in Exhibit E are essentially time dependent in that the shorter the construction period, the less the cumulative impact. Of particular concern is increased hunting and fishing pressure and the general disturbance to the environment that will occur throughout the construction period. The lower dams, with less placement of fill material, will require less time for construction. This, in turn, will result in a reduction of cumulative impact. Although completion of construction would not totally eliminate some sources of impact (e.g. access to the area), impacts due to other factors may be reduced by shorter construction times. Such factors include:

Erosion
Potential for Oil and Hazardous Material Spills
Blasting
River Diversions
Reservoir Filling
Water Quality Changes
Maintenance of Access and Temporary Camps
Aircraft Disturbance

Table A-6 shows the relationship between dam elevation, construction time, and labor requirements. The total labor requirements for the smaller developments are progressively less than for the 2185 project as described in the License Application. Peak manpower requirements remain essentially the same for all Harza-Ebasco designs but are less than those originally planned.

TABLE A-6

CONSTRUCTION TIME AND LABOR REQUIREMENTS

| Development | Construction Total (yrs) | Time to first power (yrs) | Labor Requirements total, thousand man-days | Labor Requirements Maximum, thousand individuals |
|---|---|---|---|---|
| 2185 FERC | 10 | 8 | 3,140 | 3.3 |
| 2185 Modified | 8 | 8 | 2,520 | 2.8 |
| 2100 | 8 | 7 | 2,140 | 2.7 |
| 2000 | 7 | 6 | 1,730 | 2.6 |
| 1900 | 7 | 5 | 1,480 | 2.6 |

## 2.1.4 Relict Channel

An ancient channel, now filled, is present in the north bank of the Watana reservoir approximately 2,600 feet upstream of the dam. This channel runs from the Susitna River gorge to Tsusena Creek and represents a potential source of leakage from the Watana reservoir. The controlling bedrock surface of the channel is at elevation 1740 and contains up to 454 feet of glacial deposits.

To preserve the integrity of the rim of the Watana 2185 reservoir and to control losses due to potential seepage, a number of remedial measures are proposed in the FERC License Application. These measures will have a net result of disturbance to the vegetation and wildlife resources of that zone. For lower reservoir elevations (2100 to 1900), and depending on the results of future analyses of the tightness of the overburden, needed remedial measures may be reduced resulting in less ground disturbance than previously indicated.

### 2.1.5 Flood Control

The Watana 2185 project as described in the FERC License Application is designed so that the powerhouse and outlet facilities, plus reservoir storage, will have sufficient capacity to pass floods with recurrence intervals up to once in fifty years without operating the main spillway. During floods of this magnitude, the reservoir will be allowed to surcharge to elevation 2193. By containing the fifty year flood without use of the spillway structure, problems related to nitrogen supersaturation and resultant fish kills will be minimized. If a lower elevation for the Watana project is considered (2100 to 1900), project facilities will be modified (e.g. larger outlet works capacity) so that nitrogen supersaturation of the water is avoided. Flows up to the 1 in 50 year flood will continue to be passed without operation of the main spillway. Sufficient flood routing studies will be conducted to assure that the project can adequately meet these criteria.

### 2.1.6 Emergency Flows to Tsusena Creek

The project as described in the License Application includes an emergency spillway to pass flood flows in excess of 150,000 cfs (recurrence interval of less than once in 10,000 years). The emergency spillway will consist of a long straight chute excavated in rock and leading in the direction of Tsusena Creek. An erodible fuse plug at the upstream end will remain in place until overtopped.

Flows of up to 120,000 cfs in excess of the combined main spillway and outlet facility capacities may be released to Tsusena Creek, thus preventing overtopping of the main dam under conditions approaching the Probable Maximum flood (PMF). It is estimated that flows down the emergency spillway to Tsusena Creek would continue for a period of 20 days under the PMF analysis. A comparable emergency spillway is shown in the License Application for the Devil Canyon Development. All Harza-Ebasco alternatives for the Watana site (and the revised drawings for the Devil Canyon Development) have deleted the emergency spillway. The main spillway for each development has been increased in capacity to handle flows up to the PMF flood.

Although flows in excess of 150,000 cfs have an extremely low frequency of occurrence (once in 10,000 years), their removal from Tsusena Creek would remove a potential source of project impact. Elimination of the emergency spillway will result in elimination of direct disturbance to approximately 60 acres of low shrub and black spruce vegetation (common types in the area) and the elimination of the potential for much greater impacts to the terrestrial, aquatic, and aesthetic resources of the lower Tsusena Creek area if the emergency spillway were ever used. Discharges down the emergency spillway would cause major changes in the characteristics of the lower portion of Tsusena Creek and loss of important habitat for moose, brown and black bear, grayling and other terrestrial and aquatic resources.

Much of the lower portion of Tsusena Creek would still be inundated by flows approaching the PMF. Without the emergency spillway, the creek valley would be inundated by backwater from the river without the erosive force of flows from the emergency spillway. This type of inundation would result in considerably fewer lasting impacts on the area.

Elimination of the emergency spillway from the Devil Canyon Development will have comparable effects to the proposed change in the spillway at Watana. Approximately 60 acres of mixed woodland vegetation will remain undisturbed where the emergency spillway would have been constructed. To this extent, aesthetic impacts at the Devil Canyon site will be reduced. Since the emergency spillway would discharge directly to the river, there will be no change in impacts resulting from its elimination.

The approach channel to the main spillway is increased in size to handle the increased flows. Material excavated from this area will be used in construction of the dam and will partially replace material that previously would have come from excavation for the dam foundation, construction of the spillway and from the upland rock quarry. Much of the excavation for the approach channel will be below the normal reservoir surface (regardless of alternative) and therefore not visible following completion. Thus, these modifications will have no significant impact except possibly a slight reduction in the amount of rock to be excavated from the quarry.

### 2.1.7 Other Design Changes

During the development and costing of project alternatives, possible design changes for specific project features were considered as well as the alternative development concepts and operational modes. The elimination of the emergency spillway to Tsusena Creek has already been considered. Three other general changes in project design were also considered that could influence project impacts. These are the possible substitution of concrete arch dams for the fill dams at the three lower Watana developments, modifications to the powerhouse designs including a surface powerhouse, and modifications to the discharge facilities. Although these have not been adopted at this time, the environmental implications of these changes are considered below. Other design refinements discussed in the report on "Review and Update of Conceptual Design" (e.g. orientation of underground caverns, modifications to the cofferdam diversion tunnel concept, and changes in the power conduits) will have no significant effects and are not considered in this report.

2.1.7.1 Arch Dam vs. Fill Dam. The basic environmental difference between a fill dam and a concrete arch dam at a given location is in their construction. In general, the arch dam requires less construction time and less borrow material than a comparable fill dam. These changes are similar to the changes previously discussed when considering lowering the normal surface elevation at the Watana development. Reducing borrow material and construction time would both tend to reduce construction impact at the site.

Analysis of the arch dam possibilities at the three lower Watana elevations indicated, however, that this location is not suited to such a project. Large lateral, fill dikes would be required, thus losing much of the environmental advantages of an arch dam. In all three instances, the arch dam alternative was more expensive, without compensating advantages.

2.1.7.2. Powerhouse Modifications. Replacement of the underground powerhouse by a surface powerhouse located between the main spillway and the dam was considered, but not adapted, for the Watana alternatives. The area where a surface powerhouse would be located will be heavily disturbed even with construction of the underground powerhouse, so this would not be a new loss of natural vegetation. The surface powerhouse would be designed to blend in with the surrounding area and not be unnecessarily obtrusive.

Elimination of the underground powerhouse would also result in the removal of the powerhouse control building near the switchyard but, instead, require the construction of a 2,100 ft. above ground transmission line from the powerhouse at elevation 1600 to the switchyard at elevation 2270.

The initial installation of four rather than six units as proposed in the License Application would not significantly alter long-term average project outflows. The main advantages attributed to the last two units are load following and spinning reserve. In view of the reduced load growth in the Railbelt region, installation of the fifth and sixth units may be delayed. Increased load following with six units would potentially result in much higher powerplant discharges (up to 21,000 cfs as compared with a maximum of 14,000 cfs with only four units) and increased flow fluctuations downstream. Environmental aspects of load following operation are discussed in Sections 3.2.1 and 4.2.3 of this report.

Each Watana alternative would have three large penstock tunnels instead of the six individual smaller tunnels as described in the License Application. Although the intake structure itself would be shortened because of this change, rock excavation would increase because of the curved approach channel required by the topography. Excavated material would be used in dam construction. Following completion, much of the excavated area would be below the reservoir surface. The net environmental effect of this change following construction is minimal.

2.1.7.3 Discharge Facilities. Except for enlargement of the main spillway to handle the PMF and elimination of the emergency spillway to Tsusena Creek, the project discharge facilities for all alternatives will have essentially the same capacities as described in the License Application. All flows with a return frequency of less than 50 years will be passed through the turbines and/or cone valves without use of the spillway.

2.1.8 Reservoir Drawdowns

Normal maximum reservoir drawdown for the three lower reservoir alternatives will be 150 feet as compared to 120 feet for the modified W2185 development. Variations of this magnitude in the extent of maximum drawdown will not be significant, but reducing the area exposed by the drawdown, by lowering the normal maximum elevation, will reduce adverse effects on wildlife and their movements.

## 2.2 DEVIL CANYON DEVELOPMENT

This development, as presently being considered, is comparable to that described in the License Application (maximum elevation 1455). Incorporation of this development into the recommended project plan will not add important differential impacts in relation to those described in the License Application.

The development remains a concrete arch dam with a 4-unit powerhouse. The only modification is the removal of the emergency spillway, as discussed in Section 2.1.6.

Design studies have included consideration of 100 feet of drawdown in the reservoir. To accommodate this change, the intake structure would be redesigned to include openings at three levels rather than the two as shown in the License Application. Impacts on wildlife due to the possible increase in drawdown are expected to be small since the canyon in that area is relatively steep and narrow and not utilized by moose and other wildlife to the same extent as areas further upstream in the vicinity of the Watana Development.

Construction of the Devil Canyon Development prior to Watana was considered in the economic analysis and found to be economically less favorable than constructing Watana first. Once the upstream storage capacity of the Watana reservoir is developed, the Devil Canyon Development becomes a very economical project to meet increased load demands.

From an environmental standpoint, impacts of the Devil Canyon Development would be as described in the License Application. Differential impacts as compared to the presently proposed development sequence would be to delay Watana impacts for a few years. Impacts of the two development projects would be the same regardless of which was constructed first.

# 3.0 DOWNSTREAM FLOWS

## 3.1 SEASONAL FLUCTUATIONS

The Susitna Project will be operated to maximize average energy generation while at the same time maintaining a high level of firm energy, and meeting the specified downstream minimum flow regime (Table A-7). Reservoir storage rule curves will differ for each of the alternative development concepts (as defined by the normal maximum reservoir elevation -- 2185, 2100, 2000, or 1900 feet -- of the Watana Development, with or without the Devil Canyon Development) because of differences in maximum drawdown and active storage volume of the alternatives (Table A-1). The downstream minimum flow regime, the "Case C" scenario discussed in the License Application, is used in the comparison of all alternatives except as discussed for the Watana 1900 Development in the Watana only analysis.

Average monthly flows at Gold Creek under natural and with-project conditions are shown on Exhibit A-2 with three energy demand levels for each alternative dam height. The first demand level assumes a year 2000 energy demand of 4709 GWh (DOR Mean forecast as discussed in the Economic and Financial Update Report). With this demand level, only the Watana Development would be in operation. The second demand level occurs when both Devil Canyon and a Watana alternative are in operation and presents flows at Gold Creek for a year 2010 energy demand of 5945 GWh. The third level presents year 2020 flows for an energy demand of 7505 GWh. In all of these cases, there is no significant difference in downstream flow regimes resulting from project operation between the 2185 Project as described in the FERC License Application and that for the 2185 project as modified in certain design characteristics. Only downstream flows as used in the Harza-Ebasco Update are presented in this report.

Table A-7

MINIMUM DESIGNATED WITH-PROJECT DOWNSTREAM FLOW REGIME AT GOLD CREEK a/

| Month | Flow cfs | Month | Flow cfs |
|---|---|---|---|
| October | 5000 | April | 5000 |
| November | 5000 | May | 6000 |
| December | 5000 | June | 6000 |
| January | 5000 | July | 6480 b/ |
| February | 5000 | August | 12000 |
| March | 5000 | September | 9300 b/ |

a/ As discussed in the License Application, this, the "Case C" flow scenario, was selected as the basic project operational flow regime considering both project and environmental interests.

b/ Flows change by 1000 cfs per day from 6000 on July 25 to 12,000 on August 1 and from 12,000 on September 14 to 6000 on September 21.

| Date | | |
|---|---|---|
| July | Sept. | Flow cfs |
| 25 | 21 | 6000 |
| 26 | 20 | 6000 |
| 27 | 19 | 7000 |
| 28 | 18 | 8000 |
| 29 | 17 | 9000 |
| 30 | 16 | 10000 |
| 31 | 15 | 11000 |

Downstream flow regimes following project construction will be altered from natural conditions as shown in Exhibit A-2. Under natural conditions, the average August flows (22,017 cfs ave.) are 12 times the average December flows (1825 cfs). Under with project conditions, the flow regime is characterized by increases in winter flows and decreases in summer flows. This change in seasonal flow patterns will result in changes to the physical characteristics of the river downstream following project development as discussed in Section 4.0 of this report. Table A-8 summarizes average August and December flows for each demand level and each alternative dam elevation for the Watana Development. These months were selected for study because, under project conditions as characterized by the Case C scenario, August flows will generally be the highest of the year and are deemed to be critical in terms of salmon access to their traditional spawning areas in the reach between Devil Canyon and Talkeetna. December power demands are the highest of the year, and therefore December project outflows are the greatest of the winter season.

Table A-8

AVERAGE AUGUST AND DECEMBER
WITH-PROJECT FLOWS AT GOLD CREEK

| Watana Alternative | Energy Demand 4709 GWh Aug | 4709 GWh Dec | 5945 GWh Aug | 5945 GWh Dec | 7505GWh Aug | 7505GWh Dec |
|---|---|---|---|---|---|---|
| 2185 | 12,680 | 11,146 | 18,436 | 9,430 | 12,678 | 10,979 |
| 2100 | 13,755 | 10,689 | 16,050 | 9,796 | 13,548 | 11,274 |
| 2000 | 15,900 | 8,697 | 19,020 | 9,764 | 17,424 | 8,906 |
| 1900 | 22,017 | 7,802 | 21,057 | 7,058 | 20,363 | 7,054 |
| Natural | 22,017 | 1,825 | 22,017 | 1,825 | 22,017 | 1,825 |

Depending on both dam elevation and power demand level, average August flows may be decreased from a natural flow of 22,017 cfs to 12,678 cfs for the fully loaded two development project (year 2020 demand of 7505 GWh). Average December flows are increased from a natural flow of 1825 cfs to a range of 7000 to 11,300 cfs. For individual years out of the 33-year period of record, average monthly December flow may exceed 14,000 cfs (Exhibits A-3 through A-7). August flows are maintained at a minimum of 12,000 cfs in accordance with the "Case C" scenario even though operation solely for power production would have resulted in less than 12,000 cfs at Gold Creek.

Exhibits A-3 through A-5 show the frequency distribution of August and December flows for each dam height for each power demand level. For the year 2000 demand (Exhibit A-3) and the Watana 2185 development, August flows for 26 of the 33 years of simulation were the minimum of 12,000 cfs as specified by the "Case C" flow regime. At lower dam heights, the minimum flow of 12,000 cfs occurred 16 times for the development at 2100 and only four times at 2000. Flows greater than 15,000 cfs, the natural minimum August flow, occurred only three times out of 33 years for Watana 2185, six times for the 2100 development, and 15 times for the Watana 2000 Development. At this power demand level, the frequency distribution of August flows for the Watana 1900 Development was identical to the natural flows. Thus, the with project frequency distribution of August flows at Gold Creek is related to the height of the Watana dam and the corresponding storage capacity of the reservoir. With higher dams, the summer flows are stored for winter generation. At the lower dam heights, the summer flows meet reservoir storage needs in early summer and additional flows are passed through the project. Hence, flows approach natural conditions.

December flows for the Watana 2185 and 2100 Developments (4709 GWh energy demand) would range from 10,000 to 12,000 cfs (18 and 29 out of 33 years, respectively). For Watana 2000, all 33 years had flows between 8,000 and 10,000 cfs, and 30 of the 33 years had flows between 6,000 and 8,000 cfs for the Watana 1900 Development. Comparable distributions for increased energy demands are shown on Exhibits A-4 and A-5. Under higher demand levels, the with project frequency distribution of August and December flows exhibit the same trends as discussed for the year 2000 demand level. An alternative method of comparison is shown in Exhibits A-6 and A-7. Monthly flow duration levels were prepared for August and December for each dam height and each energy demand level. The results are shown graphically on Exhibit A-7. December flows are greatly increased compared to natural conditions for all dam heights and power demand levels. In general, December flows are greater at greater dam heights. Conversely, August flows at Gold Creek decrease as dam height and reservoir storage capacity increase. Since the lower Watana Developments have less active storage capacity (see Table A-1) and tend to fill earlier in the summer high flow season, regulation of the summer flows decreases with lowered normal maximum reservoir elevation.

## 3.2 DAILY FLUCTUATIONS

The License Application states that "Watana will be operated as a base-loaded plant until Devil Canyon is completed. This will produce daily flows that are virtually constant throughout a 24-hour period for most of the year" (page E-2-104). "With both Watana and Devil Canyon operating, Watana can be operated as a peaking plant because it will discharge directly into the Devil Canyon reservoir, which will be used to regulate the flow. The peaking of Watana will cause a daily fluctuation of less than one foot in the Devil Canyon reservoir. Devil Canyon will operate as a base-loaded plant for the life of the project" (page E-2-156).

For each development concept (Watana elevation) studied, alternative operational modes have been considered. These are:

1. operating the downstream project (Devil Canyon or Watana if Devil Canyon is not present) as base-load as described in the License Application;

2. operating the project for load following, with flows naturally attenuating as they proceed downstream.

Under the first of these operational modes, downstream flows will remain virtually constant except for seasonal changes as discussed in Section 3.1 and shown in Table A-7. Under the second operational mode, and in the absence of a reregulating dam, project discharges, and river stage at Gold Creek, may vary on a daily cycle to follow the load demand. Actual project operation may need to be a combination of base load and load following to provide upper and lower limits on project discharges.

### 3.2.1 Load Following Operation Without Regulation

In order to provide load-following capabilities at the Watana Development (and eventually at Devil Canyon), project discharges may vary on a daily cycle, although average daily flows may remain essentially constant from one day to the next. Flow fluctuations at Gold Creek due to load-following may be greater during the winter than during the summer. If only four units are initially installed at Watana, maximum discharge capacity of the Watana powerhouse would be 14,000 cfs, with a power generation capacity of approximately 730 MW at full reservoir elevation (i.e., 2185 feet). If August flows were to be maintained at the powerhouse discharge capacity, the total monthly generation of about 540 GWh would exceed the total August system energy demand of 518 GWh in the year 2020 (DOR mean forecast). Thus, even with no other system generation at that time, it is unlikely that full generating capacity would be utilized at Watana during August.

A discharge of 14,000 cfs at the Watana site in August, however, would result in a flow of approximately 17,600 cfs at Gold Creek. Since average August discharges for the Watana 1900 Development exceed this flow for all three power demand scenarios and the average August discharges for the elevation 2000 Development equal or exceed this level for two of the three power demand scenarios, average releases, at least for these lower development alternatives, would have to be maintained at a high level whether they were discharged from the turbines or through the discharge facilities.

On a typical winter day, the maximum turbine discharge capacity of the project would remain the same, but tributary inflow would be reduced and the maximum four-unit flows at Gold Creek would be approximately 14,600 cfs. Depending on water availability and project operation, there might be little turbine discharge from the lower Watana alternatives during the early morning hours, with little inflow further downstream. Dam height would influence the potential magnitude of daily load-following flow fluctuations. For the Watana only, year 2000 energy demand scenario, average monthly project outflows decrease from 11,100 cfs for the 2185 development to 10,700, 8,700 and 7,800 cfs for the 2100, 2000, and 1900 alternatives respectively. If maximum flows remain the same (limited by the turbine discharge capacity) and the average flows decrease, minimum flows would likewise decrease, and the potential magnitude and duration of daily fluctuations would increase for the lower dam heights.

These fluctuations in river stage, however, represent a worst case situation. As the fluctuating flows proceed downstream from their source, some attenuation of the highs and lows may occur. At this time, it is not known how much reduction there will decrease the two extremes. Since the variations between highs and lows will decrease as the flow proceeds downstream, flows from Watana would be more attenuated at Gold Creek than comparable discharges from Devil Canyon. In comparison, base loading of the Devil Canyon Development (or Watana prior to construction of Devil Canyon) or development of a reregulating dam would result in virtually no fluctuations in river stage at Gold Creek over long periods of time.

### 3.2.2 Project Flows with Reregulating Structure

If a reregulating reservoir were developed as the most downstream development, project releases could be adjusted so that flows could be held essentially constant for extended periods of time and would be changed only gradually (approximately 1,000 cfs per day) from one rate of release to another (see Table A-7) to meet seasonal discharge requirements.

Releases from the reregulating dam would vary only for the following reasons:

1. Pre-planned, seasonal project operating rule curves indicate that project releases should be increased or decreased.

2. All upstream storage capacity is filled, and inflow exceeds the power discharges. At this point, the project returns essentially to run-of-river releases dictated by flows entering the project and routed through the various developments.

Although its function would be to minimize downstream impacts, any reregulating facility would be new to the Susitna Project and would create its own environmental impacts which would have to be considered.

## 4.0 DOWNSTREAM IMPACTS ON AQUATIC AND RIPARIAN RESOURCES

Alternative concepts for the Susitna River Hydroelectric Project may result in impacts to downstream aquatic and riparian resources that differ from those described in Exhibit E of the License Application. In this section, the implications of alternative dam heights for Watana on downstream resources are discussed.

The discussion is organized into four sections. In Section 4.1, differential impacts on aquatic resources due to operation of the alternative Watana developments are discussed. In Section 4.2, any additional differential impacts that may occur during initial filling are described. In both sections, the assumption is made that there will not be large daily fluctuations of flows. In Section 4.3, the implications of large daily flow fluctuations due to load following operation are considered. Section 4.4 discusses potential impacts on downstream riparian resources.

As discussed in Exhibit E (e.g., page E-3-100 and page E-3-117), the buffering effect of flows from the Chulitna and Talkeetna rivers and other tributaries entering downstream of Talkeetna is expected to reduce the magnitude of project-related flow changes in the lower river. Consequently, the following discussions of potential impacts emphasize the Talkeetna to Devil Canyon reach of the Susitna River where differences related to the Watana alternatives would most likely be observed.

For purposes of this report, impacts are considered to be any deviation from natural conditions and can be either beneficial or detrimental. Also, it is assumed that the greater the deviation from natural conditions, the greater the impact. Given that impacts are of similar intensity, it is further assumed that impacts are more significant if they occur over a longer time period.

## 4.1 IMPACTS TO AQUATIC RESOURCES DURING PROJECT OPERATION

As described in Exhibit E, Chapter 3 (see pages E-3-108 to E-3-120 and E-3-130 to E-3-133), project operation will primarily alter downstream flow regimes and water quality (temperature and sediment concentrations).

In general, flows at Gold Creek under all operating regimes will be higher than the natural conditions in the winter and will be lower than natural conditions in the summer (see Exhibit A-2 through A-7). These changes from natural flow conditions at Gold Creek will decrease for the lower dam heights. Altering discharge patterns may have a variety of secondary impacts, including possible changes in downstream flow velocities, sediment processes, water depths, ice processes, flood frequency and groundwater processes.

During project operation, the major downstream water quality changes expected to impact aquatic resources are alterations of temperature and suspended sediments. The temperature of the outlet water during winter will be higher than natural conditions for some distance downstream, whereas summer temperatures will be near pre-project levels.

The sediment concentration and turbidity of water released from the dam will be significantly lower than natural conditions in the summer and slightly greater than natural conditions in the winter. Alternative dam heights should not appreciably change the predicted turbidity levels of outlet water.

In the following subsection, downstream impacts as a result of project operation will be discussed first for the open water or ice-free season and then for the ice-covered season.

4.1.1 Impacts of Project Operation During the Open Water Season

As considered in Exhibit E, project operation may have a variety of potential impacts on downstream aquatic resources during the open water season. These include impacts on migration of adult fish, access to spawning areas, spawning habitat, incubation and emergence, rearing, and outmigration.

Project operation during the open water season may result in both the gain and loss of rearing habitat for anadromous and resident fish in the Susitna River (e.g., p. E-3-111). Losses of some rearing habitat (e.g., river margins, upland sloughs) will occur if depth is reduced enough to make areas too shallow for fish to use or if cover is eliminated. Reduced depths at the entrance to some sloughs may prevent fish from gaining access to rearing areas. At the mouths of tributaries, backwater areas caused by the stage of the mainstem are important rearing areas for some fish (e.g., juvenile chinook and rainbow trout). Lower mainstem flows during operation in the spring and summer could reduce backwater effects sufficiently such that the availability of this type of habitat decreases.

Increases in rearing habitat in spring and summer could result from the reduced velocities, turbidities and scour of the substrate. Reduced velocities could increase rearing habitat in mainstem and side channel areas since juvenile fish tend to prefer low velocity areas. Reduced turbidities and scouring would tend to enhance rearing by improving habitat conditions for benthic invertebrates, since currently, high turbidities and scouring effects apparently limit benthic production. This assumes, however, that the post-project turbidities will be low enough to benefit invertebrates. At this time, the net gain or loss of rearing habitat has yet to be quantified. Greater change (whether positive or negative) in habitat should occur at higher dam heights since mainstem depths and flows are more reduced at higher dam elevations.

Project operation in the spring and summer may have an impact on the outmigration of juvenile anadromous species since most fry and smolts outmigrate during this period. Flows during project operation should provide sufficient depths, however, for outmigrating fish.

The significant reduction in the number and magnitude of floods and high velocities that will occur as a result of project operation (e.g., p. E-2-156 to p. E-2-162) could have beneficial impacts, especially for salmon. Adult salmon enter the Susitna River to spawn primarily between June and September. This upstream migration is apparently related to flow, since unusually high, low, or unstable flows can slow or even halt upstream movements (ADF&G)[1/]. Thus, a reduction in the magnitude and frequency of flood flows could reduce disruptions in upstream migrations. Upstream migration may be facilitated at higher dam heights since the greater active storage capacity would tend to reduce flood flows. On the other hand, lower dam heights have higher average flows which likewise could facilitate upstream movement provided flood flows can also be reduced. The net advantage of one factor over the other is under investigation.

Project operation may also impact the ability of spawners to enter spawning areas in tributaries and sloughs. Access to these habitats was identified as a critical issue in Exhibit E since many salmon spawn in these habitats. In addition, some resident fish (e.g., grayling and rainbow trout) also move into the tributaries for spawning. Prelimi-

---

1/ ADFG, 1983. Synopsis of the 1982 Aquatic Studies and Analysis of Fish and Habitat Relationships. Susitna Hydro Aquatic Studies. Phase II Report. ADF&G. SuHydro Team.

nary analyses of access to tributaries (Trihey 1983)2/ indicates access under project operation will probably not be a problem if mainstem flows are at or above 8,000 cfs at Gold Creek. At this flow, tributary discharge will likely provide sufficient depth to maintain access. Assuming 8,000 cfs (June to September) represents a threshold for access to tributaries3/, then access of tributaries by salmon would potentially be more restricted at higher dam heights since average monthly flows during June and July are more frequently less than 8,000 cfs than for lower heights. During August and the first half of September all flows exceed 8,000 cfs since the "Case C" minimum flows are greater than that amount.

The ease of access to sloughs for adult salmon (primarily chum and sockeye) also decreases under low flow conditions. Based upon preliminary results of ADF&G studies, access to some sloughs used for spawning becomes an increasingly greater problem as mainstem discharge decreases below 20,000 cfs (as measured at Gold Creek). Access problems will potentially be most significant under the Watana 2185 alternative scheme since project flows during the spawning period (as indexed by August flows) are generally the lowest of all alternatives (Exhibit A-7); most average flows in August for the 2185 alternative are minimum flows (i.e., 12,000 cfs). Access during operation will be less acute at lower dam heights because average flows would be larger. Under natural conditions, average monthly flows for August exceed 20,000 cfs 60 percent of the time. Combining the three power demand scenarios

---

2/ Trihey, W. 1983. Preliminary Assessment of Access by Spawning Salmon into Portage Creek and Indian River. Anchorage, AK. Alaska Power Authority. Susitna Hydro Aquatic Studies. I vol.

3/ Access at flows less than 8,000 cfs was not considered.

(years) as typical of the life of the project, average August flows would exceed 20,000 cfs 56 percent of the time for a dam at El. 1900, 27 percent of the time at El. 2000 and 12 and 15 percent at 2100 and 2185, respectively. For the higher dams, the higher August flows would be most common shortly after completion of the Devil Canyon Development (year 2010 power demand shown on Exhibit A-7) when the Project would have the greatest flexibility in meeting both power and fishery interests.

Project operation in the spring and summer could impact the location and availability of spawning habitat in the mainstem, side channels, and sloughs (e.g., p. E-3-109). In the mainstem and the side channels, reduced flows may have both positive and negative impacts on spawning habitat. Although the net gain or loss of spawning habitat under post-project flows has yet to be quantified, it is possible there may be little change or even an increase in mainstem and side channel spawning areas. Currently, there is little or no spawning in the mainstem and small amounts in the side channels. As dam height is increased, the frequency and magnitude of flood flows is decreased. This post-project reduction in the magnitude and frequency of flood events may add new side channel and mainstem spawning habitat. Presently, these flood flows transport large amounts of sediment, scour the riverbed, and remove spawning gravel. A reduction in flood flows would reduce these habitat disruptions in the mainstem and many side channels. In addition, a reduction of the sediment load of the water would, over time, remove interstitial silts from the streambed, thereby possibly increasing the amount of spawning substrate available.

Reduced, but more stable, water depths associated with reduced flows following project development may also alter the amount of available spawning habitat in side channels. In side channels, spawning often occurs under present conditions in small isolated areas located on the river margins or behind velocity barriers. These areas could be lost at reduced flows (e.g., from dewatering) but the more stable flows through the channel may more than compensate for this loss through development of new spawning habitat.

Slough spawning areas may also be impacted by reduced operational flows in the summer (e.g., page E-3-97) which result in potential problems with access, changes in groundwater upwelling and reduced frequency and magnitude of overtopping of the upstream berms of the sloughs. As discussed previously, many slough spawning areas may be inaccessible to fish due to low flows. Also, adult salmon that spawn in sloughs appear to spawn primarily in areas with upwelling groundwater. Consequently, if a reduction in mainstem flow reduces the extent of upwelling, then the amount of spawning area available could be reduced. Overtopping impacts the spawning area in sloughs, since high overtopping flows can alter the concentration and distribution of silts and fines in the spawning gravel and otherwise impact incubating eggs. Also, if slough overtopping was significantly reduced under with-project conditions (Appendix E.2.A of the License Application suggests that sloughs 8A, 9 and 21 are all overtopped to some degree at flows in excess of 26,000 cfs at Gold Creek), then an increase in aquatic vegetation and siltation in sloughs could reduce the area available for spawning. Lower dam heights at Watana would tend to increase the overtopping of sloughs as compared to the 2185 alternative.

The net effect of reducing spring and summer flows in the Susitna River would probably be transformation of the physical characteristics of many habitats. By reducing overtopping and decreasing the water surface elevation of the river, some side sloughs will become upland sloughs (i.e., not overtopped at all), some side channels would become more like side sloughs (i.e., reducing the frequency of overtopping), and some mainstem areas could take on the characteristics of side channels. Quantifying the net positive or negative effect of habitat transformation on fish production has not yet been done. Alternative dam heights will likely have an effect on the number of these habitat changes that occur with fewer habitat transformations, and less flow stabilization occurring at lower dam heights.

### 4.1.2 Impacts of Project Operations During the Ice Season

During fall and winter, it is expected that post-project flows, turbidity, and temperature will be altered from natural conditions. The main impact of these alterations will probably be on incubation, emergence and overwintering of anadromous and resident species.

Flow and temperature increases may have a significant effect on ice processes1/ (e.g., location of ice front, extent of ice cover) which may impact incubation, emergence and overwintering (See Chapter 2 of Exhibit E). Under operation of Watana and Devil Canyon, the ice cover in the middle river will probably form downstream of where it presently forms (likely between Talkeetna and Sherman). Downstream at Talkeetna, ice formation will probably be delayed. At the ice front, and for some distance upstream, the river stage will increase over natural open water conditions, termed "staging", due to the increased resistance to river flow caused by the presence of the ice front. Stage increases of up to 5 to 6 feet over natural conditions may occur upstream of Talkeetna (e.g., at Gold Creek) due to the higher winter flows from project operation. Downstream of Talkeetna, increased staging effects may be limited due to the many channels available to convey water (p. E-2-127). Immediately upstream of the ice front, staging and backwater effects will be increased over preproject conditions due to the higher flows. The stage in the open water reach further upstream of the ice front would be less than the stage in the reach under ice (p. E-3-134).

---

1/ The actual extent of the ice cover and the staging which would result from operations can only be predicted with detailed ice simulations. These are currently in progress.

Staging due to ice formation occurs under natural conditions. As a consequence, berms at the upstream end of some sloughs at and downstream of the ice front (primarily downstream of Gold Creek) overtop, and cold mainstem water flows through these overtopped sloughs. Under such circumstances, the intergravel temperatures of these sloughs may decrease and cause the developmental rate to slow or eggs to be killed due to thermal shock (primarily in the early stages of development). Moreover, if scouring occurs when sloughs are overtopped, incubating eggs could be destroyed. The net effect of reducing incubation temperatures could result in delayed emergence of fry and a smaller size of fry at emergence, both of which affect the fry's survival. The higher winter flows under project conditions, compounded by the ice staging effects wil increase the probability of overtopping the sloughs. At lower dam heights for the Watana Development, winter operational flows would be more like natural flows. Therefore, the probability of sloughs being overtopped because of ice staging will be less at successively lower dam heights.

The increased staging downstream of the ice front might provide more overwintering habitat in some areas (e.g., side channels) for resident and anadromous species, if wetted perimeter and depths increase under the ice as a result of increased fish could be benefited. Warmer water temperatures upstream of the ice front could enhance the survival of overwintering fish by reducing mortalities associated with freezing. In addition, the increased water temperature upstream of the ice front could increase the development rate for embryos (e.g., salmon and burbot) developing under the influence of the mainstream water. Early emerging salmon fry could be adversely affected, however, if they move downstream too early and encountered 0°C water or lack of food.

Lower dam heights would not likely result in appreciable changes to water temperatures in the open water reach. Flows would be reduced as dam height decreases which may cause the ice front to move upstream;

thus, less open water would exist upstream of the ice front, but more overwintering habitat may be available under the ice cover.

## 4.2 IMPACT TO AQUATIC RESOURCES DURING INITIAL RESERVOIR FILLING

Chapter 3 of Exhibit E (pages E-3-88 to E-3-106 and E-3-129 to E-3-130) describes the expected impacts to downstream aquatic resources resulting from the initial filling of the Watana and Devil Canyon reservoirs. Significant impacts to downstream aquatic resources are not expected to result from initial filling of the Devil Canyon reservoir (e.g., page E-3-133). Therefore, only differential impacts resulting from the initial filling of the Watana reservoir alternatives are considered in this section.

Under median flow conditions, the Watana 2185 reservoir is expected to take three open water seasons to fill. The filling rate will be such that downstream flow requirements for resource protection are met and a flood storage factor maintained. Table E-3-25 of the License Application presents the increase in water surface elevation and filling rate (ft/day) for the Watana 2185 reservoir.

Lower dam heights may result in shorter periods of time needed to fill the Watana reservoir. Actual filling schedules will depend on many factors besides the size of the dam, the rate at which it increases in height, and inflow to the reservoir. Other factors, including inflow, being equal, however, initial reservoir filling will occur over one or two open water seasons for the 1900 and 2000 alternatives and for two or three open water seasons for the 2100 and 2185 developments. For example, under medium flow conditions with filling beginning in May, the 2185 and 2100 reservoir alternatives will take approximately twice as long to fill as the 1900 alternative (Table A-9). In the following subsections, impacts resulting from altered flows and water quality downstream during reservoir filling are discussed separately.

Table A-9

APPROXIMATE TIME TO FILL WATANA RESERVOIR
AT FOUR ALTERNATIVE DAM HEIGHTS

| Dam Height Alternative | Months to Fill[1/] | When Reservoir will be filled |
|---|---|---|
| 2185 | 28 | August of 3rd yr. |
| 2100 | 25 | May of 3rd yr. |
| 2000 | 14-15 | June-July of 2nd yr. |
| 1900 | 12-13 | April-May of 2nd yr. |

1/ Assumes median flow conditions with filling beginning in May of year one.

### 4.2.1 Effects of Altered Flow Regimes During Initial Reservoir Filling

During initial filling, essentially natural flows will be discharged during winter (November to April). There will, however, be substantial flow reductions in spring and summer (Table E.3.26 of the License Application).

These reductions may have a variety of impacts on fisheries resources (e.g., page E-3-83 to E-3-106), including effects on upstream migration of adult salmon, access to spawning areas, spawning habitat, and rearing.

Adult salmon enter the Susitna River to spawn between June and September. As discussed in relation to operational flows, a reduction in the magnitude and frequency of high flows and associated high velocities during those months could facilitate the upstream migration of adults. During reservoir filling, the effect of flow reduction would be most significant for the 2185 and 2100 dam heights because impacts would occur over at least two years; impacts under the 1900 and 2000 plans would occur for less than two years.

Alteration of mainstem discharge during initial reservoir filling may facilitate access to some new spawning areas for resident and anadromous species (e.g. p. E-3-90). As discussed in Exhibit E, access of chinook to the area upstream of the entrance to Devil Canyon (especially to Tsusena, Fog and Devils Creeks) may be facilitated by a reduction in stream flows during the second and third years of initial filling (i.e., for the Watana 2185 and 2100 alternatives.) If a reregulation dam is built and completed prior to filling Watana reservoir, this possibility for movement of fish further upstream might be eliminated depending on the location of the reregulation dam.

Access for adult salmon to sloughs and tributaries is apparently influenced by mainstem discharge. Access problems will be most acute during the second summer of filling when only the proposed minimum flows (i.e., 6,000 to 12,000 cfs) will be maintained at Gold Creek. Access will be a more severe problem under the 2185 and 2100 development alternatives since filling spans at least two spawning seasons and will encompass the period with the lowest flows.

In addition to influencing spawning migrations and access to spawning areas, reduced mainstem discharges during initial filling may impact (both positively and negatively) the quantity and quality of spawning habitat. In side channel areas, some spawning habitats of salmon may be lost due to dewatering. On the hand, new mainstem and sidechannel spawning areas may become available for several reasons. First, many of the habitat disruptions (e.g., fluctuating velocities, bank gouging associated with ice breakup, ice scour) that currently limit the use of many mainstem and side channel habitats will likely be diminished during initial reservoir filling. Moreover, a reduction in the frequency of overtopping of side channels may increase the amount of side channel spawning areas, assuming there is adequate spawning substrate. By reducing the frequency of overtopping, many side channels would take on the characteristics of side sloughs which are more heavily utilized by spawning salmon. At this time, the net impact of altering flow regimes during initial reservoir filling on the availability of mainstem and side channel habitat (i.e., will more or less habitat be available) has not been quantified. However, impacts will occur for all four dam heights. Impacts will occur over a longer time period (i.e., two to three filling seasons) for the 2185 and 2100 alternatives.

Overtopping of the upstream ends of sloughs can also affect the quality of spawing habitat. A reduction in the frequency of overtopping during initial reservoir filing could thus alter the quality of some spawning substrate. Slough spawning habitats would be potentially impacted at all four dam heights. Because filling flows are most reduced during the second and third filling seasons (i.e., at the 2185 and 2100 dam heights), more slough habitat might be temporarily lost at the higher dam heights.

As considered in Exhibit E (e.g., P. E-3-104), the reduction of spring and summer flows during initial filling may impact rearing of anadromous and resident fish in the Susitna River. Some rearing areas (e.g., river margins, side channels and sloughs with high streambed elevations) that are currently utilized may be temporarily lost due to a reduction in depth. The greatest impact to most fish, especially juveniles, will occur if the reduction in depth also reduces or eliminates the utility of cover. Lower mainstem flows may also reduce backwater effects at tributary mouths and thus possibly reduce the availability of this habitat type for rearing by some species (e.g., juvenile chinook). However, where flow velocities decrease but sufficient depth, food and cover occur, new rearing areas will become available. Thus, while the location of many rearing areas may likely change, the amount of rearing area could stay the same or potentially increase.

The net impact (i.e., gain or loss) on rearing habitat has not been quantified at this time. Rearing habitat will be impacted at all dam heights as a result of altered flows during initial reservoir filling. Impacts will be greatest at the two higher dam heights (i.e., 2185 and 2100) because two to three years of impacts are involved as opposed to one to two years for the two lower heights.

### 4.2.2 Effects of Altered Water Quality During Initial Reservoir Filling

As a result of initial filling, water quality downstream of the dam will differ from natural conditions. This will principally involve changes in suspended sediment loads and water temperature.

The sediment concentrations of water released from the reservoir during initial filling will be greatly reduced from natural conditions. This will be similar to the changes in turbidity discussed in the previous section on reservoir operations. Effect of reduced turbidity during filling will occur for one to two open water seasons for the 1900 and 2000 alternatives and for two to three seasons for the higher alternatives.

As described in Chapter 2 of Exhibit E (p. E-2-85 to E-2-88), the major change in downstream water temperature during initial reservoir filling is that temperatures during the second open water season of filling will be reduced (i.e., spring and summer). August temperatures during this period are predicted to be 5 to 6°C as opposed to natural temperatures of 10°C. This altered temperature pattern may adversely impact juvenile and adult fish.

The reduced temperature encountered by adult salmon in the Susitna River upstream of Talkeetna in the second season of filling may: 1) increase milling behavior; 2) delay migration from the lower to middle river; and 3) slow migration rate (p. E-3-92 and p. E-3-93). Ultimately, some fish may not spawn, have poor spawning success, or select alternative spawning areas. Anadromous and resident fish rearing in mainstem and side channel habitats above Talkeetna may also experience reduced feeding activity and growth because of the reduced temperatures. This impact will be confined to the second year of initial reservoir filling and thus have minimal long term impacts. Filling of the reservoir during the second year for the 1900 and 2000 alternatives should be sufficient to allow operation of the multiple level release facilities thereby avoiding most of these temperature related impacts. Impacts will occur for the 2185 alternative since the release facilities will not likely be operable until after the second open water season of filling.

## 4.3 IMPACTS TO DOWNSTREAM RIPARIAN RESOURCES

Changes in flow regimes downstream due to project operation may result in both changes to riparian habitat quality and quantity through altered availability and local distribution of early successional vegetation types, and to the behavioral patterns of moose and other wildlife in the area. The most significant changes will occur "between Gold Creek and Talkeetna, where annual spring and summer flooding and spring scour by ice jams will be reduced" (E-3-249). In addition, higher post-project winter flows may cause a widening of the unvegetated flood plain, including a decrease in the size of islands (E-3-408). These higher winter flows, lower summer flows, lack of ice scouring, and lack of ice cover in portions of the area (depending on the severity of the winter) will alter riparian processes in the Devil Canyon-Talkeetna reach of the river. Although the net result may be improved moose habitat for 10-20 years after project generation, flow stabilization and related streambank stabilization will eventually result in the decreased availability of good moose habitat along this river reach. The extent of vegetation changes will vary considerably along the lower reaches of the Susitna River because of the diluting effect of tributaries as well as changing channel morphology.

In addition to the loss of browse, the loss of riparian habitat and river islands will result in the loss of preferred calving habitat for moose. Islands appear to be particularly good calving areas, perhaps as a result of lower numbers of predators (E-3-408). Winter moose movements (crossing the river and to and from islands) may be greatly restricted in reaches where ice cover does not exist due to the presence of the project because of the hesitancy of moose to cross open water areas during cold weather. Further downstream, the river channel may be ice covered but subject to fluctuations in stage (if non-regulated load-following is practiced) and therefore of broken, uneven surface that would be difficult to cross. If any islands became connected to the river banks due to channel alteration, their value as calving areas would also be decreased.

Greater winter flows, and reductions in spring and summer flows will also affect beaver and muskrat populations downstream. Any site currently occupied should still be available post-project. In addition, many areas now subject to freeze-out will also be available for colonization because winter flows will be higher than at present. The more stable year-round flows and reduced spring and summer flooding of food caches and other beaver structures will also result in improved downstream habitat for beaver and muskrat. This, in turn, may have secondary adverse impacts on fishery resources.

As with other downstream resources, the extent of impacts of the Watana alternatives will be dependent on their extent of change of downstream flow. Thus, the lowest elevation dam has the least impact in that it most nearly represents natural or pre-project conditions and would be least likely to result in long-term changes to riparian habitat.

These downstream impacts will be further complicated if the Susitna Project is operated on a load following basis as described in the following section.

## 4.4 DOWNSTREAM IMPACTS OF DAILY FLOW FLUCTUATIONS

For each of the four Watana alternatives, two operational scenarios were evaluated. One of these scenarios (base load operation) results in daily flows that are relatively stable, whereas the other scenario (load following without reregulation), results in daily discharges from the project that vary significantly over the day. The impacts that have been discussed in Sections 4.2, 4.2 and 4.3 have assumed a relatively stable daily flow regime. In this section, some potential effects of short-term flow fluctuations on downstream aquatic resources are considered.

As discussed in Section 3.2, daily changes in discharge and stage are potentially greatest for the lower dam heights during the winter. Daily flows could potentially fluctuate up to 14,000 cfs with four units installed at Watana and 21,000 cfs with six units, with little release from the project for portions of the day, while the stage at Gold Creek may fluctuate up to three to five feet under open water conditions. During the latter part of the summer (August and September), daily fluctuations at Gold Creek would be greatest (two to three feet) for the higher Watana alternatives.

At this time, all studies of potential project impacts have assumed relatively constant discharges (maximum change of 2000 cfs daily), at least on a weekly basis, which was the premise on which the text of Exhibit E was based. The results of these studies, therefore, do not permit prediction of potential impacts due to fluctuating flows on ice formation, ice staging or aquatic and riparian resources. On the basis of studies of other hydroelectric projects, it can be hypothesized that significant daily fluctuations in flow will primarily have negative impacts on downstream aquatic resources. Positive impacts are not likely.

The environmental ramifications of operating the Susitna Hydroelectric Project on a load following basis are highly dependent upon the magnitude discharge variations during a 24-hour period and the season in which these variations occur. The most significant effects of load following are expected to occur within the aquatic ecosystem as similarly encountered at other hydroelectric projects operated on a load following or peaking basis. The effects to the terrestrial system are primarily those which would occur within the daily inundation zone, the associated riparian habitats along the river margins, and in the floodplains. In addition, load following could result in potential impacts to cultural, aesthetic and recreation resources and socioeconomic activities. A discussion of the potental impacts is presented below for each aspect.

### 4.4.1 Aquatic Ecosystem Implications

The magnitude of the expected effects of load following on the aquatic ecosystem is dependent on several hydraulic characteristics and the life stages of the aquatic species present in the river. The hydraulic characteristics which will determine the magnitude of effects include:

1. The magnitude of change during the 24-hour period;

2. The base flow from which increase to the maximum flow is made;

3. Rate of change of discharge (up and down);

4. River channel morphology; and

5. Attenuation of the change in discharge downstream from the dams.

The following discussion outlines the types of effects which have been experienced at other hydroelectric facilities as well as some aspects which are associated with specific features of the Susitna River. It also assumes that the load following operation will occur at both Watana and Devil Canyon facilities.

The potential effects to the fisheries and aquatic resources due to the load following operation include:

1. Stranding or isolation of fish, primarily juveniles, when the water surface elevation recedes;

2. Short-term rapid changes in availability and distribution of various habitat types;

3. Delay or inhibition of upstream movement of adult salmon;

4. Dewatering and freezing of incubating eggs;

5. Inundation of incubating eggs with cold water in otherwise somewhat protected areas (e.g., overtopping of upstream because of side sloughs);

6. Changes in ice processes which indirectly affect aquatic resources; and

7. Potential increases in bank erosion due to bank instability.

Stranding of fish could be significant in areas where fish remain in pools isolated from the main current as waters recede. These fish also become more susceptible to predation and dessication when the habitat dewaters due to water seepage out of the pool through the gravels. Juvenile salmon are particularly susceptible because they frequently utilize shallow, near-shore access for rearing (ADF&G).

In addition to the potential for fish stranding, habitats utilized by juvenile salmon for rearing may be seriously disrupted by constantly changing mainstem discharges. Studies to date (ADF&G, 1983) indicate that at least in some areas, the availability of rearing habitats utilized by juvenile salmon is correlated with discharge. With constantly changing discharges in the river, juvenile salmon may not be able to maintain themselves in an appropriate area because of the daily disappearance of habitat or significant changes in water velocity. In other areas, juvenile rearing habitat appears to be unaffected by mainstem discharge and, therefore, may not be significantly affected by constant changes in water surface elevation. This too, however, is highly dependent upon the daily range of discharge fluctuation and water surface elevation.

Daily load following changes in discharges may inhibit upstream migration of adult salmon to the various spawning habitats. Data collected by ADF&G over the past three years (ADF&G 1982, ADF&G 1983, and pers. comm.) show that during periods of rapidly rising discharges due to storm events, upstream movement of adult salmon nearly ceases. As the flood peaks and discharge declines movement of salmon resumes. Daily fluctuation in discharge could significantly delay movement of adult salmon to the spawning areas.

Beyond the potential delay in upstream migration of adult salmon, daily discharge variation could eliminate mainstem areas as viable spawning and incubation areas for salmon due to the constant dewatering and potential freezing of suitable sites. Associated with this, suitable spawning areas in sidesloughs and side channels may be rendered unsuitable if there is daily overtopping of the upstream berms with mainstem water.

The above concerns are most commonly associated with river reaches immediately below hydroelectric projects and are generally attenuated further downstream. Upstream of the confluence of the Chulitna and Talketna Rivers, little attenuation of the daily fluctuation is anticipated in the Susitna River because of the steep gradient in the upstream reach. Downstream of the confluence area, some attenuation is expected because of the lower gradient and the effect of inflow from the major tributaries. The attenuation will be greatest during the open water season when flows are highest from the tributaries. However, when tributary flow is low as in the winter months, daily fluctuation in the Susitna River downstream of the Chulitna and Talkeetna Rivers will be more significant.

Potential effects of load following during the ice covered period could possibly be more significant than during the open water season, although less directly observable. Under load following conditions, the ice processes become somewhat more complex than without the project or under base load operation of the project. In open water areas, daily changes in discharge during the winter may result in considerable build up of ice along the banks of the river. This would occur as a result of exposure of the river bank during water level changes. The implication to the fishery involves stranding of juvenile fish and freezing of incubating eggs in the spawning areas.

At the leading edge of the ice cover area, daily flow variation could cause periodic flooding of floodplain areas and could result in significant ice jams. Increased flooding is associated with the increased water surface elevations which are observed during the development of the ice cover under current conditions. Additionally, the mechanical action of discharge variation may tax the integrity of the ice cover. If the integrity of the ice cover is compromised, mechanical breakup would occur as the ice cover rides the changing water elevation as observed in the Peace River in Canada. In addition, downstream movement of the ice to form ice jams similar to what occurs during breakup under existing conditions which in turn, could cause excessive flooding.

The increased flooding could affect over-wintering habitats for juvenile salmon and resident fish through scouring of bed material, increased velocities in suitable habitats, and decreased temperatures resulting from cold mainstem water inundation of warmer groundwater.

Minimization or avoidance of all potential effects may be achieved through limitation of the range of daily flow changes and the rates of change, both on the ascending portion and receding portion of the hydrograph. The best method of defining acceptable discharge ranges would be to define the maximum acceptable range of water surface elevation change.

### 4.4.2 Botanical and Wildlife Resource Implications

The downstream effects of daily flow fluctuations may include impacts on moose movements, decreased beaver overwinter survival and riparian habitat changes. These effects would mainly occur in the ice-covered portions of the river downstream to the vicinity of Talkeetna. Below the Talkeetna area flow attenuation and dilution by major tributaries would likely reduce the effects to insignificant levels. It should be emphasized that until further hydrologic and hydraulic evaluations are completed, effects of daily flow fluctuations on botanical and wildlife resources are primarily speculative.

Daily flow fluctuations may create a more irregular and broken ice surface, thereby making river crossings by moose more difficult and hazardous. As a result, moose movements and habitat use along the ice-covered portion of the river would be more restricted, and the potential for accidents and exposure to wolf predation would be increased.

Daily flow fluctuations may also reduce over-winter survival of beavers due to the entrapment of greater portions of food caches in ice and/or the uprooting and washing downstream of food caches. This latter mechanism may also negatively affect beavers upstream of the ice-covered portions of the river, but the lack of ice cover may overshadow the negative effect in this area.

The extent of ice damage to riparian vegetation may be increased due to the greater ice movement and thickness resulting from daily flow fluctuations. Damage to vegetation due to higher summer flow fluctuations may also occur. As a result, the unvegetated floodplain may be widened and the stage of plant succession may be retarded along the many shoreline areas, at least initially. A wider unvegetated floodplain is likely to result in the long term as well. It is not clear, however, without further evaluation, whether the long-term net result would be to increase or decrease the availability of early successional vegetation. The resultant long-term effects of these riparian habitat changes on moose and other wildlife are also unclear.

## 5.0 REGIONAL SOCIOECONOMIC IMPACTS OF WATANA ALTERNATIVES

Differential impacts of the alternative Watana Developments will primarily result from differences in associated labor requirements. As shown in Table A-10 and Exhibit A-8, the modified Watana 2185 project reduces the peak work force by 500 workers (15 percent) compared to the peak work force identified in the License Application. The lower dam height alternatives will not significantly further reduce the peak work force. Instead the schedule will be shortened.

Table A-10

CONSTRUCTION WORK FORCE REQUIREMENTS FOR ALTERNATIVE WATANA DEVELOPMENTS

| Alternative | Total Worker-Months to First Power($x10^3$) | Peak Work Force Requirements($x10^3$) |
|---|---|---|
| 2185 FERC | 103 | 3.3 |
| 2185 Modified | 83 | 2.8 |
| 2100 | 70 | 2.7 |
| 2000 | 57 | 2.6 |
| 1900 | 49 | 2.6 |

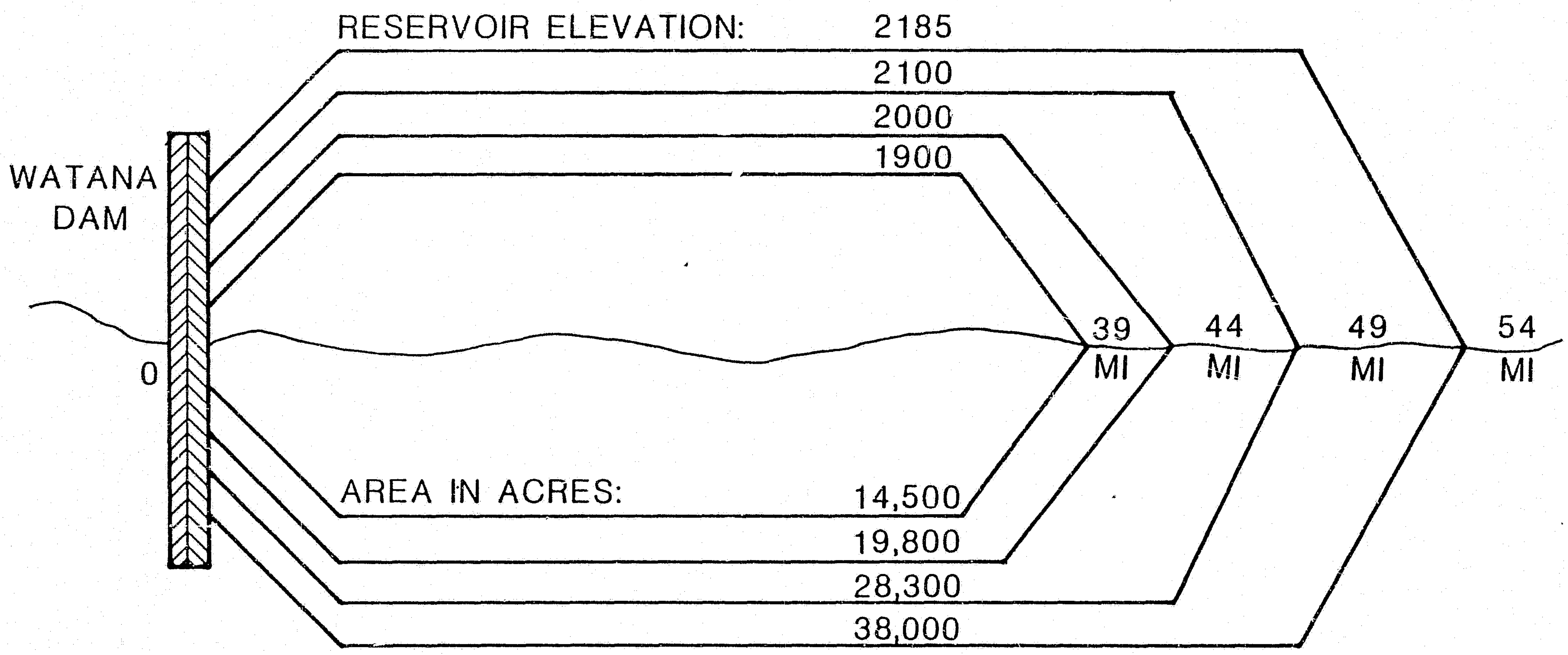
The modified Watana 2185 Development also reduces the total labor requirements by 20 percent. The three lower dam height and reservoir alternatives further reduce these requirements by 16, 31, and 41 percent compared to the modified development design.

It is anticipated that project-related population, employment and income, housing, services and facilities, and fiscal impacts will be similar to those described in Exhibit E. Differential effects related to the Watana alternatives will result from reduced peak labor requirements and a shorter construction schedule for the lower development, with resultant shorter duration of peak requirements for housing and other facilities and services.

The implications of load following on cultural, socioeconomic, recreation, aesthetic, and land use resources cannot be accurately determined until additional hydrologic and hyraulic studies are conducted and until the results of those studies are factored into an analysis of load following impacts on aquatic and terrestrial resources.

In general, based on available information, it is anticipated that load following may decrease bank stability, thereby increasing bank erosion. If this occurs, additional archeological and/or historic sites could be eliminated. In addition, increased erosion and fluctuations of the river level could potentially reduce the aesthetic quality of affected areas. Furthermore, individuals and businesses relying on fish and wildlife resources for food, recreation, cultural, and/or commercial activities (including hunters, trappers, guides, and lodge owners) could be negatively affected if load following reduces the magnitude of available fish and wildlife resources in the project area and if load following makes navigation of the river (by boat during ice-free months and by snowmobile during the winter) more difficult or hazardous. Moreover, if load following increases the likelihood of ice jams and flooding downstream, the chances of economic losses due to flooding would increase.

EXHIBITS




ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT UPDATE

**WATANA RESERVOIR AREAS
UNDER ALTERNATIVE DEVELOPMENT CONCEPTS**

SEPTEMBER 1983

EXHIBIT A–1

EXHIBIT A-2
AVERAGE MONTHLY FLOWS AT GOLD CREEK
(Natural and Post-Project Conditions)

| Scenario | Oct. | Nov. | Dec. | Jan. | Feb. | March | April | May | June | July | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Natural Flows | 5,822 | 2,608 | 1,825 | 1,499 | 1,264 | 1,126 | 1,374 | 13,244 | 27,763 | 24,435 | 22,017 | 13,457 |
| Year 2000 Watana only 4709 GWh Demand | | | | | | | | | | | | |
| Watana 1900 | 7,808 | 6,870 | 7,802 | 5,192 | 4,278 | 4,168 | 4,152 | 9,543 | 16,190 | 14,904 | 22,017 | 13,661 |
| Watana 2000 | 8,168 | 8,138 | 8,697 | 6,718 | 5,936 | 5,373 | 5,380 | 11,205 | 15,494 | 13,323 | 15,900 | 12,434 |
| Watana 2100 | 9,127 | 10,372 | 10,689 | 8,531 | 7,832 | 6,683 | 6,255 | 10,190 | 12,184 | 9,710 | 13,755 | 11,628 |
| Watana 2185 | 8,822 | 11,138 | 11,146 | 9,636 | 9,072 | 7,782 | 7,608 | 9,460 | 10,147 | 9,258 | 12,680 | 10,443 |
| Year 2010, 2-Development 5945 GWh Demand | | | | | | | | | | | | |
| Watana 1900 + DC | 8,644 | 7,527 | 7,058 | 6,184 | 6,088 | 5,500 | 6,620 | 7,743 | 10,507 | 16,094 | 21,057 | 13,558 |
| Watana 2000 + DC | 8,187 | 9,033 | 9,264 | 8,092 | 7,243 | 6,337 | 6,276 | 8,880 | 9,665 | 11,245 | 19,030 | 13,548 |
| Watana 2100 + DC | 7,878 | 8,862 | 9,796 | 9,266 | 9,287 | 9,219 | 7,755 | 8,594 | 9,236 | 9,124 | 16,050 | 12,938 |
| Watana 2185 + DC | 7,430 | 8,596 | 9,430 | 8,719 | 8,672 | 7,732 | 6,994 | 8,313 | 8,997 | 10,427 | 18,436 | 13,166 |
| Year 2020, 2-Development 7505 GWh Demand | | | | | | | | | | | | |
| Watana 1900 + DC | 8,716 | 7,297 | 7,054 | 6,121 | 5,924 | 5,429 | 6,211 | 8,528 | 12,123 | 15,369 | 20,363 | 13,558 |
| Watana 2000 + DC | 8,554 | 8,943 | 8,906 | 7,969 | 7,246 | 6,344 | 6,305 | 9,746 | 10,989 | 11,123 | 17,424 | 13,282 |
| Watana 2100 + DC | 8,957 | 10,197 | 11,274 | 10,001 | 8,908 | 7,049 | 7,599 | 9,117 | 10,170 | 8,887 | 13,548 | 11,449 |
| Watana 2185 + DC | 8,101 | 9,801 | 10,979 | 10,190 | 10,218 | 9,083 | 8,646 | 9,132 | 9,678 | 8,480 | 12,678 | 10,357 |
| Natural Flows | 5,822 | 2,608 | 1,825 | 1,499 | 1,264 | 1,126 | 1,374 | 13,244 | 27,763 | 24,435 | 22,017 | 13,457 |

Exhibit A-3

FREQUENCY DISTRIBUTION OF AUGUST AND DECEMBER FLOWS AT GOLD CREEK
Watana Only
Year 2000, Demand Level=4709 GWh

| Average Monthly Flow (cfs) | August Frequency (n=33) | | | | | December Frequency (n=33) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Natural | 2185 | 2100 | 2000 | 1900 | Natural | 2185 | 2100 | 2000 | 1900 |
| 866 - 1,499 | | | | | | 10 | | | | |
| 1,500 - 1,999 | | | | | | 9 | | | | |
| 2,000 - 3,264 | | | | | | 14 | | | | |
| 3,265 - 6,132 | | | | | | | | | | |
| 6,133 - 7,999 | | | | | | | | | | 30 |
| 8,000 - 9,999 | | | | | | | 7 | 3 | 33 | 3 |
| 10,000 - 11,999 | | | | | | | 18 | 29 | | |
| 12,000 | | 26 | 16 | 4 | | | | | | |
| 12,001 - 14,999 | | 4 | 11 | 14 | | | 8 | 1 | | |
| 15,000 - 19,999 | 13 | 2 | 4 | 9 | 13 | | | | | |
| 20,000 - 24,999 | 14 | 1 | 1 | 5 | 14 | | | | | |
| 25,000 - 29,999 | 2 | | 1 | | 2 | | | | | |
| 30,000 - 38,538 | 4 | | | 1 | 4 | | | | | |

EXHIBIT A-3

Exhibit A-4

## FREQUENCY DISTRIBUTION OF AUGUST AND DECEMBER FLOWS AT GOLD CREEK
Watana and Devil Canyon
Year 2000, Demand Level=5945 GWh

| Average Monthly Flow (cfs) | August Frequency (n=33) | | | | | December Frequency (n=33) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Natural | 2185 | 2100 | 2000 | 1900 | Natural | 2185 | 2100 | 2000 | 1900 |
| 866 - 1,499 | | | | | | 10 | | | | |
| 1,500 - 1,999 | | | | | | 9 | | | | |
| 2,000 - 3,264 | | | | | | 14 | | | | |
| 3,265 - 6,132 | | | | | | | | | | |
| 6,133 - 7,999 | | | | | | | | 1 | 5 | 32 |
| 8,000 - 9,999 | | | | | | | 33 | 6 | 21 | 1 |
| 10,000 - 11,999 | | | | | | | | 26 | 7 | |
| 12,000 | | 9 | 14 | 7 | 2 | | | | | |
| 12,001 - 14,999 | | 2 | 6 | 3 | 2 | | | | | |
| 15,000 - 19,999 | 13 | 9 | 6 | 11 | 10 | | | | | |
| 20,000 - 24,999 | 14 | 11 | 5 | 7 | 13 | | | | | |
| 25,000 - 29,999 | 2 | | 1 | 3 | 2 | | | | | |
| 30,000 - 38,538 | 4 | 2 | 1 | 2 | 4 | | | | | |

Exhibit A-5

FREQUENCY DISTRIBUTION OF AUGUST AND DECEMBER FLOWS AT GOLD CREEK
Watana and Devil Canyon
Year 2000, Demand Level=7505 GWh

| Average Monthly Flow (cfs) | August Natural | August Frequency (n=33) 2185 | 2100 | 2000 | 1900 | December Natural | December Frequency (n=33) 2185 | 2100 | 2000 | 1900 |
|---|---|---|---|---|---|---|---|---|---|---|
| 866 - 1,499 | | | | | | 10 | | | | |
| 1,500 - 1,999 | | | | | | 9 | | | | |
| 2,000 - 3,264 | | | | | | 14 | | | | |
| 3,265 - 6,132 | | | | | | | | | | |
| 6,133 - 7,999 | | | | | | | 5 | 5 | 7 | 32 |
| 8,000 - 9,999 | | | | | | | 3 | 3 | 23 | 1 |
| 10,000 - 11,999 | | | | | | | 18 | 10 | 3 | |
| 12,000 | | 27 | 25 | 10 | 4 | | | | | |
| 12,001 - 14,999 | | 4 | 3 | 4 | 3 | | 7 | 15 | | |
| 15,000 - 19,999 | 13 | 1 | 2 | 10 | 9 | | | | | |
| 20,000 - 24,999 | 14 | 1 | 2 | 7 | 12 | | | | | |
| 25,000 - 29,999 | 2 | | 1 | | 2 | | | | | |
| 30,000 - 38,538 | 4 | | | 2 | 3 | | | | | |

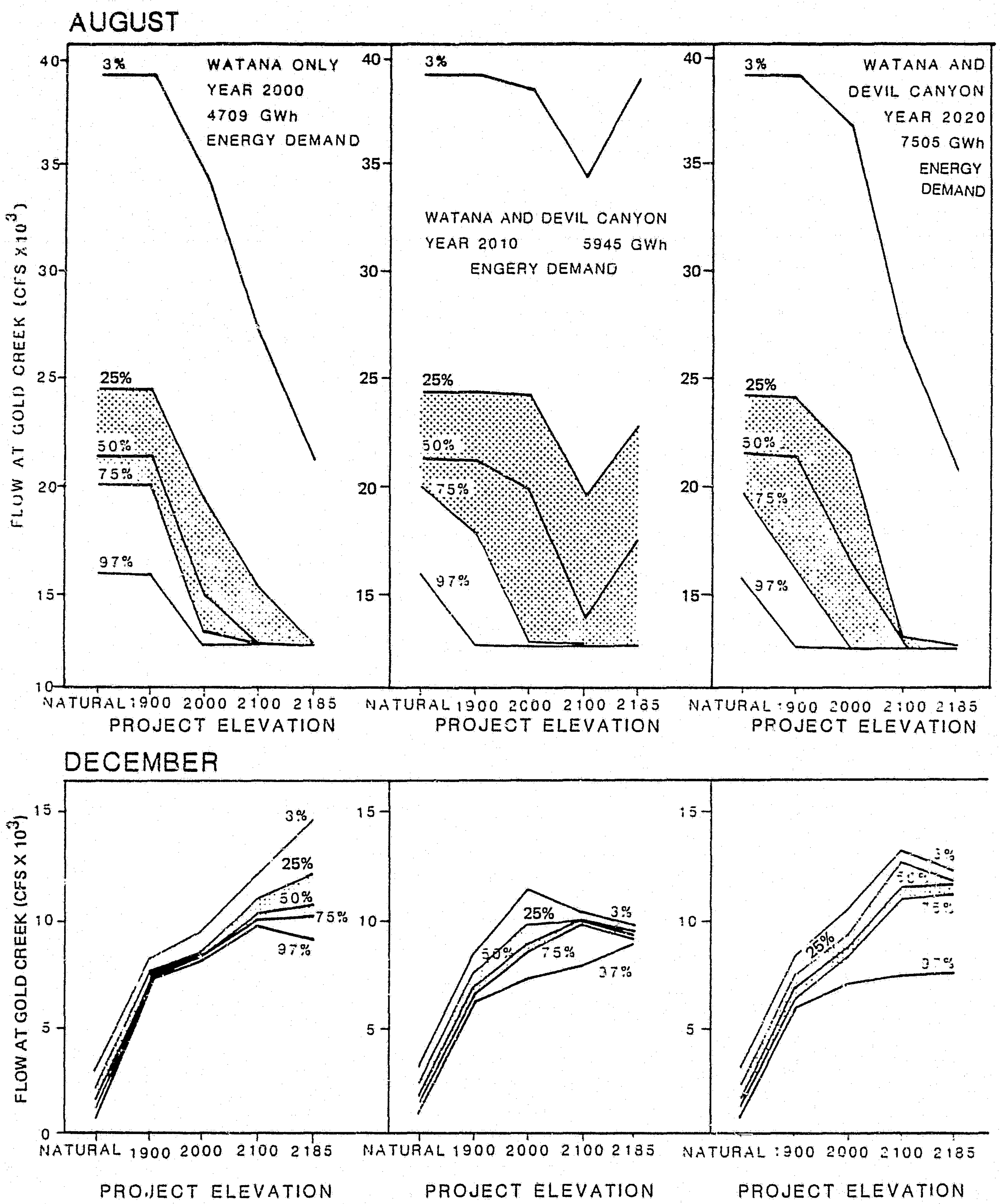
EXHIBIT A-6
AUGUST AND DECEMBER FLOW DURATIONS

Average August Flows at Gold Creek
(33 years of record)

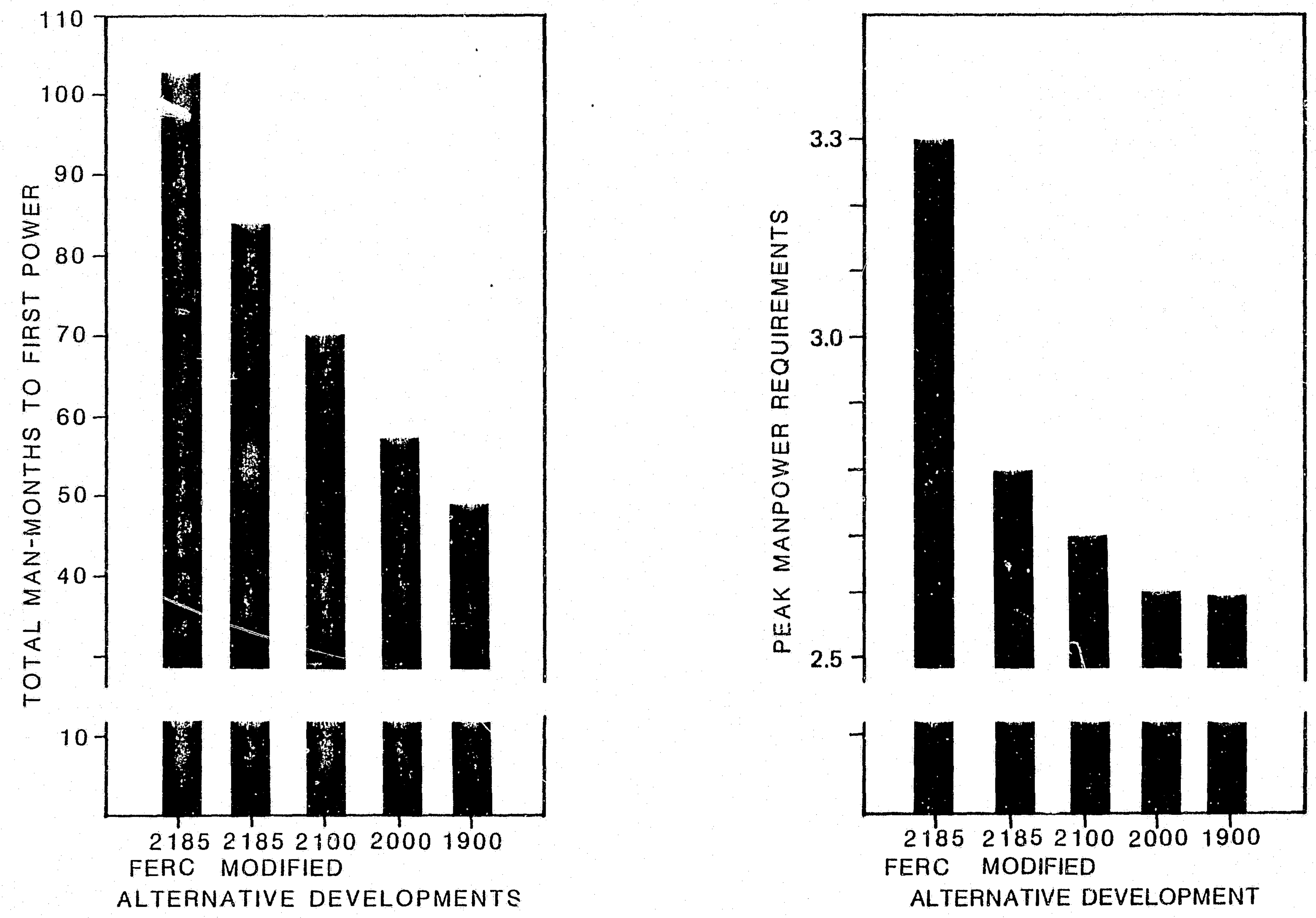
| Percent of Time Flows Exceeded | Natural Flows | Year 2000 4709 GWh Demand Watana Only | | | | Year 2010 5945 GWh Demand Watana and Devil Canyon | | | | Year 2020 7505 GWh Demand Watana and Devil Canyon | | | | Natural Flows |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1900 | 2000 | 2100 | 2185 | 1900 | 2000 | 2100 | 2185 | 1900 | 2000 | 2100 | 2185 | |
| Highest | 38,538 | 38,538 | 33,676 | 26,576 | 20,705 | 38,538 | 37,919 | 33,944 | 38,538 | 38,538 | 36,197 | 25,990 | 20,238 | 38,538 |
| 25% exceedance | 23,670 | 23,670 | 18,561 | 14,641 | 12,000 | 23,670 | 23,550 | 19,290 | 22,280 | 23,550 | 21,132 | 12,387 | 12,000 | 23,670 |
| 50% exceedance | 20,610 | 20,610 | 14,367 | 12,059 | 12,000 | 20,540 | 19,144 | 13,505 | 17,396 | 20,460 | 15,943 | 12,000 | 12,000 | 20,610 |
| 75% exceedance | 19,290 | 19,290 | 12,517 | 12,000 | 12,000 | 17,170 | 12,127 | 12,000 | 12,000 | [illegible],624 | 12,000 | 12,000 | 12,000 | 19,290 |
| Lowest | 15,274 | 15,274 | 12,000 | 12,000 | 12,000 | 12,000 | 12,000 | 12,000 | 12,000 | 12,000 | 12,000 | 12,000 | 12,000 | 15,274 |
| Average | 22,017 | 22,107 | 15,900 | 13,755 | 12,680 | 21,057 | 19,030 | 16,050 | 18,436 | 20,323 | 17,424 | 13,548 | 2,678 | 22,017 |

Average December Flows at Gold Creek

| Percent of Time Flows Exceeded | Natural Flows | 2000: 1900 | 2000: 2000 | 2000: 2100 | 2000: 2185 | 2010: 1900 | 2010: 2000 | 2010: 2100 | 2010: 2185 | 2020: 1900 | 2020: 2000 | 2020: 2100 | 2020: 2185 | Natural Flows |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Highest | 3,264 | 8,360 | 9,788 | 12,168 | 14,714 | 8,491 | 11,514 | 10,513 | 9,839 | 8,491 | 10,677 | 13,237 | 12,328 | 3,264 |
| 25% exceedance | 2,290 | 7,913 | 8,813 | 11,046 | 12,060 | 7,517 | 9,922 | 10,198 | 9,520 | 7,517 | 9,554 | 12,848 | 11,972 | 2,290 |
| 50% exceedance | 1,700 | 7,780 | 8,623 | 10,576 | 10,997 | 6,927 | 8,925 | 10,110 | 9,433 | 6,927 | 8,925 | 11,757 | 11,865 | 1,700 |
| 75% exceedance | 1,465 | 7,690 | 8,519 | 10,331 | 10,344 | 6,692 | 8,623 | 10,048 | 9,364 | 6,692 | 8,925 | 11,033 | 11,179 | 1,465 |
| Lowest | 866 | 7,538 | 8,349 | 9,944 | 9,387 | 6,261 | 7,356 | 7,908 | 9,070 | 6,158 | 7,199 | 7,675 | 7,624 | 866 |
| Average | 1,825 | 7,802 | 8,697 | 10,689 | 11,146 | 7,058 | 9,264 | 9,796 | 9,430 | 7,054 | 8,906 | 11,274 | 10,979 | 1,825 |
| Total Annual Average | | 1,923 | 2,453 | 2,979 | 3,762 | 4,280 | 5,032 | 5,790 | 5,934 | 4,648 | 5,411 | 6,241 | 6,818 | |




AUGUST AND DECEMBER FLOW DURATION CURVES
NATURAL AND WITH PROJECT CONDITIONS




# PROJECT LABOR REQUIREMENTS

EXHIBIT A-8

# ENVIRONMENTAL IMPLICATIONS
# OF
# SUSITNA PROJECT ALTERNATIVES

SEPTEMBER 1983

## PART B

## A COMPARISON OF ENVIRONMENTAL IMPACTS ASSOCIATED WITH ELECTRIC GENERATING PROJECTS ALTERNATIVE TO SUSITNA HYDROELECTRIC DEVELOPMENT

TABLE OF CONTENTS

## LIST OF TABLES

PART B

# A COMPARISON OF ENVIRONMENTAL IMPACTS ASSOCIATED WITH ELECTRIC GENERATING PROJECTS ALTERNATIVE TO SUSITNA HYDROELECTRIC DEVELOPMENT

## 1.0 INTRODUCTION

This study presents a comparison of first-order environmental impacts associated with the development of selected proposed electric power generation projects that are alternatives to the Susitna Hydroelectric Project. These alternatives are based on two other fuel types in addition to hydroelectric power, coal and natural gas, and four technologies: coal fired steam electric generation, gas fired simple cycle (combustion turbine), gas fired combined cycle (combustion turbine with steam heat recovery boilers), and hydroelectric.

The coal and gas alternatives, in terms of development and location, are somewhat complex. A brief condensation of the current trend in development options for these alternatives is given below, as well as a summary description of the Chakachamna project, the hydroelectric alternative.

### 1.1 COAL

There appears to be two viable locations for development of a coal facility alternative, the Beluga region or Nenana region (Ebasco 1981 a,b). The Nenana location can probably support up to approximately a 400 MW facility, while the Beluga potential is much greater. Current load forecasts indicate that the Nenana facility

4091A

would eventually be inadequate to meet demands (Alaska Power Authority 1983). The suggested development option is the simultaneous development of both Nenana and Beluga fields (Alaska Power Authority 1983a).

The development of the Beluga field will require, in addition to power plant construction, the erection of a major new transmission line from Beluga to the Willow Substation along the Intertie. For purposes of this study, to parallel assumptions made in the economic evaluations, it is assumed that a mine and mine support facilities have previously been developed (Alaska Power Authority 1983a). Potential significant environmental impacts from mine development are therefore not presented in this document. Similarly, the construction of a power plant at Nenana will require an upgrade of transmission line facilities and mine expansion (Alaska Power Authority 1983a). Impacts from the proposed mine expansion are not evaluated in this document.

## 1.2 NATURAL GAS

Development of natural gas would first utilize Cook Inlet reserves (Alaska Power Authority 1983a). Power plants would be located in the Beluga region and/or the Kenai/Nikiski area. Development in the Beluga region will require erection of a new transmission line as in the coal utilization scenario, while plant development in the Kenai/Nikiski area will require transmission line construction from the plant location to Anchorage (Alaska Power Authority 1983a,b). Current load forecasts and projected gas field reserve data indicate that at some future date utilization of North Slope gas would be required, upon depletion of Cook Inlet reserves (Alaska Power Authority 1983a). There are three feasible locations for a power plant utilizing North Slope gas: the North Slope, Fairbanks, and

Kenai/Nikiski (Alaska Power Authority 1983b). The North Slope location would utilize untreated natural gas in simple cycle combustion turbines. A major new transmission line from the North Slope to Fairbanks via the Utility Corridor and an upgrade of the Fairbanks-Anchorage interconnection would be required. A power plant situated at Fairbanks could be supported via a new small diameter gas pipeline from the North Slope, or a tap from the proposed Alaska Natural Gas Transportation System (ANGTS) line, or alternately a tap from the proposed Trans Alaska Gas System (TAGS) pipeline. An upgrade of the Fairbanks to Anchorage transmission system is required. A power plant at the Kenai/Nikiski location would require development of the TAGS system. A major transmission line from near tidewater to Anchorage would also be required (Alaska Power Authority 1983b).

## 1.3 CHAKACHAMNA PROJECT

The Chakachamna Project is a proposed hydroelectric development of approximately 300 to 400 MW in capacity in the vicinity of Lake Chakachamna and the Chakachatna and McArthur rivers. There are currently six alternate development scenarios for this project which are significantly different in design and scope. These alternatives are as follows:

Chakachatna Dam - construction of a dam in the Chakachatna River canyon approximately 6 miles downstream from the lake outlet.

McArthur Tunnel Alternatives A and B - diversion of flow from Chakachamna Lake to McArthur Valley to develop a head of approximately 900 feet via a power tunnel (lake tap). Alternative A would divert all stored water, while Alternative B would maintain approximately 19 percent of the average inflow into the lake for release to the Chakachatna River.

Chakachatna Tunnel Alternatives C and D - similar to A and B above, a lake tap would be developed. This tap would be through the right wall of Chakachatna valley and the powerhouse would be downstream in the valley. Alternative C would divert all flow, while Alternative D would maintain a release of approximately 30 cfs at the natural lake outlet.

Alternative E - essentially a refinement of Alternative B. Specific facilities are provided for maintaining instream flows and fish passage. Reservoir drawdown is also restricted. In addition, a tunnel boring machine rather than "drill and shoot" techniques (utilized in Alternatives A-D) is employed.

The Chakachatna Dam has been dropped from serious consideration for foundation considerations, as well as fishery impact considerations. Alternatives A and C would result in a loss of the anadromous fishery (including approximately 41,000 sockeye salmon) and are therefore also not under serious consideration at this time. Of the remaining alternatives, Alternative E is the preferred alternative and appears to be the configuration to which the project would be developed, should the Chakachamna Project be constructed (Bechtel 1983).

## 1.4 ENVIRONMENTAL ASSESSMENT

First-order environmental impacts may be defined as impacts directly related to various power plant and auxiliary facility characteristics and represent the primary effects of the development on the environment. Impact evaluation has been performed by technology (coal, gas, or hydroelectric) within discrete environmental categories. These categories include air resources, water resources, aquatic ecology, terrestrial ecology, aesthetics and socioeconomics. Each environmental discussion outlines the option and location specific factors for each of the alternatives described above.

A brief summary and conclusions sectior follows the detailed alternative discussions. A table is presented which shows a qualitative comparison of impacts within environmental categories for the various development options.

4091A

## 2.0 COAL FIRED FACILITIES

The two viable locations for the coal fired power plants are in the Beluga coal field region and Nenana coal field region. Environmental impacts associated with the development of these facilities is discussed below.

### 2.1 BELUGA

#### 2.1.1 Air Resources

The emissions of products of combustion [particulates, sulfur dioxide ($SO_2$), and nitrogen oxides ($NO_x$)] form the prime potential for impacts to the air resources at this location. Anticipated emissions are 0.03 lb particulate matter, 0.6 lb $SO_2$ and 0.6 lb $NO_x$ per million Btu, utilizing a typical particulate emission control device such as an electrostatic precipitator or a baghouse, and a flue gas desulfurization system to control $SO_2$ emissions. Compliance with regulatory criteria employing Best Available Control Technology should minimize adverse impacts. The location of the Class I area at Denali National Park could pose the most severe siting constraints for a development of a coal fired facility at this location. The allowable increments of air quality deterioration are extremely small in Class I areas. A minimum distance from this area would probably be at least 20 miles, but each potential site should be analyzed in great detail to ensure a proper evaluation. The Class I visibility regulations could significantly affect this minimum distance.

Construction activities may cause temporal localized impacts due to dusting. These impacts are not expected to be great or persistent. The long term impacts from operation of transmission lines are expected to be negligible. The transmission lines would generate small amount of ozone which would be undetectable at ground levels and would not cause problems with nearby vegetation.

### 2.1.2 Water Resources

A coal fired facility generally has significant water requirements. Requirements for a generic 200 MW facility have been estimated at approximately 300 gpm for a plant employing dry cooling, or 1,950 gpm for a facility utilizing wet cooling towers. Three potential water supplies at this location include the Beluga River, Cook Inlet (seawater), and groundwater.

Flow data for the Beluga River is not immediately available. However, from area-rainfall considerations, it appears that streamflow reduction would exceed 10 percent, and that groundwater supply would be the more viable alternative at this general location. Although well yields have been estimated as high as 1,000 gpm near surface resources in the Beluga area, characteristic yields appear to be only 10 to 100 gpm. Thus, water withdrawals could be a major impact at this location.

The facility would most probably be designed to function in a zero discharge mode. Therefore, impacts to water quality through discharges are expected to be minimal.

Construction activities of the transmission lines between Beluga and Willow substation would result in temporary impacts. The transmission lines would cross several rivers and numerous creeks, resulting in temporary stream siltation, bank erosion, and the potential for accidental spillage of lubricating oils and other chemicals into the watercourses. Construction equipment along streambanks or crossing smaller streams could cause direct siltation of the watercourse or cause indirect streambank erosion and siltation through the removal of vegetation and disturbance of permafrost. The effects of siltation could alter stream channels, fill ponds, or damage aquatic flora or fauna. These potential adverse impacts can be reduced or eliminated through appropriate mitigation measures and good engineering practice.

### 2.1.3 Aquatic Ecology

Assuming a groundwater supply is utilized, and the plant is designed in a zero discharge mode, impacts from facility operation to aquatic ecosystems are expected to be negligible. Significant, difficult to mitigate impacts should not occur.

Impacts to fisheries from transmission line construction, such as increased runoff and sedimentation could occur through clearing of the right-of-way and crossing of watercourses by construction equipment. The introduction of silt into streams can delay hatching, reduce hatching success, prevent swimup, and produce weaker fry. Siltation also reduces the benthic food organisms by filling in available intergravel habitat. These potential adverse impacts can be reduced or eliminated through contruction scheduling and good engineering practice.

### 2.1.4 Terrestrial Ecology

The greatest impact on the terrestrial biota resulting from the development of a coal fired power plant at Beluga will be the loss or alteration of habitat and disturbance-related impacts. Potential power plant locations contain seasonal ranges of moose, caribou, and bears, as well as numerous small game species. Land requirements would be on the order of 75 acres for a 200 MW facility. This loss of habitat would have varying impacts depending on specific facility siting, however, some impacts could be anticipated, most notably loss of carrying capacity of the land to support the above species. Impacts would be more severe if the facility was located in an undeveloped area requiring access roads.

Another wildlife impact results from birds colliding with the cooling towers. The significance of this impact is highly dependent on cooling tower design and location in relation to daily and seasonal migratory routes. Locations subject to frequent fogging may also increase the significance of this impact. Bird collision impacts, however, can be mitigated through proper siting. Major migratory bird corridors occur throughout Cook Inlet and Prince William Sound.

Impacts from construction of the transmission line are potentially significant. Right-of-way requirements would require a minimum clearing of a 110 foot strip in vegetated or forested areas. Disturbance or alteration of this habitat could have significant impacts, particularly near trumpeter swan nesting sites, moose calving areas, and bear denning sites. Detailed siting and routing studies are required to properly identify and minimize these potential impacts. However, some moderate impacts can be anticipated. Impacts due to bird collisions may also be locally important.

### 2.1.5 Socioeconomic Factors

Most of the communities located near the Beluga coal fields are generally small in population and have an infrastructure that is not highly developed. In light of this, the construction and operation of a power plant has a high potential to impact local communities and cause a boom/bust cycle. In the area, the largest community, Tyonek, only has a population of 239. While a construction camp could mitigate this impact to some degree, disturbance of the area's infrastructure must be anticipated.

For a 200 MW facility, a peak construction workforce of 500 personnel and an operational workforce of over 100 personnel is estimated to be required. Transmission line construction personnel requirements would add significantly to these figures. Hence, major socioeconomic impacts should be anticipated at this location.

### 2.1.6 Aesthetic Factors

The relatively large land requirements, facility structures, storage areas, and stack plumes have the potential to cause significant visual degradation, from an aesthetic viewpoint. In addition, moderate noise impacts can be expected from facility operation. Odors should not be a significant difficulty, if good engineering and operation practices are followed.

The visual impacts from the new transmission line are also significant. Much of the area where the lines could potentially be routed are pristine wilderness; large transmission towers and lines are considered to be a significant degradation of the viewscape.

## 2.2 NENANA (Healy)

### 2.2.1 Air Resources

The air resources considerations for a coal fired facility in the vicinity of Nenana are similar to those discussed above for the Beluga location. However, Nenana is situated in a Class I PSD area and in a nonattainment area for carbon monoxide (CO) emissions. This implies that a high degree of effort will be required to achieve satisfactory emissions levels at this location. From a regulatory standpoint, receiving an offset and siting a coal fired facility at this location could prove to be very difficult. Therefore, impacts to air resources at this location must be considered to be extremely significant. Extraordinary emissions control measures would be required to satisfy regulatory criteria.

### 2.2.2 Water Resources

Water requirements and considerations would be similar to those at the Beluga location. However, sufficient surficial supplies exist in the nearby river systems (e.g., Tenana and Nenana rivers) so that water use would have negligible potential environmental impacts.

Construction considerations for a transmission line upgrade would not be significant in comparison to the Beluga location. However, some minor, temporal impacts could be anticipated. Good construction practices would serve to mitigate against any adverse impacts.

### 2.2.3 Aquatic Ecology

The Nenana location is in proximity to one of the more accessible, urbanized areas of Alaska. Considering other developments in the vicinity, coupled with minimal wastewater discharges and large nearby river systems, the impacts to the aquatic ecosystem from the development of a coal fired facility at Nenana are anticipated to be insignificant. Minor, temporal impacts could occur from activity associated with the transmission line upgrade; however, no long term impacts are anticipated.

4085A

## 2.2.4 Terrestrial Ecology

The impacts on the terrestrial biota from development of a coal fired facility at Nenana are expected to be similar to those at Beluga. Habitat losses would be similar, and this location also has seasonal ranges of moose, caribou, and bears. While the facility's total land requirements are modest (approximately 75 acres for a 200 MW plant), disturbance of range areas at this location will lower the carrying capacity of the land to support these species. This could represent a significant terrestrial impact. Impacts would be more severe if the facility was located in an undeveloped area requiring access roads. Transmission line upgrading is not anticipated to have any significant long term impacts to the terrestrial ecology.

## 2.2.5 Socioeconomic Factors

If the Nenana coal field site is located with an approximately 50 mile radius of Fairbanks, a boom due to construction will be an unlikely event, since many of the 500 construction personnel could commute to the site from Fairbanks. The impact of project construction would also be mitigated by the sizeable Fairbanks labor market and high unemployment rate. A site located further than 50 miles from Fairbanks would, however, incur impacts similar to those anticipated at the Beluga field site. However, the magnitude would not be as extreme as the Beluga location.

## 2.2.6 Aesthetic Factors

Aesthetic considerations would be identical to those discussed for Beluga, with the exception that there would be no additional major factors associated with transmission line construction.

# 3.0 NATURAL GAS FIRED FACILITIES

The development of a natural gas fired energy development scenario will proceed with the utilization of Cook Inlet gas at Beluga or Kenai, followed by the utilization of North Slope gas at either the North Slope, Fairbanks, or Kenai. Environmental impacts of these various options are presented below in the above order.

## 3.1 COOK INLET GAS

### 3.1.1 Beluga

3.1.1.1 Air Resources: The considerations for a combustion turbine located at Beluga are similar to those for a coal fired facility at this location. The major difference is that $NO_x$ rather than $SO_2$ or particulates is the pollutant of concern, due to high combustion temperatures and the low sulfur content of the fuel. An improperly operated facility also has the potential to emit high levels of uncombusted hydrocarbons; this should not pose any problems if correct operating procedures are followed. Steam plumes from $NO_x$ water injection control could have minor local impacts. Construction and transmission line considerations would be identical to those for a coal fired facility, essentially minor and temporal.

3.1.1.2 Water Resources: The water considerations are similar to those for a coal fired facility at this location; groundwater would still likely be the supply source. Water requirements would be minor, however, approximately 200 gpm for the plant, excluding water injection requirements for $NO_x$ control. If this type of control system is included, an additional requirement of 500-800 gpm may result in significant impacts to the water resources from water withdrawals, as in the cause of a coal fired facility. Discharges are negligible, and no significant impacts to the water quality are anticipated. Construction and transmission line impacts to the water resources should be identical to those noted for the coal fired facility at this location.

3.1.1.3 Aquatic Ecology: The impacts to aquatic ecology parallel those of a coal-fired facility at this location. Significant, difficult to mitigate impacts should not occur.

3.1.1.4 Terrestrial Ecology: The impacts to the terrestrial ecology would be almost identical to those for a coal fired facility at this location. The key impacts are associated with habitat loss and disturbance. Transmission line considerations would be identical.

3.1.1.5 Socioeconomic Factors: The socioeconomic considerations would be very similar to those for a coal fired facility at this location. The peak construction workforce would be around 200 personnel and an operational workforce of 130-150 would be required. A boom/bust cycle could be anticipated, together with long term community alterations, resulting in major socioeconomic impacts to surrounding small communities.

3.1.1.6 Aesthetic Factors: Aesthetic considerations would be very similar to those for a coal fired facility at this location. Plant facilities and the associated transmission line would create noticeable degradation of the viewscape; plant noise would also cause a localized impact.

3.1.2 Kenai/Nikiski

3.1.2.1 Air Resources: The impacts to air resources should be similar to those for a combustion turbine located at Beluga.

However, there do not appear to be as significant regulatory considerations, as the nearest restricted area occurs in the Tuxedni National Wildlife Refuge, across the inlet to the south. $NO_x$ controls (water injection) would still likely be required; therefore unmitigatible impacts to air resources are not anticipated.

<u>3.1.2.2 Water Resources</u>: The water supply at this location will likely come from groundwater supplies, which are ample. Water requirements will be identical to those for the facility at Beluga (approximately 200 gpm and 500-800 gpm for $NO_x$ control). Similarly, discharges are infrequent and impacts to water quality are anticipated to be negligible. Impacts from construction of the transmission line would be similar to those discussed for the Beluga coal fired facility. Areas of concern revolved around siltation, erosion, and streambed disturbance. Good construction practices should mitigate potential adverse impacts associated with transmission line construction.

<u>3.1.2.3 Aquatic Ecology</u>: The impacts to the aquatic ecology would be similar to those associated with a facility located at Beluga. Essentially, groundwater withdrawal and infrequent discharge preclude significant impacts to aquatic ecology.

Impacts associated with transmission line construction would be similar to those of the Beluga location, and identical to those for the Kenai North Slope gas scenario, discussed below. To minimize and mitigate these construction impacts, careful scheduling and good engineering practices are required. However, moderate impacts to aquatic ecology can be expected.

<u>3.1.2.4 Terrestrial Ecology</u>: The impacts to the terrestrial ecology would be similar to those for the facility located at

Beluga, with essentially habitat loss and disturbance being the key issues. However, the more developed nature of the Kenai location results in lower overall wildlife usage, as avoidance has already occurred to a certain extent.

The impacts from construction of the transmission lines will be similar to those of the Beluga location, and identical to those for the North Slope gas scenario discussed below. Moderate impacts due to alteration and elimination of vegetative cover and associated changes in small game and non-game communities can be anticipated. Potential for bird collision impacts will also be created. These can be minimized by careful siting and routing.

3.1.2.5 Socioeconomic Factors: Socioeconomic impacts at this location are not expected to be nearly as severe as those at the Beluga location. The relatively large population base in the area will tend to mitigate any potential boom/bust cycle, although some effect can be anticipated through increased employment opportunities. The creation of 130-150 permanent jobs may be considered as a positive impact. However, demand for housing could possibly exceed the existing supply.

Transmission line impacts would be identical to those discussed below for the North Slope gas scenario. Essentially, most of the peak workforce of over 200 would be hired from the labor pools at Kenai and Anchorage.

3.1.2.6 Aesthetic Factors: Aesthetic parameters would be similar to those for the Beluga location. However, due to the previous developments on the Kenai side of Cook Inlet, the actual impacts would not be considered nearly as signficant as for those in a pristine wilderness area. Again, both visual degradation and noise output would be the most significant factors. Proper design and landscaping should serve to minimize these impacts.

## 3.2 NORTH SLOPE GAS

As described in the introductory section, the North Slope gas utilization scenarios consist of three location specific alternatives: generation at the North Slope, Fairbanks, or Kenai/Nikiski. Environmental considerations for these locations are presented below.

### 3.2.1 North Slope

3.2.1.1 Air Resources: As noted in the previous combustion turbine discussion, the prime air resource consideration encompasses $NO_x$ emissions, and the control of such emissions by water injection. However, water or steam injection in the Prudhoe Bay area causes undesirable levels of ice fog. Furthermore, water or steam injection requires fresh water supplies that are generally not economically available on the North Slope. For these reasons, air quality regulatory agencies have not defined BACT for the North Slope to include using water or steam injection to control nitrogen oxides. Imposition of the requirement for water or steam injection would add substantial costs and significantly decrease the relative feasibility of this option. With no water injection requirement, air quality regulations would not be likely to hamper installation of a gas-fired power plant in the Prudhoe Bay area. However, a judicious siting effort would be necessary to avoid compounding any air pollution problems from existing facilities.

The construction of facilities would result in temporary air quality impacts. The use of heavy equipment and other construction vehicles would generate fugitive dust as well as exhaust emissions. The dusting problem is known to be especially severe during certain periods of air inversion conditions at this location. Tight construction period schedules may not permit construction delays during such inversion periods, creating a significant yet temporal impact.

3.2.1.2 Water Resources: The principal effects of the proposed North Slope generating facility on the water resources of the Prudhoe Bay area include consumptive withdrawals from freshwater sources (existing lakes) for potable supplies and miscellaneous uses such as equipment wash-down. Because the generating station will require minor volumes (approximately 50 gpm) of water and will be served by existing water treatment facilities in the area, water resources effects associated with these uses will not be significant.

Transmission line construction between the North Slope and Fairbanks may impact the quality of surface water resources through erosion caused by land disturbance, but has little or no impact on water supplies. Erosion control, especially in steep terrain or areas of susceptible soils, will be a major requirement imposed by permits issued for right-of-way clearing and construction of the transmission and related facilities, such as access roads. For example, the Bureau of Land Management (BLM) land use plan for the Prudhoe Bay-Fairbanks Utility Corridor (BLM 1980) within which the transmission facilities would be routed, specifically requires protection of stream banks and lake shores by restricting activities to prevent loss of riparian vegetation. Other water resource transmission line considerations would be similar to those presented for other locations.

3.2.1.3 Aquatic Ecology: The major aquatic ecosystems of the North Slope area include the marine environment of the Beaufort Sea, the freshwater environments of the Sag and Put Rivers and their tributaries, and estuarine habitats at the rivers' mouths. Shallow lakes in the area do not support fish because of complete freezing in the wintertime. Deeper lakes may contain resident species such a stickleback, but in general, knowledge of these lakes is presently limited. In the rivers and estuaries, two groups of fish are considered important: river fish such as the grayling, and anadromous fish such as the Arctic char and cisco. The anadromous species descend local rivers at ice-breakup to feed in the shallow littoral and sublittoral zone of the Beaufort Sea. They ascend these rivers in the autumn and overwinter in deep pools. These fish do not appear to undertake extensive migrations up the Sag or Put Rivers.

These fishery resources could be affected by construction and operation of a water supply intake, pipeline and access road construction, gravel mining in rivers which could affect overwintering and general habitat quality of the fish, and the need to cross larger river channels which could interfere with fish passage. The latter item may require the use of special culverts to maintain migratory routes. Each of these potential effects would be analyzed on a site-specific basis, and detailed impact avoidance or mitigation measures developed.

There are a number of secondary environmental effects, related to transmission line construction which should also be considered. Between the North Slope and Fairbanks, the transmission line would cross as many as 150 waterbodies which are utilized by fish for migration, rearing, spawning, and/or wintering. Siting should avoid or minimize impact to spawning areas in approximately 35 waterbodies and to wintering areas in approximately 15 water bodies.

Counterpoise (ground cable) construction may require excavation in streambeds; this activity must be carefully planned (both spatially and temporally) and monitored in accordance with individual permit requirements. Conditions vary along the corridor, so that environmental protection stipulations imposed by the regultory agencies will tend to be site-specific.

<u>3.2.1.4 Terrestrial Ecology</u>: The North Slope area and specifically the river delta areas provide a variety of habitats that are important to a diversity of plants and animals. Project related impacts which require special consideration include: (1) direct habitat elimination through the construction of project facilities, access roads, and gravel borrow areas; (2) indirect habitat elimination resulting from access roads which impede drainage or which generate significant traffic related dust; and (3) restrictions to large mammal movements, especially caribou.

Construction of a power plant, switchyard, construction camp and related access roads will disturb approximately 65 acres of land. All construction equipment should be restricted to areas covered with a gravel pad. Tundra adjacent to the generating facility should not be disturbed.

Because the generating facility will be located within the Prudhoe Bay industrial complex, terrestrial habitat impacts engendered by this project will be an added increment to those which have already occurred as a result of oil field development. Final siting efforts should include evaluation of the factors listed above, and will be the mechanism through which highly significant terrestrial impacts can be avoided, particularly the indirect impacts and migratory blockages. The direct impacts of habitat removal due to facility construction are generally unavoidable, but can be minimized through careful site planning and construction management.

Impacts from transmission line development should also be considered. Construction of the transmission line facilities will require vegetative clearing in forested areas. Clearing should be restricted to the following categories of vegetation: trees and brush which may fall into a structure, guy, or conductor; trees and brush into which a conductor may blow during high winds; trees and brush within 20 feet of a conductor or within 55 feet of the line centerline; and trees or brush that may interfere with the assembly and erection of a structure. Bird collisions with transmission line conductors and other facilities are also on and at major river crossings.

Between the North Slope and Fairbanks, much of the area south of Nutirwik Creek will require clearing of trees within the right-of-way. Because two lines will be built and trees within 55 feet of the line will be cleared, the total width of cleared vegetation will be 220 feet. Over the length of the line, approximately 7,000 acres will be cleared.

The transmission line corridor passes through a wide variety of terrestrial ecosystems, and is adjacent to several major federal land areas which have been protected, in part, for their wildlife values. The Bureau of Land Management (BLM) land use plan for the Utility Corridor (BLM 1980) has identified several areas as containing critical wildlife habitat. Specific management restrictions have not as yet been formulated; however, measures may be required for a number of areas.

The land use plan also specifically requires protection of raptor habitat and critical nesting areas. Protection of crucial raptor habitats preserves the integrity of raptor population and maintains predator-prey relationships. Facilities and long-term habitat alterations are prohibited within one mile of peregrine falcon nest sites unless specifically authorized by the U.S. Fish and Wildlife Service, because of the endangered species status of the peregrine falcon. As the transmission line corridor generally avoids known nesting areas, the restriction may only apply to material sites.

It is unlikely that the transmission line would be sited in or near important Dall sheep habitat. A primary concern is aircraft traffic over critical wintering, lambing, and movement areas. Moose winter browse habitat in the Atigun and Sag River valleys is limited to areas of tall riparian willow. Habitat has already been eliminated by the construction of Trans Alaska Pipeline System (TAPS) and further destruction of this habitat should be avoided or minimized. The willow stand along Oksrukuyik Creek, in particular, should not be disturbed.

System design must allow free passage for caribou, but these animals should not be a major consideraton in siting. Carnivore/human interaction is a major concern in facilities design and in construction and operations methods, but not in siting considerations.

Line routing and tower siting should avoid or minimize disturbance of the treeline white spruce stand at the head of the Dietrich Valley, which has been nominated for Ecology Reserve status.

<u>3.2.1.5 Socioeconomic Factors</u>: Potential socioeconomic and land use effects of the North Slope scenario include both temporary impacts related to the influx of workers and permanent land use impacts.

Since the generating plant would be located within the Prudhoe Bay/Deadhorse industrial complex, the in-migrating workforce would not significantly affect the social and economic structure of the region. The workforce requirements are small in comparison to the existing size of the transient workforce in the Prudhoe Bay region. For five months of each year during the period 1993 throgh 2010 a maximum of 200 employees will be needed to assemble the prefabricated units of the plant. Housing facilities would be provided for the employees at the adjacent construction camp. During off-work periods, the majority of the employees would spend time outside of the borough. The operations workforce is expected to be approximately 150 and will reside in the labor camp. The spending of wages earned by the employees within the North Slope Borough is expected to be minimal due to the transience of the workforce.

The use of land for an electrical generating plant would be compatible with the land uses of the industrial enclave. The Coastal Zone Management Program for the North Slope Borough has delineated zones of preferred development. Permanent facilities are allowed in the industrial development zone, consisting of the existing Prudhoe Bay/Deadhorse complex and the Pipeline/Haul Road Utility corridor (North Slope Borough 1978). The generating plant would be located within the preferred development zone.

Within the Prudhoe Bay/Deadhorse complex, the plant would be located to minimize interferences with existing or planned facilities, including buildings, pipelines, roads, and transmission lines. Land ownership and lease agreements will limit the land available for the electrical generating facility.

Socioeconomic and land use impacts related to construction and operation of transmission facilities between Prudhoe Bay and Fairbanks will be strictly controlled as a result of the guidelines and constraints for development within the designated utility corridor. Construction employees would be housed either at the pump stations or the permanent camp facilities constructed for the trans-Alaska oil pipeline. Construction activities would be consistent with the land use criteria developed by the BLM. The BLM has prepared land use plans for the utility corridor between Sagwon Bluffs and Washington Creek. Road and highway crossings would be minimized, and areas of existing or planned mineral development would be avoided.

Permanent facilities would be consolidated at carefully selected locations in the vicinity of Livengood Camp, Yukon Crossing, Five Mile Camp, Prospect, Coldfoot, Chandalar, and Pump Station #3. Existing facilities such as work pads, highways, access roads, airports, material sites and communications would be used to the maximum extent possible.

The schedule for constructing the transmission lines is approximately 3 years with activities occurring mainly during the autumn and spring of each year. A peak work force of 2400 employees would be required during the first year of construction when the pads would be built, and in subsequent years the total work force would be substantially reduced to approximately 500 in the second year, 600 in the third year, and 670 in the final year. It is expected that these workers will be hired from the Anchorage and Fairbanks union hiring halls.

<u>3.2.1.6 Aesthetic Factors:</u> The potential aesthetic impacts of the proposed North Slope development, especially the transmission lines,

are significant. The cumulative effects of these facilities could result in significant degradation of the aesthetic character of pristine wilderness landscapes as described in previous discussions. In locations where visual impacts cannot be avoided through careful routing or tower spotting, mitigative measures such as the use of nonreflective paint or vegetative screening can be employed.

### 3.2.2 Fairbanks

3.2.2.1 Air Resources: A facility located in the Fairbanks area would impose critical siting efforts and control technologies to avoid significant impacts. Analyses of the Fairbanks urban "heat island" have shown that winds are generally light in the winter and that wind directions change dramatically in the vertical direction during the wintertime. During the winter months, the air near the ground is relatively cold, compared to the air aloft. This reduces mixing of the air in the vertical direction, and when combined with relatively light winds, often leads to periods of air stagnation.

In large part due to the winter stagnation conditions, the Fairbanks area is currently designated as a nonattainment area for CO. Emissions of CO are largely due to automobiles. The State Department of Environmental Conservation and the Fairbanks North Star Borough Air Pollution Control Agency are implementing a plan to reduce the ambient CO mainly through the use of vehicle emission or traffic control techniques. In addition, relatively high levels of nitrogen oxides have recently been monitored in the Fairbanks area. Only an annual average nitrogen dioxide standard exists, but the short term measurements of nitrogen oxides are as high as in major urban areas such as Los Angeles.

Because Fairbanks is a nonattainment area, the operators of a facility must demonstrate that they will reduce, or offset, impacts of the power plant by reducing emission levels of CO at other sources. Emissions of CO from a natural gas-fired power plant are relatively low, and any displacement of the burning of other fuels, such as coal or oil, will likely lead to improved air quality. This arises from the clean-burning nature of natural gas and from the fact that emissions from a major facility will be injected higher in the atmosphere (due to plume buoyancy) than the displaced emissions. During the very stagnant conditions in midwinter, the plume from a power plant will likely remain well aloft with little mixing to the surface layers. The complex urban heat island and associated wind pattern will require a great deal of in-depth modeling and analysis to determine air quality impacts in terms that will withstand regulatory scrutiny.

The nitrogen oxides limits at Fairbanks will be the most constraining atmospheric pollutant. The operation of a power plant will also consume a portion of the allowable deterioration in air quality for nitrogen oxides. While it is possible that the power plant could be sited near Fairbanks, its installation would constrain other development efforts which also might consume a portion of the air quality increment. The nature, magnitude, and duration of emission plumes must be studied as well as the potential for beneficial impacts due to reduced combustion at other sources within the area.

The Fairbanks area is also subjected to extended periods of wintertime ice fog, and the Alaska Department of Environmental Conservation will require the impact of any water vapor plumes to be carefully assessed. A combustion turbine power plant which uses water or steam injection techniques would have an adverse impact on the ice fog and icing deposition nearby. This emissions control technology may thus not be feasible. This is similar to the situation that exists at the North Slope location.

3.2.2.2 Water Resources: A gas fired combined cycle power plant at Fairbanks will use approximately 200 gpm of freshwater for boiler makeup, potable supplies, and miscellaneous uses such as equipment washdown. Because ample groundwater exists in the Fairbanks area and because the water requirements are not particularly large, impacts on water supplies in the area will not be significant. Impacts associated with the natural gas transport system, however, could be very significant.

A gas pipeline from the North Slope to Fairbanks will cross 15 major streams and rivers, including the Yukon River, and could potentially impact numerous additional small streams and drainages. The pipeline will be buried for its entire length; vegetation will be disturbed within a 50-foot wide strip. Without careful siting and construction practices, erosion from exposed areas could cause sedimentation problems in nearby water bodies.

To control soil-loss and subsequent sedimentation effects, several mitigation practices should be used during pipeline construction. Existing work pads, highways, access roads, airports, material sites, and disposal sites should be used whenever possible to minimize vegetation disturbance. Pipeline rights-of-way and access roads should avoid steep slopes and unstable soils. Hand clearing could be used in areas where the use of heavy equipment would cause unacceptable levels of soil erosion. A 50-foot buffer strip of undisturbed land could be maintained between the pipeline and streams, lakes, and wetlands wherever possible. Construction equipment should not be operated in water bodies except where necessary. Where high levels of sediment are expected from construction activity, settling basins should be constructed and maintained. All disturbed areas should be left in a stabilized condition through the use of revegetation and water bars; culverts and bridges should be removed, and slopes should be restored to approximately their original contour.

A significant problem with the operation of a chilled, buried pipeline is the formation of aufeis. Aufeis is an ice structure formed by water overflowing onto a surface and freezing, with subsequent layers formed by repeated overflow. Chilled pipe in streams can cause the stream to freeze to the bottom in the vicinity of the pipe, creating aufeis over the blockage. A chilled pipe through unfrozen ground can also form a frost bulb several times larger than the pipe diameter. This frozen area can block subsurface flow, forcing water to the surface and causing aufeis. Road cuts can also expose subsurface flow channels, causing aufeis build-up over the roadway. The potential for aufeis and possible effects will require detailed considerations for all construction areas.

All stream crossing facilities should be designed to withstand the Pipeline Design Flood as defined for the ANGTS system. Streams should be stabilized and returned to their original configuration, gradient, substrate, velocity, and surface flow. Water supplies for compressor or meter stations should not be taken from fish spawning beds, fish rearing areas, overwintering areas or waters that directly replenish those areas during critical periods.

The Yukon River crossing will utilize an existing bridge. The Yukon River will therefore not be significantly affected by the pipeline.

4086A

3.2.2.3 Aquatic Ecosystem: The location of a facility in the Fairbanks vicinity will not cause significant impacts to the aquatic resources at the plant site. The water supply for the power plant will most likely be obtained from groundwater, and therefore will not affect surface water bodies. Discharges from the plant will be treated to meet effluent guidelines before being released, so that fish habitat should not be significantly affected. Discharge quantities will be relatively low, on the order of 200 gpm. However, there may be significant impacts associated with pipeline and transmission line construction.

The transmission line corridor between Fairbanks and Anchorage makes as many as 100 crossings of rivers and streams and comes within one mile of numerous lakes and ponds. All of these waterbodies are important habitat for endemic and anadromous fisheries Impacts to fisheries such as increased runoff and sedimentation could occur through clearing of the right-of-way and crossing of watercourses by construction equipment. The introduction of silt into streams can delay hatching, reduce hatching success, prevent swimup, and produce weaker fry. Siltation also reduces the benthic food organisms by filling in available intergravel habitat.

The potential adverse impacts can be reduced or eliminated through construction scheduling. Construction of the transmission lines during the winter would minimize erosion since the snow protects low vegetative cover that stabilizes soils. Ice bridges could be used by construction equipment for crossing spawning areas, where possible. Otherwise, where equipment would move through watercourses, construction could occur during periods when there are no eggs or fry in the gravel.

4086A

A natural gas pipeline from the North Slope to Fairbanks will cross numerous rivers and creeks, including the Yukon River. Aquatic resource impacts will include all those discussed above and additional impacts caused by the chilled pipeline crossing waterbodies. Several mitigation measures, in addition to those already discussed, should be implemented to protect the fish habitat affected by pipeline construction and operation. Stream crossings should be constructed such that fish passage is not blocked and flow velocity does not exceed the maximum allowable flow velocity for the fish species in a given stream. If these criteria cannot be met, a bridge should be installed.

Chilled pipes in streams should not cause: a) lower stream temperatures so as to alter biological regime of stream; b) slow spring breakup and delay of fish migration; or c) early fall freeze-up which would affect fish migration. In addition, the temperature of surface or subsurface water should not be changed significantly by the pipeline system or by any construction-related activities.

The timing of construction is also critical. Adverse impacts may be encountered, if the following regional schedule (developed for ANGTS) is not noted (Region I, Beaufort Sea to the Continental Divide of the Brooks Range; Region II, Continental Divide of the Brooks Range to the Yukon River; and Region III, Yukon River to Fairbanks):

| | | |
|---|---|---|
| Region I | 1 May-20 July | A critical period for most streams due to the occurrence of major spring migrations and spring spawning (primarily grayling). |
| Region II | 15 April-15 July | |
| Region III | 1 April-15 July (early breakup streams)<br>15 April-15 July (late breakup streams) | |

4086A

| | | |
|---|---|---|
| Region I<br>Region II<br>Region III | 20 July-25 August<br>15 July-25 August<br>15 July-1 September | A sensitive period. Fry of spring spawning species have emerged and major fall emigrations have not yet begun. Fish are mobile at this time and can move to avoid or reduce effects of disturbance. |
| Region I<br><br><br><br>Region II<br><br><br><br>Region III | 25 August-1 October (small streams)<br>25 August-15 October (large streams)<br>25 August-1 October (small streams)<br>25 August-15 October (large streams)<br>1 September-1 November | A critical period for all streams. Fish must emigrate from streams that do not provide winter habitat prior to freeze-up. Major upstream migrations and spawning of fall spawning species occurs in streams that provide overwintering habitat. |
| Region I<br><br><br><br>Region II<br><br><br><br>Region III | 1 October-1 May (small streams)<br>15 October-1 May (large streams)<br>15 October-15 April (small streams)<br>1 November-15 April (large streams)<br>1 November-1 April (early breakup streams)<br>1 November-15 April (late breakup streams) | A preferred period for construction in many streams that do not provide winter habitat. These streams generally are dry or freeze to the bottom during winter. This is a critical period for fish overwintering in springs, large rivers, and lakes. |

3.2.2.4 Terrestrial Ecology: A power plant in the Fairbanks vicinity will affect terrestrial resources primarily through habitat disturbance. Potential power plant sites in the Fairbanks area are located in developed or previously disturbed areas. The potential for adversely affecting terrestrial habitats is therefore not considered to be significant. However, as for aquatic ecology, there are potential significant impacts associated with transmission line and pipeline construction.

For the Fairbanks to Anchorage transmission line approximately 80 percent of the corridor is located in forested areas (Commonwealth

Associates 1982). Assuming two additional lines are built and the Intertie is extended, a total of about 8,700 acres will be cleared. The principal impacts associated with clearing a right-of-way and construction of the transmission line are the alteration of existing habitats and subsequent disruption of wildlife species that use those habitats and disturbance to indigenous fauna and bird populations.

Most big game species would relocate during the construction of the transmission lines. The construction schedule should be flexible so as to avoid construction near calving and denning sites during appropriate seasons. Moose, which adapt to many different habitat types, avoid the right-of-way construction, but may benefit in the long-term from the removal of overstory vegetation which enhances browse production. The distribution of caribou is limited along the transmission line corridor but those that do occur in the vicinity of the right-of-way would be displaced. The caribou, however, generally utilize habitats with low vegetative cover, resulting in little alteration of caribou habitat.

Grizzly and black bears would relocate to avoid construction activity along the right-of-way, except where construction occurs near a den site during winter dormancy. Construction activity near denning areas should be avoided from October 1 through April 30. The alteration of habitats could temporarily affect bear use of the right-of-way but this impact is expected to be relatively short-term.

Wolves within the vicinity of the right-of-way would also be displaced during construction of the transmission line. While these impacts would be temporary, long-term impacts would occur to the wolf if their principal prey species, such as caribou, sheep, and moose were adversely affected.

Dall sheep occur only at the northern end of the transmission line corridor and would be impacted only minimally by construction activities. The use of helicopters to construct the lines in the Moody and Montana Creek drainages could severely disturb sheep in the vicinity of Sugarloaf Mountain.

The impact to regional populations of any of the small game species is expected to be negligible. Small game species are expected to relocate during construction activities and reinvade the right-of-way once construction is over.

In heavily forested areas along the corridor, the right-of-way clearing could provide an improved habitat for most of the small game species that utilize subclimax communities.

Migratory waterfowl are susceptible to disturbance from construction activities from mid-April to the end of September when they are nesting and brood rearing. Construction activities should be restricted from May through August in areas with active trumpeter swan nesting territories. Collisions with transmission lines, guywires, and overhead groundwires are another potential impact.

Furbearers are not expected to be greatly affected by construction activities except during the initial right-of-way clearing. Most furbearers will either adapt to the presence of the cleared right-of-way or undergo short-term impacts. The maintenance of a shrub community in the right-of-way will reduce the loss of individuals.

The impacts on nongame mammals and birds are expected to be insignificant. Some small mammals and nongame birds would undergo population shifts during construction activities but populations are expected to recover within one to two reproductive seasons. Raptors may lose some habitat as a result of clearing. Benefits of a cleared right-of-way could occur as some raptors could find that it provides hunting habitat or hunting perches not previously available.

The construction of a gas pipeline from the North Slope to Fairbanks will require total clearing of a 50-foot right-of-way for the length of the gasline. In addition, ten 10-acre compressor stations, two 1.5-acre metering stations and a gas conditioning facility (15 acres) will be constructed. Construction activities will disrupt terrestrial animals near the corridor during the three-year construction period. The pipeline alignment will avoid the peregrine falcon nest sites near the Franklin and Sagwon Bluffs, but other raptors may restrict construction schedules. Special construction measures may be necessary in the areas delineated by the BLM land use plan, as discussed for the North Slope scenario. Construction activities, especially aircraft traffic, could disturb Dall sheep habitat in critical wintering, lambing, and movement areas. These construction-related impacts would be less than three years in duration.

Long-term terrestrial impacts will result primarily from habitat elimination. Important moose browsing habitat, such as the willow stand along Oksrukuyik Creek, should be preserved. The treeline white spruce stand at the head of Dietrich Valley, which has been nominated for Ecology Reserve status, should be avoided. The pipeline design should allow for free passage of caribou and other large animals, to avoid significant adverse impacts.

3.2.2.5 Socioeconomic Factors: The relatively large population base in the Fairbanks vicinity preclude major impacts from a boom/bust cycle associated solely with power plant construction. The potential socioeconomic impacts are rather associated with transmission line and pipeline construction.

The size of the construction workforce for the generating facility is expected to be approximately 200 persons. These generation units will be constructed during the summer for about four or five months.

Since the project could draw on the large labor pool at Fairbanks, it can be expected that the majority of workers will be hired locally. Economic benefits to the region will not be significant as employment on the project will be temporary. Any in-migrating workforce will have to seek temporary housing on their own since housing will not be provided at the project site. The extent of the impacts on the local housing supply will depend on the vacancy rate for the summer of each year of construction.

Development of a generating facility on the outskirts of the Fairbanks area should not engender significant land use conflicts, since the focus of the final site selection activities will be on areas which are presently used for industrial development. However, the long-term staged development of a major electric generating complex will certainly be a determinant of future land uses in the local area.

Construction activities at the generating plant site will generate additional worker and construction vehicle traffic loads on the local road system. However, disruptions to existing traffic patterns can be minimized through site selection by utilizing major highways and arterials to the maximum extent possible and by

4086A

developing a local access plan and schedule. Depending on the site selected, new access requirements will be planned in recognition of local traffic requirements.

Development of additional transmission facilities between Fairbanks and Anchorage could have potential significant socioeconomic and land use impacts, since this segment is moderately populated and subject to future land use development. Temporary campsites would be provided to house the work crews at locations accessible by the Parks Highway or the Alaska Railroad. The schedule for constructing the transmission lines is approximately 22 months. A peak work force of approximately 520 employees would be required during the last 6 months and the average work force would be approximately 300. These estimates do not include the helicopter crews. It is assumed that the project would utilize the labor pools of Fairbanks and Anchorage.

Impacts to local communities would be minimized through careful siting of the temporary work camps. It is expected that the work camps would be self-contained in order to keep to a minimum interaction between the construction workers and the local residents. The project is expected to have minor primary economic benefits since few, if any, residents would be employed on the project.

Land use impacts could include encroachment of the project on residential areas as well as preclude future residential development land available for homesteading. The most significant potential impact would be the crossing of recreation lands and the subsequent effects on recreation and aesthetic values these lands are meant to preserve.

For construction of the gas pipeline in the North Slope-Fairbanks corridor, employees will be housed either at the pump stations or the permanent camp facilities that were constructed for the trans-Alaska oil pipeline. Construction activities will be consistent with the BLM land use criteria.

3.2.2.6 Aesthetic Factors: The Fairbanks area, already containing noticeable development, would not be significantly impacted by the construction of a combustion turbine power plant, assuming careful siting and adequate landscaping criteria are employed. However, the potential aesthetic impacts of the proposed Fairbanks transmission facilities and/or pipelines are significant. The cumulative effects of these facilities and previous linear developments (e.g., TAPS) could result in significant degradation of the aesthetic character of pristine wilderness landscapes. The visibility of the transmission lines from existing travel routes (Dalton Highway, Parks Highway, etc.) will vary depending on distance, topography and intervening vegetation. Special care would be taken in selecting final route alignments in proximity to areas of special visual significance, such as national parks, or high visual sensitivity, such as areas within the viewing range of motorists on the Parks Highway. In locations where visual impacts cannot be avoided through careful routing or tower spotting, mitigating measures, such as the use of nonreflective paint or vegetative screening, can be employed.

### 3.2.3 Kenai/Nikiski

3.2.3.1 Air Resources: The air resources considerations for this option would be identical to those already discussed under the Cook Inlet utilization at this location. However, there are additional

4086A

secondary impacts to air resources that should be mentioned. These impacts are associated with construction of transmission lines, gas pipelines and other support facilities. The construction of these facilities would result in temporary air quality impacts. The use of heavy equipment and other construction vehicles would generate fugitive dust and exhaust emissions. Slash burning of material to clear the right-of-way would produce emissions. The impacts from these construction-related activities are expected to be small because the emissions would be widely dispersed and temporal in nature.

3.2.3.2 Water Resources: The water resources considerations for the plant would be identical to those already discussed under the Cook Inlet utilization of this location. However, transmission line construction would have significant impacts, which are elaborated upon below. Potential effects of pipeline construction would be similar to those previously described under the Fairbanks option.

A transmission line from Kenai to Anchorage would cross the streams and creeks listed below:

| | |
|---|---|
| Soldatna Creek | Moose River |
| Mystery Creek | Chickaloon River |
| Big Indian Creek | Little Indian Creek |
| Potter Creek | Furrow Creek |
| Campbell Creek | Chester Creek |
| Ship Creek | |

The water quality of these streams should not be directly affected if towers will be set back from the streambank at least 200 ft, and construction activities stay out of stream channels. Indirect impacts on the water bodies, however, will result from construction activity in the small drainageways that feed the main channel, primarily from removal of vegetation (causing higher erosion rates), equipment crossings of small drainages, and access road construction. Becauase helicopter construction will be used along most of the route, the use of heavy equipment, vegetation removal, and access road construction should be minimal.

The transmission line will cross Turnagain Arm from Gull Rock to the mouth of McHugh Creek via seven buried submarine cables. Construction phase impacts will consist of increased turbidity from the cable installation, and construction activity near the shore on both shorelines. Operation phase impacts will primarily be the potential for cable rupture and subsequent cable oil contamination of Turnagain Arm. The cable will be designed to have a very low probability of rupture over the life of the project. A synthetic cable oil, dodecobenzene, should be used for cable insulation. If this oil accidentially leaks, it will rise to the surface and quickly evaporate when exposed to air. This oil is used specifically to minimize environmental effects associated with a cable rupture.

3.2.3.3 Aquatic Ecology: The water supply at the Kenai/Nikiski location will probably come from groundwater supply. Therefore, as noted under the Cook Inlet option, direct plant impacts would be minimal. However, there are additional considerations associated with support facilities, especially transmission lines and pipelines.

Soldatna Creek and Moose River flow into the Kenai River system, a major river for anadromous fish habitat. Soldatna Creek provides spawning and rearing habitat for silver salmon, and Moose River contains king, silver, and sockeye salmon (U.S. Army Corps of Engineers 1978). Sedimentation of these water bodies from

4086A

transmission line or pipeline construction could affect spawning and rearing habitat in these streams. Because helicopter construction will be used for most of the route, however, sedimentation effects would be relatively minor.

Impacts to freshwater aquatic resources will be mitigated primarily through the control of sedimentation of water bodies, keeping construction equipment out of streambeds and wetlands, and avoiding areas of high biological value.

For a facility located at Kenai, crossing Turnagain Arm with underwater cables poses additional environmental hazards. Turnagain Arm is an enviromentally sensitive area in the general vicinity of the project that contains marine mammals, including Harbor Seals, sea lions and Beluga whales (U.S. Department of Commerce 1979). Salmon are present in some of the small streams that enter this area (Alaska Department of Fish and Game 1978).

Installation of buried submarine cables will temporarily disrupt the sea floor along the cable route and increase turbidity and suspended solids in the vicinity of the crossing. Tidal currents could carry suspended sediment beyond the immediate crossing site. Special construction techniques should be used to minimize disturbance of the substrate. Installation should take place when biological activity is at its lowest point in the yearly cycle.

An accidental rupture of a cable would leak cable oil into the aquatic environment. The cable oil used should be dodecobenzene, as it rises rapidly to the surface and evaporates when exposed to air, thereby minimizing environmental impacts.

The cables may operate at a temperature level above ambient conditions. Because the cables will be buried six to ten feet, only the substrate temperature and not water temperatures would be elevated (Bonneville Power Administration 1981).

3.2.3.4 Terrestrial Ecology: Impacts to terrestrial ecology for the power plant would be identical to those discussed under the Cook Inlet utilization option. A power plant in the Kenai vicinity will be located in an area already extensively developed; little habitat degradation will occur. The area disturbed for power plant construction, approximately 140 acres, will not significantly affect terrestrial resource in the area.

The transmission route passes through an area of caribou habitat northeast of Kenai (University of Alaska 1974). Little alteration of caribou habitat will result from construction of the transmission line because the animal utilizes cover types that require little, if any, clearing.

Much of the route between Kenai and Anchorage is within moose rangeland. However, because moose utilize many different habitat types, they will be the least adversely affected by habitat alterations (Spencer and Chatelain 1953). Where the proposed route crosses heavily forested areas, moose will benefit from additioanl clearing of the right-of-way and the subsequent establishment of a subclimax community (Leopold and Darling 1953). The route does not cross Dall sheep or mountain goat habitat.

The transmission line corridor passes near Chickaloon Flats and Potter Marsh on Turnagain Arm, both key waterfowl areas. Various puddle ducks, geese and sandhill cranes feed and rest during seasonal migration periods in these areas. The shoreline of Turnagain Arm is also used by seals and sea lions. The transmission line would not directly affect this wildlife habitat but could be a source of avian collision mortality.

Construction of the submarine cable could slightly affect terrestrial habitat indirectly by increasing turbidity of Turnagain Arm and thereby affecting food sources. This would be a temporary effect during the construction phase only.

The transmission corridor passes through several vegetation types. Between Kenai and Sterling, the vegetation is primarily bottomland spruce-poplar forest. As corridor extends northeasterly towards Turnagain Arm, the vegetation becomes upland spruce-hardwood forest and, on the foothills of the Kenai Mountains, coastal western hemlock-Sitka spruce forest. North of Turnagain Arm, the vegetation is primarily bottomland spruce-poplar forest (University of Alaska 1974).

Transmission line construction will necessitate clearing a 220-foot wide corridor in all forested areas. Over the length of the corridor, it is assumed that a total of 550 acres would be cleared within the right-of-way.

<u>3.2.3.5 Socioeconomic Factors</u>: The socioeconomic effects of locating a facility in the Kenai/Nikiski area depends primarily on the size of the in-migrating workforce. Land use impacts are not expected to occur as these facilities are compatible with the heavily industrialized development that dominates the Kenai/Nikiski area. The size of the construction workforce for the generating facility is expected to be approximately 175 persons. The construction schedule would require that a unit be constructed every

year during the period 1993 to 2010, with the exception of 1994 and 1999, when no new units would be required. The duration and time of the construction period would be four to five months in the summer.

The extent to which local people would be hired would depend on the match of skills required for the project to those skills of the available labor force. Labor union policies would also influence the extent of local hires on the project. The in-migrating workforce would have to seek temporary housing on their own since housing would not be provided at the project site. The magnitude of the impacts on the local housing supply would depend on the vacancy rate for the summer of each year a unit was constructed.

The project is expected to have little effect on the unemployment rate since employment on the project would be seasonal. In addition, these job openings would be competitive with other employment opportunities in seasonal industries such as construction and fisheries.

The operations workforce is expected to be approximately 100. The magnitude of potential impacts depends on the availability of local labor to meet the workforce requirements. If the majority of the employees migrate to the Kenai/Nikiski region, the demand for housing could exceed the supply.

Construction of transmission lines between Kenai and Anchorage is expected to take 22 months. The peak workforce is estimated at 221 persons during the last six months and average construction workforce is expected to be approximately 163 workers. It is assumed that workers would be hired from the labor pools of Kenai and Anchorage.

3.2.3.6 Aesthetic Factors: The aesthetic considerations would be identical to those described under the Cook Inlet option for the plant location. Transmission line and pipeline considerations would be very similar to those described for Fairbanks, with the potential for visual degradation.

4086A

# 4.0 HYDROELECTRIC FACILITY - CHAKACHAMNA

The Chakachamna hydroelectric alternative has been investigated further than the other alternatives, with site specific preliminary engineering, feasibility analysis, and monitoring data available. Therefore, the scope of the discussions presented in this section is in correspondingly greater detail, drawing heavily upon the recent findings of Bechtel's studies (Bechtel 1983).

## 4.1 AIR RESOURCES

Hydroelectric facilities have minimal impacts to the air resources, with effects restricted to potential localized meteorological changes associated with creation of a reservoir. Since Lake Chakachamna already exists, there will be no first order air resource impacts anticipated from development of this facility.

## 4.2 WATER RESOURCES

The water resource impacts of project development can be segregated into those associated with project construction activites and those associated with the operation of the facility.

### 4.2.1 Construction Impacts

The construction related impacts fall into three general areas: effects of permanent or temporary alterations to water bodies, changes in water quality associated with the alterations, and direct effects of construction activities.

Few alterations of water bodies are expected during the construction phase of the project. However, alterations may be associated with installation of bridges or culverts for roads and rights-of-way; rerouting of runoff from camps and materials storage areas; and rerouting of flow in areas of near-stream or in-stream construction.

Bridges and/or culverts will need to be installed to provide road access over streams and other waterways. Properly designed bridges and culverts, installed so as to prevent perching and high water velocities should have few adverse impacts on waterways. During construction or installation of the bridges/culverts, some local increases in turbidity and localized disturbance would be expected, but these should be of relatively short duration.

Rerouting of runoff from camps, materials storage areas, and construction sites is expected to affect small areas, primarily in the McArthur River canyon. The rerouting is expected to primarily involve rerouting of surface runoff, where silt and soluble materials would otherwise be carried into the waterbody. Some rerouting of in-channel flows may be necessary to allow construction activities in certain site areas. Presently, there are insufficient data to identify the extent of these areas. The rerouting of flow in some construction and camp areas may be permanent.

There are a variety of water quality impacts that could potentially occur during construction. These generally involve the discharge of silt-laden waters from various areas and effluents. Most impacts due to such discharges can be mitigated, if not eliminated altogether.

Silt-laden waters from collected runoff and from excavation of facilities, could represent a considerable source of silt and turbidity to the river unless they are held in detention ponds before being discharged. Spoils will be disposed of or stored at the headwater area of the Chakachatna and McArthur rivers. Spoil at the upper McArthur River canyon will result from tunneling and powerhouse excavation. Much of this will be used for construction of river training works needed to protect the powerhouse tailrace channel from erosion and damage by the river. The disposal area for excess spoil will be located so as to avoid significant adverse effects. Spoils in the Chakachatna River drainage would include materials removed from the spillway channel, gate shaft excavation, fish passage facilities, and tunnel excavation. Some spoil will be used to construct the outlet structure dike, while the excess will be disposed of in locations yet to be determined and selected so as to minimize adverse environmental impact. Disposal ares will be diked, and runoff controlled to minimize sediment discharge into waterways. Settling ponds will be used for sedimentation of suspended silts prior to discharge to reduce potential impacts.

The primary change in water quality that may occur from construction is increased turbidity. This may be produced by increased erosion associated with disposal of tunnel spoils and construction activities. Turbidity originating from runoff and construction is often associated only with actual clearing activities and rainfall events. The increases in turbidity in the Chakachatna disposal area would occur near maximum lake levels. Increases in turbidity would vary with the type, extent, and duration of construction activity, but would be expected to be local in nature and of relatively short duration.

The production of concrete for construction of the fish passage facility and powerhouse may result in production of concrete batching waste. A particular problem with this waste is its high pH (10+) and the need to neutralize it (pH 7) prior to discharge. It is expected that this waste will be treated as required by the anticipated project NPDES permit.

During peak construction activity, facilities to house workers will be located primarily in the McArthur floodplain. The housing and supply storage area will occupy 20 to 30 acres. Due to the presence of a large construction force in the area, sanitary waste will need to be treated and discharged.

Direct construction activities include activities that can be expected to occur throughtout the construction of the project. These activities, for the most part, will be confined to specific areas. During construction, some of the first activities to occur will include the construction of access roads, clearing of construction areas, stockpiling of construction materials and fuel, movement of heavy equipment, and construction of support facilities. Activities associated with support facility construction will include cutting and clearing in areas near several streams.

The removal of ground cover during this project will be minor but may locally increase the potential for greater runoff, erosion, increased turbidity, and increased dissolved solids. The extent of impacts can be minimizeed through the use of mitigative practices to control erosion and related sedimentation and turbidity.

There are no plans for regular operations of heavy machinery in streams. The primary use of heavy machinery would be during the rerouting of flow. The extent of potential impact due to siltation and turbidity should be short term and dependent upon the extent of machinery operation and the type of substrate in the streams affected. Smaller substrates tend to be more affected. However, if water velocities are sufficiently high, the deposition of suspended sediments may not occur locally, and the effects would be minor. Current construction plans do not require instream blasting.

As part of the construction activities, water will be diverted from streams in the construction area to be used for dust control, drinking water, fire-fighting water, sanitary water, concrete batching, and wet processing of gravel among other uses. The diversions will probably be accomplished by pumping from local stream segments and intakes will be screened and designed to use very low velocities to avoid fish impingement and entrainment.

### 4.2.2 Operational Impacts

The potential impacts to water resources from the operation of the Chakachamna alternative will vary for the three general water bodies; Chakachamna Lake and tributaries, Chakachatna River, and McArthur River.

Chakachamna Lake will be affected by a 72 ft annual water level fluctuation during proposed project operation. The maximum proposed reservoir level of 1155 ft is near the maximum historical lake level; this level will occur seasonally under post-project conditions. Minimum reservoir levels will be approximately 45 ft below pre-project minimum levels. Such a drawdown will expose lake shoreline and stream deltas which are normally inundated. Lake levels will vary in Chakachamna Lake and will result in increased inundation of lakeshore and delta areas during high reservoir levels; dewatering of submerged shoreline would occur during periods of drawdown.

The project effects on the water quality of Lake Chakachamna may include increased suspended sediment and turbidity concentrations near tributary mouths. The potential sediment inflow from the tributaries is discussed below.

The channel gradient of the Chakachamna Lake tributaries will be affected by the drawdown and fluctuation of the reservoir level. Maximum water levels will cause inundation of the lower reaches of streams which are not normally affected; minimum water levels will expose the entire stream delta surface and the upper portion of the steep delta front. Resulting changes in stream gradient will be progressive and sequential. These will likely be similar at the mouths of all tributaries, but to different degrees. The anticipated changes due to seasonal minimum reservoir levels include: dewatering of over 7 $mi^2$ of delta area; increase in stream gradient and accompanying erosion where the stream flows down the front of deltas; development of new deltas; eventual channel degradation at the tributary mouths to near the lowest regulated reservoir level; and degradation upstream as far as is required for the stream to reach equilibrium between the streamflow regime during low reservoir levels and the materials through which it is flowing, possibly resulting in localized rapids during the low water period, if erosion resistant materials are reached.

Maximum reservoir levels can cause deposition of stream-borne sediments in those reaches of stream affected by backwater from the reservoir. Some of the deposited sediments would likely be eroded as the reservoir level drops through the winter. Breakup flows may remove the rest of the deposits.

According to the proposed reservoir operation schedule, the reservoir will be at maximum level during September and drawn down to lower levels over the winter with a minimum level occurring during April or May.

Water releases will be made to the Chakachatna River below the fish passage facility. The quantity of the actual releases is not presently known, however, preliminary release flows have been estimated (Table B-1). Such flows constitute a relatively small percentage of pre-project annual flow. Tributary inflow downstream from the lake contributes relatively small quantities of flow compared with pre-project flows at the lake outlet. However, depending upon the time of year, the tributary inflow may substantially increase post-project flows downstream of the release structure. Historical low flows will be substantially reduced by project operation during October through March. Ten percent of the average annual flow is considered to be the minimum for short term survival of fish and other aquatic organisms (Tennant 1975). However, in this system, post-project releases from January through April may be less than 10 percent but still represent between 60 and 122 percent of pre-project average monthly flows, respectively.

Flood flows would be modified in the regulated flow regime. Chakachatna River flood flows would be smaller in magnitude than past events, but would exhibit a greater variation around a mean flood value due to the relatively small influence of Chakachamna Lake on the post-project river system. The seasonal distribution and hydrograph shape of the annual floods may shift during the mid-summer, long duration floods under the natural flow regime, toward a fall, short duration flood more typical of basins within the storage effects of lakes and glaciers.

The sedimentation characteristics of the Chakachatna River system will change with the required flow regime. Sediment transport will drecrease in response to decreased flows.

TABLE B-1

NATURAL AND ALTERNATIVE E REGULATED MEAN MONTHLY AND MEAN ANNUAL FLOW AT THE CHAKACHAMNA LAKE OUTLET

| MONTH | NATURAL (cfs) | REGULATED[1/] (cfs) |
|---|---|---|
| Jan | 613 | 365 |
| Feb | 505 | 357 |
| Mar | 445 | 358 |
| Apr | 441 | 582 |
| May | 1,052 | 1,094 |
| Jun | 5,875 | 1,094 |
| Jul | 11,950 | 1,094 |
| Aug | 12,000 | 1,094 |
| Sep | 6,042 | 1,094 |
| Oct | 2,468 | 365 |
| Nov | 1,206 | 365 |
| Dec | 813 | 363 |
| MEAN ANNUAL FLOW | 3,645 | 685 |

1/ Regulated flows were estimated using the Montana Method.

4087A

The configuration of certain stream reaches would likely change as a result of the flow alteration associated with the project. The mountainous reaches on the Chakachatna River would retain a single channel steep gradient condition, although it would be carrying less flow. Split channel reaches would likely assume more of a meandering configuration. The braided reaches above Straight Creek and in Noaukta Slough would likely become more stable and the flow would be carried by fewer channels which are characteristics of a split configuration. The lower reaches of the Chakachatna and Middle rivers would likely retain their meandering configuration. Ice formation and breakup processes will also likely be affected by the project. The evaluation of the nature and extent of these effects has not yet been investigated.

Observations made during March and October 1982 have indicated that flow in sloughs located in the Chakachatna River canyon and at station 17 appear to be independent of river flow. It is not expected that reduced flow in the river will have an adverse effect on these water bodies.

The McArthur River will receive flows from the powerhouse ranging from a minimum of approximately 4600 cfs in July to a maximum of approximately 7500 cfs in December. Present flows in the upper McArthur River near the powerhouse are estimated to average about 600 cfs in July and 30 cfs in December. Thus, flows in this upper section will be substantially increased by the operation of the project during the entire year. The relative magnitude of increase will be less downstream of its confluence with the Blockade Glacier channels. Post-project summer flow in the McArthur River downstream of its confluence with the Noaukta Slough will be less than pre-project conditions due to the substantial decrease in flow through Noaukta Slough.

4087A

Floods on the McArthur River upstream of Noaukta Slough would be increased by the operation of the project. The amount of increase will be roughly equivalent to the modification of the base flows upon which the floods are superimposed. That is, the source of the flood waters remains unchanged, but the flow in the McArthur River as the flood begins will be greater. The relative increase in flow would decrease in a downstream direction along the McArthur River. Below its confluence with Noaukta Slough, the McArthur River would likely experience a reduced flood magnitude. This is due to the decrease of inflow from Noaukta Slough during the summer as compared with the inflow under pre-project conditions. Noaukta Slough contributes a greater mean daily flow to the McArthur River from mid-June through mid-September under pre-project conditions than the maximum that will be diverted to the MacArthur River for power generation during project operation.

The upper McArthur River will experience increased sediment transport loads due to the larger discharges in the channel. The upstream reaches will likely scour the channel bed to reduce its gradient. In addition, bank erosion will likely increase its rate and areal extent as a result of the increased flow. Flood discharges in mid-September 1982 caused bed scour and bank erosion, and transported large quantities of sediments along its channel. The magnitude of this short duration event was approximately 50 percent greater than those expected on a daily basis under post-project conditions.

The increased post-project flows in the McArthur River are not anticipated to cause significant changes in channel configuration. However, some meandering reaches, especially toward the upstream end, may assume split channel characteristics. Further analysis is required to ascertain the effects on channel configuration, of the increased sediment transport into the lower reaches of the McArthur River.

The ice processes in the McArthur River will also likely be affeced by the project. Ice formation may be reduced or possibly eliminated by the increased quantity and temperature of flow. Evaluation of these effects requires further study.

Turbidity in the McArthur River canyon would be expected to increase during the winter months. Pre-project winter flow in that area appears to be derived from upwelling and is clear. Water from the powerhouse tailrace would be expected to have a higher turbidity as is normally found in Chakachamna Lake. Turbidity in the lake varies with depth during certain times of the year but is generally similar to that measured near the powerhouse location in the McArthur River. Below the McArthur canyon, flow from the Blockade Glacier channel is also turbid and therefore effects below the confluence of that channel should be minimal.

Pre-project water temperatures in the vicinity of the proposed powerhouse location have a wide diurnal variation during the open water season. The discharge of Chakachamna Lake water during operation would tend to stabilize the temperatures. Water temperatures at the proposed lake tap depth were as follows: March - 2.1°C, August - 6.5°C, September - 6.2°C. The temperature of discharge water should be fairly constant and should reduce diurnal variation.

There may be a potential for the discharge of dissolved gases at levels greater than 100 percent of gas saturation at the powerhouse. Water discharged at the powerhouse, entrained at lake

4087A

tap depths of more than 100 ft., will undergo a pressure change of more than 3 atmospheres. The change in pressure will reduce the amount of gas that the water will hold, thus creating the potential for supersaturation to occur. Evidence of a potential for supersaturation was detected during sampling in September 1982.

## 4.3 AQUATIC ECOLOGY

The potential impacts to aquatic ecology resources from the various alternative development scenarios for the Chakachamna Hydroelectric Project are a significant factor in arriving at the preferred development scenario (Alternative E). Therefore, potential aquatic resource impacts from these scenarios are briefly described below, followed by a detailed discussion of the preferred alternative.

### 4.3.1 Chakachatna Dam Alternative

If a dam was constructed and operated on the Chakachatna River, it is likely that substantive adverse impacts would be inflicted on fish of the Chakachatna drainage. A fish passage facility would be necessary to preserve stocks of anadromous fish which spawn above Chakachamna Lake. If such passage was not provided, the 41,000 sockeye which are estimated to spawn above the lake and their contribution to the Cook Inlet Fishery would be lost. The Dolly Varden population which migrate to and spawn in tributaries above Chakachamna Lake would also be lost. If passage was maintained, impacts to those populations could be similar to Alternative E.

Siting of the dam at the mouth of the canyon would result in the loss of slough spawning habitat for coho, pink, sockeye, and chum salmon and Dolly Varden in that area.

Due to the water quality alterations in the river downstream from the dam, the use of some fish migratory and rearing habitat may be reduced. This, in turn, could adversely impact Cook Inlet commercial fishery resources. Construction impacts from this alternative would be more extensive due to increased area and materials requirements.

### 4.3.2 McArthur Tunnel Alternatives A and B

Through the implementation of Alternatives A or B, the impacts resulting from construction and logistical support activities would be very similar.

Once in operation, the increased flows in the McArthur River may result in changes in water quality and alterations in the chemical cues that direct anadromous fish to their spawning grounds. This could cause additional losses of spawning adults or reduce the productivity of spawning areas through crowding and redd superimposition. Although the possibility also exists that the population of salmon will increase in the McArthur River, predation may also increase. If large mammals begin to concentrate in these high density fish areas, sport and subsistence hunting pressure will probably also increase.

The major difference in these McArthur tunnel alternatives is that in Alternative A, no water would be provided in the upper reaches of the Chakachatna River, while in Alternative B, some flow would be maintained. Alternative A would likely result in a total loss of the population of sockeye salmon which spawn upstream of Chakachamna Lake. The estimated escapement of sockeye upstream of the lake was 41,000 fish during 1982. This would also cause the loss of their contribution (presently unknown) to the Cook Inlet fishery. In addition, because no maintenance flows would be provided below the lake, the spawning, rearing, and migration of salmon and resident fish in the Chakachatna River drainage would likely be significantly and adversely affected. Estimated escapement of salmon below the lake is over 16,000 fish which could be lost. In Alternative A there is a significant potential to drastically reduce the populations of salmon which are represented by the estimated escapement of over 57,000 salmon in the Chakachatna drainage.

Alternative A provides no fish passage to and from the lake. The sockeye salmon and Dolly Varden which spawn above the lake would not be able to ascend to the lake unless the lake level exceeded the present channel invert (El. 1128) by at least 1 ft at the lake outlet. Downstream migrants could not pass from the lake unless the water was at this level of if they passed through an outlet structure which would provide the mitigative flow. The impact of this alternative without provision for a fish passage structure could be substantial.

Alternative B would provide for year round flow releases to the Chakachatna River. Instream flows selected are approximately 30 percent of the average annual flow during May through September and approximately 10 percent of the average annual flow during the winter months, October through March. April flows are intermediate. The implementation of Alternative B should inflict less adverse impacts on the fish which spawn and rear below the lake than Alternative A. The severity of adverse effects upstream of the lake would depend on reservoir operation and the mitigative measures taken. The influence on the human resources will probably also be less severe since the commercial fishery will probably not be as heavily impacted, but the impact due to the loss of a portion of the lake tributary spawning could be substantial.

While the impacts related to Alternative A affecting local resources would be difficult to mitigate and significant changes in both the distribution and abundance of fish and wildlife populations would almost certainly occur, the impacts resulting from Alternative B would be less severe primarily through the installation of fish passage structures and maintenance of adequate downstream discharge.

It should be noted, however, that while not directly stated, the loss of spawning areas and juvenile habitat due to any of the project alternatives will most likely eventually manifest itself as a decline in the population of adult fish as well. In addition, since eggs, fry, and juveniles of all species provide food (prey) for other species, losses of spawning and nursery areas will almost certainly result in eventual reductions in the standing crop of their predators. For example, losses of juvenile sockeye salmon in Chakachamna Lake would probably also result in an overall decline in lake trout.

### 4.3.3 Chakachatna Tunnel Alternatives C and D

Through the implementation of Alternatives C or D, the impacts resulting from logistical support or construction activities would be similar. However, since all activities are restricted to the Chakachatna floodplain in these alternatives, the resources in the McArthur drainage will not be affected. Significant impacts will occur to the fisheries. Since access to Chakachamna Lake will be increased, sport and subsistence fishing pressure may increase.

During the pre-operational phases, the fishery in the Chakachamna drainage will probably only be impacted to a small extent over a relatively short term. Above the powerhouse, the impact on the Chakachatna River and Chakachamna Lake fishery will be dependent on whether flows are maintained and fish passage facilities provided. Alternative C does not allow for these mitigative measures. Therefore, the impacts to the fishery in or above the lake, and thus the wildlife and commercial fishery in the surrounding area will be similar to that inflicted through Alternative A. Since Alternative D does provide flows and migratory passages, the impacts would be similar to those described for Alternative B, but with substantially less adverse impact below the powerhouse due to the higher flows released by that facility.

### 4.3.4 McArthur Tunnel Alternative E

Construction and operation of the proposed Chakachamna Hydroelectric Project will result in changes to the aquatic habitat and associated fishery resources in the McArthur and Chakachatna rivers, Lake Chakachamna, and tributaries upstream of Lake Chakachamna, such as the Chilligan and Igitna rivers.

The construction impacts focus primarily around increased turbidity and sedimentation. Increased turbidity can reduce visibility and decrease the ability of sight-feeding fish (e.g., salmonids) to obtain food. In addition, salmonids may avoid spawning in turbid waters, and many fish, particularly older life stages, may completely avoid waters containing high turbidity. However, the turbidity increases in mainstem areas of the Chakachatna and McArthur rivers would be expected to have a lower potential for adverse effect on fish due to the naturally high turbidity levels found in these water bodies.

Siltation (sedimentation) is often associated with construction activities. Siltation and turbidity impacts have their greatest adverse effects on eggs and larval fish. In general, siltation can cause a significant loss of incubating eggs and pre-emergent fry in redds. This is generally a result of interference with water and oxygen exchange in redds. Upwelling flow in affected areas may tend to reduce such impacts by reducing the amount of sediment which settles into the redd.

Operation of the camps will also result in increased access to an area that has previously experienced relatively little fishing pressure. The areas potentially affected would be those stretches of the McArthur River and its tributaries that are easily accessible by foot from the camp.

The operation of the reservoir will have effects on the fish rearing habitat within the lake. During open water, juvenile sockeye, lake trout, round whitefish, and Dolly Varden are found throughout the lake with many fish found offshore along steep dropoffs and just under the ice in winter. It is unclear what the effect of changing water levels may have on winter water temperatures or habitat use, particularly near shore.

At high reservoir levels (during October and November) lakeshore areas may be used as spawning habitat by lake trout. After reservoir levels drop, incubating eggs and fry may be exposed to freezing or dessication. Relatively immobile invertebrates which reproduce in shoreline areas may also be affected. There are, presently, insufficient data to assess the impact of such effects on lake trout populations and standing crop of benthic invertebrates, although the effects could be substantial.

Lake levels will be near minimum level at breakup, at which time the principal movement of fish consists of emergent fry moving from their tributary rearing areas to the lake. It is not expected that the high gradients to the lake will adversely affect these migrants.

During the period in which sockeye salmon and Dolly Varden spawn in tributaries above the lake, reservoir levels will be greater than pre-project lake levels. This will potentially result in lake water flooding downstream areas of the Chilligan River and the Kenibuna Lake/Shamrock Lake rapids. The effect of the lake water on the utilization of the lower areas of the Chilligan River is not presently known but there is some evidence that this may not be an important effect. The area at the mouth of the river contained a low density of spawning sockeye compared to areas further upstream. It was used extensively as a milling area. During September 1982, lake water inundated the area without apparent impact on either sockeye or Dolly Varden spawning. Adverse effects would be expected if flooding of the lower Chilligan River resulted in increased siltation which could affect hatching success.

The lake tap (or multiple lake taps) will withdraw water at approximately El. 974. The submergence depth would vary between 109 ft and 181 ft. Fish that are entrained into the lake tap would be exposed to turbine passage at the powerhouse and most would be expected to be killed by the turbines, or during passage through the pressure differential between the depth of the lake tap and the power plant. Juvenile sockeye and both juvenile and adult lake trout, Dolly Varden, and round whitefish may be vulnerable.

Hydroacoustic observations of fish distribution in the lake have indicated that most fish were detected well above the depth of the lake tap. During the winter, over 99 percent of fish were detected in the upper 50 ft of the water column. During September 1982, over 88 percent of the fish detected were in water at least 60 ft above the proposed lake tap (at that time of year it would have been located at 181 ft) with no fish detected below 161 ft. Thus, potential loss of fish due to the lake tap based upon current data would be relatively low. However, additional seasonal information would be needed to quantify potential losses.

This alternative includes a fish passage facility which is designed to permit upstream migrants to ascend from the Chakachatna River to the lake and to allow downstream migrants to pass from the lake to the Chakachatna River. The facility is composed of components found in a variety of existing fish passage facilities. Presently, there are insufficient data available to assess the potential effects of this facility on migrating fish in a quantitative manner.

Sockeye salmon and Dolly Varden would be expected to use this facility, as both have been observed to spawn above the lake. Escapement estimates of sockeye indicate that (based upon 1982 data) over 41,000 sockeye (possibly more depending upon yearly variation) would need to successfully pass through the facility to migrate upstram. Since the percentage of the run successfully reaching the Chilligan and Igitna Rivers is not known, the true extent of the sockeye salmon resource can only be estimated. From 10 to more than 100 times as many sockeye can be expected to migrate downstream due to the normally higher production of young fish. A smaller number of downstream Dolly Varden would also be expected to pass through the facility. If the facility works as planned the impact to the sockeye run should be low.

If the facility did not successfully allow the migration of sockeye both upstream as adults and downstream as juveniles, then some part of the estimated adult spawning population would be expected to be lost, as well as a portion of its presently unknown contribution to the Cook Inlet fishery.

The release of water from Chakachamna Lake into the McArthur system could potentially result in impacts to fish which would normally spawn in Chakachamna Lake and tributaries above it. While the "homing" of salmon is not completely understood, the orientation of upstream migrants to olfactory cues originating in natal streams has been considered to be a principal factor. Fish entering the system through the Middle River should not be affected by the McArthur release. Fish entering the system through the mouth of the McArthur River may encounter olfactory cues from flows entering the McArthur River at the confluence of the lower Chakachatna with the McArthur River, from the confluence of the Noaukta Slough with the McArthur River, and from water discharged from the tailrace of the power plant located in the McArthur canyon. Fish that entered the Chakachatna River either at the lower river confluence, or the Noaukta Slough would be following what is hypothesized to be the present migratory pathway and would not be expected to be significantly affected by the other power plant discharge; some delay due to confusion may occur. There is a potential for some of the upstream migrants to be attracted to the tailrace in the McArthur canyon. Since the fish could not migrate further upstream into Chakachamna Lake, three basic scenarios could develop: the fish could back down the system until they detect alternate olfactory cues (i.e., at the Noaukta Slough) and then migrate up the Chakachatna River; the fish could mill in the tailrace until sexually matured and then back down the system until alternate cues were detected; or the fish could spawn in the McArthur Canyon.

The significance of a delay in migration is not presently known. However, the spawning of large numbers of lake tributary origin sockeye in the McArthur River canyon area would result in low egg hatching success due to high densities of spawning fish and resulting redd superimposition, the use of poor spawning habitat, or females not spawning. In addition, the rearing habitat in the McArthur canyon is probably less suitable for sockeye salmon than Chakachamna Lake. Thus, if increased spawning occurred in this area, rearing would probably be less successful.

The mainstem habitats appear to be currently used as migratory pathways, rearing areas for sub-adult and resident fish, and there appears to be a small amount of side channel spawning associated with areas of upwelling or slough flow. Table B-2 lists estimated escapements of fish species for water bodies in the Chakachatna River drainage, classified as to whether the water body is likely to be affected by the reduced mainstem flow. The tributary water bodies are not expected to be significantly affected by reduced flows.

Side channels in the Straight Creek mouth area and at station 17 are expected to be most affected. Observations during 1982 have indicated that these areas will probably not be dewatered or perched. The observations have indicated that turbid mainstem overflow, which is present in these areas during higher flows, would be absent. Without the cover provided by this turbid flow, fish spawning in these areas may be more vulnerable to predation. Side channel spawning in both areas represents less than 50 percent of observed spawning at each site. Depth of water at entry points to side channels at station 17 would be expected to be shallow and may adversely affect fish entry.

Based upon 1982 observations, the milling areas at Tributary C1 and at the mouth of the Chakachatna canyon sloughs would be significantly less turbid than at present. This may also increase potential vulnerability to increased predation. The extent of the potential increase in vulnerability to predation of spawning adults

TABLE B-2

ESTIMATED ESCAPEMENT OF IMPORTANT FISH SPECIES IN THE CHAKACHATNA RIVER SYSTEM BY WATER BODY CLASSIFIED BY POTENTIAL EFFECTS OF DECREASED FLOW OF WATER FROM CHAKACHAMNA LAKE

| Species | POTENTIALLY AFFECTED WATER BODIES: More Affected: Straight Creek Mouth | POTENTIALLY AFFECTED WATER BODIES: More Affected: Chakachatna Bridge Side Channels and Sloughs | POTENTIALLY AFFECTED WATER BODIES: Less Affected: Chakachatna Canyon Sloughs | POTENTIALLY AFFECTED WATER BODIES: Less Affected: Chakachatna Tributary (C1) | POTENTIALLY NON-AFFECTED WATER BODIES: Igitna River | POTENTIALLY NON-AFFECTED WATER BODIES: Chilligan River | POTENTIALLY NON-AFFECTED WATER BODIES: Straight Creek | POTENTIALLY NON-AFFECTED WATER BODIES: Straight Creek Clearwater Tributary |
|---|---|---|---|---|---|---|---|---|
| Sockeye Salmon | 203 | 1,193 | 392 | 238 | 2,781 | 38,576 | 0 | 254 |
| Chinook Salmon | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1,422 |
| Pink Salmon | 0 | 59 | 279 | 0 | 0 | 0 | 0 | 7,925 |
| Chum Salmon | 152 | 1,482 | 121 | 165 | 0 | 0 | 0 | 0 |
| Coho Salmon | 76, | 1,560 | 608 | 183 | 0 | 0 | 0 | 172 |
| Dolly Varden | | X[1/] | X | X | X | X | | X |

1/ X = Used as spawning areas.

at these sites will need to be assessed after more data are collected.

There are a number of fish species which use mainstem and side channel areas as rearing habitat. The effect of decreased flow on the availability and suitability of this habitat cannot be determined at this time. While decreased flow will decrease the wetted perimeter and therefore the area of the stream, the decrease is not linearly proportional to the decrease in flow. Additional sources of inflow, including sloughs and tributaries such as Straight Creek, should result in somewhat increased flow downstream of the outlet structure. The additional water sources (Straight Creek, various sloughs, and unnamed tributaries) will reduce effects of the decrease in upstream releases. In areas where pre-project water velocities are too great to contain suitable rearing habitat, decreased velocities could potentially increase suitable habitat. Presently, there are insufficient data to evaluate all expected changes.

Decreased flows during winter may cause changes in the ice conditions and also result in decreased overwintering habitat. The actual nature and extent of effects cannot be determined from available data but a significant decrease in mainstem overwintering habitat is likely during the early winter. The overwintering habitat in sloughs should not be affected by reduced flow in the mainstem of the river.

Downstream migrants originating in the Chakachatna drainage may require high seasonal breakup flows to trigger their migration; proposed post-project discharges may not be sufficient to trigger this behavior. However, post-project releases during April and May are greater than pre-project flows and depending upon the timing of outmigration may be sufficient to trigger the downstream movement. Data collected during 1982 suggest that outmigration of chum salmon and some sockeye occurs during late May and early June. Collections made during the summer and fall and in the Susitna drainage suggest downstream migration and smoltification of coho, chinook, and sockeye salmon continues throughout the summer and fall. Overall, available data do not suggest that an adverse effect would be expected on stimulation of downstream migration.

Mainstem areas of the McArthur River appear to be used as migratory pathways for sub-adult and residential adult rearing, and for spawning in the McArthur River canyon.

Table B-3 lists escapement estimates of major species that spawn in the McArthur River drainage by water body. The only area in which spawning habitat of these species is likely to be affected is in the McArthur canyon. All other listed areas are tributaries. Spawning habitat in sloughs and side channels of the McArthur canyon occur upstream of the powerhouse tailrace. It is unlikely that these areas will be significantly affected. Based upon 1982 escapement estimates, a relatively small percentage of spawning salmon will be vulnerable to changes in mainstem flow. Some fish that normally spawn above Chakachamna Lake may be attracted to the powerhouse tailrace which may affect spawning adults of McArthur origin.

The redistribution of substrate in the powerhouse area may also affect spawning. Presently, there are insufficient data to determine if the effect would be beneficial or adverse to the availability of habitat to spawning adults.

Eulachon spawn in the lower reaches of the McArthur River mainstem, below the Noaukta Slough. Flow alterations are not expected to

TABLE B-3

ESTIMATED ESCAPEMENT OF IMPORTANT FISH SPECIES IN THE MCARTHUR RIVER SYSTEM
BY WATER BODY CLASSIFIED BY POTENTIAL OF INCREASED FLOW OF WATER

| | POTENTIALLY AFFECTED AREA | POTENTIALLY NON-AFFECTED AREAS | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Streams | | | | | |
| Species | McArthur Canyon | Stream 13X | Stream 130 | Combined | 12.1 | 12.2 | 12.3 | 12.4 | 12.5 |
| Sockeye Salmon | 666 [1] | 5,416 | 1,213 | 27,636 | 16,711 [2] | 6,085 [2] | 2,512 [2] | 2,328 [2] | - |
| Chinook Salmon | 0 | 452 | 1,633 | 22 | - | 22 [3] | - | - | - |
| Pink Salmon | 60 | 4,225 | 5,402 | 10,090 | 8,499 [2] | 1,566 [2] | 4 [2] | 18 [2] | 3 [2] |
| Chum Salmon | 1 [4] | 0 [1] | 23 [1] | 5 [1] | 4 [5] | - | - | 1 [5] | - |
| Coho Salmon | 1,182 [1] | 1,378 [1] | 32 [1] | 2,137 [1] | 2,000 [1] | 46 [1] | 89 [1] | - | - |
| Dolly Varden | X [6] | X | X | X | X | X | X | X | X |

1 Based on 10 day stream life.
2 Based on 6 day stream life.
3 Based on count of live and dead fish.
4 Based upon 10 day stream life.
5 Based on peak on total counts.
6 X = Probably spawning areas.

affect spawning of this species because during the period of eulachon spawning, the continued post-project McArthur River and Noaukta Slough flows are expected to be similar to pre-project flows.

There are a number of fish species which use mainstem habitats in the McArthur River for rearing habitat. Presently, the effect of changes in the flow regime in different reaches of the river at different times of year cannot be determined. Changes in wetted perimeter, depth, and velocity for different areas will affect the overall total suitable area for each species and lifestage. Thus, suitable habitat may increase, decrease, or remain the same. This will also need to be assessed.

Increased flow in the McArthur canyon from the power plant discharge may affect available overwintering habitat in the McArthur drainage. Data collected during 1982 indicate that the McArthur canyon and areas below it may be used as overwintering areas. Increased flow and depth may increase the overwintering area available. Insufficient data are available to assess such changes.

Water discharged from the powerhouse will probably be warmer than water of McArthur origin; 2.1°C, as compared with 1.2°C, respectively, during March 1982. This may result in greater metabolic activity by fish and other aquatic biota during the winter, and result in more rapid incubation and earlier emergence times for McArthur canyon fish. Such emergence times would be similar to those found in the Chakachatna River. It is unclear from present data whether this will have an adverse effect.

Increased post-project turbidity during the winter months should not have a significant adverse effect on fish in the McArthur canyon. Turbidity levels should be similar to those measured in this area

4087A

during the spring through fall, and it would be expected that fish are well adapted to them.

If supersaturation occurs it could have adverse effects on fish in the immediate area of the discharge unless mitigative measures are taken. Some sloughs in the immediate vicinity of the tailrace of the power plant may become inundated and water velocities may increase. These changes may affect the suitability of these habitats. The extent of such changes cannot be determined at this time. No significant changes would be expected in McArthur River tributaries due to post-operational flows based upon current data.

## 4.4 TERRESTRIAL ECOLOGY

The development of a hydroelectric power project at Chakachamna Lake will result in changes in the distribution and species composition of vegetative communities. Based upon current designs for Alternative E, these changes would occur over a relatively small portion of the project area. Changes that do occur may be beneficial or detrimental to the biota depending upon the type of changes as well as the location, duration, and magnitude of change.

Construction of a rockfill dike and fish passage facility in the upper Chakachatna River canyon and a powerhouse in the McArthur River canyon will necessitate the removal of vegetation over a relatively small area. The powerhouse and fish passage facility will be primarily underground, thus minimizing surface disturbance. The rockfill dike will be sited in the upper reach of the Chakachatna canyon where the floodplain is unvegetated and the canyon walls and glacial moraine support Sitka alder and willow which are abundant throughout the project area. The areal extent of vegetation removal during road, camp, airstrip, and borrow pit development is not yet known because the location and size of these facilities have not been sufficiently defined.

The most notable changes in the distribution of vegetation will likely occur in the lower McArthur River and Chakachatna River canyons. In the lower McArthur canyon, increased flows emanating from the tailrace and the deposition of excavated materials within the floodplain near the powerhouse may reduce the extent of riparian vegetation. In the Chakachatna canyon below the dike, reduced flows may enable riparian vegetation to become established within what is now the active floodplain. In time, if these riparian thickets do expand, additional habitat for moose, songbirds, and furbearers may be provided.

Disposal of materials excavated from the power tunnel and fish passage facility will be stockpiled in the floodplain above the dike, When the dike is completed and the lake level raised to an elevation of 1155 ft, this disposal area, as well as portions of the lakeshore will be flooded. In the area subjected to the annual fluctuations of lake water levels, portions of the Nagishlamina, Chilligan, and other smaller lake tributary deltas will most likely realize a change in their vegetative cover. Vegetation may recede due to inundation and shoreline destabilization. However, such changes are expected to influence only a small area since under pre-project conditions, the lake level occasionally reaches elevations at or near 1155 ft. Above the high water level, the shore may also develop a different species composition; one more representative of early seral stages and wetter soil conditions. The anticipated changes in riparian and shoreline vegetation cannot be further refined until site specific, field verified, habitat maps have been prepared and the operating reservoir levels better defined.

4087A

Downstream from the McArthur and Chakachatna canyons, the influence of altered flows, either increased or decreased, on riparian vegetation will depend upon the direction and magnitude of channel migrations and the amount of floodplain area removed from the influence of flood events. Based upon current information, the McArthur River channel above Noaukta Slough has been naturally migrating and some rechanneling has occurred in the slough under normal flow conditions. Sustained higher flows in the upper McArthur River may result in accelerating this migration. The extent of channel migration is also dependent upon floodplain substrate on these parameters, the speed, direction, and magnitude of migration in the upper McArthur River cannot be assessed. The influence of reduced flows in the Chakachatna River and Noaukta Slough may be to reduce the frequency and magnitude of rechanneling in the slough and to remove portions of the now active floodplain from the influence of flood events. Based upon current information, it is not possible at this time to estimate the location, extent, or timing of revegetation.

The influence of wind or vehicle generated dust emanating from cleared areas, roads, and borrow pits may influence the vegetative community composition in the immediate vicinity of these facilties. Accumulations of dust may accelerate the rate at which snow melts and affect the growth of cottongrass and mosses. The extent of vegetation changed due to accumulations of dust will be dependent upon the methods and level of effort exerted to reduce dust.

Off road use of vehicles in the project area may affect vegetation depending upon the type of vehicle, the time of year, and soil moisture conditions. Currently, no policy exists to control or permit off road use of the site.

4087A

The construction and operation of the Chakachamna Lake Hydroelectric project will also affect the wildlife resources of the area. Direct habitat losses due to facility siting will occur with construction of the dike, disposal areas, powerhouse, fish passage facility, camps, roads, airstrip, port and docking facilities, and borrow pits. The influence of this habitat loss on wildlife populations should be negligible. The dike will be sited at the outlet of Chakachamna Lake; an area that receives little use by birds and mammals. The powerhouse and fish passage facility will be located in the McArthur River and Chakachatna River canyons, respectively. Because these facilities will be primarily underground, relatively small quantities of surface habitat will be lost. Although the exact size and precise location of the remaining facilities have not been determined, each will occupy a relatively small amount of habitat in an area that is not considered to be essential to any species of bird or mammal. Development of disposal areas in both the McArthur and Chakachatna floodplains will result in the largest habitat loss, and greatest disturbance to birds and mammals. Without proper site selection, stockpile design, and erosion control, this disposal could significantly alter valuable riparian habitats, and detrimentally affect wildlife species that rely upon these habitats. Moose, ptarmigan, small mammals, and passerine birds would be most likely affected from substantial floodplain habitat alterations.

In the vicinity of the lake above the dike, fluctuating water levels may have several implications. As the lake level is lowered during the winter, ice along the shore will most likely fracture, eventually resulting in a zone of broken ice that may prevent some large mammals from venturing out onto the frozen lake surface. Moose, bears, wolves, and small mammals are the primary inhabitants of the lake shore during winter. However, the degree to which these mammals use the frozen lake surface will need to be established. During the ice free period, a variety of birds and mammals use the shore of the lake. The higher, fluctuating water level during this period may alter small areas of shoreline habitat but should not significantly influence the overall use of the shore by these wildlife.

Construction activities occurring in the Chakachatna River and McArthur River canyons may influence the apparently limited use of the canyons by mammals and birds. The canyons are used by eagles, bears, furbearers, moose, and passerine birds. Near the construction sites, increased levels of noise from heavy equipment and blasting may discourage eagles, moose, and bears from using adjacent areas. However, other mammals, including furbearers and small birds appear to have a higher tolerance for human disturbance and may not substantially alter their distribution. This influence of noise and disturbance on wildlife populations in the canyons should be limited to the construction period.

Below the canyons, wildlife activity is more abundant and diverse. In these areas, a variety of wildlife species could be influenced by construction activities. Due to increased levels of noise and disturbance, sensitive species such as moose, grizzly bears, gray wolves, eagles, and swans may discontinue their use of the affected area. Other species, including coyotes, ducks, and other small birds, are more tolerant of disturbance and will probably not alter their distribution. If avoidance of a contruction area occurred it would most likely be temporary with individuals returning to the area soon after noise and activity levels subsided. However, if areas used by wildlife for important life functions are abandoned, a decrease in the abundance of some local species may be noted. To evaluate which species may be affected and to what extent, it will be necessary to establish the use and importance of the Chakachatna and McArthur floodplains to wildlife.

The alteration of habitat and wildlife distributions below the canyons during the operation of the project may be evident as a result of changes in the vegetation communities or as changes in the abundance or distribution of prey (particularly anadromous fish). Changes in the distribution of vegetation will probably not result in significant changes in the distribution of wildlife populations. Channel migration along the upper McArthur River and rechanneling in Noaukta Slough may erode relatively small areas of riparian vegetation. This may displace a few individuals, but overall abundance of a wildlife population in the project area should not be significantly changed. Likewise, a small increase in the abundance of floodplain riparian vegetation along the Chakachatna River will probably not result in a significant change in wildlife species diversity or abundance in this drainage. The anticipated changes may be more clearly defined by acquiring information on the extent of channel migration, revegetation, and the use of riparian areas for denning, wintering, breeding, and calving.

It is unlikely that minor changes in anadromous fish abundance and distribution will have a significant effect on the distribution of either birds or mammals. Several species of wildlife feed on anadromous fish. Although bears and eagles are the most visible, mink, harbor seals, and beluga whales also consume fish originating in the Chakachatna or McArthur drainages. The degree to which these species will be affected can be evaluated by investigating the anticipated changes in fish distribution or abundance and the reliance of wildlife on this resources. Based upon the anticipated change in anadromous fish abundance and the opportunistic nature of

4087A

the wildlife species involved, no significant change in the abundance of distribution of wildlife is currently expected to occur in either the Chakachatna or McArthur drainage as a result of this project.

Increased access to the area will affect wildlife populations by two means; increased disturbance from construction activities, and increased local hunting (sport and subsistence) pressure. By utilizing the existing road network for construction and operation in the Chakachatna drainage, only a slight increase in vehicle related disturbance to wildlife should occur. However, through the construction and use of two road extensions to access the McArthur drainage and Chakachatna canyons, there will likely be a short term reduction in the use of areas adjacent to these roads by species that are sensitive to traffic, particularly moose, bears, wolves, eagles, and swans. The extent of this influence will depend upon the location of moose wintering and calving grounds, the location of brown bear, black bear, wolf, and wolverine denning sites, and the location of swan and eagle nesting, brood rearing, and fall staging areas. Future studies will be needed to identify the locations of these important habitats and to allow for more definitive assessments.

Whether local wildlife populations are influenced by increased hunting pressure will depend upon the magnitude of the hunting increase and the level of road access allowed. Currently no policy affecting access of the project area has been outlined.

The influence on wildlife of constructing and maintaining a transmission line and the likelihood of bird collisions or electrocutions with the lines will be dependent upon the species inhabiting the area, transmission line design, and construction and

4087A

maintenance techniques. Until this information is available, these effects cannot be measured.

## 4.5 SOCIOECONOMIC FACTORS

The socioeconomic impacts of the proposed Chakachamna Hydroelectric development are significant. The construction and operation of a large hydroelectric plant has a high potential to cause a boom/bust cycle, causing significant impact on community infrastructure. The site is located at or near communities with a population of less than 500. An inmigration of approximately 250 workers will be necessary for construction. In some of these remote communities, the population would more than quadruple. The installation of a construction camp would not mitigate the impacts on the social and economic structure of a community.

The expenditures that flow out of the region account for investment in equipment and supervisory personnel. For this large scale project, a larger proportion of the expenditures can be attributed to the civil costs. Approximately 35 percent of an investment in the project will be made outside the region while 65 percent will be made within Alaska. The breakdown of operating and maintenance expenditures for a hydroelectric project will be approximately 11 percent spent outside the state and 89 percent spent within the region.

This project will also create impacts due to improved access and the potential for increased recreational activities (e.g., hiking, fishing, hunting). The extent of this impact is unknown at this time, but is likely to be secondary to the boom/bust construction activities.

## 4.6 AESTHETIC FACTORS

The potential aesthetic impacts of the proposed Chakachamna Hydroelectric development are significant, particularly from a visual standpoint. Potential fluctuations in Lake Chakachamna levels will leave exposed lakeshore (bottom) at certain periods. Significant reduction in outflows will result in the loss of much of the white water reach of the Chakachatna River canyon, as well as noticeable alterations to the floodplain. Disposal areas in McArthur valley will be noticeable, and together will support facilities (roads, powerhouse, etc.) will result in degradation of the aesthetic character of pristine wilderness landscapes.

4087A

## 5.0 SUMMARY AND CONCLUSIONS

The environmental and socioeconomic effects of the above described development scenarios are substantial and extremely varied. Table B-4 presents a summary of some of the environment-related facility characteristics of these alternatives. Based upon these data, together with the detailed discussions presented in the individual environmental sections, relative environmental impacts by category for location and technology options are summarized in Table B-5.

The ranking values within an individual category are unweighted with respect to another category. For example, a moderate impact to water resources may be more significant than a high impact to aesthetics.

It is apparent that there is no one superior project alternative in terms of minimizing environmental impacts in all categories. Rather, many impacts are a function of specific site selection, detailed engineering and extent of mitigative measures. Compliance with regulatory criteria and good engineering practices should minimize most impacts. To further differentiate between alternatives from an environmental standpoint would require weighting of factors between categories, an involved process which requires input from all parties who have an interest in or who may be affected by project development.

TABLE B-4

ENVIRONMENT RELATED FACILITY CHARACTERISTICS FOR ALTERNATIVE POWER GENERATION OPTIONS

| Environmental Factor | Location/Technology | | | | | | |
|---|---|---|---|---|---|---|---|
| | Beluga (Coal Fired) | Nenana (Coal Fired) | North Slope (Nat. Gas) | Fairbanks (Nat. Gas) | Kenai (Nat. Gas) | Beluga (Nat. Gas) | Chakachamna (Hydro) |
| **Air Environment** | | | | | | | |
| Emissions | | | | | | | |
| Particulate Matter ($lb/10^6$ Btu) | 0.03 | 0.03 | a/ | a/ | a/ | a/ | Negligible |
| Sulfur Dioxide ($lb/10^6$ Btu) | 0.6 b/ | 0.06 b/ | a/ | a/ | a/ | a/ | |
| Nitrogen Oxides ($lb/10^6$ Btu) | 0.6 | 0.6 | c/ | c/ | c/ | c/ | |
| Physical Effects-(max. struct. height ft.) | - | - | 50 | 50 | 50 | 50 | |
| **Water Environment** | | | | | | | |
| Plant Water Requirements (gpm) | 287 d/ | 287 d/ | 25-50 | 100-200 | | | |
| Water Injection | | | | | 500-800 | 500-800 | 1.64 million (ave) |
| Other | | | | | 200 | 200 | |
| Plant Discharge Requirements (gpm) | | | 50 | 200 | | | |
| Process Water | None | None | | | | | |
| Coal Pile Runoff | Infrequent | Infrequent | | | | | |
| Demineralizer | | | | | 40 | 40 | 1.64 million (ave) |
| Stream Generators | | | | | 70 | 70 | |
| Treated Sanitary Waste | | | | | 15 | 15 | |
| Floor Drains | | | | | 25 | 25 | |
| **Land Environment** | | | | | | | |
| Land Requirements (acres) | | | | | | | |
| Plant | 25 | 25 | 60-90 e/ | 90-140 | 120-175 | 120-175 | 40 mi, road |
| Construction Camp | - | - | 5 | 5 | - | - | |
| Solid Waste Disposal | 50 | 50 | | | | | |
| **Socioeconomic Environment** | | | | | | | |
| Construction Workforce, peak (personnel) | 500 | 500 | 115-200 | 100-200 | 200 | 200 | 1,220 |
| Operating Workforce (personnel) | 109 | 109 | 140-200 | 50-150 | 130-150 | 130-150 | 1-2 |

a/ Below standards
b/ Assumes 70% Reduction
c/ Emissions variable within standards. Dry control techniques would be used to meet calculated $No_x$ standard of 0.014 percent of total volume of gaseous emissions. This value calculated based upon new source performance standards, facility heat rate and unit size.
d/ Dry Cooling. Wet Cooling = 1,947 gpm
e/ Includes Switchyard

TABLE B-5

QUALITATIVE RANKING OF ENVIRONMENTAL IMPACTS ASSOCIATED WITH ALTERNATIVE PROJECTS

| Environmental Category | Location/Technology | | | | | | |
|---|---|---|---|---|---|---|---|
| | Beluga (Coal Fired) | Nenana (Coal Fired | North Slope (Nat. Gas) | Fairbanks (Nat. Gas) | Kenai/Nikiski (Nat. Gas) | Beluga (Nat. Gas) | Chakachamna (Hydro) |
| Air Resources | 2 | 4 | 2 | 3 | 1 | 1 | 0 |
| Water Resources | 3 | 1 | 1,2 | 0,2 | 0,2 | 2 | 4 |
| Aquatic Ecology | 0 | 0 | 1,2 | 0,2 | 1,2 | 0 | 4 |
| Terrestrial Ecology | 2 | 2 | 1,3 | 0,3 | 0,3 | 1 | 2 |
| Socioeconomics | 4 | 1 | 1,2 | 0,2 | 1,2 | 3 | 3 |
| Aesthetics | 3 | 2 | 1,4 | 1,3 | 1,3 | 2 | 3 |

NOTE: In cases where two numbers appear, the first number refers to the power plant only, while the second number incorporates secondary support facility impacts (e.g., gas line, transmission line).

Key: 0 - no impact
1 - low impact
2 - moderate impact
3 - high impact
4 - severe impact

## 6.0 REFERENCES


Alaska Power Authority. 1983a. Before the Federal Energy Regulatory Commission application for license for major project - Susitna Hydroelectric Project. Volume 1 -Initial Statement. Exhibit A, C, D. Alaska Power Authority. Anchorage, Alaska.

Alaska Power Authority. 1983b. Use of North Slope gas for heat and electricity in the Railbelt - final report. Ebasco Services, Inc. Bellevue, Washington.

Bonneville Power Administration. 1981. Underground cable systems: Potential environmental impacts, Draft Report. Bonneville Power Administration, Washington, D.C.

Bureau of Land Management. 1980. The utiliy corridor, land use decisions. U.S. Department of the Interior, Bureau of Land Management, Fairbanks, Alaska.

Commonwealth Associates, Inc. 1982. Environmental Assessment Report for the Anchorage-Fairbanks Transmission Intertie. Alaska Power Authority, Anchorage, Alaska.

Dvorak, A.J. 1978. Impacts of coal-fired plants on fish, wildlife, and their habitats. Argonne National Laborator, Office of Biological Services and Environmental Contaminants Evaluation of the Fish and Wildlife Service. U.S. Dept. of the Interior. Argonne, Ill.

Ebasco Services Incorporated. 1981a. Railbelt electric power alternatives study, technology assessment profile report. Ebasco Services Inc. Bellevue, Washington.

Ebasco Services Incorporated. 1981b. Railbelt electric power alternatives study, coal fired steam electric alternative. Ebasco Services Inc. Bellevue, Washington.

Ebasco Services Incorporated. 1981c. Railbelt electric power alternatives study, natural gas combined cycle alternative. Ebasco Services Inc. Bellevue, Washington

Ebasco Services Incorporated. 1982. Railbelt electric power alternatives study, Chakachamna Hydroelectric alternative. Ebasco Services Inc. Bellevue, Washington.

Kim, K.B., E.F. Dul, and J.N. Brogard. 1975. Water and wastewater management at fossil fueled power generating stations. Proceedings of the American Power Conference. Illinois Institute of Technology. Chicago, Ill.

Leopold, A. and F. Darling. 1953. Effects of land use on moose and caribou in Alaska. Transactions of the North American Wildlife Conference. 18:553-582.

Nelson, G.R. 1974. Water recycle/reuse possibilities: power plant boiler and cooling systems. U.S. Environmental Protection Agency. Pacific Northwest Environmental Research Laboratory. Corvalis, Oregon.

North Slope Borough. 1978. Coastal management program, Prudhoe Bay Area. North Slope Borough, Barrow, Alaska.

Selkregg, L. 1974. Alaska regional profiles: Vol. 1, Southcentral region, Vol. 2, Yukon region. Arctic Environmental Information and Data Center, University of Alaska. Anchorage, Alaska.

Spencer, D.L., and E.F. Chatelain. 1953. Progress in the management of the moose of South Central Alaska. Transactions of the North American Wildlife Conference. 18:539-552.

University of Alaska, Arctic Environmental Information and Data Center. 1974. Alaska Regional Profiles, Southercentral Region. State of Alaska, Office of the Governor, Juneau, Alaska.

4095A