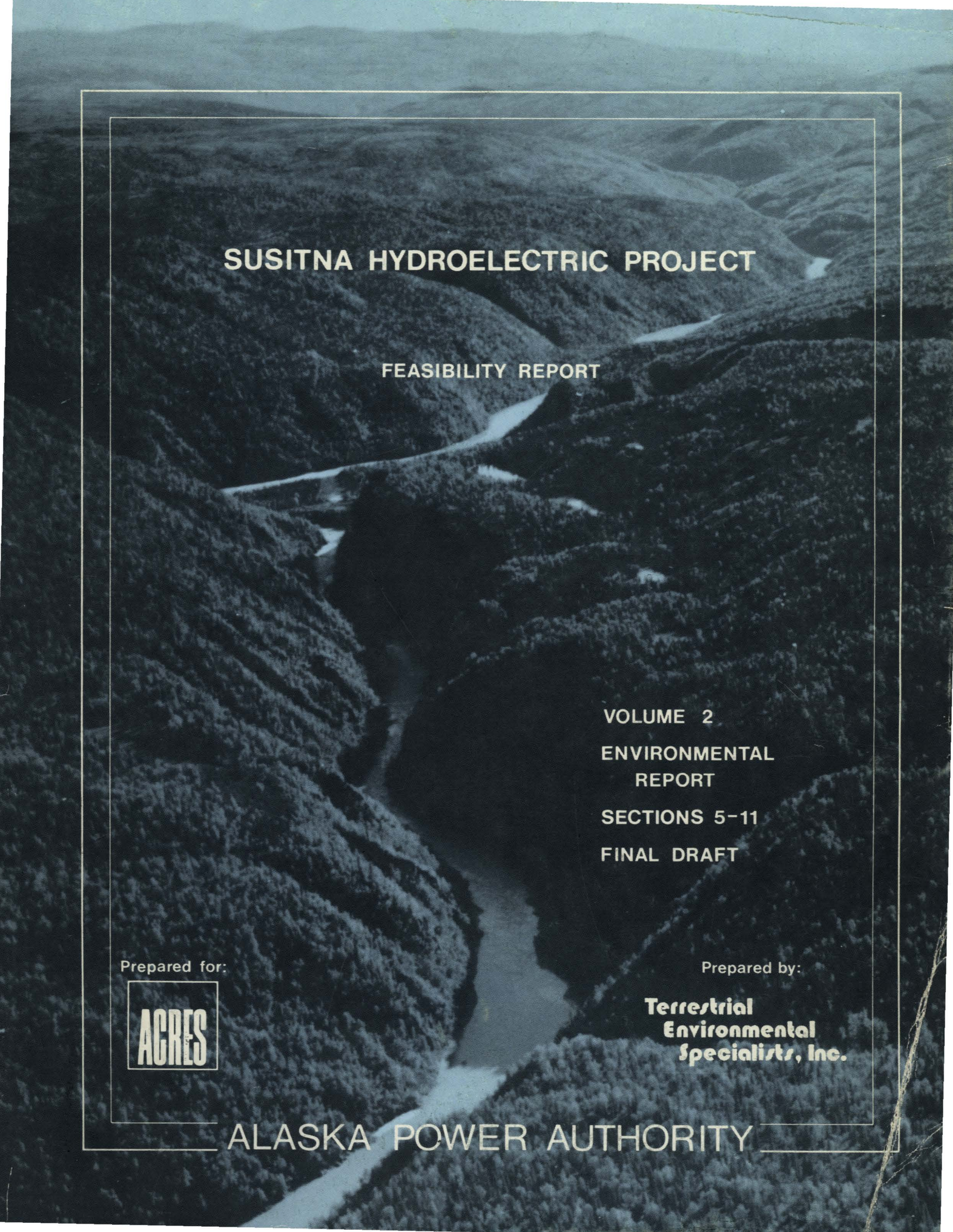

SUSITNA HYDROELECTRIC PROJECT

FEASIBILITY REPORT

VOLUME 2

ENVIRONMENTAL REPORT

SECTIONS 5-11

FINAL DRAFT

Prepared for:

ACRES

Prepared by:

Terrestrial Environmental Specialists, Inc.

ALASKA POWER AUTHORITY

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5 - REPORT ON SOCIOECONOMIC IMPACTS

This socioeconomic analysis is designed to provide an assessment of socioeconomic changes that could occur if hydropower is developed from the Susitna River. The analysis involved: 1) a literature review; 2) determination of data availability; 3) definition of impact areas; 4) a description and analysis of baseline conditions and trends; 5) development of baseline forecasts; 6) development of impact forecasts; 7) a comparison of baseline and impact forecasts; and 8) determination of significance of project socioeconomic changes. The availability of time-series data for different geographic areas of Alaska was determined. The data available limited the choice of assessment methods because it was not possible to collect a significant amount of primary data.

Impact areas were defined based upon data availability, worker residence and commuting patterns and probable locations of most socioeconomic changes. Because this project involves a construction community and due to the vastness of Alaska, the impact areas defined in this study are larger than most impact areas reviewed in the literature.

To better understand the impact areas and make baseline forecasts, recent socioeconomic conditions were described and analyzed. These included employment, population, income, housing, facilities and services, fiscal aspects, land use, and other socioeconomic elements.

Baseline forecasts were made for each socioeconomic element. Baseline forecast refers to forecasting the baseline socioeconomic elements over time given anticipated growth in the absence of the construction of the hydroelectric project. A brief description of the forecasting technique used for each element and sub-element is displayed in this section. Forecasts were made for the years 1981-2000.

Impact forecasts, which refer to forecasting changes in socioeconomic conditions caused by construction of the hydroelectric project, were also made for each socioeconomic element listed above. An accounting model was developed to accommodate the several labor categories and geographic disaggregations. This model was computerized to provide for efficient analysis and to make sensitivity analysis feasible. A brief description of the impact forecasting techniques used for each element and sub-element is shown on the following page. The impact forecasts were made from 1983, the year in which construction is to begin, to 2000.

Finally, baseline and impact forecasts were compared and contrasted to identify project-induced changes in the forecast baseline conditions. The significance of these changes are analyzed and discussed in the final section of this report.

BASELINE FORECASTING TECHNIQUES

ELEMENT	FORECASTING TECHNIQUE
EMPLOYMENT	
State and Region	Time-series econometric [a]
Census Division	Linear regression
POPULATION	
State and Region	Time-series econometric [a]
Census Division	Linear regression
Community	Population Share (judgmental)
INCOME	
State, Region and Census Division	Trend analysis and judgment
HOUSING	
Region and Census Division	Person per household trend multiplier
FACILITIES AND SERVICES	
Census Division and Community	Per capita planning standards
FISCAL	
Census Division and Community	Per capita multiplier

IMPACT FORECASTING TECHNIQUES

ELEMENT	
EMPLOYMENT	
State, Region and Census Division	Accounting model
State and Region	Time-series econometric (for comparison purposes only) [a]
POPULATION	
State, Region and Census Division	Accounting model
State and Region	Time-series econometric (for comparison purposes only) [a]
INCOME	
State, Region and Census Division	Accounting model
HOUSING	
Region and Census Division	Person per household trend multiplier
FACILITIES AND SERVICES	
Census Division and Community	Per capita planning standards
FISCAL	
Census Division and Community	Per capita multiplier

a. Results from Institute of Social and Economic Research's Man-in-the Arctic Model, October, 1981.

5.1 - Summary of Impacts

Potential impacts of the Susitna Hydroelectric Project are summarized below. The magnitude and geographic distribution of these impacts are determined in large part by a series of judgments and assumptions. Some of the key assumptions include: (1) the number of construction workers that will relocate from outside the Railbelt region (Impact Area 3) or outside Alaska to communities in the Railbelt region; (2) the number of workers that will relocate from various areas of the Railbelt region to communities of the Matanuska-Susitna (Mat-Su) Borough; and (3) the number of workers that will remain at place of relocation after construction employment is terminated. These and other assumptions are elaborated upon in Section 5.4.

- The project will provide approximately 6,365 new jobs at the peak of construction activity in 1990; of this amount, 3,500 will be on-site and 2,865 will be direct and induced.

- Between 1983 and 2002, an estimated $418 million will be spent in the Railbelt region by construction workers; of this amount, $67 million will be spent in the Mat-Su Borough.

- The population of the Mat-Su Borough will increase moderately due to construction (the peak population influx will equal 1,112 in 1990). The greatest population impacts are estimated to occur in Trapper Creek and Talkeetna, where the populations will increase by 107 percent and 26 percent, respectively, over baseline forecast levels between 1983 and 1990.

- Short-term housing shortages, and rapid residential construction are expected to occur in Trapper Creek and Talkeetna. Housing conditions in other areas of the Mat-Su Borough and Railbelt region are not expected to be significantly affected.

- Schools and transportation systems will be the most burdened public services in Mat-Su Borough as a result of the project. These effects will be most apparent in the greater Trapper Creek-Talkeetna area.

- The access road could be a major addition to the Mat-Su Borough's road system, possibly contributing to more mineral development and recreational activity in the area.

- Fiscal impacts will be generally twice as great in 1990 (Watana peak) as they will be in 1999 (Devil Canyon Peak); however, in all cases these impacts will be small, both absolutely and relatively.

- The Mat-Su Borough will experience relatively more fiscal impacts than will incorporated communities in the Borough.

- The dominant fiscal impact that could be experienced by the Mat-Su Borough will result from cash-flow cycles. Initially, the costs of service delivery will be accelerated and will not be matched by an immediate parallel increase in revenues. However, the tax base is expected to expand enough to generate sufficient additional revenues to affect project-induced expenditures.

- There are many opportunities within current fiscal structures to raise local revenues to offset increasing costs in the event that State Revenue Sharing decreases.

- Trapper Creek, and to a lesser extent, Talkeetna, may experience rapid inflation caused by increased demands of incoming project-induced population and the competitive pay scales of the project.

- Local government informal community organization in the communities nearest the site will likely develop to respond to rapid growth. Planning and community organization may themselves change the nature of the communities.

- There is potential for conflict between the values and lifestyles of local residents and newcomers in the greater Trapper Creek area.

- Increases in the incidence and nature of many "people problems" (for example, rise in alcoholism, drug abuse, crime, divorce, and the lack of trained medical and counseling personnel), likely associated with stress related to rapid changes may occur in the small communities that experience the highest project-induced population growth rates.

5.2 - Identification of the Socioeconomic Impact Area

Hydroelectric development in the upper Susitna basin will cause employment, population and related changes for a significant part of Alaska. Due to current and likely future "without project" population levels and distributions, and probable "with project" inmigrant residence and commuting patterns, most of these changes will occur in the Railbelt corridor. These changes will be most significant where project-induced population changes are large relative to future ("without project") population levels.

(a) Local-Impact Areas 1-2

The Borough is designated as the "local" impact area (also referred to as Impact Area 2). It is the smallest statistical area for which relevant time-series economic and socioeconomic data are available and is large enough to contain a population sufficient in size to allow for the organization of social life for the pursuit of one or several common interests and to provide for necessary support systems. Project-induced population changes could be large relative to future ("without project") population levels in the Matanuska-Susitna (Mat-Su) Borough and in several communities within this Borough. Potential project-induced changes in the Borough's communities are addressed (although more data are available for some communities than others) to provide for an approximation of the geographic distribution of changes.

The local impact area also includes Impact Area 1: the construction sites, access road, transmission line corridor from the dam sites to the Intertie, some staging areas, impoundment areas and lands to be utilized for the construction camps and villages.

(b) Regional-Impact Area 3

Eight Census Divisions, including the Matanuska-Susitna Borough, make up the "regional" impact area. These are the Anchorage, Kenai Cook Inlet, Seward, Valdez-Chitina-Whittier, Mat-Su and Southeast Fairbanks Census Divisions, and part of the Yukon-Koyukuk Census Division (see Figure 5.1-1). Population changes could be significant in the seven Census Divisions that surround the Mat-Su Borough, particularly the Anchorage Census Division and the Fairbanks North Star Borough (also a Census Division). Some of the physical inputs and many of the labor inputs for construction and operation will be drawn from Anchorage and the Fairbanks North Star Borough.

For analytical purposes, Impact Area 3 is divided into three regions: Anchorage, Fairbanks and Valdez. The Anchorage, Kenai-Cook Inlet, Seward and Matanuska-Susitna Census Divisions comprise the Anchorage region; the Fairbanks North Star Borough and Southeast Fairbanks Census Division comprise the Fairbanks region, and the Valdez-Chitina-Whittier Census Division comprises the Valdez region. The portion of the Yukon-Koyukuk Census Division that is in Impact Area 3 is considered separately from these regions.

(c) State-Impact Area 4

The fourth impact area is the State of Alaska. Socioeconomic changes that could occur outside of the regional impact area, combined with regional changes, provide an approximation of statewide socioeconomic change.

5.3 - Baseline Description

Baseline conditions and trends in the impact areas are addressed in this section. Tables 5.1 and 5.2 indicate resident population and components of change in local, regional and state impact areas and data on the available labor force and unemployment for these areas.

(a) Local

The Mat-Su Borough's trends in population, employment and per capita income are displayed graphically in Figure 5.2. Differences in 1980 population figures for the Mat-Su Borough are a result of discrepancies in the 1980 Census data and a Borough population survey. The latter were used as the basis for forecasting population.

(i) Population

The Borough's population has grown rapidly since 1970, largely reflecting construction of the trans-Alaska pipeline and the evolution of Borough areas into bedroom communities for the Municipality of Anchorage. From 1970 to 1980 the population of the Borough grew 175 percent. Table 5.3 shows population in the Borough by community. Palmer and Wasilla stand out as the largest communities, with 1981 populations of approximately 2,567 and 2,168, respectively.

Approximately 90 percent of the Borough's estimated 1981 population of 22,339 resides within a 20-mile radius of Wasilla. The bulk of the remainder is distributed along the Parks Highway and railroad corridor. Several hundred inhabitants are scattered throughout the Borough's wilderness regions accessible primarily by water or air; these inhabitants include the few Borough residents of the upper Susitna basin in the vicinity of the proposed impoundments.

(ii) Housing

Table 5.4 shows 1981 housing stock estimates and vacancy rates, by areas of the Mat-Su Borough. A recent survey by the Borough shows total housing stock of 8,582 units, of which 79.4 percent or 6,814 were occupied. Most of the housing units were in the Palmer-Wasilla area.

An earlier survey, by Policy Analysts (1979-1980) showed that single-family housing units predominate in the Borough, representing 83 percent of the total; mobile homes account for 11 percent and multi-family units five percent. The dominant pattern in the Borough is ownership of one's residence.

Housing vacancy rates fluctuate rapidly, with a five percent rate seen by local authorities to be healthy and growth-promoting. Some surveys of Mat-Su Borough housing stocks include a significant number of recreational units not occupied year-round and thus serve to artificially inflate the vacancy rate. During the summer of 1981, vacancy rates in the incorporated cities ranged from 6.7 percent to 10 percent; more remote communities such as Talkeetna and Trapper Creek experienced very low vacancy rates of between one and two percent.

Population per household for selected communities in the Borough averages 3.07 according to 1980 Census data. This is considerably higher than the national and state averages.

(iii) Fiscal Condition of Local Government

The Mat-Su Borough is a second class Borough and, as such, has the areawide powers of taxation, education and planning, platting and zoning. In addition, the Borough has non-areawide (outside incorporated cities) powers of solid waste disposal and libraries. The Borough is admin-istered under a part-time Mayor-Manager-Assembly form of government.

In addition, there are currently three incorporated communities in the Borough. Palmer is a first class, home-rule city, and operates its own police, fire, water and sewage treatment facilities. Wasilla and Houston are both second class cities.

The Mat-Su Borough Budget FY81/82 appropriated $38,419,973 in expenditures consisting of the following funds and their respective portion of total revenues: General Fund (36 percent); Service Areas Fund (three percent); Land Management Fund (three percent), and Education Operating Fund (58 percent). Property taxes currently provide almost 50 percent of total General Fund Revenue. The mill rate for fiscal 1982 is 6.7 per $1,000 assessed valuation. It provided $5,388,356 in total property tax revenues.

	Mill Levy
General Government	0.06
Parks and Recreation	0.08
Ambulance Service	0.24
Community College	0.07
Subtotal	.45
Education	6.25
Total	6.70

Currently, no taxes are raised for capital projects due to abundant State funding from petroleum revenues. The current ratio of bonded indebtedness to total assessed valuation is 0.075, based on a total assessed property value of $893,591,412 as of January 1, 1981. This ratio represents the maximum total bonded indebtedness desired by the Borough Administration.

Current per capita expenditures for FY81/82 in the Mat-Su Borough Budget are provided in Table 5.5 based upon a total areawide population of 22,285.

The school district budget for FY81/82 is the single largest category of revenues and expenditures across all services provided within the Borough and within the incorporated communities. The composition of revenues for the School District budget for FY81/82 is:

State Sources	68%	$17,434,148
Local Sources	26%	6,560,949
Federal Sources	6%	1,448,000
Total		$25,443,097

The distribution of school budget dollars by function is as follows:

Regular Instruction	33%
Vocational Education	4%
Special Education	6%
Support Services	18%
Operations and Maintenance	19%
Pupil Transportation	8%
Other	12%

The City of Palmer Budget FY82 consists of a General Fund, and separate funds for water, sewer and capital projects. The composition of General Fund Revenues is local taxes 35 percent (property tax 23 percent based upon four mills per $1,000 assessed valuation; sales tax 12 percent based upon two percent retail sales tax); intergovernmental revenue 25 percent; service charges 30 percent and miscellaneous 10 percent. The current ratio of bonded indebtedness to total assessed valuation is 0.04, based on a total assessed property value of $64,710,668. This ratio is not anticipated to increase over time. Per capita expenditures for the City of Palmer are provided in Table 5.5.

The City of Wasilla Budget FY81/82 consists of a General Fund, Library Fund, and Capital Project Fund. As a 2nd class city, Wasilla does not levy a property tax and is dependent upon intergovernmental transfers of revenues from the Borough, the State and the Federal Government. The City has just completed a central water supply system and will be floating its first local bond issue in Spring 1982. Other local funding for this project will be derived from a property assessment only on lots that will benefit from this improvement. Expenditures for services are provided in Table 5.5.

The City of Houston Budget FY81/82 obtains revenues from a variety of State and local grants which generally specify a portion of the use to which the funds are put. Expenditures for the services provided by the City of Houston are listed in Table 5.5.

The communities of Talkeetna and Trapper Creek and other small communities do not have formal local government. The Mat-Su Borough provides existing services including ambulance, fire protection, solid waste disposal and road maintenance and repair. These services are administered by the Borough and paid for by Borough funds derived both locally and from the State. Property located within the service boundary is liable for taxes levied to cover the costs of service delivery.

(iv) Public Facilities and Services

Current usage and capacity of public services, including water supply, sewage, solid waste disposal, transportation, police, fire, health care services, education and recreational services, in the Mat-Su Borough are displayed in Table 5.6.

- Water

The cities of Palmer and Wasilla have water supply and chlorination treatment systems with peak capabilities of 1,368,000 gallons per day (gpd) and 864,000 gpd, respectively. Other areas are provided with water on an individual basis, by wells, or by a community water system.

- Sewage

Palmer has a city-wide sewage facility. Residents of other areas rely on septic tanks, waste from which is trucked to Anchorage for disposal by private companies. Borough voters have authorized construction of a treatment plant in the Borough. Some Borough areas are served by small public sewage systems: 43 Class A systems serve subdivisions and trailer parks;

77 Class B systems serve schools and businesses, and 45 Class C systems serve duplex and triplex structures. Ratings are by the Alaska Department of Environmental Conser-vation and relate to the number of people served.

- Solid Waste

The Borough has non-areawide solid waste management authority and operates nine landfills. The Borough intends to close most of these and set up transfer stations for bringing the waste to an 80-acre central site, near Palmer, for final disposal.

- Transportation

The Parks Highway is the principal surface transport route within the Borough, linking it to both Fairbanks and Anchorage. The Borough is also connected with Valdez and the Al-Can Highway via the Glenn and Richardson Highways. During the summer months, the 180-mile unpaved Denali Highway connects the Parks and Richardson Highways. Many major Borough communities are connected by the Alaska Railroad which also provides access to a number of small communities which have no road access. The largest airport in the Borough is the Palmer Municipal Airport. There are a number of airstrips.

- Police

Police protection in the Borough is provided by Alaska State Troopers, 17 stationed in Palmer and three in Trapper Creek. Four other troopers are responsible for fish and wildlife protection and enforcement. The City of Palmer has police powers and maintains a force of eight officers and several civilian support personnel. There are three detention and correctional facilities in the Borough: a temporary detention facility maintained by the Palmer Police Department; McLaughlin Youth Center in Wasilla, and the Adult Correctional Facility near Sutton. Borough correctional facilities serve the whole Anchorage region.

- Fire

There are nine operating fire service areas in the Mat-Su Borough. Costs of fire protection are funded by special millage rates on assessed valuations within the service areas. In the interest of achieving a rating of eight from the Insurance Service Organization (ISO), the maximum rating for areas without community water systems, the Borough's fire chiefs in 1981 prepared a fire protection plan which proposes 12 additional stations and the purchase of new equipment for existing stations.

Residents of the Borough not within the boundaries of the fire service areas rely on their own resources and neighbors' volunteer assistance for fire protection.

Fire stations in Palmer, Wasilla and Houston are city-maintained; there are two paid employees in Palmer and one in Wasilla. The Borough maintains other stations which rely completely on volunteer staffing.

- Health Care

The 23-bed Valley Hospital, built in Palmer in 1954, provides acute and some long-term care. The hospital is staffed by eight doctors. There is a satellite x-ray facility in Wasilla. A plan for a hospital addition which will add 7 beds and additional space for equipment to the Valley facility has been approved and will enable the hospital to serve a Borough population of up to 30,000. Another addition of 30 beds could be built at a later date.

Ambulance service in the Borough is provided through the Palmer Fire Center on a 24-hour basis. The 911 emergency service number is connected directly to the amublance dispatch center at the Palmer Fire Station and to the Valley Hospital.

Public health centers in the Borough are the Palmer Health Care Center, Wasilla Health Care Center and Cook Inlet Native Association Health Care Center (Wasilla). Langdon (Wasilla) and the Mat-Su Mental Health Center (Wasilla) provide individual and group therapy, family and marital counseling and alcohol and drug consulta tion. The Palmer Pioneer Home provides long-term nursing and non-nursing care for the elderly.

- Education

The Mat-Su Borough operates 17 schools: 12 elementary schools, two junior high schools and three high schools. At the beginning of the 1981-1982 school year, enrollment totalled 4,515 students. Plans call for expansion of existing facilities and construction of three new schools: an elementary school serving 400 pupils in Wasilla, a permanent elementary school in Trapper Creek for up to 150 students and a secondary school initially accommodating 300 in the Houston area. The School District also offers correspondent education to any resident of the State.

The Matanuska-Susitna Community College, a branch of the University of Alaska, provides academic and vocational courses to area residents. Enrollment totalled 1,500 full and part-time students in 1980-1981.

- Recreational Facilities

Opportunities for outdoor recreation abound in the Borough and surrounding areas. The largest attraction in the region is Mount McKinley National park and the surrounding Denali National Park and Preserve. Entrance to the park is off the Parks Highway north of the Borough.

Denali State Park, located within the Borough, will eventually offer a variety of summer and winter recreational activities. Nancy Lake Recreation Area south of Willow, the Lake Louise area in the southeastern part of the Borough and the Big Lake area between Willow and Wasilla include other popular recreational sites.

There are relatively few local public recreational facilities in the Borough, but plans call for future development of playgrounds and neighborhood parks in conjunction with school complexes.

(v) Economic Base

Table 5.7 describes business locations and types in Mat-Su Borough communities. The economy of the Borough reflects the influence of nearby Anchorage and the Borough's economic dependence on Anchorage. Dominant sectors of the Borough economy are connected with tourism, recreation and residential construction. Businesses involved in support and service sectors predominate.

The Borough is encouraging economic development and is concentrating on the Point MacKenzie area across Knik Arm from Anchorage. Development there is to focus on dairy farming, an industrial complex and a possible petrochemical complex.

Agriculture has played an important part in the historical development of the Borough. Up until the early 1960's, commercial agricultural production continued to increase. Since then the number of farms and volume of production has declined. The Borough government is attempting to reverse the decline through various means, including the Point MacKenzie Project.

Outside of the major communities in the Borough, economic activity is related to mining, timber products and recreational services, in addition to agriculture. Two of the traditional mining districts are of particular relevance to the proposed Susitna Dam: The Susitna-Chulitna portion of the Yentna Mining District where deposits of molybdenum, gold, copper, lead, silver and antimony are found, and the Upper Susitna River area where the Denali copper prospect has been discovered but not yet mined. However, the major mineral resource in the Borough is coal. The U.S. Forest Service has classified 1,295,000 acres in the Borough as commercial forest land.

(vi) Employment

Virtually all employment in the Mat-Su Borough, as reflected in Table 5.8, is in the government, services and support sectors. Total employment by place of employment has risen steadily from 1,145 in 1970 to 3,078 in 1979, an increase of 169 percent. Employment in the first three quarters of 1980 averaged 3,224. The Borough has consistently had high unemployment rates (20 percent in 1970 and 13.8 percent in 1979) because employment opportunities have not kept pace with the growth of the labor force. The rate is often the highest in the state; in addition, the Borough is more dependent on seasonal employment than are larger population centers, such as Anchorage.

The Mat-Su Borough has an extremely high ratio of population to employment (by place of employment), averaging around 5.5 during the years for which complete data exist. This figure is more than twice as high as the overall Anchorage Region's population to employment ratio of 2.5. The lower rate for Anchorage is mostly due to the emergence of the southern part of the Borough as a bedroom community for Anchorage; approximately 40 percent of all employed Mat-Su residents commute to jobs outside the Borough. Another, lesser factor contributing to the high population to employment ratio in Mat-Su is the high unemployment rate prevailing in the Borough.

(vii) Income

Trends in per capita personal income are shown in Table 5.9. Personal income rose substantially in the Mat-Su Borough in 1970's and stabilized as the trans-Alaska pipeline was completed. Personal income rose from $3,957 per capita in 1970 to $9,032 per capita in 1977 and declined to $8,878 in 1979. The increase between 1970 and 1979 was, therefore, 124 percent. However, using the Anchorage Consumer Price Index - Urban as a measure of inflation, personal income in 1979 was only 19 percent higher than that of 1970 in real terms. The mean household income for Matanuska-Susitna Borough in 1980 was $30,627, despite one of the highest unemployment rates in the state.

(viii) Land Use

Status of land in the Borough is a complicated and ongoing issue, increasing in importance as the Borough continues to experience substantial growth concentrated in the southern portion.

Of the 14,720,000 acres in the Borough, 25 percent are Federal lands, 68 percent State lands, 2.5 percent Borough lands, one percent Native-owned land and 3.5 percent privately owned land. Of 525,836 acres of taxable land in the Borough, only 16 percent (84,838 acres) contain any type of improvements. The current amount of private land, though small in proportion to the total, has been more than sufficient to meet the recent and present demand for land.

Both the State and the Borough have been pursuing land disposal programs which put additional land into private hands. These programs are expected to continue in the future.

Much of the land involved in the proposed Susitna Hydroelectric Project has been selected by the Cook Inlet Region, Inc. (CIRI) and its member village corporations. Future use of this area will depend largely on future ownership and owner's policies regarding land use.

Some land near the Susitna Hydroelectric project site has been included in two recent State land disposals in the Indian River area. The Indian River subdivision disposal is comprised of 700 acres in 139 parcels. The Indian River remote disposal contains 1,500 acres. Two additional sites may be disposed of in FY83: one of these consists of 2,000 acres near the Indian River subdivision.

Land use planning powers in the Borough for the most part reside with the various land owners. The Borough, however, does exercise overall planning authority for all lands within its boundaries. Roughly half of the Borough is designated as a special use district permitting multiple use of the lands within the district.

The Borough's traditional reluctance to allow zoning to be implemented is beginning to change, and planned growth is being advocated as a way to avoid strip development and conflicting land use, and to protect wildlife and wildlife habitat.

(ix) Sociocultural Conditions

This section of the report (Section 5.3(a)(ix)) is Frank Orth & Associates, Inc.'s summary of a sociocultural study conducted by Stephen R. Braund & Associates for the Susitna Hydroelectric Project. It describes and analyzes baseline sociocultural conditions in those communities most likely to be directly affected by the project. For the southern communities of Talkeetna, Trapper Creek and the northern railroad communities, categories addressed include settlement patterns, economic conditions and values, political systems and community response capacity and local attitudes toward growth, change and development. Findings and conclusions relative to the more northern communities of Cantwell and McKinley, which are relatively remote from the chosen access route and project area, will be briefly summarized.

- Southern Communities

  - Settlement Patterns

    Talkeetna, Trapper Creek and the railroad communities north of Talkeetna have experienced considerable population influx, noteworthy in that they are too remote from Anchorage to serve as bedroom communities and offer litle or no economic opportunity.

    Growth of these communities occurred in several distinct phases. At the extreme, settlers can be classified into two groups: those who came primarily to develop and extract and those who came primarily to enjoy the natural resources. All residents share the desire to live in a non-industrial, relatively rural setting.

Talkeetna, located 114 miles north of Anchorage, is the former site of an Indian village. It became a mining community after the discovery of gold in 1896, serving as a base of operations for prospectors operating in the Yentna Mining District West and Northwest of town. Some miners spent the winter trapping, which was a significant part of the local economy until the 1940's. Construction of the Alaska railroad spurred growth, increasing access to the area by miners, trappers and travelers. Upon construction of the Talkeetna airfield and FAA(CAA) facility in 1940, young families began moving to the area to work for the government, changing the character of the community, which had previously been populated predominately by older bachelors.

Beginning in the 1950's, a new period of growth began, based on tourism and recreation. Talkeetna became the center for mountaineering expeditions to Mt. McKinely. Construction of the Parks Highway and Talkeetna Spur Road in 1965, paved the way for rapid change in the community. Recreational use of the area increased as did land sales and home construction for a growing population of young families.

New residents in the 1960s and 1970s sought the best of two worlds: life in a rural wilderness setting coupled with relatively easy automobile access to services offered in Anchorage and Wasilla.

Old-time residents of Talkeetna are accustomed to and inured to change, having experienced successive waves of growth. Some newcomers, however, feel that change in the form of encroaching urbanization and industrialization is in direct conflict with the rural, relatively self-sufficient lifestyle they moved to Talkeetna to pursue.

Trapper Creek was settled post-1950, initially by homesteaders. Upon construction of the Parks Highway and the operation of the State's

Open-to-Entry (OTE) land disposal program (1968-1973) a new group of residents moved to the area, some acquiring five-acre parcels for recreational use, others seeking a year-round life in the wilderness. As in Talkeetna, many of the newer residents moved to the area for the sake of natural beauty and isolation and are skeptical about future change and development.

Railroad communities north of Talkeetna include Chase, Curry, Sherman and Gold Creek. Early residents worked for the railroad, operated mines or homesteaded. Many of the settlers who moved to the area during the OTE program were young people of the turbulent 1960's who found in these areas an alternative lifestyle in a wilderness setting which coincided with their rejec tion of industrialization and urbanization. As in earlier waves of settlement, many of the settlers did not remain, but of the 300 to 400 settlers who arrived in the early 1970's, plus more recent arrivals, 80 to 150 are still permanent residents. The summer population is greater, consisting of many recreation sites and absentee landowners in addition to year-round residents.

There has been some friction between new and older settlers in the Talkeetna area, with some older residents skeptical of the motivations of newer settlers, claiming that the new, young, counterculture type of resident relies on food stamps and other asistance rather than seeking a true subsistence lifestyle. With time, however, social relations between the groups have improved, and all can be said to share the desire to live in a rural, relatively undeveloped wilderness or small town environment.

- Economic Overview

Economic opportunities in Talkeetna, Trapper Creek and the railroad communities north of Talkeetna are few, and unemployment is high. Recent arrivals seem to choose first to live in these rural communities, then worry about how to support themselves there. Lack of local jobs forces many men to leave the area to work on the North Slope, in Wasilla or Anchorage. Retail businesses in Talkeetna and Trapper Creek are generally associated with tourism and recreation. Some government employment is present. Some residents seek governmental subsidies in the form of food stamps, energy assistance, aid to dependent children or other grants to help them cope with the lack of employment opportunities. Additionally, people in all communities produce arts and crafts which they sell. Also, in all communities, residents rely on local fish and game, gather firewood as well as berries and other greens, and raise gardens.

Talkeetna has the largest number of businesses and employers in the area. Most commercial estabishments are oriented toward tourists and recreationists. Main employers in town are said to be the school, Alascom, the railroad, FAA and the local stores. There are many more people than jobs in Talkeetna. Most businesses are owner-operated and hire few employees. Many residents rely on recreational guiding for income. In 1979, some of these individuals formed a guiding asociation called Denali Wilderness Treks, a non-profit association which books clients and advertises for its members.

Trapper Creek also has limited job opportunities, with many residents working seasonally in other areas. There is some local mining, logging and farming. Some local people are artists, craftsmen and guides.

Job opportunities in the railroad communities north of Talkeetna are almost non-existent. Population density makes pure subsistence living impossible. Thus most people who live permanently north of Talkeetna must rely on a combination of sources to maintain their lifestyle. A typical household may depend on the following: seasonal construction work out of the area, supplemented with food stamps and unemployment, the harvest of local fish and game resources and personal gardens. In some respects the lack of an economic or employment base in the railroad communities gives residents the appearance of being a transient population. People are continually coming and going for seasonal jobs, supplies and services. In addition, many other users of the area are, in fact, highly transient (sports hunters, fishermen and absentee land and cabin owners.)

. Politics and Response Capacity

There are very few local political organizations in Talkeetna, Trapper Creek, and the railroad communities north of Talkeetna. While rural Native communities often struggle to determine which organization has control of what activity, the general trend in the southern study communities has been a reluctance to form political groups. Typically, in rural Alaskan native villages, numerous political organizations exist or have influence in each community (i.e., regional profit corporations, regional non-profit corporations, cities, boroughs, traditional councils, and village corporations). Because none of the southern study communities are Native villages under the Alaska Native Claims Settlement Act (ANCSA), they do not have Native corporations or traditional councils. Also, because none of the study communities have incorpor ated under State law, there are no cities in the study area. The only State recognized political organization in the area is the Matanuska-Susitna Borough, incorporated as a second class borough in 1964, which encompasses the entire study area except Cantwell and McKinley.

In the past few years, as more and more people have moved into the area, there has been a tendency toward the formation of political organizations in Talkeetna, Trapper Creek, and Chase. This trend is primarily the result of proposed developments (the Capital move, the Susitna Project, and the Intertie), State land disposals, anticipated population growth, and the growing belief that local participation and control is necessary to maintain present values. On the other hand, the formation of, and participation in, political groups is contrary to the philosophy which motivated most people to settle in this rural area--individualism, a desire for isolation, and a lack of governmental controls on one's life. This section addresses local political organizations in the area, their formation, and associated social divisions in the community, as well as community response capacity.

Organizations active in Talkeetna include the Talkeetna Historical Society, the Parent-Teachers' Association, six churches, a local library board, road and fire service area boards and the Talkeetna Chamber of Commerce. The Chamber of Commerce has a leadership role in local affairs and has incorporated in order to be eligible to pursue grants and enter into contracts with the Borough. In a hotly contested election, Talkeetna voters rejected, in 1981, a move to incorporate as a first class city. Both newcomers and long-time residents opposed incorporation, agreeing that the results of incorporation, including taxation, bureaucracy caused by another level of government, and additional regulations threatening their independent lifestyle, were undesirable.

Trapper Creek has a Community Council formed three years ago. It is designed to bring local issues into the open, afford residents the opportunity for maximum participation in community self-government and to influence higher levels of government related to community development and services. The Community Council was pre-dated by a Tokosha Citizens Council which unsuccessfuly sought, in 1978, to enact a proposal calling for transforming 144 square miles of territory into a unique residential and recreational roadless area. The spirited public debate on this issue clearly established two opposing attitudes toward economic development in the area and served to alert residents of the need to become involved in the political process. The Trapper Creek Community Council is recognized by the Mat-Su Borough as an advisory body and has been associated with acquisition of community facilities and services desired by the community. Most of the impetus for such services has come from newer residents, and some older homestead families feel costs of added services are too great compared to the relatively low population of the area.

The railroad communities have tended to avoid involve ment in political organizations, due to their residents' propensity for isolation, individualism and anarchism. It was not until 1979 that the first political group, the Chase Community Association, emerged. Residents formed this non-profit corporation primarily to resist the proposed Chase II State land disposal in their area. This disposal was for a subdivision of 5-acre lots, and residents feared it would create too great a population density to allow their semisubsistence lifestyle. The Association has also responded to other potential developments which its members believe threaten their rural, semi-remote way of life. These developments include the Susitna Hydroelectric Project and the Intertie power line. The Association seems to represent 50 to 75 percent of the permanent local residents. Many residents of the area are very involved in Talkeetna politics and were vocal in their opposition to Talkeetna incorporation.

Residents of all the southern communities generally agree that small, rural towns or wilderness areas are more favorable places to live than more urban environments, but residents do not agree on either community priorities or what should be done to protect common values. There is no consensus of opinion in the area; individualism and self-reliance are prevalent. However, because division weakens the local ability to control, the trend toward political organization may continue as rural residents band together to protect their environment.

Presently, none of the communities has an adequate system by which to respond to development impacts, though Trapper Creek is building an organization of interested people actively representing the community and recognized by the Borough. The Chase Community Association has an image as anti-development, which lessens its effectiveness with higher levels of government. The Susitna Project could tend to encourage additional political organization in the southern study area communities. Capable leaders reside in all the communities, but the need for political organization conflicts with their local rural values. Many of them moved to the area to escape government and congestion, and find active participation in the political process to be in conflict with their individualistic values.

- Attitudes toward Growth, Change, and Economic Development

Two different philosophies toward economic development and rural growth emerged in the southern communities. Because these two factions, which represent extremes on a continuum of attitudes and opinions, were found in Talkeetna, Trapper Creek, and the railroad communities north of Talkeetna, all communities are discussed together in this section. These different attitudes toward economic development and growth in rural environments include:

1. On one end of the continuum, residents have a desire to protect rural, small-town, and wilderness atmospheres; minimize change; and avoid industrial development in the area; as well as preserve wildlife and recreational areas. Residents in this group take issue with the charge that they are against growth and economic development. Rather, they point out that economic development does not only mean industrial growth. They believe that the real, long-range value for the upper Susitna valley is not its minerals or hydro potential, but its untapped potential for visual and recreational enjoyment, both summer and winter. These residents argue that a recreational/tourist economy caters to people who enjoy the land without defacing it, which is preferred to a commercial, industrial economy which does scar the landscape. These people tend to be opposed to the Susitna Hydroelectric Project as well as other large-scale development schemes in the area.

2. On the pro-development end of the continuum, residents do not necessarily desire industrial development in the area, but they cannot identify with what they feel is a no-growth attitude. Residents with an extreme development view tend to favor roads to open up additional country and believe that progress (including hydroelectric dams, more people, and roads) will come regardless of what they, or anyone else, want. Generally, long-time residents, many of whom have already witnessed considerable change in the area, do not view future developments as necessarily undesirable (see <u>Settlement Patterns</u> above). Most of these people are generally in favor of the Susitna project because they perceive that it will provide a needed economic boost to a depressed area.

   It should be pointed out that these residents do not generally desire to see their community radically changed, neither do they necessarily wish for industrial development to become the economic base in the area. Like their neighbors, they enjoy small-town qualities and desire to live in a non-industrial, relatively isolated, rural environment. But, they view change as inevitable, feel the local economy will benefit from development, and as long as there is no danger to life, not necessarily lifestyle, the Susitna project is acceptable.

Few people, in recent years, have moved to Talkeetna, Trapper Creek, or the area north of Talkeetna for economic or job opportunities. In fact, according to many local residents, one of the largest limits for growth in Trapper Creek and Talkeetna is the lack of local jobs. Some of these residents with a conservative attitude towards economic development, maintain that if jobs were available, they would not want to live in the area because the increased job opportuni ties would attract more people. This population influx would, for these residents, make Trapper Creek and Talkeetna less desirable as rural places to reside. Others, for example homesteaders who raised their families in Trapper Creek or long-time Talkeetna residents, desire economic development in the area so their children will have access to local employment. Generally, the difference between whether a resident is in favor of or opposed to the Susitna dam depends on how he perceives it will impact the area. If it is characterized as a massive, unnecessary project that will provide excess energy and lead to total industrialization of the area, which some people believe, then very few rural residents are in favor of it. But, on the other hand, if the project's impacts will be relatively minor, and it will provide constant and cost-stable electric power in the area as well as jobs, then more people are pro-Susitna. Consequently, consensus related to the Susitna Project may likely only emerge once residents of this subregion have more information about the project and its impacts upon which an intelligent dialogue can ensue and decisions can be made.

Based on the recent settlement patterns in the southern study area, it appears as though the trend is towards those who favor the development of tourism and recreation, minimum disruption of small-town qualities, the reasonable preservation of local wildlife and fish, and the enjoyment, not deterioration, of the natural environment. Concomitantly, these people oppose industrial development, rapid growth, and urbanization in the area.

- Land Availability

  Between 1979 and 1981, the State of Alaska offered seven disposals in the Talkeetna area (four agricultural, two subdivisions, and one remote parcel). In 1980-81, six disposals (one agricultural, four subdivisions, and one remote parcel) were offered in the Trapper Creek area. In 1980, the State of Alaska offered the Chase Remote Parcel area and in 1981, the Chase II subdivision. Similarly, the State offered the Indian River Remote Parcel area in 1980 and the Indian River Subdivision in 1981. Thus, the State of Alaska had offered a total of 17 land disposals in the Talkeetna, Trapper Creek, Chase, and Hurricane area in the past three years. (This is in addition to the early Open-To-Entry Program which was in effect from 1968 to 1973.)

  Although not all of the lands are accessible by road, these land disposals as well as numerous large unsubdivided homesteads and other tracts in the Trapper Creek and Talkeetna area provide a more than adequate land base for substantial growth. In addition, if the highway is relatively close, subdivision roads are relatively inexpensive to construct in this area, and large tracts can be converted into subdivisions fairly quickly. Given any economic incentive for development, it is likely that more subdivisions will appear in the upper Susitna basin.

  Related to the state land disposals, a relatively common trend in residents' attitudes has developed in the study area. Once an area is opened up to settlement (either recreational or residential), those people who first acquire land are generally opposed to any further land disposals in the immediate area that would increase the population density to levels beyond what they believe the land can support. Most people were attracted to these land disposals because the land is relatively isolated in a wilderness area. Generally, persons who acquire a remote parcel or establish residency on the land wish to preserve the unpopulated, wilderness flavor of the area. They perceive that additional state land disposals, especially subdivisions, conflict with this desire. Although at first this may seem like a selfish motive, it should be kept in mind that the State of Alaska has made several recent public land disposals in this area (seventeen in three years). During interviews, some people claimed they had known what the State had in store for this region, they might not have acquired this remote land in the first place. (Many newer absentee land owners from Anchorage do not fall into this category.)

- Northern Communities

Similarities between Cantwell and McKinley account for both their stance and likely responses to aspects of the Susitna project.

The growth of both communities is severely limited by the unavailability of land and employment; there is an un avoidable interaction between lack of lands and lack of employment. Employment in Cantwell is based, in the main, on direct public employment--transportation, communications, public health and safety, and education. The small private sector is based upon services to public sector employees and to the seasonal visitors to the general recreation area. Employment in McKinley is based almost exclusively on year-round maintenance of the Park and seasonal visitation to the Park. Many more persons would and could live in these communities were only land and employment more available.

Both communities have undergone considerable growth in the past few years due to major improvements of the road system, the communications system, government expenditures, and the growth of visitation. This has resulted in a greater ability to remain in the communities year-round, rear children, obtain supplies, and withstand the physical hardships of weather and isolation. These changes have sustained a larger permanent population than has been carried historically and may be reaching or exceeding the physical carrying capacity of adjacent lands and wildlife.

This is the critical stage in the life of each community, in terms of attitude toward growth, forms of economic development, tolerances of change, community organization and identity, and attachments to the non-rural world. Introduction of the Susitna Hydroelectric Project and the Willow-Healy Intertie is only one of several forces that appear in these communities' perceived range of opportunities and risks; these energy projects are, however, most immediate realities.

Both communities are desirous of long-term economic development, not merely short-term economic growth. Cantwell and McKinley differ significantly in their perceptions and stance toward these energy projects, based on differences in history, geography, economics, population, and values. Cantwell sees itself at the center of these energy projects as well as secondary industries leading to long-term development of population, economy, and employment. If lands around Cantwell can be made available to accommodate the thousands of workers anticipated to be associated with these projects, then economic growth of Cantwell is possible.

The orientation and interest of McKinley is almost totally with the Intertie (and other physical altera tions in the highway-railroad corridor) since it finds itself too distant from any direct relationship with the Hydroelectric Project, other than a generalized environmental concern. Given the lack of land and services and the distance from the Hydroelectric Project, McKinley sees little that would change.

McKinley residents are also extremely concerned about the growth of visitation within the park as an environmental impact, and growth outside the park as damaging to current lifestyles. If more land becomes available, they fear a huge growth in recreational housing; if land remains restricted, they fear continued inability to remain employed and housed in the area. Land unavailability is also predictive of continued escalation of property values and eventual conversion of highway residential properties (most residences are adjacent to the highway) to strip commercial properties, altering both the values and character of the community.

Both communities feel that their futures are dependent upon the decisions made by urban interests and that they are generally helpless in the face of these interests. Each appears hopeful but not optimistic that its interests, values, and character will be protected in these decisions and also by the historical volatility and uncertainty of Alaska development, which has variously produced huge projects and abandoned projects. Each would prefer more gradual, planned, and certain forms of economic development, but they are not politically or economically organized to assure this kind of development.

(b) Regional

The Railbelt Region, Impact Area 3, includes the greater Anchorage area, the Fairbanks area and the Valdez-Chitina-Whittier area. Data on employment, population and per capita income in the Railbelt Region, 1970-1980, is displayed in Figure 5.3.

(i) Population

Population in the Railbelt Region rose from 204,523 in 1970 to 284,166 in 1980. The Railbelt contains 70 percent of the State's population, with the majority centered in the greater Anchorage area. Anchorage and Fairbanks are the largest cities in the Region.

(ii) Housing

Housing stock available in the Municipality of Anchorage (1981 data) and in Fairbanks and the Fairbanks-North Star Borough (1978 data) is shown by type in Tables 5.10 and 5.11.

In 1981, the Municipality of Anchorage contained 65,771 civilian housing units. Of this total, 46 percent were single-family units; 12 percent were mobile homes, and 42 percent were in multi-family buildings. The vacancy rate in the Municipality was approximately 14 percent in 1980. The vacancy rate for housing units in apartment buildings with five or more units was nearly twice that for single-family homes.

Housing stock of the Fairbanks-North Star Borough totalled 13,738 in October, 1978, with 54 percent of the units located in the City of Fairbanks. Single-family housing accounted for 50 percent of the Borough's housing stock; duplexes for seven percent; multi-family units for 28 percent and mobile homes for 15 percent. Within the city limits, multi-family units represented 43 percent of the total, and mobile homes only two percent.

Vacancy rates in the Fairbanks-North Star Borough have risen in the post-pipeline period, from a low of 0.4 percent in 1976 to 9.1 percent in 1980. Vacancy rates were lowest for single-family houses.

(iii) Employment

Table 5.12 presents non-agricultural employment data for Impact Area 3. Employment increased by 39 percent between 1970 and 1975, and by an additional 14 percent between 1975 and 1979. Construction, service and support sectors represent large percentages of employment in the Railbelt. Employment in the Anchorage Region acounted for 69 percent of Railbelt employment in 1979.

The Municipality of Anchorage has generally represented 87 to 90 percent of employment in the Anchorage Region, with Kenai-Cook Inlet representing seven percent, Mat-Su, three percent, and Seward, one and one-half percent.

(c) State

Data on employment, population and per capita income in the State of Alaska, 1970 to 1980, is presented in Figure 5.4.

(i) Population

The population of Alaska has risen steadily since the 1940's, yet this largest of the United States is still the least populous with an estimated 1980 population of 400,331. Alaska's population grew 32 percent between 1970 and 1980, jumping by 50,000 between 1975 and 1976 alone. Most of the population is in the Southcentral Alaska-Fairbanks region (the Railbelt), and half of the State's citizens reside in Anchorage.

(ii) Employment

Alaska's economy has historically been dependent upon development of its natural resources, primarily fisheries, minerals and timber. As a result, employment has been oriented towards these consumptive and extractive industries. The military has played a major role since World War II. In recent years, employment in state and local government has increased dramatically. In addition, employment in service and support sectors of the Alaska economy is increasing, reflecting the maturation of the State's economy.

Impact of the trans-Alaska pipeline is evident in employment figures. Between 1970 and 1975, a pipeline-induced growth spurt caused employment to increase by 75 percent. From 1975 to 1980, however, total employment increased by only 2.9 percent.

(iii) Income

The average per capita personal income in the State rose from $4,638 in 1970 to $10,254 in 1976. Since completion of the pipeline, however, the pace of increase has slowed. Per capita income in the State averaged $11,150 in 1979. The real increase in per capita personal income during the nine-year period was 27 percent.

5.4 - Project Elements Influencing Change (Methodology and Results)

(a) Manpower Requirements and Payroll

Tables 5.13-5.15 display the projected total number and origin of on-site construction and operations manpower for Watana and Devil Canyon dams from 1983-2005. For the construction work force, manpower has been divided into the categories of laborers, semi-skilled/skilled, and engineering/administrative. As displayed in Table 5.13, the peak construction year occurs in 1990 with an estimated construction work force of 3,498.

The Watana dam will be constructed in two phases with an ultimate generating capacity of 1,020 megawatts (MW). The first installment of 680 MW's will be completed in 1993, at which time operations manpower will total 70 persons. The additional generating capacity will reach completion in the following year, 1994, and will result in a total operations work force of 145. Analysis of construction manpower requirements for the 600 MW Devil Canyon dam is based on construction beginning in 1994, with this facility coming on-line in the year 2002. The total on-site operations work force for both dams will equal 170 during the year 2002 and thereafter. Construction of the Watana and Devil Canyon dam facilities entails an overlap of one year in construction.

As can be seen in Figure 5.5, the first phase of the Watana dam requires a significantly greater number of workers than both the second phase of Watana and Devil Canyon combined. This difference can be attributed to the additional labor requirements in the initial years for the construction of the work camps, villages, and access road and to the more labor intensive nature of a gravel fill dam (Watana) than a concrete thin arch dam (Devil Canyon). Dramatic decreases in work force requirements (relative to the preceding years) occur between 1991 and 1996.

Total payroll is an important consideration in that it defines the parameters of monetary impacts resulting from direct on-site construction and operations work force expenditures. Based on the on-site construction and operations requirements outlined above, the total yearly project payroll from 1983-2005 were derived and are displayed in Table 5.16. These totals were derived by matching wage figures to the respective trades, assuming that for construction workers there are 1,825 worker hours in the year (54 hours per week and an average of 29 weeks per year) and for the operations work force there are 2,496 working hours in the year (48 hours per week and 52 weeks per year). The payroll in 1990, the peak year, totals $97.8 million.

Tables 5.17 and 5.18 display estimates of construction and operations work force payroll expenditure patterns in the various Census Divisions of Impact Area 3. Using the total construction and operations payroll figures calculated above, taxes and savings were subtracted and estimates were made concerning the amounts of disposable income that would be spent in different areas of Impact Area 3. The methodology for determining payroll expenditure patterns is built upon the basic premise that place of residence is the primary factor determining where payroll is spent.

(b) Numbers and Residence of Work Force and Associated Population Influx

The level of impact of the proposed Susitna hydroelectric facility on the communities surrounding the project is proportional to the size of the inmigrant work force related to direct project employment and subsequent indirect and induced employment. These individuals create the short-term, peak demand for services that has the most significant impact. The size of the inmigrant work force depends on the extent of the primary local labor supply, that is the availability of craft and professional labor currently residing in the area from which the labor force could be drawn (Impact Areas 1, 2 and 3). This section of the report addresses the issue of work force origin, relocation, and population influx and is divided into two sections: work force origin; and work force inmigration and associated population influx.

(i) Work Force Origin

Labor supply is highly idiosyncratic, and the amount of available labor from the immediate labor pool depends upon the projected size and craft mix of the future labor force, labor force participation rates, demands placed upon the labor force from other projects, the match of craft labor available to craft labor required by the Susitna project, and the differing policies and geographic spheres of each craft. In addition, the supply and demand conditions will vary from craft to craft. All of these variables make it difficult to project the number of locally available construction trade and other workers who will become employed on the Susitna Hydroelectric Project.

"Local" versus "non-local" labor supply is the common terminology used in literature referring to the origin of a construction work force. The use of "local" in this sense is not to be confused with impact area definitions and the "local impact area."

Given that there are no union hiring halls in Mat-Su Borough (Impact Area 2), manual craft labor for construction and operations and maintenance will likely be acquired through a combination of both the Anchorage and Fairbanks union hiring halls. Based on this and limited observations of current construction worker commuting practices in Alaska, the immediate or "local" labor pool is defined as that residing in Impact Area 3 (seven census divisions: Anchorage, Fairbanks, S.E. Fairbanks, Mat-Su Borough, Kenai-Cook Inlet, Valdez, and Seward).

As noted earlier, preliminary manpower requirements for construction and operations of both the Watana and Devil Canyon dams indicate that there will be a total peak on-site construction work force of 3,498 in 1990. Requirements for operations and maintenance manpower commence in 1993 at 70 workers and increase to 170 in the year 2001.

The local availability of construction labor was analyzed according to the total manpower requirements, which have been divided into the categories of laborers, semi-skilled/ skilled, and engineering/administrative. The percentage of jobs which can be filled by the local available work force varies with each classification. In general, a greater portion of laborers than engineers and administrators will be supplied "locally."

The basic assumptions for on-site construction work force as previously displayed in Table 5.14, are: for laborers, 85 percent will be supplied locally, five percent from other areas of the state, and 10 percent will originate from out-of-state; 80 percent of semi-skilled/skilled workers will be supplied from Impact Area 3, five percent from other areas of the state, and 15 percent from out-of-state; and for the administrative/engineering category, 65 percent will come from Impact Area 3, five percent will come from other areas of the state, and 30 percent will be from out-of-state. For the indirect and induced manpower requirements it is assumed that the percentage of jobs to be filled by inmigrants in Impact Area 3 ranges from zero in Seward to 45 percent in the Mat-Su Borough. Approximately 25 percent of the indirect and induced jobs in Anchorage will be filled by inmigrants.

The allocation of the construction work force's residences among the various census divisions and within Mat-Su Borough communities is initially based on a calculation of the total current proportion of workers, by classification and census division, to total construction work force in Impact Area 3. The percentage distributions so derived are then applied to the projected Susitna manpower requirements to determine the likely residence distribution of the work force at the beginning of the project. These percentage distributions are adjusted to reflect proximity to the project site, and the percentages change over time as certain areas become more attractive as places to reside, and work force migration occurs.

Table 5.19 displays the residence distribution of the on-site construction work force within Impact Area 3 prior to factoring in inmigration and relocation.

(ii) Work Force Inmigration and Associated Population Influx

As indicated earlier, the amount of work force inmigration is directly responsible for the degree of impacts on the various communities in Impact Area 3. Table 5.19 in the previous section displayed the number and residence of the work force associated with on-site construction. Based on the assumptions of locally available on-site construction work force outlined earlier, estimates can be made on the number of inmigrants necessary to fulfill the projected manpower requirements. Table 5.20 displays the results of these assumptions and includes relocation of construction work force currently residing within Impact Area 3.

Table 5.21 displays similar information to that illustrated in Table 5.19, but added to direct on-site construction employment is indirect and induced work force by place of residence in Impact Area 3. These residence factors are based on the assumptions of available local work force for indirect and induced manpower requirements outlined earlier. Table 5.22 then displays total inmigration and place of relocation of the work force associated with direct, indirect and induced employment.

Inmigration into Impact Area 3 at the peak of construction activity will represent 13 percent of the total direct construction, indirect and induced work force of 6,365. When considering only direct on-site construction work force at the peak, 3,500 in 1990, the percentage of inmigrants to total is even lower, representing approximately 5 percent. This low percentage of inmigration of on-site construction workers is directly related to the availability of local labor and of the remote location of the dam sites and the provision of temporary camp and family village facilities.

During the peak of construction activities, 828 inmigrant employees, associated with direct, indirect and induced employment, will be living in Impact Area 3. Of this total, 170 workers are related to direct on-site construction employment. About 50 percent of the inmigrant employees whose employment on the project is completed after 1990 are expected to remain in the area. After construction activity peaks at the Watana site in 1990, inmigration subsides until 1997-2000 at which time construction activity peaks at the Devil Canyon site.

As construction activity is completed in the year 2002, approximately 12 percent of inmigrants to Impact Area 3 are expected to remain. For the Mat-Su Borough, the figure is much higher with approximately 60 percent of the inmigrants remaining. The majority of the inmigration to the Borough consists of workers originating from Anchorage, Kenai-Cook Inlet and Fairbanks Census Divisions; it is assumed that 100 percent of these individuals who move to the Borough will remain even after their work on the project is completed. When considering Impact Area 3 in its entirety, the percentage of workers that remain is much smaller, since Alaska non-local and out-of-state workers make up a large percentage of the total. It is assumed that the majority of these workers will not remain in the area after their work on the project is completed, consequently only 12 percent of total inmigrants to Impact Area 3 remain after 2002.

Within the Mat-Su Borough, the settlement of inmigrants is expected to contrast sharply from the settlement patterns of the existing population. Accordingly, inmigrants will establish residence in the communities of Talkeetna and Trapper Creek with greater frequency. A great deal of settlement will also occur in "other" areas of the Borough, which corresponds to the areas outside of designated cities or towns, such as Montana Creek, Caswell and Willow. At the peak of construction activity, approximately 89 on-site construction, indirect and induced workers will inmigrate to Talkeetna, 117 to Trapper Creek, and 128 to other areas of the Borough (Table 5.22).

Table 5.23 contains data on the total population influx into Impact Area 3, by Census Division and for selected Mat-Su Borough Communities, precipitated by direct, indirect and induced employment. These projections are based on assumptions that, for the direct construction work force, 95 percent of inmigrants will be accompanied by dependents and that an average of 2.11 dependents will come with each inmigrant worker who is accompanied. For the indirect and induced work force, the Alaska State average number of persons per household figure was used to calculate population influx. Total population influx into Impact Area 3 during the two peak periods (1990 and 1999) equals 2,324 and 1,228, respectively. Of the total population influx associated with direct, indirect and induced employment in 1990, 2,214 or 95 percent, will relocate to the Anchorage region. The remainder is expected to relocate to the Fairbanks-North Star Borough, especially to the City of Fairbanks, and to the Valdez Chitina-Whittier Census Division.

Within the Anchorage region, it is projected that Kenai-Cook Inlet, Anchorage, and Fairbanks will experience a slight net outmigration of population during various stages of construction activity as outmigration to the Mat-Su Borough exceeds inmigration from other areas. The totals increase as the project ends as a result of a portion of the inmigrant workers and their families returning to other areas of Alaska and to out-of-state locations.

During the peak constuction period at Watana (1990), the total project-induced population increase to the Mat-Su Borough totals 1,112, which accounts for 48 percent of the total to Impact Area 3. Of this total, 694 are expected to remain in the Borough at the end of construction in 2002.

In 1990, Talkeetna, Trapper Creek and "other" areas of the Borough experience 89 percent of the total population influx to the Mat-Su Borough: Trapper Creek 31 percent; Talkeetna 24 percent and; "other" areas 34 percent. These projections represent considerable population increases relative to the baseline forecasts for each of these areas. Conversely, Palmer, Wasilla and Houston will experience only moderate increases in population. At the conclusion of the project, total population increases to Trapper Creek, Talkeetna and "other" equal 175, 173 and 257 respectively.

The number of school age children accompanying inmigrant direct, indirect and induced workers into Impact Area 3 will total 562 during the peak of construction. Of this total, 304 will be primary school age and 258 will be of secondary school age. Tables 5.24, 5.25 and 5.26 display data on the projected timing and geographic distribution of school age children accompanying inmigrant workers.

5.5 - Socioeconomic and Sociocultural Project Impacts

This section provides information on probable impacts of the project for each Impact Area, and for selected communities within Impact Area 2 (Trapper Creek and Talkeetna). Attention is focused on the peak construction years (1990 and 1999) and on the transition to the operations phase of the Devil Canyon facility (approximately 2002-2003); it is felt that impacts of the project will be greatest at these points in time. It should be noted, however, that the changes discussed for those years are expected to build over several-year periods.

(a) Local

It is anticipated that the impacts on socioeconomic conditions in the Mat-Su Borough will be greatest on the communities of Trapper Creek and Talkeetna, due to their proximity to the work sites and their relatively small size. Accordingly, impacts of the project on these communities are discussed separately.

(i) Mat-Su Borough

Table 5.27 presents an overview of impacts of the project on the Borough as a whole. Impacts on the incorporated communities of Palmer, Wasilla and Houston are summarized in Tables 5.30, 5.32 and 5.34.

- Population

The population of the Mat-Su Borough will increase moderately as a result of construction of the project, but this will be only one of several factors contributing to the Borough's projected rapid rate of growth over the next twenty years; the dominant factor behind this growth will be spillover from Anchorage.

Population in the Mat-Su Borough, unrelated to the Susitna hydroelectric project, is projected to increase by 16,982 people between 1983 and 1990. In contrast, population influx into Borough communities associated with the project is estimated to be approximately 1,112 during the same period. This population influx will represent a 2.6 percent increase over the baseline forecast population level in 1990.

As the Watana peak is completed, a slight decrease in inmigrant population associated with the project is expected to occur; however, the overall Borough population will continue to grow rapidly in the 1990's. In 1999, the population impact forecast (forecast with project) of 67,204 represents only a one percent increase in population over the baseline forecast (without project).

The population influx into the incorporated communities is expected to be small; between 1983 and 1990, the project will result in an increase of approximately 40 people in Palmer and Houston, each, and 50 in Wasilla. Over 50 percent of the inmigrant population in the Borough is expected to settle in the Trapper CreekTalkeetna area, and the remainder will probably establish homes in the Willow-Montana Creek area, the suburban area surrounding Palmer and Wasilla, and possibly in the newly available Indian River subdivision (near Hurricane).

In addition to this increase in population in Mat-Su Borough communities, there will be an additional peak amount of 1,464 people from out-of-state and other areas of Alaska who will be living at the work camp/village full-time in 1990. This segment of the population influx is expected to have a limited effect on conditions in the Borough, as a result of the planned provision of housing and other facilities and services by the construction contractor. Their major impact will be related to expenditures made in Trapper Creek, Talkeetna, and other Borough communities.

- Housing

A total of approximately 374 project-induced households are expected to settle in the Mat-Su Borough between 1983 and 1990, the height of construction activity at the Watana site. Based upon an average five percent vacancy rate, there will be a projected 2,336 vacant housing units in the Borough in 1990, or about six times as many units as inmigrant households. Thus, the in-migration is not likely to cause any dislocations in the Borough's housing market as a whole.

The availability of housing in some of the small communities closest to the project will be much tighter than the above figures indicate, since communities nearest to the project typically have the fewest units of available vacant housing. In general, the forecasts for housing need presented in Tables 5.27 through 5.38 should be considered housing demand by inmigrants. If the supply of housing in a given community is not adequate to meet the demands, the remaining inmigrant households are assumed to locate their residences elsewhere in the Borough.

- Fiscal Impacts on Local Government

The methodology used in the fiscal impact analysis is the per capita multiplier method, an average cost technique that assumes current per capita revenues and costs are a good approximation of future flows, other variables remaining constant. It is implicit, therefore, that any revenue or expenditure projections based on per capita amounts will vary in direct proportion to changes in population. The fiscal impact analysis is to be viewed as a set of trend indicators of future fiscal flows, and not as a predictor of actual receipts and costs to be incurred. The analysis is not comprehensive in that it focuses on major sources of revenue and major categories of service costs. Therefore, projections could be either higher or lower varying primarily as a result of public policy decisions and budgetary allocations.

. Matanuska-Susitna Borough Budget

Baseline and impact forecasts for the major sources of revenue and expenditures for selected funds in the Mat-Su Borough budget are provided in Table 5.28. The impacts of the project are greater in

1990 during the peak construction year of the Watana dam than those to be experienced in 1999, the peak construction year of the Devil Canyon dam. Total revenues between 1990 and 1999 will increase approximately 50 percent with or without the project, over 1990 levels.

The Service Area Fund will be impacted most by the project, causing a 28 percent increase in revenues over baseline in 1990, while other funds will average a 2.6 percent change due to the project. However, even in the absence of the project, Service Area Fund revenues will rise 114 percent by 1990 over 1981 levels, increasing at a faster rate than the population increase of 93 percent. Changes in the 1999 impact forecast over baseline forecast will be 50 percent less than those in 1990, averaging 1.3 percent for all funds excluding the Service Area Fund. However, Service Area Fund revenues in 1999 will remain a constant 25 percent over those forecast without the project. This is consistent with the population settlement forecasts that the majority of the population influx will reside in the outlying areas of the Borough.

The Borough will have to increase substantially the delivery of services to service areas. These include basic services such as sanitary land fill, library, fire protection, ambulance, and road construction and repair.

The Borough administration will experience a short-term impact from the lag between receipt of revenues and outlays for service costs. There may be an initial net deficit due to the costs of delivering services to substantially larger client groups and receiving additional revenues, both local and state. Increases in local revenues will be generated in the form of property taxes and service user charges.

The increased population will indirectly expand the tax base through changes of land ownership, whereby more Borough lands will be in private ownership. (See section (a)(ii) for example of impacts on a service area.)

Currently property taxes account for 30 percent of total Service Area Fund revenues; however, this may change depending upon the mill levy rate per $1,000 assessed valuation, the ratio of assessed value to real market value, and the proportion of total Service Area Revenues attributed to property taxes. There is usually a lag between the time new property is placed on tax rolls and is assessed, and the receipt of tax revenues. However, over time, increases in the tax base are anticipated to offset the increases in service delivery cost. In addition, there is a lag in the receipt of State revenues; however, these will continue to increase as long as allocation formulas are based upon population.

Certain General Fund sources of revenues will be impacted more than others: property tax revenues with the project will rise nearly 5 percent in 1990 and 3.6 percent in 1999 over the baseline forecast. Actual property tax revenues will double by 1999 for both forecasts. These are based on a 4 percent annual real rate of increase in property values and a mill levy of 6.75 mills per $1000 assessed valuation. Per capita share of property taxes declines from $261 in 1981 to $195.40 in 1990, and $179.23 in 1999 under the baseline forecast. Declines in per capita share of property taxes with the project are $199.82 in 1990 and $184.20 in 1999, over 1981 levels.

State funds for school debt service reimbursement increase from 30 percent of total revenues in 1981 to 37.5 percent in 1990, when 100 percent of local school capital project debt is anticipated to be reimbursed by the state. This represents a 150 percent increase in 1990 over 1981 levels and 50 percent increase in 1999 over 1990 levels with the project forecast. Miscellaneous sources of revenue for the general fund will decline 10 percent in 1990 with the project over those required without the project; the reduced requirements in 1999 will be approximately 7 percent with the project over the baseline forecast. This reduction in miscellaneous sources of revenue is due to the increases in Municipal Assistance Funds and property tax revenues, which are a function of changes in population.

Total bonded indebtedness for the Mat-Su Borough is not anticipated to exceed 7.5 percent of total assessed valuation. By 1990 total bonded indebtedness for the Mat-Su Borough could reach $95.3 million (baseline forecast) or $97.8 million with the project. By 1999 this could increase to approximately $136 million.

Expenditure forecasts are based upon average per capita expenditures found in the FY81/82 budget. The cost of delivering services almost doubles by 1990 and increases by only 50 percent in 1999 over 1990 levels with or without the project. The vast majority of impacts will be experienced in the increase in delivery of services to service areas with particular emphasis on communities experiencing a large population influx, such as Talkeetna and Trapper Creek. Total differences between baseline and impact forecasts in the costs of service average 2.6 percent in 1990, and only 1.3 percent in 1999. Costs for administration, fire service, and road maintenance and repair are likely to experience the largest increases. Service user changes are anticipated to rise proportionately to the increases in the costs of service delivery.

- <u>Matanuska-Susitna Borough School District Budget</u>

The school district budget for FY 81/82 is the single largest category of revenues and expenditures across all services provided within the Borough and within the incorporated communities. Table 5.29 provides baseline and impact forecasts of major revenues and expenditures for the school district budget. Total revenues double by 1990 and increase 60 percent by 1999 over 1990 levels with or without the project. This is consistent with increases in the school age population. The impact of the project in 1990 results in an overall 2.5 percent average increase over the baseline forecast.

Total State revenues comprise approximately 75 percent of total school revenues with State Foundation Program revenues accounting for 86 percent of total State funding. Local property taxes provide approximately 15 percent with the remainder of revenues coming from Federal sources. Local property taxes for school revenues are based on a mill levy of 6 mills per $1000 assessed valuation. School Debt Service Reimbursement monies from the State go to the General Fund to pay for major capital projects, and thereby make up the shortfall found between total expenditures and total revenues. The lag between reimbursement of funds and expenditures to be paid produces a short-term impact on fiscal cash flows. This condition would prevail even in the absence of the project.

Total expenditures will follow a similar trend as revenues, increasing by 125 percent in 1990 over 1981 levels and 62 percent over 1990 levels without the project. With the project, increases in expenditures between 1981 and 1990 will average 130 percent and 64 percent between 1990 and 1999. In either case, expenditures for education will be rising at a faster rate than the increase in revenues. Regular instruction comprises 30 percent of total expenditures, with special and vocational education accounting for 10 percent and 2 percent, respectively. Special education is anticipated to increase substantially from 6 percent in 1981 due to the passage of PL 94142. Current plans for capital projects for educational facilities take into account the possible increases in school-age population which will be associated with the project. It is anticipated that school facilities will have sufficient capacity to adequately handle the influx. Average costs of education excluding capital projects are assumed to increase by 5 percent in real dollars by 1990. Average per pupil expenditures excluding capital projects are assumed to be $3,003 per elementary pupil and $3,728 per secondary pupil.

- City of Palmer

  The effects of the Susitna hydroelectric project on fiscal flows in the City budget will be negligible. Total increases in revenues will vary from one percent in 1990 and 0.5 percent in 1999 over the baseline forecast (Table 5.31). In general, increases average 50 percent in 1990 over 1981 and 36 percent in 1999 over 1990 levels assuming normal growth. Between 1990 and 1999 the impacts on fiscal flows will be the same with or without the project averaging a 36 percent increase over 1990 levels.

  Local sources of revenue provide 35 percent of total General Fund revenues: property taxes account for 52 percent of total local revenues and are based on a mill levy of 4 mills per $1000 assessed valuation; sales tax revenues represent the balance of local revenues based upon a 2 percent gross retail sales tax assuming average per capita expenditures of $4,674 per year for retail consumption. In addition, Palmer provides services based upon user-fees to help cover the cost of service delivery. These user fees are assumed to increase 3 percent in real dollars by 1990 and represent 30 percent of total General Fund revenues. There are separate funds for sewer services and water supply with sewer revenues rising at a faster rate than those for water. Both funds levy service user fees.

The ratio of total bonded indebtedness to assessed valuation is currently 4 percent and is not anticipated to exceed this ratio. Total possible bonded indebtedness under these assumptions would be $3.8 million in 1990 and $5.4 million in 1999, with little variation between the baseline and impact forecasts.

Expenditures, like revenues, are not noticeably impacted by the changes in population influx due to the project. Expenditures for social services and facilities rise approximately one percent over the baseline forecast in 1990 at a slightly greater rate than increases in total revenues. Total expenditures increase from $2.3 million in 1981 to $4.2 million in 1990 and reach $5.7 million in 1999 without the project. Expenditures with the project in 1999 will increase approximately half of one percent over the baseline forecast. Between 1990 and 1999 expenditures will average a 36 percent increase among all services with or without the project; This is consistent with population increases of 36 percent between 1990 and 1999. No sudden large capital improvements are anticipated for the City of Palmer with or without the project. Expansion or additions to existing facilities and services appear to be well integrated into the current planning process.

- <u>City of Wasilla</u>

Fiscal impacts on the City of Wasilla will vary due to normal growth and growth attributed to the population influx associated with the project will be negligible. Actual increases in revenues

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and expenditures will average about 90 percent with or without the project, for each decade.

Actual impacts associated with the project will be very small, with increases in revenues and expenditures averaging about 1.2 percent over the baseline forecast in 1990 and about 0.5 percent over the baseline forecast in 1999. The majority of revenues comprise State shared taxes and State revenue sharing. Locally derived revenues from licenses and fines account for only four percent of total revenues, though additional revenues are to be generated from an assessment on lots directly benefitting from a new centralized water supply system. The City of Wasilla does not levy property taxes and it does not utilize service user fees to cover costs of service delivery. In addition, capital projects are funded primarily through State and local grants.

Expenditure forecasts are derived from actual average per capita costs of service, with each service accounting for the following share of total expenditures, excluding capital project costs: parks and recreation seven percent, library 15 percent, fire service 11 percent, local government administration 39 percent, and road maintenance and repair 28 percent. These proportions are assumed to remain fairly constant over the period of the forecasts, with possible increases in administration and road repairs due to the increased population influx.

- City of Houston

The overall impact of the project in 1990 will raise revenues and expenditures approximately 2.7 percent over the baseline forecast and will increase fiscal flows slightly less than one percentage point in 1999 over the baseline forecast. Total revenues and expenditures will rise at the same rate as population increases, doubling approximately every eight years. Houston does not raise any funds locally, either through property assessments or service user fees. Current revenues are derived from State and local grants; this pattern is expected to continue, however, many local revenue generating alternatives are available to the residents within Houston City limits.

As the community grows, it is likely to provide additional services for which it may choose to levy taxes, set user charges or other forms of recipient fees. As petroleum revenues decline in the 1990's and State funding cuts back, local communities and cities will have to find increasingly creative methods of raising funds to cover the costs of service delivery. Local taxes and user fees are the predominant methods used by local fiscal officials.

Expenditures for local government administration represent 47 percent of total expenditures, and road maintenance 29 percent, with fire service comprising 15 percent. This distribution of expenditures is similar to that of the cities of Wasilla and Palmer reflecting similar local priorities. Other major services are provided by the Mat-Su Borough.

- Public Facilities and Services

Public facility and service impacts have been estimated using the following approach: (1) Appropriate per capita standards were developed, based upon an extensive literature review and the input of local officials; (2) the adequacy of existing facilities and services were assessed; and (3) estimates of future needs related to natural growth and to project-induced population influx have been compared with present and planned capacity. With the exception of Trapper Creek, substantial increases in public facilities and services will be needed to accommodate baseline forecast growth, and population influx related to the project will only add slightly to these needs. In contrast, the large proportional increase of population in Trapper Creek will have substantial impacts on the needs for public facilities and services.

. Water Supply

The water supply needs of the project and of the work force and families living at the Watana and Devil Canyon sites will be provided for by the contractors. There will be no impact on public facilities in the Mat-Su Borough.

The population influx associated with the project will have only a slight impact on the public water systems in the Borough. In Palmer, water consumption at the peak of construction at the Watana site (1990) will rise one percent over the baseline forecast level of 608,000 gallons per day; water consumption attributable to the population influx during the Devil Canyon site construction peak (1999) will represent a 0.5 percent increase over the baseline level of 917,650 gallons per day. There will be no additional need for pipe associated with this slight increase in water consumption, as these families are expected to move into vacant housing units, where presumably water lines are already hooked up.

In Wasilla, water consumption is expected to increase by 1.1 and 0.5 percent during the two construction peaks, over the baseline forecast consumption levels during those years. This increase in population will not have major impacts on the Wasilla water system; however, it may contribute slightly to the population density in Wasilla, and thereby contribute to the need for an expansion of the water system (the present system currently serves only the downtown area).

- Sewage

The sewage treatment needs of the work force and families living at the construction sites will be provided for at the work camp and family village. No impacts on the local public facilities are expected.

Population influx into Palmer will result in an increase in sewage treatment requirements of 5,000 gallons per day (0.9 percent) above the 1990 baseline forecast level and 4,013 gallons per day (0.5 percent) over the 1996 baseline forecast level. The population influx during 1983-1990 will occur at a time when existing facilities are already reaching their limits, and a third sewage treatment cell will be required.

Sewage treatment requirements in Wasilla are currently handled by individual septic tanks, but as the city population grows, a city-wide system will be needed with or without dam construction.

- Solid Waste

The solid waste requirements of personnel and dependents living at the construction work sites will be provided for at the camp and village, and will have no significant impacts on public facilities in the Mat-Su Borough.

The population influx into the Borough communities associated with the project will increase the annual landfill needs of the Borough by .069 hectares (ha) (.17 acres) in 1990 and .073 ha (.18 acres) in 1999. This represents 2.5 percent and 1.3 percent increases over the baseline forecast levels in those years. This population increase may contribute to a slight advance in requirements for additional landfill acreage, which is expected to be needed under the baseline forecast conditions around 1994-1995.

- Law Enforcement

The population influx into Mat-Su Borough communities that is associated with the project will increase the requirements of State Troopers by one to two officers over the baseline forecast need of 38 in 1990, the year of peak construction activity.

The project construction contractors will provide for police protection around the dam sites, but it is possible that the State Trooper force in Trapper Creek may be enlarged somewhat to reflect the growing population in the northern part of the Borough during the construction phase of the project.

- Fire Protection

Fire protection planning in rural areas such as the Mat-Su Borough is more dependent on the distance of facilities from population centers than on the size of population. Since inmigrants are expected to settle into existing vacant housing, there will be little impact on fire protection facilities in most communities. Firefighters will continue to be, for the most part, volunteers.

The project facilities and work camp/family village will be protected by firefighting equipment and services at the work sites; there will be little impact on the existing governmental facilities and services.

- Health Care

  The work camp/family village at the construction site will provide facilities for health care, including a 20-bed hospital. It is expected that there will be little impact of the construction-site population on the Mat-Su Borough's health facilities, with the exception of cases of major illness or accidents which cannot adequately be handled by the site hospital.

  The population influx into the Mat-Su Borough communities associated with the project is expected to raise the number of hospital beds needed in 1990 by about one bed. This population influx may contribute to a slightly accelerated need for a new hospital, a development which was projected to be required around 1990 under baseline forecast conditions.

- Education

  School-age children at the construction site will be educated at project facilities and hence will not have an effect on the Mat-Su Borough School District. There will be an increase of 159 primary school children and 133 secondary school children accompanying inmigrants into communities in the Mat-Su Borough during the Watana peak, representing about three percent of the baseline forecast levels. These figures will decline to 127 and 106, respectively, during the Devil Canyon peak. There will be a need of about seven additional primary school classrooms and teachers and seven secondary school classrooms and teachers in 1990, in addition to the 216 primary school and 230 secondary school classrooms which will be needed to accommodate growth without the project.

- Public Recreation Facilities

  Recreational facilities will be provided at the construction site for use by project employees and their families. Thus, residents of the work camp are not expected to have much of an impact on public recreational facilities, although some increase in visits to the national and state parks near Mt. McKinley, and to other parks can be expected. Residents can also be expected to engage in outdoor recreation activites in portions of the upper Susitna basin where no public facilities now exist.

The project-induced population influx into Borough communites will represent 2.6 percent of Borough population in 1990 and 1.3 percent in 1999. This additional population will have a slight impact on the requirements for public recreational facilities.

- Transportation

  The Susitna hydroelectric project includes the construction of a road into an area that currently has no auto access. If policymakers decide to allow public access to this road, the result will be a major addition to the local transportation system. The ultimate status of the road is unsettled at this point, due to environmental concerns.

  It is anticipated that the majority of project-related supplies and equipment will be transported by rail to Gold Creek, and then by truck to the work sites. The rail system is currently underutilized and the increased revenues are expected to benefit the railroad.

  An increase in vehicular traffic on the Parks Highway and nearby roads will result to the extent that pri vate automobiles are allowed to use the access road to the sites. This increase in road traffic could include workers commuting to and from the site, and traffic related to potential recreational activity in the impoundment areas.

- Business Activity

The potential for displacing residences and businesses in Impact Area 1 and for enhancing business activity in the Borough are discussed in this section.

- Residences

  Although some cabins used intermittently by hunters, trappers and recreationists will be displaced by the project, no permanent residences are expected to be inundated or totally displaced. Some residents of the upper basin are expected to voluntarily leave the area for other wilderness regions in response to increased construction and recreational activity.

- Businesses

Most business activities in Impact Area 1 (proximity to dams, access roads and transmission lines) are dependent upon abundance and location of fish and game species. These activities include guiding, lodging, trapping, salmon fishing and other recreation. Short term dis placement of such enterprises by construction activity may occur, but in the long run increased access to the area may increase business opportunities.

Guides are expected to have to adjust to changes in abundance and location of fish and game species, but may benefit from improved access to wilderness areas. Lodges catering to hunters and fishermen will be affected by the same factors, but may find new opportunities to offer access to sports such as cross country skiing or to provide facilities for business conferences. Trappers will be affected by loss of habitat for furbearers. Salmon stocks will be affected by changes in species mix and numbers of fish, but long term impacts on Cook Inlet commercial fishermen, recreational fishermen and other user groups are expected to be minor. Impacts on other types of recreation will include the loss of sections of Susitna River to white-water kayaking, but general recreational use is expected to increase as a result of improved access.

One active mining site is expected to be totally displaced by the project and one inactive site partially displaced. However, the project may prove beneficial to other mining activities by improving access, hence allowing existing claims to be worked more profitably and facilitating discovery of new deposits.

Business activity will increase in the Borough during the mid to late 1980s as a result of road and dam construction at the Watana site. Businesses that supply construction materials such as sand, gravel, fuel, etc., will have increased sales as will firms that provide transportation services such as trucking, helicopter, and airplane support services. Further, it is estimated that by 1990 more than 400 support sector jobs will be created by the project. Existing support sector businesses such as restaurants, service stations, lodging establishments, retail food stores, etc., will expand and new businesses will be started. Most of this activity will be concentrated along the Parks Highway from Wasilla to Cantwell.

- Employment

The Susitna project will dramatically increase the employment opportunities in the Mat-Su Borough. At the peak of project construction in 1990, direct on-site work force requirements of the project will total 3,500, and an additional 428 indirect and induced jobs are expected to be created in the Borough. Altogether, this will represent an increase of 57 percent over the baseline forecast of employment in the Borough (by place of employment).

It is expected that Mat-Su Borough residents will account for over 10 percent of the on-site construction employment and over 85 percent of the indirect and induced employment related to the project.

- Income

At the peak of project employment in 1990, it is estimated that approximately $97.8 million (1980 dollars) in payroll will be distributed to the on-site construction work force. As previously displayed in Section 5.4, Table 5.17, this payroll will be spent in various Census Divisions in Impact Area 3 based on expenditure assumptions. In 1990 it is estimated that approximately $8 million of on-site construction payroll will be spent in Mat-Su Borough; in total, between the years 1983-2002, the figure is $67 million. This payroll spent in the Borough will, in turn, stimulate an increase in indirect and induced business activity and employment.

(ii) Trapper Creek

Impacts of the project on the community of Trapper Creek are summarized in Table 5.36.

- Population

The population influx associated with the project is projected to result in a doubling of the population of this small community by the peak year of project activity (1990), from the baseline forecast (without project) of 320 to the impact forecast of 661 for that year. As the Watana peak winds down and the project work force is cut, about half of the workers and their families will leave the area (166 persons between 1990 and 2002). If new sources of employment do not develop, this exodus could be somewhat larger.

- Housing

The population influx into Trapper Creek between 1983 and 1990 will result in an increased demand for approximately 114 housing units over the baseline forecast level of 107. This is likely to cause a substantial short-term housing shortage. To the extent that this doubling in housing needs cannot be met, it is expected that inmigrants will seek housing in nearby areas of the Borough.

Traditionally, the availability of vacant housing in Trapper Creek has been extremely limited. Under baseline forecast conditions, this trend is expected to continue, as additional housing is built only to satisfy definite needs. Thus, only one or two vacant housing units are expected to be available in 1990, far short of the 114 needed.

It is possible that speculative activity prior to the construction peak period will result in additional housing units being available to meet part of the increase in demand. Some families may reside temporarily in cottages or rooms owned by lodges in the area, and part of the housing needs may be met quickly by purchase of mobile homes and trailers, to be used on individual lots or in trailer parks. While there is not a great deal of private land in the Trapper Creek area, there is a sufficient amount to support the expected population influx.

- Fiscal Impacts

Any analysis of fiscal impacts for Trapper Creek and other small communities would have to fall under the Mat-Su Borough budget as revenues and expenditures are collected and administered by the Borough. Changes in revenue receipts would affect the Borough government directly, and the delivery of services to communities indirectly. The Borough has the power to levy property taxes on service areas to cover the costs of service delivery. These could be impacted due to costs of service delivery which over time could be offset by increases in the tax base.

In FY81/82, the areawide mill levy was 6.7 per $1000 assessed valuation and the non-areawide (service areas only) mill levy was 0.52 per $1000 assessed valuation.

It is assumed that neither Trapper Creek nor other small communities will incorporate before 2000. Although population increases will be substantial, the actual size of the total community is assumed not to be sufficiently large to warrant incorporation. Therefore, the Mat-Su Borough government will remain responsible for the provision of services and facilities to the extent necessary.

The Borough is assumed to levy a total property tax of 6.5 mills per $1000 assessed valuation until 1989 and 6.75 mills from 1990-2000. This will include a mill levy of 0.5 for 1981-89 and 0.75 for 1900-2000, for non-areawide services such as fire and road service. Ambulance service is assumed to continue operating on a user fee basis. Projections of estimated local taxes to cover the costs of capital projects can not be made as this will depend upon the size of the project, the availability of State and Federal grant monies, local preferences, and the Mat-Su Borough's bonding capabilities.

The dominant fiscal impact experienced by the Borough Administration will be the result of cash-flow cycles. Initially the costs of service delivery will be accelerated and these will not be matched by an immediate parallel increase in revenues. It is anticipated there will be a two-year lag between the receipt of revenues and the outlay for additional service costs. This lag is a function of the time it takes to input new property owners on the tax rolls, for the property assessments to be made, and taxes collected.

- Public Facilities and Services

- Water, Sewage and Solid Waste

  Water and sewage needs are met by individual wells and septic tanks, and solid waste is disposed at a nearby landfill run by the Borough. No adverse impacts caused by the population influx as such are probable.

  It is anticipated that Borough and State oversight of growth of Trapper Creek could prevent any problems of hastily built housing developments that do not meet health standards for wells, septic tanks and trash disposal.

- Transportation

  Increased vehicle traffic on the Parks Highway is expected. The addition of housing units may result in additional roads to serve them, and the increased population may add to the need for additional paved or gravel roads.

- Police Protection

  It is possible the project and the increased population in the northern part of the Borough will induce an enlargement of the State Trooper substation at Trapper Creek, thus resulting in an increased police presence in the community.

- Fire Protection

  The population influx into Trapper Creek will exacerbate the need for active fire facilities in the community. It is possible that the additional population added to the natural growth over the 1983-2000 period could stimulate the Borough to create a fire service area for Trapper Creek.

- Health Care

  With the exception of an ambulance, no health care facilities are currently available in Trapper Creek. The population influx associated with the project is not expected to have an effect on health care for Trapper Creek residents.

- Education

  The planned six-classroom elementary school in Trapper Creek will have a capacity of 150 students. It is anticipated that the population influx associated with the project into Trapper Creek and the surrounding area could bring the school's enrollment close to capacity by the peak year of construction at the Watana site. The combination of natural population growth and the continued presence of over half of the inmigrants associated with the project will result in a need for additional classroom space in the 1990's.

- Business Activity

  It is not expected that business activity will change appreciably in Trapper Creek during the 1980s if the dams are not built. By 1990, project-induced demand for services will equal or exceed that of the forecast baseline population. With dam construction it is very likely that Trapper Creek will have service types and levels similar to those of Talkeetna today. Because Trapper Creek is on the Parks Highway, it could even have more service businesses than present-day Talkeetna by 1990.

- Employment

  The Susitna project will present vastly increased employment opportunities for residents of Trapper Creek, both in terms of on-site construction, and in terms of jobs in the support sector.

- Income

  Income spent in Trapper Creek is anticipated to increase sharply during the construction phase of the project, as a result of the increased employment of local residents and the inmigrant population, and as a result of expenditures made by work camp residents on items such as food, beverages, gasoline and recreation.

(iii) Talkeetna

Table 5.37 displays a summary of the expected impacts of the project on Talkeetna. In general, this analysis refers to the area that was proposed for incorporation in 1981.

- Population

Between 1983 and 1990, an estimated population influx of 263 is expected to occur as a result of the project. This will represent a 26 percent increase over the baseline forecast of 1,000. By 1999, 210, or 80 percent of the earlier population influx will remain. A further moderate decline in population of 37 is expected between 1999 and 2002.

- Housing

The population influx related to the Watana construction phase will result in an addition of 87 households between 1983 and 1990 to the Talkeetna area. As in Trapper Creek, a shortage of available housing is probable. Under baseline forecast conditions, only six vacant housing units will be available in that year. This estimate is based on the community's historically low vacancy rate.

The expected short-term shortfall in housing supply may be made up by speculative advance construction, temporary residence in local lodges/hotels, the use of mobile homes and trailers, and rapid construction. To the extent that the housing supply cannot meet demand, it is likely that some inmigrant families will find housing elsewhere in the northern part of the Borough.

- Fiscal

Baseline and impact forecasts for revenues generated by or on behalf of the Talkeetna Service Areas for the Mat-Su Borough Administration are shown in Table 5.35. Due to substantial population changes caused by the project, there will be a 26 percent increase in revenues from property taxes in 1990 over the baseline forecast for 1990. The change due to normal growth would increase revenues by 134 percent without the project and 196 percent with the project, over 1981 levels. Increases of 13 percent between 1990 and 1999 with the project are consistent with other trends where the changes due to the project are twice as large in 1990 as they are in 1999. Property tax revenues are based upon a non-areawide mill levy of 1.5 mills in 1990 and 1.75 mills in 1999 per $1000 assessed valuation.

State General Revenues for fire service areas are based upon population and therefore will follow the same trend as property tax revenues, increasing 26 percent in 1990 and increasing 13 percent in 1999 over the baseline forecast. Revenues for road maintenance and repair are assumed to increase 10 percent per year in 1981, consistent with assumptions regarding all revenues for maintenance of roads within the Borough that will experience significant increased use.

Total revenues to the Borough will increase 116 percent from 1981 to 1990, and 130 percent from 1990 to 1999 without the project. Total revenues to the Borough with the project will increase 10 percent in 1990 and four percent in 1999 over baseline forecast.

The community of Talkeetna is assumed not to incorporate before 2000 if the Susitna project is not built. Under these conditions the Matanuska-Susitna Borough will continue to provide services, including ambulance, fire protection, solid waste disposal, and road maintenance and repair. Police protection will continue under State Troopers. Services will be administered by Borough officials and paid for by the Borough government out of funds derived both locally and from the State. Property located within the service boundary will continue to be liable for taxes levied to cover the costs of service delivery. The mill levy for education is assumed to remain constant at 6.0 mills per $1,000 assessed valuation. The nonareawide tax mill levy is assumed to increase, thereby generating additional revenues over and above those that result form real increases in the value of property over time.

In addition to stimulating revenues and raising expenditures for service delivery, the impact of the Susitna hydroelectric project is likely to accelerate the time-table in which the Talkeetna community will decide to incorporate. The increased population influx will act as an impetus for the community to organize itself such that it can control the delivery of necessary services. The City of Talkeetna would be able to levy taxes to cover the costs of government administration and service operations, functioning either as a second class city or a Home Rule city. The city is likely to elect to provide its own fire and ambulance services and as a second class city, would continue police protection under State Troopers. The Mat-Su Borough would continue to provide services to the road service area which would exclude the city limits of Talkeetna. Local government would then be responsible for providing road maintenance and repair within the City limits. The Borough would continue to levy non-areawide taxes for services delivered under non-areawide powers. The areawide tax would also be levied to cover the costs of education provided by the Mat-Su Borough School District.

Any additional fiscal expenditures are not anticipated. It is assumed that individual septic tanks will continue to be the mode of sewage disposal. Water supply systems are anticipated to remain as wells on individual lots. However, should city lot sizes prove to be inadequate for individual wells, the residents may elect to build a community well. The costs of this would most likely be borne by those residents who directly benefit from the improvements. Solid waste will likely continue to be disposed of at the Borough land fill sites. The majority of funding for capital projects is assumed to be grant monies derived from either Borough or State funds. Local shares will likely be paid for by monies derived from taxes levied on residents who benefit directly or by issuing municipal bonds.

- Public Facilities

  - Water and Sewage

    As in Trapper Creek, it is possible that quickly constructed housing will need to be closely supervised to ensure compliance with health standards regarding wells and septic tanks.

  - Solid Waste

    The peak population influx into Talkeetna associated with the project will occur just around the time that the Borough's landfill near Talkeetna is expected to be closed (1987-89). A new landfill or a transfer station will be needed at that time. The additional population is not expected to have any adverse impacts.

- Transportation

  Construction of new housing may result in the need for additional roads to serve these new units.

- Police Protection

  As Talkeetna grows, there may be a community desire for a police presence closer than the Trapper Creek substation. The additional 26 percent population influx associated with the project between 1983 and 1990 and the proximity of the work camp to the community may further reinforce this tendency.

- Fire Protection

  Increased population is not expected to affect firefighting facilities in the area; these are planned on the basis of distance between the station and population centers, and on the availability of pumped water. The planned addition of equipment to the Talkeetna fire station should be sufficient to serve the community until such time as a community water system is put into place.

- Health Care

  Residents of Talkeetna currently use the health care facilities in the southern part of the Borough and Anchorage. The population influx related to the project is not expected to have any adverse impacts.

- Education

  The population influx associated with the project will include approximately 38 primary school-age children by 1990, just as the enrollment in the elementary school in Talkeetna is projected to exceed its capacity of 120. Additional classroom space and teachers will be needed.

  Between 1990 and 1999, facilities for an additional 76 elementary school children will need to be built, as a result of baseline forecast growth. The Susitna project is expected to have limited impacts during this period.

There will be an additional 31 secondary students associated with the project attending Susitna Valley High School in 1990 over the baseline forecast level. By 1999, this will decline to 26.

- Business Activity

By 1990, without the project, the demand for services will almost double. It is expected that existing businesses will operate at fuller capacity and some will expand their services. A few new businesses will emerge to meet the increased demands. Some of these might offer services not currently available in Talkeetna.

The project is expected to have a significant impact on Talkeetna's business activity as new residents and workers from the project spend their income in Talkeetna. The new residents will have spending patterns similar to those residents now living in Talkeetna, and the workers who come to Talkeetna for short visits will be expected to concentrate their expenditures on food, beverages, lodging, and related items. If workers make visits to Talkeetna frequently (this would be probable if workers are allowed to fly to and from the construction site), the demand for services could be double that implied by the 1990 baseline forecast of population.

- Income

Income spent in Talkeetna is anticipated to increase somewhat during the construction phase of the project, but at a more moderate level of increase than that anticipated for Trapper Creek. The increase in income and expenditures will be primarily in the form of local residents obtaining employment on the project and due to the inmigrant workers and families. In that Talkeetna is situated off of the Parks highway and that the proposed access route does not go through Talkeetna, there will be fewer purchases of supplies and other goods and services made by work camp residents in Talkeetna. However, if workers are able to fly into Talkeetna from the work camp, then considerably more income could be spent in Talkeetna, particularly for food, beverages and lodging.

(iv) Sociocultural Impacts

The sociocultural impacts discussed in this section (Section 5.5(a)(iv) are extracted from a study prepared by Stephen R. Braund & Associates for the Susitna Hydroelectric Project. The impacts are based on population, school-age children, and housing stock projections. In this section, the Base Case refers to baseline forecasts (i.e. future projections without the Susitna Project). These Base Case projections are then compared to the forecasts of population, school-age children, and housing stock in the local communities which have resulted from the project. The difference between the two forecasts results in the project impacts. These community level forecasts are only available for Trapper Creek and Talkeetna; therefore, the discussion of impacts related to the railroad communities north of Talkeetna is totally qualitative.

For purposes of analysis, only the population projections specifically allocated to Trapper Creek and Talkeetna were used. If those project-related people who locate outside of the immediate cities and communities (See the "Other" category in Table 5.23) are proportionally allocated to the greater Trapper Creek and Talkeetna "areas", the impacts discussed below would be greater.

The Susitna Project will cause a 61 percent population increase in Trapper Creek from 1986 to 1987. (The project adds 175 residents to a Trapper Creek Base Case population of 285 for a total population of 460). Included in this one year population influx are 45 school-age children. By 1990, the Watana peak, Trapper Creek is projected to have a population of 661, over twice as many people as without the project (320). Included in these cumulative figures for 1990 are an additional 88 school-age children (a 117 percent increase over the 75 Base Case projections). Also, by 1990, project-related families who move to Trapper Creek will require an additional 133 housing units over the Base Case housing stock.

As Watana winds down, the work force is reduced, and some families leave the area. The low point between Watana and Devil Canyon construction occurs in 1995, when project-related population in Trapper Creek drops to 198 (from a high of 341 in 1990). As a result, Trapper Creek's population drops from a high of 661 in 1990 to a low of 588 in 1995 (11 percent drop). (Although 143 project related people leave the community, Base Case growth adds 70 persons during the same period.

Consequently, a total of 213 move in and out of Trapper Creek.) At the peak of Devil Canyon construction in 1999, the project accounts for 245 of Trapper Creek's 701 people (a 54 percent increase over the Base Case population of 456). By the end of the project forecast period (2002), 70 project-related people (29 percent of the 1999 peak) leave Trapper Creek. It is assumed that Base Case growth accounts for 57 additional inmigrants for a net population loss of 13 people between 1999 and 2002.

Although the long time frame of the Susitna Project will cushion any final decline (one is hardly noticeable by the year 2002), the projected rapid influx of project-related persons in Trapper Creek between 1986 and 1990 will result in a boom situation for the community. According to Davenport and Davenport (Boom Towns and Human Services, University of Wyoming Publications, Laramie, Wyoming, 1979) a "boom town" is defined as:

1. A community experiencing above average economic and population growth;

2. which results in benefits for the community, e.g. expanded tax base, increased employment opportunities, social and cultural diversity;

3. but which also places or results in strain on existing community and societal institutions (e.g. familial, education, political, economic).

Not all impacts associated with boom towns are negative. For example, positive consequences include substantial benefits to the local economy such as more jobs, more businesses, higher pay scales, increased prosperity, and an increased tax base. In addition, an expanded and updated educational curriculum may result from the new demands made by incoming students and their parents. Generally, the benefits associated wtih rapid growth caused by a large development project are primarily economic. In the case of Trapper Creek, for the segment of the population which is not primarily motivated by economic advancement, the negative effects of rapid growth will likely overshadow any benefits.

Among the consequences and human costs associated with boom towns, the following major problem areas have been identified ("The Sociological Analysis of Boom Towns". In Boom Towns and Human Services, Davenport and Davenport, eds, 1979):

- Demands for and strain on existing facilities and services, including human services such as marital, child abuse, and delinquency counseling, that exceed the capacities of local systems to meet them.

- Economic problems centered around high inflation caused by increased demands of large numbers of incoming project-related personnel and families (increased cost of living, especially for housing; new pay scales beyond the limits of some local business; more formality in conducting business; and hardships associated with inflation on those living on fixed incomes such as the elderly or chronically unemployed).

- Increases in the incidence and nature of many "people problems" (rise in alcoholism, child abuse, crime, suicide attempts, divorce, and the lack of trained medical personnel), likely associated with stress related to rapid change.

- Potential conflict between the values, norms, beliefs and lifestyles of local residents and the newcomers.

- Local government is forced to take a more active and expansive role in the lives of community residents as it tries to expand services and respond to rapid growth. Generally, a time lag exists between the demand for services and their availability.

Based on its lack of infrastructure, its small rural nature, and the characteristic that a significant portion of its residents are not primarily motivated by economic advancement, most of the preceding general comments related to boom town problems seem to apply to Trapper Creek. In addition, the problems are compounded by the 1995 lull and a second project peak in 1999. Based on the projections, Trapper Creek will experience a boom (1986-1990), a downswing (1991-1995), an upswing (1996-1999), and a slow decline in project-related persons beginning in 2000. The lull in the early 1990's could be especially problematic as workers (especially indirect and induced) will live in anticipation of another project. This period will likely be easier for direct construction workers, as they will probably go elsewhere to work.

Uncontrolled rapid growth generally results in negative consequences. Local residents who live in the small community prior to the growth tend to blame the developer and the new residents for problems associated with population influxes. These problems are exacerbated if the community does not have the infastructure to accommodate the new growth. Resentment between current residents and newcomers may develop because the former often bears the burden of the expense for new facilities and services, often in the form of higher taxes. The result is often citizen against citizen; the town against the developer; and local government against higher levels of government (Borough and State).

One way to diffuse many of these potential conflicts is to distribute the costs and benefits of the project equitably (Jirovec. "Preparing a Boom Town for the Impact of Rapid Growth." In Boom Towns and Human Services, Davenport and Davenport, eds., 1979). In this case, those who gain the benefits (the developer, the state) help pay the costs. In this way, those who generally pay the costs (the rural community resident) are protected and their quality of life preserved.

Generally, a town facing rapid growth desires to develop the local capability to assure that the effects of growth will be as beneficial as possible. Controlling the impacts of rapid growth on small, rural towns within the context of local values begins with community planning, community organization, and research. As Jirovec points out, urban planning techniques may not apply; a rural community needs rural planning. The success of any plan depends on community support and organization. In addition, it requires the developer to share with the community detailed information about the project. Finally, a community requires time (i.e. 2 years) for planning and preparation for rapid growth.

Even if it is effectively managed, boom growth apparently results in increased urbanization and modernization of the rural style of living -- the population becomes more diverse; current residents know a smaller percentage of their neighbors; more and more interactions between people become formal and con-tractual rather than personal and face-to-face (Cortese and Jones, 1979). Planning and community organization to prepare for the boom become part of the problem. The planning process typically adds anonymity, differentiation, bureaucratization, impersonalization, and so forth (Cortese and Jones, 1979). In effect, in rural communities, the solution can become the problem. According to Jirovec (1979) prospective boom towns must choose between uncontrolled rapid growth (with many negative side-effects), managed or controlled rapid growth (with greater urbanization and modernization), or moderate or no growth (which would maintain the status quo). From the community perspective, local residents do not always have the latter choice.

Based on the population forecasts (both Base Case and project-related), the most significant feature of Talkeetna's future is the constant growth without the project. Whereas Trapper Creek experiences a boom between 1986 and 1990, Talkeetna's project-related population, during the same period, only increases 6.5 percent per year over the Base Case projections. During the biggest year of project impact, 1986-1987, the project adds 138 persons to a Base Case population of 862. This represents a one year increase of 16 percent where Trapper Creek had a 61 percent project-related increase in the same year. The forecast situation in Talkeetna emphasizes that although project impacts are much less than Trapper Creek, the cumulative effect of both the Base Case population increase and the project-induced growth is significant and represents the real change with which Talkeetna must contend.

Without a community effort to identify and implement common goals, this growth in Talkeetna may result in the community losing its small-town, rustic, frontier flavor which attracts many tourists. It will likely continue as a tourist town and staging area for McKinley climbing parties. The increased population and access related to the project will likely result in increased rate of decline in local wildlife populations, which local residents value highly. Increased human populations in the work camps and increased aerial activity will likely contribute to this trend.

It is possible that many more people than are anticipated will move to Talkeetna as a result of the project. This partially depends on the new work schedule, whether Trapper Creek successfully accommodates its projected growth, and the possibility that people find Talkeetna, despite its aditional 30 miles from the project, a more desirable place to live. Because Talkeetna and Trapper Creek are similar communities, all of the potential problems discussed for Trapper Creek increasingly apply to Talkeetna as its population (both with and without the project) increases, and therefore are not discussed here.

Although there is an abundance of land available, primarily due to the State land disposals, it is unlikely that the permanent population in the Chase/Curry area will increase dramatically, either with or without the project. Without the project, employment opportunities will likely remain relatively non-existent, and the main attraction to the area will continue to be recreational for most people and residential for only a few persons. In this area, the recreational impact, again both with and without the project, could be significant. Without the Susitna project, recreation seekers will continue to use the area as Talkeetna continues to promote tourism. As more and more people visit this subregion, the chances that they will apply for some of the surplus available State land increases. The railroad will continue to provide access into the area, and although it will likely remain relatively unpopulated, seasonal recreationists will probably increasingly visit it. As more and more of the existing residents in this area have families, they will likely desire additional services, such as a school and better access to Talkeetna.

With the Susitna project, recreation in the area will more than likely significantly increase (i.e. more than without the project). Workers and their families who move to the area will certainly hunt, fish, and participate in other outdoor activities. Improved access to and increased awareness of the area east of the Susitna River due to the project, will likely attract more recreationists. The proposed access road will provide vehicle access to the east side of the Susitna River and therefore make the general area more accessible to more people. (Policies related to public use of this road during and after project construction could postpone or prevent some or most of the impacts. As more and more people recreate in this area, the chances for conflict between them and local residents increase.

The Susitna project will result in increased employment for residents in this area, which will enhance the well-being in these communities by providing potential jobs. At the same time, the increased employment opportunity created by the project will attract more people into the general area. This population influx will likely have a negative effect on the existing small town or rural way of life for those people in the railroad communities who value relative isolation in a wilderness environment.

With the project, the Gold Creek area is likely to be the most heavily impacted. If the proposed access route is chosen, Gold Creek will be connected by an 18 mile road to the Parks Highway. The patented homesteads in the vicinity comprise a private land base that could accommodate future expansion and growth, a likely occurrence if the area becomes easily accessible by road. People affected by this potential development will be mainly local miners, a few local residents, and absentee, recreational property owners, all of whom value their wilderness retreat. If vehicular access occurs in this area, local residents and absentee landowners between Hurricane and Gold Creek, as well as entrants in the Indian River Remote Parcel land disposal will be subject to increased traffic, noise, and congestion.

Currently, no one lives in the Hurricane/Parks Highway area nor are any services available: however, three factors indicate that some development may occur here related to the project: it is the intersection of the proposed access road and the Parks Highway, private land is available, and it will be only 44 road miles from Devil Canyon. In the spring of 1981, the State of Alaska offered the Indian River subdivision. Located at the junction of the Parks Highway (Mile 168) and the Alaska Railroad (just south of Hurricane), access is available from both the Parks Highway and the railraod. The 140 separate four to five acre lots in this subdivision as well as the roads are surveyed and platted, although the roads within the subdivision are not constructed. Currently, none of the lots have any structures on them.

Because of their location, it is likely that some people will buy these lots, and, if the project proceeds, a small settlement will probably develop. Currently, there are no services here, and, even with the project, it is unlikely that a school will be constructed in the vicinity. Families that locate in the Hurricane area could use the Trapper Creek Elementary School and the Su-Valley High School; these facilities are 54 miles and 69 miles away respectively. Because of the relatively long distnce to these schools, it is unlikely that many families with children will locate in the Hurricane area. It is more reasonable to assume that single persons or couples without children will acquire lots in the Indian River subdivision and move a trailer or build a small cabin on their land.

Once the project begins, it is likely that a limited amount of services will appear near the subdivision: for example, a service station, restaurant, bar, and motel (lodge). Because no one currently lives in this area, this development will not impact an existing community. Without the project, people may purchase lots from the State, and a few persons may build recreational cabins. If the proposed access route becomes final, it is likely that people will purchase lots in the Indian River Subdivision for speculation. In this respect, the project, whether it is built or not, will influence land values in the area.

Cantwell, situated 85 road miles from Devil Canyon, lies at the extreme boundary for worker commutation to the construction site. However, in practical terms, the 41 highway miles between Hurricane and Cantwell are winding and seasonally hazardous. This distance, combined with lack of available private property, makes it unlikely for construction workers or secondary or induced work forces to make Cantwell their place of primary residence.

This is not to say that Cantwell will not see itself as significantly affected by the design of the project. Briefly, the growth and development of Cantwell is limited by unavailability of private land and of economic opportunity (jobs or business). As a consequence, neither incoming populations nor the school children of current residents perceive much opportunity to settle in this otherwise attractive locale. Many local residents rely on seasonal and/or nonlocal employment in order to continue to reside in Cantwell.

In order for Cantwell residents to participate effectively in the project, they will be compelled to move closer, individually, to the job site during the construction period (similar to workers coming from Anchorage or Fairbanks). While they may receive somewhat more highway traffic and highway business due to generally increased activity within the region as a whole, these benefits are likely to be offset by the personal, familial, and economic costs of temporary and permanent outmigration.

(b) Region

Table 5.38 summarizes the major impacts of the Susitna hydroelectric project on Impact Area 3 (the Railbelt).

(i) Population

The Susitna project is expected to stimulate a population influx of 2,324 between 1983 and 1990 into Impact Area 3. This will represent less than a one percent increase over the baseline forecast for that year. Of this total, 1,137 will relocate in the Municipality of Anchorage. The population impact on Fairbanks is expected to be slight. Few people are expected to settle in Cantwell due to the lack of available housing and of land to build on and distance to the project site.

(ii) Housing

No significant impacts of the project are expected on housing conditions in the Railbelt, outside of the Mat-Su Borough. The estimated vacant housing units in 1990 in Anchorage and Fairbanks alone, (4,033 and 1,200, respectively) should be far more than sufficient to accommodate the additional 482 households associated with the project.

(iii) Fiscal Impacts

Baseline and impact forecasts for expenditures in Anchorage and Fairbanks are provided in Table 5.39. The project has little impact on either city. Total expenditures in Anchorage are projected to increase one-half of one percent in 1990 due to the project and remain almost the same as baseline forecasts for 1999. Normal growth as measured by the baseline forecast will result in a 32% increase in expenditures by 1990 over 1981 levels and an 11% increase between 1990 and 1999. Increases are evenly distributed among all categories of service.

Total expenditures in Fairbanks increase eight-tenths of one percent over the baseline forecast for both 1990 and

1999. This constant rate of change is reflected by the fact that with or without the project the population in Fairbanks will increase 30 percent between 1981-1990, and 16 percent between 1990-1999. (The prevailing trend in Impact Area 2 has indicated a decrease of 50% in the total fiscal impacts between 1990 and 1999 due to a decreased rate of population growth.) Natural growth in Fairbanks without the project is projected to increase total expenditures by 35% in 1990 over 1981 levels, and by 17% in 1999 over 1990 levels. Once again, increases are evenly distributed among all categories of service.

(iv) Employment

The direct, indirect and induced employment opportunities in Impact Area 3 associated with the project are expected to reach a peak of 6,365 persons in 1990. This will result in a three percent increase over the baseline forecast level of 200,112 in that year. Residents of Impact Area 3 are expected to obtain approximately 80 percent of the new jobs created.

(v) Business Activity

The new employment opportunities created by the project will provide considerable stimulus to the Railbelt region economy during 1987-1990. Anchorage and Mat-Su Borough (particularly Trapper Creek and Talkeetna), will receive the most stimulus. Secondary manufacturing (reforming steel, for instance) could develop in Anchorage. Fairbanks, Kenai-Cook Inlet, and Palmer, Wasilla, and Houston will receive significant stimulus. Industry sectors that will be most affected include: construction, transportation, wholesale and retail trade, real estate, and services.

If the natural gas pipeline is constructed by 1987, it is probable that these sectors will experience a boom period, particularly in Fairbanks and Anchorage. Impacts elsewhere in Impact Area 3 would be much less pronounced. In this case, the employment opportunities made available by the Susitna project could serve to help prevent the Fairbanks and Anchorage economies from stagnating or possibly even retrenching upon completion of the pipeline.

(vi) Income

Construction of the Watana and Devil Canyon dams will generate approximately $834.3 million in direct on-site construction payroll during the years 1983 through 2002. Based on assumptions of construction work force expenditure patterns, it is estimated that approximately 50 percent, or $418 million, of this payroll distributed will be spent in Impact Area 3. This figure represents 80 percent of total expendable payroll after taxes and savings are subtracted. The income generated and expended in Impact Area 3 is a contributing factor to the indirect and induced employment opportunities in Impact Area 3 outlined above.

5.6 - Mitigation Process

Mitigation refers to the process of lessening the harsh or undesirable effects that transpire as a result of a certain action. The definitions of harsh and undesirable are purely subjective and are voiced as a community consensus. Each individual within the community will have different definitions and in all likelihood, each individual's definitions will change with time.

An individual's, or community's attitude toward change, and rate of change, is an important consideration in developing an effective mitigation plan. Attitudes toward change, ways of mitigating change, and developing mitigation plans are elements discussed below as they relate to potential socioeconomic changes resulting from the Susitna Hydroelectric Project.

(a) Attitudes Toward Change

Persons in Anchorage, Fairbanks, Cantwell, and in the major communities of the southern part of the Mat-Su Borough generally favor economic growth and development in their area. Some of the residents of Trapper Creek, Talkeetna and the "railroad communities" are in favor of economic growth and development and others are against it or undecided. Most of these residents are very concerned about the types and rates of project-induced changes.

The impact analysis results of Section 5.5 indicate that Trapper Creek and Talkeetna are likely to experience significant changes at a rapid pace. Given this analysis and the current range of attitudes toward changes in these communities, it would be appropriate to consider identifying means of mitigating the changes in those communities. Further, it would be appropriate to identify means of enhancing changes in Anchorage, Fairbanks, Cantwell, and the major communities of the southern part of the Mat-Su Borough. This could be done to the extent that the changes stimulated economic growth and development at appropriate rates.

Because project-induced changes will begin to occur in the mid to late 1980s in Trapper Creek and Talkeetna, and because there will be significant population growth in both of these communities between now and the mid to late 1980s, it would be appropriate to reevaluate any mitigation plans that might be developed in the near future. The reason for this is that persons who move into these communities may have attitudes different from the current consensus of attitudes, and current residents' feelings toward changes might be different in the future from what they are now. This argument also holds for other cities and communities that could be affected by the project.

(b) Ways to Mitigate Change

Changes in Trapper Creek and Talkeetna will be caused by influxes of new residents and frequent stops by construction workers and workers who supply materials for construction. Changes will include increased employment opportunities, increased revenues for service and related businesses, increased demand for housing, schooling, and other public facilities and services, increased vehicular traffic and population density, etc. Those changes that are considered harsh or undesirable are candidates for mitigation.

In general, population influx and workers stopping in these communities could be controlled or mitigated by establishing policies and associated regulations before, during, and after dam construction. Several policy issues to consider prior to construction include: (1) type and size of construction work camp and village; (2) type, origin, pick-up points and cost (to workers) of mass transit to construction sites; (3) camp rules (e.g., whether workers are allowed to drive personal vehicles or fly chartered planes to the construction site); (4) work schedule (e.g., four weeks on, one off; or seven weeks on, two off); and (5) public use of the access roads during and after construction. Decisions on these and other policy issues will influence both the magnitude and geographic distribution of changes. As these decisions are made, communities can begin to develop policies and plans to mitigate or enhance changes in their own area.

It should be noted that, as the baseline forecasts indicate, changes are going to occur in Talkeetna and Trapper Creek regardless of the hydroelectric project. It is as important for these communities to plan for these changes as it is for them to begin to consider mitigating and enhancing changes that could occur if the hydroelectric facility is built.

(c) Developing Mitigation Plans

Mitigation planning is a dynamic process. The plan must be flexible and reevaluated at regular intervals; attitudes change and potential and actual types and rates of changes might be significantly different from previously anticipated developments.

This implies that it is essential to monitor attitudes and changes and to update forecasts of changes. For example, the impact forecasts in this report are based on a series of assumptions. These assumptions were made using the best available information and thorough, systematic research and analysis. There is no doubt that more accurate forecasts of change could be made next year or in some later year. An accurate forecast is a prerequisite to a successful mitigation and enhancement plan. If the forecast were substantially inaccurate, then the mitigation and enhancement could be totally ineffective or, worse, could make conditions less desirable rather than better. Even with accurate forecasts, the plan could fail because it reflects old attitudes that have since changed.

Every mitigation plan development process should ideally be composed of at least the following:

1. Initial impact forecasts should be made.

2. Impact areas with appropriate representation (e.g., community council, community impact task force, etc.) should be clearly defined.

3. The roles and responsibilities of government institutions and contractors involved with the project should be clearly defined.

4. An effective communication system between (2) and (3) should be established.

5. Draft mitigation and enhancement plans should be developed based on initial impact forecasts.

6. Attitudes and changes should be monitored.

7. Forecasts should be updated based on changes to date and other new information.

8. Draft mitigation and enhancement plans should be revised to reflect new attitudes and revised impact forecasts.

9. Revision of plans should occur at regular intervals.

These elements will help insure the mitigation and enhancement plans are successful. The reason that most mitigation plans have failed or have been only partially successful is that one or more of these elements were neglected.

TABLE 5.2: TOTAL RESIDENT POPULATION AND COMPONENTS OF CHANGE BY IMPACT AREA: 1970-1980

	Impact Area 2 (a) Matanuska-Susitna Borough	Impact Area 3 (b) Railbelt (d)	Impact Area 4 (c) State
1980 Census	17,766	284,166	400,481
1970 Census	6,509	204,523	302,361
Net Change	+11,257	+79,643	+98,120
Percent Change	+173	+39	+32
Change in Military Pop.	+141	-4,730	-8,102
Natural Increase (Births & Deaths)	+1,430	+45,107	+61,142
Implied Net Civilian Migration	9,686	39,266	45,080

a. Includes Impact Area 1.
b. Includes Impact Area 2.
c. Includes Impact Area 3.
d. Fairbanks, S. E. Fairbanks, Mat-Su, Anchorage, Kenai Peninsula, and Valdez-Cordova Census Divisions.

Sources: U.S. Census Bureau and Alaska Department of Labor, Administrative Services Division. Alaska's 1980 Population: A Preliminary Overview. Juneau, Ak. p. 26.

TABLE 5.2: CIVIALIAN LABOR FORCE DATA AND PERCENT UNEMPLOYED FOR SELECTED AREAS (a)

Area	1970 Labor Force	1970 Percent Unemployed	1975 Labor Force	1975 Percent Unemployed	1979 Labor Force	1979 Percent Unemployed
State	116,800	10.3	155,104	6.9	180,000	8.9
Study Area 3	79,347	9.9	110,283	6.1	126,110	9.0
Anchorage	51,398	8.3	65,938	5.9	78,822	7.1
Fairbanks	18,003	10.4	24,989	4.8	20,537	12.3
Kenai-Cook Inlet	5,727	17.1	8,576	8.7	10,971	12.1
Seward	938	17.1	1,255	9.2	1,494	10.9
Southeast Fairbanks	(included in Fairbanks)		2,041	3.8	2,052	10.7
Matanuska-Susitna	2,130	20.3	4,784	11.1	9,018	13.8
Valdez-Chitina-Whittier	1,151	11.5	2,700	5.3	3,216	9.5

a. By place of residence

Source: 1970 data - Alaska Department of Commerce and Economic Development, Division of Economic Enterprise.

1975 and 1979 data - Alaska Department of Labor, Research and Analysis Section.

TABLE 5.3: COMMUNITY POPULATION: MATANUSKA-SUSITNA BOROUGH CENSUS DATA 1939, 1950, 1960, 1970, 1976, 1980, 1981

Community	1939	1950	1960	1970	(a) 1976	(b) 1980	(a) 1981
Talkeetna	136	106	76	182	328	265	640
Willow	N.A.(c)	N.A.	78	38	328	134	N.A.
Wasilla	96	97	112	300	1566	1548	2168
Palmer	150	890	1181	1140	1643	2143	2567
Montana	N.A.	N.A.	39	33	76	40	N.A.
Big Lake	N.A.	N.A.	74	36	721	412	2408
Butte	N.A.	N.A.	559	448	2207	N.A.	N.A.
Chickaloon	11	N.A.	43	22	62	20	N.A.
Eska Sutton	14	54	215	89	496	N.A.	N.A.
Houston	N.A.	N.A.	N.A.	69	375	325	600

COMMUNITY POPULATION: OTHER COMMUNITIES NOT IN MATANUSKA-SUSITNA BOROUGH

Community	1950	1960	1970	1976	(b) 1980
Nenana	242	286	382	493	471
Healy	N.A.	N.A.	79	503	333
Cantwell	N.A.	85	62	N.A.	95
Denali	N.A.	N.A.	N.A.	N.A.	3
Paxson	N.A.	N.A.	20	N.A.	30
Glennallen	142	169	363	N.A.	488
Copper Center	90	151	206	N.A.	213
Gakona	50	33	88	N.A.	85
Gulkana	65	51	53	N.A.	111

a. Mat-Su Borough Survey. The methodology for these surveys differs from U.S. Census data and hence the 1976 and 1981 figures are not comparable to Census data.

b. Alaska Department of Labor, Administrative Services Division. January 1, 1981. Alaska 1980 Population: A Preliminary Overview. Juneau, Ak.

c. N.A. = Not Available.

Source: Matanuska-Susitna Borough Planning Department. April 1978. Phase I: Comprehensive Development Plan. Palmer, Ak.

TABLE 5.4: 1981 HOUSING STOCK ESTIMATES AND VACANCY RATES, BY AREAS OF MATANUSKA-SUSITNA BOROUGH

Area	Number of Units	Percent of Total	Vacancy Rate
Talkeetna	196	2.3	1.0%
Houston	229	2.7	9.6
Big Lake Special Area	1,750	20.4	49.9
Wasilla	718	8.4	6.7
Suburban[a]	3,801	44.3	6.8
Palmer	872	10.2	10.2
Other Areas	1,016	11.8	52.8
Average Mat-Su	8,582	100.0	20.6%

a. Includes an area that is outside of Palmer and Wasilla's city limits and extends west to Houston and east to Sutton.

Source: Mat-Su Borough Planning Department.

TABLE 5.5

COMPARISON OF AVERAGE PER CAPITA EXPENDITURES FOR SELECTED SOCIAL SERVICES.

	LOCAL GOVT ADMIN	POLICE	FIRE	AMBLNC	PARKS & RECR	LIBRARY	HEALTH CARE	TRANS	SEWAGE SERVICE	SOLID WASTE DISPOSAL	WATER SUPPLY	PUBLIC WORKS	ELECTRIC UTILS	ROAD MAINT
ANCHORAGE	N/A	$153	$100	$19	$56	$21	$25	$84	$91	$21	$124	N/A	N/A	N/A
FAIRBANKS	N/A	$135	$142	N/A	$35	N/A	$32	N/A	$110	N/A	$83	$102	$360	N/A
MAT-SU BR	$750	N/A	$35	$30	$50	$32	N/A	N/A	N/A	$16	N/A	N/A	N/A	$33
PALMER	$190	$190	$50	$19	$23	$33	$31	N/A	$40	N/A	$80	$250	N/A	N/A
WASILLA	$122	N/A	$34	N/A	$22	$47	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$88
HOUSTON	$54	N/A	$17	N/A	$9	N/A	N/A	N/A	N/A	$1.50	N/A	N/A	N/A	$33

Compiled from data contained in tables providing individual city expenditure data for FY 81/82.

Note: The sum of individual entries may not equal totals due to independent rounding.

TABLE 5.6
COMMUNITY FACILITIES SUMMARY

	Schools																									Government				
	Elementary	Secondary	Higher	Water	Sewer	Solid Waste Disposal	State Trooper Post	Local Police	Court System	Fire Hall	Health Center	Long Term Care Fac.	Mental Health Facility	General Hospital	Roads	Railroad	Public Transportation	Airstrip	Library	Community Building	Post Office	Park System	Power	Telephone Service	Communication/Media	Home Rule	First Class	Second Class	Unincorporated	Unified Home Rule
Nenana	*	*		*	*	*	*			*	*				*	*		*		*	*	*	*	*	*		*			
Cantwell	*					*	*				*				*	*		*		*	*		*	*	*				*	
Trapper Creek						*	*								*						*		*	*	*				*	
Talkeetna	*					*				*					*	*		*	*	*	*	*	*	*	*				*	
Willow	*					*									*	*		*	*	*	*		*	*	*				*	
Houston						*				*					*	*							*	*	*			*		
Palmer	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		*	*	*	*	*	*	*	*	*				
Wasilla	*	*	*	*		*				*	*		*		*	*		*	*	*	*	*	*	*	*			*		
Paxson						*									*			*					*	*	*				*	
Glennallen	*	*				*	*		*	*	*	*		*	*			*	*	*	*		*	*	*				*	
Copper Center	*		*			*				*	*				*			*		*	*		*	*	*				*	
Gakona						*									*			*		*	*		*	*	*				*	
Healy	*	*		*	*	*	*				*				*	*		*			*		*	*	*				*	
Gulkana				*	*	*					*				*					*			*	*	*				*	
Valdez	*	*		*	*	*	*	*	*	*	*	*	*	*	*			*	*	*	*	*	*	*	*	*				
Anchorage	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*					*
Fairbanks	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*				

TABLE 5.7

MAT-SU BOROUGH COMMUNITIES:

BUSINESS LOCATION AND TYPE

	Number in Community [a]					
Standard Industrial Classification	Big Lake	Houston	Palmer	Talkeetna	Wasilla	Willow
Agriculture, Forestry, Fisheries	3	-	22	-	-	-
Mining	-	-	2	-	-	-
Construction	19	3	50	3	91	4
Manufacturing	3	-	21	2	4	3
Transportation & Public Utilities	2	-	20	8	-	6
Wholesale Trade	-	-	11	-	-	-
Retail Trade	24	3	80	19	-	18
Finance, Insurance, Real Estate	-	1	22	2	37	3
Services	17	1	115	13	129	4
Public Administration	-	1	12	3	5	-
Nonclassifiable Establishments	6	-	19	1	98	-
Total	74	9	374	51	364	38

(a) SIC classifications were assigned by the OEDP staff for use in this table, and number of establishments must be considered approximations.

Source: Overall Economic Development Program Inc. July 1980. Volume II: Economic Conditions, Development Options and Projections. Palmer, AK. pp. 19-21.

TABLE 5.8: MATANUSKA-SUSITNA BOROUGH ANNUAL NONAGRICULTURAL EMPLOYMENT BY SECTOR

	1970		1975		1979		PERCENT OF STUDY AREA 3		
	Total	%	Total	%	Total	%	1970 %	1975 %	1979 %
TOTAL - Nonagricultural Industries (a)	1,145	100.0	2,020	100.0	3,078	100.0	1.8	1.8	2.7
Mining	N.A. (b)	-	N.A.	-	11	.3	N.A.	N.A.	.0
Construction	120	10.5	188	9.3	184	6.0	2.3	1.1	2.2
Manufacturing	N.A.	-	30	1.5	40	1.3	N.A.	1.2	1.1
Transportation, Communiciation, & Utilities	114	9.6	218	10.8	316	10.2	1.9	1.8	2.6
Wholesale Trade	174	15.2	44	2.2	49	1.6	1.4	.8	1.0
Retail Trade			271	13.4	696	22.6		1.7	3.8
Finance, Insurance, and Real Estate	22	1.9	62	3.1	129	4.2	.8	1.3	2.1
Services	179	15.6	288	14.3	447	14.5	2.0	1.4	2.3
Federal Government	106	9.3	124	6.1	97	3.1	.9	1.0	.8
State and Local Government	376	32.8	758	37.5	1,101	35.8	3.2	4.3	5.2
Miscellaneous	N.A.	-	N.A.	-	21	.7	N.A.	N.A.	1.8

a. Figures may not total correctly because of averaging and disclosure limitations on data.

b. N.A.: Data unavailable due to disclosure policy.

Source: Alaska Department of Labor. Statistical Quarterly. Juneau, Ak.

TABLE 5.9 PER CAPITA PERSONAL INCOME IN THE MAT-SU BOROUGH IN CURRENT AND 1970 DOLLARS

Year	Per Capita Personal Income	
	Current Dollars	In 1970 Dollars[a]
1970	3,957	3,957
1971	4,279	4,150
1972	4,539	4,286
1973	4,970	4,526
1974	6,068	5,011
1975	8,092	5,855
1976	8,542	5,718
1977	9,032	5,666
1978	8,939	5,231
1979	8,878	4,704

a. Discounted using the Anchorage Consumer Price Index - Unadjusted (CPI-U) as a measure of inflation.

Source: U.S. Department of Commerce, Bureau of Economic Analysis.

TABLE 5.10: 1981 CIVILIAN HOUSING STOCK IN THE MUNICIPALITY OF ANCHORAGE, BY TYPE

Type of Unit	Number of Units	Percent of Total
Single Family[a]	30,097	45.8
Duplex	6,040	9.2
3-4 Units	6,211	9.4
5-19 Units	9,356	14.2
20+ Units	6,036	9.2
Mobile Homes	8,031	12.2
In Parks	6,146	9.3
On Lots	1,885	2.9
Total	65,771	100.0

a. Excluding mobile homes

Source: Municipality of Anchorage Planning Department

TABLE 5.22: HOUSING STOCK IN FAIRBANKS AND THE FAIRBANKS-NORTH STAR BOROUGH BY TYPE, OCTOBER 1978

	Fairbanks-North Star Borough	Municipality of Fairbanks
Single Family[(a)]	6,849	3,312
Duplex	690	714
Multifamily	3,832	3,187
Mobile Homes	2,097	138
Total	13,738	7,351

a. Excluding mobile homes.

Source: Fairbanks North Star Borough Community Information Center. Community Information Quarterly: Summer 1980. Volume III, Number 2, p. 70.

TABLE 5.12: RAILBELT ANNUAL NONAGRICULTURAL EMPLOYMENT BY SECTOR

	1970 Total	1970 %	1975 Total	1975 %	1979 Total	1979 %	PERCENT OF STATE 1970 %	PERCENT OF STATE 1975 %	PERCENT OF STATE 1979 %
TOTAL[a] - Nonagricultural Industries	62,690	100.0	113,818	100.0	113,204	100.0	67.8	70.4	68.0
Mining	1,610	2.6	2,243	2.0	2,822	2.5	53.7	59.2	48.9
Construction	5,264	8.4	16,359	14.4	8,257	7.3	76.3	63.3	81.8
Manufacturing	1,850	3.0	2,596	2.3	3,705	3.3	23.7	26.9	28.9
Transportation, Communitication, & Utilities	6,021	9.6	12,094	10.6	12,062	10.7	66.2	73.4	72.2
Wholesale Trade			5,366	4.7	5,083	4.5		90.8	92.2
	12,111	19.3					79.2		
Retail Trade			15,965	14.0	18,309	16.2		78.6	76.7
Finance, Insurance, and Real Estate	2,520	4.0	4,696	4.1	6,139	5.4	81.3	77.9	76.7
Services	8,868	14.1	20,995	18.4	19,674	17.4	77.8	83.5	69.4
Federal Government	12,372	19.7	13,022	11.4	12,728	11.2	72.4	71.2	71.0
State and Local Government	11,585	18.5	17,799	15.6	21.130	18.7	62.6	60.9	57.7
Miscellaneous	52	.1	217	.2	712	.6	26	19.0	98.9

a. Figures may not total correctly because of averaging and disclosure limitations on data.

Source: Alaska Department of Labor. Statistical Quarterly. Juneau, Ak. (various issues)

TABLE 5.13: ON-SITE CONSTRUCTION AND OPERATIONS MANPOWER REQUIREMENTS, 1983-2005[a]

	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
CONSTRUCTION												
LABORERS	140	55	562	843	1279	1693	1897	2369	2202	1723	894	549
SEMI-SKILLED/SKILLED	120	139	148	323	355	448	502	627	583	422	220	136
ADMINISTRATIVE/ENGINEER.	40	106	390	184	268	359	402	502	467	355	185	115
SUB-TOTAL CONSTRUCTION	300	300	1100	1350	1902	2500	2801	3498	3252	2500	1299	800
OPERATIONS AND MAINTENANCE												
ALL LABOR CATEGORIES											70	145
TOTAL	300	300	1100	1350	1902	2500	2801	3498	3252	2500	1369	945

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
CONSTRUCTION											
LABORERS	338	539	844	1076	1144	1002	507	105			
SEMI-SKILLED/SKILLED	92	148	230	295	312	308	234	24			
ADMINISTRATIVE/ENGINEER.	71	115	176	229	243	187	159	22			
SUB-TOTAL CONSTRUCTION	501	802	1250	1600	1699	1497	900	151			
OPERATIONS AND MAINTENANCE											
ALL LABOR CATEGORIES	145	145	145	145	145	145	145	170	170	170	170
TOTAL	646	947	1395	1745	1844	1642	1045	321	170	170	170

(5)05

(a) Supplied by Acres American, Inc.

TABLE 5.14: ON-SITE CONSTRUCTION WORKFORCE: LOCAL, ALASKA NONLOCAL, AND OUT-OF STATE, 1983-2000

LOCAL	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
LABORERS (85%)	119	47	478	717	1087	1439	1612	2014	1872	1465	760	467	287	458	717	915	972	852	431	89
SEMI-SKILLED/ SKILLED (80%)	96	112	118	258	284	359	402	502	466	337	176	109	74	118	184	236	250	246	187	19
ADMINISTRATIVE/ ENGINEERING (65%)	26	69	254	120	174	233	261	326	304	231	120	75	46	75	114	149	158	122	103	14
SUBTOTAL LOCAL	241	227	850	1094	1545	2031	2276	2842	2642	2033	1056	650	407	651	1016	1299	1380	1220	722	122
NON-LOCAL																				
ALASKA NON-LOCAL																				
LABORERS (5%)	7	3	28	42	64	85	95	118	110	86	45	27	17	27	42	54	57	50	25	5
SEMI-SKILLED/ SKILLED (5%)	6	7	7	16	18	22	25	31	29	21	11	7	5	7	11	15	16	15	12	1
ADMINISTRATIVE/ ENGINEERING (5%)	2	5	20	9	13	18	20	25	23	18	9	6	4	6	9	11	12	9	8	1
SUB-TOTAL ALASKA NON-LOCAL	15	15	55	67	95	125	140	175	163	125	65	40	25	40	62	80	85	75	45	7
OUT-OF-STATE																				
LABORERS (10%)	14	6	56	84	128	169	190	237	220	172	89	55	34	54	84	108	114	100	51	11
SEMI-SKILLED/ SKILLED (15%)	18	21	22	48	53	67	75	94	87	63	33	20	14	22	34	44	47	46	35	4
ADMINISTRATIVE/ ENGINEERING (30%)	12	32	117	55	80	108	121	151	140	107	56	35	21	35	53	69	73	56	48	7
SUB-TOTAL OUT-OF-STATE	44	58	195	188	262	344	386	482	448	342	178	110	69	111	172	221	234	202	134	21
TOTAL NON-LOCAL	59	73	250	255	357	469	526	656	610	467	243	150	94	151	234	301	319	277	179	28
TOTAL	300	300	1100	1350	1902	2500	2801	3498	3252	2500	1299	800	501	802	1250	1600	1699	1497	900	151

TABLE 5.15: OPERATIONS WORK FORCE: LOCAL, ALASKA NON LOCAL, AND OUT-OF-STATE, 1993-2005

YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Activity													
Watana (680 MW)	30	60	60	60	60	60	60	60	60	60	60	60	60
Watana (340 MW)		45	45	45	45	45	45	45	45	45	45	45	45
Devil Canyon (600 MW)										25	25	25	25
Dispatch Control	40	40	40	40	40	40	40	40	40	40	40	40	40
Total	70	145	145	145	145	145	145	145	145	170	170	170	170

TABLE 5.16: TOTAL PAYROLL FOR ON-SITE CONSTRUCTION AND OPERATIONS MANPOWER, 1983-2005
(IN THOUSANDS OF DOLLARS)

	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
CONSTRUCTION (a)																							
LABORERS	3895	1258	16847	25323	38319	50739	56863	70984	65985	51529	26806	16543	10186	16141	25433	32211	34255	29892	14950	3114			
SEMI-SKILLED/ SKILLED	2607	3468	3671	9162	9441	11750	13169	16440	15282	10643	5475	3389	2383	3871	5952	7725	8189	8182	6438	574			
ADMINISTRATIVE/ ENGINEER	940	2342	8159	3810	5555	7436	8334	10404	9671	7362	3842	2378	1465	2374	3655	4737	5038	3946	3289	492			
SUBTOTAL CONSTRUCTION	7442	7068	28677	38295	53315	69925	78366	97828	90938	69534	36123	22310	14034	22386	35040	44673	47482	42020	24677	4180			
OPERATIONS (b)																							
ALL LABOR CATEGORIES											2684	5559	5559	5559	5559	5559	5559	5559	5559	6517	6517	6517	6517
TOTAL PAYROLL (7)02	7442	7068	28677	38295	53315	69925	78366	97828	90938	69534	38807	27869	19593	27945	40599	50232	53041	47579	30236	10697	6517	6517	6517

(a) Based on 1,825 working hours in the year.

(b) Based on 2,496 working hours in the year.

TABLE 5.17: TOTAL ON-SITE CONSTRUCTION WORK FORCE PAYROLL EXPENDITURE PATTERN[(a)]
(IN THOUSANDS OF DOLLARS)

PLACE OF EXPENDITURE	YEARS																			
	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
TOTAL PAYROLL [(b)]	7442	7068	28677	38295	53315	69925	78366	97828	90938	69534	36123	22310	14034	22386	35040	44673	47482	42020	24677	4180
EXPENDABLE INCOME [(c)]	4149	3886	15760	21385	29757	39020	43729	54589	50746	38803	20157	12457	7838	12499	19553	25583	27789	26109	15517	2603
IMPACT AREA 3	3658	3282	13452	18946	26383	34588	38763	48390	44982	34417	17877	11046	6949	11079	17337	22750	24779	23495	13854	2339
ANCHORAGE REGION	2796	2509	10282	14480	20548	26947	30202	37709	35052	26815	13916	8588	5394	8613	13494	17715	19296	18293	10771	1795
ANCHORAGE	2045	1833	7525	10596	14104	18475	20698	25825	24010	18385	9576	5938	3756	5955	9289	12169	13250	12565	7429	1308
MAT-SUE REGION	433	399	1607	2228	4353	5728	6428	8042	7471	5696	2924	1778	1092	1784	2833	3741	4078	3856	2251	307
KENAI-COOK INLET	313	272	1130	1627	2051	2692	3017	3768	3502	2681	1389	856	536	858	1346	1770	1931	1836	1070	177
SEWARD	6	5	20	29	40	53	59	74	69	53	27	17	11	17	26	35	38	36	21	4
FAIRBANKS	796	716	2930	4119	5352	7008	7851	9794	9106	6971	3633	2255	1429	2262	3526	4618	5028	4769	2829	501
SE FAIRBANKS	5	4	18	25	36	47	52	65	61	46	24	15	9	15	23	31	33	32	19	3
VALDEZ-CHITINA-WHITTIER	62	54	223	321	447	587	657	821	763	584	303	187	118	188	294	386	421	401	235	40

(a) Table shows total expenditures by construction work force in Impact Area 3.

(b) Total construction payroll, all labor categories.

(c) Gross payroll minus 30 percent for taxes (federal, F.I.C.A., and unemployment/workman's compensation with self and one dependent) minus 10 percent for net income saved.

TABLE 5.18: TOTAL OPERATIONS WORK FORCE PAYROLL EXPENDITURE PATTERN[a]

In Thousands of Dollars

Place of Expenditure[b]	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Total Payroll[c]	2,684	5,559	5,559	5,559	5,559	5,559	5,559	5,559	5,559	6,517	6,517	6,517	6,517
Expendable Income[d]	1,691	3,502	3,502	3,502	3,502	3,502	3,502	3,502	3.502	4,106	4,106	4,106	4,106
Village	1,015	2,101	2,101	2,101	2,101	2,101	2,101	2,101	2,101	2,464	2,464	2,464	2,464
Anchorage	338	700	700	700	700	700	700	700	700	821	821	821	821
Fairbanks	85	175	175	175	175	175	175	175	175	205	205	205	205
Mat-Su	253	526	526	526	526	526	526	526	526	616	616	616	616

(a) Table shows total expenditures by operations work force in selected areas.

(b) Assumed that 60 percent of payroll to be spent at Village; 15 percent in the Mat-Su Brorough; 20 percent in Anchorage; and 5 percent in Fairbanks.

(c) Total Operations Payroll.

(d) Gross payroll minus 30 percent for taxes (federal, FICA, and unemployment/workman's compensation with self and one dependent) minus 10 percent for net income saved.

TABLE 5.19: ON-SITE CONSTRUCTION WORK FORCE: PROJECT EMPLOYMENT AND RESIDENCE OF INDIVIDUALS CURRENTLY RESIDING IN IMPACT AREA 3

	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
IMPACT AREA 3	241	227	850	1094	1545	2031	2276	2842	2642	2033	1056	650	407	651	1016	1299	1380	1220	722	122
ANCHORAGE REGION	178	168	627	808	1141	1499	1679	2097	1949	1500	779	480	300	480	750	959	1019	900	532	90
ANCHORAGE	135	127	475	612	864	1135	1272	1588	1477	1136	590	363	228	364	568	726	772	682	403	68
MAT-SU	16	15	58	74	104	137	153	191	178	137	71	44	27	44	68	87	93	82	49	8
KENAI-COOK INLET	27	25	94	121	172	225	253	315	293	226	117	72	45	72	113	144	153	135	80	14
SEWARD	0	0	2	2	3	4	5	6	5	4	2	1	1	1	2	3	3	2	1	0
FAIRBANKS	57	54	202	260	368	483	542	676	629	484	251	155	97	155	242	309	329	290	172	29
SE FAIRBANKS	0	0	2	2	3	4	5	6	5	4	2	1	1	1	2	3	3	2	1	0
VALDEZ-CHITINA-WHITTIER	5	5	18	23	32	43	48	60	55	43	22	14	9	14	21	27	29	26	15	3
MAT-SU COMMUNITIES																				
PALMER	2	2	6	7	10	14	15	19	18	14	7	4	3	4	7	9	9	8	5	1
WASILLA	1	1	5	6	8	11	12	15	14	11	6	4	2	4	5	7	7	7	4	1
HOUSTON	0	0	2	2	3	4	5	6	5	4	2	1	1	1	2	3	3	2	1	0
TRAPPER CREEK	0	0	1	1	1	1	2	2	2	1	1	0	0	0	1	1	1	1	1	0
TALKEETNA	1	1	2	3	4	5	6	8	7	5	3	2	1	2	3	4	4	3	2	0
OTHER	12	11	42	54	77	101	113	141	131	101	52	32	20	32	50	65	69	61	36	6

(11)05

TABLE 5.20: ON-SITE CONSTRUCTION WORK FORCE: IMMIGRATION AND PLACE OF RELOCATION IN IMPACT AREA 3

	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
TOTAL IMPACT AREA 3	16	16	54	67	93	122	137	170	158	140	111	98	91	91	91	100	102	98	84	65
ANCHORAGE REGION	12	12	41	51	99	131	147	184	175	160	137	128	122	122	122	129	131	127	116	101
ANCHORAGE	5	5	17	20	-37	-51	-57	-73	-76	-80	-86	-89	-91	-91	-91	-89	-88	-89	-92	-97
MAT-SU	7	7	23	29	152	202	227	285	279	267	253	247	243	243	243	248	249	246	239	229
KENAI-COOK INLET	0	0	1	2	-14	-18	-20	-25	-26	-26	-27	-28	-28	-28	-28	-28	-28	-28	-28	-29
SEWARD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FAIRBANKS	4	4	13	16	-8	-11	-12	-16	-19	-23	-29	-31	-33	-33	-33	-31	-30	-32	-34	-39
SE FAIRBANKS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VALDEZ-CHITINA-WHITTIER	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MAT-SU COMMUNITIES																				
PALMER	0	0	1	1	6	8	9	11	11	11	10	10	10	10	10	10	10	10	10	9
WASILLA	0	0	1	1	8	10	11	14	14	13	13	12	12	12	12	12	12	12	12	11
HOUSTON	0	0	1	1	6	8	9	11	11	11	10	10	10	10	10	10	10	10	10	9
TRAPPER CREEK	2	2	6	7	38	50	57	71	70	67	63	62	61	61	61	62	62	62	60	57
TALKEETNA	2	2	6	7	38	50	57	71	70	67	63	62	61	61	61	62	62	62	60	57
OTHER	2	3	9	11	56	75	84	105	103	99	94	91	90	90	90	92	92	91	88	85

(23102

TABLE 5.21: TOTAL LOCAL IMPACT AREA 3 EMPLOYMENT: ON-SITE CONSTRUCTION, INDIRECT AND INDUCED

	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
IMPACT AREA 3	408	386	1475	1897	2664	3609	4043	5049	4768	3669	1907	1175	736	1176	1875	2399	2548	2288	1356	232
ANCHORAGE REGION	318	300	1156	1487	2099	2866	3212	4010	3751	2886	1499	923	579	925	1483	1897	2016	1792	1061	181
ANCHORAGE	250	236	917	1180	1608	2193	2456	3066	2851	2194	1142	705	444	706	1140	1457	1547	1368	812	142
MAT-SU	32	30	111	142	264	375	421	526	489	375	193	117	72	117	185	239	254	224	131	18
KENAI-COOK INLET	36	34	127	163	225	296	332	414	408	314	163	100	63	100	157	200	213	199	117	20
SEWARD	1	1	2	3	4	5	6	7	7	5	3	2	1	2	3	3	4	3	2	0
FAIRBANKS	83	79	294	378	521	684	766	957	942	725	377	233	146	233	363	464	493	460	273	47
SE FAIRBANKS	1	1	2	3	4	5	5	7	6	5	2	2	1	2	2	3	3	3	2	0
VALDEZ-CHITINA-WHITTIER	6	6	22	28	39	52	58	72	67	52	27	17	10	17	26	33	35	33	19	3
MAT-SU COMMUNITIES																				
PALMER	3	3	10	13	22	31	35	44	41	31	16	10	6	10	15	20	21	19	11	2
WASILLA	2	2	9	11	20	28	31	39	37	28	14	9	5	9	14	18	19	17	10	1
HOUSTON	1	1	4	5	10	14	16	20	18	14	7	4	3	4	7	9	9	8	5	1
TRAPPER CREEK	1	1	2	3	10	15	17	22	20	15	8	5	3	5	7	10	10	9	5	0
TALKEETNA	2	2	7	9	29	43	49	61	57	43	22	13	8	13	21	27	29	26	15	2
OTHER	22	21	79	101	172	243	272	341	317	243	125	76	47	77	120	155	165	145	85	13

(19)06

TABLE 5.22: TOTAL INMIGRATION INTO IMPACT AREA 3: ON-SITE CONSTRUCTION, INDIRECT AND INDUCED

	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
IMPACT AREA 3	64	62	236	300	425	592	664	828	783	621	361	252	188	245	345	425	448	409	269	96
ANCHORAGE REGION	55	53	205	261	401	562	630	787	739	574	363	267	209	261	353	424	444	406	281	129
ANCHORAGE	43	41	164	210	211	302	337	419	382	273	98	25	-19	24	100	155	170	139	44	-72
MAT-SU	10	10	34	42	196	268	301	378	365	335	287	267	255	263	275	289	293	285	262	231
KENAI-COOK INLET	2	2	7	9	-5	-6	-6	-8	-6	-11	-19	-23	-25	-23	-20	-18	-17	-17	-22	-28
SEWARD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FAIRBANKS	8	8	30	37	19	25	27	33	37	20	-7	-18	-24	-19	-11	-4	-2	-2	-17	-35
SE FAIRBANKS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VALDEZ-CHITINA-WHITTIER	0	0	2	2	3	4	4	5	5	4	2	1	1	1	2	2	3	3	2	0
MAT-SU COMMUNITIES																				
PALMER	0	0	1	2	7	10	11	14	14	13	11	10	10	10	11	11	11	11	10	9
WASILLA	0	0	2	2	9	12	13	17	16	15	14	13	13	13	13	14	14	13	13	12
HOUSTON	0	0	1	1	7	9	10	13	13	12	11	10	10	10	10	11	11	11	10	9
TRAPPER CREEK	3	3	9	12	60	83	93	117	112	100	80	71	67	71	77	82	84	81	71	58
TALKEETNA	2	2	7	9	46	63	71	89	86	80	70	65	63	65	67	70	71	69	64	58
OTHER	4	4	13	16	67	90	102	128	124	115	102	96	93	95	98	102	103	101	94	85

(30102

TABLE 5.23: TOTAL POPULATION INFLUX INTO IMPACT AREA 3: DIRECT, INDIRECT AND INDUCED

	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
IMPACT AREA 3	182	178	672	852	1203	1671	1867	2324	2191	1735	1014	714	535	690	957	1170	1228	1122	743	278
ANCHORAGE REGION	157	152	583	739	1139	1589	1777	2214	2075	1669	1027	761	602	742	986	1177	1229	1122	788	378
ANCHORAGE	122	117	463	590	578	826	919	1137	1030	725	242	42	-77	35	240	385	425	339	84	-225
MAT-SU	28	29	99	123	580	789	886	1112	1074	988	852	796	763	784	817	856	866	844	778	694
KENAI-COOK INLET	6	6	21	26	-16	-20	-23	-28	-22	-37	-60	-70	-76	-71	-64	-57	-55	-54	-68	-85
SEWARD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FAIRBANKS	24	24	85	107	52	66	72	88	96	49	-26	-57	-75	-62	-41	-20	-14	-15	-56	-107
SE FAIRBANKS	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0
VALDEZ-CHITINA-WHITTIER	1	1	5	6	8	11	12	15	14	11	5	3	2	3	5	7	7	8	5	1
MAT-SU COMMUNITIES																				
PALMER	1	1	4	5	22	30	33	42	40	38	33	31	30	31	32	33	33	33	31	28
WASILLA	1	1	5	6	26	36	40	50	49	46	41	39	37	38	39	40	41	40	38	35
HOUSTON	1	1	3	4	20	27	31	38	37	35	32	31	30	30	31	32	32	31	30	28
TRAPPER CREEK	8	8	27	34	175	242	272	341	327	291	235	212	198	209	225	241	245	236	209	175
TALKEETNA	6	7	22	27	138	186	209	263	254	236	208	196	189	193	199	207	210	205	191	173
OTHER	11	11	37	46	199	268	301	378	366	342	304	288	278	284	291	302	305	299	280	257

(23)06

TABLE 5.24: TOTAL SCHOOL-AGE CHILDREN ACCOMPANYING IMMIGRANT WORKERS: ON-SITE CONSTRUCTION, INDIRECT AND INDUCED[(a)]

	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
TOTAL IMPACT AREA 3	44	43	160	203	286	400	449	562	533	426	253	181	138	176	242	297	313	287	191	74
ANCHORAGE REGION	37	36	138	175	273	382	430	538	507	412	259	195	157	191	252	300	315	289	205	101
ANCHORAGE	29	27	108	137	127	183	206	257	234	163	49	2	-27	1	52	89	99	79	15	-63
MAT-SU	7	8	26	32	152	207	233	292	283	262	229	215	206	212	220	230	233	227	210	189
KENAI-COOK INLET	1	1	5	6	-5	-7	-8	-10	-8	-12	-17	-20	-21	-20	-18	-16	-16	-15	-19	-23
SEWARD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FAIRBANKS	6	6	21	27	11	14	15	19	20	9	-9	-17	-21	-18	-13	-7	-6	-6	-16	-29
SF FAIRBANKS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VALDEZ-CHITINA-WHITTIER	0	0	1	1	2	2	3	3	3	2	1	1	1	1	1	2	2	2	1	0
MAT-SU COMMUNITIES																				
PALMER	0	0	1	1	6	8	9	11	11	10	9	8	8	8	9	9	9	9	8	8
WASILLA	0	0	1	2	7	9	11	13	13	12	11	10	10	10	11	11	11	11	10	9
HOUSTON	0	0	1	1	5	7	8	10	10	9	9	8	8	8	8	9	9	8	8	8
TRAPPER CREEK	2	2	7	9	45	62	70	88	85	76	62	57	53	56	60	64	65	63	56	47
TALKEETNA	2	2	6	7	36	49	55	70	68	63	56	53	51	52	54	56	56	55	52	47
OTHER	3	3	10	12	53	71	80	100	97	91	82	78	75	77	79	82	82	81	76	70

(30103

(a) Calculated by applying a ratio of .86 school-age children per accompanied immigrant worker to the number of accompanied immigrants; these data assume that 95 percent of immigrant workers are accompanied.

TABLE 5.25: TOTAL PRIMARY SCHOOL-AGE CHILDREN ACCOMPANYING INMIGRANT WORKERS INTO IMPACT AREA 3: ON-SITE CONSTRUCTION, INDIRECT, AND INDUCED (a)

	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
TOTAL IMPACT AREA 3	24	23	87	110	155	216	243	304	289	231	137	98	75	95	131	161	169	155	104	40
ANCHORAGE REGION	20	20	75	95	148	207	233	292	275	223	140	106	85	104	137	163	171	157	111	55
ANCHORAGE	15	15	58	74	68	99	111	138	126	88	26	0	-15	0	27	47	53	42	8	-34
MAT-SU	4	4	14	17	83	113	127	159	154	143	125	117	113	116	120	125	127	124	115	103
KENAI-COOK INLET	1	1	3	3	-3	-4	-4	-5	-4	-6	-9	-11	-11	-11	-10	-9	-9	-8	-10	-13
SEWARD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FAIRBANKS	3	3	12	14	6	7	8	10	11	5	-5	-9	-12	-10	-7	-4	-3	-3	-9	-16
SE FAIRBANKS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VALDEZ-CHITINA-WHITTIER	0	0	1	1	1	1	1	2	2	1	1	0	0	0	1	1	1	1	1	0
MAT-SU COMMUNITIES																				
PALMER	0	0	1	1	3	4	5	6	6	5	5	5	4	5	5	5	5	5	5	4
WASILLA	0	0	1	1	4	5	6	7	7	7	6	6	6	6	6	6	6	6	6	5
HOUSTON	0	0	0	1	3	4	4	6	5	5	5	5	4	4	5	5	5	5	4	4
TRAPPER CREEK	1	1	4	5	24	34	38	48	46	41	34	31	29	31	33	35	36	34	31	26
TALKEETNA	1	1	3	4	20	27	30	38	37	34	31	29	28	28	29	30	31	30	28	25
OTHER	2	2	5	7	29	39	44	55	53	50	45	43	41	42	43	45	45	44	41	38

(30)64

(a) Calculated by applying a ratio of .47 primary school-age children per accompanied worker to the number of accompanied inmigrants; these data assume 95 percent of inmigrant workers are accompanied.

TABLE 5.26: TOTAL SECONDARY SCHOOL-AGE CHILDREN ACCOMPANYING INMIGRANT WORKERS INTO IMPACT AREA 3: ON-SITE CONSTRUCTION, INDIRECT, AND INDUCED (a)

	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
TOTAL IMPACT AREA 3	20	20	74	93	131	183	206	258	244	195	116	83	63	80	111	136	143	131	87	34
ANCHORAGE REGION	17	17	63	80	125	175	197	247	232	189	118	89	71	87	115	138	144	132	93	46
ANCHORAGE	13	13	49	63	59	85	95	119	108	76	23	1	-12	1	24	41	46	37	7	-28
MAT-SU	3	3	12	14	69	94	106	133	129	119	104	97	94	96	100	104	106	103	95	86
KENAI-COOK INLET	1	1	2	3	-2	-3	-3	-4	-4	-5	-8	-9	-9	-9	-8	-7	-7	-7	-9	-10
SEWARD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FAIRBANKS	3	3	10	12	5	6	7	9	10	4	-4	-7	-10	-8	-6	-3	-2	-3	-7	-13
SE FAIRBANKS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VALDEZ-CHITINA-WHITTIER	0	0	0	1	1	1	1	2	1	1	1	0	0	0	1	1	1	1	1	0
MAT-SU COMMUNITIES																				
PALMER	0	0	0	1	3	4	4	5	5	5	4	4	4	4	4	4	4	4	4	3
WASILLA	0	0	1	1	3	4	5	6	6	6	5	5	5	5	5	5	5	5	5	4
HOUSTON	0	0	0	1	2	3	4	5	5	4	4	4	4	4	4	4	4	4	4	3
TRAPPER CREEK	1	1	3	4	20	28	32	40	39	35	28	26	24	25	27	29	30	29	26	22
TALKEETNA	1	1	3	3	17	22	25	32	31	29	25	24	23	24	24	25	26	25	23	21
OTHER	1	1	4	5	24	32	36	46	44	42	37	35	34	35	36	37	37	37	34	32

(30105

(a) Calculated by applying a ratio of .39 secondary school-age children per accompanied worker to the number of accompanied inmigrants; these data assume 95 percent of inmigrant workers are accompanied.

TABLE 5.27: SUMMARIZED IMPACT OF THE SUSITNA HYDROELECTRIC PROJECT ON MATANUSKA-SUSITNA BOROUGH

	Present Conditions		Watana Construction Peak				Devil Canyon Peak			
Socioeconomic Variable	1981 Capacity	1981 Amount/ Usage	1990 Baseline Forecast	1990 Forecast with Project	Impact of Project	Percent Increase Over Baseline Forecast	1999 Baseline Forecast	1999 Forecast With Project	Impact of Project	Percent Increase Over Baseline Forecast
Population	N.A.	22,285	42,964	44,076[a]	1,112[a]	2.6[a]	66,338	67,204[a]	866[a]	1.3[a]
Employment[b]	N.A.	4,002	6,914	10,842	3,928	56.8	9,505	11,554	2,049	21.6
Housing Demand (no. of units)	8,582	6,810	14,417	14,791	374	2.6	24,670	24,992	322	1.3
Water (gallons per day)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Solid Waste Disposal (acres per year)	617	2.5	6.7	6.9	0.2	2.5	13.6	13.8	0.2	1.3
Sewage Treatment (gallons per day)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Police	20	20	38	40-42	2-4	5.3	60	61	1	1.7
Education (primary students)	3,136	2,388	5,406	5,565	159	2.9	8,884	9,011	127	1.4
(secondary students)	3,380	2,141	4,605	4,738	133	2.9	7,568	7,674	106	1.4
Hospital Beds	23	20	60	61	1	1.7	109	110	1	0.9
Community[c] Parks (acres)	0	-	80	82	2	2.4	133	135	2	1.5

N.A. - Not Applicable

(a) Population increase refers to population influx in Mat-Su Borough communities, and does not include population residing only at work camp/village.
(b) By place of employment.
(c) Community parks generally contain facilities such as tennis courts, ball diamonds, play apparatus, basketball courts, nature walks, and swimming pools.

Source: Forecasts by Frank Orth & Associates, Inc.

TABLE 5.28: SUMMARIZED FISCAL IMPACTS OF THE PROJECT ON THE MAT-SU BOROUGH

General Fund:

REVENUES ($000)	Property Taxes	School Debt Service Reimburesment	Municipal Assistance	Federal Revenue Sharing	Misc. Revenues	General Fund Total Revenues	Service Area Fund Total Revenues	Land Management Fund Total Rev.$	Total Bonded Indebtedness
1981 Current	5,719	3,635	1,900	535	328	12,117	1,190	944	67,019
1990 Baseline Forecast	8,395	8,761	3,663	1,031	1,511	23,361	2,547	1,821	95,389
1990 Forecast W. Project	8,807	8,987	3,758	1,057	1,358	23,967	3,263	1,868	97,857
Impact of Project	412	226	95	26	-153	606	716	47	2,468
% Change	4.91	6.22	2.59	2.52	-10.13	2.59	28.11	2.58	2.59
1999 Baseline Forecast	11,949	13,527	5,656	1,592	3,347	36,071	3,623	2,811	135,769
1999 Forecast W. Project	12,379	13,703	5,730	1,613	3,117	36,542	4,584	2,848	137,540
Impact of Project	430	176	74	21	-230	471	961	37	1,771
% Change	3.60	1.3	1.31	1.32	-6.87	1.31	26.52	1.32	1.30

EXPENDITURES ($000)	Areawide Admin.	Ambulance	Sanitary Landfill	Library	Fire Service	Parks & Rec.	Land Mgmt. Program	Road Maint. & Repair	Total Expenses
1981 Current	11,151	688	357	713	780	1,114	1,114	797	16,714
1990 Baseline Forecast	21,019	1,353	722	1,375	1,578	2,148	2,148	1,880	32,223
1990 Forecast W. Project	21,611	1,388	740	1,410	1,620	2,204	2,204	1,880	33,057
Impact of Project	592	35	18	35	42	56	56	0	834
% Change	2.82	2.82	2.49	2.55	2.66	2.61	2.61	0	2.59
1999 Baseline Forecast	30,876	2,110	1,114	2,123	2,462	3,317	3,317	4,434	49,753
1999 Forecast W. Project	31,337	2,138	1,129	2,151	2,494	3,360	3,360	4,434	50,403
Impact of Project	461	28	15	28	32	43	43	0	650
% Change	1.49	1.33	1.35	1.32	1.30	1.30	1.30	0	1.31

Forecasts in 1981 $.

Selected years from forecasts prepared by Frank Orth & Associates, Inc.

TABLE 5.29: SUMMARIZED FISCAL IMPACTS OF THE PROJECT ON THE MAT-SU BOROUGH SCHOOL DISTRICT

REVENUES ($000)[1]	State Foundation Program Revenue	State Trans. Revenue	Total State Revenues	Local Property Taxes	Federal Revenues	Total Revenues
1981 Current	15,030	2,106	17,136	5,362	1,404	23,901
1990 Baseline Forecast	33,758	4,505	38,263	7,631	3,003	48,897
1990 Forecast W. Project	34,746	4,637	39,383	7,828	3,091	50,105
Impact of Project	988	132	1,120	197	88	1,208
% Change	2.93	2.93	2.93	2.58	2.93	2.47
1999 Baseline Forecast	55,478	7,403	62,881	10,861	4,936	78,678
1999 Forecast W. Project	56,260	7,508	63,768	11,003	5,005	79,634
Impact of Project	782	105	887	142	69	956
% Change	1.41	1.42	1.41	1.32	1.40	1.22

EXPENDITURES ($000)	Regular Instruction	Vocational Instruction	Special Education	Support Services	Operations and Maintenance	Pupil Trans-portation	Other[2]	Total Expends
1981 Current	8,726	1,058	1,587	4,760	5,024	2,115	3,173	26,442
1990 Baseline Forecast	17,819	1,188	5,940	10,691	10,691	5,940	7,127	59,395
1990 Forecast W. Project	18,340	1,223	6,113	11,004	11,004	6,113	7,336	61,134
Impact of Project	521	35	173	313	313	173	209	1,739
% Change	2.92	2.95	2.91	2.93	2.93	2.91	2.93	2.93
1999 Baseline Forecast	29,283	1,952	9,761	17,570	17,570	9,761	11,713	97,610
1999 Forecast W. Project	29,696	1,980	9,899	17,818	17,818	9,899	11,878	98,986
Impact of Project	413	28	138	248	248	138	165	1,376
% Change	1.4	1.43	1.41	1.41	1.41	1.41	1.41	1.41

1. Revenues do not include State Reimbursement for School Debt Service Payments. See General Fund Table 5.28.

2. This category includes some capital improvements.

Forecasts in 1981 $.

Selected years from forecasts prepared by Frank Orth & Associates, Inc.

TABLE 5.30: SUMMARIZED IMPACT OF THE SUSITNA HYDROELECTRIC PROJECT ON THE CITY OF PALMER

Socioeconomic Variable	Present Conditions		Watana Construction Peak				Devil Canyon Peak			
	1981 Capacity	1981 Amount/ Usage	1990 Baseline Forecast	1990 Forecast with Project	Impact of Project	Percent Increase Over Baseline Forecast	1999 Baseline Forecast	1999 Forecast With Project	Impact of Project	Percent Increase Over Baseline Forecast
Population	N.A.	2,567	4,525	4,567	42	0.9	6,167	6,200	33	0.5
Employment (a)	N.A.	- (b)	- (b)	- (b)	27	- (b)	- (b)	- (b)	13	- (b)
Housing Demand (no. of units)	872	783	1,551	1,563	12	0.8	2,299	2,311	12	0.5
Water (gallons per day)	1,368,000	300,000	608,000	614,000	6,000	1.0	917,650	922,626	4,976	0.5
Sewage Treatment (gallons per day)	500,000	300,000	543,000	548,000	5,000	0.9	740,040	744,053	4,013	0.5
Police	8	8	8	8	0	0	9	9	0	0.0
Education										
(primary students)	800 (c)	685 (c)	569	580	11	1.9	826	830	4	0.5
(secondary students)	1,400 (c)	951 (c)	485	490	5	1.0	704	708	4	0.6
Hospital Beds	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.

N.A. - Not Applicable
(a) By place of employment
(b) Data not available
(c) School service areas do not correspond exactly to city limits. 1981 enrollment may include a service area that extends beyond city boundaries, whereas projections for 1990 and 1999 refer only to school children living in Palmer

Source: Forecasts by Frank Orth & Associates, Inc.

TABLE 5.31: SUMMARIZED FISCAL IMPACTS OF THE PROJECT ON PALMER

REVENUES ($000)	Property Taxes	State Sales Tax	Total Local Revenues	Intergovt. Revenue	Service Charges	Misc. Revenue	Total General Fund Revenue	Total Water Fund Revenue	Total Sewer Fund Revenue	Capital Project Fund Revenues
1981 Current	256	329	585	417	336	333	1,671	249	108	2,258
1990 Baseline Forecast	452	423	875	625	610	390	2,500	440	190	3,982
1990 Forecast W. Project	457	427	884	631	617	394	2,526	443	192	4,018
Impact of Project	5	4	9	6	7	4	26	3	2	30
% Change	1.11	0.95	1.0	.9	1.15	1.03	1.04	0.68	1.04	0.75
1999 Baseline Forecast	616	576	1,192	851	832	531	3,406	599	259	5,426
1999 Forecast W. Project	620	580	1,200	857	837	534	3,428	602	261	5,456
Impact of Project	4	4	8	6	5	3	22	3	2	30
% Change	0.65	0.70	0.67	0.71	0.6	0.56	0.65	0.50	0.77	0.55

EXPENDITURES ($000)	Admin.	Police	Fire	Ambulance	Parks and Recreation	Health	Library	Public Works	Water Supply	Sewer	Total Expend.	Total Bonded Indebtedness
1981 Current	487	487	128	47	59	79	84	641	205	103	2,320	2,692
1990 Baseline Forecast	860	886	237	90	104	140	149	1,188	362	181	4,197	3,832
1990 Forecast W. Project	868	894	240	91	105	142	151	1,199	365	183	4,238	3,832
Impact of Project	8	8	3	1	1	2	2	11	3	2	38	0
% Change	0.93	0.90	1.27	1.11	0.96	1.43	1.34	0.93	0.83	1.1	0.91	0
1999 Baseline Forecast	1,171	1,207	327	124	142	191	204	1,619	493	246	5,724	5,453
1999 Forecast W. Project	1,178	1,213	329	125	143	192	205	1,628	496	248	5,757	5,453
Impact of Project	7	6	2	1	1	1	1	9	3	2	21	0
% Change	0.60	0.50	0.61	0.81	0.70	0.52	0.50	0.56	0.51	0.61	0.37	0

Forecasts in 1981 $.

Selected years from forecasts prepared by Frank Orth & Associates, Inc.

TABLE 5.32: SUMMARIZED IMPACT OF THE SUSITNA HYDROELECTRIC PROJECT ON WASILLA

	Present Conditions		Watana Construction Peak				Devil Canyon Peak			
Socioeconomic Variable	1981 Capacity	1981 Amount/ Usage	1990 Baseline Forecast	1990 Forecast with Project	Impact of Project	Percent Increase Over Baseline Forecast	1999 Baseline Forecast	1999 Forecast With Project	Impact of Project	Percent Increase Over Baseline Forecast
Population	N.A.	2,168	4,157	4,207	50	1.2	7,969	8,010	41	0.5
Employment[a]	N.A.	-[b]	-[b]	-[b]	27	-[b]	-[b]	-[b]	13	-[b]
Housing Demand (no. of units)	718	670	1,404	1,421	17	1.2	2,965	2,980	15	0.5
Water (gallons per day)	864,000	-[b]	559,000	565,000	6,000	1.1	1,185,787	1,191,861	6,074	0.5
Sewage Treatment (gallons per day)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Police	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Education (primary students)	1,170	959[c]	523	530	7	1.3	1,067	1,073	6	0.6
(secondary students)	1,800-[c]	1,068[c]	446	452	6	1.3	909	914	5	0.6
Hospital Beds	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.

N.A. - Not Applicable
(a) By place of employment
(b) Data not available
(c) School service areas do not correspond to city limits. 1981 enrollment may include a service area that extends beyond city boundaries, whereas projections for 1990 and 1999 refer only to school children living in Wasilla.

Source: Forecasts by Frank Orth & Associates, Inc.

TABLE 5.33: SUMMARIZED FISCAL IMPACTS OF THE PROJECT ON WASILLA

REVENUES ($000)	Intergovt. Transfer	State Shared Taxes	Federal & State Revenue Sharing	Licenses Fines & Mics.	Total General Fund Revenues		Capital Project Fund Revenues	Library Fund Revenues
1981 Current	26	314	195	22	557		3,533	102
1990 Baseline Forecast	49	603	374	41	1,067		6,776	195
1990 Forecast W. Project	50	610	379	42	1,081		6,858	198
Impact of Project	1	7	5	1	14		82	3
% Change	2.04	1.16	1.34	2.,44	1.22		1.21	1.54
1999 Baseline Forecast	95	1,156	717	79	2,047		12,989	374
1999 Forecast W. Project	96	1,161	721	80	2,058		13,056	376
Impact of Project	1	5	4	1	11		67	2
% Change	1.05	0.43	0.56	1.27	0.54		0.52	0.53

EXPENDITURES ($000)	Parks & Recreation	Library	Fire Service	Local Government Administration	Road Maint. & Repair	Total O + M	Capital Project Expends.
1981 Current	47	102	74	264	191	679	3,794
1990 Baseline Forecast	91	195	148	507	366	1,308	7,275
1990 Forecast W. Project	93	198	150	513	370	1,324	7,362
Impact of Project	2	3	2	6	4	16	87
% Change	2.20	1.54	1.35	1.18	1.09	1.22	1.20
1999 Baseline Forecast	175	375	287	972	701	2,511	13,946
1999 Forecast W. Project	176	376	289	977	705	2,523	14,017
Impact of Project	1	1	2	5	4	12	71
% Change	0.57	0.27	0.70	0.51	0.57	0.48	0.51

Forecasts in 1981 $.

Selected years from forecasts prepared by Frank Orth & Associates, Inc.

TABLE 5.34: SUMMARIZED IMPACT OF THE SUSITNA HYDROELECTRIC PROJECT ON HOUSTON

Socioeconomic Variable	Present Conditions: 1981 Capacity	Present Conditions: 1981 Amount/Usage	Watana Construction Peak: 1990 Baseline Forecast	Watana Construction Peak: 1990 Forecast with Project	Watana Construction Peak: Impact of Project	Watana Construction Peak: Percent Increase Over Baseline Forecast	Devil Canyon Peak: 1999 Baseline Forecast	Devil Canyon Peak: 1999 Forecast With Project	Devil Canyon Peak: Impact of Project	Devil Canyon Peak: Percent Increase Over Baseline Forecast
Population	N.A.	600	1,415	1,453	38	2.7	3,335	3,367	32	1.0
Employment[(a)]	N.A.	-[(b)]	-[(b)]	-[(b)]	15	-[(b)]	-[(b)]	-[(b)]	7	-[(b)]
Housing Demand (no. of units)	229	207	508	522	14	2.8	1,249	1,261	12	1.0
Water (gallons per day)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Sewage Treatment (gallons per day)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Police	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Education (primary students)	0[(c)]	0[(c)]	178	184	6	3.4	447	451	4	0.9
(secondary students)	0[(c)]	0[(c)]	152	156	4	2.6	380	384	4	1.1
Hospital Beds	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.

N.A. - Not Applicable
(a) By place of employment
(b) Data not available
(c) School service areas do not correspond to city limits. Children in Houston currently attend schools outside of the city. A secondary school initially accommodating 300 students is planned.

Source: Forecasts by Frank Orth & Associates, Inc.

TABLE 5.35: SUMMARIZED FISCAL IMPACTS OF THE PROJECT ON HOUSTON AND TALKEETNA

Houston	Total Estimated Grant Funding	Total Expenditures	Local Govt. Admin.	Fire Service	Parks & Recreation	Road Maintenance	Solid Waste
1981 Current	436,800	68,700	32,400	10,200	5,400	19,800	900
1990 Baseline Forecast	1,030,120	165,556	76,410	25,258	12,735	49,030	2,123
1990 Forecast w/Project	1,058,117	170,054	78,487	25,944	13,081	50,362	2,180
Impact of Project	27,997	4,499	2,077	686	346	1,332	57
% Change	2.72	2.72	2.72	2.72	2.72	2.72	2.68
1999 Baseline Forecast	2,427,880	394,230	180,090	60,130	30,015	118,993	5,003
1999 Forecast w/Project	2,451,094	398,000	181,812	60,705	30,302	120,131	5,050
Impact of Project	23,214	3,770	1,722	575	287	1,138	47
% Change	0.96	0.96	0.96	0.96	0.96	0.96	0.94

Talkeetna	Property Taxes Paid to Mat-Su Borough	State General Revenues for Fire Service	State Shared Revenues for Road Repairs	Total Revenues to Borough from Talkeetna Service Areas
1981 Current	20,742	4,800	45,820	71,362
1990 Baseline Forecast	48,615	7,500	98,215	154,330
1990 Forecast w/Project	61,401	9,473	98,215	169,089
Impact of Project	12,786	1,973	0	14,759
% Change	26.30	26.31	0	9.56
1999 Baseline Forecast	88,649	11,722	254,713	355,084
1999 Forecast w/Project	100,560	13,298	254,713	368,571
Impact of Project	11,911	1,576	0	13,487
% Change	13.44	13.44	0	3.8

Forecasts in 1981 $.

Selected years from forecasts prepared by Frank Orth & Associates, Inc.

TABLE 5.36: SUMMARIZED IMPACT OF THE SUSITNA HYDROELECTRIC PROJECT ON TRAPPER CREEK

	Present Conditions		Watana Construction Peak				Devil Canyon Peak			
Socioeconomic Variable	1981 Capacity	1981 Amount/ Usage	1990 Baseline Forecast	1990 Forecast with Project	Impact of Project	Percent Increase Over Baseline Forecast	1999 Baseline Forecast	1999 Forecast With Project	Impact of Project	Percent Increase Over Baseline Forecast
Population	N.A.	225	320	661	341	106.6	474	710	236	49.8
Employment[a]	N.A.	-[b]	-[b]	-[b]	66	-[b]	-[b]	-[b]	31	-[b]
Housing Demand (no. of units)	69	68	107	221	114	106.5	169	261	92	54.4
Water (gallons per day)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Sewage Treatment (gallons per day)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Police	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Education (primary students)	30[c]	40[d]	78	128-148	50-70	64.1	116	151-171	35-55	30.1
(secondary students)	0[d]	0[d]	34	74	40	117.6	52	82	30	57.7
Hospital Beds	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.

N.A. - Not Applicable
(a) By place of employment
(b) Data not available
(c) Planned capacity of 150
(d) School service areas do not correspond exactly to community delineations. The Trapper Creek elementary school serves a wide area outside of the community. Secondary school-age children from Trapper Creek attend Susitna Valley High School.

Source: Forecasts by Frank Orth & Associates, Inc.

TABLE 5.37: SUMMARIZED IMPACT OF THE SUSITNA HYDROELECTRIC PROJECT ON TALKEETNA

	Present Conditions		Watana Construction Peak				Devil Canyon Peak			
Socioeconomic Variable	1981 Capacity	1981 Amount/ Usage	1990 Baseline Forecast	1990 Forecast with Project	Impact of Project	Percent Increase Over Baseline Forecast	1999 Baseline Forecast	1999 Forecast With Project	Impact of Project	Percent Increase Over Baseline Forecast
Population	N.A.	640	1,000	1,263	263	26.3	1,563	1,773	210	13.4
Employment[a]	N.A.	-[b]	-[b]	-[b]	71	-[b]	-[b]	-[b]	34	-[b]
Housing Demand (no. of units)	196	194	334	421	87	26.0	581	658	77	13.3
Water (gallons per day)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Sewage Treatment (gallons per day)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Police	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Education (primary students)	120[d]	73[d]	126	164	38	30.2	209	240	31	14.8
(secondary students)	0[d]	0[d]	107	138	31	29.0	178	204	26	14.6
Hospital Beds	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.

N.A. - Not Applicable
(a) By place of employment
(b) Data not available
(c) School service areas do not correspond exactly to community delineations. Secondary school-age children attend Susitna Valley High School.

Source: Forecasts by Frank Orth & Associates, Inc.

TABLE 5.38: SUMMARIZED IMPACT OF THE SUSITNA HYDROELECTRIC PROJECT ON IMPACT AREA 3[a]

Socioeconomic Variable	1980 Amount	Watana Construction Peak: 1990 Baseline Forecast	1990 Forecast with Project	Impact of Project	Percent Increase Over Baseline Forecast	Devil Canyon Peak: 1999 Baseline Forecast	1999 Forecast With Project	Impact of Project	Percent Increase Over Baseline Forecast
Population	284,166	397,999	400,323	2,324	0.6	473,191	474,419	1,228	0.3
Employment	114,112[b]	200,112	206,477	6,365	3.2	232,311	235,668	3,357	1.4
Households	96,899	138,938	139,794	856	0.6	171,895	172,384	489	0.3

(a) Includes the following census divisions: Anchorage, Kenai Peninsula, Mat-Su Borough, Fairbanks-North Star Borough, S.E. Fairbanks and Valdez-Chitina-Whittier.

(b) Average employment during the first nine months of 1980.

Source: Forecasts by Frank Orth & Associates, Inc.

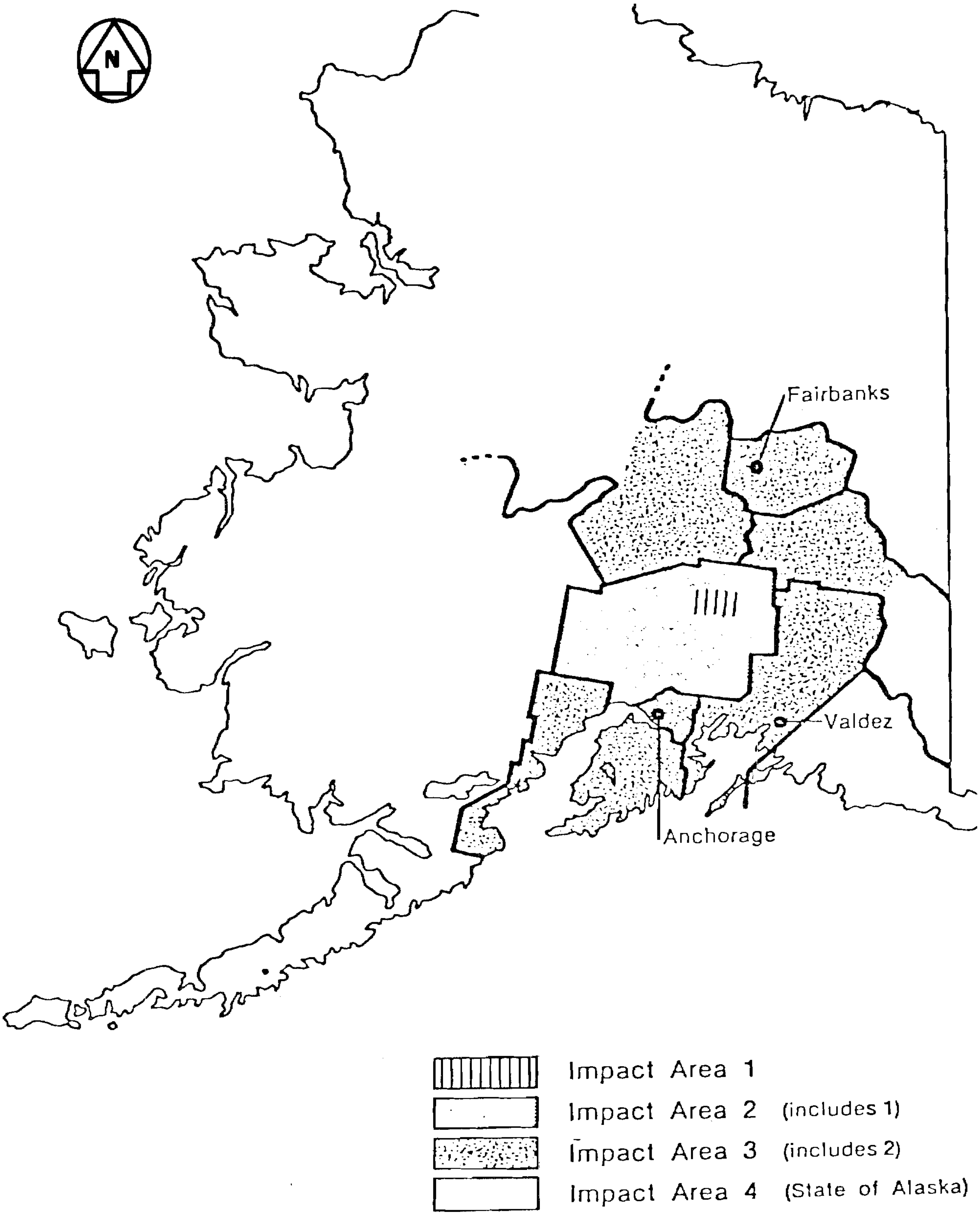
TABLE 5.39: SUMMARIZED FISCAL IMPACTS OF THE PROJECT ON ANCHORAGE AND FAIRBANKS

REVENUES ($000)	Police	Fire	Ambulance	Parks and Recreation	Library	Health Care	Transpor-tation	Sewage Service	Solid Waste Disposal	Water Supply	Total Expend-tures
1981 Current	26,732	17,472	3,320	9,784	3,669	4,368	14,676	15,899	3,669	21,665	121,254
1990 Baseline Forecast	35,304	23,523	4,469	12,546	4,705	5,769	18,818	20,998	4,846	28,613	159,590
1990 Forecast W. Project	35,484	23,642	4,492	12,609	4,728	5,798	18,914	21,105	4,870	28,758	160,400
Impact of Project	180	119	23	63	23	29	96	107	24	145	810
% Change	0.51	0.51	0.51	0.50	0.49	0.50	0.51	0.51	0.50	0.51	0.51
1999 Baseline Forecast	39,044	26,275	4,992	13,875	5,203	6,427	20,812	23,222	5,359	31,644	176,853
1999 Forecast W. Project	39,111	26,320	5,001	13,898	5,212	6,438	20,847	23,262	5,368	31,698	177,156
Impact of Project	67	45	9	23	9	11	35	40	9	54	303
% Change	0.17	0.17	0.18	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17

EXPENDITURES ($000)	Parks and Recreation	Police	Fire Service	Health Care	Public Works	Sewer Service	Electric Utilities	Water Supply	Total Expenditures
1981 Current	796	3,069	3,228	727	2,319	2,501	2,154	1,887	16,681
1990 Baseline Forecast	1,037	4,120	4,418	977	3,173	3,357	2,891	2,533	22,505
1990 Forecast W. Project	1,046	4,156	4,456	985	3,201	3,386	2,916	2,555	22,702
Impact of Project	9	36	38	8	28	29	25	22	198
% Change	0.88	0.87	0.86	0.82	0.88	0.86	0.86	0.87	0.88
1999 Baseline Forecast	1,209	4,805	5,204	1,173	3,701	3,915	3,372	2,954	26,333
1999 Forecast W. Project	1,220	4,847	5,249	1,183	3,733	3,949	3,401	2,980	26,564
Impact of Project	11	42	45	10	32	34	29	26	231
% Change	0.91	0.87	0.86	0.85	0.86	0.87	0.86	0.88	0.88

Forecasts in 1981 $.

Selected years from forecasts prepared by Frank Orth & Associates, Inc.

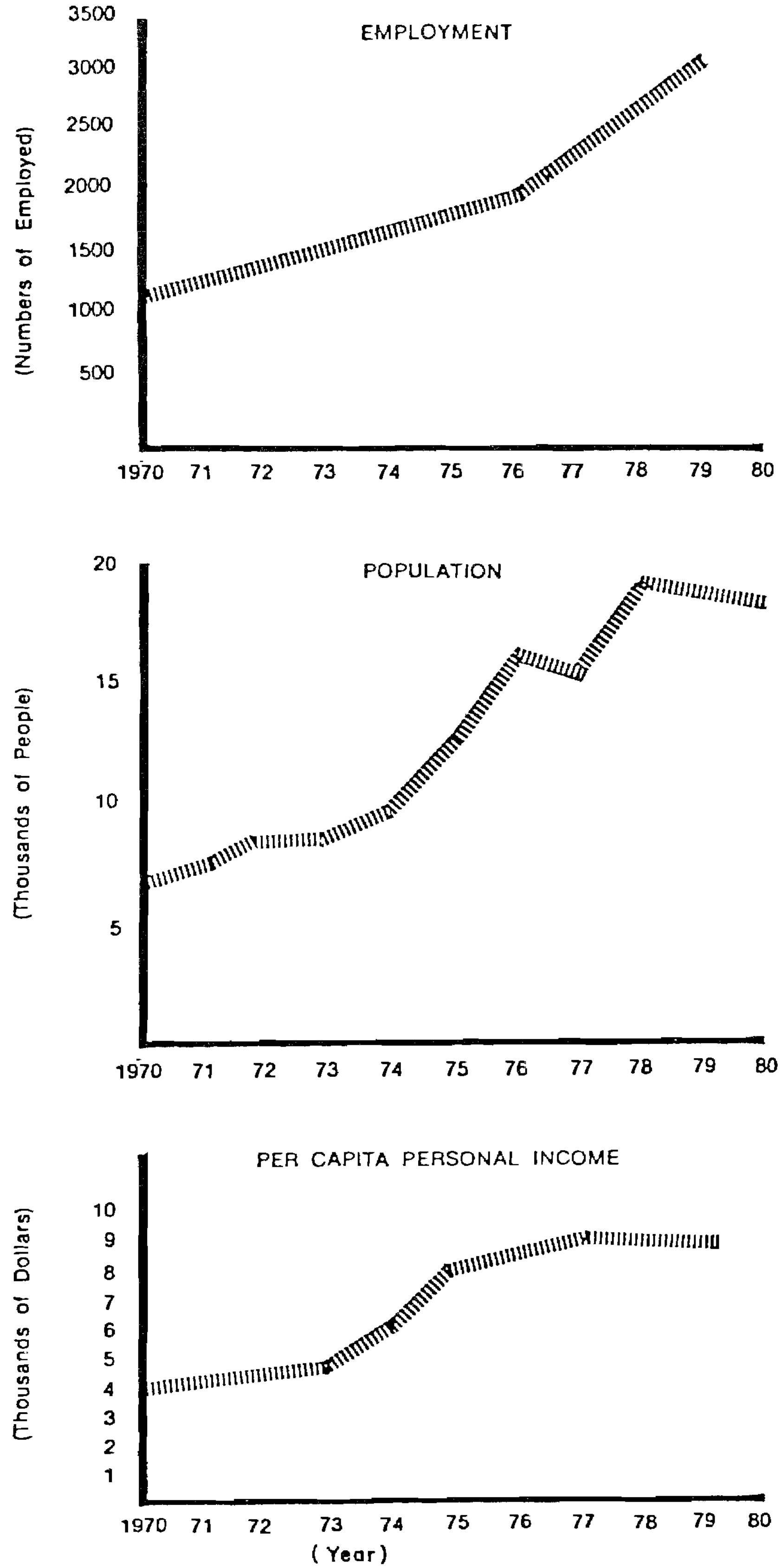


SOCIOECONOMIC IMPACT AREAS

ACRES

FIGURE 5.1

PREPARED BY TES / FRANK ORTH & ASSOCIATES, INC.

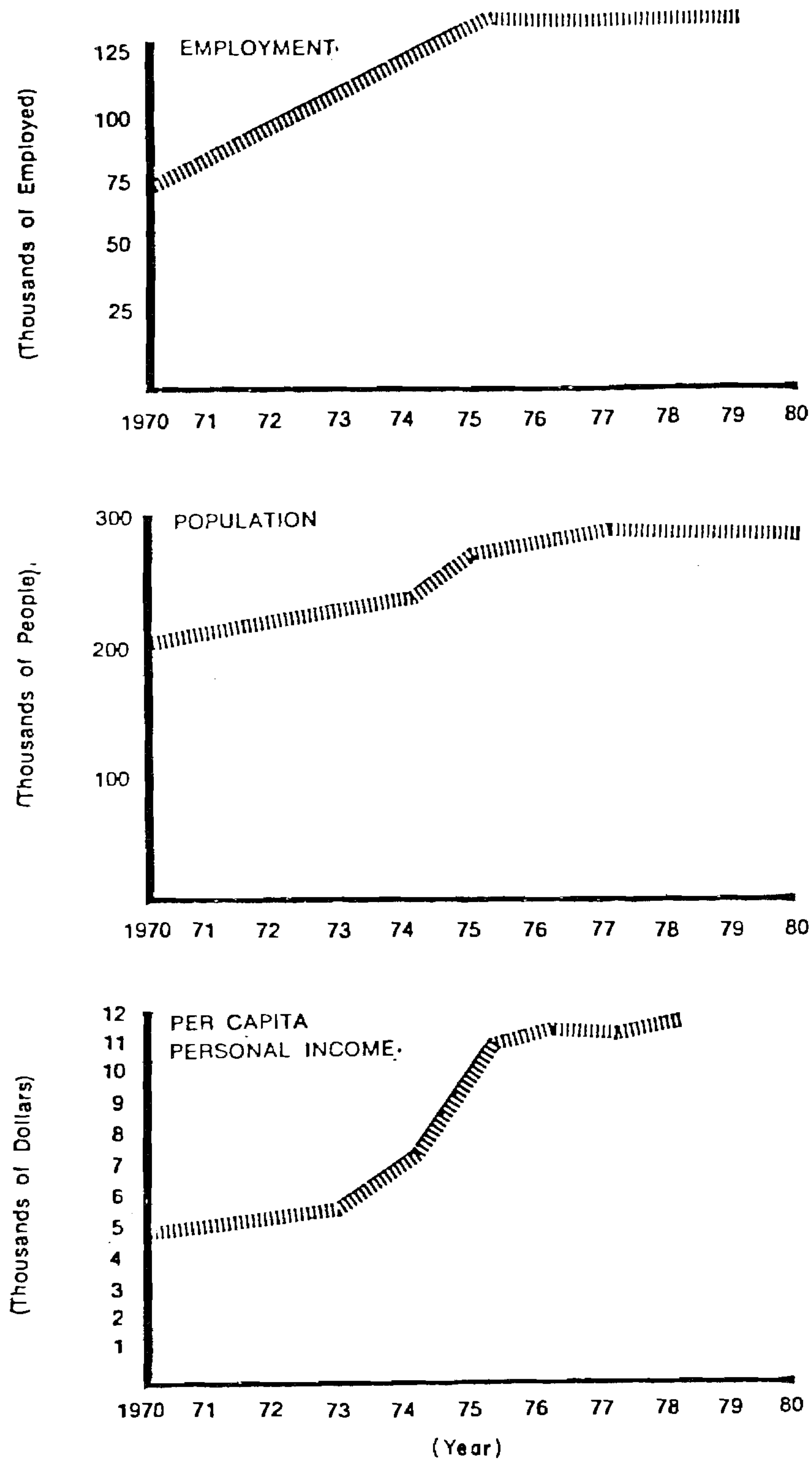


EMPLOYMENT POPULATION AND PER CAPITA PERSONAL INCOME IN THE MATANUSKA - SUSITNA BOROUGH 1970 - 1980

FIGURE 5.2

ACRES

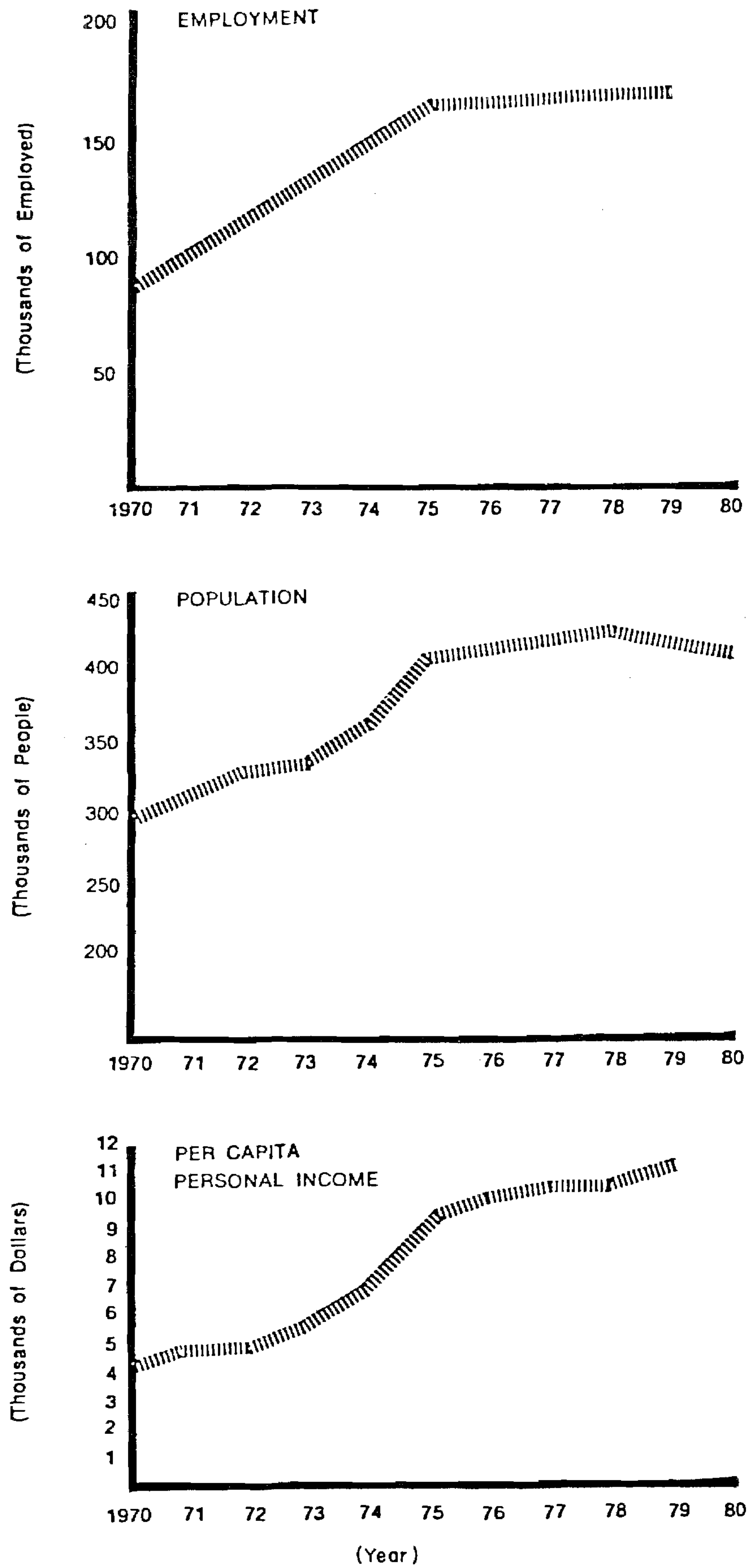
PREPARED BY TES/ORTH & ASSOCIATES, INC.



EMPLOYMENT, POPULATION AND
PER CAPITA PERSONAL
INCOME IN THE RAILBELT REGION

FIGURE 5.3

PREPARED BY TES/FRANK ORTH & ASSOCIATES, INC.

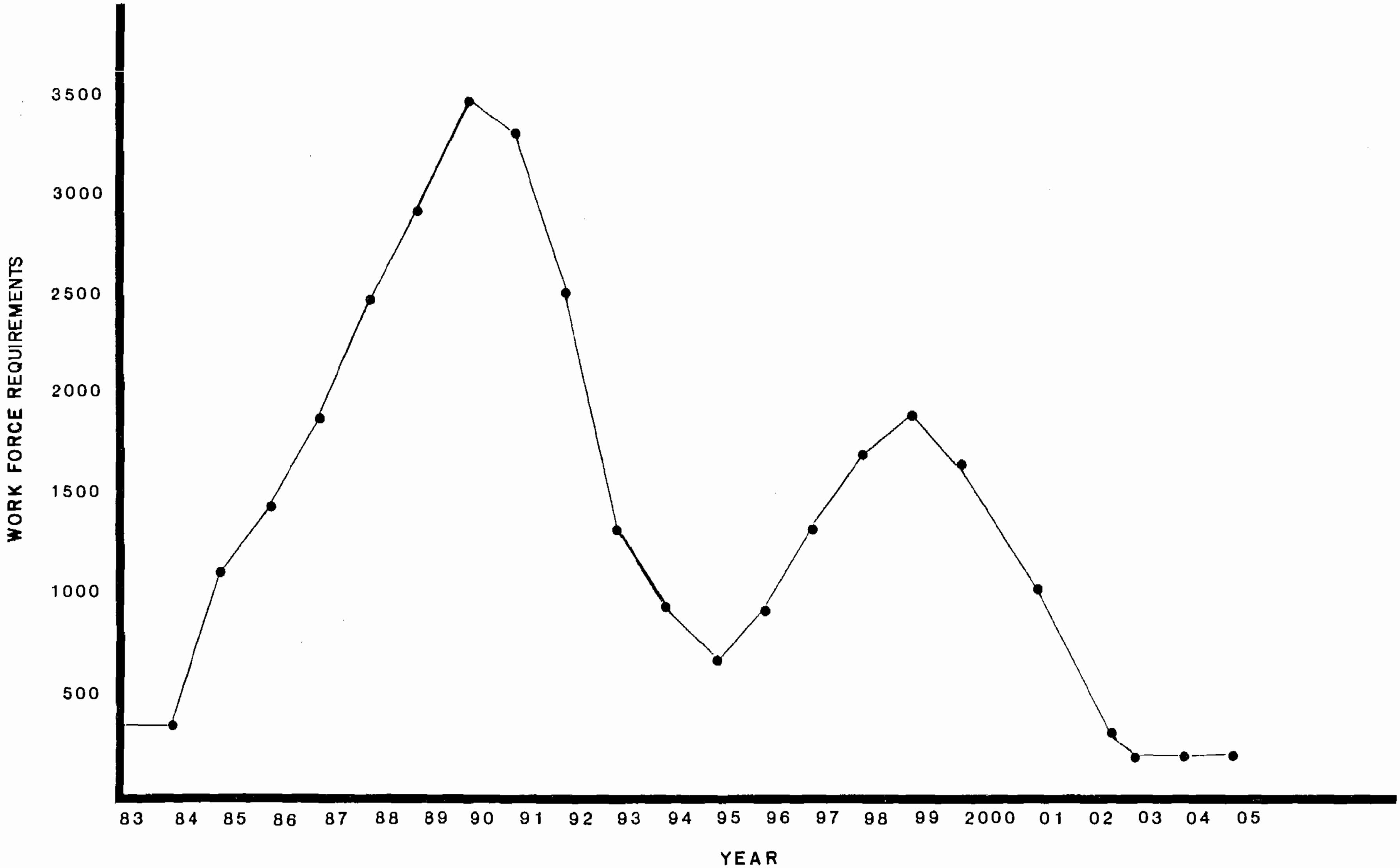


EMPLOYMENT, POPULATION AND PER CAPITA PERSONAL INCOME IN THE STATE OF ALASKA, 1970-1980

FIGURE 5.4

ACRES

PREPARED BY TES/FRANK ORTH & ASSOCIATES, INC.



ON-SITE CONSTRUCTION AND OPERATIONS WORK FORCE REQUIREMENTS

FIGURE 5.5

ACRES

PREPARED BY TES/FRANK ORTH & ASSOCIATES, INC

6 - GEOLOGY AND SOILS

This section presents a general description of the geology and soils present in the project area. More detailed information is available in the Sustina Hydroelectric Project, 1980-81 Geotechnical Report, February 1982.

6.1 - General Geology and Soils

The area of study is located within the Coastal Trough Province of south-central Alaska, with a drainage of approximately 6,000 square miles. The Susitna River is glacier-fed, with headwaters on the southern slope of the Alaska Range. From its preglacial channel in the Alaska Range, the Susitna River passes first through a broad, glaciated, intermontane valley of knob and kettle, and braided channel topography. Swinging westward along the edge of the Copper River lowlands, it enters the deep V-shaped valleys of the proposed damsites, winding through the Talkeetna Mountains until it emerges into a broad, glacial valley leading to Cook Inlet.

Virtually all topography within 16 kilometers of the project damsites consists of scoured bedrock knobs and ridges, glacial sediments and alluvium.

Soils of the Susitna Basin are typical of those found in cold, wet climates. These soils have developed from glacial till and outwash. In low-lying and poorly drained areas of forests and also above the tree line, soils are acidic, saturated, and high in organic matter. Well-drained soils of the forest zone are acidic and relatively infertile, the result of constant leaching caused by high precipitation. Sands and gravels along streams are the few neutral to alkaline soils in the region. Volcanic ash outfalls have affected the entire region, with soils in the lower basin and the west containing the most ash.

The Watana damsite is located in a relatively broad, U-shaped valley rising in steps, with the steep lower portion breaking into somewhat flatter slopes and becoming much gentler near the higher elevations. Access to the lower sections is limited because of vertical rock outcrops. Gravel bars, which can be quite wide, are exposed in the riverbed during low water flows.

At the Devil Canyon site, the river enters a very narrow gorge about two miles in length with steep walls up to 600 feet high. The valley is generally asymmetrical in shape, with the north abutment sloping at about 45° and the south abutment steeper at about 60°. The south abutment displays overhanging cliffs and detached blocks of rock. The north abutment is somewhat less rugged in the upper half, but the lower portion is very steep. Access at river level is very limited, but narrow benches are accessible at low water levels. The canyon itself is approximately 1,000 feet wide at the proposed dam crest elevation.

6.2 - Devil Canyon Reservoir

The topography in and around the Devil Canyon site and reservoir is bedrock-controlled. Overburden is thin to absent, except in the upper reaches of the proposed reservoir where alluvial deposits cover the valley floor.

(a) Bedrock Geology

A large intrusive plutonic body, composed predominantly of biotite granodiorite with local areas of quartz diorite and diorite, underlies most of the reservoir and adjacent slopes. The rock is light gray to pink, medium grained, and composed of quartz, felspar, biotite, and hornblende. The most common mafic mineral is biotite. Where weathered, the rock has a light yellow-gray to pinkish yellow-gray color, except where it is highly oxidized and iron stained. The granodiorite is generally massive, competent, and hard with the exception of the rock exposed on the upland north of the Susitna River where the biotite granodiorite has been badly decomposed as a result of mechanical weathering.

The other principal rock types in the reservoir area are the argillite and graywackes, which are exposed at the Devil Canyon damsite. The argillite has been intruded by the massive granodiorite, and as a result, large isolated roof pendants of the argillite and graywacke are found locally throughout the reservoir and surrounding areas. The argillite and graywacke varies to a phyllite of low metamorphic grade, with possible isolated schist outcrops.

The rock has been isoclinally folded into steeply dipping structures which generally strike northeast-southwest. The contact between the argillite and the biotite granodiorite crosses the Susitna River just upstream from the Devil Canyon damsite. The contract is nonconformable and is characterized by an aphanitic texture with a wide, chilled zone. The trend of the contact is roughly northeast-southwest where it crosses the river. Several large outcrops of the argillite completely surrounded by the biotite granodiorite are found within the Devil Creek area.

(b) Slope Stability and Erosion

The Devil Canyon reservoir will be entirely confined within the walls of the present river valley. This reservoir will be characterized by a narrow, deep water body that will be subject to only minimal seasonal drawdown. Much of the topography of this reservoir is bedrock-controlled. In the vicinity of Devil Creek, downstream from the damsite, the slopes of the reservoir and its shoreline consist primarily of bedrock which, in some areas, has a thin veneer of colluvium or till. Upstream from Devil Canyon, the slopes of the reservoir comprise increasing amounts of unconsolidated materials, especially on the south abutment. These materials are principally basal till and coarse-grained floodplain and alluvial fan deposits.

Current and previous slope failures in this area of the Susitna River, as defined by photogrammetry and limited field reconnaissance, are skin and bimodal flows in soil and block slides and rotational slides in rock. The basal tills are the primary materials susceptible to mass movement. On the south abutment and south of the damsite, there is a possibility of sporadic permafrost, but it is generally thought to be minimal. Upstream from this area, the basal till is nearly continuously frozen as evidenced by field information along the access road corridors and in Borrow Area "H."

Downstream from the Devil Creek area, instability is largely reserved to small rock falls. Beaching will be the primary process activity upon the shoreline in this area. Although this area is mapped as a basal till, it is coarser grained than that which is found in the Watana Reservoir, and therefore, it is more susceptible to beaching.

In areas where the shoreline is in contact with steep bedrock cliffs, the fluctuation of the reservoir will contribute to rock falls. Fluctuation of the reservoir and, therefore, the ground water table, accompanied by seasonal freezing and thawing, will encourage frost wedging as an erosive agent to accelerate degradation of the slope and beaching. These rock falls will be limited in extent and will in no way have the capacity to produce a large wave which could affect dam stability. In Devil Creek, a potential small block slide may occur after the reservoir filling.

Beyond Devil Creek, beaching will also be the common erosive agent up to approximately river mile 180. Present slope instability above reservoir normal pool level will continue to occur with primary beaching occurring at the shoreline. At river mile 175, there is a possibility that a large old landslide on the south abutment could become mobile and slide into the river valley. This landslide has a large accurate back scarp which has become completely vegetated since its last movement. This landslide, which has a volume of approximately 3.4 million cubic yards, has the potential for further sliding after impoundment because of thawing and/or changes in the ground water regime. However, the maximum pool elevation extends only to the toe of this slide. Therefore, it is unlikely that a large catastrophic slide could result from normal reservoir impoundment.

(c) Summary

The meandering of the river valley makes the potential of a wave induced by a massive landslide that could affect the dam stability very remote.

In general, the following conclusions can be drawn about the slope conditions of the Devil Canyon reservoir after impounding:

- Minimal drawdown of the reservoir is conducive to stable slope conditions;

- The lack of unconsolidated materials along the lower slopes of the reservoir and the existence of stable bedrock conditions are indicative of stable slope conditions after reservoir impounding;

- A large old landslide in the upper reservoir has the potential for instability; and

- The probability of a landslide-induced wave in the reservoir overtopping the dam is remote.

6.3 - Watana Reservoir

The Watana reservoir area is generally characterized by a variety of rock and soil types. The lower section of the Watana reservoir and adjacent slopes are predominantly covered by a veneer of glacial till and lacustrine deposits.

(a) Surficial Deposits

Two main types of till have been identified in the area: ablation and basal tills. The basal till is predominantly over-consolidated, has a fine grain matrix (more silt and clay), and a low permeability. The ablation till has less fines and a somewhat higher permeability. Lacustrine deposits consist primarily of poorly graded fine sands and silts with lesser amounts of gravel and clay that exhibit a crude stratification.

On the south side of the Susitna River, the Fog Lake area is characteristic of a fluted ground moraine surface. Upstream in the Watana Creek area, glaciolacustrine material forms a broad, flat plain which mantles the underlying glacial till and the semi-consolidated Tertiary sediments. Significant alluvial deposits exist in the river valley and consist of reworked outwash and alluvium. Glaciation of the area was accompanied by the filling in of the Susitna River valley. Subsequent modification by alluvial processes during deglaciation resulted in the formation of floodplain terraces. Ice disintegration features such as kames and eskers are adjacent to the river valley.

Permafrost exists in the area, as evidenced by ground ice, non-sorted polygons, stone nets, and slumping of the glacial till overlying permafrost. Numerous slumps have been identified in the Watana reservoir area, especially in sediments comprising basal till. Additional details regarding this subject will be addressed in subsequent sections. In addition, numerous areas of frozen alluvium and interstitial ice crystals have been observed in outcrops and drill hole samples.

(b) Bedrock Geology

The Watana damsite is underlain by a diorite pluton. Approximately three miles upstream from the Watana damsite, a nonconformable contact between argillite and the dioritic pluton crosses the Susitna River. An approximate location of this contact has also been delineated on Fog Creek, four miles to the south of the damsite. Just downstream from the confluence of Watana Creek and the Susitna River, the bedrock consists of semi- consolidated, Tertiary, sedimentary rocks (Smith 1974) and volcanics of Triassic age. These Triassic volcanics consist of metavolcaniclastic rocks and marble (Csejtey et al. 1980). Just upstream from Watana Creek to Jay Creek, the rock is a metavolcanogenic sequence dominantly composed of metamorphosed flows and tuffs of basaltic to andesitic composition. From Jay Creek to just downstream from the Oshetna River, the reservoir is underlain by a metamorphic terrain of amphibolite and minor amounts of greenschist and folidated diorite. To the east of the Oshetna River, glacial deposits are predominant.

The main structural feature of the Watana reservoir is the Talkeetna thrust fault which trends northeast-southwest (Csejtey et al. 1980). This thrust fault crosses the Susitna River approximately eight miles upstream from the Watana damsite. The dip of this fault is uncertain, as Csejtey and others (Csejtey, Foster, and Nokleberg 1980) have interpreted it to have a southeast dip, while Turner and Smith (Turner and Smith 1974) suggest a northwest dip. At the southwest end of the fault, unfaulted Tertiary volcanics overlie the fault (Csejtey, Foster, and Nokleberg 1980). A general discussion of regional geology is presented in Volume 1, Section 7 of this report.

(c) Slope Stability and Erosion

The geology of the slopes underlying and adjacent to the reservoir consists of unconsolidated material. As a generalization, the distribution of permafrost is nearly continuous in the basal till and is scattered to continuous in the lacustrine deposits. The distribution of permafrost has been delineated primarily on the flatter slopes, generally below the 2,300-foot contour. Other areas, including inclined slopes, may be underlain by permafrost which, when thawed, could result in slope instability. Current or previous slope instability on the slopes above the Susitna River, as defined by aerial photographic interpretation and limited field reconnaissance, indicates that the types of mass movement consist primarily of solifluction, skin flows, bimodal flows, and small rotational slides. These types of erosion occur predominantly in basal till or in areas where the basal till is overlain by lacustrine deposits. In addition, solifluction which originated in the basal till has proceeded downslope over some of the floodplain terraces.

Three major factors that will contribute significantly to potential slope instability in the Watana reservoir are the change in the ground water regime, the large seasonal fluctuation of the reservoir level (estimated at 140 feet), and the thawing of permafrost. The two processes affecting the shoreline of the reservoirs are beaching and slope stability. Models of shoreline conditions were developed and applied to select reaches of the reservoir shoreline and evaluated for conditions at or near normal pool levels. It should be noted that the slope stability of the Watana reservoir was evaluated for the "worst" case which considered the maximum and minimum pool levels for slope instability. In cases where sliding will occur, it will not be uncommon for some flows or possibly beaching to occur over the same reach.

The filling of the reservoir to the normal pool level is estimated to take approximately three years. Because of the rate of impoundment, the potential for slope instability occurring during flooding of the reservoir will be minimal and confined to shallow surface flows and possibly some sliding. These slopes will be more susceptible to slope instability after impoundment when thawing of the permafrost soils will occur and the ground water regime has reestablished itself in the frozen soils.

Assuming that the current contours will remain unchanged, the north abutment will have the potential for beaching near the damsite, except for possibly some small flows and slides adjacent to Deadman Creek. On the south abutment, thawing of the frozen basal tills will result in numerous skin and bimodal flows, and there will be a potential for small rotational sliding to occur primarily opposite Deadman Creek.

On the south abutment, between the Watana damsite and Vee Canyon, the shoreline of the reservoirs is susceptible to a high potential for flows and shallow rotational slides. In contrast to the north abutment, the shoreline is almost exclusively in contact with frozen basal tills, overburden is relatively thick, and steeper slopes are present. Thermal erosion, resulting in the erosion and thawing of the ice-rich, fine grained soil solids, will be the key factor influencing their stability. On the north abutment and on both abutments upstream from Vee Canyon, the geological and topographic conditions are more variable and therefore have a potential for varying slope conditions. In the Watana Creek drainage area, there is a thick sequence of lacustrine material overlying the basal till. Unlike the till, it appears that the lacustrine material is largely unfrozen. In addition, slope instability may occur as a result of potential liquefaction of the lacustrine material during earthquakes. Overall, the north abutment in contrast with the south abutment does not have the constant steep slopes, and the slopes are slightly better drained, which may be indicative of less continuous permafrost and/or slightly coarse material at the surface with a deeper active layer.

In general, the potential for beaching is higher because the seasonal drawdown zone will be in contact with a thin vaneer of colluvium over bedrock and, in a number of areas, low slopes. In the Oshetna-Goose Creek areas, there is a thick sequence of lacustrine material. Permafrost appears to be nearly continuous in this area based on the presence of unsorted polygonal ground and potential thermokarst activity around some of the many small ponds (thaw lakes/kettles). The reservoir will be confined primarily within the floodplain, and therefore little modification of the slopes is expected. Where the slopes are steep, there could be some thermal niche erosion resulting in small rotational slides.

The potential for a large blockslide occurring and generating a wave with the likelihood of overtopping the dam is very remote. For this condition to occur, a very high, steep slope with a potentially unstable block of large volume would need to exist adjacent to the reservoir. In approximately the first 16 miles upstream from the dam, the shoreline will be in contact with the low slopes of the broad, U-shaped valley. Between 16 and 30 miles upstream from the dam, no potentially large landslides were observed. Beyond 30 miles upstream, the reservoir begins to meander and narrows; therefore, any wave induced in this area by a large landslide would, in all likelihood, dissipate prior to reaching the dam.

(d) Summary

In general, the following conclusions can be drawn about the slope conditions of the Watana reservoir after impoundment:

- The principal factors influencing slope instability are the large seasonal drawdown of the reservoir and the thawing of permafrost soils. Other factors include the change in the ground water regime, the steepness of the slopes, coarseness of the material, thermal toe erosion, and the fetch available to generate wave action;

- The potential for beaching will occur primarily on the north abutment of the reservoir;

- A large portion of the reservoir slopes are susceptible to shallow slides, mainly skin and bimodal flows and shallow rotational slides;

- The potential for a large blockside that might generate a wave that could overtop the dam is remote; and

- The period in which restabilization of the slopes adjacent to the reservoir will occur is largely unknown.

In general, most of the reservoir slopes will be totally submerged. Areas where the filling is above the break in slope will exhibit fewer stability problems than those in which the reservoir is at an intermediate or low level. Flow slides induced by thawing permafrost can be expected to occur over very flat-lying surfaces.

6.4 - Mitigation Measures

The primary method of mitigating impacts to soils will be through standard stabilization, reclamation, and revegetation techniques.

All temporary access roads will be graded, recontoured and seeded following abandonment. Areas near streams or rivers where erosion may occur will be rip-rapped during the construction period and re-sealed when construction is complete. Borrown area will be excavated only if necessary and will either be regraded and seeded with appropriate species or, if excavation is deep enough, converted to ponds.

To insure success of restoration efforts, a comprehensive restoration and revegetation plan will be decycled and implemented to prevent soil erosion. This plan will include the use of terrain (if necessary) mulch (hay and straw) mulch anchored with a light asphalt tack and mats in area of high erosion potential. Seeding mixtures will be developed to provide the most rapid recovery possible and inlcude species adapted to all soil and light (shad, sun, etc.) conditions present at the site. Seed mixtures may be applied using the hydroseeding techniques which includes a mixture of fertilizer, lime and seeds. Restoration procedures will be monitored to insure their efficiency. Any areas showing erosion or where restoration is not effective will be restored with modified plans.

Rock excavated and not utilized in construction will be used as backfill in borrow areas or disposed of in areas which will be inundated by the reservoir.

6.5 - Conclusions

Some amount of slope stability will be generated in the Watana and Devil Canyon reservoirs as the result of reservoir filling. These areas will be primarily in locations where the water level will be at an intermediate level relative to the valley depth.

Slope failure will be more common in the Watana reservoir because of the existence of permafrost soil throughout the reservoir. The Devil Canyon reservoir is generally in more stable rock, and the relatively thin overburden is unfrozen in the reach of the river upstream from the dam.

Although skin flows, minor slides, and beaching will be common in parts of the reservoirs, they will present only a visual concern and pose no threat to the project. Many areas in which sliding does occur will stabilize into beaches with a steep backslope.

Tree root systems left from reservoir clearing will tend to hold shallow surface slides and, in cases where permafrost exists, may have a stabilizing influence, since the mat will hold the soil in place until excess pore pressure has dissipated.

7 - REPORT ON RECREATIONAL RESOURCES

7.1 - Recreational Lands Designations

Currently, there are no areas within or near the proposed project boundary that are included or designated for inclusion in the National Wild and Scenic Rivers System, the National Trails System, or a wilderness area under the Wilderness Act.

The Susitna River was among several rivers recommended for detailed study as possible additions to the National Wild and Scenic Rivers System in 1978 under Sec. 204 (e) of the Federal Land Policy and Management Act of 1976. The allowed three-year study period ended November 1981 without Congressional action to include the river in this system. Currently, it is not under consideration for inclusion under any program.

7.2 - Existing and Proposed Recreation Facilities

(a) Existing Recreation Facilities - Project Area

(i) Facilities

Presently, there are no publicly developed recreation facilities within the vicinity of the project, and the only privately owned facilities of this nature are three lodges. Access to these lodges is primarily by air, and they are used chiefly for fishing, hunting, boating, hiking, and skiing. The first, Stephan Lake Lodge, is located south of the Susitna River at Stephan Lake and is the largest of the three. It is comprised of ten structures with additional outlying cabins and offers its predominantly European clientele a variety of services on a year-round basis. High Lake Lodge has eleven structures and is located north of the proposed Devil Canyon dam site at High Lake. The clientele at present is strictly seasonal and restricted to project personnel who use the facility as an auxiliary study camp. Tsusena Lake Lodge, with three structures, is north of the proposed Watana dam site at Tsusena Lake. Clientele is restricted to family, friends, and associates of the lodge owners.

In addition to the lodges, there are also numerous private cabins in the project area utilized by individual owners. These are used primarily on a seasonal basis for hunting, fishing, trapping, and other recreational activities (Refer to Section 9.1).

(ii) Activities

Various types of recreational activities take place in the upper Susitna River basin that are not necessarily associated with formally developed facilities. The greatest concentration of use is found at lakes within the basin that are accessible by float plane (Refer to Section 9.1). These recreational activities are primarily characterized by low-volume use associated with hunting, fishing, camping, hiking, and boating. Some rafting and kayaking takes place on the Susitna and Tyone rivers and Prairie Creek.

Various trails for dog sleds, ORVs (off-road-vehicles), and snowmachines are present throughout the basin. Their use is primarily for subsistence, recreation, or mineral exploration activities.

(b) Existing Recreation Facilities - Adjacent Areas

Most of the existing recreational facilities adjacent to the project area serve the two urban centers of Anchorage and Fairbanks and, secondarily, the population along the Parks Highway that connects the two. The majority of the state's population lives in these areas.

While there are few formally developed recreational facilities within the immediate vicinity of the project, many such facilities exist in the region. These areas and facilities are described in Table 7.1. The primary attraction in the region is the Denali National Park and Preserve. With 2.3 million ha (5.7 million a), it is the largest and most popular recreational attraction in the region. Facilities include several lodges, visitor centers, gas station, bus service, campgrounds, interpretive services, and trail system.

North of the project area, the Bureau of Land Management maintains the 1.8 million ha (4.4 million a) Denali Planning Block that encompasses most of the Denali Highway and contains within its boundaries the Tangle Lakes Archeological District. More archeological sites lie within this district than in any other known area of comparable size in the American subarctic. It is of major archeological significance, with sites dating back 12,000 to 15,000 years ago. The Bureau also maintains small campground and picnic areas along the Denali Highway, with boat launches and canoe trails at Tangle Lakes.

Denali State Park is comprised of about 170,430 ha (421,120 a) and is located west of the project area. The park offers a major campground at Byers Lake, where camping, picnicking, canoeing, and a trail system are available.

Well south of Denali State Park and located approximately 110 km (70 mi) from Anchorage is Nancy Lake State Recreation Area. Comprised of 9180 ha (22,680 a), with more than 130 lakes and ponds, this area offers camping, picnicking, fishing, canoeing, and boating. Canoeing occurs through the chain of lakes that make up the 13 km (8 mi) Lynx Lake Loop, and on the Little Susitna River downstream from the Parks Highway. Overland trails available in the area are used in summer for hiking and in winter for skiing and snowmachining.

Similar facilities exist at Chugach State Park, approximately 16 km (10 mi) from Anchorage. This park covers about 200,000 ha (494,000 a) with camping, picnicking, hiking, hunting, canoeing, and fishing facilities. Summer- and winter-use trails are also provided. Developed campgrounds exist at Eklutna Lake, Eagle River, Peters Creek, and Bird Creek, all within park boundaries.

Lake Louise, with adjoining Susitna Lake, is a popular fishing, boating, and hunting area located southeast of the project area. The Lake Louise area is primarily in private ownership, although there is also a state-maintained Lake Louise wayside. As the source of the Tyone River, an upper Susitna River tributary, the lake receives occasional use from river floaters who make the trip from Lake Louise to the Susitna River.

Privately owned and operated facilities in adjacent areas provide the public with somewhat different services. Lodges, cabins, restaurants, airstrips and flying services, guiding services, whitewater rafting trips, and campgrounds are the types of services and facilities provided by private enterprises.

(c) Proposed Recreation Facilities

The following plan for recreation development is tentative. It is subject to approval by the Power Authority and review by other agencies and will likely undergo some modification and refinement. Furthermore, the results of a planned public participation survey, which will influence the development plans, are not yet available.

(i) Immediate Development

Recreational facilities to be provided within the project area reflect opportunity types that will be available to the public. The proposed opportunity settings are shown in Figure 7.1, and a description of the management program and activities to be emphasized is provided in Table 7.2. The recreational opportunity settings proposed include semi-modern, semi-primitive, and primitive. The primary emphasis will be on day-use with overnight facilities provided near the two dam sites and road-oriented recreation at the alpine lakes.

The two proposed reservoirs and the dams themselves as well as scenic lakes within the project area will be prime attractions. Along with the trails and portages to these lakes, various waterfalls in the area will offer additional opportunities not available at the reservoirs.

Figure 7.2 and Table 7.3 indicate recreational facilities proposed for development within three years of commencement of project operation. The greatest concentration of use will be near the Devil Canyon and Watana dam sites where there will be access to the reservoirs. Recreation facilities to be provided in the first three years include developed auto campgrounds (designed to accommodate various types of vehicle users and allowing for future expansion), picnic grounds, boat launches, and parking areas. Emphasis will be on rustic facilities with a minimum level of services and a maximum of natural aesthetic features.

Recreational development at Devil Canyon reservoir is limited by the reservoir's narrow gorge and steep canyon walls. While several side canyons may offer some degree of protection from wind, providing sheltered moorages for boats, the steep-sloped banks are not suitable for any type of development. Farther up the impoundment, however, there are slopes more appropriate for development of recreational facilities.

The Devil Canyon dam will serve as a focal point for recreational activities in the lower sections of Devil Canyon reservoir. A mix of day-use and overnight facilities will be available to visitors interested in both water-based and land-oriented activities ranging from boating and picnicking to hiking and camping. Day-use facilities available at the dam site will include picnic and rest areas with orientation and interpretive information and a scenic overlook of the reservoir.

Boat ramps with parking areas will be located at Cheechako Canyon (east of Devil Canyon dam) and downstream of Watana dam at Tsusena Creek. Overnight camping will also be available near Cheechako Canyon with a minimally developed auto-oriented campground. Locating the campground at Cheechako Canyon instead of directly at Devil Canyon makes it accessible to all types of visitors while removing it from the operation and maintenance activities of the dam. The topography and natural vegetation along the canyon also present a pleasant and secluded atmosphere for visitors. A trailhead from a parking area near the campground will lead to a series of waterfalls along Cheechako Creek with a short loop trail designed specifically for the physically handicapped. To minimize conflict with non-motorized day-use of the canyon, lower Cheechako Canyon, above the boat ramp, would be designated as a no-wake zone, that is, boat speed is so regulated as not to produce any wake.

Boating access at Tsusena Creek on the upper Devil Canyon reservoir will provide for dispersion of some of the reservoir's recreational use, while allowing immediate access to the upper portion of the reservoir from a launch area. Overnight camping facilities located north of this boat access point will be similar to, but slightly smaller than, those at the Cheechako Canyon campground. All developed sites will have conveniently located comfort stations that are serviced on a regular basis.

Watana reservoir will probably receive low-volume, dispersed use, mostly for boating, hunting, and sightseeing activities. Access to the reservoir will be via a boat ramp and parking area at Deadman Creek.

Both Watana and Devil Canyon reservoirs may have hazards caused by wind, wakes from passing boats, depth and temperature of the water, steep banks, and fluctuating water levels. For public safety and the encouragement of boating courtesy, boat patrols will be necessary.

Boat launching, docking, and mooring facilities in both reservoirs will need to be designed to accommodate the changes in water level. On a daily basis, these changes will be insignificant. From June to September, however, the average water level of Devil Canyon reservoir will rise 15 m (50 ft) and that of Watana will rise 9 m (30 ft). When the reservoirs are not full, the aesthetics of the exposed drawdown zone (Section 8.2) could reduce the attractiveness of water-based recreation.

Other project area developments will be in the semi-primitive opportunity setting along the access road corridor. Scenic viewpoints, pull-outs at trail-heads, and access at Indian River, where spawning salmon can be viewed during the summer months, are the facilities planned for the road system. Waste containers will be placed at the Indian River access point and at trailhead pull-outs; waste disposal for these containers will be scheduled. All other scenic viewpoints, for both short-term viewing and for photography, will not have waste containers.

Between Devil Canyon and Watana dam sites, a mix of low-speed, auto-oriented sightseeing, with scenic overlooks and trails to accessible lakes and waterfalls within the area, will provide a view of the alpine tundra. To protect the sensitive resource base and to maintain a semi-primitive recreational opportunity, no facilities are to be provided except overlooks and trails. Dispersed camping will be permitted, however, with enforcement of "pack-in, pack-out" policy. This will involve periodic inspection of the more popular camping areas to assess impact, communicate with visitors, and enforce policies.

To avoid further conflict and interference with existing private lodge operations at High Lake, this area will not be developed for recreation. Primitive portages to other alpine lakes in the area will be cleared of brush and the wet areas stabilized, but will not have developed trails. Some regulations will be developed to manage specific aspects of visitors' use of the area. For example, no off-road-vehicle use will be permitted in the project area; enforcement of this prohibition will be a normal part of the patrolling effort. Visitors will also be informed of rules on handling food within the project area to reduce their encounters with bears. These rules will apply as well to the backcountry and dispersed use areas along the reservoirs.

(ii) Long Range Development

After the first three years of project operation, long-term development will focus on the expansion of the campgrounds at Cheechako Canyon and Tsusena Creek and on the additions of two boat-in campgrounds along the Watana reservoir, and a boat-in picnic area at Devil Canyon reservoir (Figure 7.3). Boaters coming down the Susitna River from the Denali Highway and down the Tyone River from Lake Louise and Lake Susitna will be accommodated at a proposed camping area near the confluence of the two rivers. Delay in the development of these boat-in facilities is necessary until the shoreline effects are evaluated.

The semi-primitive opportunity settings will be maintained for the reservoirs. Any plans for additional facilities will have to incorporate trends in usage and public demand and be compatible with resource capability to support such usage. The option of providing commercial services such as service stations, lodging, boat rentals, campsites, or other facilities will be considered if such developments are shown to be both economically feasible and suitable for the opportunity setting. If this option is desirable it could be pursued under a concession contract.

7.3 - Plan for Public Access

(a) Shoreline Buffer Zone

Low-density, dispersed use of back country areas and reservoir shorelines will minimize damage to areas resulting from overuse or concentrated use. Monitoring of recreational use will be necessary, particularly in areas of greatest use.

The shoreline buffer zone allows for public access at both reservoirs while protecting the scenic, cultural, and other environmental values of their shorelines. To protect and enhance these values, proposed recreation facilities will be designed and located to have the least impact on the landscape. Developments at the dam sites will be located away from the reservoirs and are intended to blend into the landscape, to be of rustic design, and to be situated among vegetation with higher absorption factors. Recreation development at the dam sites will also be concentrated near areas of prior development for construction of the dams.

The shoreline buffer zone will constitute 61 m (200 feet) horizontal distance from the full-pool level of the reservoirs. [The proposed full-pool level at Devil Canyon is 444 m elevation (1455 ft.); at Watana, 666 m (2185 ft.)]. A 61-meter buffer zone will also be provided around planned recreation sites.

(b) Access Route Plan and Policy

Access from the Parks Highway to the impoundments and recreation facilities will be provided by a gravel road, which falls within the semi-modern classification of the opportunity spectrum (cf. Section 9.2; also see Figure 7.1). The road will connect with the Parks Highway at Hurricane and be constructed to Gold Creek. From Gold Creek to Devil Canyon dam, it will follow the south side of the Susitna River. It will cross Devil Canyon and be routed on the north side of the river to the Watana dam site (Acres 1981).

An orientation and information sign on the Parks Highway, at the entrance to the project road, will inform visitors of the opportunities and restrictions in the project area. This display and other signs along the road will be of simple and rustic design. Scenic viewpoints, pull-outs at trailheads, and access at Indian River are facilities planned to be served by the road system.

During construction, use of the access road will be restricted to construction personnel and to the transport of project materials and supplies. After construction, access will be allowed; however, ORV use could be prohibited. ORV use, particularly in the alpine zone, would destroy the opportunities that the recreation plan and other mitigation plans are designed to protect. Road patrols will monitor the area, and a visitor check-point, perhaps at the Devil Canyon dam, could be established.

(c) Relationship of Access to Recreation Plan

Access has a significant role in the planning of recreation facilities. The location and types of opportunities and facilities available to the public are determined primarily by the access route that is developed, the traffic for which the route is designed (and maintained), and the access policy.

It is anticipated that most road-oriented use will involve driving for pleasure and access for short hikes, photography, and fishing. Lands adjacent to the road will offer visitors a different opportunity, a chance to participate in dispersed, backcountry activities such as hiking, canoeing, and camping in an alpine-tundra environment. To protect both this unique opportunity in the semi-primitive portion of the opportunity spectrum and the environmental settings in which they occur, it will be necessary to zone the road corridor against all types of ORV use, and to enforce this restriction (as discussed in the previous section). Recreational use of lands other than project lands will need to comply with the policies established by the land-owners or management agencies. Cooperative agreements may be required where such lands border either the access corridor or recreation facilities on the reservoirs.

7.4 - Estimates of Existing and Future Recreational Use

(a) Regional Use

There are no comprehensive statistics for the amount of recreational use the project vicinity in the upper Susitna basin receives on a yearly basis. The type of use, however, primarily involves dispersed, low-volume activities, such as hunting, fishing, and boating. The predominant mode of travel to the area is by private aircraft. Lack of ready access combined with low-volume activity make accurate data collecting difficult and expensive.

Traffic counts for the Denali and Parks highways provide some indication not only of the amount of use these highways receive during the summer months but also the time of year when the majority of recreational use occurs within the region. Traffic counts taken by the Alaska Department of Transportation and Public Facilities from 1973 to 1978 are shown on Table 7.4 with the average daily traffic count for the entire length of the Denali Highway and for the East Fork Maintenance Station (Mile A185) along the Parks Highway. This station is approximately 32 km (20 m) north of the intersection of the proposed project area access road and the Parks Highway. Table 7.4 shows the average daily traffic count for both highways from mid-May to October (this coincides with the time the Denali Highway is open to the public) and the annual average daily traffic count for the Parks Highway.

Results of the 1975 outdoor recreation study for the Denali Highway area indicated that for the 75-day season from 1 July - 13 September 1975, approximately 6,400 recreation groups (average size 3.2 persons) used the Denali Highway area for a total of 20,500 recreation visits (Johnson 1975). The study determined that 90% of highway travelers interviewed (1,088 respondents) cited recreation as the primary purpose of their trip. The majority of the respondents (82%) were Alaska residents, with 35% from Anchorage and 27% from Fairbanks.

A summary of visitor counts taken by the Alaska Division of Parks for state recreation areas adjacent to the Parks Highway is shown in Table 7.5. These figures were compiled from data collected for the summers of 1979 and 1980.

(b) The Participation Survey

The major objective of the participation survey is to determine a gross estimate of recreation participation rates. Knowledge of these rates can then be used to estimate the cost effectiveness of proposed recreational facilities and the unit cost of recreational services. The number of people that a recreational facility will ultimately be designed to accommodate can also be determined from the results of the survey, when they are available.

(c) Recreational Use Resulting from Increased Access

It is obvious that recreational use of the area will increase dramatically when road access is available. A quantitative estimate, however, is not possible without the results of the participation survey, which are not available at this time.

7.5 - Schedule and Cost of Recreation Facility Development

Like the details of the proposed recreation plan, the following schedule and costs are tentative. They are subject to Power Authority approval, and will require review by other agencies.

(a) Short Term

The majority of the proposed site developments are scheduled for completion during the first three years of project operation. Since most of the cost of development is road-related, however, some site preparation could take place at the time of road construction at little extra cost. In addition, once the type and location of opportunities to be offered to the public have been established, it is important to stabilize these opportunities at that level. Failing to do so early will permit the original opportunities to be changed or lost as additional developments are introduced. The results of such an alteration will be to displace the established clientele, replacing them with a group seeking a higher level of development.

Short-term costs for recreational facility development, exclusive of road construction costs, are estimated in 1981 dollars to be $2,215,317. A summary of these costs, with the subtotal for each opportunity setting and recreation site, is shown in Table 7.6.

The estimated cost of parking areas varies with the type of area designed. Parking areas located at boat launchings have 3.1 m x 12.2 m (10 feet X 40 feet) spaces; in all other areas they will be 3.1 m x 9.1 m (10 feet x 30 feet). The estimated cost of scenic overlooks and pull-outs is based on an average size of 1,300 m^2 (14,000 sq. ft) per pull out. Actual costs will depend upon actual site conditions, distance to nearest material site, and other factors. Cost estimates are subject to modification once detailed site planning and construction drawings are completed.

(b) Long Term

Proposed site developments scheduled for completion after the first three years (long-term development) include the boat-in picnic ground at Devil Canyon reservoir, two boat-in campgrounds at Watana reservoir, and the expansion of the two campgrounds at Cheechako Canyon and Tsusena Creek.

Long-term costs for recreational facility developments, exclusive of road construction costs, are estimated in 1981 dollars at $1,050,585. A summary of these costs with the subtotal for each opportunity setting and recreation site is shown in Table 7.7. The total for both phases, in 1981 dollars, is $3,265,902.

Estimated operating costs are shown in Table 7.8 and were developed by determining normal agency operations, developing a list of possible cost categories, and soliciting 1981 costs for these items. The projected total operating cost in 1981 dollars would be $405,939 for the first year and $290,280 per year after that.

TABLE 7.1: REGIONAL RECREATIONAL FACILITIES

Site Development	Location[a]	Managing Agency	Area	Accommodations
WITHIN PROJECT AREA				
High Lake Lodge and airstrip	5 kilometers (3 miles) N.E. of Devil Canyon damsite at High Lake	Private	45 hectares (111 acres)	8 units
Stephan Lake Lodge and airstrip	16 km (10 miles) S.W. of Watana damsite at Stephan Lake	Private	17 hectares (42 acres)	24 units
Tsusena Lake Lodge and airstrip	16 km (10 miles) N.W. of Watana damsite at Tsusena Lake	Private	20 hectares (49 acres)	8 units
OUTSIDE PROJECT AREA				
Denali National Park and Preserve	Parks Highway, Mile 237.7	National Park Service	2,306,790 (5.7 m. acres)	228 units
Brushkana River Campground	Denali Highway, Mile 105	Bureau of Land Management	19 hectares (47 acres)	17 campsites
Tangle Lakes Campgrounds and Boat Launch	Denali Highway, Mile 21.5	Bureau of Land Management	16 hectares (47 acres)	13 campsites
Upper Tangle Lakes Campground and Boat Launch	Denali Highway, Mile 21.7	Bureau of Land Management	10 hectares (25 acres)	7 campsites

a. Locations of site developments taken from the 1980 Milepost.

Site Development	Location[a]	Managing Agency	Area	Accommodations
Chugach State Park	East of Anchorage	Alaska Division of Parks	200,327 hectares (495,000 acres)	Unknown
Denali State Park	Parks Highway, Mile 132 to 169	Alaska Division of Parks	170,427 hectares (421,120 acres)	Unknown
Tokositna	Parks Highway, West of Mile 135	Alaska Division of Parks	17,095 hectares (43,240 acres)	Undeveloped
Byers Lake Rest Area	Parks Highway, Mile 147.2	Alaska Division of Parks	Unknown	Unknown
Byers Lake Wayside	Parks Highway, Mile 147	Alaska Division of Parks	Unknown	61 campsites 15 picnic sites
Nancy Lake Recreation Area	Parks Highway, Mile. 67.2	Alaska Division of Parks	9,181 hectares (22,685 acres)	136 campsites
Nancy Lake Wayside	Parks Highway, Mile 66.6	Alaska Division of Parks	14 hectares (35 acres)	30 campsites 30 picnic sites
South Rolly Lake Campground	Parks Highway, Mile 67	Alaska Division of Parks	Unknown	106 campsites 20 picnic sites
Big Lake, South and East Waysides	Parks Highway, Mile 52.3	Alaska Division of Parks	14 hectares (35 acres)	28 campsites 8 picnic sites
Lake Louise Recreation Area	Glenn Highway, Mile 157	Alaska Division of Parks	35 hectares (90 acres)	Unknown
Lake Louise Wayside	Glenn Highway, West of Glennallen	Alaska Division of Parks	20 hectares (50 acres)	6 campsites

Site Development	Location[a]	Managing Agency	Area	Accommodations
Tolsona Creek Wayside	Glenn Highway, Mile 172.5	Alaska Division of Parks	243 hectares (600 acres)	5 campsites
Willow Creek Recreation Area	Parks Highway, Mile 71.2	Alaska Division of Parks	97 hectares (240 acres)	Unknown
Willow Creek Wayside	Parks Highway, Mile 71.2	Alaska Division of Parks	36 hectares (90 acres)	17 campsites
Sourdough Creek Campground	Richardson Highway, Mile 147.4	Alaska Division of Parks	65 hectares (160 acres)	20 campsites
East Fork Rest Area	Parks Highway, Mile 185.7	Alaska Division of Parks	Unknown	Unknown
Clearwater Creek camping area	Denali Highway, Mile 55.9	Bureau of Land Management	8 hectares (20 acres)	No development
Black Rapids picnic area	Richardson Highway, Mile 225.4	Alaska Department of Transportation	Unknown	Unknown
Paxson Lake Wayside,	Richardson Highway, Mile 179.4	Bureau of Land Management	1.6 hectares (4 acres)	4 campsites
Paxson Lake Campground and Boat Launch	Richardson Highway, Mile 175	Bureau of Land Management	16 hectares (40 acres)	20 campsites
Little Nelchina Wayside	Glenn Highway, Mile 137.4	Alaska Division of Parks	9 hectares (22 acres)	6 campsites

Site Development	Location(a)	Managing Agency	Area	Accommodations
Matanuska Glacier Wayside	Glenn Highway, Mile 101	Alaska Division of Parks	94 hectares (231 acres)	6 campsites
Long Lake Recreation Area	Glenn Highway, Mile 85	Alaska Division of Parks	194 hectares (480 acres)	Unknown
Long Lake Wayside	Glenn Highway, East of Palmer	Alaska Division of Parks	151 hectares (372 acres)	8 campsites
Bonnie Lake Recreation Area	Glenn Highway, Mile 82.5	Alaska Division of Parks	52 hectares (129 acres)	Unknown
Bonnie Lake Wayside	Glenn Highway, Northeast of Palmer	Alaska Division of Parks	13 hectares (31 acres)	8 campsites
King Mountain Wayside	Glenn Highway, Mile 76.1	Alaska Division of Parks	8 hectares (20 acres)	22 campsites 2 picnic sites
Moose Creek Wayside	Glenn Highway, Mile 54.7	Alaska Division of Parks	16 hectares (40 acres)	8 campsites
Finger Lake Wayside	Parks Highway, North of Wasilla	Alaska Division of Parks	19 hectares (47 acres)	14 campsites
Rocky Lake Wayside	Parks Highway, Mile 52.3	Alaska Division of Parks	19 hectares (48 acres)	10 campsites
Mirror Lake Wayside	Glenn Highway, Mile 23.5	Alaska Division of Parks	36 hectares (90 acres)	30 campsites
Peters Creek Wayside	Glenn Highway, Mile 21.5	Alaska Division of Parks	21 hectares (52 acres)	32 campsites

Site Development	Location[a]	Managing Agency	Area	Accommodations
Dry Creek Recreation Area	Richardson Highway, Mile 117.5	Alaska Division of Parks	151 hectares (372 acres)	Unknown
Dry Creek Wayside	Richardson Highway, Northeast of Glennallen	Alaska Division of Parks	52 hectares (128 acres)	58 campsites 4 picnic sites
Houston Campground	Parks Highway, Mile 57.3	Community of Houston	32 hectares (80 acres)	42 campsites
Knik Wayside	Approx. 64 km (40 miles) North of Anchorage	Unknown	16 hectares (40 acres)	Unknown
Talkeetna Riverside Boat Launch	Talkeetna	U.S. Coast Guard	0.8 hectares (2 acres)	Unknown
Independence Mine Historic Area	Hatcher Pass Road	Alaska Division of Parks	110 hectares (271 acres)	Undeveloped
Adventures Unlimited Lodge & Cafe	Denali Highway, Mile 100	Private[b]	Unknown	Unknown
Gracious House cabins, cafe, guide services	Denali Highway, Mile 82	Private	Unknown	Unknown
Summit Lake Lodge - motel, restaurant, airstrip, guide service	Richardson Highway, Mile 195	Private	Unknown	Unknown
McKinley KOA	Parks Highway, Mile 248	Private	Unknown	70 campsites

b. This list is not an all inclusive list of privately-run facilities, but only a representation of most types of recreational opportunities offered by the private sector.

Site Development	Location[a]	Managing Agency	Area	Accommodations
McKinley Village Motel, Restaurant	Parks Highway, Mile 231.1	Private	Unknown	Unknown
North Face Lodge	Mt. McKinley Park Road	Private	Unknown	15 campsites
Grizzly Bear Camper Park campground, raft trips	Parks Highway, Mile 231.1	Private	Unknown	Unknown
Chulitna River Lodge & Cafe cabins, fly-in fishing, glacier trips, raft trips	Parks Highway, Mile 156.2	Private	Unknown	Unknown
Montana Creek Lodge campground, cabins	Parks Highway, Mile 96.5	Private	Unknown	Unknown
Carlo Creek Lodge	Parks Highway, Mile 223.9	Private	Unknown	Unknown
Mt. McKinley View Lodge	Parks Highway, Mile 134.5	Private	Unknown	Unknown
Mt. McKinley View Ldoge	Parks Highway, Mile 325.8	Private	Unknown	Unknown

TABLE 7.2: DESCRIPTION OF OPPORTUNITY SETTINGS

(Keyed to Figure 7.1)

Recreation Opportunity	Opportunity Setting	Activity Emphasis	Management Program
Semi-modern	A	Day-use; auto sightseeing; photography	Pull-out and area information sign at Parks Highway intersection. Also a series of scenic pull-outs at Indian River, Susitna River, and over-look at Susitna canyon. The assumption is that the road will be gravel.
Semi-modern	B	Day-use; auto sightseeing; photography	A series of scenic overlooks and pull-outs in the alpine zone along the road connecting the two dams. Portages and trailheads to alpine lakes and waterfalls in the area with limited parking areas. Overnight use will be permitted along the road.
Semi-primitive	C	Day-and over-night use; boating; sight-seeing; hiking; at Devil Canyon reservoir	Boat launch, picnic grounds and parking area near Cheechako Creek Primitive, auto-oriented campground and trail at Cheekchako Creek with no-wake zone management of the canyon to separate motorized and non-motorized boating. At Tsusena Creek there will be a boat launch with parking area and gravel road access. A primitive, auto-oriented picnic ground will be located nearby. Long-term development will provide for a boat-in picnic ground.
Semi-primitive	D	Day- and over-night-use; boat-ing; sightseeing; hunting; and fishing at Watana reservoir	Gravel road access from Watana dam area to Deadman Cove. A boat launch, campgrounds and parking are scheduled for Watana reservoir. Two small, boat-in campgrounds near shoreline of Watana reservoir.
Semi-primitive	E	Day- and over-night-use; hiking; canoe-ing; fishing; photography; hunting	Trails and portages from the road will lead to the more accessible lakes and waterfalls on Devil, Cheechako, and Tsusena creeks. Emphasis will be on dispersed, low-density use with camping permitted and 'pack-in, pack-out' policy enforced. Primitive portages will not have developed trails. All ORV use will be prohibited.
Primitive	F	Day- and over-night-use; hiking; back-packing, sight-seeing, and hunting	No ORV use; pack-in, pack-out policy.

TABLE 7.3: DESCRIPTION OF PROPOSED RECREATION SITES AND FACILITIES

(Keyed to Figures 7.2 and 7.3)

Opportunity Setting	Site Number	Site Description
A	1[a]	Pull-out with area information sign
	2[a]	Pull-out and parking area with access to Indian River
	3[a]	Scenic pull-out and viewing point above the Susitna River
	4[a]	Scenic pull-out, with small parking area, for waterfalls near the road
	5[a]	Scenic pull-out and viewing point; large, rustic project entrance sign before reaching site 4
	6[a]	Scenic pull-out and small parking area below the Devil Canyon dam near the bridge over the canyon
B	1[a]	Scenic pull-out with panoramic view of reservoir; trailhead and parking area with developed trail to observation point
	2[a]	Trailhead and developed portage to Dawn Lake; primitive portage to other lakes (brushed trails only); parking area limited to five vehicles
	3[a]	Trailhead and developed portage to Mermaid Lake; parking area limited to five vehicles
	4[a]	Pull-out with parking area and trailhead to Devil Creek Falls; parking area limited to five vehicles
	5[a]	Scenic pull-out overlooking Swimming Bear Lake
	6[a]	Scenic pull-out
	7[a]	Scenic pull-out and access to Tsusena Creek; parking area limited to five vehicles
	8[a]	Pull-out and trailhead for short trail to overlook of Tsusena Creek Canyon and Tsusena Falls
C	1[a]	Boat launch and parking area with picnic grounds and parking nearby; trailhead for Cheechako Canyon Trail with short loop for physically handicapped
	2[a]	Primitive, auto-oriented campground (100 units, 60 units to be developed for first 3 years) and a secondary trailhead to Cheechako Canyon

a. Handicapped accessible.

TABLE 7.3 (Continued)

Opportunity Setting	Site Number	Site Description
	3	Primitive, boat-in picnic ground (10 units, long-term development)
	4[a]	Simple boat launch, and picnic and parking area at Tsusena Creek and gravel access road
D	1[a]	Boat launch, and parking area, with primitive auto campground (60 units, 30 units to be developed the first three years) with a gravel road; primary access point for Watana reservoir
	2	Primitive boat-in campground at Watana cove (10 units long-term development)
	3	Primitive boat-in campground at Jay Creek (10 units long-term development)
	4	Camping area for Susitna and Tyone River floaters (to be developed in agreement with BLM)
E	1	Trail to observation point north of Devil Canyon (see B-1)
	2	Develop portage to alpine lakes and primitive portages to more distant lakes (see B-2)
	3	Develop portage to alpine lakes (see B-3)
	4	Develop trail to Devil Creek Falls (see B-4)
	5	Develop trail to Tsusena Creek Falls (see B-7)
	6[a]	Develop trail to Cheechako Creek Falls (see C-1, C-2)
F		No developed facilities

TABLE 7.4: DAILY TRAFFIC COUNT FOR THE DENALI AND PARKS HIGHWAY

	1973	1974	1975	1976	1977	1978
Denali Highway[a]	36	53	103	66	72	58
Parks Highway[a]	551	588	721	619	739	735
Parks Highway[b]	334	387	516	452	481	468

a. Average daily traffic count, from mid-May to October
b. Annual average daily traffic count

TABLE 7.5: VISITOR COUNTS FOR STATE RECREATION AREAS ADJACENT TO PARKS HIGHWAY

Location	Summer - 1979[a]	Summer - 1980[b]
1. Byers Lake Wayside	10,238	13,327
2. Denali State Park (excluding Byers Lake Wayside)	N.A.[c]	1,337
3. Nancy Lake Wayside	10,487	10,035
4. Nancy Lake Recreation Area (excluding Nancy Lake Wayside)	8,976	8,179
5. Big Lake - East Wayside	15,075	14,776
6. Big Lake - South Wayside	17,883	11,887

a. Total for the months of July, August, and September 1979.
b. Total for the months of May, June, July, and September 1980.
c. Not Available.

TABLE 7.6: CAPITAL IMPROVEMENT COSTS - PHASE 1

Opportunity Setting	Site Number		Total Cost[a] (Excluding Roadwork)
A	1		$ 1,216
	2		2,329
	3		336
	4		1,779
	5		1,264
	6		480
		Subtotal	$ 7,404
B	1		$ 564
	2		886
	3		886
	4		336
	5		336
	6		336
	7		336
	8		886
		Subtotal	$ 4,566
C	1		$ 128,705
	2		1,083,282
	4		128,705
		Subtotal	$1,340,692
D	1		$ 728,081
		Subtotal	$ 728,081
E	1		$ 23,482
	2		4,548
	3		4,548
	4		31,811
	5		8,443
	6		61,742
		Subtotal	$ 134,574
		Grand Total	$2,215,317

a. Total cost without the cost of roads, pull-outs and parking lots

Source: Alaska Department of Natural Resources, Division of Parks, Estimated Facility Costs, January 1981; U.S. Department of the Interior, Forest Service, RIM Cost Figures For Selected Facilities and Chugach Cost Data Guide for Engineering and Road Construction, 1981; Bob's Services Unlimited, Anchorage; and various local building supply dealers.

TABLE 7.7: CAPITAL IMPROVEMENT COSTS - PHASE 2

Opportunity Setting	Site Number		Total Cost[a] (Excluding Roadwork)
A	1-6		$ -0-
		Subtotal	$ -0-
B	1-8		$ -0-
		Subtotal	$ -0-
C	1		$ -0-
	2		583,748
	3		50,365
		Subtotal	$ 634,113
D	1		$ 350,232
	2		33,120
	3		33,120
	4		-0-
		Subtotal	$ 416,472
E			$ -0-
		Subtotal	$ -0-
		Grand Total	$1,050,585

a. Total cost without the cost of roads, pull-outs and parking lots

TABLE 7.8: ESTIMATED ANNUAL OPERATING COST

- Projected First Year Operational Costs -
(Estimated in 1981 dollars)

1.	Personnel		$ 145,140
	1 Park Ranger III - permanent, 3 months		
	1 Park Ranger II - permanent, 12 months		
	1 Park Ranger I - part-time, 6 months		
	1 Park Tech. II - permanent, 12 months		
	2 Park Tech. I - part-time, 6 months		
	1 Main. Worker - part-time, 6 months		
	1 Clerk/Typist - part-time, 6 months		
2.	Travel Expenditures		7,257
3.	Contractual Services		72,570
4.	Commodities		12,095
5.	Equipment		
	Shop Maint. Equip., Tools & Supplies	$19,579	
	2 Boats with Equip., Tools & Supplies	38,134	
	4 Pick-up Trucks with Equip., Tools & Supplies	34,936	
	Office Equip., Tools & Supplies	8,571	101,220[a]
		Subtotal	$ 338,282
		20% Contingency Factor	67,657
		Total	$ 405,939

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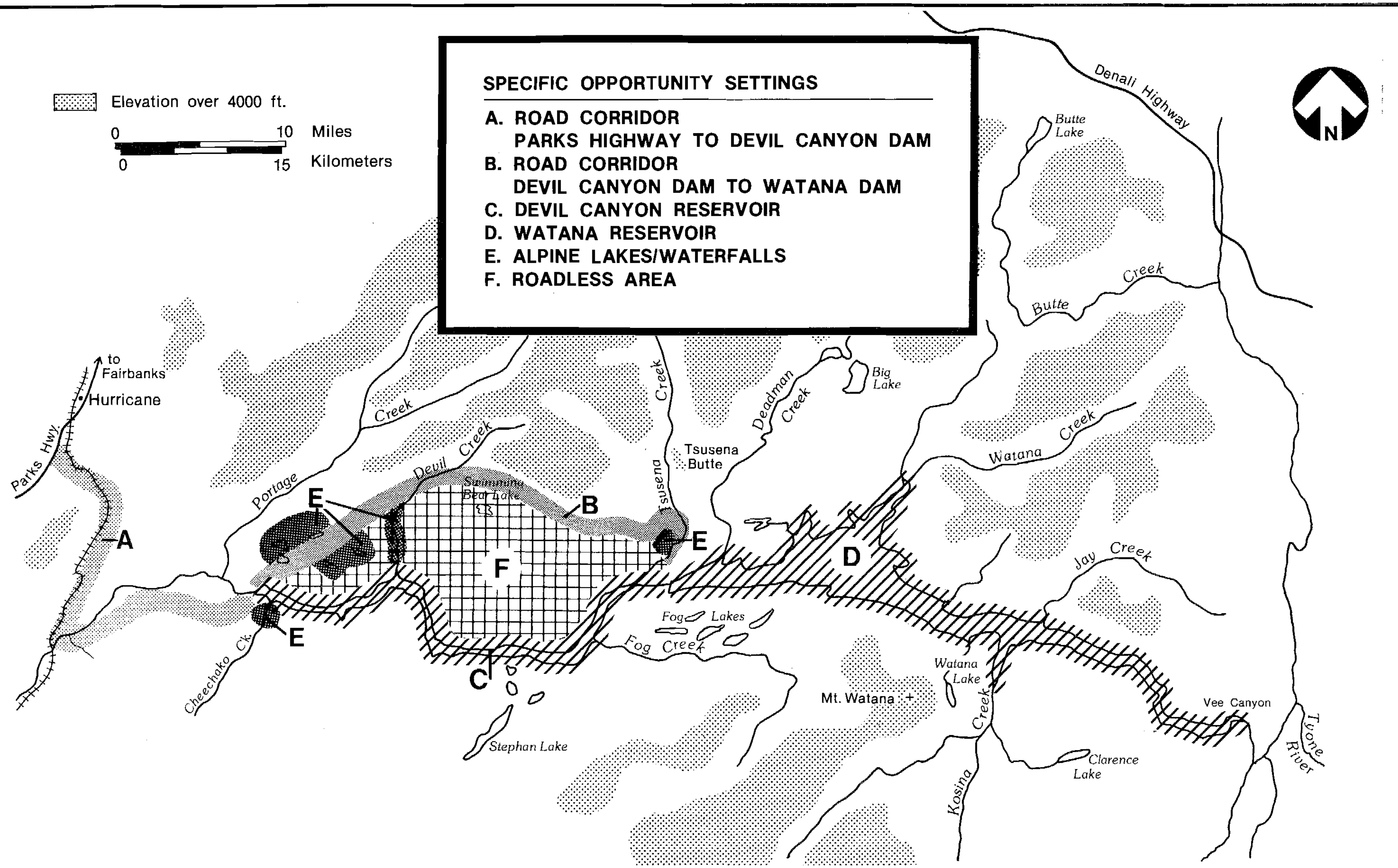
a. Projected equipment costs for successive years would be less by approximately $4,838. Total operating cost would be estimated at $241,900 with a 20% contingency factor for a total of $290,280.

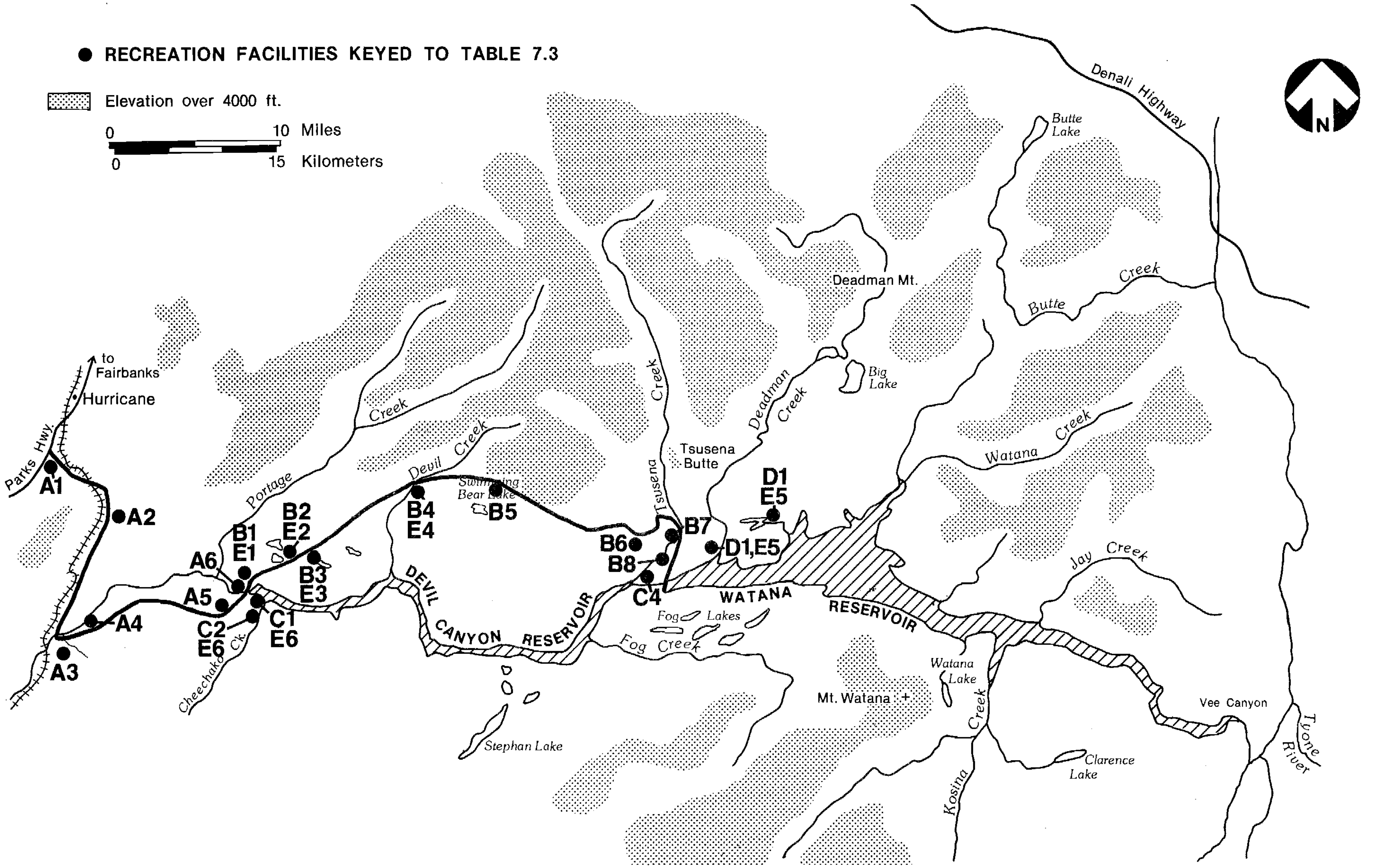


RECREATIONAL OPPORTUNITY SETTING FOR THE SUSITNA AREA

PREPARED BY TES/UNIVERSITY OF ALASKA

FIGURE 7.1

ACRES

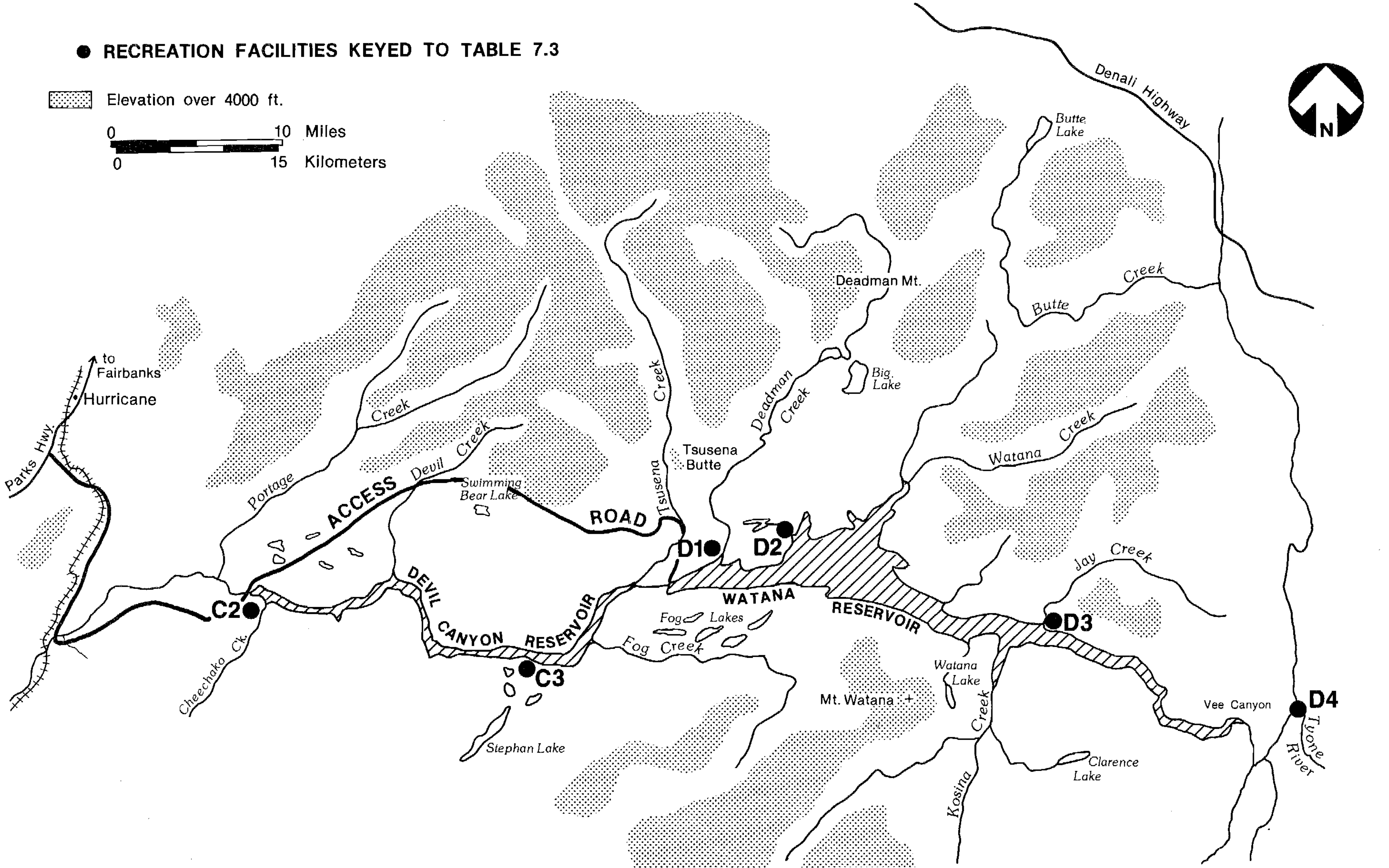


RECREATION FACILITIES -- IMMEDIATE DEVELOPMENT

PREPARED BY TES / UNIVERSITY OF ALASKA

FIGURE 7.2

ACRES



RECREATION FACILITIES -- LONG-TERM DEVELOPMENT

PREPARED BY TES/UNIVERSITY OF ALASKA

FIGURE 7.3

ACRES

8 - REPORT ON AESTHETIC RESOURCES

8.1 - Aesthetic Character of Lands and Water to be Affected

The upper Susitna River basin comprises a diverse landscape, largely roadless and relatively uninhabited. The combination of these factors creates a natural region in which, depending upon a viewer's location in the basin, a variety of visual groupings exists free from the imprints of man. In contrast to other areas in Alaska, the aesthetic resources of the project area are generally not seen as outstanding (with the one exception of Devil Canyon itself). Because the area is a wilderness region positioned between the two major population centers of Fairbanks and Anchorage, however, the aesthetic resources of the upper Susitna basin are an important consideration when evaluating the impact of the proposed hydroelectric project. Photographs of the vicinities of the two proposed dam sites are presented in Figure 1.2.

The upper Susitna basin contains a variety of aesthetically distinct landscapes. This diversity arises from a mix of vegetation, water, and topographical features which display many combinations of form, line, color, and texture. These combinations are enhanced by both sub-elements and ephemeral qualities, including atmospheric conditions; observer distance, angle, and position; illumination; the presence of wildlife; and natural scents and sounds.

The landforms of the area are defined by three major elements: the deeply incised Susitna River valley and its tributaries, the northern Talkeetna and Chulitna Mountains, and the northern Talkeetna plateau. The area's features, textures, and relief are dominated by the plateau's northeast trending; rounded, low mountains; and generally rolling highlands. These areas of rolling terrain slope to meet adjacent landforms that are moderately rugged, higher, and more mountainous. Other landforms in the east reflect the influence of the adjoining Copper River basin. These are characterized by lower mountains and hills widely spaced on the plateau and by flat terrain interspersed with numerous ponds.

Vegetation is diverse and varies with elevation. Dense spruce-hardwood forests blanket the lower drainages and slopes, while large meadows of tundra cover higher elevations. A variety of shrub types occur between the two biomes, adding texture and color to the setting. This diversity of vegetation enhances edge effect found in the more scenic visual groupings.

Color also enhances the scenic composite, particularly in autumn, when the leaves of deciduous trees turn gold or orange and create a vivid contrast to the dominant dark spruce green. Also, in the autumn the tundra bursts into a brief period of color, especially striking when viewed against a high lake and mountainous backdrop.

The V-shaped valleys of the Susitna River and its tributaries are visually prominent as they cut a distinct swath of green through a predominantly tundra landscape. The deeply cut canyon of the Susitna River is particularly striking at Devil and Vee Canyons, where turbulent rapids, rock outcroppings and cliffs, and enclosed walls dominate the scene. There are numerous clear, fast-flowing mountain creeks, some of which flow over and through steep, rocky embankments to form waterfalls and flumes. Lakes in a variety of forms and settings are numerous in the basin. They range from small, irregularly shaped lakes set in woods and against a backdrop of mountain peaks; to lakes which reflect their glacial origin; to a complex of five, finger-shaped lakes (Fog Lakes) set in a black spruce and shrub wetland region.

The higher mountain peaks, including Deadman, Devil, and Watana mountains, as well as the more accessible overlooks of Tsusena and Chulitna buttes and the ridges above Vee Canyon and at Big and Swimming Bear lakes provide viewpoints that overlook the project and adjacent areas. Many of these sites allow extensive views of the central Talkeetna Mountains and the Alaska Range, often focusing on Mounts McKinley, Deborah, and Hess and on the Eldridge, West Fork, and Susitna glaciers.

Overall, the upper Susitna basin has considerable aesthetic appeal. Furthermore, certain natural features in the area have been identified as having exceptional aesthetic quality. These features, their locations, and their descriptions appear on Table 8.1 and on Figure 8.1. Other noteworthy natural features are listed in Table 8.2 and are also designated on Figure 8.1.

8.2 - Impact on Aesthetic Resources

(a) Dams and Impoundments and Associated Facilities

(i) Effects Common to Both Dams

The overall impact of the project will be the modification of existing scenic values. The two proposed dams and their associated facilities will contrast vividly with the natural landscape in material, color, and mass; as a result, the structures will tend to be visually isolated from the surrounding environment. Although the proposed dams will introduce into the landscape a significant non-natural feature, they will also attract visitors interested in viewing them. Because of their size (Watana will be the highest dam in North America) and the engineering accomplishment that they will represent, the dams will be impressive structures.

The construction zones around the dam sites will necessitate topographical changes, vegetation clearing, and ground disturbance that will introduce lines and forms unrelated to the natural scene. Even after recontouring and revegetation, these zones will contrast with the surrounding landscape. In addition, the dam sites will become centers of human activity and will be highly visible in an otherwise generally still area.

The primary effects on aesthetic resources resulting from inundation by the reservoirs will be the loss of the variety and natural character of the V-shaped valley floor, rock cliffs and outcroppings, river and rapids, and confluences with tributaries. These natural features will be replaced by large lakes with drawdown zones. The created shorelines, in most areas, will lack the characteristic qualities of natural shorelines. Because of their sizes, the reservoirs will be prominent features of the landscape. While these new lakes may visually enhance the landscape by juxtaposing land and water, this advantage may be limited by bank slumping, the appearance of the exposed drawdown zone, and the possible turbidity of the water.

Prior to their inundation, the impoundment zones will be cleared of trees, thereby avoiding the visual impact of dead trees in shallow areas and floating debris in the reservoir. Although vegetation above the full-pool level will not be cleared, water table changes and melting of permafrost may kill trees along portions of the reservoir shoreline.

(ii) Watana Dam and Impoundment

Watana dam and reservoir will constitute a major impact on aesthetic resources in the basin. (The factors contributing to this impact are discussed in the previous section.).

The reservoir, at full capacity, will be surrounded by shrub communities and black spruce, with a few white spruce stands in the Vee Canyon area. The relatively steep banks will be subject to periodic drawdowns of up to 61 m, creating mud flats devoid of vegetation and susceptible to erosion. Average annual drawdowns are expected to be about 27 m, with about eight meters (vertical) of drawdown zone visible in June, diminishing to zero in September. The majority of visitors to the reservoir area are expected in the period between these two months. At the head of the reservoir and in the present Watana Creek drainage, extensive mud flats could be exposed when reservoir water levels are low. In other areas of the reservoir, because of unstable soils and melting permafrost, slumping may occur, creating steep slopes with a beach flattened out to the waterline.

The unavoidable results of creating the Watana reservoir include the inundation of native vegetation (Section 3.5, Impacts on Botanical Resources) and the loss of two significant natural features, namely, Deadman Falls and the Vee Canyon rapids. In addition, the project will cause the partial loss through inundation of Vee Canyon gorge.

(iii) Devil Canyon Dam and Impoundment

The Devil Canyon concrete dam will be an imposing structure in relation to the adjacent rolling topography. The associated facilities will also have considerable visual impact on an area now aesthetically appealing (Figure 1.2).

The impoundment will be very narrow, in comparison to the Watana reservoir, and thus will not be as prominent a feature on the landscape. The water in the reservoir is expected to be clearer than that in the Watana impoundment. The pool level will fluctuate about 20 m on an annual basis (somewhat less than Watana), and the steeper slope of the canyon will further limit the extent of the drawdown zone. In the summer months, however, when the majority of visitors are expected, the Devil Canyon impoundment will not be full; the drawdown zone in June, about 20 m (vertical), will diminish to about 5 m in September.

The Devil Canyon reservoir will unite the surrounding landscape and increase viewing opportunities, although the exposed drawdown zone will degrade its appearance. Unavoidable negative effects, however, will include the loss of the character and diversity of the river valley and the major loss of much of Devil Canyon, with its rapids, rock and spruce terraces, and enclosure. Of all the natural features in the basin, Devil Canyon is, by far, the most significant, the basin being known primarily for this gorge (Table 8.1, Figure 8.1).

(b) Borrow Areas

The locations of borrow sites for construction of the dams are shown in Figure 9.8. Borrow areas, in general, create both unnatural forms and line and color contrast and are, therefore, seen as visually disruptive in a natural setting. Negative aesthetic impacts are caused by denuding expansive areas of vegetation, changing the natural topography, perhaps creating erosion, and adding spur access roads, all of which contrast visually with the surrounding landscape. The evidence of borrow area excavation will remain visible for many years. To reduce some of the long-term effects of this excavation, the borrow areas will be recontoured to resemble natural topography, and the sites will be revegetated [Section 3.9 (b)(ii)].

Table 8.3 lists the potential impact of the borrow areas for dam construction, Areas A-L; (Area C is no longer being considered). Of these sites, the highest impact on the area's aesthetic resources will perhaps be caused by Borrow Area D, since it is located in low-absorption vegetation and is highly visible from both the reservoir and a portion of the access road. A reserve area, Quarry A, is located in a scenic region. Areas E and F will alter the appearance of the area along Tsusena Creek, and although Tsusena Falls is not within either of these borrow sites, it is likely that the setting of this exceptional natural feature (Table 8.1) will be disturbed. Borrow Area K has the potential for infringing on the series of falls on Cheechako Creek; a recreational facility has been proposed in this vicinity [Section 7.2 (c)]. Area E in the upper Devil canyon reservoir will extend above the full-pool elevation, with the result that some surface scarring and modification of topography will occur. Borrow Area I will be developed to 15 m above the existing river elevation, to a maximum elevation of 472 m (1550 ft). Therefore, lower portions of the site will be inundated by the Devil Canyon impoundment, but at the upper end, it will remain exposed. This area will be particularly visible if a proposed recreational facility is built at Tsusena Creek for boating access to the Devil Canyon reservoir. As with all the other sites, recontouring to resemble natural topography will help reduce the permanent impacts. In some cases, borrow areas will be used as disposal areas for waste material from dam construction, perhaps restoring the original topography.

(c) Access Route

The proposed access route (Figure 9.7) runs from the Parks Highway along Indian River to Gold Creek and along the south side of the river to the Devil Canyon dam site, where it crosses to the north and connects to the Watana site. This road into the presently roadless project area represents a major influence on the area's aesthetic resources. The construction of a road is a long-term linear alteration of the landscape, sharply contrasting with the natural background and interrupting the unified sweep of the surroundings. A road will also allow public access into a remote region -- a change which has potential consequences for the existing resources but also affords many people the opportunity to view these aesthetic resources.

The strong horizontal line created by right-of-way clearing and by the road itself will appear incongruous with the natural setting of the Susitna basin. Long-lasting visual effects will result, even with revegetation of the right-of-way and road construction borrow areas not within the right-of-way. While views from the road will be, for the most part, attractive, with expansive views from the road segment between the two dam sites, in most areas, the transmission line on one side of the road will detract from the scene.

Construction of the permanent access road will be facilitated by a pioneer road into the project area. The portions of this pioneer route that do not coincide with the permanent access route will be visually evident for a long time.

Table 8.3 also notes the potential effects of borrow areas (1 through 8) proposed for the access route (Figure 9.8). The highest degree of impact will occur in Area 1. Located in a scenic setting adjacent to the Indian and Susitna rivers, Area 1 will be visible from the road and the river, from the Susitna bridge crossing, and from other key viewpoints. Development of this site will be of particular concern to future residents, who are expected to settle in this vicinity as a result of state land disposal.

Area 7 is on the northern edge of Mermaid Lake, a scenic area, and is set in low-absorption shrub vegetation along the access route. Area 2, which is also set in low-absorption shrub vegetation along the access route and visible from key viewpoints, may adversely affect a waterfall. Area 8 is located in a tundra region and includes a good view of the surrounding landscape. The general discussion of the types of impact caused by excavation of borrow areas, as given in Section 8.3 (b), also applies to borrow sites for road construction.

Parking lots and staging areas associated with construction of the access road, and its subsequent utilization during dam construction, will entail clearing and grading of natural areas. This transition from essentially natural to developed land areas will result in loss of vegetation and in a reduction of aesthetic character.

Access will introduce people into previously sparsely occupied land. A recreation plan has been developed (Section 7) to control some of this use and to minimize adverse effects. Nevertheless, litter and disturbance of both vegetative cover and existing recreational sites are inevitable. Overuse of some planned road pull-outs (including roadside camping) and other facilities may occur. The results of easier access may thus be incongruous with the natural setting and may have a cumulative negative effect on the landscape. The lake shores (where accessible), reservoir perimeters, creeks, and areas of tundra cover will not be able to withstand heavy traffic pressure, which will degrade the visual quality of the setting by noticeable vegetative and shoreline disturbances. Access will also increase fire hazard; excessive burning would alter the landscape, creating texture and color contrasts.

Imposing increased activity on a nearly pristine landscape will drastically reduce the peace and solitude of the area; the reduction of both scenic quality and the potential for wilderness experience will cause some previous users to seek these amenities elsewhere. The roads and borrow areas seen from the river and reservoir will alter users' visual experience. Planned foot trails, however, will allow visitors to view the landscape in a more natural setting (refer to Section 7.2).

Where the topography is suitable for their use, off-road vehicles (ORV), if permitted, would disturb the terrain. The area traversed by the access route between the two dam sites, because of its topographical make-up and fragile vegetative cover, is extremely susceptible both to ORV use and to consequent damage. ORV use on lands of tundra and shrub cover types would lead to long-term vegetative and visual damage, degrading the original character of the land. Documented ORV use off the Denali Highway has led to severe soil disturbances, left areas denuded of vegetation, and formed gullies 6-8 m wide and up to 3 m deep (Sparrow et al. 1978). If ORV use is restricted, especially in the area between the dam sites (as discussed in Section 7.3), such degradation of the landscape can be avoided.

(d) Transmission Line

(i) Impacts Common to All Study Areas

The major impact of the transmission line will be the creation of incongruous lines across the landscape, where existing utility corridors are not present, decreasing landscape unity and interfering with scenic views by deflecting attention from natural scenes. The noticeable contrast between man-made structures and the landscape's natural elements is caused by irregular patterns: the visibility of towers, because of their height above existing vegetation and their color contrast with the surroundings; the reflection of the conductors; sizeable clearings of vegetation; unconcealed substations; and conspicuous access roads and staging areas needed for construction and maintenance purposes.

Negative impacts on the aesthetic resources will occur where the transmission line is viewed against the horizon, is routed along a ridge, appears on level terrain with unobstructed views, or crosses rivers and gorges. Every effort was made, however, to avoid such areas, both in the initial corridor (5-10 km wide) selection phase and again at the route (0.8 km wide) selection phase of the study.

Construction activities cause both short- and long-term impact on aesthetic resources. The creation of new access where none previously existed will add significantly to the potential for visual disturbance caused by the transmission line. Again, efforts were made to parallel existing utility corridors and to utilize existing access whenever appropriate. Discussions of the impact of borrow areas, roads, and construction camps appear in Sections 8.2 (b), (c), and (e).

Maintenance activities during the operational phase of the lines can also cause adverse impacts as a result of clearing or of chemical treatment of the right-of-way. Impacts will vary depending upon the timing and method of right-of-way maintenance but can be minimized through careful prescription of maintenance techniques.

(ii) Upper Basin

The major impact of the upper basin transmission line will be degradation of the basin's wilderness quality; the line will disrupt otherwise unobstructed views and will decrease the unity of the natural landscape. This impact will be experienced most severely by users of High Lake Lodge and its surrounding lands and waters. The lines will be located within 1.6 km of High Lake and, although in the background, will be incongruous with the otherwise natural setting of the lodge area. For this reason, an alternative route has been proposed, which would locate the lines beyond the viewshed of the lodge and its environs. Map M8 in Appendix E3 graphically presents both route locations.

Another impact will result from clearing vegetation from one strip 122 m (400 ft) wide between the two dams (although tall-growing vegetation exists only on a small portion of this segment) and from a second strip 213 m (700 ft) wide from Devil Canyon dam to the point of intersection with the Intertie near Gold Creek. These impacts are depicted graphically on Figures 25-36 in Appendix E3. The line, where visible near the access road and reservoirs, will impair the viewer's scenic experience. Background views of the lines from Otter Lakes and from the access road will be present. Foregound and middle-ground views will be evident particularly from High Lake (unless the alternative route is selected) and again from points along the access road.

(iii) Healy to Fairbanks and Willow to Anchorage

The Healy-to-Fairbanks route will cause aesthetic impact at the three crossings of the Parks Highway, the three river crossings, the two railroad crossings, and two areas where the line is visible from and parallels the highway or railroad. Careful placement of towers, and whenever possible, retention of vegetative screens, however, will greatly reduce the degree of impact. Furthermore, by closely paralleling the existing transmission facilities where appropriate, incremental rather than totally new impacts will result. Information on aesthetics appears on Northern Study Area Figures (1-24) in Appendix E3.

The Willow-to-Knik Arm route will cause major visual impacts near Willow. Here, the line will cross the Parks Highway and the Alaska Railroad and will be most evident to travelers on these routes. The transmission line route passing west and north of the community of Willow could affect the visual setting of this community because the line may also be apparent to residents as well as to recreators on Willow Creek. The route will likewise disturb the wilderness quality of the region and will interfere with natural views, most severely near the Iditarod Trail and the Susitna Flats Game Refuge. Between a point southwest of Willow and Knik Arm, the line will intrude upon the landscape, although by following existing trails, new roads will not need to be built along much of the transmission line right-of-way. In addition, existing recreation areas will be avoided. Because the route is removed from travel corridors, the visibility of the line in this area is low, with the exception of the Little Susitna River crossing, which will be relatively noticeable. Again, the retention of vegetative screens along the river banks could significantly reduce the degree of visual intrusion at this location. Information on visual quality for this study area is presented graphically on Figures 27-48 of Appendix E3.

For that area east of Knik Arm to the proposed substation south of Muldoon Road, visual impacts will be significant. Because of the presence and proposed proximity of existing transmission structures in this area, however, impacts will be incremental rather than totally new. To help mitigate these impacts, tower and conductor materials, spacing, and design could approximate closely that which is already present.

(e) Construction Camps and Villages

The current plan is to build temporary construction camps (single worker housing) and villages (family housing) at both Devil Canyon and Watana. The village at Devil Canyon will be removed after construction, but the Watana village is planned as a permanent town site. The construction camps and village sites will be incongruous with the existing natural landscape, and the concentrated, constant human use therein will disturb the scene. Permanent and temporary human use will introduce waste disposal sites, litter, and leisure activities potentially damaging to the environment in an area now relatively free of human imprint.

Large numbers of people will be using the construction camps and villages for considerable amounts of time; as a result of this pressure, the sites and their immediate vicinities will undergo significant changes in character. Site preparation will include clearing of vegetation, which will create long-term alterations to the sites. Human activity will create paths throughout the vicinity and, as a result of anticipated heavy use, will affect any nearby streams or lakes. The aesthetic resources in the area of the housing facilities will evidence visual alteration long after the facilities are removed and the property restored. The types of impacts associated with the town site at Watana are similar in nature, but of a lesser degree because of the few people, though longer term because of the permanency of the town.

A subjective evaluation of the visual impacts associated with the construction camps and village sites at Watana and Devil Canyon is included in Table 8.3. The sites at Watana will be quite visible because of the relatively low absorption capability of the shrub community and because the sites are within the viewsheds of portions of the access road and reservoir. On the other hand, the proximity of the sites to the dam construction site serves to concentrate the impact in a limited area.

Creation of the Devil Canyon camp and village will require the clearing of trees, giving rise to contrasts of texture, color, and line between the facility and its natural environment. Because of the higher absorption capability of the surrounding spruce-hardwood forests, however, and owing to other micro-relief factors, the Devil Canyon facilities will likely be shielded from most viewsheds. Also, no permanent town site is currently planned for Devil Canyon. Thus, while the impact on aesthetic resources will be significant, it will be lessened at the Devil Canyon site.

The sites of any temporary camps for road and transmission line construction crews are presently unknown, so specific impacts cannot be discussed. If such camps are located, built, and maintained in an environmentally sensitive manner and if the sites are later restored with the same concern, then the camps' impact will be relatively short-term.

TABLE 8.1: EXCEPTIONAL NATURAL FEATURES

Feature	Location	Description
Devil Canyon	Susitna River, west end of project area T.32N., R.1W., 1E., and T.31N., R.1E., S.M.	A steep-sided, nearly enclosed gorge, its sides alternating spruce-covered terraces and rock-bound walls, constricts the channel of the Susitna River, producing an 18 km stretch of turbulent whitewater. Two narrow falls, flowing through deeply incised crevasses, plummet a distance to the river below. Devil Canyon combines unusual geology, hydrology, and aesthetics with uncommon recreational opportunities, such as kayaking, to render it a unique natural feature in both the project area and the state of Alaska.
Vee Canyon	Susitna River, east end of project area T.30N., R.10E., Sec. 11 & 12, S.M.	Vee Canyon occupies a double hairpin bend in the deeply cut channel of the Susitna River, creating a stretch of whitewater. The canyon walls are composed of very steep rock ridges and are unusually colorful, the rock often interlayed with marble and green schist. Vee Canyon, more visible than Devil Canyon and with its walls more open, is exceptional in its scenic beauty.
Clear Valley	Approx. 6 km south of Fog Lake 2230 T.30N., R.5E., Sec. 5, 8, 17, 20, 29, 34., S.M.	Clear Valley contains unusual flat surfaces raised off the valley floor and surrounded by meandering streams; the valley's dominant feature is its visually apparent geological history. Geologically, the valley is fairly young and contains good examples of lateral moraines. Clear Valley contrasts significantly with the surrounding viewscape; the valley is unusual for its geologic features.
Deadman Falls	Near mouth of Deadman Creek T.32N., R.5E., Sec. 26., S.M.	Deadman Falls with an elevation of 521 m (1710 ft) is one of the largest and most scenic waterfalls in the project area. Deadman Creek surges over loose rocks in its incised channel, plummeting straight down over rocky slopes and outcroppings into a clear boulder-dominated pool, a pool often veiled in vapor.
Tsusena Falls	Above mouth of Tsusena Creek T.32N., R.5E., Sec. 20, S.M.	Clear and turbulent, Tsusena Creek drops nearly 60 m as it rushes over a steep, rocky cliff, creating a waterfall of considerable volume, which cascades into a large, deep, rock-enclosed pool. The view of the waterfall; creek; rock outcroppings; and dense, green vegetative cover is impressive.

TABLE 8.1 (Continued)

Feature	Location	Description
Devil Creek Falls	Above mouth of Devil Creek T.32N., R.2E., Sec. 20., S.M.	Devil Creek, constricted by a narrow opening between jagged rock walls, plunges over the steep embankment in a narrow, contained flow before fanning out and cascading to the pool below. The irregular pattern of the waterfall, against bare rock and surrounded by the densely vegetated, incised creek valley walls, creates a scene of high aesthetic appeal. Elevation 579 m (1900 ft).
Big Lake	N.E. of proposed Watana dam site T.22S., R.3W., Sec. 18, 19, 30, T.22S., R.4W, Sec. 25., F.M.	Big Lake, largest lake in the project area, is a prime example of a lake held in by a terminal moraine. Big Lake's proximity to Deadman Lake and, from Big Lake, the panoramic view of the Alaska Range and nearby Deadman Mountain combine with the lake's observable glacial origin to create an area that is noteworthy for both scenic and geologic features.
Mt. Watana Cirque Lake	East of VABM Mt. Watana T.30N., R.7E., Sec. 2., S.M.	A cirque lake high on Mount Watana provides a scenic interpretation of the area's glacial history. The cirque contains a pristine lake, simple in outline and distinguished by the natural amphitheater formed on three sides by towering scree slopes, with a scenic view of the valley from the remaining side.
Tyone River	East end of project, area confluence with Susitna River T.30W, R.12E., Sec. 9., S.M.	The slow-flowing, dark, and clear Tyone River, near its confluence with the Susitna River, is flanked on its south shore by starkly contrasting chalk-colored cliffs. These are composed of lacustrine deposits left behind by an expansive proglacial lake, one of three such lakes of significant size recorded in Alaska. This particular region of the Tyone River is exceptional for its prominent glacial remains, scenic white bluffs, and dark/clear river.

TABLE 8.2: OTHER IMPORTANT NATURAL FEATURES

Feature	Location	Description
Fog Lakes	Sections 3, 7-11, 13, 18, T31N.,R.5E., and Sections 5, 7, 8, 18, T.31N., R.6E., S.M.	Five lakes in proximity to one another; average surface area is 109 ha, with no lake smaller than 56 ha.
Stephan Lake	Sections 2, 3, 9-11, 16, 17, 20, 21, T.30N., R.3E., S.M. Between Watana and Devil Canyon dam sites on south side	The longest lake immediately adjacent to the project area, it measures 7 km in length, and is the nearest lake to the project are with a run of salmon and one of the few with relatively high recreational use.
Watana Lake	Section 6, T.30N., R.8E., S.M. Section 1, T.30N., R.7E., S.M. Section 36, T.31N., R.7E., S.M. Section 31, T.31N., R.8E., S.M. East of Mt. Watana	Mount Watana, rising directly to the west of Watana Lake, provides an aesthetically pleasing setting for the high (914 m) lake.
Swimming Bear Lake (unnamed lake)	Section 4, T.32N., R.3E., S.M. Sections 32, 33, T.33N., R.3E., S.M. 8-10 km north of VABM Devil near proposed access route	One of the highest lakes in the project area, Swimming Bear Lake (Ms. K. Oldham, pers. comm.) is a large alpine lake set in mat and cushion/sedge-grass tundra surroundings.
Deadman Mountain	Sections 6, 7, 17-20, 29-32, T.21S., R.3W., F.M. Sections 1, 2, 11-14, 23-26, 34-36, T.21S., R.4W., F.M.	Isolated Deadman Mountain, reaching a height of 1684 m, overshadows Deadman Lake and Big Lake.
Tsusena Butte and Tsusena Butte Lake	Sections 16, 20-22, 27-29, T.33N., R.5E., S.M. North of Watana dam site	A prominent butte (1341 m), Tsusena Butte rises above Tsusena Butte Lake, one of the deepest lakes in the project area (34 m). The lake is comprised of two irregularly shaped segments.

TABLE 8.2 (Continued)

Feature	Location	Description
Chulitna Butte	Sections 22, 27, T.33N., R.2W., S.M. South of Hurricane	Chulitna Butte overlooks the Alaska Railroad's past and present communities and provides an accessible viewpoint of part of the project area from the Parks Highway.
Cheechako Falls	Sections 4, 8, 9, T.31N., R.1E., S.M. First creek southeast of Devil Canyon dam site. Elevation: 510 m.	A series of five waterfalls along Cheechako Creek, set in a steep gorge. The two largest falls are approximately 8 m apart, with pools and rocky cliffs, and surrounded by thick mats of moss and other vegetation.
Mount Watana Falls	Section 33, T.31N., R.7E., S.M. On north side of Mount Watana. Elevation 1370+ m.	A waterfall flows over a deeply incised rock gorge interlaid with black and white marble; barren tundra surrounds the falls, and a mist hangs above it.
Spearpoint Falls (unnamed falls)	Section 1, T.31N., R.7E., S.M. In an easterly direction, first creek past Watana Creek and Susitna River confluence on the north side. Elevation 625+ m.	Four waterfalls occur along a relatively small creek. The largest one is below the others in a large, hollowed-out area. (Named for a spearpoint that was discovered in one of two nearby archeological sites.)
Devil's Club Falls (unnamed falls)	Section 11, T.31N., R.2W., S.M. In an easterly direction, first creek past Gold Creek and Susitna River confluence on the south side. Near Borrow Area 2 for access road. Elevation: 297+ m.	Devil's Club Falls is a scenic waterfall, easily accessible from the Susitna River below the Devil Canyon rapids. (Temporarily named for the abundance of devils club that is present all the way up to the falls).

TABLE 8.3: POTENTIAL AESTHETIC IMPACTS OF BORROW AREAS AND HOUSING SITES[a]

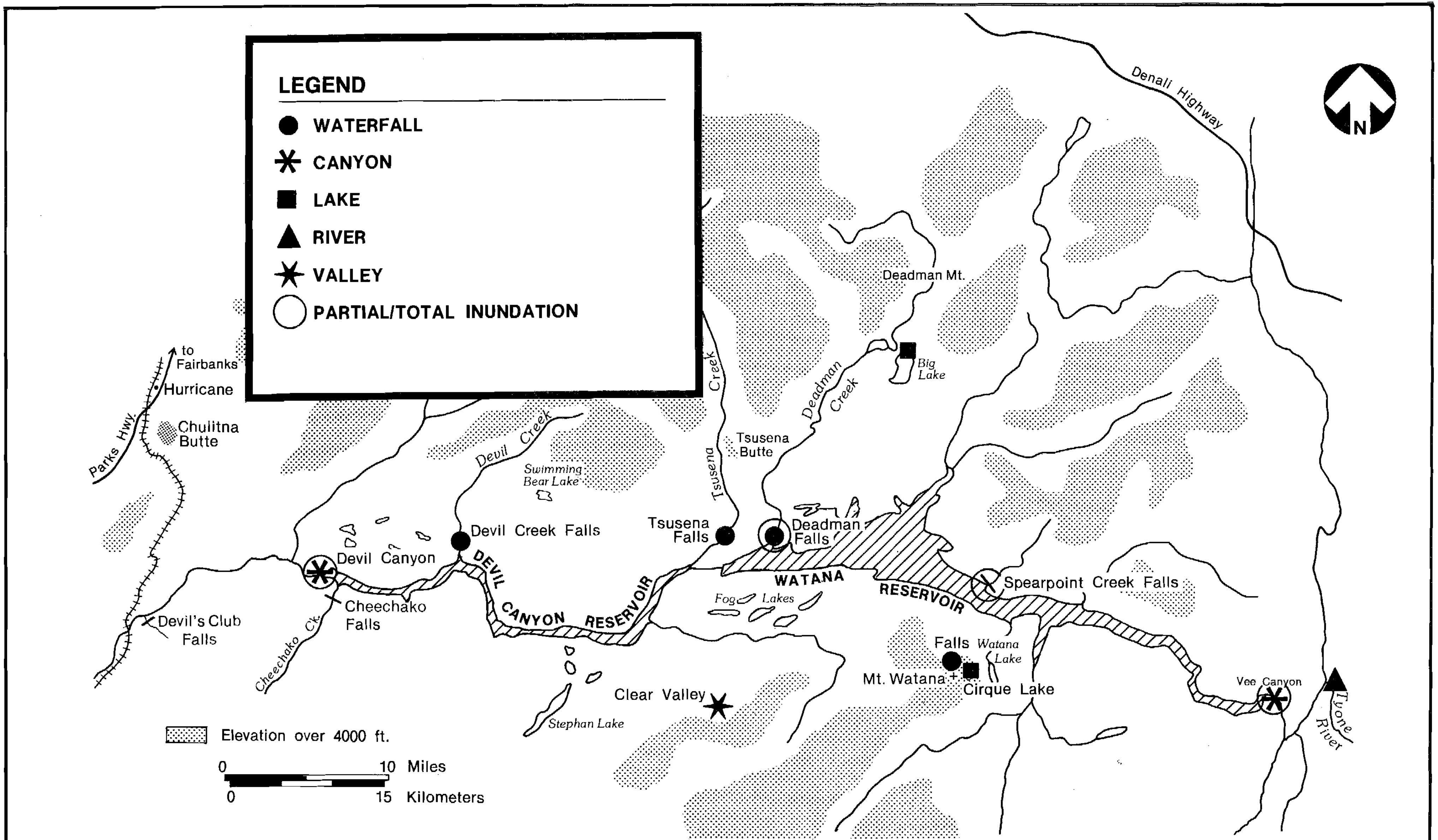
CATEGORY	DAM BORROW AREAS											ACCESS ROAD BORROW AREAS								VILLAGE SITES		CONSTRUCTION CAMPS	
	A	(b) B	D	E	F	(b) G	H	(c) I	(b) J	K	(b) L	1	2	3	4	5	(b) 6	7	8	Devil Canyon	Watana	Devil Canyon	Watana
Viewshed from Access Route	3	*	5	4	5	*	0	0	*	2	*	5	5	3	4	4	*	0	4	4	5	2	5
Viewshed from Reservoir(s)	5	*	5	5	0	*	3	5	*	2	*	(d) 5	(d) 5	(d) 4	0	0	*	0	0	0	5	(d) 2	4
Vegetative Cover	5	*	4	3	4	*	4	3	*	2	*	4	3	3	3	3	*	4	5	3	5	4	5
Accessible Viewpoints	4	*	5	4	5	*	3	3	*	2	*	5	2	2	3	3	*	4	5	3	5	4	5
Visual Setting	4	*	5	5	5	*	5	3	*	5	*	5	5	3	2	3	*	5	4	2	5	4	5

a. A subjective numerical scale is used with 5 representing a great impact and 1 a small or negligible impact; 0 represents no impact at all.

b. Inundated by reservoir.

c. Most of borrow area inundated.

d. Relatively high probability would be in Susitna River viewshed below Devil Canyon dam site.



EXCEPTIONAL NATURAL FEATURES (SYMBOLS)
AND OTHER IMPORTANT NATURAL FEATURES

PREPARED BY TES/UNIVERSITY OF ALASKA

FIGURE 8.1

ACRES

9 - REPORT ON LAND USE

The land use analysis involved an assessment of the direct and indirect effects of the proposed Susitna hydroelectric project on land use. The analysis was designed to evaluate changes in land use that would occur with and without the project, including the effects of the proposed dams, reservoirs, access transportation system, and transmission line routes.

Three study areas (Zones 1, 2, and 3) were defined for analysis (Figure 9.1). These zones were designated according to geographic and land use relationships with the proposed project and extend to varying widths from the river between Gold Creek and the mouth of the Tyone River.

Zone 1 was designated to include those structures and land uses which would be affected by inundation. Zone 2, extending about 10 km (6 mi) from the river, is based upon the locations of lakes which characterize aggregations of land use. Zone 3, which extends approximately 20 km (12 mi) beyond Zone 2, is characterized by fewer aggregations of land use; existing structures and land use are sparse.

The methodology for the land use analysis was to assess past, present, and future land use. Present developed land uses in the Susitna project area are subtle and widely dispersed. Aerial photographs and topographic maps were used to locate cultural features such as trails, structures, and other indications of past and present land use. To aid in identifying present dispersed land use activities, an oral history technique was employed: residents in adjacent and other areas were interviewed. Determinations were made as to present patterns of human land use within the project area and the forces which created different types of land use. Aerial and ground truthing methods were utilized to verify many of the present land use patterns discerned from the oral history interviews.

Additional information was obtained from reports and interviews with federal, state, and local agency personnel concerning past, present, and possible future land use activities in the project area.

9.1 - Existing Land Use in Project Area

Historically, access has been a determinant of the types and level of land use in the upper Susitna River basin. Early access to the area for trapping was by dog teams and showshoeing. When the price for furs dropped, some trappers turned to the more lucrative occupation of acting as guides to sport hunters. Commercial bush pilots provided access to the area using lakes and tundra airstrips for landing. By the early 1970's, use of the area by private pilots during hunting seasons had somewhat reduced the need for hunting guides.

(a) General Patterns

Present land use patterns in the project area reflect the deep ties people of the area have with the land as a source of food, shelter, income, and recreation. Although land use developments are dispersed, present use and activity patterns can be discerned from analysis of known historic uses in the project area and by locating actual remnants of past activity.

Access trails provide indications of past land uses and their influence on present use patterns. Trails provided access into the project area for subsistence hunting, fishing, and trapping, and today these same routes, undoubtedly undergoing some changes, provide access to scattered cabins and to the region in general for recreational purposes.

Existing use patterns in the project area have been identified for hunting, fishing, trapping, mining, and recreation. Brief descriptions of each land use activity follow. The most intensive land use activity is concentrated along the major highways, and in the southern part of Mat-Su Borough well to the south of the project area. Except for hydroelectric power studies, most activity within the project area is related to recreation or mining and, as mentioned, is subtle and dispersed.

(i) Hunting

Hunting within the Susitna project area became popular in the 1960's. Two hunting lodges located within the Zone 2 study area, one on High Lake and the other on Stephan Lake, have catered to an international clientele. Guests at the lodges fly or hike from the lodges to small outreach camps on lakes or streams for stays of a few days at a time.

Lodges typically handle 15 to 25 guests at a time and about 40 guests per season. The increasing popularity of sport hunting in the 1960's caused an increase in the number of small cabins on many of the lakes in the project area. Both guided and non-guided hunting occur within the project area, particularly near Stephan, Fog, Clarence, Watana, Deadman, Tsusena, and Big lakes in addition to many of the area's smaller lakes. Both lodges and cabins provide the field bases for many hunters.

(ii) Fishing

Fishing in the project area occurs singly or in close association with other activities, such as hunting and trapping. Fish present in the area's lakes and streams include burbot, grayling, rainbow trout, Dolly Varden, lake trout, and whitefish. Salmon migrate up Indian River and up the Susitna as far as Portage Creek. Considerable fishing for lake trout, grayling, and salmon occurs in the Stephan Lake - Prairie Creek drainage. Salmon fishing occurs in lower Portage and Chunilna (Clear) creeks and Indian River. Fishing in Fog, Clarence, Watana, Tsusena, Deadman, Big, and High lakes appears to be associated with other activities such as hunting, summer cabin use, and mining. There is little stream fishing elsewhere in the project area.

(iii) Trapping

Trapping activity has declined over the past 30 years, although recently there has been a slight increase in trapping. Present trapping in the project area occurs mostly on the south side of the Susitna River near Stephan and Fog lakes. Some trapping also occurs near Tsusena Creek and Clarence and High lakes.

(iv) Mining

Mineral exploration and mining have been limited in the immediate project area. Typical of the mining done in the upper Susitna River basin since 1930 is a low density of claims characterized by intermittent activity. Nevertheless, mining has played a key role in the land development of the upper river region, particularly along Valdez Creek.

Placer mines working alluvial deposits for minerals are found in sites throughout Mat-Su Borough. Active mining has been more concentrated in Gold, Chunilna (Clear), and Portage creeks than in other areas of the upper Susitna basin with some other active claims around Stephan and Fog lakes, Jay Creek, and the Watana Hills east of Jay Creek. Mining at Gold Creek was active from the early 1950's through the late 1970's; most claims were gold, copper, and silver placer mines. A concentration of at least six mining claims has existed on Chunilna Creek where gold placer claims have been worked since the late 19th century. Mining has occurred in the Portage Creek area since the late 19th century, but only one claim remains active (see Section 5.7).

Coal is the major mineral resource in Mat-Su Borough. Although extensive deposits of varying quality are located in the river valley areas, no coal mining activity occurs in the project area. Most coal is mined to the south and west of the project area; much of it is used for household fuel.

(v) Hydroelectric Research

Following preliminary studies, the Bureau of Reclamation proposed in 1952 that the Susitna be considered for potential hydroelectric development. Since then, there have been many feasibility, design, and environmental studies of the proposed inundation zone and adjacent areas. Combined, these studies have probably contributed more total man-days of use in the area in the past twenty years than all other uses.

(vi) River Boating/Floating

Boating within the project area has involved research, fishing, or recreation. There is considerable summer boating on many of the lakes including Clarence, Watana, Fog, Stephan, Tsusena, High, Otter, Bear, and Dawn. Individuals and riverboat services out of Talkeetna travel up the Susitna and Talkeetna rivers. Some of the services offered include day trips to Devil Canyon; drops at camps for hunting, fishing, and photography; and canoe hauls to many tributary streams.

Raft float trips are taken from the Denali Highway on the Susitna or Tyone rivers down to either just above Vee or Devil canyons where rafters portage to below Devil Canyon and float to Talkeetna. Some canoeing and rafting takes place from just below Devil Canyon to Talkeetna. Boating below Devil Canyon is further discussed in Section 9.1 (e).

(b) Land Use Developments

Existing land use developments are associated with hunting, fishing, trapping, food or equipment storage, research, recreation, and mining. Categories covering the frequency with which structures are used are 1) no use, 2) seasonal use--past, 3) seasonal use--present, 4) seasonal use--past and present, 5) year round use--past, 6) year round use--present, 7) year round use--past and present, and 8) no use information.

Most of the developments, whether structures or discrete objects, are associated with some means of access. Unpaved roads and trails were or are presently used for access to certain points in the project area. Vehicles such as tracked vehicles (Cats), four-wheel drive vehicles, rolligons, dog sleds, and horses have been used for freighting, for transportation within the area, and for access to the project area. Airstrips on gravel bars or flat ground are commonly located in proximity to other historical artifacts such as cabins, trails, or lodges. Trails emanate primarily from existing structures and connect them with airstrips, lakes (on which a ski or float plane can be landed), fishing streams, or other structures.

Geographical zones within the project area (as designated in Figure 9.1) provide an approximate measure of development locations and types of use in proximity to the Susitna River. Both historically and currently, the sparsely distributed developments throughout the project area have been used predominantly on a seasonal basis. The majority of the land use developments or artifacts have been utilized for hunting, fishing, trapping, boating, mining, and other general recreation purposes, such as cross-country skiing or photography.

(i) Zone 1

Types of developments located in Zone 1, the inundation zone plus 61 m (200 ft), include structures, trails, and airstrips.

Ten isolated structures are located in Zone 1 on the shores of the river or on its steep banks (Table 9.1 and Figure 9.2). Historically, these structures were line cabins for trapping and structures used by transient fishermen, boaters, hunters, and for research. Of the ten structures, only three are maintained and then only used on a seasonal basis. Two others, though not actively maintained, appear to be sporadically used by transient hunters, fishermen, or boaters. The remainder are not currently used or usable.

(ii) Zone 2

The greatest number of existing land use developments and historical artifacts are located in Zone 2, the 10 km (6 mi) corridor which flanks Zone 1 on both shores of the Susitna. Zone 2 is a much smaller area than Zone 3, yet there is more evidence of use within Zone 2 than within Zone 3. Types of developments found in Zone 2 include structures, trails, roads, airstrips, and mines. General types of use associated with these artifacts consist of hunting, trapping, fishing, boating, mining, recreation, and research.

Although the primary distribution of uses throughout the project area is low in density, particularly noteworthy in Zone 2 is the occurrence of aggregations of existing developments and historical artifacts. The nuclei of these aggregations are the small lakes and lake systems located throughout Zone 2, which provide access by air. Like the single, scattered land uses in Zone 3, the aggregations of developments consist of cabins and related structures, lodges, roads, trails, and airstrips. Table 9.2 and Figure 9.2 present information on Zone 2.

(iii) Zone 3

Existing structures within Zone 3, the outlying influence zone, are located within a 20 km (12 mi) ribbon of land which flanks the lower and upper portions of the Zone 2 boundary. The 21 structures in Zone 3 have historically been associated with land uses such as hunting, fishing, trapping, mining, boating, research, and other types of recreational use. Fourteen of the 21 structures are currently used during some portion of the year.

Aggregations of use, although they exist, are much less common in Zone 3 than in Zone 2 and occur in the areas of Chunilna and Prairie creeks south of the project area. A summary of existing structures within the area is presented in Table 9.3 and Figure 9.2.

(iv) Summary of Land Use Patterns in the Project Area

The combined factors of the size of the Susitna project area, its isolation, and its location in a subarctic environment result in extremely low-density land use. The history of the project area provides information concerning the deeply rooted values of the people for whom the land is still a source of income, food, and related subsistence activities, and recreation. The development of land use has been a slow, evolutionary process involving utilization of the resource base. Many historic uses are relevant in assessing present land use patterns, and indeed many of the remnants of past uses shape present patterns. Structures verified through aerial truthing are shown by land use zones in Tables 9.1 - 9.3 and are summarized in Table 9.4. The major trail access routes into the project area, although not structures, represent substantial environmental modifications and reflect general use patterns; they are presented in Table 9.5. Figure 9.3 gives the locations and types of uses of developments where these are sufficiently clustered to be identifiable on the ground. Thus, intensity of use might refer to a series of isolated cabins lining a shoreline, as at Stephan Lake, or to several small mines clustered together, as at Chunilna Creek.

(c) Wetlands and Floodlands

Within the approximate boundaries of Zone 1, there are 12,579 ha (31,083 a) of wetlands of various types, including riverine. These are summarized in Table 3.7. In the vicinity of the proposed Watana impoundment, there are 10,913 ha (26,966 a), and in the vicinity of Devil

Canyon, there are 1,666 ha (4,117 a). The table indicates the sizes and types of wetlands in relation to the proposed impoundments, dams, and spillways; camps, villages, and airstrip; and borrow areas. Cover types (including wetland types) are shown on Figures 3.2 through 3.4. A map of wetlands alone is included in the 1980 Annual Report on Plant Ecology Studies (APA 1981).

Floodlands have been identified for the Susitna River downstream from Devil Canyon to Talkeetna. A map of vegetation types in this floodplain is included in the 1980 Annual Report on Plant Ecology Studies (APA 1981).

(d) Land Stewardship

Prior to the Alaska Act, Statehood, and the Alaska Native Claims Settlement Act, the entire Susitna drainage area was mostly federally owned. There were no agency resource management plans for the area and very little resource exploitation, except for some minimal mining and timbering. A major limiting factor to development of the area has been access. It has not been economically feasible to utilize the resource base of the area.

(i) Ownership Patterns

The Susitna River proper and immediately adjacent lands along with the bench country around Stephan and Fog lakes extending eastward to the Kosina Creek drainage have been selected by Cook Inlet Region, Inc. (CIRI) and associated Native village corporations. The State has selected land entitlements on the north side of the proposed reservoir between the remaining federal lands and the Native lands (Figure 9.4). In the areas designated for the Cook Inlet land trade, the State will select all those lands that are not selected by the Natives. Matanuska-Susitna Borough owns no lands in the project area.

Two state land disposal sites (Figure 9.4) exist near the Indian River in the westernmost part of the project area just north of the Susitna River. The Indian River Subdivision (T33N, R2W S.M.) lies near mile 168 of the Parks Highway, northwest of Chulitna Butte and contains approximately 518 ha (1,280 a) of land. The disposal area has been subdivided into roads and some 139 lots averaging about 2 ha (5 a) per lot. South of this subdivision is the Indian River remote parcel, located northeast of the confluence of the Susitna and Indian rivers. This remote parcel (T31-32N, R2W S.M.) is located just eat of and, at some places, adjacent to Denali State Park. The Indian River Remote Parcel is comprised of 2,590 ha (6,400 a). Approximately 607 ha (1,500 a) in 75 parcels is being disposed of.

These land disposals, along with scattered private parcels of land, represent the only real dedication of a given piece of land to a particular use. Table 9.6 displays various land holdings in the vicinity of the proposed project and Table 9.7 summarizes those holdings by status/ownership category.

(ii) Land Use Management

Personnel employed by responsible land managing agencies were interviewed to gain information about present and future programs. The results are summarized in Table 9.8.

One federal agency, one state agency in addition to the Alaska Power Authority, one borough, and one regional Native corporation have various management concerns in the project area. These entities are the Bureau of Land Management (U.S. Department of Interior), the Alaska Department of Natural Resources, Matanuska-Susitna Borough, and the Cook Inlet Region, Inc. and associated village groups.

Federal lands to the north of the project area are managed by the Bureau of Land Management (BLM). These lands are included in the Denali Planning Block, for which a land use plan has been approved.

Management in the Denali Unit and those areas not yet conveyed to the Natives or the State is essentially passive. Very few management activities are taking place.

BLM's main objective is to protect the natural environment of the area, with particular attention to caribou calving areas and river recreation routes. Fire control is also a current management consideration; BLM has a cooperative fire control agreement with the State of Alaska that covers the project area.

BLM is also developing regulations for the management of public easements across Native lands. Lands in the project area that have been identified for conveyance to the Natives have a total of six easements across them. These include: an access trail 15 m (50 ft) wide from the Chulitna wayside on the Alaska Railroad to public lands immediately east of Portage Creek; a state site easement and trail easements on Fog Lake No. 4; a site easement and trail easements on Stephan Lake; and an access trail running east from Gold Creek. Easements were only identified when it was shown that access to public lands was not possible from any other public land area. There are no easements immediately adjacent to the Susitna River above Gold Creek.

Finally, BLM is also developing a wildlife habitat management plan in cooperation with Alaska Department of Fish and Game (ADF&G) for the Alphabet Hills between the Tyone and Maclaren rivers (T11-12 N, R2-9 W, Copper River Meridian). This plan will involve moose habitat manipulation. As yet, however, only study plots for this project have been mapped out.

Most State lands fall under the jurisdiction of the Alaska Department of Natural Resources (DNR). As indicated, the State is disposing of 607 ha (1,500 a) of remote housing parcels and 518 ha (1280 a) in a subdivision. These disposal areas (located north and south of Chulitna) are west of the project area and in the vicinity of the proposed access route.

In the project area, the State has done only a resource assessment for those lands it is proposing to select. Planning for State lands in this area will not occur before 1983.

Matanuska-Susitna Borough is involved in three separate management efforts which affect the project area. These are the Mat-Su Borough Comprehensive Plan (1970), the Talkeetna Mountains Special Use District, and the Mat-Su Borough Coastal Management Program. The current Mat-Su Borough Comprehensive Plan (1970) contains very little discussion of the Susitna area lands. The borough has already selected more than its entitlement and is concentrating its selections in the lower Susitna basin near existing highways. Thus, it is unlikely that the borough will select any lands in the project area.

The borough, by ordinance, has created the Talkeetna Mountains Special Use District, through which the borough can exercise planning and zoning authority over all lands within the district's boundaries. The Special Use District includes the project area. The ordinance provides for multiple resource use of the district, and takes into account unique scenic values. Thus, lands within the special use district are subject to permit requirements for specified developments (roads, subdivisions, etc.).

The borough is updating its comprehensive plan and additional studies are being performed. The project area is considered a mixed use zone which would permit hydro development. Management objectives for the project area will probably not be refined until the current hydro studies are complete.

Through a cooperative arrangement with the Office of Coastal Zone Management (National Oceanic and Atmospheric Administration, U.S. Department of Commerce) and the Alaska Coastal Management Program (Division of Community Planning, Alaska Department of Community and Regional Affairs), Mat-Su Borough is preparing a Coastal Management Program. Preliminary studies were completed in May, 1981; the Susitna River through Devil Canyon was designated to be within the biophysical boundaries of the program (Figure 9.5). Program results to date provide for a preliminary determination of uses subject to the program guidelines including, specifically, hydroelectric development in Devil Canyon. The appropriateness of this use is to be reviewed as resource analysis continues in subsequent phases of the program.

The Cook Inlet Region, Inc. received conveyance of selected Native lands to hold in trust until these lands are conveyed to the appropriate villages (Chickaloon-Moose Creek, Tyonek, and Knik). Currently, no land management activities are being carried out. When the villages obtain their lands, the different village ownerships will create a checkerboard pattern. Immediate land problems and land reconveyance to villages are being handled by the Village Deficiency Management Association, a group made up of representatives from each of the concerned villages. Because of the checkerboard nature of future land ownership, any management of Native lands may be undertaken by this association.

The results of the interviews with BLM, DNR, Mat-Su Borough, and the Cook Inlet Region, Inc. are meaningful within the context of general resources management in present-day Alaska. Agencies, the Native corporations, and the private sector have been heavily involved in the selection and transfer of land ownership under the Alaska Statehood Act and the Alaska Native Claims Settlement Act. Because of the uncertain outcomes of the Alaska National Interest Lands Conservation Act (ANILCA) and the proposed Susitna hydroelectric project, little attention has been given to actual land management. Furthermore, the area has not been exploited in the past because it was not economically feasible to do so. It is still not economically feasible to mine and process what minerals exist within the project area, although improved access may improve the economics of exploitation. Discussions with land owners/managers and consideration of present market conditions indicate that without the project little change is likely to occur soon in existing land use patterns, regardless of changing landownership. Even if the State of Alaska or the Cook Inlet Region, Inc. and village corporations sell remote parcels surrounding the accessible lakes, it is unlikely that there will be any significant change until access into the area is improved.

(e) Downstream Navigation

The Susitna River, downstream of Devil Canyon, has long provided a major means of access into the region. The Susitna is navigable from its mouth in Cook Inlet to the area around Portage Creek. The Susitna River has been determined by BLM to be navigable as far upstream as Devil Canyon based upon (1) prior use by a boat for any purpose and (2) suitability as a highway of commerce since Alaska Statehood in 1959. Beyond Devil Canyon no determination of navigability has been made by BLM. The U.S. Coast Guard considers the Susitna River between Gold Creek and the Tyone River to be non-navigable due to shifting sand and gravel bars and shifting channels.

A variety of craft are used on the downstream portion (below Devil Canyon) of the Susitna, including rafts, canoes, airboats, and riverboats. In addition, floatplanes are used throughout the Susitna drainage area. Considerable boating is done along the Susitna, particularly near boat launches at Willow Creek, Talkeetna, Kashwitna Landing, and Sunshine. Boats are used for fishing during the warmer months of the year and as a means of access to hunting areas in the fall. Riverboat services, several of which are based in Talkeetna, are increasingly popular and provide trips up the Susitna and Talkeetna rivers for recreationists and others wishing to reach inland areas not otherwise easily accessible.

Most boating activity is concentrated on the Susitna and Talkeetna rivers. The Yentna River and its tributaries, the Skwentna and Kahiltna rivers, the Deshka River (Kroto Creek), and Willow and Alexander creeks all receive some use. The Yentna is used for fishing, other recreation, and as access to hunting areas. The Deshka River receives extensive use by sport fisherman during salmon runs. The Talkeetna River receives heavy use for trapping, subsistence, recreation, and mineral development purposes. Riverboats, many with jet units, utilize portions of the

Talkeetna River in the summer. From just below Devil Canyon to north of Talkeetna, the Susitna is highly regarded and utilized by rafters and kayakers. The rapids of Devil Canyon are considered world class white-water, but few kayakers have successfully negotiated the gorge.

In the winter, the Susitna River is used as an avenue of transportation by means of dogsleds and snowmobiles. These means of transportation are used for purposes such as trapping, recreation, and travel between Trapper Creek and Talkeetna.

9.2 - Land Uses With the Project

(a) Project Facilities

Figure 9.7 shows the locations of proposed project facilities in the upper Susitna basin. Locations of the dams, impoundments, access road, construction camps and villages, borrow areas, and related facilities are indicated. Brief descriptions of the major facilities are presented below, and details may be found in Volume 1 of the Feasibility Report.

(i) Watana Dam and Impoundment

The Watana dam will be a 247-meter (810 ft) high gravel filled structure with a crest length of 1,148 m (3,765 ft). The dam will be located at Susitna River kilometer 266 (mile 165), approximately three kilometers (two miles) upstream from the mouth of Tsusena Creek. It will impound just over 80 km (50 mi) of river to 666 m (2,185 ft) elevation and inundate over 16,000 ha (40,000 a).

An underground power plant with associated penstocks, tailrace, and related facilities will be constructed with 1,020 megawatts installed capacity. A spillway constructed on the north side of the dam will be capable of passing 165,000 cfs of water.

(ii) Devil Canyon Dam and Impoundment

Devil Canyon dam will be a 194-meter (635 ft) concrete thin arch dam and a rockfilled saddle dam constructed at river kilometer 216 (mile 134) in Devil Canyon. Its crest length will be 754 m (2,475 ft). The dam will impound 45 km (28 mi) of river to 444 m (1,455 ft) elevation. Approximately 3,055 ha (7,550 a) of land will be inundated.

The underground power plant will have an installed capacity of 600 megawatts. The emergency spillway for the dam on the south side of the river is designed to pass 222,000 cfs of water. A tailrace tunnel will extend more than two kilometers (1.3 mi) downstream on the north side of the river.

(iii) Access

Construction of a permanent access road will be facilitated by a pioneer road to be constructed from Gold Creek to the Watana site. For about 70% of the distance (discontinuous) between Gold Creek and Devil Canyon, this pioneer road will follow an existing bulldozer trail (used in earlier studies by the Corps of Engineers). Spurs will be built from the pioneer road to certain points on the permanent access route. A temporary low-level bridge will cross the river, with a series of switchbacks down into the canyon just above the dam site. Between the two dam sites the pioneer road will mostly follow the route of the permanent access road.

Full access for construction and operation of the dams and access to proposed project recreation facilities will be by a gravel road from the Parks Highway. There will also be a railroad yard in the vicinity of Gold Creek, with a short road connection to the main access road. The main access road will connect with the highway near Hurricane and roughly parallel the alignment of the Alaska Railroad through Chulitna Pass south to the confluence of the Indian and Susitna rivers north of Gold Creek. The road will then parallel the Susitna River on the south side to Devil Canyon. Initially, a bridge will be constructed at this point over the canyon; after construction, the Devil canyon dam will serve as a bridge. The road will extend northeasterly through the alpine lakes area north of Devil Canyon and parallel the upper Devil Creek drainage. From this point, the road will follow a generally easterly direction to the Watana dam site.

The total length of the access road from Hurricane to the Watana site will be 110 km (68 mi), aligned within a 60 m (200 ft) corridor. The roadway will be 10 m (34 ft) wide, with 2 m (5 ft) shoulders on either side.

Several pull-outs will be constructed along the access road to permit viewing of natural areas and some of the project facilities. Additionally, access to recreation sites from the road will be provided as indicated in the plan for recreation (Section 7.2).

(iv) Transmission Facilities

Maps of the proposed transmission routes are included in Appendix E3. From Watana to Devil Canyon within the 0.8 km (0.5 mi) wide route, a 122 m-wide (400 ft) transmission right-of-way will mostly parallel the access road. Two single-circuit 345,000 volt (345 kV) lines will be constructed. From Devil Canyon to the intertie near Gold Creek, a total of five single-circuit 345 kV lines will require a right-of-way about 213 m (700 ft) wide.

These lines (two to the north, three to the south) will parallel the intertie to Healy and Willow. From Healy to Fairbanks and Willow to Anchorage, the right-of-way will be approximately 122 m (400 ft) wide. Most of the towers are expected to be X-shaped structures approximately 30 m (100 ft) tall. In some places, such as near the Municipality of Anchorage, double-circuit construction may be used, thus requiring taller towers. Double circuit towers, while approximately 15 m (50 ft) taller than single circuit towers, allow a narrower right-of-way.

(v) Construction Camps and Villages

Construction camps (single worker housing), villages (family housing), and associated facilities will be located within the immediate project area: there will be one camp and village at each dam site. Construction of Watana dam is scheduled to begin in 1985, five years before the dam at Devil Canyon. Plans call for the building of a construction camp and village first at Watana. When construction phases down at the Watana site, the camp will be relocated to the Devil Canyon dam site. Part of the village at Watana will remain as a permanent town to provide housing and other community facilities for workers who will operate the dams. No such permanent village is currently planned for the Devil Canyon site.

The proposed camp and village at the Watana site will be constructed northeast of the dam site between Deadman and Tsusena creeks on what is now BLM land. Approximately 1-2 km (1 mi) will separate the construction camp from the village. Work on the village will begin about one year after construction of the camp has begun. Structures at the camp will be of factory-built, modular design, to facilitate their relocation to Devil Canyon. Permanent buildings are planned for the village facilities at Watana, since the village community will remain after the dams are built.

Facilities at the village will include family housing (for a projected 550 families), a school, gymnasium, recreation center, shopping center (food supermarket, department and specialty stores), fire station, generating station, and structures for other support activities. Facilities and services to be provided at the construction camp include modules for housing (dormitories) for about 5,000 workers, camp offices, food services, warehousing, fire and security protection, banking and postal services, hospital care, recreation, communications, and power generation.

Camp and village utilities will include a potable water supply system, sewage system, power supply and distribution system, communications, fuel storage, and a solid waste disposal system. The water supply is expected to serve an estimated peak population of 6,820 (5,070 in the camp and 1,750 in the village) including workers, families, and visitors. The water source will be from Tsusena Creek (where a small impoundment will be created) and groundwater wells. The treatment plant, also of modular design, will fulfill primary and secondary Environmental Protection Agency (EPA) requirements. Treated water will be stored in three tanks, two at the camp and one at the village. Sludge, a by-product of the treatment plant, and solid waste from the two sites, will be properly treated and disposed of in a landfill.

The facilities at the construction camp and village to be built at Devil Canyon will differ only slightly from those at Watana, though fewer workers will need to be accommodated. The camp will be situated south of Portage Creek and just west of Devil Canyon on the south side of the Susitna River. The village will be temporary, unlike the one at Watana, and will be just west of the camp.

(b) Induced Land Use Changes

Construction and operation of the dams and related facilities will cause impacts on area resources. Prior to determining the extent of alteration or disruption which land use patterns will experience, land uses were assessed in terms either of man's use of the landscape for particular purposes (many of which tend to be site-specific), or of man's dedication of a given geographical area to preserve some specified values. In some cases, these values and their protection are identified in agency management programs that apply to the area. Based on available information and agency interviews, however, it has been determined that no comprehensive management plans exist at present. The Alaska Department of Fish and Game (ADF&G) has developed species-specific objectives for the region, but it has no land management authority. Other agencies have only preliminarily addressed land management concerns (see Section 9.1). The generation of hydroelectric power will become the predominant land use in the area, and the presence of the project will be an important factor when agencies eventually develop comprehensive land management plans for the surrounding areas.

With increased access, certain land use activities are expected to become more intense than at present. In terms of displacement of existing land uses, by both the project itself and the induced land uses, the primary effects will be changes in the manner in which individuals (rather than land management agencies) are presently using the area.

Figures 9.8 and 9.9 shows points and areas in the vicinity of the project which will experience changes in land use and activity patterns. Project facilities will create immediate, direct impacts on the landscape, as shown on Figure 9.7; some of these impacts will be temporary, such as those of the construction camps and construction activity itself. Other aspects of the project will create or facilitate permanent and often subtle changes in the type, nature, and intensity of use and activity patterns. Chief among these aspects is the provision for automobile access to an area currently lacking such access [Section (iii) below]. For purposes of discussing induced changes in land use and associated activity patterns as they relate to major project components, impacts on four general land use categories were assessed:

- Land uses inherently associated with site-specific activities:

  This category includes land uses that involve some form of long-term commitment of resources (for example, structures) and the activities associated with them. These include the following: residences, commercial properties (primarily recreational), mining, agriculture, and transportation.

- Dispersed and isolated non-site-specific activities:

  This category includes activities that are generally non-continuous and do not involve a commitment of resources at any particular site. These include consumptive recreational or subsistence activities, such as hunting and fishing; riverine activities, such as boating or rafting; and dispersed activities, such as camping, hiking, and photography.

- Resource management activities and related concerns:

  This category involves consideration of present or potential future activities related to conservation or planned use of the land and resources, and includes fish and wildlife management, dispersed recreation management, off-road vehicle management, Native claims, and land values.

- Natural aesthetics:

  This category involves consideration of the natural land cover type itself as opposed to the uses of the land. Considered are the visual character of both land and water resources, ground cover (specifically vegetation), land surface integrity, and general natural character. Project impacts related to aesthetics are discussed primarily in Section 8.2.

(i) Dams and Impoundments

The emplacement of the dams and impoundments will cause the direct loss of ten structures (six by Watana, four by Devil Canyon). These structures and their uses are described in Table 9.1. Only three of the ten are actively maintained, being used on a seasonal basis, but two others are used sporadically. The remaining five are currently unused or unusable. The primary uses of the structures to be affected are hunting, fishing, boating, and trapping, as well as hydroelectric feasibility studies.

The impoundments will displace relatively low levels of riverine boating and rafting patterns of use between the upstream end of Watana reservoir and Devil Canyon. Kayaking (in which one must employ considerable technical expertise to negotiate the turbulence in Vee Canyon and world-class whitewater of Devil Canyon) will be eliminated. In place of these activities there will be reservoir boating. As discussed in the following section, some rafting and kayaking downstream of Devil Canyon may continue.

There likely will be increased hunting activity, as well as alterations to current patterns, resulting from the impoundments. The reservoirs and access to them [see also Section 9.2 (b) (iii)] will facilitate floatplane landing and boat travel and thus permit easier penetration by big game hunters into areas now rarely visited. As shown in Figures 9.8 and 9.9, an increase in moose hunting will likely occur immediately adjacent to the proposed impoundments. Increased hunting for caribou (to the extent that the permit system allows) will likely occur a relatively short distance back from the impoundments.

There is likely to be increased fishing for resident species, primarily grayling, in tributaries in the vicinity of the impoundments, as shown in Figures 9.8 and 9.9. A limited reservoir fishery may also develop (see Section 3.7). Because of the proximity of the Devil Canyon facility, salmon fishing in Portage Creek could increase. If necessary, further regulations can be implemented to prevent overfishing in this area.

At present, some trapping takes place in the upper basin. The reservoirs will cause disruption of present trapping patterns. Project impacts on trapping, fishing, hunting, and other land uses are further discussed in Section 5.7.

(ii) <u>Downstream Effects of Dam Operations</u>

A number of impact issues have been raised concerning the potential effects of project flows on downstream navigation. These concerns include the following: (1) whether present access for fishing, hunting, and other purposes via the Susitna and its tributaries may be affected by reduced summer flows in certain channels; (2) whether a reduction in flow could alter the stream bed morphology of the various tributaries at their confluences with the Susitna, thus hampering the ability of boats to enter the tributaries; and (3) whether access to land disposal areas which is now acomplished by boat and floatplane will be affected by reduced summer flows. In addition, concern has been expressed about the loss of kayaking and rafting opportunities, and also about potential impacts on winter use of the river.

Future navigational use is likely to increase along the Susitna River and other water courses in the Railbelt as the population in the region increases (see Section 5.2). Development and settlement of state land disposal areas below Devil Canyon will also change present navigational use. Therefore, the change in summer flow in the Talkeetna to Devil Canyon reach is a particular concern, although railroad access will continue and road access will be created by the project access road.

Review of limited aerial photographs, river cross-section data, and simulated water surface profiles in the reach between Devil Canyon and Talkeetna indicates that proposed project stream flows are likely to cause periodic navigation problems during the months of August and September. If project flows were increased in August and September, few areas would experience navigation problems.

One area of concern is the reach 1-5 km (1-3 mi) below Sherman where the main channel crosses the floodplain. The water depth at 6500 cfs is approximately 0.75 m (2.5 ft) at the cross section here, indicating the channel is navigable. However, examination of nearby areas (for which cross-sectional data are unavailable) indicates that they may not be navigable. Navigation problems may be encountered in about one year out of three in August, and in about one year out of two in September in this reach with the proposed flows. If water is stored in the spring to augment flows in August and September, navigation problems may be encountered in this reach in about one year out of ten during June.

Cross-sectional data were gathered for the main channel below Talkeetna in sloughs and side channels used for river access near Kashwitna Landing and Willow Creek, and at the upper access channel to Alexander Slough. While stage-discharge data at these sites are very limited, initial analysis indicates that operation of the dam will have no significant negative impacts on navigation on the main channel below Talkeetna or to access at Kashwitna Landing. Access channels near Willow Creek should be navigable at the proposed flows. Minor navigation problems could occur in this area during May if water is stored to augment flows in August and September.

Data are insufficient to completely define the flow required at Susitna Station in order to keep upstream access to the Alexander Slough area, but the decrease in stage will be less than .3 m (1 ft) for the proposed flows.

If rafting and kayaking downstream of Devil Canyon are still possible with project flows, the river will not be as appealing as at present due to the controlled flows. The limited daily peaking operations proposed for the Devil Canyon facility may present some boating hazards immediately below this facility. Because these hazards will be unlike the natural hazards posed by a wild river, this vicinity may be unsuitable for river floating.

Ice studies have predicted that during project operation the Susitna River below Devil Canyon dam will have open water in winter at least as far downstream as Talkeetna. This open water will preclude the present use of snowmobiles and dogsleds for transportation on this portion of the river.

(iii) Access

As indicated previously, increased access is a critical factor with respect to land uses. Road access will cause both the disruption of present land use and the inducement of future land uses. The most significant aspect of the access road relates not so much to various impacts associated with the road per se but rather to the concept of access itself, in any form, to the interior of the Susitna basin. The provision of a means by which the general public can easily and frequently venture inland to an area which is essentially wilderness will likely cause profound alterations in the character of the Susitna area.

Access, because it will facilitate the influx of people and activity into the basin, will affect the following: small population concentrations and isolated residences; peripheral commercial and transportation systems; resource utilization and level of recreational activity; visual and aesthetic factors; and the overall character of the area. These effects will have ramifications for management: the need for it and its extent and adequacy (for example, fish and game management, land management, etc.). Access will influence changes in land values and development, and may expedite the exploitation of the area's mineral resources.

Road access to the dam sites from the Parks Highway will likely create increased traffic and related activity along the Parks Highway and in adjacent communities. Residential and commercial use and the values of land made more accessible by the new road will probably be affected; there is likely to be increased demand for these parcels (due to an increased population and markets for commercial services), and improved access will make them more attractive to prospective buyers. The proposed route through Chulitna Pass and along Indian River will provide road access to state land disposal sites on Indian River.

There will likely be increased hunting for moose and bear along the access corridor. The zone around the access road subject to increased hunting will be much larger if off-road vehicles are permitted. In addition to the impacts of increased hunting activity in a larger area due to both the road and the impoundments, there will be disruption or displacement of the persons who currently hunt in the upper basin. Those who presently hunt in the area will either have to adjust to larger numbers of hunters or hunt in other areas. Fishing will also increase (for example, for salmon in Indian River) with potential effects on both the resource and those people who currently fish in the area.

The access road between the two dams on the north side of the Susitna will disrupt current use patterns at High Lake Lodge. Disruption might also occur to fly-in fishing and hunting around the lakes nearer to Devil Canyon. Some recently established trapping territories around the High Lake area would also be altered. In addition to increased hunting and fishing, this area will also recieve increased recreational use for hiking, backpacking, sightseeing, and other activities.

Further details on the anticipated impacts of the road (and the improved access it will provide) on natural resources and their present and potential uses are found in the following sections: 3.5(e), 3.6(e), 3.7(e), 4.4(a)(iv), 5.7, 7.3, and 8.2(c).

(iv) Transmission Facilities

Analysis of proposed transmission facilities for the Susitna project involved assessment of three study areas: 1) the northern study area, containing that segment of the line between Healy and Fairbanks; 2) the central study area, containing transmission lines from the power plants at the dams to the intertie; and 3) the southern study area, covering Willow to Anchorage.

The route analysis involved mapping of selected land use features and land ownership within a previously established 5-10 km wide (3-6 mi) corridor. In the central study area the corridor covered both sides of the river and thus was as wide as 23 km (14 mi) in some places. Land use features included existing recreation facilities; developed residential, commercial, and other uses; significant privately owned lands, including disposal areas; and the existing transportation network. These features are shown on the maps in Appendix E3 as man-made constraints.

Features were identified as constraints if there is the potential for physical conflicts between either existing or likely future land use developments (in the absence of the project) and the proposed transmission lines and towers.

- Northern Study Area

  There are several moderate concentrations of land use developments along or adjacent to the proposed route between Healy and Fairbanks. Significant among these are developments at Healy, Nenana, and Ester. In Healy and Ester, there will be a direct interface between existing land uses and the proposed transmission route.

  There are several large land disposal areas (on the west side of the Parks Highway) through which the route will pass. In traversing these disposal areas, the lines will closely parallel an existing transmission line.

  Impacts in this study area will include the acquisition of a 122 m (400 ft) wide right-of-way and the elimination of future land development within this strip. In addition, one dwelling located off the Parks Highway approximately 6 km (4 mi) south of Browne may have to be acquired. Many potential impacts, however, were avoided during the selection of the corridor and route. Visual impacts of this route are discussed in Section 8.2.

- Central Study Area

  Between the Watana and Devil Canyon dam sites, there will be significant conflicts between the proposed route, like the access route which it parallels, and the development at High Lake Lodge: the proposed route will pass just northwest of High Lake and the wilderness lodge and cabins located there. Several other alpine lakes are also located in this area, and the transmission line could potentially interfere with floatplane landings. A right-of-way 122 m (400 ft) wide will be required to accommodate transmission facilities between the dams.

  Although slightly more land area would be required, locating the line well to the west of the proposed route within the alternative route alignment (identified on Figure 31 in Appendix E3) would reduce the conflict with existing uses at High Lake Lodge. The alternative route would roughly parallel the Portage Creek drainage just below the ridge to the east of the creek, and pass well to the west and north of High Lake.

  The segment of the proposed route from the Devil Canyon facility to the intertie near Gold Creek will conflict little with existing uses. The lines and towers, however, will probably be visible from areas north of the Susitna River in the Indian River remote parcel disposal, Otter Lakes, and from some places on the river.

- Southern Study Area

The proposed route between Willow and Knik Arm northeast of Point MacKenzie will traverse an area that receives dispersed but increasing use. In this study area are land disposal areas and private lands, most of which the proposed route avoids. Access to these land holdings is via floatplanes, ORVs, and snowmachines. Boating occurs along the Susitna and Little Susitna rivers and Willow Creek as well as on many of the numerous small lakes. Potential conflicts between the proposed lines and private lands and boating use occur wherever the lines and towers will be visible. Floatplane flight patterns may be affected where the lines pass near lakes used for landing and taking off.

The route crosses or parallels numerous trails including the Iditarod Trail, seismic survey clearings, tractor and pioneering ORV trails, and several recreational trails farther north near Willow. Trails that receive substantial ORV use are located near Willow, Red Shirt Lake, and Knik Arm. The proposed route will likely not affect physical use of trails, although visual conflicts may occur where the lines and towers pass near various trails.

Residential use occurs in Willow, Red Shirt Lake, and on many of the small lakes mostly to the east of the route. Scattered cabins in the vicinity of Willow are close to the Alaska Railroad and Parks Highway. Red Shirt Lake has approximately 25 cabins along its shores; seven other lakes have several cabins along their shores and a few cabins are widely scattered elsewhere. The proposed route will not directly affect these existing structures, although the lines and towers may be visible in areas west of Long Lake, Red Shirt Lake, and smaller lakes where topography is not sufficient to screen them from view.

The corridor and portions of the western boundary of the route in this area are located in the northeast corner of the Susitna Flats Game Refuge. Agricultural use occurs north of the Point MacKenzie area, and agricultural clearings occur from a region just northeast of Middle Lake to the Little Susitna River south of Yohn Lake. Future agricultural land sales are proposed in the Department of Natural Resource's draft land use plan for the Willow sub-basin along with programs for protecting wildlife habitat and sportsmen's access. While land within a transmission right-of-way can still be cultivated, the towers could displace small areas of existing and potential future agricultural use, or disrupt normal patterns of agricultural development or cultivation.

Land use in the area of the existing Chugach Electric Association, Inc. Point MacKenzie-University Substation line (which will be paralleled by project lines east of Knik Arm to a new substation to be located south of Muldoon Road) is predominantly military: most of the route here lies within the Fort Richardson Military Reservation. Impacts on these lands will be limited primarily to those associated with the area's visual quality (see Section 8.2).

(v) Construction Camps and Villages

Construction camps and villages at each dam site and the permanent town at Watana will have a significant effect on present and future land use. Access to and from the camp and village sites could open up new areas in the project area to hunting, fishing, and recreation, or at least increase the activity levels in areas now rarely visited. If recreation by residents occurs to the south of the Watana dam site, conflict could arise with existing use patterns at Fog and Stephan lakes.

TABLE 9.1: ZONE 1 - EXISTING STRUCTURES (a)

Map # (b)	Structure	Location	Access (c)	Currently Maintained	Use Status
2	Boat cabin	S. bank Susitna: on tributary 4.8 km S.W. of Fog Creek/ Susitna confluence	boat, foot	Yes	Built in 1960's for Stephan Lake Lodge; currently used seasonally by Stephan boating/ hunting guests
90	Hunting lean-to	S.E. bank of Kosina/ Susitna confluence	boat, foot, floatplane	Yes	Built in late 1970's for hunting/ fishing purposes; fresh supplies indicate current use
91	Cabin	3 km N.E. of Watana/Susitna confluence	floatplane	No	Built in 1950's; used as seasonal hunting and fishing cabin; supplies indicate current use
112	Line cabin	N.E. corner of Jay/ Susitna confluence	foot, dog team, boat, floatplane	No	E. Simco's line (trapping) and and hunting cabin built in 1939; dates and game records indicate annual use
119	Trailer; work shack	N. bank of Susitna: 1.6 km W. of Deadman/ Susitna confluence	helicopter	Yes	Built in 1970's by Army Corps for Susitna study
107	Cabin	S. bank of Susitna at Devil Canyon	4WD	No	Built and used in 1950's for Bureau of Rec. study; currently not in use
6	Cabin foundations	N. shore of Susitna: W. bank of 1st tributary W. of Tsusena/Susitna confluence	foot, dog team	No	Built in 1939 by Oscar Vogel as a trapping line cabin; used until late 1950's, now collapsed; no longer used

a. Zone 1 is the impoundment zone plus a 61 m (200 ft) perimeter.
b. See Figure 9.2.
c. Almost all sites are accessible by helicopter.

TABLE 9.1 (Continued)

Map # (b)	Structure	Location	Access (c)	Currently Maintained	Use Status
120	Shack	S. bank of Susitna: 1.6 km W. of Deadman/ Susitna confluence	helicopter	No	Used and built in 1970's as a research site; since Army Corps study, has collapsed; no longer used
92	Cabin/ cache	N.W. bank of Watana/Susitna confluence	dog team, foot	No	Built in 1960's for hunting purposes; cabin collapsed; no longer in use
111	Cabin	S. bank of Susitna: 1.6 km E. of Watana/ Susitna confluence	dog team, foot	No	Built in 1945 as a trapping line/hunting cabin; used for trapping until mid 1950's, presently covered with brush; no longer used

Summary: Ten structures exist within this zone. Of these, five are currently being used on a seasonal basis for purposes of fishing, boating, hunting, and research.

(a)

TABLE 9.2: ZONE 2 - EXISTING STRUCTURES

Map #	Structure	Location	Access	Currently Maintained	Use Status
1	Cabin; meat house	Lake E. of Stephan Lake, 564 m (1850 ft) elevation	floatplane, skis	Yes	Built in 1960's and in current use for seasonal hunting, fishing, and boating
3 4	Cabin; shed Cabin	N.W. shore of Stephan Lake	airplane	Yes	Built 1960's and in current use for seasonal hunting, fishing, and boating
5	Cabin foundations	Tsusena Creek: 6 km from Tsusena/Susitna confluence	foot, dog team	No	Built in 1940's as a trap line cabin and used until late 1950's; no longer in use
7	Cabin; shed	S. shore of Fog Lake #2	floatplane	Yes	Built in 1960's and currently being used as a seasonal fishing and hunting cabin
8	Cabin;	On knob of Fog Lake #1	airplane	Yes	Built in 1960's and currently being used as a seasonal hunting and fishing cabin
9	Stephan Lodge (10 structures)	W. central shore of Stephan Lake	airplane, foot	Yes	Built in 1960's and in current use as hunting, fishing, and recreation lodge; can accommodate up to 35 guests; operates year-round
10	Cabin; shed	0.8 km S.W. of Stephan Lodge on Stephan Lake shore	airplane, foot	Yes	Built in 1960's and in current use seasonally as a hunting and fishing cabin
11	Cabin; shed	E. shore of Stephan Lake	airplane, foot	Yes	Hunting, fishing, boating, seasonal use; built in 1960's

a. Zone 2 is the 10-km perimeter around Zone 1 (impoundment zone plus 61 m).

Map #	Structure	Location	Access	Currently Maintained	Use Status
11	Cabin; shed	E. shore of Stephan Lake	airplane, foot	Yes	Hunting, fishing, boating, seasonal use; built in 1960's
12 13 14 15 40	Cabin; shed Cabin; shed Cabin; shed Cabin; shed Cabin; shed	E. shore of Stephan Lake	airplane, foot	Yes	Built in 1960's and in current seasonal use as hunting, fishing, and boating cabins
16	Cabin; shed	Mouth of Prairie Creek at Stephan Lake	airplane, foot, horse	No	Built in 1940's and used until late 1950's as a hunting, fishing, and trapping base and residence; no longer used
17 18	Cabin Cabin	W. shore of Prairie Creek	airplane, foot	Yes	Built in 1960 and 1970 respectively and currently used as a year-round residence from which hunting, fishing, and trapping occur
19	Cabin; meathouse	E. shore of Murder Lake (S. of Stephan Lake)	airplane, foot	Yes	Built in 1960's and used as a year-round residence; hunting and fishing
20 21	Cabin; shed Cabin; shed	S.E. shore of Daneka Lake	airplane, foot	Yes	Built in 1960's and currently used on a seasonal basis for hunting, fishing, and recreation by guests of Stephan Lodge
25	Mining buildings (5)	Portage Creek: 4 km. N. of Portage/ Susitna confluence	airplane, ATV, foot, dog team, horse	No	Mining records exist as far back as 1890's; mined 1920's and sporadically 1930's, then 1950-70's; currently inactive mining operations; buildings not in use

Map #	Structure	Location	Access	Currently Maintained	Use Status
26	Cabins (2)	1.6 km N. of Portage Creek mining	airplane, ATV foot, dog team	Yes	Mining; built in 1950's; used Creek seasonally
27	Cabins (2)	N.W. shore of Dawn Lake	airplane, ATV horse, dog team	Yes	Built in 1960's by owners of High Lake; used currently as a hunting cabin on a seasonal basis
28	Lodge, High Lake (9 buildings)	S. shore of High Lake	airplane, ATV horse, dog team	Yes	Built in 1960's for use as an international hunting/fishing lodge; currently in use by Acres American Susitna project on a seasonal basis
30	Cabin foundations	S. shore of High Lake	airplane, ATV horse, dog team	Yes	Building under construction as of June 1980
34	Chunilna Creek Placer (7 buildings)	Chunilna Creek	airplane, ATV, 4WD, snowmachine	Yes	Large placer mining operation in existence since 1950 and currently actively mined on a seasonal basis
42	Cabin	Portage Creek 3 km N.W. of Dawn Lake	foot, sled road, airplane, ATV	Yes	Built in 1960's and currently used on a seasonal basis for hunting and fishing
45	Cabin	1.8 km W. of Portage Creek mining	foot, airplane, ATV/4WD	Yes	Currently used on a seasonal basis for recreational purposes
46	Cabin	1.8 km W. of Portage Creek mining, on sled road	foot, airplane, ATV, 4WD	Yes	Currently used on a seasonal basis for recreational purposes
47 48 49	Cabin Cabin Cabin	Unnamed lake N. of Otter Lake	foot, airplane, ATV, 4WD	Yes	Currently used on a seasonal basis for recreational purposes

Map #	Structure	Location	Access	Currently Maintained	Use Status
50	Trailer	W. end of S. shore of unnamed lake N. of Otter Lake	foot, airplane, ATV, 4WD	No	Currently not in use; abandoned
51	Cabin	W. end of S. shore of unnamed lake N. of Otter Lake	foot, airplane, ATV, 4Wd	No	Built in late 1960's and currently used for hunting and fishing on a seasonal basis
52 53	Cabin Cabin	S. shore of unnamed lake N. of Otter Lake	foot, airplane, ATV, 4WD	Yes	Built in late 1960's and seasonally used since then for hunting and fishing
55	Cabins (3)	W. end of Bear Lake	foot, airplane, ATV, 4WD	Yes	Built in 1970's and currently used on a seasonal basis for hunting and fishing
56	Cabin	N. shore of Bear Lake	foot, airplane, ATV, 4WD	Yes	Built in 1970's and currently used on a seasonal basis for hunting and fishing
57 59	Lodge	N. shore of Bear Lake	foot, airplane, ATV, 4WD	Yes	Built in 1970's; lodge and cabin used for fishing, hunting, and skiing on a year-round basis; seasonal boating
58	Cabin foundations	E. end of Bear Lake	foot, airplane, ATV, 4WD	No	Built in 1950's for trapping purposes; no longer in use
64 65 65	Cabin Cabin Cabin	Miami Lake	rail, foot, car, airplane	Yes	Perhaps being used as recreational cabins
69	Cabin	S. shore of Swimming Bear Lake	airplane, foot, 4WD	Yes	Built in 1960's and currently used for hunting, fishing, and swimming

Map #	Structure	Location	Access	Currently Maintained	Use Status
70	Lodge	N. shore of Tsusena Lake	airplane, ATV	Yes	Built in 1958; used for commercial guided hunts until 1976; presently used on a seasonal basis for private hunting, fishing, and skiing trips
75	Cabin	6 km from Watana/ Susitna confluence	airplane, ATV	Yes	Built in the 1970's; currently used on a seasonal basis for hunting
76	Cabin	11 km east of Big Lake	airplane, ATV	Yes	Constructed in 1970's and currently used on a seasonal basis for hunting and mining
77 78	Cabin Cabin	N. end of Watana Lake	airplane, dog team, snow-machine	Yes	Built in 1950's and 1960's respectively and currently used seasonally for hunting and fishing
79 80	Cabin Cabin	E. end of Watana Lake	airplane, dog team, snow-machine	Yes	Built in 1950's and 1960's respectively and currently used seasonally for hunting and fishing
81	Cabin	E. end of Gilbert/ Kosina confluence	foot, dog team	No	Built in 1936 as a trapping line cabin; used until 1955; currently abandoned with everything intact
82	Tent frame structure	S.W. end of Clarence Lake	foot, dog team	No	Built in 1950's and used until 1960's for seasonal hunting
84	Cabins (2)	S.E. end of Clarence Lake	airplane	Yes	Built in 1950's and currently used seasonally as a hunting and fishing cabin
85	Cabin	E. end of Clarence Lake	airplane	Yes	Built in 1970's and currently used on a seasonal basis for hunting, fishing, and trapping

Map #	Structure	Location	Access	Currently Maintained	Use Status
86	Cabin	N. end of Clarence Lake	airplane	Yes	Built in 1960's and currently used on a seasonal basis for hunting, fishing and trapping
87	Cabin	On tributary 1.6 km E. of Clarence Lake	foot, dog team	No	Built in 1930 and used until 1950 for trapping, hunting, and fishing (Simco's line cabin #4); currently used seasonally as a hunting shelter
88	Cabins (2)	Gaging station: S. bank of Susitna	airplane	No	Built in 1950's for research purposes; currently not used or maintained
93	Cabin	W. of Jay/Susitna confluence	airplane	Yes	Built in 1960's and used currently on a seasonal basis for hunting and fishing
94	Cabin	Laha Lake: 2.4 km W. of Jay Creek	floatplane, airplane	Yes	Built in 1960's and used currently on a seasonal basis for fishing
95 96	Cabin Cabin	Unnamed lake: 4 km S.E. of Vee Canyon gaging station	airplane	Yes	Built in 1950's and used currently on a seasonal basis for fishing
99	Cabin	Tyone River/Susitna confluence	boat	Yes	Built in 1960's by Stephan Lodge owner as a river cabin for Stephan Lodge boating guests
103	Cabin	Jay Creek: 5 km N. of VABM Brown	ATV	Yes	Built in 1970's for hunting and currently used on a seasonal basis
105	Cabin	Coal Creek	ATV, airplane	Yes	Built in 1970's for hunting and currently used on a seasonal basis

Map #	Structure	Location	Access	Currently Maintained	Use Status
110	Cabin	N. end of Madman Lake	airplane	Yes	Built in 1960's and currently used on a seasonal basis for hunting and fishing
115	Cabin	3 km N. of Tsusena Lake	airplane	Yes	Built in 1970's and currently used as a year-round residence by a guiding outfit
116	Cabin	1.6 km W. of VABM Oshetna	airplane	Yes	Built in 1970's for hunting purposes and is currently used on a seasonal basis
112	Cabin foundations	W. bank of Portage Creek: 6 km from Portage/Susitna confluence	dog team, foot	No	Built in 1940's as a mining/ prospecting cabin; no longer in use
117	Cabin	Tyone River/Tyone Creek confluence	boat, dog team	Yes	Built in 1960's for hunting and fishing purposes and currently used on a seasonal basis
118	Cabin	17.7 km due E. of Tyone River/ Susitna confluence	boat, dog team	No	Built in 1960's for hunting and fishing purposes; no longer in use

Summary: Seventy-six structures exist within Zone 2.

(a)
TABLE 9.3: ZONE 3 - EXISTING STRUCTURES

Map #	Structure	Location	Access	Currently Maintained	Use Status
22	Cabin; shed	Prairie/Talkeetna confluence	foot, dog team, boat	Yes	Built in 1960's and currently used seasonally by Stephan Lodge for purposes of fishing and hunting
23	Cabin; shed	Game Lake	airplane, foot	Yes	Built in 1940's and used since then for trophy game hunting; now a part of Stephan Lodge's series of outreach cabins used on a seasonal basis
36	Mining buildings	Chunilna Creek: 13 km S.W. of VABM Clear	airplane, ATV, 4WD, snow-machine, dog team, foot	Yes	Four buildings built in the 1920's, 1940's and 1960's and used seasonally for the purpose of mining
37	Cabin	5 km N.E. of VABM Curry	foot, dog team	No	Built in 1940's and used seasonally for trapping until early 1960's; no longer in use
38	Cabin	Grizzly Camp: 8 km E. of Daneka Lake	foot, dog team, airplane	Yes	Built by Vogel in the 1940's as a hunting cabin; currently used on a seasonal basis as a Stephan outreach cabin for purposes of hunting
39	Cabin	14 km E of Stephan Lake: 11 km s. of Fog Lake	foot, airplane	Yes	Built in 1970's; current use not known at this time
59 60 61 62 63	Cabin Cabin Cabin Cabin Cabin	Chulitna Pass: near railroad	rail, foot, car, airplane	Yes	Exact construction dates not known; currently used as year-round residences

a. Zone 3 is that zone beteen 10 km and 19 km from the impoundments.

TABLE 9.3 (Continued)

Map #	Structure	Location	Access	Currently Maintained	Use Status
72	Cabin	Deadman Lake: W. of Big Lake	airplane, ATV	Yes	Built in 1960's for fishing and hunting purposes and currently used on a seasonal basis
73 74	Cabin Cabin	Big Lake	ATV	Yes	Built in 1960's; currently used on a seasonal basis for hunting and fishing
89	Cabin	Unnamed lake 5 km S.W. of Clarence Lake (island in middle)	floatplane, boat	Yes	Exact construction date not known; currently used on a seasonal basis for fishing
98	Cabin	Oshetna River: 16 km S. of Oshetna/ Susitna confluence	dog team, foot, boat	No	Built by Simco in 1930 as a trap line cabin and used on a seasonal basis for hunting and fishing
100	Tent platform	Susitna sandbar: S. of Tyone River/ Susitna confluence	boat, helicopter	No	Built in 1970's and used currently for transient boaters
101	Cabin	0.4 km S. of Maclaren/Susitna confluence	boat	Yes	Built in 1960's and currently used for boating on a seasonal basis
106	Cabin	S. end of Coal Lake	ATV, airplane	Yes	Built in 1960's and currently used on a seasonal basis for mining and fishing
113	Cabin	Unnamed lake: 10 km W. of Murder Lake	airplane	No	Built in 1960's for hunting purposes; no longer in use
114	Cabin	11 km N.E. of VABM Disappointment	airplane	Yes	Built in 1970's for hunting use and currently used for seasonal hunting purposes

Summary: There are twenty-one locations in Zone 3 with existing structures.

TABLE 9.4: USE INFORMATION FOR EXISTING STRUCTURES IN THE UPPER SUSITNA RIVER BASIN

	Zone 1	Zone 2	Zone 3
PRESENT CONDITION OF STRUCTURE			
Remains of structured foundations only (no use)	1	5	-
Badly weathered; partial structure remains - use no longer possible	2	-	1
Structure intact; not currently maintained			
- seasonal use - past & present	2	2	2
- no current seasonal use	2	7	1
Structure intact; maintained with seasonal use - past & present	3	49	12
Structure intact; maintained with year-round use	-	9	3
Structure intact; maintained; no current use information	-	4	3
USE TYPES			
Hunting, fishing, trapping	3	7	1
Hunting, fishing	2	43	3
Hunting only	1	7	2
Fishing only	-	1	-
Boating	1	21	-
Skiing	-	6	-
Mining	-	4	1
Research/exploration	3	2	-
ACCESS			
Air:			
Airstrip	3	26	6
Floats/skis	2	34	6
ATV	1	20	5
4WD	1	16	1
Boat	3	3	1
Foot, dog team	6	37	9
Snowmachine	-	6	1
Horse	-	4	-
Rail	-	1	2
Car	-	1	2

TABLE 9.5: MAJOR TRAILS IN THE UPPER SUSITNA RIVER BASIN

Type	Beginning	Middle	End	Years Used
Cat, ORV	Gold Creek		Devil Canyon	1950's-present
Cat, ORV	Gold Creek	Ridge top west of VABM Clear	Confluence of John & Chunilna creeks	1961-present
Packhorse	Sherman		Confluence of John & Chunilna creeks	1948
Cat	Alaska Railroad, mile 232		Chunilna Creek	1957-present
Foot	Curry		Cabin 3 km east of VABM Dead	1926
Packhorse, foot	Talkeetna	North of Disappointment Creek	Stephan Lake	1948
Packhorse, old sled road	Chunilna	Portage Creek	Lake west of High Lake	1920's-present
ATV	Denali Highway	Butte Lake	Tsusena Lake	1950's-present

TABLE 9.6: PARCELS BY LAND STATUS/OWNERSHIP CATEGORY[a]

USGS Talkeetna Mountains Quad	Land Status/ Ownership Category	Location[b]	Areas Hectares	Areas Acres
C-1	Federal D-1	T29N,R12E SM	1,295	3,200
	Regional Selection	T29N,R10-12E SM	9,324	23,040
		T29-31N,R12E SM	4,921	12,160
		T30&31N,R11E SM	4,921	12,160
	State Selection Suspended	T29-31N,R10&11E SM	11,655	28,800
C-2	Regional Selection	T29-30N,R8-10E SM	20,979	51,840
	State Selection Suspended	T29-31N,R8-10E SM	35,094	86,719
	Private (Clarence Lake)	T30N,R9E SM Sections 19, 20, 21	5	12
C-3	Regional Selection	T29&30N,R5-8E SM	33,152	81,920
	Village Selection	T31N,R5E SM	404	998
	State Selection Suspended	T30-31N,R5-8E SM	22,921	56,639
	Private (Watana Lake)	T31N,R7E SM Sections 25 & 36	6	15
C-4	Regional Selection	T29&30N,R2-5E SM	33,152	81,280
	Village Selection	T30&31N,R2-5E SM	15,410	38,079
	State Selection Suspended	T30N,R3-5E SM	7,381	18,239
	Private (Stephan Lake)	T30N,R3E SM Sections 9, 16, 17, 20, 21	17	42
C-5	Regional Selection	T29&30N,R1W,1&2E SM	32,893	81,280
	Village Selection	T30&31N,R2E SM	1,942	4,799
	State Selection Suspended	T30&31N,R1W,1&2E SM	20,461	50,560
	Private	T29N,R2E SM Section 15	2	5
C-6	State Patented or TA'd	T31N,R2W SM	2,331	5,760
	Regional Selection	T29&30,R1&2W SM	12,302	30,399
	Native Group Selection	T30N,R2W SM	1,554	3,840
	State Selection Suspended	T29-31N,R1&2W SM	9,712	23,999
	Private (north of Chunilna Creek)	T30N,R2W SM Sections 23, 26	163	403
	(south of Gold Creek)	T31N,R2W SM Sections 29, 30	34	84
	Mining Claims	T29N,R2W SM Sections 2, 3, 10, 11, 15, 16	Unknown	

a. Status and ownership are subject to change through administrative and court proceedings.
b. Seward Meridian
c. TA'd - tentatively approved
d. Fairbanks Meridian

Source: Compiled from various sources, including Land Status Maps prepared by CIRI/H&N 1980 and 1981; Alaska Department of Natural Resouces, State Land Disposal Brochures 1979, 1980, 1981; U.S. Department of Interior, Bureau of Land Management Records, 1982.

USGS Talkeetna Mountains Quad	Land Status/ Ownership Category	Location	Areas Hectares	Acres
		(d)		
D-6	Federal (Railroad Withdrawal)	T22S,R11W FM		
		Sections 22, 23,		
		26, 27, 33, 34	803	1,984
		T33N, R2W SM		257
		Sections 15 - 17	104	180
	(near Chulitna)	T32N,R2W SM		25,600
		Sections 1, 2, 11	73	10,240
	Denali State Park	T31-33N,R2W SM	10,360	479
	State Selection	T32&33N,R2W SM	4,144	5,120
		T32&33N,R2W		
		Sections 6 & 31	194	479
		T22S,R11W FM	2,072	5,120
	State Patented or TA'd	T31N,R2W SM	3,885	9,600
		T22S,R10W FM	1,295	3,200
	Village Selection	T31&32N,R1W SM	3,108	7,680
	State Selection Suspended	T31N,R1W SM	907	2,241
		T33N,R1W SM	1,554	3,840
	Private (Indian River Remote)	T31&32N,R2W SM		
		Sections 2-4, 9, 10,		
		13, 24,25-27, 33-36	2,590	6,400
	(Indian River Sub Div.)	T33N,R2W SM	518	1,280
	(near Chulitna)	T32N,R2W SM		
		Sections 1, 2, 11, 12	150	371
	(near Gold Creek)	T31N,R2W SM		
		Sections 17, 19-21, 29,		
		30	388	959
	(Pass Creek)	T33N,R2W SM (sec. 27)	1	2
	(Summit Lake)	T33N,R2W SM (sec. 34)	2	5
	(Chulitna Pass)	T33N,R2W SM (sec. 35)	1	2
	(near Alaska RR)	T31N,R2W SM (sec. 9)	1	2
D-5	State Selection	T32&33N,R1W,1&2E SM	24,863	61,438
	State Selection TA'd	T22S,R8-10W FM	11,784	29,119
	Village Selection	T31-33N,RW,1&2E SM	8,547	21,120
	Tyonek	T31-33N,R1W,1&2E SM	3,755	9,279
	Knik	T31-32N,R1W,1&2E SM	7,252	17,920
	Chickaloon	T31&32N,R1W,1&2E SM	1,424	3,519
	State Selection Suspended	T31-33N,R1W,1&2E SM	13,079	32,319
	Private (High Lake)	T32N,R2E SM (sec. 20)	45	111
	(north of Devil Canyon)	T32N,R1E SM (sec. 16)	5	12
		T23N,R1E SM (sec. 30)	3	7
		T32N,R1W SM (sec. 9)	2	5
		T32N,R1W SM (sec. 10)	5	12
		T32N,R1W SM (sec. 23)	3	7
D-4	State Selection	T32&33N,R3-5E SM	38,461	95,039
	State Selection TA'd	T22S,R5-8W FM	11,914	29,440
	Village Selection	T31&32N,R3-5E SM	7,511	18,560
	Tyonek	T31&32N,R3-5E SM	2,978	7,359
	Knik	T31&32N,R3-5E SM	5,050	12,479

USGS Talkeetna Mountains Quad	Land Status/ Ownership Category	Location	Areas Hectares	Acres
	Chickaloon	T31N,R3E SM	78	193
	State Selection Suspended	T31N,R3E SM	4,921	12,160
	Private (Tsusena Butte Area)	T33N,R5E SM		
		Section 16, 21	20	49
D-3	State Selection	T32&33N,R5-7E SM	33,411	82,560
	State Patented or TA'd	T32N,R8E SM	1,295	3,200
		T33N,R8E SM	842	2,081
		T22S,R2-4W FM	8,806	21,760
		T22S,R5W FM	2,331	5,760
	Native Selection	T32N,R8E SM	1,036	2,560
	Village Selection	T31&32N,R5-7E SM	7,511	18,560
	Tyonek	T32N,R5&6E SM	1,683	4,159
	Knik	T31&32N,R5&6E SM	2,460	6,079
	State Selecton Suspended	T31N,R5-8E SM	11,396	28,160
	Private (Fog Lakes Area)	T31N,R5E SM		
		Sections 13 + 24	21	52
D-2	Federal D-1	T22S,R1E FM	259	640
		T22S,R2W FM	285	704
	BLM	T22S,R1&2W,1E FM	10,101	24,960
	State Patented or TA'd	T32N,R8E SM	1,813	4,480
		T22S,R2W FM	1,424	3,519
	Native Selection	T32&33N,R8-10E SM	39,109	96,640
	Village Selection	T31N,R8-10E SM	17,353	42,880
D-1	Federal D-1	T22S,R1-3E FM	7,770	19,200
		T33N,R11&12E SM	10,101	24,960
	Regional Selection	T22S,R1E FM	259	640
		T31&32N,R12E SM	13,727	33,920
		T32&33N,R10-12E SM	19,435	48,000
	Village Selection	T31N,R10-11E SM	7,252	17,920
	Fish & Wildlife Service	T33,R11E SM (sec. 20)	Unknown	
	State Selection Suspended	T31N,R10E SM	62	153

USGS Healy Quad	Land Status/ Ownership Category	Location	Areas Hectares	Acres
A-1	Federal D-1	T22S,R1&2E FM	2,460	6,079
	Regional Selection	T22S,R1&2E FM	1,554	3,840
	Historic Site (cemetery)	T22S,R1E FM (sec. 1+2)	Unknown	
A-2	Federal D-1	T22S,R1&2W,1E FM	5,309	13,119
	State Patented or TA'd	T22S,R1&2W,1E FM		
		Section 19-21, 28-33	2,331	5,760
		T22S,R2W FM	52	128
	Regional Selection	T22S,R1&2W,1E FM	5,698	14,080
	Private	T22S,R2W FM (sec. 3)	2	5
A-3	Federal D-1	T22S,R2-4W FM	9,842	24,320
	State Patented or TA'd	T22S,R2-4W FM	388	959
	Regional Selection	T225,R5W FM	2,409	5,953
A-4	State Patented or TA'd	T22S,R5-7W FM		
		Sections 19-36	4,662	11,520
	Regional Selection	T22S,R5-7W FM		
		Sections 1-18	4,662	11,520
A-5	State Patented or TA'd	T22S,R8-10W FM		
		Sections 19-36	4,662	11,520
	Regional Selection	T22S,R8-10W FM		
		Sections 1-18	4,662	11,520
A-6	Federal RR. Wdl.	T22S,R11W FM	932	2,303
	State Selection	T22S,R11W FM	4,014	9,919
	State Patented or TA'd	T22S,R10W FM	1,295	3,200
		T22S,R12&13W FM	6,475	16,000
	Private	T22S,R11W FM (sec. 1)	13	32

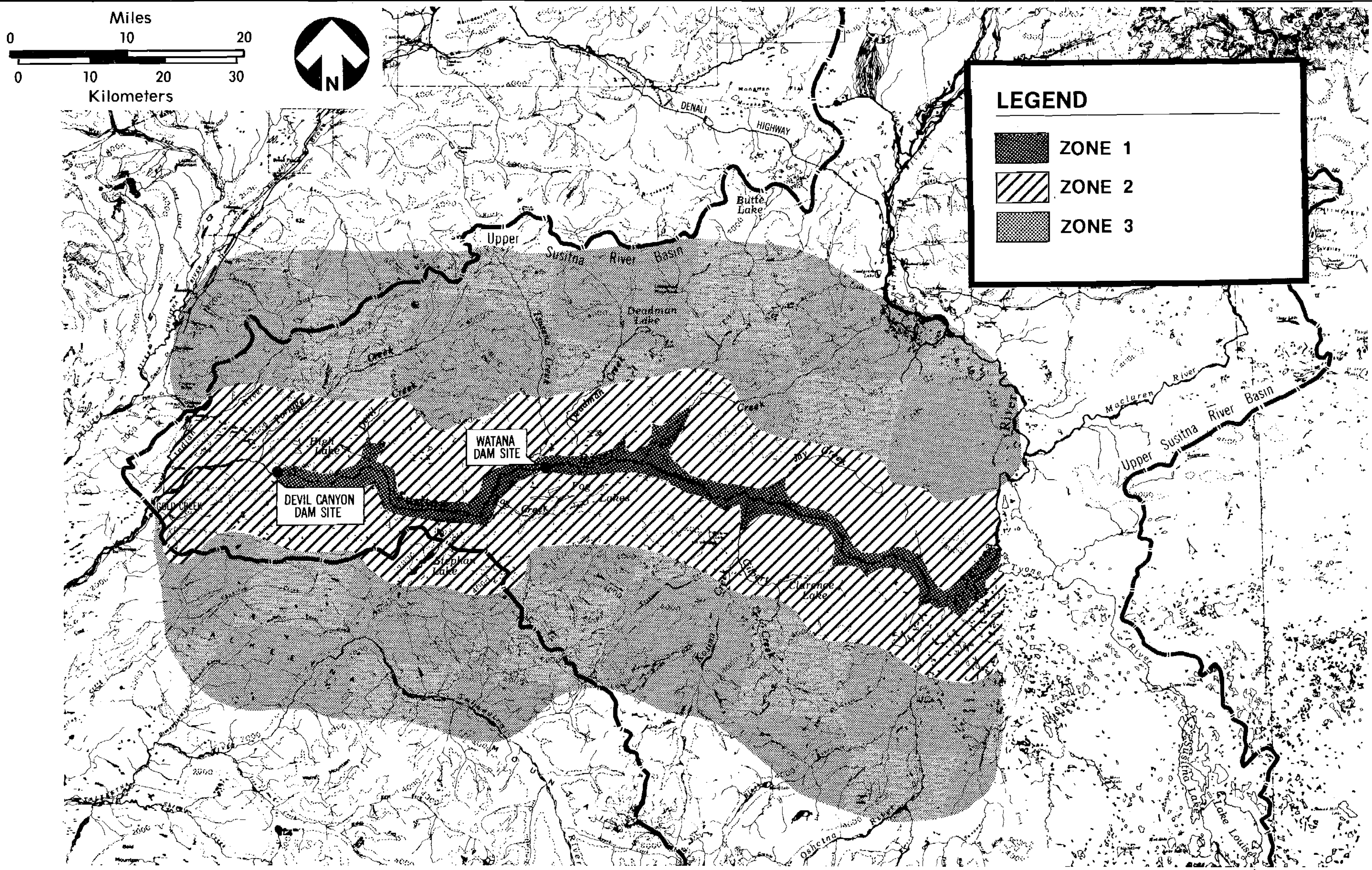
TABLE 9.7: SUMMARY OF LAND STATUS/OWNERSHIP IN PROJECT AREA[a]

Land Status/Ownership Category	Total Area Hectares	Acres
Federal D-1	37,321	92,222
Federal Railroad Withdrawal	1,912	4,725
Bureau of Land Management	10,101	24,960
State Selection	107,159	264,796
State Patented or Tentatively Approved (TA'd)	67,585	167,006
State Selection Suspended	139,143	343,830
Denali State Park (within study area)	10,360	25,500
Regional Selection	204,040	504,194
Native Group Selection	41,699	103,040
Village Selection	69,038	170,597
Tyonek	8,416	20,796
Knik	14,762	36,378
Chickaloon	1,502	3,712
Private	3,997	9,877

a. Summarized from Table 9.6.

TABLE 9.8: SUMMARY OF PRESENT AND FUTURE LAND MANAGEMENT ACTIVITIES IN THE PROPOSED SUSITNA HYDROELECTRIC PROJECT AREA

Land Management Agency	Current Management	Future Management Direction
U.S. Department of Interior Bureau of Land Management	Protection of natural environment; no activities other than fire control and the issuing of some special use permits. Land use planning being undertaken.	Future management will be guided by Southcentral Planning Area Management Framework Plan and an easement management plan.
Alaska Department of Natural Resources	Planning for the disposal of state lands that are immediately adjacent to the west side of the project area (north and south of Chulitna).	State will select lands in project area not selected by the natives. Management planning on these lands will not begin before 1983.
Alaska Power Authority	Performing hydroelectric development feasibility studies.	Dependent upon outcome of feasibility studies.
Matanuska-Susitna Borough	Borough has no lands in the project area. Project area does fall within the borough's boundaries and is part of the borough's Talkeetna Mountain Special Use District. Project area is a "mixed use" zone.	By Ordinance No. 79-35 creating the Talkeetna Mountains Special Use District, the borough can exercise planning and zoning authority over private lands within its boundaries; will commence further activities when hydro studies are completed.
Matanuska-Susitna Borough (in affiliation with the Federal Office of Coastal Zone Management and the Alaska Coastal Management Program)	Currently has designated the Susitna River to and including Devil Canyon as part of a biophysical area for the Coastal Zone Management Program.	Continuing CZM studies will determine any additional management direction.
Cook Inlet Region, Inc. and several villages	None; lands currently being transferred to individual villages.	Management planning not yet underway.

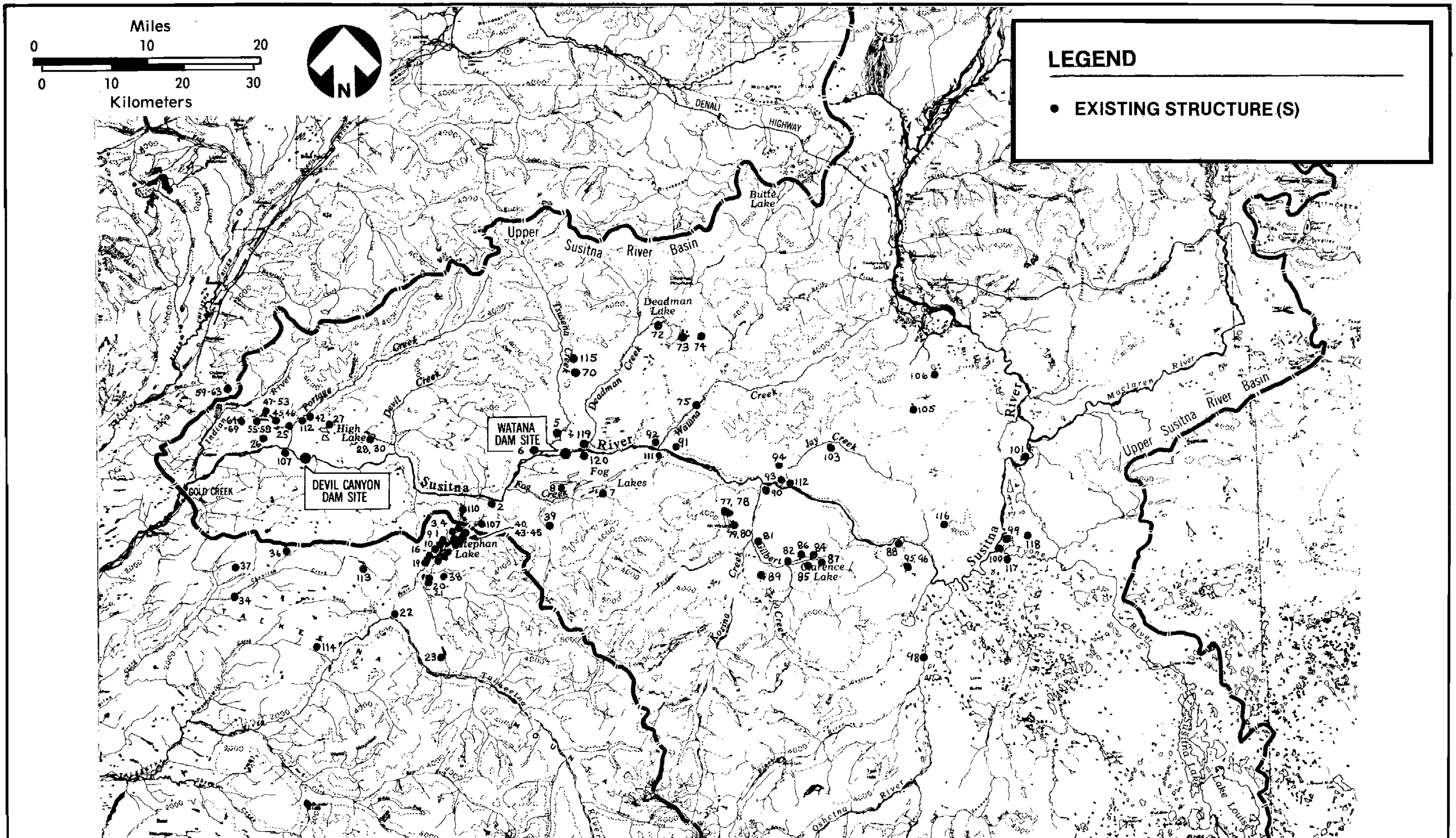


STUDY AREAS FOR LAND USE ANALYSIS

PREPARED BY TES

FIGURE 9.1

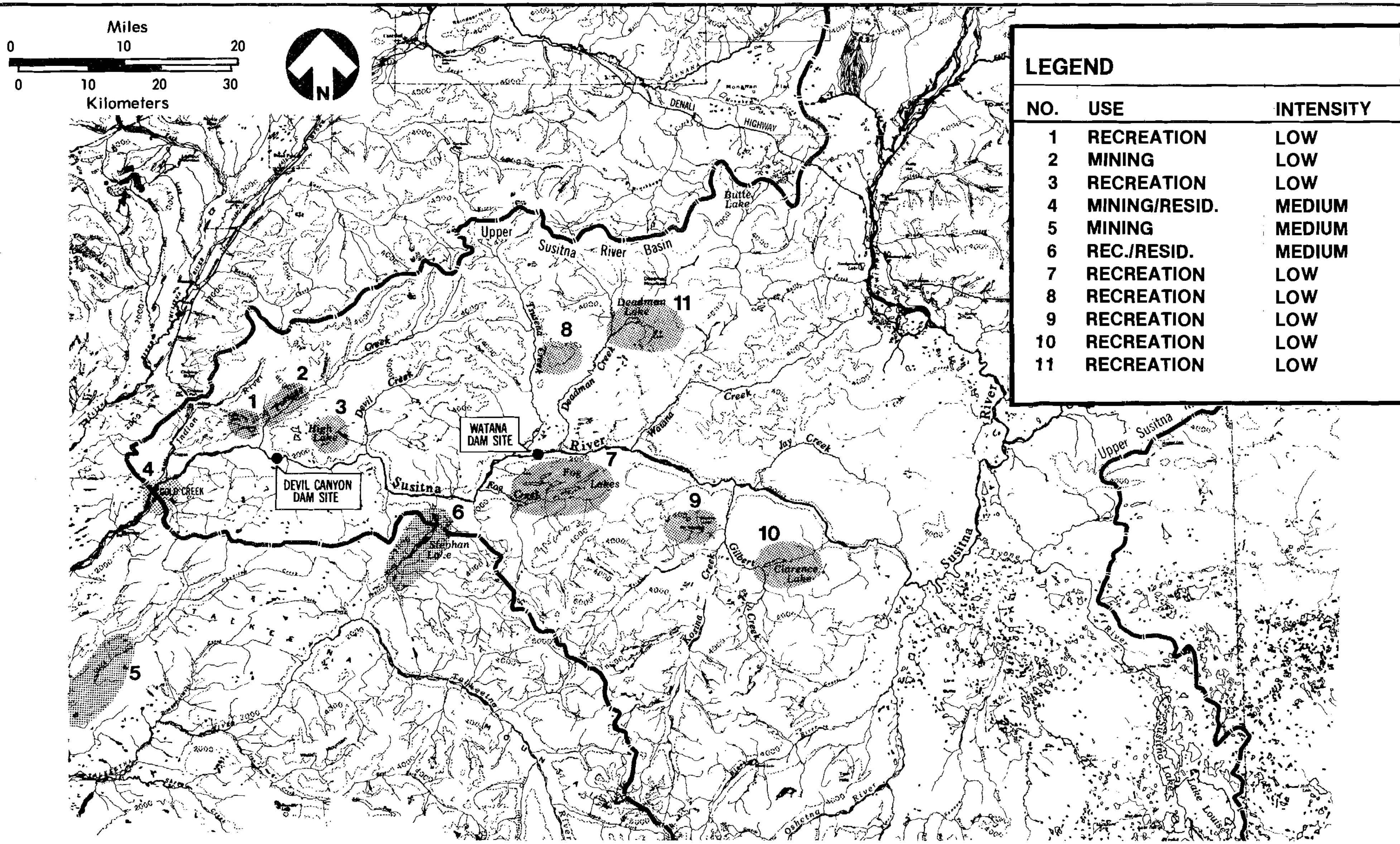
ACRES



EXISTING STRUCTURES

PREPARED BY TES

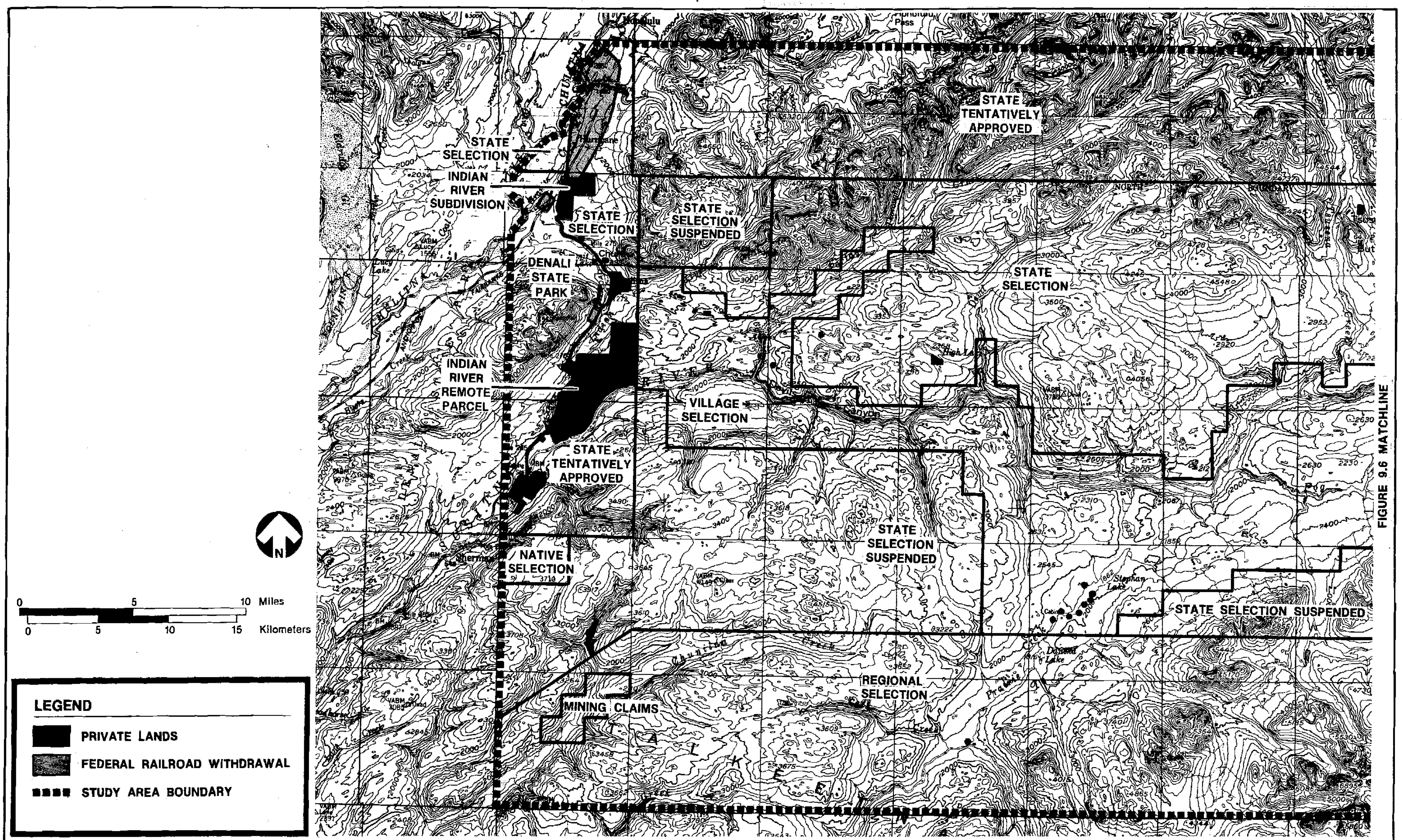
FIGURE 9.2



LAND USE AGGREGATIONS:
RECREATION, MINING, RESIDENTIAL

PREPARED BY TES

FIGURE 9.3

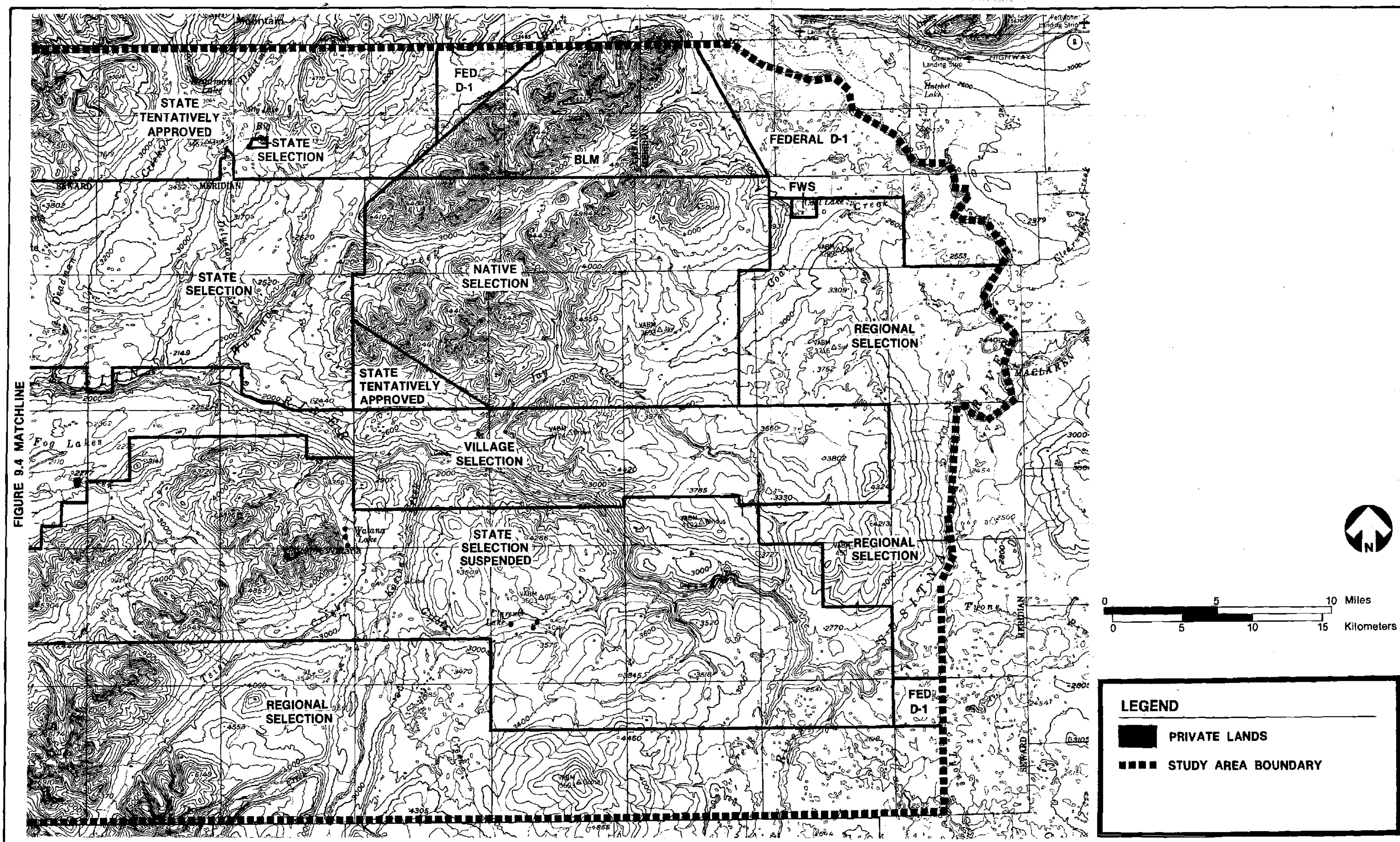


LAND OWNERSHIP/STEWARDSHIP, DEVIL CANYON PORTION

PREPARED BY TES

FIGURE 9.4

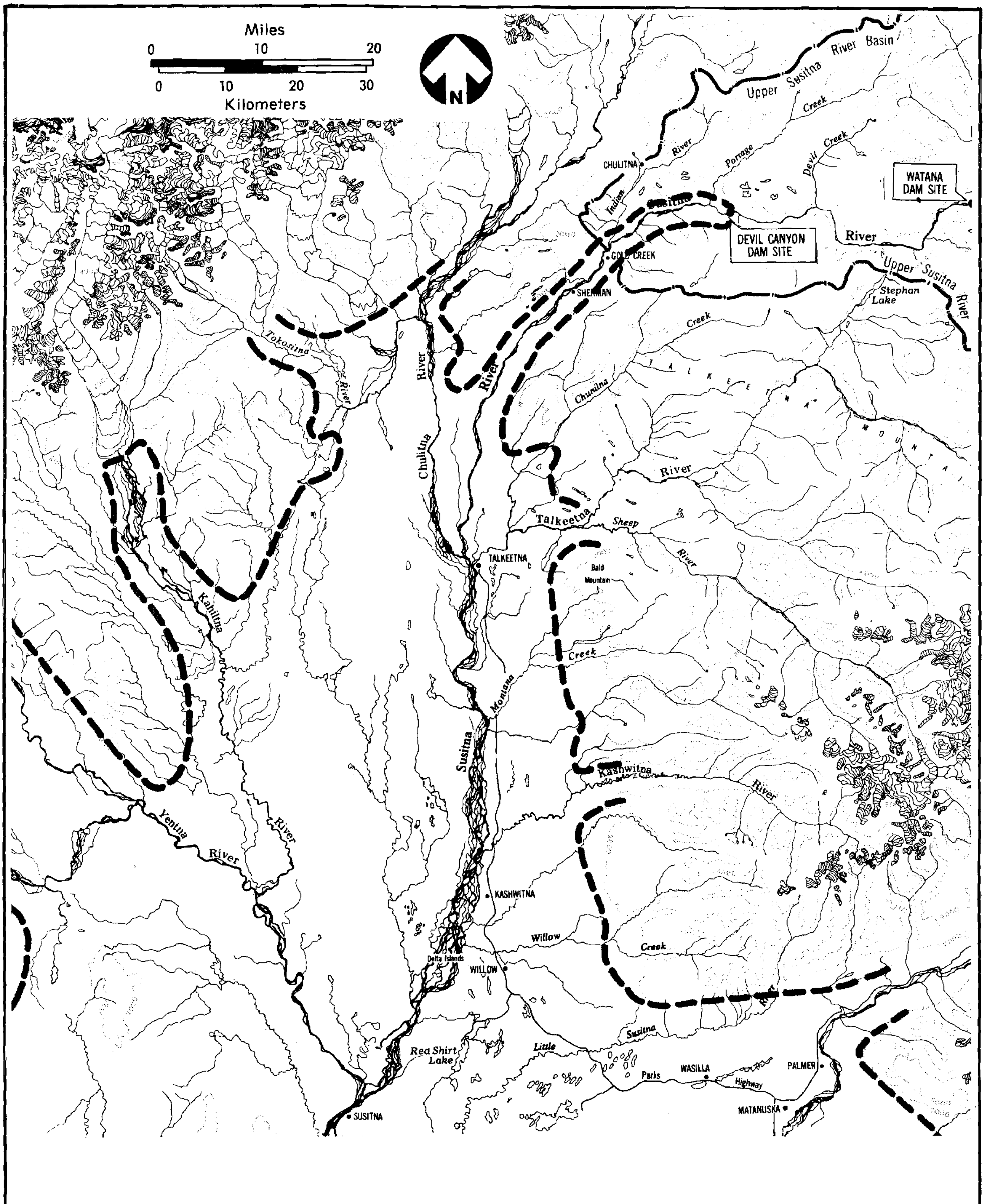
ACRES



LAND OWNERSHIP/STEWARDSHIP, WATANA PORTION

PREPARED BY TES

FIGURE 9.5

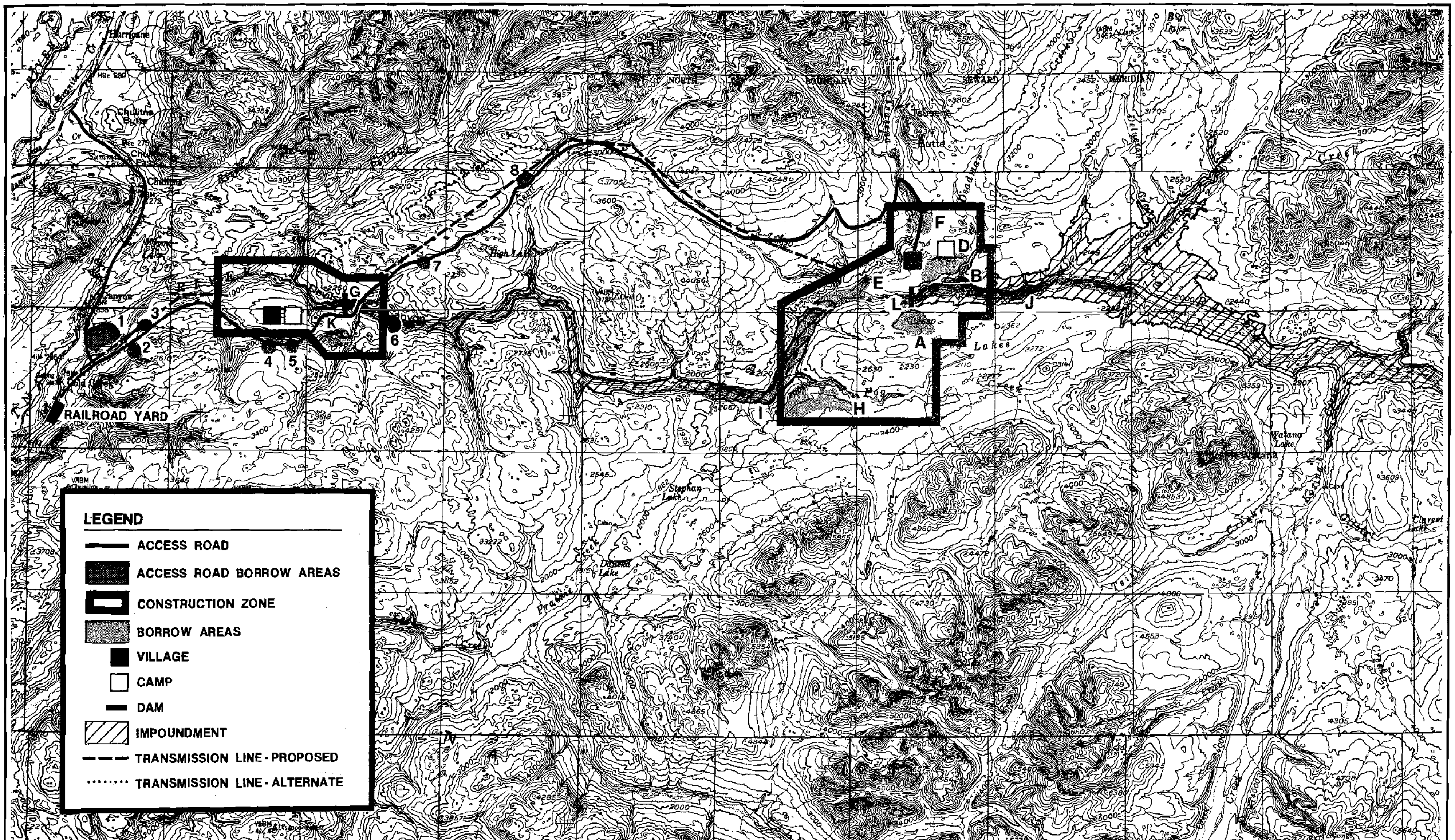


BIOPHYSICAL COASTAL BOUNDARY
MATANUSKA - SUSITNA BOROUGH
COASTAL MANAGEMENT PROGRAM

PREPARED BY TES

ACRES

FIGURE 9.6

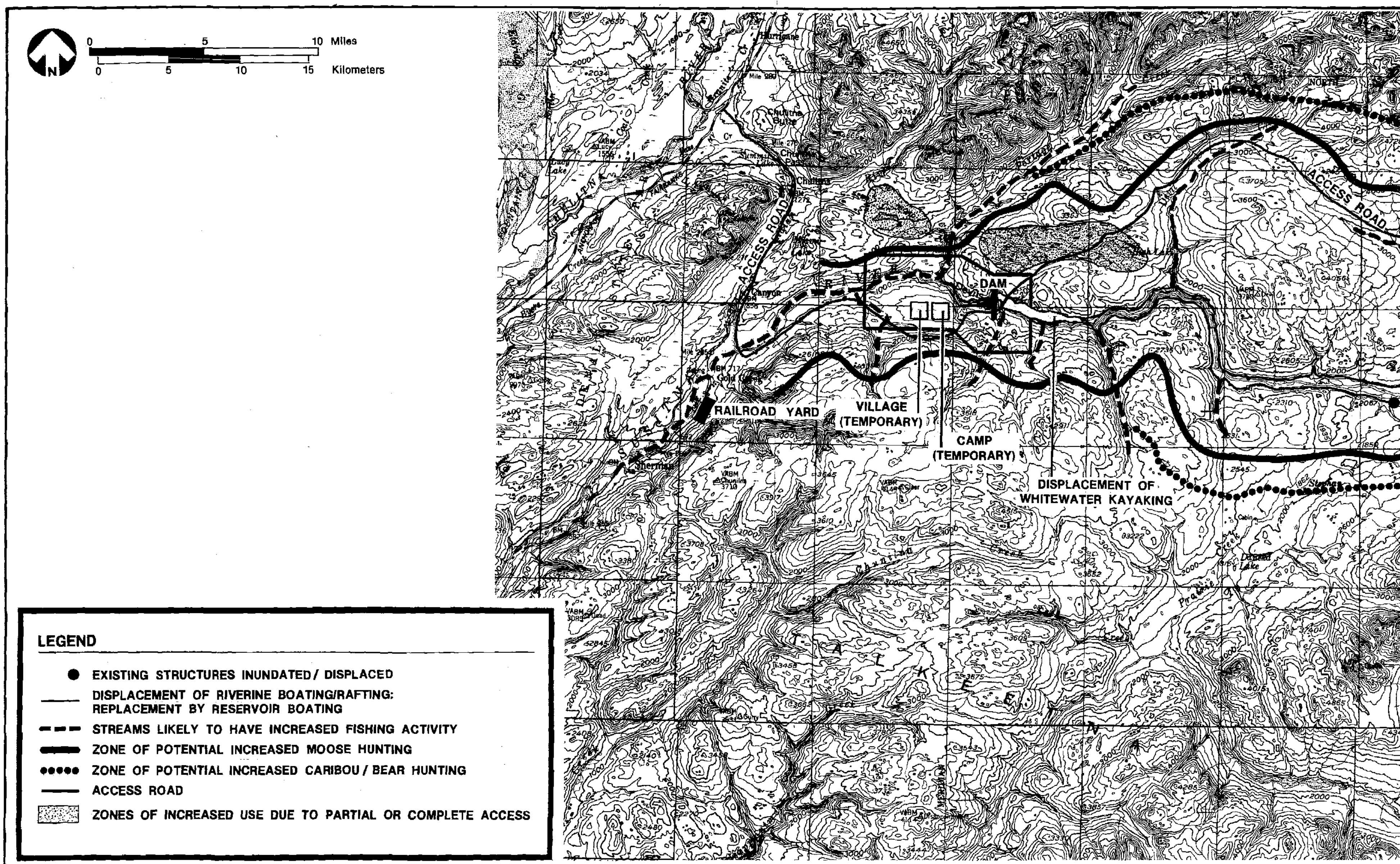


PROJECT FACILITIES

PREPARED BY TES

FIGURE 9.7

ACRES

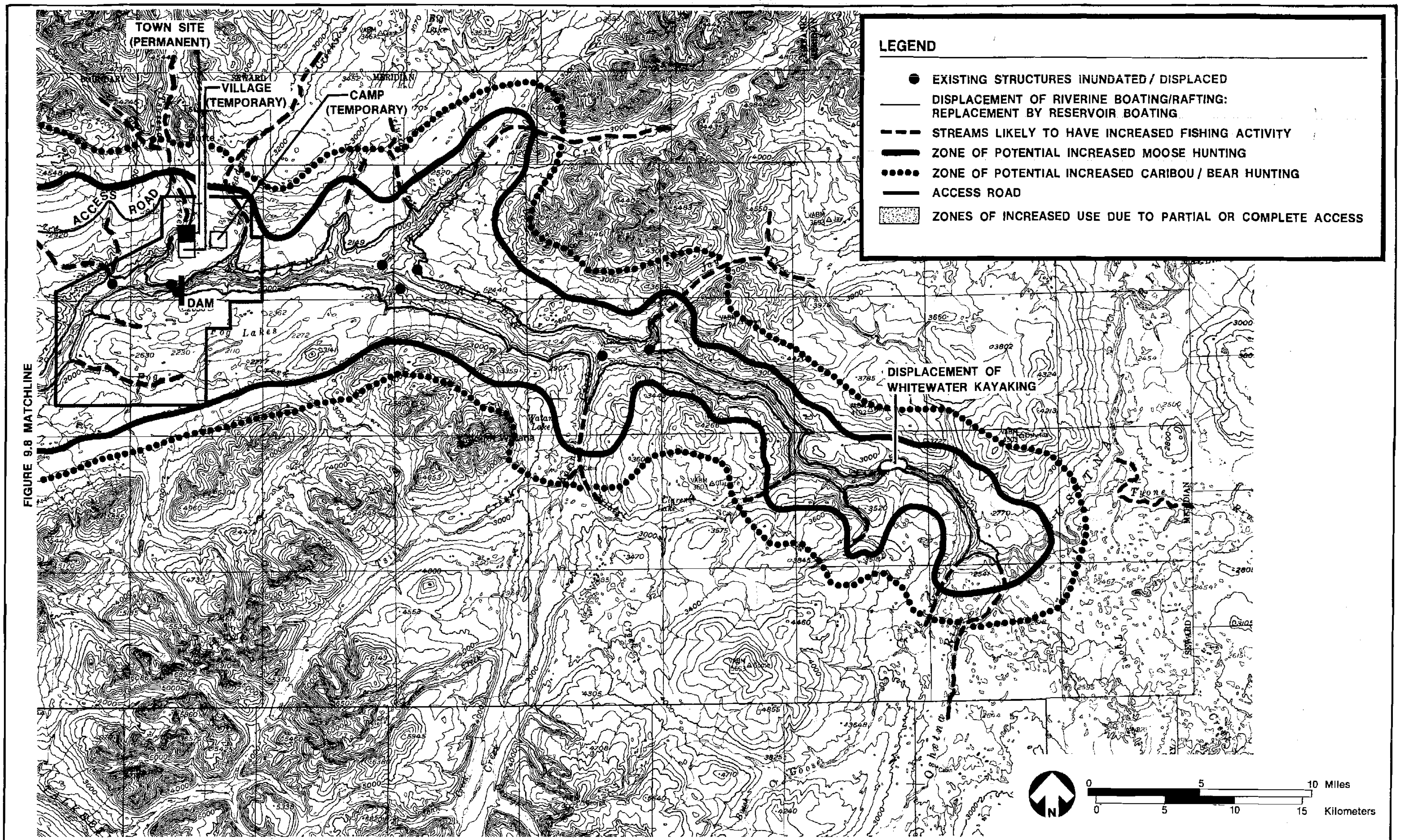


INDUCED LAND USE ACTIVITIES, DEVIL CANYON PORTION

PREPARED BY TES

FIGURE 9.8

ACRES



INDUCED LAND USE ACTIVITIES, WATANA PORTION

PREPARED BY TES

FIGURE 9.9

ACRES

10 - ALTERNATIVES TO THE SUSITNA PROJECT

This section presents the results of assessments of the environmental impacts of alternatives to the proposed Susitna Hydroelectric Project. Included in this assessment is a consideration of alternative hydroelectric generating sites outside the upper Susitna basin and alternative sites within the basin. An environmental analysis of these alternative sites is described.

An environmental assessment of two alternative methods of generation, coal-fired thermal and tidal, is also presented. Finally, a comparison of hydroelectric, thermal and tidal alternatives is presented in terms of differential environmental impact.

10.1 - Non-Susitna Hydroelectric Alternatives

The analysis of alternative sites for non-Susitna hydropower development followed the plan formulation and selection methodology discussed in Section 1.4 of Volume I. The material presented in this section is an expansion of that appearing in Section 6 of Volume I and contains additional environmental information.

Step 1 in the plan formulation and selection process was to define the overall objective of the exercise. For Step 2 of the process, all feasible sites were identified for inclusion in the subsequent screening process. The screening process (Step 3) eliminated those sites that did not meet the screening criteria and yielded candidates which could be refined to include in the formulation of Railbelt generation plans (Step 4).

Details of each of the above planning steps are given below and presented in Figure 10.1. The objective of the process was to determine the optimum Railbelt generation plan which incorporates the proposed non-Susitna hydroelectric alternatives.

(a) Screening of Candidate Sites

As discussed in Section 4, Volume 1, numerous studies of hydroelectric potential in Alaska have been undertaken. A significant amount of the identified potential is located in the Railbelt region. Review of the above studies and in particular the various published inventories of potential sites identified a total of 91 potential sites (Table 10.1). All of these sites are technically feasible and, under Step 2 of the planning process, were identified for inclusion in the subsequent screening exercise.

The screening process applied to these sites for this analysis required the application of four iterations with progressively more stringent criteria.

(i) First Iteration

As discussed in Section 6, Volume 1, the first screen or iteration determined which sites were not economically viable and rejected these sites. The standard for economic viability in this iteration was defined as energy production cost less than 50 mills per kWh, based on economic parameters. This value for energy production cost was considered to be a reasonable upper limit consistent with Susitna Basin alternatives for this phase of the selection process.

As a result of this screen, 26 sites were eliminated from the planning process (Table 10.1). The remaining 65 sites were subjected to a second iteration of screening which included additional criteria on environmental acceptability.

(ii) Second Iteration

The inclusion of environmental criteria into the planning process required a significant data survey to obtain information on the location of existing and published sources of environmental data. A detailed review of this data and the sources used are presented in Appendix C of the Development Selection Report.

The basic data collected identified two levels of detail of environmental screening. The purpose of the first level of screening was to eliminate those sites which were least acceptable from an environmental standpoint. Rejection of sites occurred if:

- They would cause significant impacts within the boundaries of an existing National Park, Wild and Scenic River, National Wilderness Area, or a proclaimed National Monument area;

- Or they were located on a river in which:

  - Anadromous fish are known to exist;

  - The annual passage of fish at the site exceeds 50,000; and

  - Upstream from the site, a confluence with a tributary occurs in which a major spawning or fishing area is located.

The definition of the above exclusion criteria was made only after a review of the possible impacts of hydropower development on the natural environment and the effects of land issues on particular site development.

Of the 65 sites remaining after the preliminary economic screening, 19 sites were eliminated on the basis of the requirements set for the second screen. These sites appear in Table 10.1, and the reason for their rejection in Table 10.2. The location of the remaining 46 sites appears in Figure 10.2.

(iii) Third Iteration

The reduction in the number of sites to 46 allowed a reasonable reassessment of the capital and energy production costs for each of the remaining sites to be made. Adjustments were made to take into account transmission line costs necessary to link each site to the proposed Anchorage-Fairbanks intertie. This iteration resulted in the rejection of 18 sites based on judgmental elimination of the more obvious uneconomic or less environmentally acceptable sites (Table 10.1). The remaining 28 sites were subjected to a fourth iteration which entailed a more detailed numerical environmental assessment.

(iv) Fourth Iteration

To facilitate analysis, the remaining 28 sites were categorized into sizes as follows:

- Less than 25 MW: 5 sites;
- 25 MW to 100 MW: 15 sites; and
- Greater than 100 MW: 8 sites.

The fourth and final screen was performed using a detailed numerical environmental assessment which considered eight criteria chosen to represent the sensitivity of the natural and human environments at each of the sites.

The eight evaluation criteria are listed in Table 10.3. For each of the evaluation criteria, a system of sensitivity scaling was used to rate the relative sensitivity of each site. A letter (A, B, C or D) was assigned to each site for each of the eight criteria to represent this sensitivity. The scale rating system is defined in Table 10.4.

Each evaluation criterion has a definitive significance to the Alaskan environment and degree of sensitivity to impact. A discussion of each criterion, and the reference maps used to obtain information on these criteria, is presented in Appendix C2 of the Development Selection Report. A summary of the evaluation and comparison of each site on the basis of these criteria is presented in the following paragraphs.

(b) Basis of Evaluation

The criteria were initially weighted in accordance with their relative significance in comparisons. The first four criteria--big game, agricultural potential, birds, and anadromous fisherieswere chosen to represent the most significant features of the natural environment. These resources require protection and careful management because of their position in the Alaskan environment, their roles in the existing patterns of life of the state residents, and their importance in the future growth and economic independence of the state. They were viewed as more important than the following four criteria because of their quantifiable and significant position in the lives of the Alaskan people.

The remaining four criteria--wilderness; cultural, recreation and scientific features; restricted land use; and access--were chosen to represent the institutional factors to be considered in determining any future land use. These are special features which have been identified or protected by governmental laws or programs and may have varying degrees of protected status; or the criteria represent existing land status which may be subject to change by the potential developments.

Data relating to each of these criteria were compiled separately and recorded for each site, forming a data-base matrix. Then, based on these data, a system of sensitivity scaling was developed to represent the relative sensitivity of each environmental resource (by criterion) at each site. A detailed explanation of the scale rating may be found in Table 10.5.

The scale ratings for the criteria at each site were recorded in the evaluation matrix. Site evaluations of the 28 sites under consideration are given in Table 10.6. Preliminary data regarding technical factors were also recorded for each potential development. Parameters included installed capacity, development type (dam or diversion), dam height, and new land flooded by impoundment. The complete evaluation matrix may be found in Table 10.7.

In this manner, the environmental data were reduced to a form from which a relative comparison of sites could be made. The comparison was carried out by means of a ranking process.

(c) Rank Weighting and Scoring

For the purpose of evaluating the environmental criteria, the following relative weights were assigned to the criteria. A higher value indicates greater importance or sensitivity than a lower value.

Big Game	8
Agricultural Potential	7
Birds	8
Anadromous Fisheries	10
Wilderness Values	4
Cultural Values	4
Land Use	5
Access	4

The criteria weights for the first four criteria were then adjusted down, depending on related technical factors of the development scheme.

All the sites were ranked in terms of their dam heights which were assumed to be the factor having the greatest impact on anadromous fisheries.

Sites were also ranked in terms of their new reservoir area, or the amount of new land flooded, which was considered to be the one factor with greatest impact on agriculture, bird habitat, and big game habitat. The same adjustments were made for the big game, agricultural potentials, and bird habitat weights based on this flooded area impact (see Table 10.8).

The scale indicators were also given a weighted value as follows:

- B = 5
- C = 3
- D = 1

To compute the ranking score, the scale weights were multiplied by the adjusted criteria weights for each criteria and the resulting products were added.

Two scores were then computed. The total score is the sum of all eight criteria. The partial score is the sum of the first four criteria only, which gives an indication of the relative importance of the existing natural resources in comparison to the total score.

(d) Evaluation Results

The evaluation of sites took place in the following manner: sites were first divided into three groups in terms of their capacity.

Based on the economics, the best sites were chosen and environmentally evaluated as described above. Table 10.9 lists the number of sites evaluated in each of the capacity groups in ascending order according to their total scores for each of the groups. The partial score was also compared. The sites were then grouped as better, acceptable, questionable, or unacceptable, based on the scores.

The partial and total scores for each of the sites, grouped according to capacity, appear in Table 10.10.

Sixteen sites were chosen for further consideration. Three constraints were used to identify these 16 sites. First, the most economical sites which had passed the environmental screening were chosen. Second, sites with a very good environmental impact rating which had passed the economic screening were chosen. And finally, a representative number of sites in each capacity group were to be chosen (Table 10.11).

From the list of 16 sites, 10 were selected for detailed development and cost estimates required as input to the generation planning. The ten sites chosen are underlined in Table 10.1.

Further discussion of the basis of selection of these 10 sites is presented in Appendix C2 of the Development Selection Report.

(e) Plan Formulation and Evaluation

Steps 4 and 5 in the planning process was the formulation of the preferred sites identified in Step 3 into Railbelt generation scenarios. To adequately formulate these scenarios, the engineering, energy, and environmental aspects of the ten short-listed sites were further refined (Step 4).

This resulted in formulation of the ten sites into five development plans incorporating various combinations of these sites as input to the Step 5 evaluations. The five development plans are given in Table 10.12.

The essential objective of Step 5 was established as the derivation of the optimum plan for the future Railbelt generation, incorporating non-Susitna hydro generation as well as required thermal generation. The methodology used in the evaluation of alternative generation scenarios for the Railbelt is discussed in detail in Section 8 of Volume I. The criterion on which the preferred plan was finally selected in these activities was least present-worth cost based on economic parameters established in Section 8, Volume I.

The selected potential non-Susitna hydro developments (Table 10.13) were ranked in terms of their economic cost of energy. These developments were then introduced into the all-thermal generating scenario in groups of two or three. The most economic schemes were introduced first followed by the less economic schemes.

On the basis of these evaluations, the most viable alternative to the Susitna project was found to be the development of the Chakachamna, Keetna, and Snow sites for hydroelectric power, supplemented with a thermal generating facility. The potential environmental impacts of hydroelectric development at these sites are discussed below; discussion of the environmental effects of thermal development is in Section 10.4.

10.2 - Environmental Assessment of Selected Alternative Sites

The analysis of alternative development scenarios outside the upper Susitna Basin showed Chakachamna, Snow and Keetna hydroelectric sites offer the most suitable schemes for development. Because maximum total power production from these three sites would be only 650 MW, additional thermal and tidal development would also be required. The potential environmental impacts of hydroelectric development at these three sites are discussed below; coal-fired thermal and tidal power are discussed in Sections 10.4 and 10.5.

The Chakachanmna area has been studied previously for hydroelectric development and is currently under study by the Power Authority. As such, fairly detailed information is available. Keetna and Snow, however, have not been intensively studied and information is limited primarily to non-specific inventory data and resource maps.

(a) Description of Chakachamna Site

Chakachamna Lake is located in the Alaska range approximately 80 miles west of Anchorage. The lake is drained by the Chakachatna River which runs southeasterly out of the lake and eventually into Cook Inlet. Three primary methods have been explored as a way to produce power at the site; one via construction of a dam on the Chakachatna River, one via diversion of water from the lake utilizing a tunnel into the MacArthur River, and one via diversion down the Chakachatna Valley. Transmission lines would run from the site to a location near the Chugach Electric Association (CEA) Beluga power plant and would then parallel existing lines to a submarine crossing of Knik Arm and then to a terminal on the eastern shore (Bechtel Civil and Minerals, Inc., 1981).

(i) Topography and Geology

Chakachamna Lake is located in a deep valley of the Alaska range surrounded by glaciers and high mountains. From an elevation of approximately 1200, land elevation drops fairly rapidly to sea level within 40 miles. In lower elevations, drainage is poor with numerous wetlands present.

Lake Chakachamna was formed by the Barrier Glacier and associated morainal deposits descending from the south side of Mount Spurr. The area is underlain by semi-consolidated volcanic debris of late Tertiary or Quaternary age and, closer to Cook Inlet, by alluvial and tidal sand, silt, and gravel of Holocene age (Cook Inlet Region, Inc, and Placer

Amex, Inc., 1981). Past movement by glaciers has resulted in scattered boulders and glacially scattered till. Chakachamna Lake, the south side of the Chakachatna River Valley, and the MacArthur River Canyon are bordered by granitic bedrock. The north side of the Chakachatna River Valley is bordered by volcanic bedrock.

(ii) Surface Hydrology

Chakachamna Lake is approximately 13 miles in length and is 1.5 to 3.0 miles wide. Inflow to the lake is primarily glacial in origin and consists of the Nagishlamina and Chilligan Rivers entering from the north (U.S. Fish and Wildlife Service 1962).

The Chakachatna River originates at the outlet of Chakachamna Lake and flows easterly approximately 15 miles through a canyon and then through lowland areas to Cook Inlet. Mean annual discharge at its origin is 3645 cfs with a range from 441 cfs in April to 12,000 cfs in July; average annual stream flow at the reservoir site is estimated at 2.5 million acre feet (Bechtel Civil and Minerals, Inc., 1981). The total length is 36 miles and the total drainage area is 1,620 square miles.

The MacArthur River originates from the MacArthur glacier and is also fed by the Blockade glacier. The river is later joined by waters from Noaukta Slough, which carry water from the Chakachatna River. The MacArthur River continues to the confluence with the Chakachatna and then empties into Trading Bay.

(iii) Terrestrial Ecology

Vegetation in the project area varies with elevation and moisture conditions. The major community types present include spruce forest, bogs, and willow thickets. Dominant species present include paper birch, black cottonwood, alder, bog blueberry, and willow (Bechtel Civil and Minerals, Inc., 1981).

Big game species utilizing the area include moose, caribou, black bear, and grizzly bear. Other species present include wolverine, mink, and various small mammals (Bechtel Civil and Minerals, Inc., 1981).

Birds present in the area are typical for the area of Alaska, with peak numbers and species occurring during the spring and fall migration periods. Goldeneyes were observed nesting in the area in 1960 with other waterfowl species present during migration, including redheads, greenwinged teal and mallards; bald eagles and trumpeter swans are known to nest in the area primarily near Cook Inlet (Bechtel Civil and Minerals, Inc., 1981).

(iv) Aquatic Ecology

The water of the tributaries to Chakachamna Lake, the lake itself and the Chakachatna and MacArthur Rivers provide a variety of water temperatures, water quality and substrate, resulting in various types of aquatic habitats.

Chakachamna Lake contains populations of lake trout, Dolly Varden, whitefish and sculpins (U.S. Fish and Wildlife Service, 1962). More importantly, sockeye salmon migrate up the Chakachatna River and spawn within Chakachamna Lake. Although the lake is not heavily utilized by sport fishermen, these spawning salmon contribute to the commercial fisheries of Cook Inlet.

The Chakachatna River is utilized by a wider variety of fish species. The upper reaches are characterized by boulders and swift currents and do not appear to be a spawning area. This reach is utilized by the anadramous fish that spawn in Chakachamna Lake (Bechtel Civil and Minerals, Inc., 1981). Sockeye salmon, chum salmon and pink salmon spawn in the river while chinook and coho salmon and Dolly Varden are known to occur.

The MacArthur River supports a fishery similar to that of the Chakachatna (Alaska Power Administration 1980). Dolly Varden are present with chinook, coho, pink, sockeye, and chum salmon present as spawners in the side channels. Pygmy whitefish occur further downstream (Bechtel Civil and Minerals, Inc., 1981).

(v) Cultural Resources

The Alaska Heritage Resource Survey File maintained by the State Historic Preservation Office lists no sites present in the Chakachamna project area. The area has not been thorougly studied and further investigations would be necessary should the project proceed.

(vi) Socioeconomics

The Chakachamna project is located in a sparsely populated area of the Kenai Peninsula Borough. The only community in the vicinity of the project area is the native village of

Tyonek, population 239. Commercial fishing and subsistence activities are the major sources of income with some employment provided by timber harvesting, gas and oil exploration activities and government.

Housing consists primarily of prefabricated structures. One school serves grades K through 12, with a current enrollment of 146. Police protection is provided by the Alaskan State Troopers, headed by a resident constable. Fire protection is provided by the U.S. Bureau of Land Management. Medical services are available in a medical center located in the village. Water is supplied from a nearby lake and wastewater disposed via septic systems.

Transportation is limited to gravel surface roads and small airstrips.

The Kenai Borough and City of Anchorage would likely contribute to the work force for the project. The work force in the Borough is 12,300, with 9.8 percent unemployed; Anchorage has a work force of 91,671, with 6.9 percent unemployment (Bechtel Civil and Minerals, Inc., 1981).

(b) Description of Snow Site

The Snow site is located on the Snow River in the Kenai Peninsula (Figure 10.2). Power development would include a dam with diversion through a tunnel approximately 7,500 to 10,000 feet in length. A transmission line would extend from the site northward for nine miles to Kenai Lake and then northwesterly for 16 miles to tie in with existing lines.

The Snow River at the proposed damsite flows in a deep narrow gorge cut into bedrock on the floor of a glacial valley. Graywacke and slate are exposed and this overburden is evident (U.S. Department of Energy 1980). The river flows west and north into the south end of the Kenai Lake. The average annual streamflow at the damsite is estimated at 510,000 to 535,000 cfs. The damsite would be fed by 105 square miles of the river's 166 square mile drainage area (U.S. Department of Energy 1980; U.S. Army Corps of Engineers).

Vegetation in the area is primarily a hemlock-spruce forest. Black bear, wolf and dall sheep are known to occur in the area, and a moose concentration area is present (Cook Inlet Region 1981). Waterfowl utilize the area both for nesting and molting.

No anadromous fish are known to occur in the Snow River, but sockeye and coho salmon are present in the drainage. Rainbow trout and whitefish also occur in Kenai Lake.

Reports consulted listed no known cultural resource sites in the Snow area.

The Snow site is located in the Railbelt region of Alaska, as discussed in Section 5 of this volume. Socioeconomic conditions relative to the Snow site are also discussed in Section 5.

(c) Description of Keetna Site

The Keetna site is located on the Talkeetna River, approximately 70 miles north of Anchorage (Figure 10.2). Power development would include a dam with a diversion tunnel.

The Talkeetna River, with headwaters in the Talkeetna mountains, flows southwesterly to its confluence with the Susitna River. The damsite has a drainage area of 1,260 square miles; stream flow records indicate discharge at the site to be 1,690,000 acre feet (U.S. Department of Energy 1980).

Vegetation on the lower elevations of the valley are primarily upland spruce-hardwood forest. The upper elevations have little vegetation. Black bear and brown bear are present and the area is a known moose concentration area. A caribou winter range is nearby.

Four species of anadramous fish are present in the area (chinook, sockeye, coho, and chum salmon). The chinook salmon is known to spawn in tributaries upstream of the proposed site.

Reports consulted listed no known cultural resources at the site.

(d) Environmental Impacts of Selected Alternatives

Most environmental impacts at the Chakachamna, Snow and Keetna sites would be those that typically occur with hydroelectric development. Vegetation and wildlife habitat would be lost, resulting in a reduction in carrying capacity and wildlife populations at the site. Based on the availability of habitat in surrounding areas, this would likely not be a major impact. Reductions in fish populations (as discussed below) would reduce the food source for bears, eagles, and other fish-eating wildlife; this could affect local populations. Creation of a reservoir at the Snow and Keetna sites would provide a different habitat type and benefit such species groups as waterfowl and furbearers.

Any archaeological or historic sites in the reservoir areas would be flooded. On-ground surveys, salvage operations and protection of areas outside the reservoir but within the construction area, would mitigate most of these potential impacts.

The Keetna reservoir would inundate two scenic areas; Sentinel Rock and Granite Gorge.

Socioeconomic impacts would be similar at each site. It is expected there would be an increase in population in the towns near the site and associated increase in demand for housing, schools and other services. Because all three sites are located within 100 miles of Anchorage, it is expected much of the labor force would be drawn from this area where an adequate work force is present. Construction camps would likely be erected to house workers, thereby reducing demand on surrounding towns. Socioeconomic impacts for the Chakachamna site would be similar to those described in Section 10.3 for thermal development but of lesser magnitude.

The greatest potential impact of these developments is to the fisheries resources, particularly at the Chakachamna site. Creation of the reservoir at the Keetna and Snow sites would flood river areas, thereby reducing this type of habitat. At the Keetna site, spawning areas may be affected and upstream migration of the anadromous salmon also curtailed, unless fish ladders are constructed and adequate downstream flows maintained. At this time, the detailed studies necessary to determine adequate flows for power generation and fishery maintenance have not been conducted.

Power development at the Chakachamna site has the potential to negatively impact anadromous fish. This impact would result from decreased flowing or dewatering from the upper portions of the Chakachatna River, removal of access to Chakachamna Lake, alterations in water quality, loss of downstream migrating fingerlings, loss of spawning habitat, decrease in the food base. All of these impacts, if large enough, could impact the commercial fisheries of Cook Inlet; the magnitude of these impacts would depend upon the design and operating scheme to produce power.

If a dam was constructed on Chakachatna River, Chakachamna Lake and its tributary streams would be inaccessible to anadromous fish. Unless fish ladders were constructed, this would eliminate the anadromous fish populations in Chakachamna Lake. In addition, losses of downstream migrating fingerlings would occur unless an effective design in the dam's construction could be developed to allow them to pass safely downstream.

If diversion into the MacArthur River via tunnels is used, increased flows could result in changes in water quality and temperature, perhaps affecting the ability of anadromous fish to migrate upstream to the spawning areas. For maximum power production, no water would be released into the upper reaches of the Chakachatna River, thereby eliminating the anadromous fish populations in the lake and lake tributaries. If fishery flows were maintained, this severe impact would not occur, provided fish passage facilities were provided at the lake outlet.

If lake water is diverted into the Chakachatna River, there will be no impact to the MacArthur River ecosystem. Above the powerhouse and below the lake, impacts to the fishery will depend on the level of flows maintained and the installation of fish passage facilities. Again, if maximum flows are utilized for power production, anadromous fish populations in the lake and tributaries would also be lost. If flows were maintained in the Chakachatna River and fish passage facilities were provided, impacts would be substantially reduced.

10.3 - Upper Susitna Basin Hydroelectric Alternatives

A second feature of the alternatives analysis involved the consideration of alternative sites within the Upper Susitna Basin. This process involved consideration of technical, economical, environmental, and social aspects.

This section describes the environmental consideration involved in the selection of Devil Canyon/Watana sites as the preferred sites within the Upper Susitna Basin and also presents a brief comparison of the environmental impacts associated with alternatives that proved economically feasible. This section concentrates on the environmental aspects of the selection process. Details of the technical and economic aspects of this evaluation are discussed in Section 8 of Volume I, and also in Section 8 of the Development Selection Report.

The objectives of the selection process were to determine the optimum Susitna Basin Development Plan and to conduct a preliminary environmental assessment of the alternatives in order to compare those judged economically feasible. The selection process followed the Generic Plan Formulation and Selection Methodology described in Section 1.4 of Volume I. Damsites were identified following the objectives described above. These sites were then screened and assessed through a sequential "narrowing down" process to arrive at a recommended plan (Figure 10.4).

(a) Damsite Selection

In the previous Susitna Basin studies discussed in Section 4 (Volume I), 12 damsites were identified in the upper portion of the basin, i.e., upstream from Gold Creek (see Figure 10.5). These sites are listed below:

- Gold Creek
- Olson (alternative name: Susitna II)
- Devil Canyon
- High Devil Canyon (alternative name: Susitna I)

- Devil Creek
- Watana
- Susitna III
- Vee
- Maclaren
- Denali
- Butte Creek
- Tyone

Longitudinal profiles of the Susitna River and probable typical reservoir levels associated with the selected sites were prepared to depict which sites were mutually exclusive, i.e., those which cannot be developed jointly since the downstream site would inundate the upstream site. All relevant data concerning dam type, capital cost, power, and energy output were asssembled as discussed in Section 8 of Volume 1. Results appear in Table 10.14.

(b) Site Screening

The objective of this screening exercise was to eliminate sites which would obviously not feature in the initial stages of a Susitna Basin development plan and which, therefore, do not require any further study at this stage. Three basic screening criteria are used; these include environmental, alternative sites, and energy contribution.

(i) Environmental Screening Criteria

The potential impact on the environment of a reservoir located at each of the sites was assessed and catagorized as being relatively unacceptable, significant, or moderate.

- Unacceptable Sites

Sites in this category are classified as unacceptable because either their impact on the environment would be extremely severe or there are obviously better alternatives available. Under the current circumstances, it is expected that it would not be possible to obtain the necessary agency approval, permits, and licenses to develop these sites.

The Gold Creek and Olson sites both fall into this category. As salmon are known to migrate up Portage Creek, a development at either of these sites would obstruct this migration and inundate spawning grounds. Available information indicates that salmon do not migrate through Devil Canyon to the river reaches beyond because of the steep fall and high flow velocities.

Development of the mid-reaches of the Tyone River would result in the inundation of sensitive big game and waterfowl areas, provide access to a large expanse of wilderness area, and contribute only a small amount of storage and energy to any Susitna development. Since more acceptable alternatives are obviously available, the Tyone site is also considered unacceptable.

- Sites With Significant Impact

Between Devil Canyon and the Oshetna River, the Susitna River is confined to a relatively steep river valley. Upstream from the Oshetna River the surrounding topography flattens, and any development in this area has the potential of flooding large areas even for relatively low dams. Since the Denali Highway is relatively close by, this area is not as isolated as the Upper Tyone River Basin. It is still very sensitive in terms of potential impact on big game and waterfowl. The sites at Butte Creek, Denali, Maclaren, and, to a lesser extent, Vee fit into this category.

- Sites With Moderate Impact

Sites between Devil Canyon and the Oshetna River have a lower potential environmental impact. These sites include the Devil Canyon, High Devil Canyon, Devil Creek, Watana and Susitna sites, and, to a lesser extent, the Vee site.

(ii) Alternative Sites

Sites which are close to each other and can be regarded as alternative dam locations can be treated as one site for project definition study purposes. The two sites which fall into this category are Devil Creek, which can be regarded as an alternative to the High Devil Canyon site, and Butte Creek, which is an alternative to the Denali site.

(iii) Energy Contribution

The total Susitna Basin potential has been assessed at 6,700 GWh. As discussed in Section 5, Volume I, additional future energy requirements for the period 1982 to 2010 are forecast to range from 2,400 to 13,500 GWh. It was therefore decided to limit the minimum size of any power development in the Susitna Basin to an average annual energy production in the range of 500 to 1,000 GWh. The upstream sites such as Maclaren, Denali, Butte Creek, and Tyone do not meet this minimum energy generation criterion.

(iv) Screening Process

The screening process involved eliminating all sites falling in the unacceptable environmental impact and alternative site categories. Those failing to meet the energy contribution criteria were also eliminated unless they had some potential for upstream regulation. The results of this process are as follows:

- The unacceptable site environmental category eliminated the Gold Creek, Olson, and Tyone sites.
- The alternative sites category eliminated the Devil Creek and Butte Creek sites.
- No additional sites were eliminated for failing to meet the energy contribution criteria. The remaining sites upstream from Vee, i.e., Maclaren and Denali, were retained to insure that further study be directed toward determining the need and viability of providing flow regulation in the headwaters of the Susitna.

(c) Formulation of Susitna Basin Development Plans

In order to obtain a more uniform and reliable data base for studying the seven sites remaining, it was necessary to develop engineering layouts for these sites and re-evaluate the costs. In addition, it was also necessary to study staged developments at several of the larger dams. The results of these are described in Sections 8, 10, and 11 of Volume I. These layouts were then used to assess the sites and plans from an environmental perspective.

The results of the site-screening exercise described in Section (10.3(a)) above indicate that the Susitna Basin Development Plan should incorporate a combination of several major dams and powerhouses located at one or more of the following sites:

- Devil Canyon,
- High Devil Canyon,
- Watana,
- Susitna III,
- Vee.

In addition, the following two sites should be considered as candidates for supplementary upstream flow regulation:

- MacLaren,
- Denali.

To establish very quickly the likely optimum combination of dams, a computer screening model was used to directly identify the types of plans that are most economic. Results of these runs indicate that the Devil Canyon/Watana or the High Devil Canyon/Vee combinations are the most economic. In addition to these two basic development plans, a tunnel scheme, which provides potential environmental advantages by replacing the Devil Canyon dam with a long power tunnel, and a development plan involving the two most economic damsites, High Devil Canyon and Watana, were also introduced. These studies are described in more detail in Section 8 of Volume 1 and in Table 10.15.

These studies resulted in three basic plans involving dam combinations and one dam/tunnel combination. There were Plan 1 which involved the Watana-Devil Canyon sites; Plan 2, the High Devil Canyon-Vee sites; Plan 3, the Watana-tunnel concept; and Plan 4, Watana-High Devil Canyon sites.

(i) Plan 1

Three subplans were developed:

- Subplan 1.1: Stage 1 involves constructing Watana Dam to its full height and installing 800 MW. Stage 2 involves constructing Devil Canyon Dam and installing 600 MW.

- Subplan 1.2: For this subplan, construction of the Watana dam is staged from a crest elevation of 2,060 feet to 2,225 feet. The powerhouse is also staged from 400 MW to 800 MW. As for Subplan 1.1, the final stage involves Devil Canyon with an installed capacity of 600 MW.

- Subplan 1.3: This subplan is similar to Subplan 1.2 except that only the powerhouse and not the dam at Watana is staged.

(ii) Plan 2

Three subplans were also developed under Plan 2:

- Subplan 2.1: This subplan involves constructing the High Devil Canyon Dam first with an installed capacity of 800 MW. The second stage involves constructing the Vee Dam with an installed capacity of 400 MW.

- Subplan 2.2: For this subplan, the construction of High Devil Canyon Dam is staged from a crest elevation of 1,630 to 1,775 feet. The installed capacity is also staged from 400 to 800 MW. As for Subplan 2.1, Vee follows with 400 MW of installed capacity.

- Subplan 2.3: This subplan is similar to Subplan 2.2 except that only the powerhouse and not the dam at High Devil Canyon is staged.

(iii) Plan 3

This plan involves a long power tunnel to replace the Devil Canyon dam in the Watana/Devil Canyon development plan. The tunnel alternative could develop similar head as the Devil Canyon dam development and would avoid some environmental impacts by avoiding inundating Devil Canyon. Because of low winter flows in the river, a tunnel alternative was considered only as a second stage to the Watana development.

Following studies described in Section 8 of Volume I, a plan involving a tunnel to develop the Devil Canyon dam head and a 245-foot-high re-regulation dam and reservoir was selected with the capacity to regulate diurnal fluctuations caused by the peaking operation at Watana. The plan involves two subplans.

- Subplan 3.1: This subplan involves initial construction of Watana and installation of 800 MW of capacity. The next stage involves the construction of the downstream re-regulation dam to a crest elevation of 1,500 feet and a 15-mile-long tunnel. A total of 300 MW would be installed at the end of the tunnel and a further 30 MW at the re-regulation dam. An additional 50 MW of capacity would be installed at the Watana powerhouse to facilitate peaking operations.

- Subplan 3.2: This subplan is essentially the same as Subplan 3.1 except that construction of the initial 800 MW powerhouse at Watana is staged.

(iv) Plan 4

This single plan was developed to evaluate the development of the two most economic damsites, Watana and High Devil Canyon, jointly. Stage 1 involves constructing Watana to its full height with an installed capacity of 400 MW. Stage 2 involves increasing the capacity at Watana to 800 MW. Stage 3 involves constructing High Devil Canyon to a crest elevation of 1470 so that the reservoir extends to just downstream from Watana. In order to develop the full head between Watana and Portage Creek, an additional smaller dam would be added downstream from High Devil Canyon. This dam would be located just upstream from Portage Creek so as not to interfere with the anadromous fisheries, and it would have a crest elevation of 1030 and an installed capacity of 150 MW. For purposes of these studies, this site is referred to as the Portage Creek site.

(d) Plan Evaluation Process

The overall objective of this step in the evaluation process was to select the preferred basin development plan. A preliminary evaluation of plans was initially undertaken to determine broad comparisons of the available alternatives. This was followed by appropriate adjustments to the plans and a more detailed evaluation and comparison.

Table 10.14 lists pertinent details such as capital costs and energy yields associated with the selected plans. The cost information was obtained from the engineering layout studies described in Sections 9 and 10. The energy yield information was developed using a multi-reservoir computer model.

A more detailed description of the model appears in Section 8 of Volume I.

In the process of evaluating the schemes, it became apparent that there would be environmental problems associated with allowing daily peaking operations from the most downstream reservoir in each of the plans described above. In order to avoid these potential problems while still maintaining operational flexibility to peak on a daily basis, re-regulation facilities were incorporated in the four basic plans. These facilities incorporate both structural measures, such as re-regulation dams, and modified operational procedures under a series of form modified plans, E1 through E4.

(i) E1 Plans

For Subplans 1.1 to 1.3, a low, temporary re-regulation dam is constructed downstream from Watana during the stage in which the generating capacity is increased to 800 MW. This dam would re-regulate the outflows from Watana and allow daily peaking operations. It has been assumed that it would be possible to incorporate this dam with the diversion works at the Devil Canyon site, and an allowance of $100 million has been made to cover any additional costs associated with this approach.

In the final stage, only 400 MW of capacity is added to the dam at Devil Canyon instead of the original 600 MW. Reservoir operating rules are changed so that Devil Canyon dam acts as the re-regulation dam for Watana.

(ii) E2 Plans

For Subplans 2.1 to 2.3, a permanent re-regulation dam is located downstream from the High Devil Canyon site, while at the same time, the generating capacity is increased to 800 MW. An allowance of $140 million has been made to cover the costs of such a dam.

An additional Subplan E2.4 was established. This plan is similar to E2.3 except that the re-regulation dam is utilized for power production. The damsite is located at the Portage Creek site with a crest level set to utilize the full head. A 150 MW powerhouse is installed. As this dam is to serve as a re-regulating facility, it is constructed at the same time as the capacity of High Devil Canyon is increased to 800 MW, i.e., during Stage 2.

(iii) E3 Plan

The Watana tunnel development plan already incorporates an adequate degree of re-regulation, and the E3.1 Plan is, therefore, identical to the 3.1 Plan.

(iv) E4 Plans

The E4.1 Plan incorporates a re-regulation dam downstream from Watana during Stage 2. As for the E1 Plans, it has been assumed that it would be possible to incorporate this dam as part of the diversion arrangements at the High Devil Canyon site, and an allowance of $100 million has been made to cover the costs. The energy and cost information for these plans is presented in Section 8.

These evaluations basically reinforce the results of the screening model; for a total energy production capability of up to approximately 4,000 GWh, Plan E2 (High Devil Canyon) provides the most economic energy while for capabilities in the range of 6,000 GWh, Plan E1 (Watana-Devil Canyon) is the most economic.

(e) Comparison of Plans

The evaluation and comparison of the various basin development plans described above, was undertaken in a series of steps.

In the first step, for determining the optimum staging concept associated with each basic plan (i.e., the optimum subplan) economic criteria only are used and the least-cost staging concept is adopted. For assessing which plan is the most appropriate, a more detailed evaluation process incorporating economic, environmental, social, and energy contribution aspects is taken into account.

Economic evaluation of the Susitna Basin development plans was conducted via a computer simulation planning model (OGP5) of the entire generating system. This model and the results are described in Section 8 of Volume I.

As outlined in the generic methodology (Section 1.4 and Appendix A), the final evaluation of the development plans is to be undertaken by a perceived comparison process on the basis of appropriate criteria. The following criteria are used to evaluate the shortlisted basin development plans. They generally contain the requirements of the generic process with the exception that an additional criterion, energy contribution, is added. The objective of including this criterion is to insure that full consideration is given to the total basin energy potential that is developed by the various plans.

(i) Economic Criteria

The parameter used is the total present-worth cost of the total Railbelt generating system for the period 1980 to 2040 listed and discussed in Section 8.

(ii) Environmental Criteria

A qualitative assessment of the environmental impact on the ecological, cultural, and aesthetic resources is undertaken for each plan. Emphasis is placed on identifying major concerns so that these could be combined with the other evaluation attributes in an overall assessment of the plan.

(iii) Social Criteria

This attribute includes determination of the potential nonrenewable resource displacement, the impact on the state and local economy, and the risks and consequences of major structural failures caused by seismic events. Impacts on the economy refer to the effects of an investment plan on economic variables.

(iv) Energy Contribution

The parameter used is the total amount of energy produced from the specific development plan. An assessment of the energy development foregone is also undertaken. This energy loss is inherent to the plan and cannot easily be recovered by subsequent staged developments.

Economic and technical comparisons are discussed in Section 8 of Volume I; environmental, social, and summary comparisons appear in Tables 10.15 through 10.18.

(f) Results of Evaluation Process

The various attributes outlined above have been determined for each plan. Some of the attributes are quantitative while others are qualitative. Overall evaluation is based on a comparison of similar types of attributes for each plan. In cases where the attributes associated with one plan all indicate equality or superiority with respect to another plan, the decision as to the best plan is clear cut. In other cases where some attributes indicate superiority and others inferiority, these differences are highlighted and trade-off decisions are made to determine the preferred development plan. In cases where these trade-offs have had to be made, they are relatively convincing and the decision-making process can, therefore, be regarded as fairly robust. In addition, these trade-offs are clearly identified so the reader can independently address the judgment decisions made.

The overall evaluation process is conducted in a series of steps. At each step, only a pair of plans is evaluated. The superior plan is then passed on to the next step for evaluation against an alternative plan.

(g) Devil Canyon Dam Versus Tunnel

The first step in the process involves the evaluation of the Watana-Devil Canyon dam plan (E1.3) and the Watana tunnel plan (E3.1). As Watana is common to both plans, the evaluation is based on a comparison of the Devil Canyon dam and tunnel schemes.

In order to assist in the evaluation in terms of economic criteria, additional information was obtained by analyzing the results of the OGP5 computer runs. This information, presented in Section 8, illustrates the breakdown of the total system present-worth cost in terms of capital investment, fuel, and operation and maintenance costs.

(i) Economic Comparison

From an economic point of view, the Devil Canyon dam scheme is superior. On a present worth basis, the tunnel scheme is $680 million or about 12 percent more expensive than the dam scheme. For a low-demand growth rate, this cost difference would be reduced slightly to $610 million. Even if the tunnel scheme costs are halved, the total cost difference would still amount to $380 million. Consideration of the sensitivity of the basic economic evaluation to potential changes in capital cost estimate, the period of economic analysis, the discount rate, fuel costs, fuel cost escalation, and economic plant lives do not change the basic economic superiority of the dam scheme over the tunnel scheme.

(ii) Environmental Comparison

The environmental comparison of the two schemes is summarized in Table 10.16. Overall, the tunnel scheme is judged to be superior because:

- It offers the potential for enhancing anadromous fish populations downstream from the re-regulation dam because of the more uniform flow distribution that will be achieved in this reach;

- It inundates 13 miles less of resident fisheries habitat in river and major tributaries;

- It has a lower impact on wildlife habitat because of the smaller inundation of habitat by the re-regulation dam;

- It has a lower potential for inundating archaeological sites because of the smaller reservoir involved;

- It would preserve much of the characteristics of the Devil Canyon gorge, which is considered to be an aesthetic and recreational resource.

(iii) Social Comparison

Table 10.17 summarizes the evaluation in terms of the social criteria of the two schemes. In terms of impact on state and local economics and risks resulting from seismic exposure, the two schemes are rated equally. However, the dam scheme has, because of its higher energy yield, more potential for displacing nonrenewable energy resources, and, therefore, scores a slight overall plus in terms of the social evaluation criteria.

(iv) Energy Comparison

The results show that the dam scheme has a greater potential for energy production and develops a larger portion of the basin's potential. The dam scheme is, therefore, judged to be superior from the energy contribution standpoint.

(v) Overall Comparison

The overall evaluation of the two schemes is summarized in Table 10.18. The estimated cost saving of $680 million in favor of the dam scheme is considered to outweigh the reduction in the overall environmental impact of the tunnel scheme. The dam scheme is, therefore, judged to be superior overall.

(h) Watana-Devil Canyon Versus High Devil Canyon-Vee

The second step in the development selection process involves an evaluation of the Watana-Devil Canyon (E1.3) and the High Devil Canyon-Vee (E2.3) development plans.

(i) Economic Comparison

In terms of the economic criteria, the Watana-Devil Canyon plan is less costly by $520 million. As for the dam-tunnel evaluation discussed above, the sensitivity of this decision to potential changes in the various parameters considered (i.e., load forecast, discount rates, etc.) does not change the basic superiority of the Watana-Devil Canyon Plan.

(ii) Environmental Comparison

The evaluation in terms of the environmental criteria is summarized in Table 10.19. In assessing these plans, a reach-by-reach comparison is made for the section of the Susitna River between Portage Creek and the Tyone River. The Watana-Devil Canyon scheme would create more potential environmental impacts in the Watana Creek area. However, it is judged that the potential environmental impacts which would occur in the upper reaches of the river with a High Devil Canyon-Vee development are more severe in comparison overall.

From a fisheries perspective, both schemes would have a similar effect on the downstream anadromous fisheries, although the High Devil Canyon-Vee scheme would produce a slightly greater impact on the resident fisheries in the Upper Susitna Basin.

The High Devil Canyon-Vee scheme would inundate approximately 14 percent (15 miles) more critical, winter, river-bottom moose habitat than the Watana-Devil Canyon scheme. The High Devil Canyon-Vee scheme would inundate a large area upstream from the Vee site utilized by three subpopulation of moose that range in the northeast section of the basin. The Watana-Devil Canyon scheme would avoid the potential impacts on moose in the upper section of the river; however, a larger percentage of the Watana Creek basin would inundated.

The condition of the subpopulation of moose utilizing this Watana Creek Basin and the quality of the habitat appears to be decreasing. Habitat manipulation measures could be implemented in this area to improve the moose habitat.

Nevertheless, it is considered that the upstream moose habitat losses associated with the High Devil Canyon-Vee scheme would probably be greater than the Watana Creek losses associated with the Watana-Devil Canyon scheme.

A major factor to be considered in comparing the two development plans is the potential effects on caribou in the region. It is judged that the increased length of river flooded, especially upstream from the Vee damsite, would result in the High Devil Canyon-Vee plan creating a greater potential diversion of the Nelchina herd's range. In addition, a larger area of caribou range would be directly inundated by the Vee reservoir.

The area flooded by the Vee reservoir is also considered important to some key furbearers, particularly red fox. In a comparison of this area with the Watana Creek area that would be inundated with the Watana-Devil Canyon scheme, the area upstream from Vee is judged to be more important for furbearers.

As previously mentioned, the area between Devil Canyon and the Oshetna River on the Susitna River is confined to a relatively steep river valley. Along these valley slopes are habitats important to birds and black bears. Since the Watana reservoir would flood the river section between the Watana damsite and the Oshetna River to a higher elevation than would the High Devil Canyon reservoir (2200 as compared to 1750), the High Devil Canyon-Vee plan would retain the integrity of more of this river valley slope habitat.

From the archaeological studies done to date, there tends to be an increase in site intensity as one progresses towards the northeast section of the Upper Susitna Basin. The High Devil Canyon-Vee plan would result in more extensive inundation and increased access to the northeasterly section of the basin. This plan is judged to have a greater potential for directly or indirectly affecting archaeological sites.

Because of the wilderness nature of the Upper Susitna Basin, the creation of increased access associated with project development could have a significant influence on future uses and management of the area. The High Devil Canyon-Vee plan would involve the construction of a dam at the Vee site and the creation of a reservoir in the more northeasterly section of the basin. This plan would thus create inherent access to more wilderness than would the Watana-Devil Canyon scheme. As it is easier to extend access than to limit it, inherent access requirements are detrimental, and the Watana-Devil Canyon scheme is judged to be more acceptable in this regard.

Except for the increased loss of river valley, bird, and black bear habitat, the Watana-Devil Canyon development plan is judged to be more environmentally acceptable than the High Devil Canyon-Vee plan. Although the Watana-Devil Canyon plan is considered to be the more environmentally compatible Upper Susitna development plan, the actual degree of acceptability is a question being addressed as part of ongoing studies.

(iii) Energy Comparison

The evaluation of the two plans in terms of energy contribution criteria shows the Watana-Devil Canyon scheme to be superior because of its higher energy potential and the fact that it develops a higher proportion of the basin's potential.

Table 10.17 summarizes the evaluation in terms of the social criteria. As in the case of the dam versus tunnel comparison, the Watana-Devil Canyon plan is judged to have a slight advantage over the High Devil Canyon-Vee plan because of its greater potential for displacing nonrenewable resources.

(iv) Overall Comparison

The overall evaluation is summarized in Table 10.20 and indicates that the Watana-Devil Canyon plans are generally superior to all the other evaluation criteria.

(i) Preferred Susitna Basin Development Plan

Comparisons of the Watana-Devil Canyon plan with the Watana tunnel plan and the High Devil Canyon-Vee plans are judged to favor the Watana-Devil Canyon plan in each case.

The Watana-Devil Canyon plan is therefore selected as the preferred Susitna Basin development plan, as a basis for continuation of more detailed design optimization and environmental studies.

10.4 - Coal-Fired Generation Alternative

Previous studies have indicated that alternative generating resources available to supply power to the Railbelt region include use of the Beluga coal fields. The economic and technical feasibility of developing this resource and of the selection process utilized to conclude the economic feasibility of Beluga coal, is discussed in Section 6 of Volume I.

Information presented in this section was extracted from previous reports prepared in conjunction with studies of developing the Beluga coal fields (Commerce and Economic Development 1980; Cook Inlet Region 1981). Because specifics of plant design and location are not available, the existing environment is described for the general area and impacts are discussed in generic terms only.

For purposes of this evaluation, an electrical generating plant with total capacity of 400 MW was assumed. Coal would be strip-mined from the Beluga fields, transported to the plants, and burned to produce electricity. Treatment of waste streams, including air, water, and solid waste, would occur at the site. Approximately 1.5 million tons of coal per year would be burned. A construction camp would be built near the site, and a permanent village maintained for mining personnel and plant operators.

(a) Existing Environmental Condition

The Beluga coal fields are located approximately 50 to 60 miles southwest of Anchorage on the western side of Cook Inlet. The coal fields are bordered by Cook Inlet on the east and south, the Chakachatna River on the west, and the Beluga River, Beluga Lake, and Capps Glacier on the north (Commerce and Economic Development 1980).

(i) Air Quality

Air quality in the Cook Inlet and Beluga coal field area can be described as good. The Cook Inlet Air Quality Control Region is designated as a Class II Attainment area for all criteria pollutants. The Tuxedni National Wildlife Refuge approximately 80 miles southwest of the project area is Class I Attainment area for all criteria pollutants.

(ii) Topography, Geology, and Soils

The topography of the western shore of Cook Inlet is dominated by high glaciated mountains dropping rapidly to a glacial moraine/outwash plateau which slopes gently to the sea. The outwash/moraine deposits begin at an elevation of approximately 2500 and drop to tidewater in 30 to 50 miles (Cook Inlet Region 1981).

The major geologic feature of the area is the Nikolai moraine which lies in contact with sedimentary Tertiary rocks (Commerce and Economic Development 1980). Most coals occur in the Tyonek Formation of the Tertiary Kenai Group (Battelle Northwest 1978). The area is geologically young with higher upland elevations consisting of slightly to moderately modified glacial moraines and associated drifts.

The lowland areas are mantled with glacial deposits and overlaid by silt loam.

Soils are variable in the area. Generally, soils in the southern portion of the area are sandy but poorly drained, and soils in the west are well drained and dark, formed in fine volcanic ash and loam. Soils in the east and northern areas range from poorly drained fibrous peat to well-drained loamy soils of acidic nature.

(iii) Surface Hydrology

The three major river systems in the Beluga coal field area are the Chakachatna, Beluga, and Chuitna. The Chakachatna is the largest, with headwaters in Chakachamna Lake and a 1,620-square-mile drainage area, and a length of 36 miles. The Chuitna River begins near Capps Glacier, flows 27 miles, and drains approximately 150 square miles. The Beluga River is 35 miles in length and drains 930 square miles (Commerce and Economic Development 1980).

(iv) Terrestrial Ecosystem

- Flora

Four major vegetative communities in the region are the upland spruce-hardwood forest, high brush, wet tundra, and alpine tundra.

The upland spruce-hardwood forest is centered in the southern and central portions of the Beluga area and covers 40 percent of the area (Commerce and Economic Development 1980). This forest is composed of paper birch, quaking aspen, black cottonwood, and balsam poplar (Cook Inlet Region 1981a).

The high brush community in the west central portion of the Beluga district covers 15 percent of the land area. This type occupies a wide variety of soil types and may occur as pure thickets in low-lying areas. Principal species include sitka sider, raspberry dogwood, and spirea (Commerce and Economic Development 1980; Cook Inlet Region 1981a).

The wet tundra plant community occupies 7 percent of the area in the extreme southwest portion and along the eastern boundary. The vegetative mat is dominated by sedges and cottongrass, with scattered woody and herbaceous plants. Principal species include willow, birch, labrador tea, grasses, and lichens.

The alpine tundra area occupies less than 3 percent of the land area and occurs only at the higher elevations. This community comprises primarily low mat plants, both woody and herbaceous. Principal species include birches, willows, blueberry, rhododendron, and sedges.

- Fauna

The area of the Beluga coal fields supports wildlife population typical for this area of Alaska. Big game in the areas include moose, black bear, and brown bear. Both species of bear den in the area and utilize the Selvon fishery as a food source (Cook Inlet Region 1981a). A major fall and winter concentration of moose occurs in the high brush community in the west central portion of the coal fields near the Chuitna River. They are also found throughout the area during other times of the year (Commerce and Economic Development 1980).

A high diversity of bird life is present in the area, particularly during the fall and spring migration periods. Active nesting sites of bald eagles and trumpeter swans occur on the Chuitna River and peregrine falcons occur in the area (Cook Inlet Region 1981a). The coastal areas are heavily utilized by waterfowl (Commerce and Development 1980). Harbor seals, Beluga whales, and other species of marine mammals occupy Cook Inlet near the study area.

(v) Aquatic Ecosystem

The cold, running waters of river and streams in the area support both resident and anadramous fisheries. The Chuitna River supports five species of salmon (pink, king, chum, coho, and sockeye) plus rainbow trout, Dolly Varden and round white fish (Commerce and Development 1980). Nikolai Creek, Jo's Creek, Pitt Creek, and Stedatana Creek are also known to support anadramous fish populations.

(vi) Marine Ecosystem

The Cook Inlet region just south of the Beluga coal fields is a diverse area, with both aquatic and terrestrial habitats. Intertidal and shallow subtidal habitats contain broad expanses of gravel and sand and extensive areas of mud flats. These areas show varying levels of productivity, with the mud flat areas generally at low levels (Cook Inlet Region 1981a). Dominant fauna present include pelecypods and polychaete worms. The area of gravel and sand support moderate densities of amphipods and isopods.

The Cook Inlet area is also important to commercial and sport fisheries. Four species of salmon and halibut utilize this area and are harvested on a commercial basis, as are herring, shrimp, and crabs. Commercial salmon harvested in 1980 was estimated at 20.4 million pounds with a value of $18 million. The average annual herring catch is 6.4 million pounds, worth approximately $1.3 million. The smaller halibut fisheries yield approximately 0.6 million pounds, worth $400,000, while the shellfish harvest of crab and shrimp yields 16 million pounds annually, worth $8.5 million (Cook Inlet Region 1981a).

Subsistence fishing is also conducted by local natives, particularly by those from the Tyonek area. Species harvested include clams, bottomfish, salmon, and smelt.

The diverse wetland and aquatic habitats support large numbers of birds, particularly during the migration periods. The coastal wetlands and mud flats are heavily utilized by waterfowl, cranes, and shorebirds, while the offshore waters and sea cliffs are inhabited by sea birds such as gulls, puffins, and murres.

Marine mammals present in the Cook Inlet area include seals, whales, and dolphins. Only the harbor seal and Beluga whale are known to occur in the upper Cook Inlet.

(vii) Cultural Resources

Historic sites occur within the modern town of Tyonek. Other sites nearby include Californsky's fish camp, old village sites, and cemeteries. Few archaeological sites are believed to be in the area, primarily because the violent actions of the tide would have destroyed most of the sites left by coastal-dwelling natives.

(viii) Socioeconomic Conditions

The only substantial settlement on the west coast of Cook Inlet is Tyonek, inhabited by approximately 270 Tanaina Indians. The village is typical of many small villages in Alaska, with high unemployment. Recently, government programs have somewhat alleviated this problem.

Employment on the west side of Cook Inlet is supplied by three commercial developments: the Chugach generating station, Kodiak lumber mill, and crude oil processing and transportation facilities. Commercial fishing and subsistence activities are the major sources of income.

Housing consists primarily of prefabricated structures. One school, with total enrollment of 140, serves kindergarten through the 12th grade. Police protection is provided by the Alaska State Troopers utilizing a resident constable. Fire protection is provided by the U.S. Bureau of Land Management. Medical services are available in a medical center located in the village. Water is supplied from a nearby lake and wastewater disposed of via septic systems (Commerce and Economic Development 1980; Cook Inlet Region 1981a).

Transportation facilities in the areas are limited to gravel logging roads and small airstrips.

(b) Environmental Impacts

(i) Air Quality

Coal mining and power generation will result in emissions to the atmosphere of particulate matter, nitrogen oxide, sulfur oxide, carbon monoxide, and hydrocarbons, as well as lesser amounts of other pollutants. Their impacts cannot be quantified without detailed air monitoring and modeling; however, some generalizations can be made.

Mining emissions would comprise primarily particulate matter from vehicular traffic, surface disturbance, and wind across coal piles and disturbed areas. Heavy equipment operations would also result in nitrogen oxide, carbon monoxide, hydrocarbon, and sulfur oxide emissions.

Beluga coal is characterized as sub-bituminous (6,500 - 7,500 Btu/lb) with low sulfer (0.2 percent), high moisture (25 to 28 percent) and high ash content (14 to 25 percent) (Cook Inlet Region 1981a). This sulfur and heat content is comparable to that of Powder River Basin coal in Wyoming, but the moisture content is approximately twice the Powder River value. Utilizing these figures and calculations from previous reports yields approximate daily emission rates for a 700 MW facility (U.S. Fish and Wildlife Service 1978).

SO_2	40 to 60 tons per day (no scrubber)
Fly ash	3 to 5 tons per day (with precipitators)

Exact amounts of these pollutants and of nitrogen oxides cannot be calculated without specific design criteria and details on pollution-control devices.

A Prevention of Significant Deterioration (PSD) review would be necessary prior to construction. This process would require that any emissions be within the allowable increments established in the Clear Air Act regulations. However, because the area is currently relatively free of air pollution, the emissions from coal mining and generating station operation would likely result in a noticeable degradation of existing air quality. In addition, short-term maximum concentrations could, under certain meteorological conditions, exceed the National Ambient Air Quality standards near the power plant (Battelle Northwest 1978). This would would be particularly true during periods of diversion.

(ii) Topography, Geology, and Soils

Coal mining and construction of the generating facilities have the potential to impact topography and soils in the area. Mining operations would unavoidably change the topography of the area, although reclamation and compliance with regulations of the Surface Mining Control and Reclamation Act would minimize these impacts. Soil erosion from mining and plant construction activities could also occur if proper precautions are not implemented.

(iii) Hydrology

Little is known about ground water resources in the area (Cook Inlet Region 1981a). Strip mining has the potential to degrade the water quality and interferes with ground water flows. Regulations of the Surface Mining Control and Reclamation Act and the state of Alaska would require these impacts be minimized.

Surface water could be affected from runoff from the mined area, coal storage piles, site grading, road building, and other construction activities. Plant operation would also result in polluted and heated water from electrical generation. Potential sources of contamination are acid mine drainage, treatment chemicals, dust, spoil-pile runoff, fuel spillage, ash, and industrial waste. This could impact surface water quality through changes in turbidity, rates of photosynthesis, dissolved oxygen, temperature, pH, and heavy metals.

It can be expected all point sources of discharge will meet Federal New Source Performance standards and other regulations of the Federal Water Pollution Control Act. However, because of the high water quality of the river and streams in the area, any impacts will be noticeable. In addition, because of the seasonal fluctuation of flows in the area, the impacts of sedimentation and other water quality effects may be increased (Battelle Northwest 1978).

(iv) Terrestrial Ecosystems

Surface mining will unavoidably result in the removal of vegetation and wildlife habitat. If not properly restored and revegetated, erosion would result and the habitat permanently reduced in value. The areas of the generating facility, roads, and ancillary facilities would be permanently removed as wildlife habitat.

In addition to the direct impacts to wildlife, secondary effects would also occur. These include increased hunting pressure on moose and bear because of a larger human population and greater activity. New roads will add access to the area, resulting in habitat disruption and disturbance to the animals. This reduction in habitat and other secondary effects will result in a substantial loss in carrying capacity for most wildlife species and a subsequent decline in their population levels.

(v) Aquatic and Marine Ecosystems

The impacts to aquatic and marine ecosystems would depend primarily upon the effectiveness of siltation control devices and degree of water treatment. Some aquatic habitat would be lost because of mining activities. In addition, increase sedimentation, interuption or reduction in flows, and degradation of water quality could all result in negative impacts to aquatic habitats, thereby reducing fish population in the area. The potential also exists for changes in water quality to interfere with anadromous fish runs and reproduction, thereby affecting marine resources in Cook Inlet. Impacts to other marine resources, unless water quality is severely impaired, are not expected to occur.

(vi) Cultural Resources

Potential impacts to cultural resources include disturbance of sites, destruction of artifacts, and increased access to the areas resulting in disturbances to sites previously inaccessible. A cultural resource survey would be required on all areas to be mined or built upon. If significant sites are discovered, mitigation will likely occur, utilizing either avoidance or salvage operations.

Thus, with the exception of the disturbance of areas outside the project site but not currently accessible, impacts to cultural resources should be mitigatable.

(vii) Socioeconomic Conditions

There are many impacts which affect socioeconomic factors in an area. These include construction camp location (if any), commuter modes, family relocation, worker need for services, amount of local labor available, and construction schedules. Thus, only generalized impacts can be predicted.

Depending upon the size of the generation facility, direct and indirect jobs will range from 400 to 1,300 (Commerce and Economic Development 1980; Cook Inlet Region 1981a). Most of these workers would likely come from the available work force in Anchorage, with some from the Kenai Peninsula and the local village of Tyonek.

If a construction camp or new village were created near the plant site, local population would increase by several thousand. This would require construction of new roads, sewage and water systems, and other infrastructures necessary to support these workers and their families. Some of these services would be supplied by the Kenai Peninsula Borough, but most would likely be supplied either by the state of Alaska or the company building and operating the generating facility. Thus, financial impacts to the borough should be small (Cook Inlet Region 1981a). However, because the Beluga coal fields are only 75 miles from Anchorage, it is not likely a large, permanent village would be required, since most workers would prefer to live in the construction camp and leave their families in the Anchorage area.

The generating facility could add substantially to tax revenues in the Kenai-Soldotna area. This revenue would likely expand government services in the area and thereby create additional employment opportunities.

Finally, there would likely be impacts to the village of Tyonek. The large generation facility would result in increased contact with non-native people and their way of life. There could also be conflicts with subsistence hunting and fishing activities and a potential, through sport hunting, to reduce the resource bases utilized by the natives. These increased contacts with non-natives could result in the continued erosion of native customs and cultural values.

Employment opportunities would be available for Tyonek village residents. In addition, native business could likely increase to supply goods or services to the construction workers and construction site. Thus, the project would result in positive economic benefits to the village.

In summary, socioeconomic impacts to the area of plant development would not be great, primarily because of the proximity of the site to the greater Anchorage area. This area would supply most of the labor force and absorb most of the impacts from development of goods and services to supply the site. Population levels at the site would increase, with the magnitude dependent on the nature of the construction camp; however, it is likely there would not be more relocation of families to the site. Positive economic benefits would occur to the native village of Tyonek, but potential negative impacts to the cultural values also exist.

10.5 - Tidal Power Alternatives

The Cook Inlet area has long been recognized as having some of the highest tidal ranges in the world, with mean tide ranges of more than 30 feet at Sunrise on Turnagain Arm, 26 feet at Anchorage, and decreasing towards the lower reaches of Cook Inlet to 15 feet or so near Seldovia. Information concerning feasibility of tidal power generation and environmental impacts were gathered mainly from current studies being conducted for the Office of the Governor, State of Alaska (Acres American Incorporated 1981a). Initial studies of Cook Inlet tidal power development (Acres American Incorporated 1981b) have concluded that generation from tide fluctuation is technically feasible, and numerous conceptual schemes ranging in estimated capacity of 50 MW to 25,900 MW have been developed.

(a) Preferred Tidal Schemes

Studies conducted for the Governor's office (Acres American Incorporated 1981a) have indicated three sites are best suited for tidal power development. This analysis, based on capacity, energy generation and costs, considered sixteen sites and chose the following (Figure 10.6):

(i) Rainbow - This site crossed Turnagain Arm from a point near the mouth of Rainbow Creek to a point approximately two miles east of Resurrection Creek.

(ii) Point MacKenzie/Point Woronzof - This site crosses Knik Arm near Anchorage.

(iii) Eagle Bay/Goose Bay - This site crosses Knik Arm at the narrowing of the channel along Eagle and Goose bays.

Tidal power generation basically involves impounding water at high tide level and converting the head difference between the corresponding basin and the ebbing tide. Present technology allows for extension of this energy by low-head hydraulic turbines to generate electricity. A tidal power generation project, therefore, would involve construction of dams, sluice ways, powerhouses, and transmission lines (Acres American Incorporated 1981a).

(b) Environmental Considerations

Environmental assessments of the preferred Cook Inlet tidal development involve consideration of physical and biological characteristics anticipated impacts, and short- and long-term effects.

(i) Physical Characteristics

Several major characteristics of Cook Inlet are relevant to an understanding of the processes and the potential for change in the estuarine environment. These are the tidal regime, hydrology, sediment load, and climate.

The mean tide range in Knik and Turnagain Arms is 25 to 30 feet. This extreme tidal variation, combined with shallow water depths, results in a high velocity current, turbulence, and high levels of suspended sediments. Thus, suspended sediment load is also affected by the high concentration of silts and sediments present in glacial runoff that enters Cook Inlet.

Runoff from glaciers also affects the salinity concentration in Cook Inlet. In the summer months, when freshwater flows are high, salt concentrations drop and suspended load increases. In the winter, as streamflows diminish, salinity concentration increases.

(ii) Biological Characteristics

Cook Inlet is an estuary where freshwater and saltwater environments meet. These areas are usually highly productive partly because of high nutrient levels.

In Knik and Turnagain Arms, high turbidity and limited light penetration result in low biological productivity. Resident and shell-fishery populations are present only in low numbers; however, anadromous fish do use the turbid water for passage between the lower inlet and the natural streams. Five species of salmon are found in the tributaries to the Knik and Turnagain Arms. Comparatively, the

Knik Arm tributaries appear to sustain a more significant anadromous fishery than Turnagain Arm. The important salmon rivers in Turnagain Arm are Chickaloon River, Bird Creek, Indian Creek, Portage Creek, Resurrection Creek, and Six Mile Creek. Of these, the largest salmon runs have been identified in the Chickaloon River. In Knik Arm, the most important salmon tributary is the Little Susitna River. Other important streams are Fish Creek, Wasilla Creek, Cottonwood Creek, Knik River and Matanuska River.

Intertidal areas, mud flats, and lowlands are extensive in the Cook Inlet area partially because of the wide tidal fluctuations. Mud flats are broad expanses with little vegetation. Above these areas are marshland habitats, supporting grasses, emergents, submergents, and shrub vegetation. In terms of biological productivity, these coastal marshes are the most important areas within Cook Inlet. They provide important nesting and staging habitat for hundreds of thousands of shorebirds and waterfowl during the spring and fall migrations. This results in extensive recreational hunting opportunities for Alaska's most heavily populated area. During the years from 1971 to 1976, approximately 30 percent of the state duck harvest occurred in Cook Inlet.

Five coastal marshes in Cook Inlet are protected as state game refuges; four of these are in proximity to proposed tidal power development sites. They are Potter Point, located just south of Anchorage at the mouth of Turnagain Arm; Palmer Hayflats, in the upper reaches of Knik Arm; Goose Bay, on Knik Arm ten miles north of Anchorage; and Susitna Flats, to the west of Point MacKenzie at the mouth of the Susitna and Little Susitna rivers. Other important marshlands not protected as refuges are Eagle River Flats, across Knik Arm from Goose Bay, and Chickaloon Flats, across Turnagain Arm from Potter Point.

Although Cook Inlet is not an important habitat area for marine mammals, a few species do occasionally migrate to the area. Beluga whales are known to occur in the water offshore from Anchorage.

The endangered Arctic peregrine falcon is known to nest in the upper Cook Inlet region and to utilize coastal areas during the migration periods. Bald eagles, not classified as endangered in Alaska, also are present in the region. No endangered waterfowl species have been verified in Cook Inlet, although habitat for the Aleutian Canadian goose may occur in the southern reaches of the Inlet.

(iii) Anticipated Impacts

The construction and operation of a tidal power plant in either Knik or Turnagain Arm will affect the physical processes of Cook Inlet and cause changes that may directly or indirectly influence the natural environment. These impacts can be divided into short-term and long-term effects.

(iv) Short-Term Effects

Short-term effects are those associated with construction activities and include:

- Site development and construction;
- Site access and traffic;
- Operation of equipment;
- Dredging and dredged material disposal; and
- Development of construction material sources.

These short-term activities will affect, for the most part, only the environment in the vicinity of the site and will extend for the construction period. Some permanent changes will occur in the environment, such as placement of permanent facilities, but the effects will be site-specific. It should be noted that many of the negative impacts normally associated with construction can be eliminated by proper wastewater facilities, erosion control methods, and other mitigating measures.

- Dredge and Fill

The activities associated with dredging and filling may cause the most significant construction effect, because of the quantities of materials being moved and the necessary use of remote sites for dredged material disposal and acquisition of construction materials.

The Eagle Bay and Rainbow sites will both require dredging of 30 million cubic yards of sediments from the inlet bottom. Most of this will not be suitable as construction material and will need to be transported from the site for disposal. Acceptable sites for marine dumping can be found downstream where the Inlet broadens, but care must be taken to avoid commercial fisheries located in the Fire Island vicinity. The dredged material itself is not polluted or chemically contaminated. The physical constituents of the dredged material are likely to be similar to the bottom sediments found further downstream. Disposal of dredged material may temporarily disturb bottom organisms, but habitats would soon be re-established. Careful planning in the timing and choice of disposal sites can insure minimal impacts.

Because little of the dredged material at either the Eagle Bay or Rainbow sites would be suitable as construction material, upwards of seven million cubic yards of fill material must be procured from offsite sources. This would cause disturbance of upland habitats resulting from the activities of excavation and transport. Unavoidable impact of these activities may be reduced by avoiding development in sensitive environments.

The Point MacKenzie site is most attractive from the standpoint of dredge/fill operations. Less than one quarter of the dredging required for either Rainbow or Eagle Bay will be necessary for Point MacKenzie. Additionally, a substantial portion of the material removed will be rock, gravel, and sand that may be appropriate for dam construction. This further diminishes the volumes required for acquisition and disposal.

- Site Access and Traffic

Establishing access to the site by land and by sea and providing for the high volume of traffic that will occur during the construction period will affect the environment. Roads and marine docking facilities will be constructed. Marine traffic for construction purposes, delivery of equipment, and dredging operations will occur in areas where little or no shipping or boating of any type has occurred. Access roads will be established in previously undeveloped areas.

To minimize these impacts, land routes can be chosen to avoid sensitive areas such as waterfowl habitat, and the high volumes of traffic can be limited to construction periods. Marine traffic is not likely to affect the few resident species nor block the mobile anadromous species as they migrate up and downstream. The marshlands, waterfowl habitats, and upland game reserves would be most affected by development, noise, and traffic activities.

- Site Development and Construction

The preparation of the site for construction, as well as the activities associated with construction, will have its greatest impacts on the site itself. Alterations of topography and existing habitats will occur. The presence of large, noise-producing equipment and human activity will be disruptive to habitats.

Site development can be conducted in a manner that will minimize impacts. Minimization of land use, implementation of plans for erosion control and landscaping, and development of permanently useful facilities such as dry docks will aid in reducing impacts.

More site-specific details must be reviewed to determine the full scope of negative impacts versus the potential for enhancement.

Noise factors are potentially most significant at the Eagle Bay site, which is located only a few miles upstream from Goose Bay State Game Refuge. The noise levels have the potential to disrupt waterfowl, but habituation can be expected.

The marine construction activities will affect the aquatic environment. Dredging, fill placement, dry dock construction, caisson construction, and installation will occur in the water. There are few resident species to be disturbed, but migration of anadromous fish may be affected. It is likely that measures to insure fish passage will be required during all stages of construction, and this should reduce these impacts.

(v) Long-Term Effects

Certain aspects of plant operation may alter the physical regime of the estuary. These will be discussed in terms of their environmental implications:

- the altered tidal regime and estuarine hydrology; and
- the alteration of hydraulic characteristics: currents/ velocities, erosion/sedimentation.

Additionally, the following long-term impacts will be considered:

- impacts added by the causeway alternative.

- Effects of an Altered Tidal Regime

The process of capturing the tide in a basin behind the barrier and regulating the flows through it has two important consequences. First, the mean tide level in the newly formed basin will be raised by several feet. Second, the mean tide range will be substantially decreased. Mean high tide levels will probably be slightly lower and mean low tide levels will be higher than what presently exist.

The result of these changes can be conceptualized as follows. The extent of the mud flats will likely be somewhat diminished. The lowest reaches of the mud flats will remain totally submerged, since the tide will never reach its previous low levels. At the upper limits of the mud flats, marshland vegetation may encroach seaward. As the frequency of inundations decreases at the edges of the marshland, marsh grasses will grow on the former edges of the mud flats. This will result in shifts in locating mud flats and possible changes in acreages.

Other changes may alter the distribution of plant types on the lands affected by the tides. A net increase in the mean water level may alter the water table and hence runoff and other hydrologic characteristics of adjacent marshlands. Also significant is the effect of altered salinities that may occur as tidal waters are stored in the basin. There is some potential that intrusion of saltwater may have harmful effects on the ground water table. It should be noted that the Cook Inlet marshlands are high stress environments, characterized by large seasonal variation of salines. Therefore, changes in seasonal variation of salinities will probably not be detrimental to marshland vegetation, however, further investigation of these effects is necessary.

Other hydrologic characteristics could be affected, such as backwater and flooding. The raised water table could affect lowland drainage and vegetation. It appears at this time that, although the potential for alteration is great, it is also possible that only slight changes in populations will occur that will not greatly alter the nature of the environment as a habitat for waterfowl, shorebirds, and furbearing species.

The tidal regime may also be altered downstream from the barrier. However, the impoundment of a portion of high tide water behind the barrier will not greatly alter existing water levels or tidal fluctuation downstream. Possible effects caused by resonance of tidal waves will have to be studied in detail, but it appears likely that the effects of the barrier will have much greater potential for impact upstream from the dam.

- Hydraulic Characteristics of the Basin

Regulation of flow in the basin will affect hydraulics local to the dam itself, as well as having more widespread impacts. Existing current patterns and velocities throughout the basin would be altered. The most noticeable change will occur near the dam where the concentration of flow velocities through turbines and sluiceways would alter local flow patterns. These local high velocities will be dissipated with increasing distance from the dam. The decreased tidal range may result in an overall decrease in turbulence and mixing, although the tide range will still be substantial in relation to the depth of water so that the regime of total mixing may not be altered.

The effect of siltation on the environment and on the operation of the tidal power plant cannot be fully assessed. Investigations of sedimentation in the Bay of Fundy, La Rance and other construction reported that siltation caused by construction within the tidal flow is a function of (1) the degree of flow reduction caused by construction, (2) the availability of appropriate sized sediment in the water, and (3) the combined supply of material to the site.

Knowledge of the origin of sediments and the existing transport mechanism is necessary to analysis of the latter.

Sedimentation and erosion processes may be affected in the silt-laden estuary. The mud flats and bottom conditions of the Arms are highly mobile. Changes can result from a net increase or a net decrease in velocities and from redistribution of wave energy on the shoreline. These will have the greatest potential for harmful impacts to the natural environment on the shorelines of marshlands, where erosion of the outlying mud flats could result in eventual erosion of the marshland and loss of habitat. It is possible, however, that a net decrease in energy in the basin (lower tide range, decreased mixing, decreased tide range) will result in higher sedimentation rates. If this is the case, it may cause decreased storage in the basin, and correspondingly, a buildup of mud flats and an extension of marshlands.

The effects of sedimentation may also be significant downstream from a barrier in Cook Inlet. Observation of recently constructed causeways at Windsor, Nova Scotia, and on the Petitcodiac estuary in New Brunswick reveals the development of large, mid-channel mud flats seawards of the barrier caused by local flow reductions. This could result in a reduction of sediments which are normally deposited further downstream in the estuary. Effects on navigation may be significant in the Knik Arm where shoaling is already a problem in the approaches to Anchorage harbor.

Another factor related to sediment load in the Inlet waters is that of penetration of light as required for biological productivity. At present, high turbidities limit light penetration. This may be the limiting factor for growth of the aquatic food chains. It is possible that along with a decrease in sediment load, an increase in food production could result in a habitat more amenable to aquatic species.

- Causeway Development

The addition of a causeway to the tidal power project would not create any additional impacts to the upstream and shoreline environment. The most significant impacts would result from development of a permanent road through previously undeveloped areas and from the residential and commercial growth that would occur because of the new access. Other impacts to the Inlet include increased traffic noise across the causeway and increased human access to the wetlands for recreational purposes.

(c) Effects on Biological Resources

Construction and operation of a tidal power facility has the potential to affect anadromous fish in Cook Inlet. Because of the commercial and recreational importance of this resource, specific mitigation techniques would have to be developed to minimize these impacts.

Anadromous fish return to their natural streams to spawn. The mechanism by which they locate these streams is not fully understood, but it is believed the fish respond to changes in water chemistry. Thus, although it is unlikely retiming of tides will affect the hydrology and physical or chemical composition of water upstream from the reach of tidal fluctuations, the changes in sediment load and salinity of water below the power facilities could potentially affect the migration.

The largest salmon runs in Turnagain Arm occur in the Chickaloon River. Since the river is located approximately 10 miles downstream from the Rainbow site, migration should not be directly affected. In the Knik Arm area, the most important salmon tributary is the Little Susitna River, which is 10 miles downstream from the Point MacKenzie site; impacts there also should not be great. However, in both cases, it should be noted that as fish appproach their natal streams, they may wander as far as 10 miles past the mouth before turning back to the ultimate goal. In this manner, the Point MacKenzie and Rainbow sites could conceivably affect migration to the Little Susitna and Chickaloon River, respectively, although the damsites appear to be the limits of the interaction zone.

(i) Wetlands and Waterfowl Habitat

There are three primary mechanisms by which the tidal plant would directly cause impacts to marshlands: (1) interaction along the shores of the impounded basin; (2) interaction with the construction site, noise, activity, and equipment; and (3) interaction with an altered flow regime downstream from the dam.

Of these three primary impacts, the potentially most significant would be the effects of the altered tidal regime on the stability and productivity of the marshland ecosystems within the impoundment basin. Altered sedimentation patterns could result in eroded shorelines. A raised water table could result in a more saline ground water table. Altered surface hydrology may affect filtering and transport of nutrients and organics within the marsh. A loss of marsh area and a loss of vegetation types required for support of bird populations can be envisioned, thus diminishing productivity and resulting in degradation of the waterfowl habitat.

Alternatively, sedimentation may result in an enlargement of marshlands. Effects of changes in hydrology, inundations, and nutrient supplies could produce an environment more attractive to waterfowl and other species. Somewhere between the best case and the worst case lie any number of variations where, for example, vegetation or land areas may be altered but have little impact on bird populations. The conclusion, at this point, is that the interactions between hydrology, hydraulics, and the wetland ecosystem must be better understood in order to predict effects with more reliability. This should be the main focus of future environmental studies.

The second impact of a tidal power plant on marshlands would occur if the site is located in or near a marsh. None of the proposed sites is located in marshlands. A few may be close enough that effects of construction, especially noise, should be investigated.

Finally, operation of the tidal project may affect the hydraulics of the inlet downstream from the dam. These effects should be studied in greater detail for their impacts on coastal marshlands. Later phases of engineering studies should include modeling the effects of the dam on downstream hydraulics and water levels to determine ecological impacts.

(ii) Marine Mammals

Construction of tidal-generating facilities could affect the movement of marine mammals in the area. Care must be taken in design of intake structures and dam approaches to prevent harm to these animals in the event of their interaction with the structure. Other mammals may also be involved, and their movements may extend to the other damsites. This question should be more thoroughly investigated in later studies, including potential effects on marine mammal food sources.

(d) Other Effects

(i) Water Quality

Present water quality is characterized by extremely high turbidity, relatively high dissolved oxygen content, variable salinity and nutrient concentrations, and low levels of primary biological productivity. Several activities associated with the tidal project may affect water quality. These include the excavation and construction of the dam, increased ship traffic, and operation of marine equipment, as well as the regulation of flows to and from the basin.

Dredging, excavation, and placement of materials for dam construction in the submarine and intertidal environments may temporarily increase suspended sediment concentrations near the dam. Given the existing turbulence and turbidity of the water, this should not be a problem. Additionally, the introduction of new materials (sand, rock, gravel) from other sources may result in leaching of some chemical constituents not normally found in the waters. The possibility of serious chemical problems is very small.

The presence of construction equipment, tugs, barges and human activity indicates an increased possibility for such accidents as oil spills, fires, dumping of debris, and disposal of untreated sewage into the water. Adherence to health and safety plans and control of construction areas can minimize most undesirable effects.

The presence of the dam and the resultant flow patterns may act as a physical barrier which limits exchange of salt, nutrients, sediments, etc., between the freshwater inflows and the saltwater influence from the ocean. Although the total flow of water may be reduced by the dam, large volumes of water will still be exchanged. A well-mixed basin would result, although local flow patterns and water quality may be affected.

It appears that, though there are many potentials for impact to water quality, the associated risks are low.

(ii) Climatology

Short- and long-term changes in the climate of the region may occur as a result of tidal power development. Changes in ice formation, for example, could alter air temperatures in the basin vicinity. The potential changes caused by such effects should be investigated in later phases.

(iii) Rare and Endangered Species

It is not anticipated that tidal power development would affect the endangered peregrine falcon.

(e) Socioeconomic Assessment

The socioeconomic issues of a tidal development would be similar to those of other capital intensive developments, particularly to those of a large hydropower project. The investment period, characterized by very high levels of activity and expenditure, would be followed by a long operational period during which these levels would become quite low. Annual costs of operation consist mainly of capital charges. The costs of maintenance and replacement would be quite small compared to these capital charges, and the other costs of operating the facility would be negligible.

A tidal project presents, however, certain aspects and options that are very different from more conventional power modes and which may yield distinctly different social and economic results. The following examples will illustrate the characteristics in the tidal power development that may make it unique from the socioeconomic viewpoint:

- Storage and generation will take place in the sea. Consequently, very few, if any, relocations of people will be required and very little reallocation of land and water resources.

- One of the more likely construction options will be the floating in of hugh prefabricated caissons and sinking them on location as components of the structure. If this method is adopted, a significant amount of the work may be done off the site.

- Depending upon final design and the site selected for development, a tidal project in the Cook Inlet will require from 30 to 60 turbine-generating units. Such a large number may be sufficient to justify establishment of a local industry for their manufacture and overhaul.

- Tidal power will be generated in surges lasting from 4 to 6 hours followed by interruptions of approximately 8-1/2 to 6-1/2 hours duration (adding up to lunar cycle of 12 hours and 25 minutes). Energy-intensive industries that could work on the rhythm of power availability might find the general region of tidal power plants to be an attractive location.

(f) Impact on Adjacent Land Uses

The major impacts from tidal development in the Cook Inlet would occur in the Greater Anchorage Area Borough located in the south-central portion of Alaska at the head of Cook Inlet on a roughly triangular area of land between the two estuarine drainages, Knik and Turnagain Arms.

The areas within the boundaries of the municipality of Anchorage suitable for urban development are to the west of Chugach State Park, south and east including Alyeska-Girdwood, and north and east to Eagle River-Birchwood. Potential changes in land use would be to convert these areas into industrial use as businesses are attracted by availability of power.

(g) Materials Origin Supply Study

The raw materials, intermediate goods, and equipment required for a tidal project can be grouped into three main categories:

(i) Raw Materials

These materials include aggregate, rock, cement, and lumber. It is expected that aggregate and rock can be supplied locally. The final aggregate (sand) will be transported from the Palmer area. The coarse aggregate for concrete will be crushed in the rock quarry areas near the selected sites as follows:

- Rainbow: North and south side of Turnagain Arm--5-mile haul
- Point MacKenzie: North side of Turnagain area near Rainbow site--30-mile haul
- Eagle Bay: Mount Magnificant--15-mile haul

A very primary estimate of direct labor required for the production of these items indicates that about 300 to 400 jobs may be involved during the construction period.

(ii) Steel Products

These include reinforcement and fabricated gates. It is likely that these supplies would be from sources outside Alaska.

(iii) Generating Equipment

This includes hydroelectric and electrical equipment, such as the turbines, generators, transformers, and switchgear. This equipment would be supplied from North America or Europe depending on market conditions.

(h) Labor Supply and Limitations

A preliminary estimate indicates that the direct, onsite, labor requirements for the three sites considered would be approximately as follows:

Site	Rainbow	Eagle Bay	Point MacKenzie
Average man-years per year:			
Over 7.5 years	1,875		
10.5 years		2,000	
11.5 years			2,500
Peak demand man-years per year:	2,000	2,200	2,750

The peak labor requirements for any site development are not much higher than the average requirement, and it is likely that careful scheduling of the work will make it possible to arrange for a relatively steady level of employment throughout the construction period.

For each of the sites, the total demand amounts to less than 3 percent of the total labor force and about 50 percent of the construction labor force in the impact region (Anchorage-Matsu) as of March 1981. It seems likely, therefore, that a large part of the labor that would be required during the 1990s could be recruited in the surrounding region.

In 1980, the unemployment rate was about 8 percent in Anchorage-Matsu region immediately around and north of the project sites, 12 percent in the Gulf Coast region and 10 percent in the state of

Alaska. It is possible the rate of employment would be lower during the 1990s than at present, but it seems unlikely it will have become very low. Most probably, sufficient labor will be available in the region around the project sites and construction of one of the projects would likely offer a welcome contribution to reduction of unemployment in the area during the years of construction.

Supplementary labor requirements, in addition to the direct onsite requirements, are of two types. The first consists of labor employed in the production of supplies, such as cement, concrete, lumber, aggregate, steel products, turbines, generators, and other electrical products. Parts of these activities will not be located in the impact region, or even in the state of Alaska. A preliminary estimate indicated that possibly up to 300 or 400 additional jobs in the production of raw materials could be created in the Anchorage region during the construction period if in-state manufacturing facilities are developed.

Another type of supplementary labor requirement consists of additional jobs to supply the demand for services by the labor employed onsite and in supply activities.

(i) Community Impact

Direct, onsite employment would reach, in the peak years, about 2,000 to 2,750. The impact region would be the municipality of Anchorage. A socioeconomic study by the Bureau of Land Management indicates that population growth in Anchorage was responsive to the growth in economic activities: Kenai oil, Prudhoe Lease, and Trans-Alaska pipeline construction. The population of the municipality of Anchorage was estimated in that study at 195,654 as of July 1, 1979. It is likely that Anchorage could supply labor and services of sufficient variety to accommodate a project of this size.

The temporary construction activities may provide opportunities to strengthen the local infrastructure and provide lasting benefits. Transport facilities, for example, would have to be improved to facilitate construction. For site access, new roads or upgrading of existing roads would have to be done except at Eagle Point. Adjustments near the military airport would be necessary at Point MacKenzie. A viaduct off the highway over existing railroad tracks (north side) would be built at Rainbow as well as a road to the storage and work area along the shore (north side). Whenever possible, expansion of the transport facilities as required for construction should take into account opportunities to create lasting beneficial effects, but at the same time should not necessarily interfere with existing communities. It will be desirable, if and when a decision is made to build one of the projects, to initiate joint planning with municipal authorities early as possible to minimize the unavoidable strains on the communities and to maximize the benefits that can be obtained from the temporary increase in activity in the area.

(j) Impacts of a Causeway

As discussed earlier, construction of a tidal power project at any site considered in this study could be planned to provide a causeway. At Rainbow, a crossing of Turnagain Arm could be built as an integrated part of the tidal power project, and, therefore, its costs would be reduced. Turnagain Arm Crossing between the Anchorage area and the Kenai Peninsula has been considered in various studies over the past 30 years. It has been recognized that a major improvement such as a crossing of Turnagain Arm would have a great impact on the area which it serves or through which it passes.

Tourism plays a major role in the regional economics of the Anchorage-Kenai area. The opening up of territory heretofore unserved by a highway becomes of major importance.

Alaska with its almost unlimited scenary has likewise unlimited potential for recreation. Good transportation makes realization of these potentials possible as well as being one of the basic ingredients of commerce and industry. The improvement of the basic network of transportation within the Anchorage-Kenai area will produce favorable results with all of these activities.

A crossing of Turnagain Arm would bring the city of Kenai, the center of a rapidly growing petroleum industry, to the existing highway system. The 1968 study by the Alaska Department of Highways indicated that the distance between the city of Kenai and Anchorage through the crossing would be 94 miles by way of a low-level highway, whereas the distance over existing roads is 154 miles over mountain roads with long grades and passes subject to heavy snowfall.

The construction of a tidal power project at either site, Point MacKenzie or Eagle Bay, could also be planned jointly with a Knik Arm crossing. A causeway crossing joining the two sides of Knik Arm near Anchorage would provide civil benefits as well as defense benefits. The 1972 study by the state of Alaska Department of Highways indicated that the crossing will allow future economic development of the west side of Knik Arm, which would certainly add to the potential of the metropolitan area of Anchorage (State of Alaska 1982). It would shorten the Anchorage-Fairbanks highway and also would provide the necessary access for a new international airport on the west side of the arm. Such a facility presents an interesting stimulus for the future economic development of the west side of Knik Arm. In addition, the causeway crossing would provide means for development access of lands north of Knik Arm. The geographic position of Anchorage, being presently surrounded by water, mountains, and military facilities, makes the development of the lands north and west of Knik Arm very desirable. A crossing of Knik Arm would give access to the Beluga area and the Alaska Peninsula with its mineral and recreation potentials.

(k) Summary

In summary, a large number of potential impacts are associated with any construction project of this magnitude. Certain short-term and local effects cannot be eliminated--such as dredging, construction activities, traffic, noise, and installation of permanent facilities. In addition, some widespread changes in the natural regime would result from operation of the plant; namely, changes in tidal fluctuations, water levels, and sedimentation patterns. All of these changes will affect the natural environment. Further engineering and environmental studies should identify in greater detail the impact of change on the resources of Cook Inlet. Indeed, the environment may prove resilient enough to assimilate long-term changes without a net deleterious effect on resources. Enhancement potentials also exist. The State must weigh the importance of any impact on these resources against the need for growth and development.

10.6 - Comparison of Alternatives

The economic and energy aspects of each of the alternatives under consideration are discussed in Chapters 6 and 8 of Volume I. The general comparison of the environmental impacts associated with the selected alternatives are presented below. These selected alternatives are:

- Susitna/Devil Canyon Hydroelectric Sites;
- High Devil Canyon/Vee Hydroelectric Site;
- Devil Canyon Tunnel (replaces Devil Canyon only);
- Chakachanma, Keetna, and Snow Hydroelectric Sites;
- Thermal Power Development with Beluga Coal; and
- Tidal Power Development.

The environmental impacts of these alternatives have been discussed in previous sections of this chapter and in Volume I. In this section, therefore, only the major environmental impacts and the comparisons are mentioned. For more detailed discussion, the reader is referred to other sections of this chapter and to Volume I.

In this section, the Susitna/Devil Canyon proposal is compared to others. However, because the eventual installed capacity of these two dams is 1620 MW, construction of only one of the alternates would not produce the same power. For instances; the proposed Chakachamna, Keetna, and Snow sites would together have an installed capacity of only

650 MW, requiring thermal power to also be developed to meet power demands. Therefore, these developments together may have more additive impacts than development of the single Susitna/Devil Canyon complex. This should be considered when comparing the differential impacts discussed below.

(a) Air Quality

Impacts to air quality at the tidal power development site and all hydroelectric sites would occur only during the construction period. These impacts, resulting from construction vehicle exhaust emission and fugitive dust, would be minor.

Thermal power development utilizing Beluga coal would result, in addition to fugitive dust and construction vehicle emission, in substantial amounts of sulfur dioxide, fly ash, and nitrogen oxides emitted to the atmosphere. Coal mining activities would also result in additional fugitive dust and mining equipment emissions, primarily of particulate matter, hydrocarbons and nitrous oxides. Although a PSD review would require emissions be within allowable increments established by the Clean Air Act regulations, the relatively pristine air quality would be noticeably degraded.

Thus, in comparison to the other alternatives, Beluga coal development will result in much greater negative impacts to air quality; tidal and hydroelectric development would have only minor effects.

(b) Topography, Geology, and Soils

Development of tidal power or hydroelectric power would result in minor impacts to topography, geology, and soils. These impacts would occur due to construction of access roads and transmission lines, and utilization of borrow areas. Degree of impact would not differ appreciably between the various hydroelectric or tidal power alternatives and could be mitigated through restoration and revegetation efforts.

Power generation utilizing Beluga coal would result in impacts over a much larger area. Surface mining of the coal to fuel the generating station would result in surface disturbance of the topography and soils in the mined area. Reclamation efforts would reduce these impacts, but the overall impacts would be the greatest of the alternatives under consideration.

(c) Hydrology

It is difficult to predict effects of the various power development on hydrology in the project areas. Hydroelectric development at any of the sites would result in reduction in surface flows below the dams during certain times of the year. Studies for this project have indicated these changes would not impact ground water sources or ground water or surface water users downstream of the Devil Canyon site. Because all of the damsites are located in areas of very low population density, it is not expected that changes in flows would cause major impacts to water users. The primary impact associated with alteration of flows would be to aquatic ecosystems as discussed in Section (e) below.

Tidal power development would raise the mean tide level behind the tidal barrier by several feed and lower the mean tide range so that higher low tides and lower high tides occur. This may have biological ramification as discussed in Section (d) and (e) below.

Little is known about ground water resources in the vicinity of the Beluga coal fields. Strip mining has the potential to interfere with ground water flows and to degrade water quality. In addition, surface water could be affected from runoff from coal mining operations and from liquid discharges from the generating station. This would also primarily effect aquatic ecosystems as discussed in Section (e).

Thus, hydroelectric and tidal powre development will affect surface hydrology while coal powered development will affect surface and ground water hydrology and also water quality.

(d) Terrestrial Ecosystems

Impacts on terrestrial ecosystems resulting from the Susitna/Devil Canyon development are discussed in Section 3 of this report. The impacts result primarily from the flooding of approximately 48,000 acres and construction of access roads and transmission facilities. Wildlife habitat, primarily for moose and furbearers, would be inundated and caribou migration may be affected. Deciduous forest, coniferous forest, and shrub communities would be flooded.

The Vee/High Devil Canyon development would flood approximately 9,000 fewer acres. Although this is a smaller area, it is believed to be more important to wildlife. Key winter habitat utilized by three subpopulations of moose would be flooded and caribou migration routes also affected. In addition, the areas that would be flooded is of greater value to certain furbearer species, particularly red fox. Because of the distance traversed, the construction of a transmission line to the intertie from Vee/

High Devil Canyon would result in greater impacts to terrestrial ecosystem. An additional 40 miles of transmission line would be required, resulting in a minimum of 1500 more acres of land cleared.

The Devil Canyon tunnel, Keetna, and Snow sites would all result in a reduction of available wildlife habitat. The Devil Canyon tunnel scheme (including Watana development) would inundate less area than the Watana/Devil Canyon complex or the Watana/Devil Canyon/Vee complex. Depending upon the exact specification of the development scenario, Snow and Keetna together would permanently flood approximately 6,000 acres. Because the Chakachanma project involves diversion of water, land inundated and loss of habitat is expected to be minimal. Thus, overall direct terrestrial impacts from hydroelectric development outside the Upper Susitna Basin will be less than for the Watana/Devil Canyon development. However, because the amount of power produced would be substantially less, thermal development would also be required, resulting in additional impacts to terrestrial ecosystems as discussed below.

Surface mining of coal for generation plan would unavoidably result in the removal of vegetation and wildlife habitat. Mitigation efforts would partially offest this loss, but the long-term mining would result in cumulative impacts. Furthermore, the areas of the generating facility, roads, and ancillary facilities would be permanently removed as wildlife habitat.

Tidal power development would also involve disturbance of terrestrial areas. Preparation of staging sights and access roads would remove areas of habitat from use. Alteration of the tidal regime may also reduce wetland areas. Overall impacts to terrestrial ecosystems would be small.

(e) Aquatic Ecosystems

The major impacts on aquatic ecosystems resulting from the Susitna/Devil Canyon development are discussed in Chapter 3 of this volume. These impacts include reduction of downstream flows during spring, summer, and fall and possible loss of spawning habitat in the side sloughs. The chum salmon is expected to be the major species affected but mitigation efforts will likely offset any losses and insure continuance of spawning runs.

The High Devil Canyon/Vee development would inundate approximately 70 additional miles of the Susitna River. In addition, if the Olson re-regulating dam is included as part of this complex, access to Portage Creek, an important anadramous fish spawning stream, would be blocked and two miles partially inundated.

The Devil Canyon tunnel scheme would result in a smaller degree of impact to aquatic ecosystems, primarily because the number of the river miles flooded and the reservoir area created would be approximately half that of Devil Canyon reservoir.

Development at Keetna, Chakachamna, and Snow would also affect fisheries habitat, particularly at Chakachamna. Dewatering of the Chacachatna River would prevent access to Chakachamna Lake by anadramous fish, thereby eliminating spawning runs to the lake and its tributaries. Development at the Keetna site could also adversely affect upstream migration of anadramous fish.

Impacts to aquatic ecosystems from coal-fired power plants would depend upon effectiveness of siltation control devices and treatment of water discharge. Large scale mining efforts has the potential to negatively affect surface water quality over a large area.

Tidal power development could also affect migration of anadramous fish, but this is not expected to be a major impact. Possible changes in water chemistry and tidal fluctuations may change after components of the aquatic ecosystem.

(f) Cultural Resources

Potential for impacts to cultural resources is present with all development. Current studies described in Chapter 4 reveal the presence of large numbers of archaeological sites, by far, the majority of which were not discovered before these studies. Therefore, although known cultural resource sites are few at all the other development sites, it cannot be concluded that they are not present; it is likely detailed surveys would result in the discovery of these resources. Impacts to these resources are mitigatable either through avoidance or salvage operations.

Utilizing area involved as the only criteria, development at the High Devil Canyon/Vee sites and Devil Canyon/Watana sites has the highest potential for impacts and tidal power development the lowest. The other development schemes would have potentially intermediate levels of impact.

(g) Socioeconomic

Impacts on socioeconomic conditions depend primarily on the size of the project, the remoteness of the area, and condition of nearby towns. Based on this, the Watana/Devil Canyon and High Devil Canyon/Vee projects will have similar socioeconomic impacts and the tidal power development due to its size and proximity to Anchorage, the least. The use of Beluga coal would also result in substantial impacts to that area, particularly to the Tyonek Village.

(h) Summary

Comparison of the environmental impacts of the proposed Watana/Devil Canyon development with the alternatives can be summarized as follows:

(i) Hydroelectric Alternatives:

- High Devil Canyon/Vee - Similar impacts as Watana/Devil Canyon in the area of air quality, topography, geology, and soils, hydrology, cultural resources, and socioeconomics; more severe negative impacts to aquatic and terrestrial ecosystems.

- Devil Canyon Tunnel - Similar impacts as Watana/Devil Canyon in all areas except terrestrial and aquatic ecosystems. Lesser impacts to aquatic and terrestrial ecosystems. See Volume I, Chapter 8 for discussion of energy loss with this alternate.

- Chakachamna/Keetna/Snow - Fewer impacts in all areas except aquatic ecosystems due to smaller developments. Potential for severe impacts to fisheries and Chakachamna. However, low level of installed power would require supplementing with thermal increasing impacts.

(ii) Coal-fired Thermal Alternative

Greater impacts than Watana/Devil Canyon in areas of air quality, topography, geology, soils, and hydrogeology; potential for long-term negative impacts to aquatic and terrestrial ecosystems; similar levels of impacts to cultural resources and socioeconomic conditions.

(iii) Tidal Alternative

Fewer impacts than Watana/Devil Canyon in all areas, with the possible exception of anadramous fish. However, tidal power development of the same capacity of Watana/Devil Canyon (1620 MW) are not in existence anywhere in the world. Environmental impacts are not fully understood and may be greater than expected of special concern in effects of tidal regime alteration on anadramous fish. Finally, tidal power production is dependent on the tidal cycle and generation may not meet load characteristics and demands.

MAP REFERENCES

Note: File number, where present, appears to the right of the reference and is the library file number of the source at the Alaska Resources Library of the Department of the Interior, Anchorage.

File No.

List of Acronyms

ADF&G - Alaska Department of Fish and Game

AEIDC - Artic Environmental Information and Data Center (of the University of Alaska)

DOI - United States Department of Interior

FLPMA - Federal Land Policy and Management Act

JFSLUPC - Joint Federal State Land Use Planning Commission

USGS - U.S. Geological Survey

(1) "Migratory Birds: Seabirds, Raports, and Endangered Species." Resource Planning Team, JFSLUP, 1974, 1977. FW8

(2) "Birds." 100

(3) "Musk-Oxen and Caribou" adapted from data provided by ADF&G and from the University of Alaska, AEIDC. 99

(4) "Large Mammals" adapted from information prepared by ADF&G and the University of Alaska, AEIDC. 88

(5) Cultivatable Soils, Soil Conservation Service, Exploratory Survey Resource Planning Team, JFSLUPC, 1973.

(6) "Vegetation of Alaska", Data compiled by Spetzman of USGS, 1963. Overlay prepared directly from Spetzman's map by Resource Planning Team, JFSLUPC, 1972.

(7) "Selected Primitive Areas in Alaska for Consideration for Wilderness Designation", JFSLUPC, 1977.

(8) "Bear Denning and Goat Range", Resource Planning Team, JFSLUPC, 1974. FW6

(9) "Dall Sheep, Deer and Moose Concentrations", Resource Planning Team, JFSLUPC, 1974. FW67

MAP REFERENCES (Cont'd)

	File No.
(10) "Distribution of Caribou Heards in Alaska", Resource Planning Team, ALUPC, 1974.	FW5
(11) "Scenic, Natural and Primitive Values", Resource Planning Team, JFSLUPC, 1974.	PR16
(12) "Recreation, Cultural and Scientific Features", Resource Planning Team, JFLUPC, 1974.	PR17
(13) "Nationally Significant Cultural Features (Known and Known Potential)", JFSLVPC Alaska Division of Parks and National Park Service, 1977.	
(14) Alaska Map E (USGS) and USGS Quad Maps (Scale 1:250,000.	
(15) Administration National Monument Proclamation and FLPMA Withdrawals, 1980.	
(16) "Alaska" Illustrated Land Status Subject to Verification Department of the Interior, Bureau of Land Management, 1974.	
(17) Generalized State Land Activity - current to 9/30/79.	32-1
(18) "Fisheries" JFSLUPC.	FW9
(19) "Marine Mammals and Fish", Adapted from data prepared by the U.S. Fish and Wildlife Service and University of Alaska, Arctic Environmental Information and Data Center.	97
(20) "Proposed Ecological Reserve System for Alaska" by: University of Alaska, Arctic Environmental Information and Data Center, 1977.	
(21) State of Alaska "Game refuges, Critical Habitat Areas and Sanctuaries" prepared by ADF&G, Habitat Protection Section, Office of Projects Review.	
(22) "Agricultural and Range Resources, Alaska Resources Inventory, South Central Region" prepared by the Joint Federal State Land Use Planning Commission.	
(23) Alaska Map E showing "Alaska National Interest Lands Conservation Act, December 2, 1980, PL 96-487".	

TABLE 10.1: SUMMARY OF RESULTS OF SCREENING PROCESS

Site[1]	Elimination Iteration 1	2	3	4
Allison Creek				
Beluga Lower			*	
Beluga Upper				*
Big Delta	*			
Bradley Lake				*
Bremmer R. -Salmon	*			
Bremmer R. -S.F.	*			
Browne				
Bruskasna				
Cache				
Canyon Creek	*			
Caribou Creek	*			
Carlo		*		
Cathedral Bluffs				*
Chakachamna				
Chulitna E.F.	*			
Chulitna Hurrican			*	
Chulitna W.F.	*			
Cleave		*		
Coal			*	
Coffee				*
Crescent Lake			*	
Crescent Lake - 2		*		
Deadman Creek	*			
Eagle River	*			
Fox	*			
Gakona		*		
Gerstle			*	
Granite Gorge			*	
Grant Lake			*	
Greenstone			*	
Gulkana River			*	
Hanagita		*		
Healy		*		
Hicks				
Jack River	*			
Johnson				*
Junction Island		*		
Kanhshna River			*	
Kasilof River		*		
Keetna				
Kenai Lake				*
Kenai Lower			*	
Killey River	*			
King Mtn	*			
Klutina				*
Kotsina	*			
Lake Creek Lower		*		
Lake Creek Upper				*
Lane				*
Lowe				*
Lower Chulitna				*
Lucy	*			
McClure Bay			*	
McKinley River		*		
McLaren River	*			
Million Dollar		*		
Moose Horn	*			
Nellie Juan River	*			
Nellie Juan R. -Upper				*
Ohio			*	
Power Creek		*		
Power Creek - 1	*			
Ramport		*		
Sanford		*		
Sheep Creek			*	
Sheep Creek - 1	*			
Silver Lake				*
Skwentna				*
Snow				
Solomon Gulch			*	
Stelters Ranch	*			
Strandline Lake				
Summit Lake	*			
Talachulitna			*	
Talachulitna River	*			
Talkeetna R. -Sheep	*			
Talkeetna - 2				
Tanana River			*	
Tazlina				*
Tebay Lake		*		
Teklanika		*		
Tiekel River	*			
Tokichitna				*
Totatlanika	*			
Tustumena				*
Vachon Island		*		
Whiskers				*
Wood Canyon		*		
Yanert - 2		*		
Yentna			*	

Notes:

(1) Final site selection underlined.

* Site eliminated from further consideration.

TABLE 10.2: SITES ELIMINATED IN SECOND ITERATION

Site	Criterion
Carlo Yanert - 2	Denali National Park, National Park Wilderness
Healy Lake Creek Upper McKinley River Teklanika	Denali National Park
Cleave Wood Canyon	Wrangell-St. Elias National Park & Preserve, National Park Wilderness, Major Fishery
Tebay Lake Hanagita	Wrangell-St. Elias National Park & Preserve, National Park Wilderness
Gakona Sanford	Wrangell-St. Elias National Park & Preserve
Cresent Lake	Lake Clark National Park
Kasilof River Million Dollar Rampart Vachon Island Junction Island Power Creek	Major Fishery
Gulkana	Wild & Scenic River

TABLE 10.3: EVALUATION CRITERIA

Evaluation Criteria	General Concerns
(1) Big Game	- Protection of wildlife resources
(2) Agricultural Potential	- Protection of existing and potential agricultural resources
(3) Waterfowl, Raptors & Endangered Species	- Protection of wildlife resources
(4) Anadromous Fisheries	- Protection of fisheries
(5) Wilderness Consideration	- Protection of wilderness and unique features
(6) Cultural, Recreation & Scientific Features	- Protection of existing and identified potential features
(7) Restricted Land Use	- Consideration of legal restriction to land use
(8) Access	- Identification of areas where the greatest change would occur

TABLE 10.4: SENSITIVITY SCALING

Scale Rating	Definition
A. EXCLUSION	The significance of one factor is great enough to exclude a site from further consideration. There is little or no possibility for mitigation of extreme adverse impacts, or development of the site is legally prohibited.
B. HIGH SENSITIVITY	1) The most sensitive components of the environmental criteria would be disturbed by development, or 2) There exists a high potential for future conflict which should be investigated in a more detailed assessment.
C. MODERATE SENSITIVITY	Areas of concern were less important than those in "B" above.
D. LOW SENSITIVITY	1) Areas of concerns are common for most or many of the sites. 2) Concerns are less important than those of "C" above. 3) The available information alone is not enough to indicate a greater significance.

TABLE 10.5: SENSITIVITY SCALING OF EVALUATION CRITERIA

Evaluation Criteria	SCALE			
	A Exclusion	B High	C Moderate	D Low
Big Game:	--	- seasonal concentration - are key range areas - calving areas	- big game present - bear denning area	- habitat or distribution area for bear
Agricultural Potential	--	- upland or lowland soils suitable for farming	- marginal farming soils	- no identified agricultural potential
Waterfowl, Raptors and Endangered Species	--	- nesting areas for: . Peregrine Falcon . Canada Goose . Trumputee Swan - year-round habitat for neritic seabirds and raptors - key migration area	- high-density waterfowl area - waterfowl migration and hunting area - waterfowl migration route - waterfowl nesting or molt area	- medium or low density waterfowl areas - waterfowl present
Anadromous Fisheries	- major anadromous fish corridor for three or more species - more than 50,000 salmon passing site	- three or more species present or spawning - identified as a major anadromous fish area	- less than three species present or spawning - identified as an important fish area	- not identified as a spawning or rearing area.
Wilderness Consideration	--	All of the following - good-to-high quality: . scenic area . natural features . primitive values - selected for wilderness consideration	Two of the following - good-to-high quality: . scenic area . natural features . primitive value - site in or close to an area selected for wilderness consideration	One or less of the following - good-to-high quality: . scenic area . natural features . primitive value
Cultural, Recreational and Scientific Features	--	- existing or proposed historic landmark - reserve proposed for the Ecological Reserve System	- Site affects one or more of the following: . boating potential . recreational potential . historic feature . historic trail . archaeological site . ecological reserve nomination . cultural feature	- site near one of the factors in B or C

TABLE 10.5 (Continued)

Evaluation Criteria	SCALE			
	A Exclusion	B High	C Moderate	D Low
Restricted Land Use	- Significant impact to: . Existing national park . Federal lands withdrawn by National Monument Proclamations	- Impact to: . National wildlife range . State park . State game refuge, range, or wilderness preservation area	- Increase: . National forest . Proposed wild and scenic river . National resource area . Forest land withdrawn for mineral entry	- In one of the following: . State land . Native land . None of A, B, C
Access	--	- no existing roads, railroads or airports - terrain rough and access difficult - increase access to wilderness area	- existing trails - proposed roads or - existing airports - close to existing roads	- existing roads or railroads - existing power lines

TABLE 10.6: SITE EVALUATIONS

Site	Evaluation Criteria						
	Big Game	Agricultural Potential	Waterfowl, Raptors, Endangered Species	Anadromous Fisheries	Wilderness Consideration	Cultural, Recreational, and Scientific Features	Restricted Land Use
Allison Creek	- Black and Grizzly bear present	- None identified	- Year-round habitat for neritic seabirds and raptors - Peregrine falcon nesting area - Waterfowl present	- Spawning area for two salmon species	- High-to-good-quality scenic area	- None identified	- Near Chugach National Forest
Bradley Lake	- Black and Grizzly bear present - Moose present	- 25 to 30 percent of soil marginally suitable for farming - high quality forests	- Peregrine Falcon nesting areas	- None identified	- Good-to-high-quality scenery	- Boating area	- None identified
Browne	- Black and Grizzly bear present - Moose present - Caribou winter range	- More than 50 percent marginally suitable for farming	- Low density of waterfowl	- None	- None	- Boating potential	- None identified
Bruskasna	- Black and Grizzly bear present - Moose present - Caribou winter range	- None identified	- Low density of waterfowl - Nesting and molting area	- None	- Good-to-high-quality scenery	- Boating potential - Proposed ecological reserve site	- None identified
Chakachamna	- Black bear habitat - Moose present	- Upland spruce, hardwood forest	- Waterfowl nesting and molting area	- Two species present	- Area under wilderness consideration - Good-to-high-quality scenery - Primitive and natural features	- Boating areas	- None identified
Coffee	- Black and Grizzly bear present - Moose present	- More than 50 percent of upperland suitable for agriculture - Good forests	- Key waterfowl habitat	- Four species present, two spawning in area	- None identified	- Boating area	- None identified
Cathedral Bluffs	- Black and Grizzly bear present - Moose present - Dall sheep present - Moose concentration area	- More than 50 percent of land marginal for farming - Upland spruce-hardwood forest	- Low density of waterfowl - Nesting and molting area	- One species present	- Good scenery	- None identified	- None identified
Hicks	- Black and Grizzly bear present - Caribou present - Moose wintering area	- None identified	- Waterfowl nesting and molting area	- Far downstream from site only	- None identified	- None identified	- No present restrictions
Johnson	- Black and Grizzly bear present - Moose, caribou and bison present	- 25 to 50 percent of upland soil suitable for farming - Upland spruce-hardwood forest	- Low density of waterfowl - Nesting and molting area	- Salmon spawning area, one species present	- None identified	- Boating potential	- None identified
Keetna	- Black and Grizzly bear present - Caribou winter area - Moose fall/winter concentration area	- None identified	- None identified	- Four species present, one species spawning near site	- Good-to-high-quality primitive lands	- High boating potential	- None identified
Kenai Lake	- Black and Grizzly bear present - Dall sheep habitat - Moose fall/winter concentration area	- None identified - Coastal hemlock-sitka spruce forest	- Waterfowl nesting and molting area	- Four species present, two spawning	- High-quality scenery - Natural features	- Boating potential	- Chugach National Forest

TABLE 10.6 (Continued)

Site	Evaluation Criteria						
	Big Game	Agricultural Potential	Waterfowl, Rapters, Endangered Species	Anadromous Fisheries	Wilderness Consideration	Cultural, Recreational, and Scientific Features	Restricted Land Use
Klutina	- Black and Grizzly bear present - Caribou present - Moose fall concentration area	- 25 to 50 percent of soils marginal for farming - Climate marginal for farming upland spruce-hardwood forest	- Low-density waterfowl area - Nesting and molting area	- Two species present, one species spawn in vicinity of site	- High-quality scenery - Natural formations - Primitive lands - Selected for wilderness consideration	- Boating potential	- None identifed
Lane	- Black bear present - Moose present - Caribou present	- More than 50 percent of the soils in uplands suitable for farming - Bottomland spruce-poplar forest	- Low-density waterfowl area - Nesting and molting area	- Five species present and spawn in site vicinity	- None identified	- Boating opportunities identified	- None identified
Lowe	- Black and Grizzly bear present - Moose present	- None identified - Coastal western hemlock-sitka spruce forest	- Peregrine Falcon nesting area	- One species present, others downstream of site	- Good-to-high-quality scenery - Area selected for wilderness consideration	- Historical feature - Proposed ecological reserve site	- Located near the border of Chugach National Forest
Lower Chulitna	- Black and Grizzly bear present - Caribou present	- More than 50 percent of the upland soils suitable for farming	- Medium-density waterfowl area - Nesting and molting area	- Four species present, three spawning in vicinity	- Area selected for wilderness consideration	- Boating potential	- None identified
Silver Lake	- Black and Grizzly bear present - High density of seals	- None identified - Coastal western hemlock-sitka spruce forest	- Year-round habitat for neritic seabirds and raptors	- One species present, more downstream	- Good-to-high-quality scenery - Primitive value	- Boating area potential	- Chugach National Fores
Skwentna	- Black and Grizzly bear present - Moose winter concentration area	- 50 percent of upperlands suitable for farming - Lowland spruce - hardwood forest	- Low-density waterfowl area - Nesting and molting area	- Three species present, spawning in area	- None identified	- Boating area - Historical trails	- None identified
Snow	- Black bear present - Dall sheep habitats - Moose winter concentration area	- None identified	- Nesting and molting area	- None	- None identified	- Proposed ecological reserve site	- Located in Chugach National Forest
Strandline Lake	- Moose, black bear habitat - Grizzly bear present	- 25 to 50 percent marginal farming soils - Alpine tundra	- Nesting and molting area	- None present	- Good-to-high-quality scenery - Primitive lands	- None identified	- None identified
Talkeetna 2	- Black and Grizzly bear presnt - Moose fall/winter concentration area - Caribou winter range	- None identified	- None identified	- Four species present, one species spawns at site	- Good-to-high-quality scenery - Primitive lands	- Boating potential	- None identified
Cache	- Black and Grizzly bear present - Moose winter concentration area - Caribou winter range	- None identified	- None identified	- Four species of salmon present, spawning areas identified	- Good-to-high-quality scenery - Primitive lands	- Boating potential	- None identified
Tazlina	- Black and Grizzly bear present - Moose winter range - Caribou winter range	- None identified - Lowland spruce-hardwood forest	- Medium-density waterfowl area - Nesting and molting area	- Two species present at site and upstream	- None identified	- Boating potential	- None identified
Tokichitna	- Black bear present - Moose present - Caribou present	- More than 50 percent of soils are usable for farming (in upper lands)	- Medium-density waterfowl area - Nesting and molting area	- Four species present, three species spawn in site vicinity	- Border primitive area	- Boating potential	- None identified

TABLE 10.6 (Continued)

Site	Evaluation Criteria						
	Big Game	Agricultural Potential	Waterfowl, Rapters, Endangered Species	Anadromous Fisheries	Wilderness Consideration	Cultural, Recreational, and Scientific Features	Restricted Land Use
Tustumera	- Black bear habitat - Dall sheep habitat	- None identified	- None identified	- None identified	- Selected for wilderness consideration - Good-to-high-quality scenery - Natural features - Primitive lands	- None identified	- Located in Kenai National Moose Range - Site within a designated National Wilderness area
Upper Beluga	- Moose present	- More than 50 percent of upperlands are suitable for farming - Lowland spruce-hardwood forest	- Medium density water-fowl area - Nesting and molting area	- Four species present, two species spawn in area	- None identified	- Boating area	- None identified
Upper Nellie Juan	- Grizzly bear present - Moose present - Black bear habitat	- None identified - Coastal western hemlock-sitka spurce forest	- None identified	- None identified	- Selected for wilderness consideration - High primitive, scenic, and natural features	- Boating potential	- Chugach National Forest
Whiskers	- Black and Grizzly bear present - Moose present - Caribou present	- 50 percent of upperlands suitable for farming - Bottomland spruce-poplar forest	- Low-density waterfowl area - Nesting and molting area	- Five species present, two spawn in area	- None identified	- Boating potential	- None identified
Yentna	- Black and Grizzly bear present - Moose, spring/summer/winter concentration	- 25 to 50 percent of soils in lowlands are suitable for farming - Bottomland spruce-poplar forest	- Medium-density water-fowl area - Nesting and molting area	- Five species spawn in area	- None identified	- Boating potential	- None identified

TABLE 10.7: SITE EVALUATION MATRIX

	Big Game	Agricultural Potential	Waterfowl, Reptors, Endg. Species	Anadromous Fisheries	Wilderness Consideration	Cult, Recrea, & Scientific	Restricted Land Use	Access	Installed Capacity (MW)	Scheme	Dam Height (ft)	Land Flooded (Acres)
Crescent Lake	C	D	D	B	C	C	A	B	--	Reservoir w/Diversion	<150	<5000
Chakachamna	C	D	C	C	B	C	B	C	>100	Reservoir w/Diversion	<150	<5000
Lower Beluga	C	D	C	B	D	C	D	D	<25	Reservoir and Dam	<150	<5000
Coffee	C	B	C	B	D	C	D	D	25-100	Dam and Reservoir	<150	<5000
Upper Beluga	C	B	C	B	D	C	D	D	25-100	Dam and Reservoir	150-350	5000 to 100,000
Strandline Lake	C	C	C	D	C	D	D	D	<25	Reservoir w/Diversion	<150	<5000
Bradley Lake	C	C	B	D	C	C	D	D	25-100	Reservoir w/Diversion	<150	<5000
Kasilof River	C	B	C	A	D	C	B	D	--	Reservoir w/Diversion	150-350	>100,000
Tustumena	C	D	D	D	B	D	B	B	<25	Reservoir w/Diversion	<150	<5000
Kenai Lower	C	B	C	B	C	C	B	D	25-100 M	Dam and Reservoir	<150	<5000
Kenai Lake	B	D	C	B	C	D	C	D	>100	Dam and Reservoir	>350	5000 to 100,000
Crescent Lake-2	C	D	C	C	C	C	C	D	<25	Reservoir w/Diversion	<150	<5000
Grant Lake	B	D	C	B	C	C	C	D	<25	Reservoir w/Diversion	<150	<5000
Snow	B	D	C	D	D	C	C	D	25-100	Reservoir w/Diversion	150-350	5000 to 100,000
McClure Bay	D	D	B	C	B	D	C	C	<25	Reservoir w/Diversion	<150	<5000
Upper Nellie Juan R	C	D	D	D	B	C	C		<25	Reservoir w/Diversion	<150	<5000
Allison Creek	D	D	B	C	D	D	D	D	<25	Reservoir w/Diversion	<150	<5000
Solomon Gulch	D	D	B	C	D	D	D	D	<25	Reservoir w/Diversion	<150	<5000
Lowe	C	D	B	C	C	C	D	D	25-100	Dam and Reservoir	150-350	5000 to 100,000
Silver Lake	D	D	B	C	C	C	C	C	<25	Reservoir w/Diversion	<150	<5000
Power Creek	D	D	B	A	C	C	C	C	<25	Reservoir w/Diversion	<150	<5000
Million Dollar	D	D	B	A	B	C	C	C	--	Dam and Reservoir	<150	5000 to 100,000

TABLE 10.7 (Cont'd)

	Big Game	Agricultural Potential	Waterfowl, Raptors, Endg. Species	Anadromous Fisheries	Wilderness Consideration	Cult, Recrea, & Scientific	Restricted Land Use	Access	Installed Capacity (MW)	Scheme	Dam Height (ft)	Land Flooded (Acres)
Cleave	C	D	B	B	B	C	A	D	--	Dam and Reservoir	150-350	5000 to 100,000
Wood Canyon	C	D	C	B	B	B	A	D	--	Dam and Reservoir	>350	>100,000
Tebay Lake	C	D	D	C	B	D	A	B	--	Reservoir w/Diversion	<150	<5000
Hanagita	C	D	D	D	B	D	A	B	--	Reservoir w/Diversion	<150	<5000
Klutina	B	C	C	C	B	C	D	--	25-100	--	--	--
Tazlina	B	D	C	C	D	C	C	--	>100	Dam and Reservoir	150-350	5000 to 100,000
Gakona	B	C	C	C	D	C	A	D	--	Dam and Reservoir	150-350	5000 to 100,000
Sanford	B	C	C	C	D	C	A	D	--	Dam and Reservoir	--	--
Gulkana	B	D	C	C	D	B	B	D	25-100	Reservoir w/Diversion	150-350	5000 to 100,000
Yentna	B	B	C	B	D	C	D	C	>100	Dam and Reservoir	<150	>100,000
Talachultna	B	B	C	B	D	C	D	C	25-100	Dam and Reservoir	<150	5000 to 100,000
Skwentna	B	B	C	B	D	C	D	C	25-100	Dam and Reservoir	>350	5000 to 100,000
Lake Creek Upper	C	D	C	C	C	D	A	C	--	Reservoir w/Diversion	<150	<5000
Lake Creek Lower	C	B	C	B	D	C	D	C	--	Dam and Reservoir	150-350	<5000
Lower Chulitna	C	B	C	B	C	C	D	D	25-100	Dam and Reservoir	150-350	<5000
Tokichitna	C	B	C	B	C	C	D	D	>100	Dam and Reservoir	150-350	5000 to 100,000
Coal	B	D	C	C	C	C	D	D	25-100	Dam and Reservoir	150-350	<5000
Ohio	B	D	C	C	C	C	D	D	25-100	Dam and Reservoir	150-350	<5000
Chulitna	B	D	C	C	C	C	D	D	25-100	Dam and Reservoir	150-350	<5000
Whiskers	C	B	C	B	D	C	D	C	25-100	Dam and Reservoir	<150	<5000
Lane	C	B	C	B	D	C	D	C	>100	Dam and Reservoir	150-350	<5000
Sheep Creek	B	D	D	D	C	C	D	C	25-100	Dam and Reservoir	>350	<5000

TABLE 10.7 (Cont'd)

	Big Game	Agricultural Potential	Waterfowl, Raptors, Endg. Species	Anadromous Fisheries	Wilderness Consideration	Cult, Recrea, & Scientific	Restricted Land Use	Access	Installed Capacity (MW)	Scheme	Dam Height (ft)	Land Flooded (Acres)
Keetna	B	D	D	B	D	C	D	C	25-100	Dam and Reservoir	>350	5000 to 100,000
Granite Gorge	B	D	D	B	C	C	D	C	25-100	Reservoir w/Diversion	150-350	<5000
Talkeetna-2	B	D	D	B	C	C	D	C	25-100	Dam and Reservoir	>350	5000 to 100,000
Greenstone	B	D	D	B	C	C	D	C	25-100	Reservoir w/Diversion	150-350	<5000
Cache	B	D	D	B	C	C	D	C	25-100	Dam and Reservoir	150-350	<5000
Hicks	B	D	C	D	D	D	D	D	25-100	Dam and Reservoir	150-350	<5000
Rampart	C	B	B	A	D	C	C	--	>100	Dam and Reservoir	>350	>100,000
Vachon Island	B	B	C	A	D	C	D	C	>100	Dam and Reservoir	<150	>100,000
Junction Island	B	B	C	A	D	C	D	C	>100	Dam and Reservoir	150-350	>100,000
Kantishna River	C	B	C	B	D	C	D	C	25-100	Dam and Reservoir	<150	>100,000
McKinley River	B	D	C	D	B	C	A	--	--	Dam and Reservoir	150-350	<5000
Teklanika River	B	D	D	D	B	D	A	B		Dam and Reservoir	>350	5000 to 100,000
Browne	B	C	D	D	D	C	D	D	>100	Dam and Reservoir	150-350	5000 to 100,000
Healy	B	C	D	D	B	B	A	D	--	Dam and Reservoir	150-350	5000 to 100,000
Carlo	B	D	D	D	B	C	A	D	--	Dam and Reservoir	150-350	<5000
Yanert-2	B	D	D	D	B	C	A	D	--	Dam and Reservoir	150-350	5000 to 100,000
Bruskasna	B	D	C	D	D	B	D	D	25-100	Dam and Reservoir	150-350	5000 to 100,000
Tanana	B	B	C	B	D	C	D	D	25-100	Dam and Reservoir	<150	5000 to 100,000
Gerstle	B	B	C	C	D	C	D	C	25-100	Dam and Reservoir	<150	<5000
Johnson	C	B	C	C	D	C	D	D	>100	Dam and Reservoir	<150	5000 to 100,000
Cathedral Bluffs	B	C	C	C	D	D	D	D	>100	Dam and Reservoir	150-350	5000 to 100,000

TABLE 10.8: CRITERIA WEIGHT ADJUSTMENTS

	Initial Weight	Adjusted Weights					
		Dam Height			Reserv. Area		
		+	++	+++	+	++	+++
Big Game	8				6	7	8
Agricultural Potential	7				5	6	7
Birds	8				6	7	8
Fisheries	10	8	9	10			

TABLE 10.9: SITE CAPACITY GROUPS

Site Group	No. of Sites Evaluated	No. of Sites Accepted
≤ 25 MW	5	3
25- 100 MW	15	4 - 6
≥100 MW	8	4

TABLE 10.10: RANKING RESULTS

Site Group	Partial Score	Total Score
Sites: < 25 MW		
Strandline Lake	59	85
Nellie Juan Upper	37	96
Tustumena	37	106
Allison Creek	65	82
Silver Lake	65	111
Sites: 25 - 100 MW		
Hicks	62	79
Bruskasna	71	104
Bradley Lake	71	104
Snow	71	106
Cache	86	127
Lowe	89	122
Keetna	89	131
Talkeetna - 2	98	134
Coffee	101	126
Whiskers	101	134
Klutina	101	142
Lower Chulitiua	106	139
Beluga Upper	117	142
Talachultna River	126	159
Skwentna	136	169
Sites > 100 MW		
Chakachamna	65	134
Browne	69	94
Tazlina	89	124
Johnson	96	121
Cathedral Bluffs	101	126
Lane	106	139
Kenai Lake	112	147
Tokichitna	117	150

TABLE 10.11: SHORTLISTED SITES

Environmental Rating	Capacity		
	0 - 25 MW	25 - 100 MW	100 MW
Good	Strandline Lake* Allison Creek* Tustumena Silver Lake	Hicks* Snow* Cache* Bruskasna*	Browne* Johnson
Acceptable		Keetna*	Chakachamna*
Poor		Talkeetna-2* Lower Chulitna	Lane Tokichitna

* 10 selected sites

TABLE 10.12: ALTERNATIVE HYDRO DEVELOPMENT PLANS

Plan	Description	Installed Capacity	On-Line Date
A.1	Chakachamna	500	1993
	Keetna	100	1997
A.2	Chakachamna	500	1993
	Keetna	100	1997
	Snow	50	2002
A.3	Chakachamna	500	1993
	Keetna	100	1996
	Snow	50	1998
	Strandline	20	1998
	Allison Creek	8	1998
A.4	Chakachamna	500	1993
	Keetna	100	1996
	Snow	50	2002
	Strandline	20	2002
	Allison Creek	8	2002
A.5	Chakachamna	500	1993
	Keetna	100	1996
	Snow	50	2002
	Talkeetna - 2	50	2002
	Cache	50	2002
	Strandline	20	2002
	Allison Creek	8	2002

TABLE 10.13: OPERATING AND ECONOMIC PARAMETERS FOR SELECTED HYDROELECTRIC PLANTS

No.	Site	River	Max. Gross Head Ft.	Installed Capacity (MW)	Average Annual Energy (Gwh)	Plant Factor (%)	Capital Cost[1] ($$10^6$)	Economic Cost of Energy ($/1000 Kwh)
1	Snow	Snow	690	50	220	50	255	45
2	Bruskasna	Nenana	235	30	140	53	238	113
3	Keetna	Talkeetna	330	100	395	45	477	47
4	Cache	Talkeetna	310	50	220	51	564	100
5	Browne	Nenana	195	100	410	47	625	59
6	Talkeetna-2	Talkeetna	350	50	215	50	500	90
7	Hicks	Matanuska	275	60	245	46	529	84
8	Chakachamna	Chakachatna	945	500	1925	44	1480	30
9	Allison	Allison Creek	1270	8	33	47	54	125
10	Strandline Lake	Beluga	810	20	85	49	126	115

NOTES:
(1) Including engineering and owner's administrative costs but excluding AFDC.

TABLE 10.14: POTENTIAL HYDROELECTRIC DEVELOPMENT

Site	Dam Proposed Type	Dam Height Ft.	Upstream Regulation	Capital Cost $ million	Installed Capacity (MW)	Average Annual Energy Gwh	Economic[1] Cost of Energy $/1000 kWh	Source of Data
Gold Creek[2]	Fill	190	Yes	900	260	1,140	37	USBR 1953
Olson (Susitna II)	Concrete	160	Yes	600	200	915	31	USBR 1953 KAISER 1974 COE 1975
Devil Canyon	Concrete	675	No Yes	830 1,000	250 600	1,420 2,980	27 17	This Study "
High Devil Canyon (Susitna I)	Fill	855	No	1,500	800	3,540	21	" "
Devil Creek[2]	Fill	Approx 850	No	-	-	-	-	-
Watana	Fill	880	No	1,860	800	3,250	28	"
Susitna III	Fill	670	No	1,390	350	1,580	41	"
Vee	Fill	610	No	1,060	400	1,370	37	"
Maclaren[2]	Fill	185	No	530[3]	55	180	124	"
Denali	Fill	230	No	480[3]	60	245	81	"
Butte Creek[2]	Fill	Approx 150	No	-	40	130[4]	-	USBR 1953
Tyone[2]	Fill	Approx 60	No	-	6	22[4]	-	USBR 1953

Notes:

(1) Includes AFDC, Insurance, Amortization, and Operation & Maintenance Costs.
(2) No detailed engineering or energy studies undertaken as part of this study.
(3) Includes estimated costs of power generation facility.
(4) These are approximate estimates and serve only to represent the potential of these two damsites in perspective.

TABLE 10.15: RESULTS OF SCREENING MODEL

	Total Demand		Optimal Solution				First Suboptimal Solution				Second Suboptimal Solution			
Run	Cap. MW	Energy GWh	Site Names	Max. Water Level	Inst. Cap. MW	Total Cost $ million	Site Names	Max. Water Level	Inst. Cap. MW	Total Cost $ million	Site Names	Max. Water Level	Inst. Cap. MW	Total Cost $ million
1	400	1750	High Devil Canyon	1580	400	885	Devil Canyon	1450	400	970	Watana	1950	400	980
2	800	3500	High Devil Canyon	1750	800	1500	Watana	1900	450	1130	Watana	2200	800	1860
							Devil Canyon	1250	350	710				
							TOTAL		800	1840				
3	1200	5250	Watana	2110	700	1690	High Devil Canyon	1750	800	1500	High Devil Canyon	1750	820	1500
			Devil Canyon	1350	500	800	Vee	2350	400	1060	Susitna III	2300	380	1260
			TOTAL		1200	2490	TOTAL		1200	2560	TOTAL		1200	2760
4	1400	6150	Watana	2150	740	1770	NO SOLUTION				NO SOLUTION			
			Devil Canyon	1450	660	1000								

TABLE 10.16: ENVIRONMENTAL EVALUATION OF DEVIL CANYON DAM AND TUNNEL SCHEME

Environmental Attribute	Concerns	Appraisal (Differences in impact of two schemes)	Identification of difference	Appraisal Judgment	Scheme judged to have the least potential impact: Tunnel	Scheme judged to have the least potential impact: DC
Ecological:						
- Downstream Fisheries and Wildlife	Effects resulting from changes in water quantity and quality.	No significant difference between schemes regarding effects downstream from Devil Canyon.	---	Not a factor in evaluation of scheme.		
		Difference in reach between Devil Canyon dam and tunnel re-regulation dam.	With the tunnel scheme controlled flows between regulation dam and downstream powerhouse offers potential for anadromous fisheries enhancement in this 11 mile reach of the river.	If fisheries enhancement opportunity can be realized the tunnel scheme offers a positive mitigation measure not available with the Devil Canyon dam scheme. This opportunity is considered moderate and favors the tunnel scheme. However, there are no current plans for such enhancement and feasibility is uncertain. Potential value is therefore not significant relative to additional cost of tunnel.	X	
Resident Fisheries:	Loss of resident fisheries habitat.	Minimal differences between schemes.	Devil Canyon dam would inundate 27 miles of the Susitna River and approximately 2 miles of Devil Creek. The tunnel scheme would inundate 16 miles of the Susitna River.	Loss of habitat with dam scheme is less than 5% of total for Susitna main stem. This reach of river is therefore not considered to be highly significant for resident fisheries and thus the difference between the schemes is minor and favors the tunnel scheme.	X	
Wildlife:	Loss of wildlife habitat.	Minimal differences between schemes.	The most sensitive wildlife habitat in this reach is upstream from the tunnel re-regulation dam where there is no significant difference between the schemes. The Devil Canyon dam scheme in addition inundates the river valley between the two damsites resulting in a moderate increase in impacts to wildlife.	Moderate wildlife populations of moose, black bear, weasel, fox, wolverine, other small mammals and songbirds and some riparian cliff habitat for ravens and raptors, in 11 miles of river, would be lost with the dam scheme. Thus, the difference in loss of wildlife habitat is considered moderate and favors the tunnel scheme.	X	
Cultural:	Inundation of archaeological sites.	Potential differences between schemes.	Due to the larger area inundated, the probability of inundating archaeological sites is increased.	Significant archeological sites, if identified, can probably be excavated. Additional costs could range from several hundreds to hundreds of thousands of dollars, but are still considerably less than the additional cost of the tunnel scheme. This concern is not considered a factor in scheme evaluation.	-	-
Land Use:	Inundation of Devil Canyon.	Significant difference between schemes.	The Devil Canyon is considered a unique resource, 80 percent of which would be inundated by the Devil Canyon dam scheme. This would result in a loss of both an aesthetic value plus the potential for white water recreation.	The aesthetic and to some extent the recreational losses associated with the development of the Devil Canyon dam is the main aspect favoring the tunnel scheme. However, current recreational uses of Devil Canyon are low due to limited access. Recreation development of the area is similar for both schemes.	X	

OVERALL EVALUATION: The tunnel scheme has overall a lower impact on the environment.

TABLE 10.17: SOCIAL EVALUATION OF SUSITNA BASIN DEVELOPMENT SCHEMES/PLANS

Social Aspect	Parameter	Tunnel Scheme	Devil Canyon Dam Scheme	High Devil Canyon/ Vee Plan	Watana/Devil Canyon Plan	Remarks
Potential non-renewable resource displacement	Million tons Beluga coal over 50 years	80	110	170	210	Devil Canyon dam scheme potential higher than tunnel scheme. Watana/ Devil Canyon plan higher than High Devil Canyon/ Vee plan.
Impact on state economy	--	All projects would have similar impacts on the state and local economy.				Essentially no difference between plans/schemes.
Impact on local economy	--	All projects would have similar impacts on the state and local economy.				Essentially no difference between plans/schemes.
Seismic exposure	Risk of major structural failure	All projects designed to similar levels of safety.				Essentially no difference between plans/schemes.
	Potential impact of failure on human life.	Any dam failures would affect the same downstream population.				Essentially no difference between plans/schemes.
Overall Evaluation	1. Devil Canyon dam superior to tunnel. 2. Watana/Devil Canyon superior to High Devil Canyon/Vee plan.					

TABLE 10.18: OVERALL EVALUATION OF TUNNEL SCHEME AND DEVIL CANYON DAM SCHEME

ATTRIBUTE	SUPERIOR PLAN
Economic	Devil Canyon Dam
Energy Contribution	Devil Canyon Dam
Environmental	Tunnel
Social	Devil Canyon Dam (Marginal)
Overall Evaluation	Devil Canyon dam scheme is superior Tradeoffs made: Economic advantage of dam scheme is judged to outweigh the reduced environmental impact associated with the tunnel scheme.

TABLE 10.19: ENVIRONMENTAL EVALUATION OF WATANA/DEVIL CANYON AND HIGH DEVIL CANYON/VEE DEVELOPMENT PLANS

Environmental Attribute	Plan Comparison	Appraisal Judgment	Plan judged to have the least potential impact HDC/V	W/DC
Ecological: 1) Fisheries	No significant difference in effects on downstream anadromous fisheries. HDC/V would inundate approximately 95 miles of the Susitna River and 28 miles of tributary streams, including the Tyone River. W/DC would inundate approximately 84 miles of the Susitna River and 24 miles of tributary streams, including Watana Creek.	Because of the avoidance of the Tyone River, lesser inundation of resident fisheries habitat, and no significant difference in the effects on anadromous fisheries, the W/DC plan is judged to have less impact.		X
2) Wildlife a) Moose	HDC/V would inundate 123 miles of critical winter river-bottom habitat. W/DC would inundate 108 miles of this river-bottom habitat. HDC/V would inundate a large area upstream from Vee utilized by three sub-populations of moose that range in the northeast section of the basin. W/DC would inundate the Watana Creek area utilized by moose. The condition of this sub-population of moose and the quality of the habitat they are using appears to be decreasing.	Because of the lower potential for direct impact on moose populations within the Susitna, the W/DC plan is judged superior.		X
b) Caribou	The increased length of river flooded, especially upstream from the Vee damsite, would result in the HDC/V plan creating a greater potential division of the Nelchina herd's range. In addition, an increase in range would be directly inundated by the Vee reservoir.	Because of the potential for a greater impact on the Nelchina caribou herd, the HDC/V scheme is considered inferior.		X
c) Furbearers	The area flooded by the Vee reservoir is considered important to some key furbearers, particularly red fox. This area is judged to be more important than the Watana Creek area that would be inundated by the W/DC plan.	Because of the lesster potential for impact on furbearers the W/DC is judged to be superior.		X
d) Birds and Bears	Forest habitat, important for birds and black bears, exists along the valley slopes. The loss of this habitat would be greater with the W/DC plan.	The HDC/V plan is judged superior.	X	
Cultural:	There is a high potential for discovery of archaeological sites in the eaterly region of the Upper Susitna Basin. The HDC/V plan has a greater potential of affecting these sites. For other reaches of the river the difference between plans is considered minimal.	The W/DC plan is judged to have a lower potential effect on archaeological sites.		X

TABLE 10.19 (Continued)

Environmental Attribute	Plan Comparison	Appraisal Judgment	Plan judged to have the least potential impact HDC/V	W/DC
Aesthetic/ Land Use				
	With either scheme, the aesthetic quality of both Devil Canyon and Vee Canyon would be impaired. The HDC/V plan would also inundate Tsusena Falls.	Both plans impact the valley aesthetics. The difference is considered minimal.	-	-
	Because of construction at Vee Dam site and the size of the Vee Reservoir, the HDC/V plan would inherently create access to more wilderness area than would the W/DC plan.	As it is easier to extend access than to limit it, inherent access requirements were considered detrimental and the W/DC plan is judged superior. The ecological sensitivity of the area opened by the HDC/V plan reinforces this judgment.		X

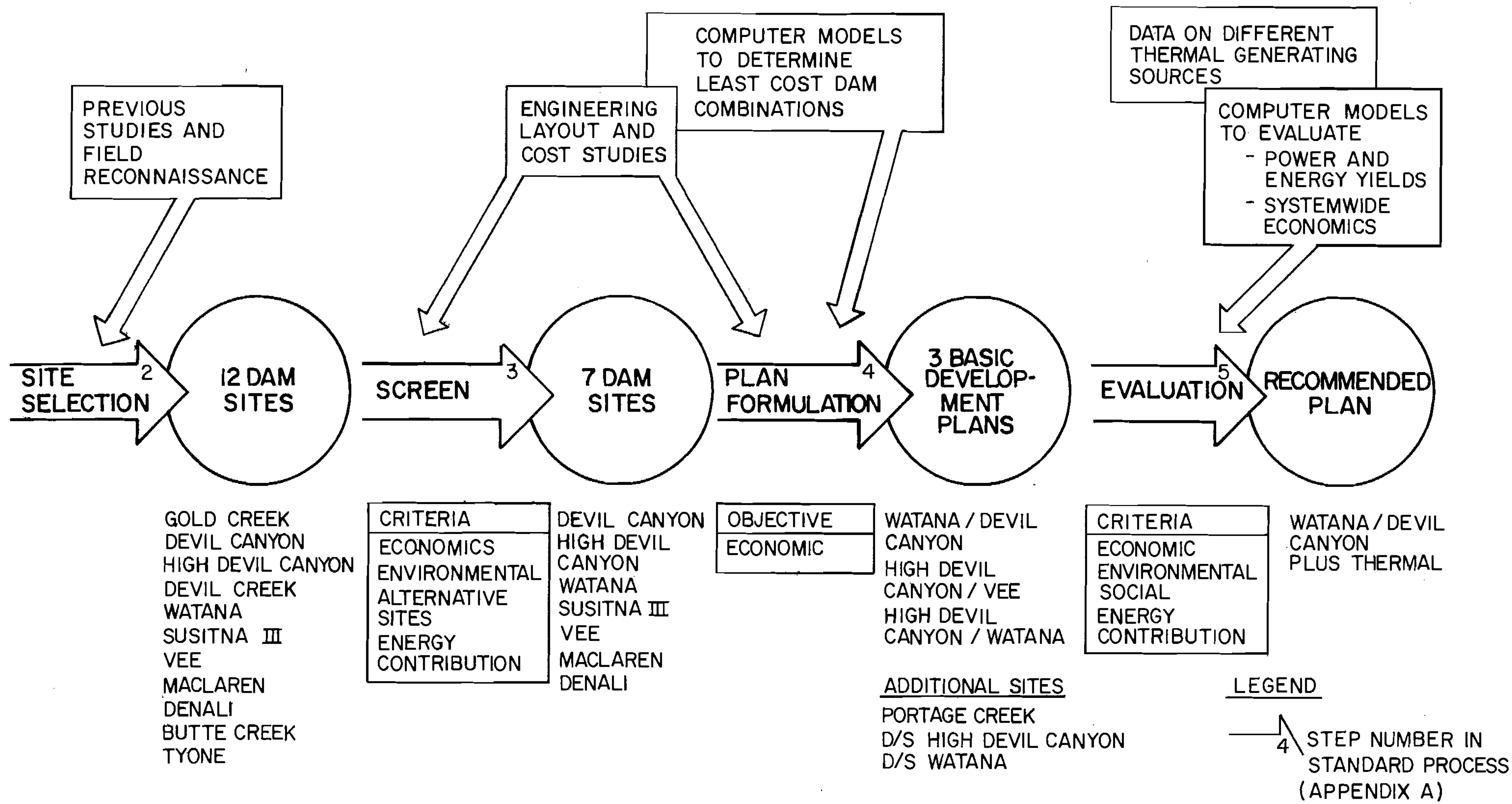
OVERALL EVALUATION: The W/DC plan is judged to be superior to the HDC/V plan.
(The lower impact on birds and bears associated with HDC/V plan is considered to be outweighed by all the other impacts which favour the W/DC plan.)

Notes:

W = Watana Dam
DC = Devil Canyon Dam
HDC = High Devil Canyon Dam
V = Vee Dam

TABLE 10.20: OVERALL EVALUATION OF THE HIGH DEVIL CANYON/VEE AND WATANA/DEVIL CANYON DAM PLANS

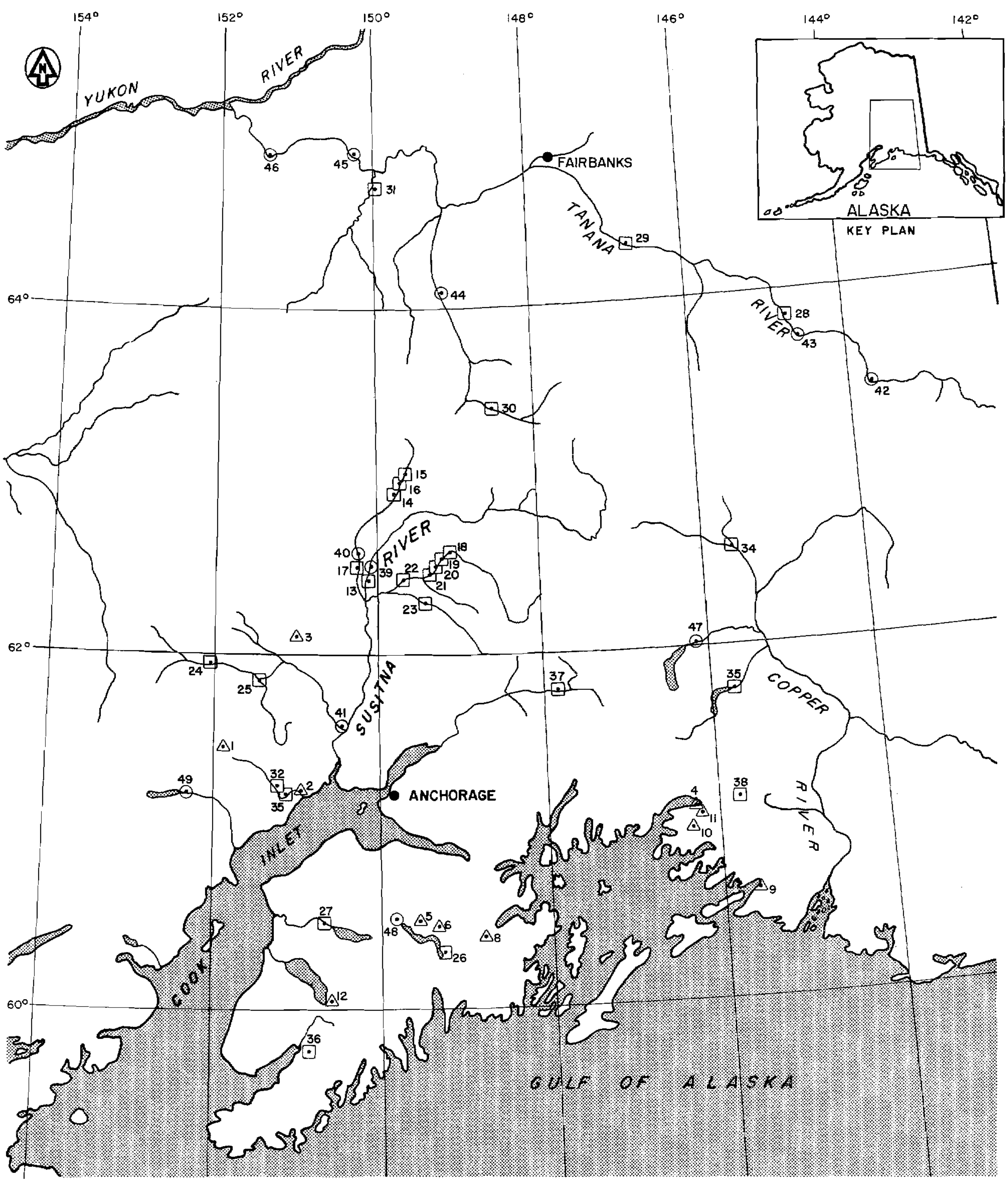
ATTRIBUTE	SUPERIOR PLAN
Economic	Watana/Devil Canyon
Energy Contribution	Watana/Devil Canyon
Environmental	Watana/Devil Canyon
Social	Watana/Devil Canyon (Marginal)
Overall Evaluation	Plan with Watana/Devil Canyon is superior Tradeoffs made: None



SUSITNA BASIN PLAN FORMULATION AND SELECTION PROCESS

FIGURE 10.1

ACRES



ALASKA RAILBELT REGION

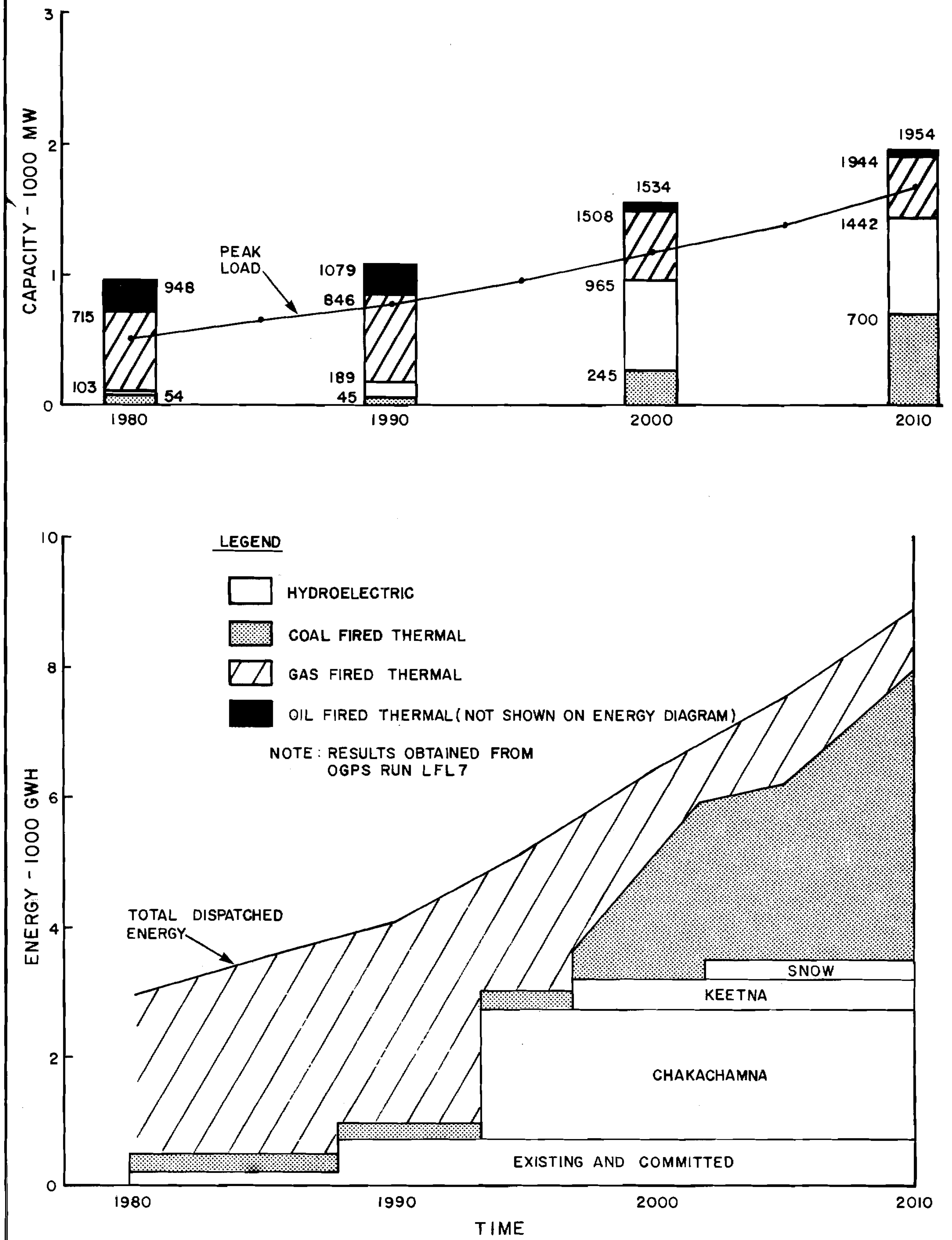
0 40 80
SCALE - MILES (APPROXIMATE)

△	⊡	⊙
0 - 25 MW	25 - 100 MW	> 100 MW

1. STRANDLINE L.
2. LOWER BELUGA
3. LOWER LAKE CR.
4. ALLISON CR.
5. CRESCENT LAKE 2
6. GRANT LAKE
7. McCLURE BAY
8. UPPER NELLIE JUAN
9. POWER CREEK
10. SILVER LAKE
11. SOLOMON GULCH
12. TUSTUMENA
13. WHISKERS
14. COAL
15. CHULITNA
16. OHIO
17. LOWER CHULITNA
18. CACHE
19. GREENSTONE
20. TALKEETNA 2
21. GRANITE GORGE
22. KEETNA
23. SHEEP CREEK
24. SKWENTNA
25. TALACHULITNA
26. SNOW
27. KENAI LOWER
28. GERSTLE
29. TANANA R.
30. BRUSKASNA
31. KANTISHNA R.
32. UPPER BELUGA
33. COFFEE
34. GULKANA R.
35. KLUTINA
36. BRADLEY LAKE
37. HICK'S SITE
38. LOWE
39. LANE
40. TOKICHITNA
41. YENTNA
42. CATHEDRAL BLUFFS
43. JOHNSON
44. BROWNE
45. JUNCTION IS.
46. VACHON IS.
47. TAZILNA
48. KENAI LAKE
49. CHAKACHAMNA

SELECTED ALTERNATIVE HYDROELECTRIC SITES

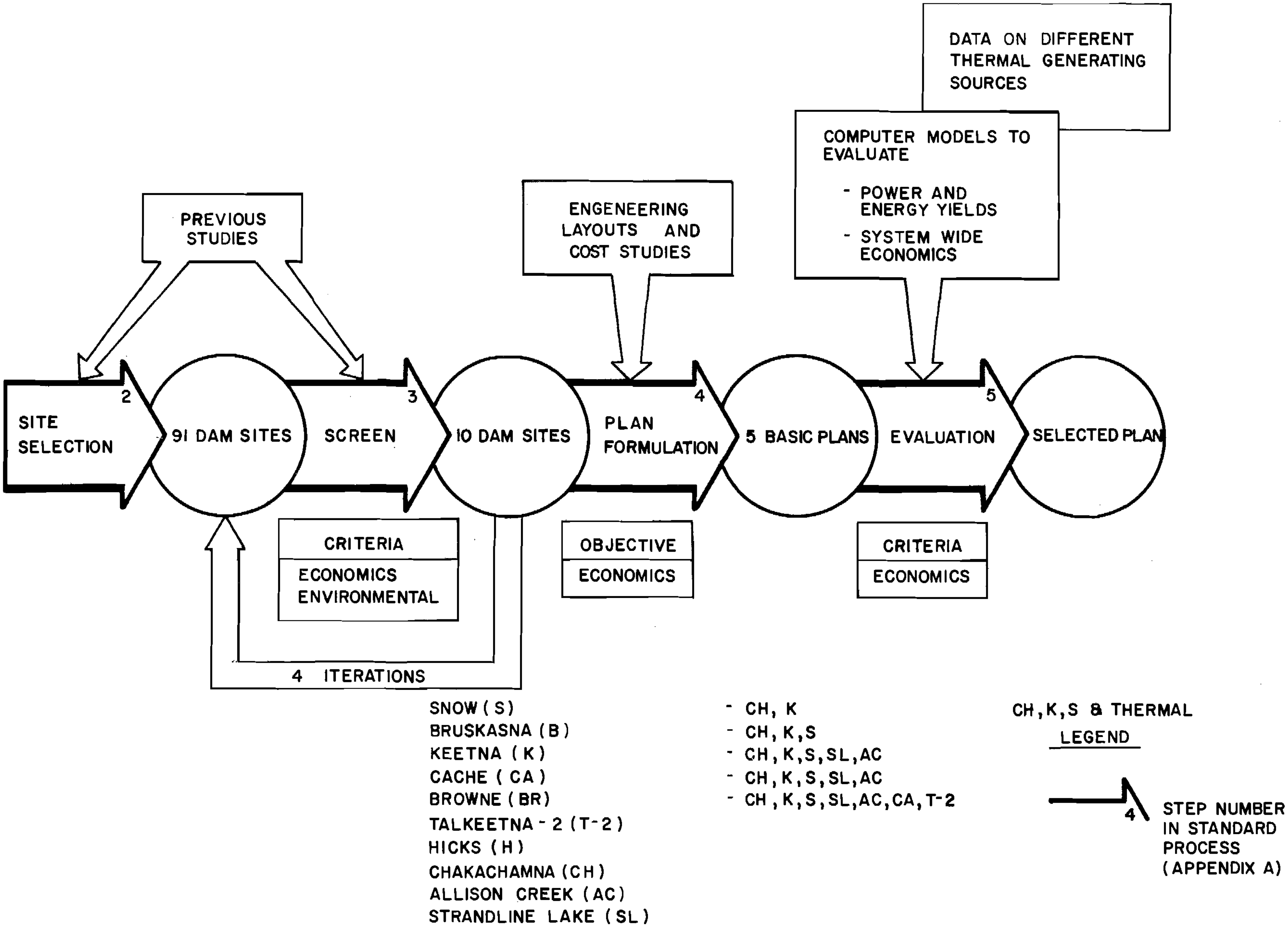
FIGURE 10.2



GENERATION SCENARIO INCORPORATING THERMAL AND ALTERNATIVE HYDROPOWER DEVELOPMENTS - MEDIUM LOAD FORECAST -

FIGURE 10.3

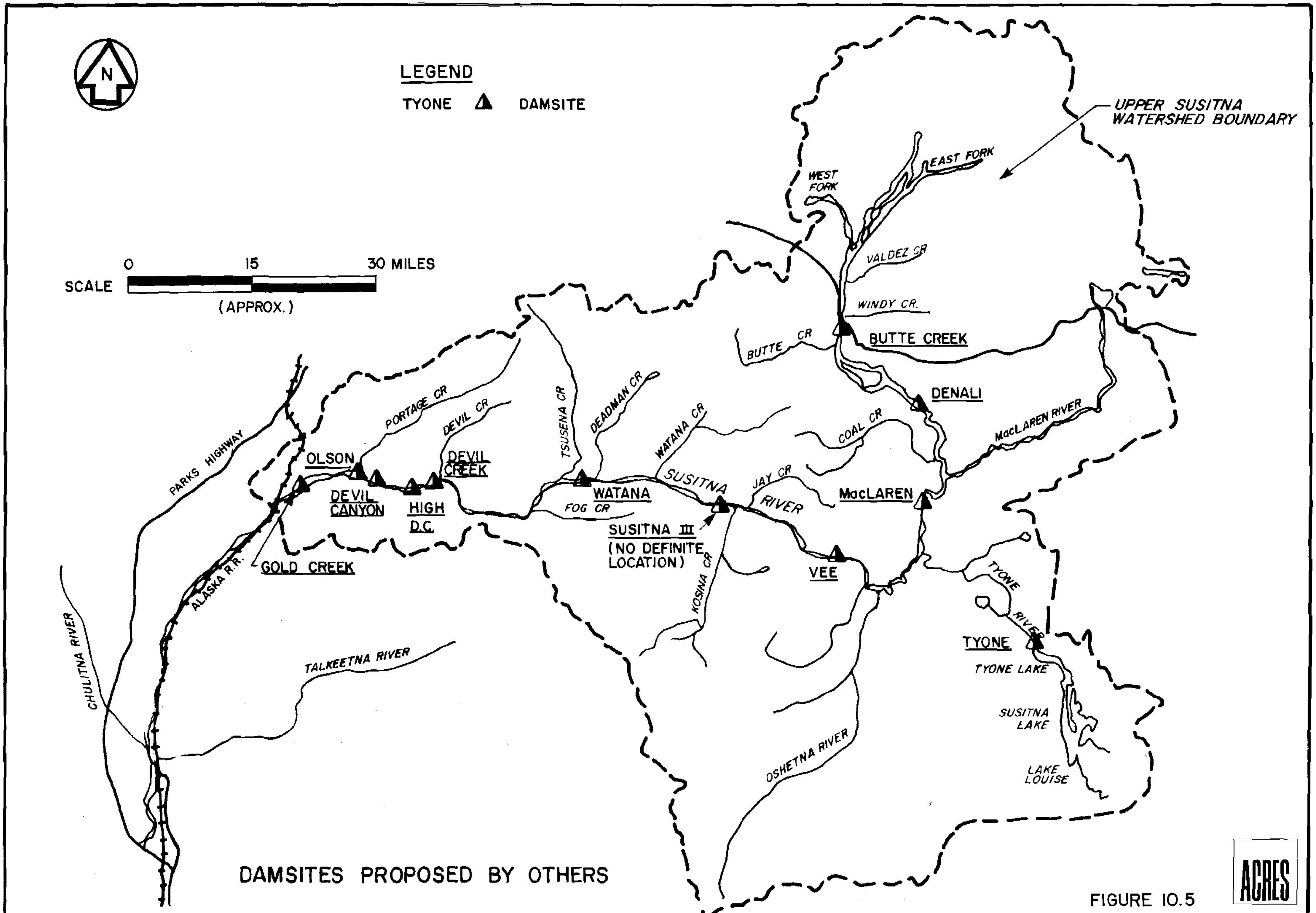
ACRES



FORMULATION OF PLANS INCORPORATING NON-SUSITNA HYDRO GENERATION

ACRES

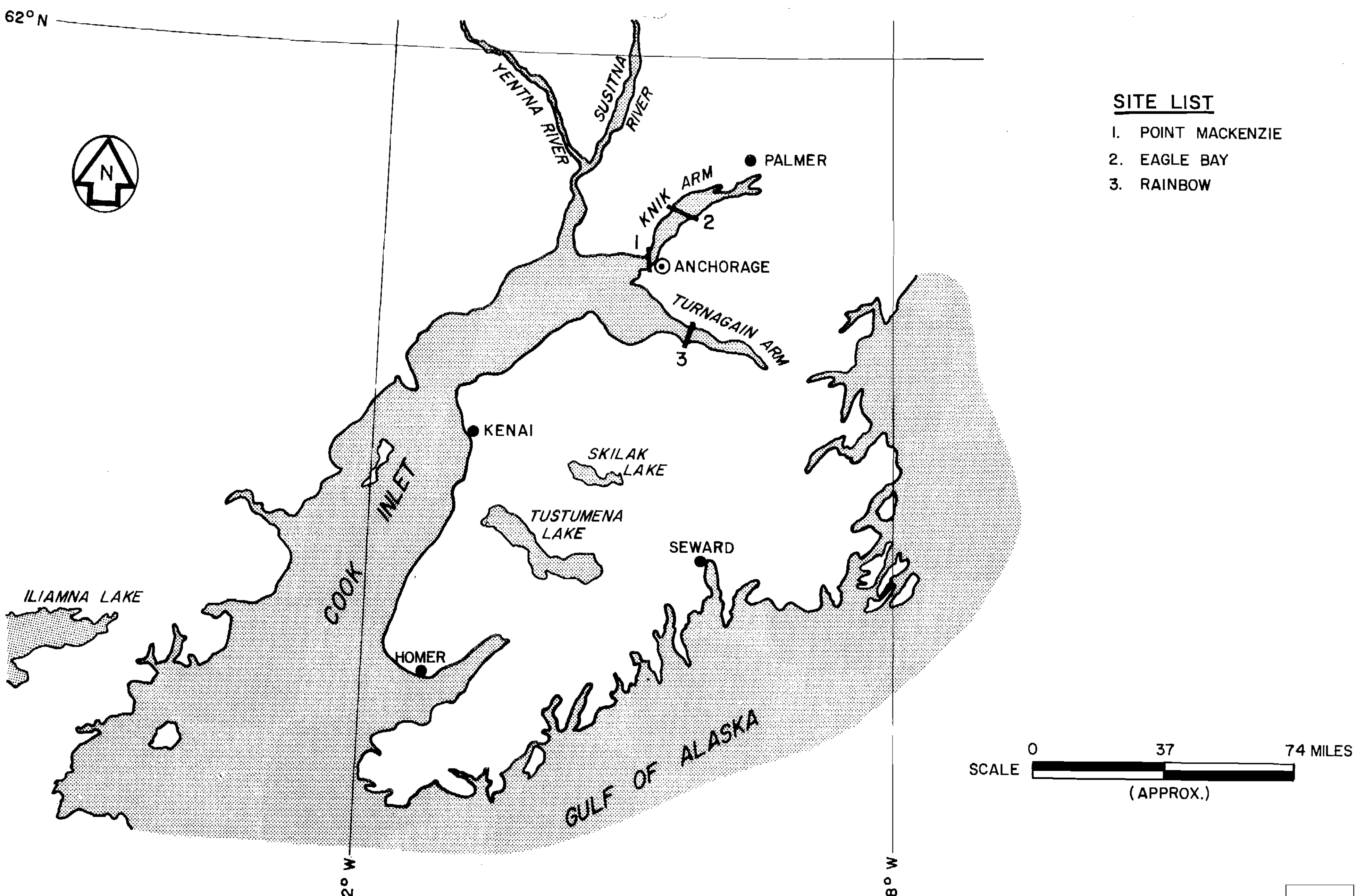
FIGURE 10.4



DAMSITES PROPOSED BY OTHERS

FIGURE 10.5

ACRES



POTENTIAL TIDAL POWER SITES

FIGURE 10.6

11 - LIST OF LITERATURE

The following is a list of literature used in the preparation of the Susitna Hydroelectric Project Environmental Studies Feasibility Report. The list is arranged by environmental report section. References which were cited in the text are denoted with an asterisk (*).

11.1 - Preface and General Description of the Locale

*Acres American, Incorporated. 1979. Susitna Hydroelectric Project Plan of Study. Alaska Power Authority, Anchorage, Alaska.

*Acres American, Incorporated. 1980. Susitna Hydroelectric Project Plan of Study. Alaska Power Authority, Anchorage, Alaska.

Acres American, Incorporated. 1981. Susitna Hydroelectric Project Subtask 6.05: Development Selection Report, Second Draft. Alaska Power Authority, Anchorage, Alaska.

ADF&G. 1981. Susitna Hydroelectric Project Environmental Studies Annual Progress Report Subtask 7.11: Wildlife Ecology Studies, Big Game. Alaska Department of Fish and Game for the Alaska Power Authority, Anchorage, Alaska.

*Bailey, R. G. 1976. Ecoregions of the United States. United States Department of Agriculture, Forest Service, Ogden, Utah.

*Bailey, R. G. 1978. Description of the Ecoregions of the United States. United States Department of Agriculture, Forest Service, Ogden, Utah.

*Hartman, C. W. and P. R. Johnson. 1978. Environmental Atlas of Alaska. Institute of Water Resources, University of Alaska, Fairbanks, Alaska.

*Searby, H. W. 1968. Climates of the States: Alaska. Environmental Data Service, ESSA. Climatology of the United States No. 60-49.

USACOE. 1975. Southcentral Railbelt Area, Alaska, Upper Susitna River Basin - Interim Feasibility Report. United States Army Corps of Engineers, Anchorage, Alaska.

USACOE. 1977. Hydroelectric Power Development, Upper Susitna River Basin - Final Environmental Impact Statement. United States Army Corps of Engineers, Anchorage, Alaska.

USACOE. 1978. Plan of Study for Susitna Hydroelectric Feasibility Analysis. Prepared for the State of Alaska by the Alaska District of the United States Army Corps of Engineers, Anchorage, Alaska.

USACOE. 1979. Southcentral Railbelt Area, Alaska, Upper Susitna River Basin - Supplemental Feasibility Report and Appendices. United States Army Corps of Engineers, Anchorage, Alaska.

*Wahrhaftig, C. 1965. Physiographic Divisions of Alaska. Professional Paper 482. United States Geological Survey, Washington, D.C.

11.2 - Water Use and Quality

Bolke, E.L., and K.M. Waddell, 1975. Chemical quality and temperature in Flaming Gorge Reservoir, Wyoming and Utah, and the effect of the reservoir on the Green River. U.S. Geological Survey, Water-Supply Paper 2039-A, 814 pp.

Doggett, G., 1981. Interview. October 21 and 28, 1981. Water Management Section, Division of Forest, Land and Water Management, Alaska Department of Natural Resources, Anchorage, AK.

Drachev, S.M., 1962. The oxygen regime and the processes of self purification in reservoirs with retarded discharge. In: Advances in Water Pollution Research, B.A. Southgate, editor, Pergamon Press, New York.

Erickson, P.A., and J.T. Reynolds, 1969. The ecology of a reservoir. Natural History, 83:11:48-53.

Fish, F.F., 1959. Effect on impoundment on downstream water quality. Journal American Water Works Association, Vol. 51, pp. 47-50.

Janke, P., 1981. Interview. October 21, 1981. Water Management Section, Division of Forest, Land and Water Management, Alaska Department of Natural Resources, Anchorage, AK.

LaPerrerie, J.D., T. Tilsworth, and L.A. Casper, 1978. Nutrient chemistry of a large, deep lake in subartic Alaska. EPA-600/78-088, U.S. Environmental Protection Agency, Environmental Research Laboratory, Corvallis, Oregon, 129 pp.

Love, K.S., 1961. Relationship of impoundment to water quality. Journal American Water Works Association, Vol, 53, pp. 559-568.

Mack, S., 1981. Interview. October 16, 1981. Northcentral District Office, Division of Forest, Land and Water Management, Alaska Department of Natural Resources, Fairbanks, AK.

Mackenthun, K.M., 1960. What you should know about algal control. Public Works, 91:9:114-116.

Mortimer, C.H., 1941. The exchange of dissolved substances between mud and water in lakes, Parts 1 and 2. Journal of Ecology, Vol. 29, pp. 280-239.

__________ 1942. The exchange of dissolved substances between mud and water in lakes, Parts 3 and 4. Journal of Ecology, Vol, 30, pp. 147-201.

Neal, J.K., 1967. Reservoir eutrophication and dystrophication following impoundment. In: Reservoir Fish Resources Symposium, Georgia University, Athens, pp. 322-332.

11.2 - Water Use and Quality (Cont'd)

Prokosch, G., 1981. Interview. October 28, 1981. Water Management Section, Division of Forest, Land and Water Management, Alaska Department of Natural Resources, Anchorage, AK.

R&M Consultants, Inc. (in _____) Alaska Power Authority Susitna Hydroelectric Project: River Morphology Studies - Devil Canyon to Cook Inlet, Report to Acres American, Inc., Buffalo, NY.

Symons, J.M., 1969. Water quality behavior in reservoirs. U.S. Public Health Service, Bureau of Water Hygiene, Cincinnati, Ohio, 200 pp.

Turkheim, R.A., 1975. Biophysical impacts of artic hydroelectric developments. In: Impacts of Mining and Hydroelectric Projects and Associated Developments on Arctic Renewable Resources and the Inuit, J.C. Day, editor, University of Western Ontario and University of Waterloo, 199 pp.

USGS, 1981. Water reserouces data for Alaska. U.S. Geological Survey, Water-Data Report AK-80-1, Water Year 1980, 373 pp.

Weiss, C.M., D.E. Francisco, and D.R. Lenat, 1973. Preimpoundment studies, Howard Mills Project. Department of Environmental Sciences and Engineering and the University of North Carolina Wastewater Research Center, Chapel Hill, North Carolina, 190 pp.

11.3 - Fish, Wildlife, and Botanical Resources

(a) Botanical Resources

ADF&G. 1980. Susitna Hydroelectric Project Environmental Studies Quarterly Report Subtask 7.11: Wildlife Ecology Studies, Big Game - Upstream Moose Studies. Alaska Department of Fish and Game for the Alaska Power Authority, Anchorage, Alaska.

APA. 1980 a. Susitna Hydroelectric Project Environmental Studies Procedures Manual Subtask 7.12: Plant Ecology Studies. Submitted by Terrestrial Environmental Specialists, Inc. and the University of Alaska to Acres American, Inc. for the Alaska Power Authority, Anchorage, Alaska.

APA. 1980 b. Susitna Hydroelectric Project Environmental Studies Annual Report Subtask 7.12: Plant Ecology Studies. Submitted by Terrestrial Environmental Specialists, Inc. to Acres American, Inc. for the Alaska Power Authority, Anchorage, Alaska.

APA. 1980 c. Susitna Hydroelectric Project Environmental Studies Subtask 7.12: Plant Ecology Studies - Preliminary Vegetation Maps of the Proposed Susitna Hydroelectric Project Impact Area (scale 1:63,360). Submitted by Terrestrial Environmental Specialists, Inc. and the University of Alaska to Acres American, Inc. for the Alaska Power Authority, Anchorage, Alaska.

APA. 1981 a. Susitna Hydroelectric Project Environmental Studies Summary Annual Report. Submitted by Terrestrial Environmental Specialists, Inc. to Acres American, Inc. for the Alaska Power Authority, Anchorage, Alaska.

APA. 1981 b. Susitna Hydroelectric Project Environmental Studies Report Subtask 7.14: Access Road Analysis - Environmental, Socioeieconomic and Land Use Analysis of Alternative Access Plans for the Susitna Hydroelectric Project. Submitted by Terrestrial Environmental Specialists, Inc., Frank Orth & Associates, and the University of Alaska to Acres American, Inc. for the Alaska Power Authority, Anchorage, Alaska.

Argus, G. W. 1973. The Genus Salix in Alaska and the Yukon. National Museum of Natural Sciences Publications in Botany, No. 2. Ottawa.

Auclair, A. N. and F. G. Goff. 1975. Intraspecific Diameter Differentiation as a Measure of Species Replacement Potential. Canadian Journal of Forestry Research 4(4): 424-434.

*Bailey, R. G. 1976. Ecoregions of the United States. United States Department of Agriculture, Forest Service, Ogden, Utah.

*Bailey, R. G. 1978. Descriptions of the Ecoregions of the United States. United States Department of Agriculture, Forest Service, Ogden, Utah.

Batten, A. R., D. F. Murray and J. C. Dawe. 1979. Threatened and Endangered Plants in Selected Areas of the BLM Fortymile Planning Unit, Alaska. BLM-Alaska Technical Report 3. Anchorage, Alaska.

*Baxter, R. M. and P. Glaude. 1980. Environmental Effects of Dams and Impoundments in Canada: Experience and Prospects. Canadian Bulletin of Fisheries and Aquatic Sciences 205: 34.

Bliss, L. C. and J. E. Cantlon. 1957. Succession on River Alluvium in Northern Alaska. American Midland Naturalist 58(2): 452-469.

Boelter, D. H. and E. S. Verry. 1977. Peatland and Water in the Northern Lake States. General Technical Report NC-31. United States Department of Agriculture, Forest Service, North Central Forest Experiment Station, St. Paul, Minnesota.

Clements, F. E. 1934. The Relict Method in Dynamic Ecology. Journal of Ecology 22: 1-68.

Conrad, H. A. 1979. How to Know the Mosses and Liverworts. William C. Brown Company, Philadelphia, Pennsylvania.

*Cowardin, L. M., V. Carter, F. C. Golet and E. T. LaRoe. 1979. Classification of Wetlands and Deepwater Habitats of the United States. FWS/BS-79/31. United States Department of the Interior, Fish and Wildlife Service, Washington, D.C.

*CRREL. 1980. Environmental Engineering and Ecological Baseline Investigations Along the Yukon River - Prudhoe Bay Haul Road. United States Army Cold Regions Research and Engineering Laboratory, Hanover, New Hampshire.

Crum, H. 1976. Mosses of the Great Lakes Forest. University Herbarium, University of Michigan, Ann Arbor, Michigan.

Drew, J. W. and R. E. Shanks. 1965. Landscape Relationships of Soils and Vegetation in the Forest-Tundra Ecotone, Upper Firth River Valley, Alaska-Canada. Ecological Monographs 35: 285-306.

*Drury, W. H., Jr. 1956. Bog Flats and Physiographic Processes in the Upper Kuskokwim River Regions, Alaska. Contributions to the Gray Herbarium, Harvard University, Boston, Massachusetts.

Dyksterhuis, E. J. 1958. Ecological Principles in Range Evaluation. Botanical Review 24: 253-272.

Gatto, L. W., C. J. Merry, H. L. McKim and D. E. Lawson. 1980. Environmental Analysis of the Upper Susitna River Basin Using LANDSAT Imagery. Report CRREL 80-4. United States Army Cold Regions Research and Engineering Laboratory, Hanover, New Hampshire.

Goff, F. G. 1968. Use of Size Stratification and Differential Weighting to Measure Forest Trends. American Midland Naturalist 79(2): 402-418.

*Hanson, H. C. 1953. Vegetation Types in Northwestern Alaska and Comparisons with Communities in Other Arctic Regions. Ecology 34: 111-140.

Haug, P. T. and G. M. Van Dyne. 1968. Secondary Succession in Abandoned Cultivated Fields: An Annotated Bibliography. ORNL-TM-2104. Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Hegg, K. M. 1970. Forest Resources of the Susitna Valley, Alaska. PNW-32. United States Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station, Juneau, Alaska.

Henry, J. D. and J. M. A. Swan. 1974. Reconstructing Forest History from Live and Dead Plant Material: An Approach to the Study of Forest Succession in Southwest New Hampshire. Ecology 55(4): 772-783.

*Hettinger, L. R. and A. J. Janz. 1974. Vegetation and Soils of Northeastern Alaska. Arctic Gas Biology Report Services 21. North Engineering Services, Company, Ltd., Edmonton, Canada.

Hironaka, M., E. W. Tisdale and M. A. Fosberg. 1976. Use of Satellite Imagery for Classifying and Monitoring Rangelands in Southern Idaho. Forest, Wildlife, and Range Experiment Station Bulletin No. 9. University of Idaho, Moscow, Idaho.

*Hulten, E. 1968. Flora of Alaska and Neighboring Territories. Stanford Univesity Press, Stanford, California.

Itow, S. 1963. Grassland Vegetation in Uplands of Western Honshu, Japan; Part II: Succession and Grazing Indicators. Japanese Journal of Botany 18(2): 133-167.

*Joint Federal-State Land Use Planning Commission of Alaska. 1973. Major Ecosystems of Alaska (map.)

Krebs, P. V., K. G. Dean and W. S. Lonn. 1978. Geomorphology and Vegetation of the Lower Susitna River Basin. United States Department of Agriculture, Soil Conservation Service, Anchorage, Alaska.

Kuchler, A. W. 1964. Where is What? Bio-Science 14(7): 39-41.

Kuchler, A. W. 1967. Vegetation Mapping. Ronald Press, New York, New York.

La Roi, G. H. 1967. Ecological Studies in the Boreal Spruce-fir Forests of the North America Taiga: I. Analysis of the Vascular Flora. Ecological Monographs 37: 229-253.

Leeuwen, G. G. 1966. A Relation Theoretical Approach to Pattern and Process in Vegetation. Wentia 15: 25-46.

McCormick, J. 1978. Ecology and Regulation of Freshwater Wetlands In Freshwater Wetlands: Ecological Processes and Management Potential. Academic Press, New York, New York.

McKendrick, J. D. and P. C. Scorup. 1974. A Super Bird's Eye View of Alaska. Agroborealis 6(1): 26-30.

Minore, D., A. W. Smart and M. E. Dubrasich. 1979. Huckleberry Ecology and Management Research in the Pacific Northwest. General Technical Report PNW-93. United States Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station, Portland, Oregon.

Mitchell, W. W. 1979. Three Varieties of Native Alaskan Grasses for Revegetation Purposes. Circular 32. Agricultural Experiment Station, University of Alaska, Fairbanks, Alaska.

Mueller-Dubois, D. and H. Ellenberg. 1974. Aims and Methods of Vegetation Ecology. John Wiley and Sons, New York, New York.

*Murray, D. F. 1980. Threatened and Endangered Plants of Alaska. United States Department of Agriculture, Forest Service and United States Department of the Interior, Bureau of Land Management, Anchorage, Alaska.

Nilsson, C. 1978. Changes in the Aquatic Flora Along a Stretch of the River Umealven, North Sweden, Following Hydro-electric Exploitation. Hydrobiologia 61(3): 229-236.

*Nilsson, C. 1981. Dynamics of the Shore Vegetation of a North Swedish Hydro-electric Reservoir During a Five-Year Period. Acta Phytogeographica Suecica 69. Uppsala, Sweden.

Payne, D. P. 1975. Introduction to Aerial Photography for Natural Resource Management. Oregon State University Press, Corvallis, Oregon.

Pichi-Sermolli, R. E. 1948. An Index for Establishing the Degree of Maturity of Plant Communities. Journal of Ecology 36: 85-90.

Rost, G. R. and J. A. Bailey. 1979. Distribution of Mule Deer and Elk in Relation to Roads. Journal of Wildlife Management 43(3): 634-641.

*Skoog, R. O. 1968. Ecology of the Caribou in Alaska. Ph.D. Dissertation. University of California, Berkeley, California.

Sochava, V. 1975. The Content of Vegetation Maps and How to Enrich It. XII International Botanical Congress, Section 8, Ecological Botany. Paper for Presentation at Symposium: Logical Principles of Construction and Improvement of Information Content of Vegetation Maps.

*Sparrow, S. D., F. J. Wooding and E. H. Whiting. 1978. Effects of Off-road Vehicle Traffic on Soils and Vegetation in the Denali Highway Region of Alaska. Journal of Soil and Water Conservation 33(1): 20-27.

Spenceley, A. P. 1973. The Effect of the Stratification of Vegetation on the Analysis of Successional Data. Journal of Ecology 61(3): 767-773.

*Spetzman, L. A. 1963. Terrain Study of Alaska, Part V: Vegetation. Engineer Intelligence Study. Office, Chief of Engineers, Department of the Army, Washington, D.C. (map).

Stanek, W. 1980. Vegetation Types and Environmental Factors Associated with Foothills Gas Pipeline Route, Yukon Territory. Environment Canada, Canadian Forestry Service, Pacific Forest Research Centre, Victoria, British Columbia.

Teskey, R. O. and T. M. Hinckley. 1977. Impacts of Water Level Changes on Woody Riparian and Wetland Communities: Plant and Soil Responses to Flooding, Volume I. United States Department of the Interior, Fish and Wildlife Service, Biological Services Program, Washington, D.C.

Thompson, J. W. 1979. Lichens of the Alaskan Arctic Slope. University of Toronto Press, Ontario.

USACOE. 1978. Plan of Study for Susitna Hydropower Feasibility Analysis. United States Army Corps of Engineers, Alaska District, Anchorage, Alaska.

USACOE. 1979. Wetlands Survey of the Watana and Devil Canyon Dam Sites. United States Army Corps of Engineers, Anchorage, Alaska.

*USDI (FWS). 1980a. Wetlands Classification System. United States Department of the Interior, Fish and Wildlife Service. Federal Register 45: 65322.

*USDI (FWS). 1980b. Endangered and Threatened Wildlife and Plants, Review of Plant Taxa for Listing as Endangered or Threatened Species. United States Department of the Interior, Fish and Wildlife Service. Federal Register 45: 82480-82569.

*Viereck, L. A. 1966. Plant Succession and Soil Development on Gravel Outwash of the Muldrow Glacier, Alaska. Ecological Monographs 36: 181-199.

*Viereck, L. A. 1970. Forest Succession and Soil Development Adjacent to the Chena River in Interior Alaska. Arctic and Alpine Research 2(1): 1-26.

*Viereck, L. A. 1975. Forest Ecology of the Alaska Taiga <u>In</u> Proceedings of the Circumpolar Conference on Northern Ecology, 1975.

Viereck, L. A. 1979. Characteristics of Treeline Plant Communities in Alaska. Holarctic Ecology 2: 228-238.

*Viereck, L. A. and C. T. Dyrness. 1980. A Preliminary Classification for Vegetation of Alaska. General Technical Report PNW-106. Pacific Northwest Forest and Range Experiment Station, Portland, Oregon.

*Viereck, L. A. and E. L. Little, Jr. 1972. Alaska Trees and Shrubs. Agricultural Handbook No. 410. United States Department of Agriculture, Forest Service, Washington, D.C.

*Viereck, L. A., J. Foote, C. T. Dyrness, K. Van Cleve, D. Kane and R. Seifert. 1979. Preliminary Results of Experimental Fires in the Black Spruce Type of Interior Alaska. PNW-332. United States Department of Agriculture, Forest Service, Washington, D.C.

Viereck, L. A. and L. A. Schandelmeier. 1980. Effects of Fire in Alaska and Adjacent Canada - A Literature Review. Alaska Technical Report 6. United States Department of Interior, Bureau of Land Management, Anchorage, Alaska.

Walker, D. A., P. J. Webber and V. Komarkova. 1979. A Large Scale (1:6000) Vegetation Mapping Method for Northern Taiga (Unpublished manuscript). Institute of Arctic and Alpine Research, Boulder, Colorado.

Wallmo, O. C., D. F. Reed and L. H. Carpenter. 1976. Alteration of Mule Deer Habitat by Wildfire, Logging, Highways, Agriculture, and Housing Developments In Mule Deer Decline in the West - A Symposium. Utah Agricultural Experiment Station, Logan, Utah.

Ward, A. L. 1979. Dispersed Recreation Impact on Big Game Resource In Dispersed Recreation and Natural Resource Management - A Syposium (in press). College of Natural Resources, Utah State University, Logan, Utah.

*Welsh, S. L. 1974. Anderson's Flora of Alaska and Adjacent Parts of Canada. Brigham Young University Press, Provo, Utah.

Whitford, P. B. 1949. Distribution of Woodland Plants in Relation to Succession and Clonal Growth. Ecology 30: 199-208.

Zasada, J. C. 1971. Natural Regeneration of Interior Alaska Forests - Seed, Seedbed, and Vegetative Reproduction Considerations In Fire in the Northern Environment - A Symposium. College, Alaska.

Zedler, P. H. and F. G. Goff. 1973. Size Association Analysis of Forest Succesisonal Trends in Wisconsin. Ecological Monographs 43(1): 79-94.

11.3 - Fish, Wildlife and Botanical Resources

(b) Wildlife Resources

*Acres American, Incorporated. 1981. Susitna Hydroelectric Project Report Subtask 6.20: Access and Camp Facilities - Watana Construction Camp. Alaska Power Authority, Anchorage, Alaska.

*Allison, L. M. 1971. Activity and Behavior of Red Foxes in Central Alaska. M.S. thesis, University of Toronto, Ontario.

*Archibald, W. R. 1980. Marten Progress Report No. 2. (unpublished). Yukon Wildlife Branch.

*Ballard, W. B. and K. P. Taylor. 1980. Upper Susitna Valley Moose Population Study. P-R Project Final Report, W-17-9, W-17-10, and W-17-11. Alaska Department of Fish and Game, Anchorage, Alaska.

*Ballard, W. B., S. D. Miller and T. H. Spraker. 1980. Moose Calf Mortality Study. P-R Project Final Report, W-17-9, W-17-10, W-17-11, and W-21-1. Alaska Department of Fish and Game, Anchorage, Alaska.

*Ballard, W. B. and R. W. Tobey. 1981. Decreased Calf Production of Moose Immobilized with Anectine. Wildlife Society Bulletin 9(3): 207-209.

*Ballard, W. B., T. H. Spraker and K. P. Taylor. 1981a. Causes of Neo-natal Moose Calf Mortality in South-Central Alaska. Journal of Wildlife Management 45 (2): 335-342.

*Ballard, W. B., C. L. Gardner and S. D. Miller. 1981b. Nelchina Yearling Moose Mortality Study. Final Report Federal Aid in Wildlife Restoration Volume 2, Projects W-17-11 and W-21-1, Job 1.27R, With Additional Support from the Alaska Power Authority, Anchorage, Alaska.

*Ballard, W. B., R. O. Stephenson and T. H. Spraker. 1981c. Nelchina Basin Wolf Studies. P-R Project Final Report W-17-9 and W-17-10. Alaska Department of Fish and Game, Anchorage, Alaska.

*Ballard, W. B., S. Miller and T. Spraker. In Press. Home Range, Daily Movements and Reproductive Biology of Brown Bears in Southcentral Alaska. Canadian Field Naturalist.

*Beecham, J. 1980. Some Population Characteristics of Two Black Bear Populations in Idaho In Bears--Their Biology and Management (Martinka and McArthur, eds.). Bear Biology Association Conference Series No. 3: 201-204.

*Bente, P. J. 1981. Nesting Behavior and Hunting Activity of the Gyrfalcon, Falco rusticolus, in the Alaska Range, Alaska. M.S. thesis, University of Alaska, Fairbanks, Alaska.

*Bergerud, A. T. 1978. Caribou In Big Game of North American (Ecology and Management) (J. L. Schmidt and D. L. Gilbert, eds.). Stackpole Books, Harrisburg, Pennsylvania.

*Bergerud, A. T. 1980. A Review of the Population Dynamics of Caribou and Wild Reindeer in North America In Reindeer/Caribou Symposium II, (E. Reimers, E. Gaare, and S. Skjenneberg, eds.). Roros. Norway.

*Berns, V. D., G. C. Atwell and D. L. Boone. 1977. Brown Bear Movement and Habitat Use at Karluk Lake, Kodiak Island In Bears--Their Biology and Management. (Martinka, C. J. and K. L. Mcarther, eds.). Biological Association Conference Series 3.

*Bishop, R. H. and R. A. Rausch. 1974. Moose Population Fluctuations in Alaska, 1950-1972. Naturaliste Canada 101: 559-593.

*Bos, G. N. 1974. Nelchina and Mentasta Caribou Reports. Federal Aid in Wildlife Restoration Project W-17-5 and W-17-6. Alaska Department of Fish and Game, Juneau, Alaska.

*Boyce, M. S. 1974. Beaver Population Ecology in Interior Alaska. M.S. thesis. University of Alaska, Fairbanks, Alaska.

*Brown, R. N. 1974. Aspects of Vocal Behavior of the Raven (Corvus corax) in Interior Alaska. M.S. thesis, University of Alaska, Fairbanks, Alaska.

*Brown, L. and D. Amadon. 1968. Eagles, Hawks and Falcons of the World, Volume 2. Country Life Books, Hamlyn Publications, Group Limited, Middlesex, Great Britain.

*Cade, T. J. 1960. Ecology of the Peregrine and Gyrfalcon Populations in Alaska. University of California Publications in Zoology 63: 151-290, Berkeley, California.

*Chatelain, E. F. 1951. Winter Range Problems of Moose in the Susitna Valley. Proceedings of the Alaska Scientific Conference 2: 343-347.

*Clarke, S. 1977. Report from New York In The Black Bear in Modern North America. Proceedings of Workshop of Management Biology of North American Black Bear (Dale Burk, ed.), Kalispell, Montana.

*Conant, B. and R. King. 1981. Alaska-Yukon Breeding Pair Survey - 1981 (on press). United States Fish and Wildlife Service Pacific Waterfowl Flyway Report 80.

*Craighead, F. C. Jr. 1976. Grizzly Bear Ranges and Movement as Determined by Radio Tracking. Pages 97-110 In M. R. Pelton, J. W. Lentfer and G. E. Folk, eds. Bears - Their Biology and Management. IUCN Publication. New Series #40 for Third International Conference on Bear Research and Management.

*Davis, J. L. 1978. History and Current Status of Alaska Caribou Herds In Parameters of Caribou Population Ecology in Alaska (D. R. Klein and R. G. White, eds.). Biological Papers of the University of Alaska Special Report Number 3.

*Dickson, J. S. 1938. Birds and Mammals of Mount McKinley National Park. Faunal Series No. 3. United States Department of the Interior, Fish and Wildlife Service, Anchorage, Alaska.

*Dixon, W. J. and M. B. Brown (eds). Biomedical Computer Programs, P-series. University of California Press, Berkeley, California.

*Erickson, A. and G. A. Petrides. 1964. Population Structure, Movements, and Mortality of Tagged Bears in Michigan In The Black Bear in Michigan. Michigan State University Agricultural Experiment Station Research Bulletin 4.

*Etkin, W. 1964. Cooperation and Competition in Social Behavior In Behavior and Organization Among Vertebrates (Etkin, W. ed.). 1964. University of Chicago Press, Chicago, Illinois.

*Franzmann, A. W. and R. E. LeResche. 1978. Alaskan Moose Blood Studies with Emphasis on Condition Evaluation. Journal of Wildlife Management 42: 344-351.

*Franzmann, A. W., C. C. Schwartz and R. O. Peterson. 1980. Moose Calf Mortality in Summer on the Kenai Peninsula, Alaska. Journal of Wildlife Management 44 (3): 764-768.

*Fuller, T. K. and L. B. Keith. 1981. Woodland Caribou Population Dynamics in Northeastern Alberta. Journal of Wildlife Management 45: 197-213.

*Gabrielson, I. N. and F. C. Lincoln. 1959. The Birds of Alaska. Stackpole Company and Wildlife Management Institute, Harrisburg, Pennsylvania.

*Glenn, L. P., J. W. Lentfer, J. B. Faro and L. H. Miller. 1976. Reproductive Biology of Female Brown Bears (Ursus arctos), McNeil River, Alaska In M. R. Pelton, J. W. Lentfer and G. E. Folk, eds. Bears - Their Biology and Management. IUCN New Series Publication 40: 381-390.

*Hagland, B. 1966. DeStora Roudjurens Vintervenor [Winter Habits of the lynx (Lynx lynx) and Wolverine (Gulo gulo) as Revealed by Tracking in the Snow]. (Summary in English). Viltrevy (Stockholm). 4: 81-299.

*Hawley, V. D. and F. E. Newby. 1957. Marten Home Ranges and Population Fluctuations. Journal of Mammalogy 38 (2): 174-184.

*Hemming, J. E. 1971. The Distribution and Movement Patterns of Caribou in Alaska. Alaska Department of Fish and Game, Wildlife Technical Bulletin No. 1. 60pp.

*Hensel, R. J., W. A. Troyer and A. W. Erickson. 1969. Reproduction in the Female Brown Bear. Journal of Wildlife Management 33 (2): 357-365.

*Hornocker, M. G. and H. S. Hash. 1981. Ecology of the Wolverine in Northwestern Montana. Canadian Journal of Zoology 59: 1286-1301.

*International Bird Census Committee. 1970. Recommendations for an International Standard for a Mapping Method in Bird Census Work. Audubon Field Notes 24: 727-736.

*Jonkel, C. J. and I. McT. Cowan. 1971. The Black Bear in the Spruce-Fir Forest. Wildlife Monographs No. 27.

*Kemp, G. A. 1972. Black Bear Population Dynamics at Cold Lake, Alberta, 1968-70. IUCN New Series Publication 23: 26-31.

*Kessel, B. 1979. Avian Habitat Classification for Alaska. Murrelet 60: 86-94.

*Kessel, B and D. D. Gibson. 1978. Status and Distribution of Alaska Birds. Studies in Avian Biology No. 1. Cooper Ornithological Society, Department of Biology, University of California, Los Angeles, California.

*King, J. G. and B. Conant. 1980. Alaska-Yukon Breeding Pair Survey - 1980. USDI FWS. Pacific Waterfowl Flyway Report. United States Department of the Interior, Fish and Wildlife Service.

*Krott, P. 1959. Der Vielfrass. Monographier der Wildsaugetiere (Gottingen) 13: 1-159.

*LeCount, A. L. 1980. Some Aspects of Black Bear Ecology in the Arizona Chaparral In Bears - Their Biology and Management. Bear Biology Association Conference Series No. 3: 175-179.

*Lensink, C. J. 1954. The Home Range of Marten (Martes americana actuosa Osgood) and Its Significance in Management (unpublished report). United States Department of the Interior, Fish and Wildlife Service.

*LeResche, R. E. 1974. Moose Migrations in North America. Naturaliste Canada 101: 393-415.

*Lindsey, f. G. and E. C. Meslow. 1977. Population Characteristics of Black Bears on an Island in Washington. Journal of Wildlife Management 41: 408-412.

*Magoun, A. J. 1979. Studies of Wolverines on and Adjacent to NPR-A In Studies of Selected Wildlife and Fish and Their Use of Habitats on and Adjacent to NPR-A, 1977-78. United States Department of the Interior.

*Martinka, C. J. 1974. Population Characteristics of Grizzly Bears in Glacier National Park, Montana. Journal of Mammalogy 55: 21-29.

*McIlroy, C. W. 1972. Effects of Hunting on Black Bears in Prince William Sound. Journal of Wildlife Management 36: 828-837.

*McIlroy, C. 1974. Moose Survey-Inventory Progress Report - 1972, Game Management Unit 13 In D. E. McKnight ed., 1974 Annual Report of Survey-Inventory Activities, Part II: Moose, Caribou, Marine Mammals and Goats. Federal Aid in Wildlife Restoration Report, Project W-17-5. Alaska Department of Fish and Game, Juneau, Alaska.

*Mech, L. D. and L. L. Rogers. 1977. Status, Distribution and Movements of Martens in Northeastern Minnesota. Research Paper NC-143. United States Department of Agriculture Forest Service, North Central Forest and Range Experiment Station, St. Paul, Minnesota.

*Miller, S. D. and W. B. Ballard. 1980. Estimates of the Density, Structure and Biomass of an Interior Alaskan Brown Bear Population, Appendix V In Moose Mortality Study. Final Report P-R Projects W-17-9, W-17-10, W-17-11 and W-21-1, Job 1.23R. Alaska Department of Fish and Game, Anchorage, Alaska.

*Modafferi, R. D. 1978. Black Bear Management Techniques Development. Final P-R Project Report W-17-8 and W-17-9, Job 17.1. Alaska Department of Fish and Game, Anchorage, Alaska.

*Mundy, K. D., and D. R. Flook. 1973. Background for Managing Grizzly Bears in the National Parks of Canada. CWS Report Series No. 22, Ottawa.

*Murie, A. 1944. The Wolves of Mount McKinley National Park. Fauna Series No. 5. United States Government Printing Office, Washington, D.C.

*Murray, D. F. 1961. Some Factors Affecting the Production and Harvest of Beaver in the Upper Tanana River, Alaska. M.S. thesis, University of Alaska, Fairbanks, Alaska.

*Pearson, A. M. 1975. The Northern Interior Grizzly Bear (Ursus arctos L.). Canadian Wildlife Service Report Series No. 34.

*Pelton, M. R. and G. M. Burghardt. 1976. Black Bears of the Smokies. Natural History: 54-63.

*Peterson, R. O. 1980. Wolf-Moose Investigation on the Kenai Peninsula, Alaska. Quarterly Report #15, Kenai National Moose Range.

*Piekielek, W., and T. S. Burton. 1975. A Black Bear Population Study in Northern California. California Fish and Game 61 (1): 4-25.

*Pils, C. M. and M. A. Marten. 1978. Population Dynamics, Predator-prey Relationships and Management of the Red Fox in Wisconsin. Tech. Bull. No. 5, Department of Natural Resources, Madison, Wisconsin.

*Poelker, R. J. and H. D. Hartwell. 1973. Black Bear of Washington. Washington State Game Department Biology Bulletin No. 14.

*Pulliainen, E. 1968. Breeding Biology of the Wolverine (Gulo gulo L.) in Finland. Ann. Zool. Fenn. 5: 338-344.

*Rausch, R. A. 1958. The Problem of Railroad-Moose Conflicts in the Susitna Valley. Job Completion Report, 12, (1), Project W-3-R-12. Federal Aid in Wildlife Restoration, Alaska Game Commission.

*Rausch, R. A. 1969. A Summary of Wolf Studies in Southcentral Alaska, 1957-1968. Transactions of the North American Wildlife and Natural Resources Conference. 34: 117-131.

*Rausch, R. A. and A. M. Pearson. 1972. Notes on the Wolverines in Alaska and Yukon Territory. Journal of Wildlife Management, 36: 249-268.

*Retzer, J. L. 1955. Physical Environmental Effects on Beavers in the Colorado Rockies. Proceedings of the 35th Annual Conference of the Western Association of State Game and Fish Commissions. 277-287.

*Reynolds, H. V. 1976. North Slope Grizzly Bear Studies. Alaska Federal Aid in Wildlife Restoration Project, W-17-6 and W-17-7.

*Reynolds, H. V. 1980. North Slope Grizzly Bear Studies. Federal Aid in Wildlife Restoration Project, W-17-11.

*Ricker, W. E. 1975. Computation and Interpretation of Biological Statistics of Fish Populations, Bulletin 191. Department of the Environment Fisheries and Marine Service, Ottawa.

*Rockwell, S. K., J. L. Perry, M. Heroldson and C. Jonkel. 1978. Vegetation Studies of Disturbed Grizzly Bear Habitat: Third Annual Report Border Grizzly Project (C. Jonkel ed.). University of Montana School of Forestry, Missoula, Montana.

*Roseneau, D. G. 1972. Summer Distribution, Numbers, and Food Habits of the Gyrfalcon (Falco rusticolus L.) on the Seward Peninsula, Alaska. M.S. thesis, University of Alaska, Fairbanks, Alaska.

*Roseneau, D. G., C. E. Tull and R. W. Nelson. 1981. Protection Strategies for Peregrine Falcons and Other Raptors Along the Proposed Northwest Alaskan Gas Pipeline Route (unpublished). LGL Alaska report to Northwest Alaskan Pipeline Company, Fairbanks, Alaska.

*Sargent, A. B., W. K. Pfeifer and S. H. Allen. 1975. A Spring Aerial Census of Red Foxes in North Dakota. J. Wildl. Manage. 39(1): 30-39.

*Schwartz, C. C. and A. W. Franzemann. 1980. Black Bear Predation on Moose. Federal Aid in Wildlife Restoration Progress Report, Projects W-17-11 and W-21-1, Job No. 17.3R.

*Schwartz, C. and A. Franzmann. 1981. Black Bear Predation on Moose. Project Progress Report, Federal Aid in Wildlife Restoration Project, W-17-2, Job 17.3R.

*Schwartz, C. and A. W. Franzemann. In Press. Effects of Habitat Manipulation on Black Bear Predation of Moose Calves. Paper Presented at Sixth International Conference on Bears, Their Biology and Management. February 1980, Madison, Wisconsin.

*Scott, T. G. and W. D. Klimstra. 1955. Red Foxes and a Declining Prey Population. Monograph Series No. 1, Southern Illinois University, Carbondale, Ill.

*Sheldon, W. G. 1950. Denning Habits and Home Range of Red Foxes in New York State. Journal of Wildlife Management 14 (1): 33-42.

*Shepherd, P. E. K. 1958. Food Habits of Railbelt Moose. Federal Aid in Wildlife Restoration, Job Completion Report, 12, (1), Project W-3-R-12.

*Shick, C. A. 1952. A Study of Pheasants on the 9,000-Acre Farm, Saginaw County, Michigan. Michigan Department of Conservation, Lansing, Michigan.

*Siniff, D. B., and R. O. Skoog. 1964. Aerial Censusing of Caribou Using Random Stratified Sampling. Journal of Wildlife Management 28: 391-401.

*Skoog, R. O. 1968. Ecology of the Caribou (Rangifer tarandus granti) in Alaska. Ph.D. dissertation, University of California, Berkeley, California.

*Spencer, D. L. and E. F. Chatelain. 1953. Progress in the Management of the Moose of Southcentral Alaska. Transactions of the American Wildlife Conference 8: 539-552.

*Spencer, H. E., Jr. 1955. The Black Bear and Its Status in Maine. Maine Department of Inland Fisheries and Game, Game Division Bulletin 4.

*Spindler, M. A. and B. Kessel. 1980. Avian Populations and Habitat Use in Interior Alaska Taiga. Syesis 13: 61-104.

*Spindler, M. A., S. M. Murphy and B. Kessel. 1981. Ground Censuses of Waterbird Populations in the Upper Tanana Valley, Alaska In Census and Inventory Methods for Populations and Habitat Sumposium (in press). Northwest Section Wildlife Society, Calgary, Alberta.

*Spraker, T. H., W. B. Ballard and S. D. Miller. 1981. Brown Bear Studies, Game Management Unit 13. Final P-R Project, Report W-17-10 and W-17-11, Job. 4.13R. Alaska Department of Fish and Game, Anchorage, Alaska.

*Storm, G. L. 1972. Population Dynamics of Red Foxes in North Central United States. Ph.D. dissertation. University of Minnesota, Minneapolis, Minnesota.

*Trent, T. T. and O. J. Rongstad. 1974. Home Range and Survival of Cottontail Rabbits in Southwestern Wisconsin. Journal of Wildlife Management 38: 459-471.

*Troyer, W. A. and R. J. Hensel. 1964. Structure and Distribution of a Kodiak Bear Population. Journal of Wildlife Management 28: 769-772.

*USACOE. Upper Susitna River Basin Southcentral Railbelt Area, Alaska - Final Environmental Impact Statement, Hydroelectric Power Development. United States Army Corps of Engineers, Washington, D.C.

*VanBallenberghe, V. 1978. Migratory Behavior of Moose in Southcentral Alaska. Proceedings at the 13th International Conference of Bame Biologists, Atlanta, Georgia.

*Van Zyll de Jong, C. G. 1975. The Distribution an Abundance of the Wolverine (Gulo gulo) in Canada. Canadian Field-Naturalist 89 (4): 431-437.

*Viereck, L. A. and C. T. Dyrness. 1980. A Preliminary Classification System for Vegetation of Alaska. General Technical Report PNW-106. Pacific Northwest Forest and Range Experiment Station, Portland, Oregon.

*Watson, G. W. and R. F. Scott. 1956. Aerial Censusing of the Nelchina Caribou Herd. Transactions of the North American Wildlife Conference 21: 449-510.

*White, C. M. 1974. Survey of the Peregrine Falcon and Other Raptors in the Proposed Susitna River Reservoir Impoundment Areas (unpublished interim report). United States Fish and Wildlife Service, Anchorage, Alaska.

*White, C. M., T. D. Ray and L. W. Sowl. 1977. The 1970-1972-1974 Raptor Surveys Along the Trans-Alaska Oil Pipeline. World Conference Birds of Prey 1: 222-229.

*Wolfe, J. O. and J. Cowling. 1981. Moose Browse Utilization in Mount McKinley National Park, Alaska. Canadian Field Naturalist 95(1): 85-88.

11.3 - Fish, Wildlife and Botanical Resources
(c) Fish Resources

Acres American, Incorporated. 1981a. Susitna Hydroelectric Project Closeout Report, Subtask 3.01: Review of Available Material. Alaska Power Authority, Anchorage, Alaska.

*Acres American, Incorporated. 1981b. Susitna Hydroelectric Project Report Subtask 2.10: Access Roads - Access Road Selection Report, First Draft. Alaska Power Authority, Anchorage, Alaska.

Acres American, Incorporated. 1981c. Susitna Hydroelectric Project - Watana Valve Type Spillway Alternative General Arrangement (map). Plate 8.1, Drawing No. SK-5706 - C6-218 (scale 1" = 200'). Alaska Power Authority, Anchorage, Alaska.

Acres American, Incorporated. 1981d. Susitna Hydroelectric Project Hydrology Information: Information on the Watana Reservoir - rough draft. Alaska Power Authority, Anchorage, Alaska.

Acres American, Incorporated. 1981e. Preliminary Design Sketches of the Watana Multilevel Intake Structure; Projected Howell-Bunger Valve Dispersion Patterns. Alaska Power Authority, Anchorage, Alaska.

Acres American, Incorporated. 1981f. Susitna Hydroelectric Project Hydrology Information. Alaska Power Authority, Anchorage, Alaska.

*ADF&G. 1972. Cook Inlet King Salmon Status Report. Alaska Department of Fish and Game, Juneau, Alaska.

*ADF&G. 1978. Alaska's Fisheries Atlas Volumes I and II. Alaska Department of Fish and Game, Juneau, Alaska.

ADF&G. 1980a. Inventory and Cataloging of Sport Fish and Sport Fish Waters of the Lower Susitna River and Central Cook Inlet Drainages. Alaska Department of Fish and Game, Anchorage, Alaska.

ADF&G. 1980b. Inventory and Cataloging of the Sport Fish and Sport Fish Waters in the Upper Cook Inlet. Alaska Department of Fish and Game, Anchorage, Alaska.

ADF&G. 1981a. Preliminary Forecasts and Projections for 1981 Alaska Salmon Fisheries. Alaska Department of Fish and Game, Anchorage, Alaska.

ADF&G. 1981b. Susitna Hydroelectric Project Environmental Studies Report Subtask 7.10: Fish Ecology Studies - Adult Anadromous Investigations, Chinook Salmon Species/Subject Report. Prepared by Alaska Department of Fish and Game for the Alaska Power Authority, Anchorage, Alaska.

ADF&G. 1981c. Susitna Hydroelectric Project Environmental Studies Report Subtask 7.10: Fish Ecology Studies - Adult Anadromous Fisheries Project. Phase 1 Final Draft Report. Prepared by Alaska Department of Fish and Game for the Alaska Power Authority, Anchorage, Alaska.

ADF&G. 1981d. Susitna Hydroelectric Project Environmental Studies Report Subtask 7.10: Fish Ecology Studies - Species Reports, Juvenile Anadromous Fish. Prepared by the Alaska Department of Fish and Game for the Alaska Power Authority, Anchorage, Alaska.

ADF&G. 1981e. Susitna Hydroelectric Project Environmental Studies Report Subtask 7.10 - Fish Ecology Studies - Juvenile Anadromous Fish Study on the Lower Susitna River. Phase 1 Final Draft Report. Prepared by Alaska Department of Fish and Game to the Alaska Power Authority, Anchorage, Alaska.

ADF&G. 1981d. Susitna Hydroelectric Project Environmental Studies Draft Report Subtask 7.10: Fish Ecology Studies - Resident Fish Investigations, upper Susitna River Species/Subject Report. Prepared by Alaska Department of Fish and Game for the Alaska Power Authority, Anchorage, Alaska.

ADF&G. 1981e. Susitna Hydroelectric Project Environmental Studies Preliminary Report Subtask 7.10: Fish Ecology Studies - Anadromous Fish Stock Separation Report, Upper Cook Inlet. Prepared by Alaska Department of Fish and Game for the Alaska Power Authority, Anchorage, Alaska.

ADF&G. 1981f. Susitna Hydroelectric Project Environmental Studies Report Subtask 7.10: Fish Ecology Studies - Investigations on the Lower Susitna River for Juvenile Anadromous and Resident Fish. Prepared by Alaska Department of Fish and Game for the Alaska Power Authority, Anchorage, Alaska.

ADF&G. 1981g. Susitna Hydroelectric Project Environmental Studies Draft Preliminary Status Report, Subtask 7.10: Fish Ecology Studies - Anadromous Fish Stock Separation. Prepared by Alaska Department of Fish and Game for the Alaska Power Authority, Anchorage, Alaska.

*APA. 1981a. Susitna Hydroelectric Project Environmental Studies Report Subtask 7.10: Fish Ecology Studies - Life History and Ecology of Selected Fishes that Occur in the Susitna River. Submitted by Terrestrial Environmental Specialists, Incorporated to Acres American, Incorporated for the Alaska Power Authority.

*APA. 1981b. Susitna Hydroelectric Project Environmental Studies Report Subtask 7.10: Fish Ecology Studies - A Preliminary Assessment of Natural Supersaturation of Devil Canyon. Submitted by Terrestrial Environmental Specialists, Incorporated to Acres American, Incorporated for the Alaska Power Authority, Anchorage, Alaska.

APA. 1981 c. Susitna Hydroelectric Project Environmental Studies Annual Report 1980 Subtask 7.10: Fish Ecology Studies. Submitted by Terrestrial Environmental Specialists, Incorporated to Acres American, Incorporated for the Alaska Power Authority, Anchorage, Alaska.

Arctic Environmental Information and Data Center. 1981. An Assessment of Environmental Effects of Construction and Operation of the Proposed Terror Lake Hydroelectric Facility, Kodiak, Alaska: Instream Flow Studies Final Report. University of Alaska, Anchorage, Alaska.

Atkinson, C. D. 1980. Information on Coho Salmon and Chinook Salmon (unpublished manuscript).

Barrett, B. M. 1974. An Assessment Study of the Anadromous Fish Populations in the Upper Susitna River Watershed Between Devil Canyon and the Chulitna River. Alaska Department of Fish and Game, Division of Commercial Fisheries, Anchorage, Alaska.

Baxter, R. M. and P. Glaude. 1980. Environmental Effects of Dams and Impoudments in Canada: Experience and Prospects. The Canadian Bulletin of Fisheries and Aquatic Sciences 205.

British Columbia Hydro and Power Authority. 1980. Peace Site C Project Environmental Impact Statement. BCHPA, Systems Engineering Division.

Broad, R. D. and H. A. Gangmark. 1956. Establishment of a Controlled Flow Area and Construction of King Salmon Spawning Pens at Mill Creek, California. The Progressive Fish-Culturist 18:131-134.

Cook Inlet Regional Planning Team. 1981. Cook Inlet Regional Salmon Enhancement Plan 1981-2000 (review draft). Anchorage, Alaska.

Cooper, A. C. 1977. Evaluation of the Production of Sockeye and Pink Salmon at Spawning and Incubation Channels in the Frasier River System. International Pacific Salmon Fisheries Commission, New Westminster, British Columbia.

Dwight, L. P. and E. W. Trihey. 1981a. A Survey of Questions and Concerns Pertaining to Instream Flow Aspects of the Proposed Susitna Hydroelectric Project - Draft. Acres American, Incorporated, Buffalo, New York.

Dwight, L. P. and E. W. Trihey. 1981b. A Survey of Questions and Concerns Pertaining to Instream Flow Aspects of the Proposed Susitna Dam Feasibility Study with Initial Comments Toward Preparation of an Instream Flow Study Plan. Acres American, Incorporated, Buffalo, New York.

Dwight, L. P. and E. W. Trihey. 1981c. A Survey of Questions and Concerns Pertaining to Instream Flow Aspects of the Proposed Susitna Hydroelectric Project - A Working Document for Preparation of an Instream Flow Study Plan. Acres American, Incorporated, Buffalo, New York.

*Friese, N. V. 1975. Preauthorization Assessment of Anadromous Fish Populations of the Upper Susitna River Watershed in the Vicinity of the Proposed Devil Canyon Hydroelectric Project. Alaska Department of Fish and Game, Division of Commercial Fisheries, Anchorage, Alaska.

Gangmark, H. A. 1955. Experimental Hatching of King Salmon in Mill Creek, a Tributary of the Sacramento River. Reprint from California Fish and Game 41: 233-242.

Gangmark, H. A. 1956. Further Observations on Stream Survival of King Salmon Spawn. Reprint from California Fish and Game 42: 37-49.

Gangmark, H. A. 1960. A Comparative Study of Unstable and Stable (artificial channel) Spawning Streams for Incubating King Salmon in Mill Creek. Report from California Fish and Game 46: 151-164.

Gustafson, J. 1977. An Evaluation of Low Water Crossings at Fish Streams Along the Trans-Alaskan Pipeline System. Special Report 16. Joint State/Federal Fish and Wildlife Advisory Team, Anchorage, Alaska.

Institute of Marine Science. 1971. Bibliography of the Oceanography and Biology of the Northern Gulf of Alaska. Alaska Oil and Gas Associates, Anchorage, Alaska.

Kinney, P. J., J. Groves and D. K. Button. 1968. Cook Inlet Environmental Data - R/V Acona Cruise 065 - May 21-28, 1968. Institute of Marine Science, University of Alaska, College, Alaska.

Lotspeich, F. B. 1971. Environmental Guidelines for Road Construction in Alaska. United States Environmental Protection Agency, Alaska Water Laboratory, College, Alaska.

May, B. and J. Huston. 1975. Kootenai River Fisheries Investigation - Status of Fish Populations in the Kootenai River Below Libby Dam Following Regulation of the River, July 1, 1972 through July 30, 1975, Phase 2, Part 1. Montana Department of Fish and Game and the United States Army Corps of Engineers.

May, B. and J. Huston. 1979. Kootenai River Fisheries Investigations - Status of Fish Populations in the Kootenai River Below Libby Dam Following Regulation of the River - Final Job Report - March 1, 1976 through June 30, 1979. Montana Department of Fish and Game and the United States Army Corps of Engineers.

*McPhail, J. D. and C. C. Lindsey. 1970. Freshwater Fishes of Northwestern Canada and Alaska. Bulletin of Fisheries Research Board of Canada, Ottawa, Ontario.

Morrow, J. E. 1980.. The Freshwater Fishes of Alaska. Alaska Northwest Publishing Company, Anchorage, Alaska.

Namtvedt, T. B. 1974. Cook Inlet Sockeye Forecast and Optimum Escapement Studies. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Washington, D.C.

Namtvedt, T. B. and N. V. Friese. 1976. Investigations of Cook Inlet Sockeye Salmon. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Washington, D.C.

National Oceanographic Data Center. 1980. NODC Catalog of OCSEAP Data. United States Department of Commerce, National Oceanographic and Atmospheric Administration, Environmental Data and Information Service, Washington, D.C.

Park, E. T. 1975. Literature Review In Effect of Reservoir Impoundment on Water Quality. Power Developments Section, Engineering Division, Water Planning and Management Branch, Inland Waters Directorate, Environment Canada, Ottawa.

Peterson, L. and R&M Consultants, Incorporated. 1982. Susitna Hydroelectric Project Hydrology Studies Draft Report. Impoundment Effects on Water Quality. Acres American, Inc., Buffalo, New York.

R&M Consultants, Incorporated. 1980a. Susitna Hydroelectric Project Hydrology Studies: Field Data Log Through Summer of 1981. Submitted to Acres American, Inc. for the Alaska Power Authority, Anchorage, Alaska.

R&M Consultants, Incorporated. 1980b. Susitna Hydroelectric Project Hydrology Studies: Preliminary Hydraulic Data in the Vicinity of Gold Creek. Submitted to Acres American, Incorporated for the Alaska Power Authority, Anchorage, Alaska.

R&M Consultants, Incorporated. 1980c. Susitna Hydroelectric Project Quarterly Report Subtask 3.03: Field Data Collection and Processing - Water Quality Data Collected (19 June 1980 - 30 September 1980). Submitted to Acres American, Incorporated for the Alaska Power Authority, Anchorage, Alaska.

R&M Consultants, Incorporated. 1981a. Susitna Hydroelectric Project Annual Report Subtask 3.03: Field Data Collection and Processing - Water Quality Data Collection. Submitted to Acres American, Incorporated for the Alaska Power Authority, Anchorage, Alaska.

R&M Consultants, Incorporated. 1981b. Susitna Hydroelectric Project Report Subtask 3.04: Water Resources Studies - Flow Variability. Submitted to Acres American, Incorporated for the Alaska Power Authority, Anchorage, Alaska.

R&M Consultants, Incorporated. 1981c. Susitna Hydroelectric Project Interim Report Subtask 3.07: Sediment Yield and River Morphology Studies - Reservoir Sedimentation. Submitted to Acres American, Incorporated for the Alaska Power Authority, Anchorage, Alaska.

R&M Consultants, Incorporated. 1981d. Susitna Hydroelectric Project Interim Report Subtask 3.07: Sediment Yield and River Morphology Studies. Submitted to Acres American, Incorporated for the Alaska Power Authority, Anchorage, Alaska.

R&M Consultants, Incorporated. 1981e. Susitna Hydroelectric Project Interim Report Subtask 3.10: Lower Susitna Studies - Preliminary Open Water Calculations. Submitted to Acres American, Incorporated for the Alaska Power Authority, Anchorage, Alaska.

R&M Consultants, Incorporated. 1981f. Susitna Hydroelectric Project Preliminary Report Subtask 3.03: Field Data Collection and Processing - Review of Existing Susitna River Basin Water Quality Data. Submitted to Acres American, Incorporated for the Alaska Power Authority, Anchorage, Alaska.

R&M Consultants, Incorporated. 1981g. Susitna Hydroelectric Project Hydrology Studies: Set of Summarized Data from Watana Continuous Water Quality Monitor, October 23, 1980 to April 16, 1981. Submitted to Acres American, Incorporated for the Alaska Power Authority, Anchorage, Alaska.

R&M Consultants, Incorporated. 1981h. Susitna Hydroelectric Project Hydrology Studies: Streamflow Data for the Following Stations: Susitna River near Denali, at Vee Canyon, near Watana and at Gold Creek. Submitted to Acres American, Incorporated for the Alaska Power Authority, Anchorage, Alaska.

R&M Consultants, Incorporated. 1981i. Susitna Hydroelectric Project Hydrographic Studies: Preliminary Channel Geometry, Velocity, and Water Level Data for the Susitna River at Devil Canyon. Submitted to Acres American, Incorporated for the Alaskan Power Authority, Anchorage, Alaska.

Raymond, J. A. 1981. Incubation of Fall Chum Salmon Oncorhynchus keta (Walbaum) at Clear Air Force Station, Alaska. Alaska Department of Fish and Game, Division of Fisheries Rehabilitation, Anchorage, Alaska.

Riis, J. C. 1977. Pre-authorization Assessment of the Proposed Susitna Hydroelectric Projects: Preliminary Investigations of Water Quality and Aquatic Species Composition. Alaska Department of Fish and Game, Anchorage, Alaska.

Robert W. Retherford Associates and International Engineering Company, Incorporated. 1980. Terror Lake Hydroelectric Project, Kodiak Island, Alaska, Application for License, Project No. 2743. Supplement to Exhibit W, Chapter W-4: Measures to Enhance the Environment or to Avoid or Mitigate Adverse Environmental Effects. Kodiak Electric Association, Incorporated, Kodiak, Alaska.

Rosenberg, D. H., D. C. Burrell, K. V. Natarjan and D. W. Hood. 1967. Oceanography of Cook Inlet with Special Reference to the Effluent from Collier Carbon and Chemical Plant. Institute of Marine Science, University of Alaska, College, Alaska.

Scully, D. R., L. S. Leveen and R. S. George. 1978. Surface Water Records of Cook Inlet Basin, Alaska, Through September 1975. United States Geological Survey, Anchorage, Alaska.

Smirnov, A. E. 1975. The Biology Distribution, and Development of the Pacific Salmon, Preliminary Bibliography. University of Moscow.

Smith, W. E. and R. W. Saalfeld. 1955. Studies on Columbia River Smelt, Thaleichthys pacificus (Richardson). Research Paper 1(3): 3-26. Washington Department of Fisheries, Seattle, Washington.

la Societe de developpement de la Baie James and la Societe d'energie/de Baie James. 1976. James Bay - Environment 1976 Symposium Proceedings. Sponsored by Environment Canada, Montreal, Quebec.

Washington Department of Fisheries. 1969. Spawning Channels 1969. Seattle, Washington.

Wendling, F. L. 1976. Preliminary Report on Gravel Porosity Studies Along the Trans-Alaska Pipeline, Special Report No. 5. Joint State/Federal Fish and Wildlife Advisory Team, Anchorage, Alaska.

West, C. J. 1978. Fisheries and Marine Service Technical Report Series No. 812: A Review of the Babine Lake Development Project 1961-1977. Enhancement and Service Branch, Fisheries and Marine Service, Pacific Region Department of Fisheries and Environment, Vancouver, British Columbia.

*Williams, F. J. 1968. Inventory and Cateloging of Sport Fish and Sport Fish Waters of the Copper River and Prince William Sound Drainages, and the Upper Susitna River. Federal Aid in Fish Restoration Study: Annual Progress Report 1967 - 1968, Project F-5-R-9, Job 14-A. Alaska Department of Fish and Game, Anchorage, Alaska.

Yee, C. S. and T. D. Reoelofs. 1980. Influence of Forest and Rangeland Management on Anadromous Fish Habitat in Western North America: Planning Forest Roads to Protect Salmonid Habitat. General Technical Report PNW-109. United States Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station, Portland, Oregon.

11.4 - Historic and Archeological Resources

*Acres American, Incorporated. 1980. Susitna Hydroelectric Project Plan of Study Alaska Power Authority, Anchorage, Alaska.

*Acres American, Incorporated. 1981. Susitna Hydroelectric Project Closeout Report Subtask 8.01: Transmission - Transmission Line Corridor Screening. Submitted by Acres American, Incorporated and Terrestrial Environmental Specialists, Incorporated to the Alaska Power Authority, Anchorage, Alaska.

Ager, T. A. 1975. Late Quaternary Environmental History of the Tanana Valley, Alaska. Ohio State University Institute of Polar Studies Report 54. Columbus, Ohio.

ADF&G. 1973. Alaska's Wildlife and Habitat. Alaska Department of Fish and Game, Juneau, Alaska.

ADF&G. 1975. Plant Community Studies in the Blair Lakes Range (map). Alaska Department of Fish and Game, Division of Parks.

ADNR. 1975. Laws and Regulations Relating to Archeology and Historic Preservation in Alaska, Chapter 35: Alaska Historic Preservation Act. Alaska Department of Natural Resources, Division of Parks, Juneau, Alaska.

ADNR. 1978. Alaska Heritage Resource Survey Index. Alaska Department of Natural Resources, Division of Parks, Anchorage, Alaska.

Alaska Native Language Center. 1974. Native Peoples and Languages of Alaska (map). Center for Northern Educational Research, University of Alaska, Fairbanks, Alaska.

Allen, H. T. 1887. Report of an Expedition to the Copper, Tanana, and Koyukuk Rivers in the Territory of Alaska, in the Year 1885. United States Army, Department of the Columbia, U.S. Government Printing Office, Washington, D.C.

Anderson, D. D. 1968a. A Stone Age Campsite at the Gateway to America. Scientific American 218(6): 2433.

Anderson, D. D. 1968b. Early Notched Point and Related Assemblages in the Western American Arctic. Manuscript on file in the University of Alaska Museum, Fairbanks, Alaska.

Anderson, D. D. 1968c. Archeology of the Northwestern Arctic (manuscript). Brown University, Providence, Rhode Island.

Anderson, D. D. 1970. Microblade Traditions in Northwest Alaska. Arctic Anthropology 7(2): 2-16.

Andrews, E. F. 1975. Salcha: An Athapaskan Band of the Tanana River and its Culture. M.A. Thesis, Department of Anthropology, University of Alaska, Fairbanks, Alaska.

*APA. 1980. Susitna Hydroelectric Project Environmental Studies Procedures Manual Subtask 7.06: Cultural Resources Investigation. Submitted by Terrestrial Environmental Specialists, Incorporated and the University of Alaska to Acres American, Incorporated for the Alaska Power Authority, Anchorage, Alaska.

*APA. 1981a. Susitna Hydroelectric Project Environmental Studies Annual Report Subtask 7.06: Cultural Resources Investigation. Submitted by Terrestrial Environmental Specialists, Incorporated and the University of Alaska to Acres American, Incorporated for the Alaska Power Authority, Anchorage, Alaska.

*APA. 1981b. Susitna Hydroelectric Project Environmental Studies Report Subtask 7.14: Access Road Environmental Analysis - Analysis of Access Road Alternatives. Submitted by Terrestrial Environmental Specialists, Incorporated to Acres American, Incorporated for the Alaska Power Authority, Anchorage, Alaska.

Arctic Environmental Information and Data Center. 1975. Alaska Regional Profiles: Southcentral Region. University of Alaska, Anchorage, Alaska.

Arndt, K. 1977. Structure of Cache Pitts at GUL-077, a Late Prehistoric Archeological Site Near Gulkana, Alaska. M.A. Thesis, Department of Anthropology, University of Alaska, Fairbanks, Alaska.

Bacon, G. (ed.). 1975a. Heritage Resources Along the Upper Susitna River. Miscellaneous Publications History and Archeology Series, No. 14. Alaska Department of Natural Resources, Division of Parks, Anchorage, Alaska.

Bacon, G. 1975b. Preliminary Testing at the Long Lake Archeological Site. Manuscript on file at the University of Alaska Museum, Fairbanks, Alaska.

*Bacon, G. 1978a. Archeology Near the Watana Dam Site in the Upper Susitna River Basin. Report prepared for the Alaska District, Corps of Engineers under contract DACW85-78-C-0034. Manuscript on file at the University of Alaska Museum, Fairbanks, Alaska.

*Bacon, G. 1978b. Archeology in the Upper Susitna River Basin. Report to the Alaska District, Corps of Engineers under contract DACQ85-78-0017. Manuscript on file at the University of Alaska Museum, Fairbanks, Alaska.

Bancroft, H. H. 1886. History of Alaska 1730-1885. Antiquarian Press, New York, New York (1959 reprint).

Borns, H. W., Jr., and R. P. Goldthwait. 1966. Late-Pleistocene Fluctuations of the Kaskawulash Glacier, Southeastern Yukon Territory, Canada. American Journal Science 264: 600-619.

Bowers, P. M. 1978a. Research Summary: 1977 Investigations of the Carlo Creek Archeological Site, Central Alaska. University of Alaska Museum, Fairbanks, Alaska.

Bowers, P. M. 1978b. Geology and Archeology of the Carlo Creek Site, an Early Holocene Campsite in the Central Alaska Range (Abstract) In Abstracts of the 5th Biennial Meeting, American Quaternary Association. Edmonton, Canada.

Bowers, P. M. 1979. Geology and Archeology of the Carlo Creek Site, an Early Holocene Campsite in the Central Alaska Range In Abstracts of the 5th Biannual Meeting, American Quaternary Association. Edmonton, Canada.

Brooks, A. H. 1973. Blazing Alaska's Trails. University of Alaska Press, Fairbanks, Alaska.

Carter, J. E. 1978. Executive Memorandum: Environmental Quality and Water Resources Management (July 12, 1978). Executive Office, Washington, D.C.

Clark, G. H. 1974. Archeological Survey and Excavation Along the Southernmost Portion of the Trans-Alaska Pipeline System: Final Report. Alyeska Pipeline Service Company, Anchorage, Alaska.

Clark, G. H. 1976. Archeological Survey and Excavations in the Copper River Basin, 1974 (MS). Paper presented at the 3rd Annual Meeting of the Alaska Anthropological Association, March 26-27, Anchorage, Alaska.

CLIAMP. 1976. The Surface of the Ice-Age Earth. Science 171: 1131-1137.

Cole, T. 1979. The History of the Use of the Upper Susitna River, Indian River to the Headwaters. Alaska Department of Natural Resources, Division of Research and Development, Anchorage, Alaska.

Cook, J. S. 1785. A Voyage to the Pacific Ocean. London, England.

Cook, J. P. 1969. The Early Prehistory of Healy Lake, Alaska. Ph.D. Dissertation, University of Wisconsin, Madison, Wisconsin.

Cook, J. P. and R. A. McKennan. 1970. The Village Site at Healy Lake, Alaska: an Interim Report. Paper presented at the 35th Annual Meeting of the Society of American Archeology, Mexico City, Mexico.

Cook, J. S. 1975. A New Authentic and Complete Collection of a Voyage Round the World Undertaken and Performed by Royal Authority. Alex Hogg at the Kings Arms, London, England.

Coutler, H. W, D. M. Hopkins, T. N. Karlstrom, T. L. Pewe, C. Wahrhaftig and J. R. Williams. 1965. Map showing extent of glaciations in Alaska. United States Geological Survey, USGS Miscellaneous Geological Investigations. Map I-415. U.S. Government Printing Office, Washington, D.C.

Csejtey, B., W. H. Nelson, D. J. Jones, N. J. Filberling, R. M. Dean, M. S. Morris, M. A. Lamphere, J. G. Smith and M. L. Silberman. 1978. Reconnaissance Geological Map and Geochronology, Talkeetna Mountains Quadrangle, Northern Part of Anchorage Quadrangle, and Southwest Corner of Healy Quadrangle, Alaska. United States Geological Survey Open-File Report 78-588-A. U.S. Government Printing Office, Washington, D.C.

deLaguna, F. 1975. The Archeology of Cook Inlet, Alaska, Second Edition. Alaska Historical Society, Anchorage, Alaska.

Denton, G.H. 1974. Quaternary Glaciations of the White River Valley, Alaska, with a Regional Synthesis for the Northern St. Elias Mountains, Alaska and Yukon Territory. Geologic Society of America Bulletin 85: 871-892.

Denton, G. H. and W. Karlen. 1973. Holcene Climatic Variations - Their Pattern and Possible Cause. Quaternary Research 3: 155-205.

Denton, G. H. and G. Stuiver. 1967. Late Pleistocene Glacial Stratigraphy and Chronology, Northeastern St. Elias Mountains, Yukon Territory, Canada. Geological Society of America Bulletin 75.

Dixon, E. J., Jr., G. S. Smith, and D. C. Plaskett. 1980. Archeological Survey and Inventory of Cultural Resources, Ft. Wainwright, Alaska: Final Report. Prepared for Department of the Army, Alaska District, Corps of Engineers. Contract DACA85-78-0047. University of Alaska Museum, Fairbanks, Alaska.

Dumond, D. E. 1977. The Eskimos and Aleuts. Thames and Hudson, London, England.

Dumond, D. E. 1979. Eskimo-Indian Relations: A View From Prehisotry. Arctic Anthropology 16(2): 3-22.

Dumond, D. E. and R. L. A. Mace. 1968. An Archeological Survey Along Knik Arm. Anthropological Papers of the University of Alaska 14(1): 1-21.

Elridge, G. H. 1900. A Reconnaissance in the Susitna Basin and Adjacent Territory, Alaska in 1898 In 20th Annual Report of the United States Geological Survey 7: 1-29. U.S. Government Printing Office, Washington, D.C.

FERC. 1981. Final Rules: Application for License for Major Unconstructed Projects and Major Modified Projects; Application for License for Transmission Lines Only; and Application for Amendment to License. United States Federal Energy Regulatory Commission. Federal Register 46: 55926-55954.

FERC. n.d. Statement of General Policy to Implement Procedures for Compliance with the National Environmental Policy Act of 1969. United States Federal Regulatory Commission 81 CFR 2.80.

Fernald, A. T. 1965. Glaciation in the Nabesna River Area, Upper Tanana River Valley, Alaska. United States Geological Survey Professional Paper 525-C. U.S. Government Printing Office, Washington, D.C.

Ferrians, O. J., and H. R. Schmoll. 1957. Extensive Proglacial Lake of Wisconsinan Age in the Copper River Basin, Alaska (abstract). Geological Society of America Bulletin 68: 1726.

Fladmark, K. R. 1978. A Guide to Basic Archaeological Field Procedures. Department of Archaeology, Publication No. 4. Simon Fraser University, Burnaby, B. C.

Funk, J. M. 1973. The Late Quaternary History of Cold Bay, Alaska, and Its Implications to the Configuration of the Bering Land Bridge (abstract). Geological Society of America Abstracts with Programs 5: 62.

Goldthwait, R. P. 1966. Evidence from Alaskan Glaciers of Major Climatic Changes In Proceedings of the International Symposium on World Climate, 8000 to 0 B.C. Royal Meteorlogical Society, London, England.

Guedon, M. F. 1975. People of Tetlin, Why Are Your Singing? Ethnology Division Paper No. 9. National Museum of Canada, Ottawa.

Hamilton, T. D. 1976. Camp Century Record vs. Dated Climatic Records from Alaska and Siberia (abstract) In Abstracts, 4th National Conference, American Quaternary Association, Tempe, Arizona.

Hamilton, T. D. 1977. Late Cenozoic Stratigraphy of the South-Central Brooks Range. United States Geological Survey Circular 772-B:B36-B38. United States Geological Survey. U.S. Government Printing Office, Washington, D.C.

Hamilton, T. D., R. Stuckenrath, and M. Stuiver, M. 1980. Itkillik Glaciation in the Central Brooks Range: Radiocarbon Dates and Stratigraphic Record (abstract). Geological Society of America Abstracts with Programs 12(3): 109.

Haselton, G. M. 1966. Glacial Geology of Muir Inlet, Southeast Alaska. Institute of Polar Studies Report 18. Ohio State University, Columbus, Ohio.

Helm, J., P. Alliband, T. Birk, V. Lawson, S. Reisner, C. Sturtevant and S. Witowski. 1975. The Contact History of the Subarctic Athapaskans: An Overview In Proceedings: Northern Athapaskan Conference, 1971. National Museum of Canada, Ottawa.

Heusser, C. J. 1960. Late-Pleistocene Environments of North Pacific North America. American Geographical Society Special Publication 35.

Heusser, C. J. 1965. A Pleistocene Phytogeographical Sketch of the Pacific Northwest and Alaska In The Quaternary of the United States. Princeton University Press, Princeton, New Jersey.

Hickey, C. G. 1976. The Effects of Treeline Shifts on Human Societies: Crazy Quilt Variability vs. Macrozonal Adaption In International Conference on the Prehistory and Paleoecology of North American Arctic and Subarctic. University of Calgary, Calgary, Alberta.

Hoeffecker, J. F. 1978. Potential of the North Alaska Range for Archeological Sites of of Pleistocene Age. A Report to the National Geographic Society and the National Parks Service. Manuscript on file in the University of Alaska Museum, Fairbanks, Alaska.

Hoeffecker, J. F. 1979. The Search for Early Man in Alaska, Results and Recommendations of the North Alaska Range Project. A Report to the National Geographic Society and the National Park Service.

Holmes, C. E. 1976. 3000 Years of Prehistory at Minchumina: The Question of Cultural Boundaries. Paper presented at the 9th Annual Conference of the University of Calgary Archeological Association, Calgary, Alberta.

Holmes, C. E. 1977. Progress Report: Archeological Research at Lake Minchumina, Central Alaska. Manuscript on file in the University of Alaska Museum, Fairbanks, Alaska.

Holmes, C. E. 1978. Report on Archeological Research at Lake Minchumina, Alaska During 1977. Manuscript on file in the University of Alaska Museum, Fairbanks, Alaska.

Hopkins, D. M. 1967. The Bering Land Bridge. Stanford University Press, Stanford, California.

Hosley, E. H. 1966. The Kolchan: Athapaskans of the Upper Kuskokwim. Manuscript on file in the University of Alaska Museum, Fairbanks, Alaska.

Hosley, E. H. 1967. The McGrath Ingalik Indians, Central Alaska In Yearbook of the American Philosophical Society.

Hughes, O. L., R. B. Campbell, J. E. Muller and J. O. Wheeler. 1969. Glacial Limits and Flow Patterns, Yukon Territory, South of 65 Degrees North Latitude. Geological Survey of Canada Paper 68 34: 1-9.

Irving, W. N. 1957. An Archeological Survey of the Susitna Valley. Anthropological Papers of the University of Alaska, Fairbanks 6(1): 37-52.

Irving, W. N. 1957. Pleistoncene Archeology in Eastern Beringia In Early Man in America, Occasional Paper No. 1. Department of Anthropology, University of Alberta, Edmonton, Alberta.

Joint Federal State Land Use Planning Commission for Alaska. 1973. Major Ecosystems of Alaska: Ecosystems Information.

Kachadoorian, R., A. T. Ovenshine and S. Bartsch-Winkler. 1977. Late Wisconsinan History of the South Shore of Turnagain Arm, Alaska. United States Geological Survey Circular 751-B:B49-B50. U.S. Government Printing Office, Washington, D.C.

Karlstrom, T. N. V. 1964. Quaternary Geology of the Kenai Lowland and Glacial History of the Cook Inlet Region, Alaska. United States Geological Survey Professional Paper 443. United States Government Printing Office, Washington, D.C.

Langway, C. C., Jr., W. Dansgaard, S. J. Johnsen and H. Clausen. 1973. Climatic Fluctuations During the Late Pleistocene In The Wisconsinan Stage. Geological Society of America Memoir 136.

Lyle, W. M. 1974. Newly Discovered Tertiary Sedimentary Basin Near Denali. Alaska Division of Geological and Geophysical Surveys Annual Report, 1973. Alaska Department of Natural Resources, Anchorage, Alaska.

Manville, R. H. and S. P. Young. 1965. Distributions of Alaskan Mammals. Circular 221. United States Department of the Interior, Bureau of Sports Fisheries and Wildlife.

Matthews, J. V., Jr. 1974. Wisconsinan Environment of Interior Alaska: Pollen and Macrofossil Analysis of a 27 Meter Core From the Isabella Basin (Fairbanks, Alaska). Canadian Journal of Earth Science 11: 828-841.

Mauger, J. E. 1970. A Study of Donnelly Burins in the Campus Archaeological Collection. M.A. Thesis. Washington State University, Pullman, Washington.

McKennan, R. A. 1959. The Upper Tanana Indians. Yale University Publications in Anthropology No. 55. Yale University Press, New Haven, Connecticut.

McKenzie, G. D. and R. P. Goldthwait. 1971. Glacial History of the Last Eleven Thousand Years in Adams Inlet, Southeastern Alaska. Geological Society of America Bulletin 82: 1767-1782.

Miller, M. M. and J. H. Anderson. 1974. Out-of-Phase Holocene Climatic Trends in the Maritime and Continental Sectors of the Alaska-Canada Boundary Range In Quaternary Environments, Proceedings of a Symposium. York University, Toronto, Ontario.

Miller, R. D. and E. Dobrovolny. 1959. Surficial Geology of Anchorage and Vicinity, Alaska. United States Geological Survey Bulletin 1093. U.S. Government Printing Office, Washington, D.C.

Moffit, F. H. 1912. Headwater Regions of the Gulkana and Susitna Rivers, Alaska. United States Geological Survey Bulletin 498. U.S. Government Printing Office, Washington, D.C.

Morlan, R. E. 1978. Early Man in Northern Yukon Territory: Perspective as of 1977 In: Early Man in America, Occasional Paper No. 1. Department of Anthropology, University of Alberta, Edmonton, Alberta.

Nelson, N. C. 1935. Early Migrations of Man to North America. Natural History 35: 356.

Nelson, N.C. 1937. Notes on Cultural Relations Between Asia and America. American Antiquity 2(4): 267-272.

Nelson, R. K. 1973. Hunters of the Northern Forest. University of Chicago Press, Chicago, Illinois.

Nixon, R. M. 1970. Executive Order 11514, Protection and Enforcement of Environmental Quality. March 7, 1970. Federal Register 35(4).

Nixon, R. M. 1971. Executive Order 11593. Protection and Enhancement of the Cultural Environment. 16 CFR 470, Federal Register 36:8921.

Olson, E. A. and W. S. Broecker. 1959. Lamont Natural Radiocarbon Measurements V. American Journal of Science 257: 1-28.

Osgood, C. 1937. The Ethnography of the Tanaina. Yale University Publications in Anthropology, No. 16. Yale University Press, New Haven, Connecticut.

Pewe, T. L. 1975. Quaternary Geology of Alaska. United States Geological Survey Professional Paper 835. U.S. Government Printing Office, Washington, D.C.

Pewe, T. L. and R. D. Reger. 1972. Modern and Wisconsinan Snowlines in Alaska In Proceedings of the 24th International Geological Congress, Montreal, Quebec.

Pitts, R. S. 1972. The Changing Settlement Patterns and House Types of the Upper Tanana Indians. M.A. Thesis. Department of Anthropology, University of Alaska, Fairbanks, Alaska.

Plaskett, D. C. 1977. The Nenana River Gorge Site, a Late Prehistoric Athapaskan Campsite in Central Alaska. M.A. Thesis. Department of Anthropology, University of Alaska, Fairbanks, Alaska.

Plaskett, D.C. and E. J. Dixon, Jr. 1978. Men Out of Southeast Asia: An Alternative Hypothesis for the Early Peopling of the Americas. Paper Presented at the 5th Annual Meeting, Alaska Anthropological Association, Anchorage, Alaska.

Powers, W. R. and T. D. Hamilton. 1978. Dry Creek: A Late Pleistocene Human Occupation in Central Alaska In Early Man in America, Occasional Paper No. 1. Department of Anthropology, University of Alberta, Edmonton, Alberta.

Rainey, F. 1939. Archeology in Central Alaska. Anthropological Papers of the American Museum of Natural History 36(4): 351-405.

Rainey, F. 1940. Archeological Investigations in Central Alaska. American Antiquity 5(4): 399-408.

Rainey, F. 1953. The Significance of Recent Archeological Discoveries in Inland Alaska. Society for American Archeology Memoir No. 9.

Rampton, V. 1971. Later Quaternary Vegetational and Climatic History of the Snag-Klutlan Area, Southeastern Yukon Territory, Canada. Geological Society of America Bulletin 82: 959-978.

R&M Consultants, Incorporated. 1981. Susitna Hydroelectric Project Preliminary Report Subtask 2.10: Access Roads - Access Plan. Submitted to Acres American, Incorporated for the Alaska Power Authority, Anchorage, Alaska.

Rampton, V. 1971. The Tilted Forest; Glaciological Geologic Implications of Vegetation Neoglacial Ice at Lituya Bay, Alaska. Quarternary Research 6: 111-117.

Reger, D. R. 1977. Prehistory in the Upper Cook Inlet, Alaska In Problems in the Prehistory of the North American Subarctic: The Athapaskan Question. Proceedings of the 9th Annual Conference of the Archaeological Association of the University of Calgary. Archeological Association, Department of Archeology, University of Calgary, Alberta.

Reger, D. R. and T. L. Pewe. 1969. Lichonometric Dating in the Central Alaska Range In The Periglacial Environment: Past and Present. McGill - Queens University Press, Montreal, Quebec.

Reid, J. R. 1970. Late Wisconsinan and Neoglacial History of the Martin River Glacier, Alaska. Geological Society of America Bulletin 81: 3593-3603.

Schmoll, H. R., B. J. Szabo, M. Rubin and E. Dobrovonly. 1972. Radiometric Dating of Marine Shells from the Bootlegger Cove Clay, Anchorage Area, Alaska. Geological Society of America Bulletin 83: 1107-1113.

Schweger, C. E. n.d. Notes on the Paleoecology of the Northern Archaic Tradition. Manuscript on file in the University of Alaska Museum, Fairbanks, Alaska.

Schweger, C. E. 1973. Late Quaternary History of the Tangle Lakes Region, Alaska - A Progress Report (Unpublished Manuscript). Anthropology Department, University of Alberta, Edmonton, Alberta.

Sellman, P. 1967. Geology of the USA CRREL Permafrost Tunnel, Fairbanks, Alaska. United States Army CRREL Technical Report 199. Cold Region Research and Engineering Laboratory, Hanover, New Hampshire.

Shackleton, N. J. and N. D. Opdyke. 1973. Oxygen Isotope and Palaeomagnetic Stratigraphy of Equatorial Pacific Core V28-238: Oxygen Isotope Temperatures and Ice Volumes on a 10^5 Year and 10^6 Year Scale. Quaternary Research 3: 39-55.

Shinkwin, A. D. 1974. Archeological Report: Dekah De'nin's Village: An Early Nineteenth Century Ahtna Village, Chitina, Alaska. Department of Anthropology, University of Alaska, Fairbanks, Alaska.

Shinkwin, A. D. 1975. The Dixthada Site: Results of 1971 Excavations. The Western Canadian Journal of Anthropology 5(3-4): 148-158.

Sirkin, L. A. and S. Tuthill. 1971. Late Pleistocene Palynology and Stratigraphy of Controller Bay Region, Gulf of Alaska In Etudes sur le Quaterniare dans le mode: Proceedings of the VIIIth INQUA Congress, 1969. Paris, France.

Sirkin, L. A., S. J. Tuthill and L. S. Clayton. 1971. Late Pleistocene History of the Lower Copper River Valley, Alaska (abstract). Geological Society of America Abstracts with Programs 3(7): 708.

Skarland, I. and C. Keim. 1958. Archeological Discoveries on the Denali Highway, Alaska. Anthropological Papers of the University of Alaska 6(2): 79-88. Fairbanks, Alaska.

Smith, G. S. and H. M. Shields. 1977. Archeological Survey of Selected Portions of the Proposed Lake Clark National Park: Lake Clark, Lake Telaquana, Turquoise Lake, Twin lakes, Fishtrap Lake, Lachbuna Lake, and Snipe Lake. Occasional Paper No. 7. Anthropology and Historic Preservation, Cooperative Park Studies Unit, University of Alaska, Fairbanks, Alaska.

Swanston, D. W. 1969. A Late-Pleistocene Glacial Sequence from Prince of Wales Island, Alaska. Arctic 22: 25-33.

Terasmae, J. 1974. An Evaluation of Methods Used for Reconstruction of Quaternary Environments, Quarternary Environments: Proceedings of a Symposium. York University , Toronto.

Terasmae, J. and O. L. Hughes. 1966. Late-Wisconsinan Chronology and History of Vegetation in the Ogilvie Mountains, Yukon Territory, Canada. Paleobotanist 15: 235-242.

Thorson, R. M. n.d. Quaternary Glacier Expansions from North America's Highest Mountain: A Preliminary Chronology for the McKinley River Area, Alaska (unpublished manuscript).

Townsend, J. B. 1970. Tanaina Ethnohistory: An Example of a Method for the Study of Culture Change In Enthnohistory in Southwestern Alaska and the Southern Yukon. University Press of Kentucky, Lexington, Kentucky.

Townsend, J. B. 1973. Eighteenth and Nineteenth Century Eskimo and Indian Movements in Southwestern Alaska. Paper presented to the Society for American Archeology Annual Meeting, San Francisco, California.

Traganza, A. E. 1964. An Archeological Survey of Mount McKinley National Park. Manuscript on file, Mt. McKinley National Park Library, Mt. McKinley National Park, Alaska.

United States of America. 1906. Antiquities Act of 1906. Public Law 59-209, 34 Stat. 225, 16USC 431-433.

United States of America. 1935. Historic Preservation Act. Public Law 74-292.

United States of America. 1960. Preservation of Historical and Archeological Data Threatened by Dam Construction or Alterations of Terrain: Reservoir Salvage Act. Public Law 86-523.

United States of America. 1966. National Historic Preservation Act of 1966. Public Law 89-665, 16 USCS 470.

United States of America. 1974. Reservoir Salvage Act of 1960 as Amended by the Archeological and Historic Preservation Act of 1974. Public Law 93-291.

United States Council on Environmental Quality. 1973. Preparation of Environmental Impact Statements: Guidelines. 40 CFR 1500.

USDI. 1974. Procedures for the Protection of Historic and Cultural Properties. United States Department of the Interior, Advisory Council on Historic Preservation. 36 CFR 800, Federal Register 39:3366.

USDI. 1977a. Criteria For Comprehensive Statewide Historic Survey and Plans. United States Department of the Interior, 36 CFR 61.

USDI. 1977b. Determinations of Eligibility for Inclusion in the National Register of Historic Preservation. United States Department of the Interior. 36 CFR 63.

USDI. 1979. Protection of Historic and Cultural Properties: Amendments to Existing Regulations. United States Department of the Interior, Advisory Council on Historic Preservation. Federal Register 44 (21), 36 CFR 800.

USDI. 1980a. Executive Director's Procedures for Review of Proposals for Treatment of Archeological Properties: Supplementary Guidance. United States Department of the Interior, Advisory Council on Historic Preservation. Federal Register 45: 78808-78811.

*USDI. 1980b. Treatment of Archeological Properties: A Handbook. United States Department of the Interior, Advisory Council on Historic Preservation, Washington, D.C.

USDI (BLM). 1980. Alaska Native Selections: Implementation of the Alaska Native Claims Settlement Act. United States Department of the Interior, Bureau of Land Management. Federal Register 45: 30606-30608.

USDI (HCRS). 1978. The Secretary of the Interior's Standards for Historic Preservation Projects. United States Department of the Interior, Heritage Conservation and Recreation Service. 36 CFR 1207, Federal Register 43: 57250.

USDI (HCRS). 1980. Uniform Rules and Regulations for the Protection and Conservation of Archeological Resources Located on Public and Indian Lands. United States Department of the Interior, Heritage Conservation and Recreation Service. 36 CFR 1215, Federal Register 45: 77755-77757.

USDI (HCRS). 1981. Proposed Uniform Rulemaking and Notice of Public Hearings: Archeological Resources Protection Act of 1979. United States Department of the Interior, Heritage Conservation and Recreation Service. Federal Register 46: 5566-5575.

USDI (NPS). 1977. Proposed Guidelines for Recovery of Scientific, Prehistoric, Historic, and Archeological Data: Methods, Standards, and Reporting Requirements. United States Department of the Interior, National Park Service. Federal Register 42: 5374-5377.

USDI (NPS). 1981. National Register of Historic Places. United States Department of the Interior, National Park Service, Washington, D.C. 36 CFR 60.

Valdez News. July 10, 1901. Valdez, Alaska.

VanStone, J. W. 1955. Exploring the Copper River Country. Pacific Northwest Quarterly 46 (4): 115-123.

VanStone, J. W. 1974. Athapaskan Adaptations. Aldine Publishing Company, Chicago, Illinois.

Vitt, R. 1973. Hunting Practices of the Upper Tanana Indians. M.A. Thesis. Department of Anthropology, University of Alaska, Fairbanks, Alaska.

Wahrhaftig, C. 1958. Quaternary Geology of the Nenana River Valley and Adjacent Parts of the Alaska Range. United States Geological Survey Professional Paper 293-A. U.S. Government Printing Office, Washington, D.C.

Wahrhaftig, C. and A. Cox. 1959. Rock Glaciers in the Alaska Range. Geological Society of America Bulletin 70: 383-436.

Wahrhaftig, C., J. A. Wolfe, E. B. Leopold and M. A. Lanphere. 1969. The Coal-Bearing Group in the Nanana Coal Field, Alaska. United States Geological Survey Bulletin 1274-D. U.S. Government Printing Office, Washington, D.C.

West, C. E. 1978. Archeology of the Birches Site, Lake Minchumina, Alaska. M.A. Thesis. Department of Anthropology, University of Alaska, Fairbanks, Alaska.

West, F. H. 1965. Excavation at Two Sites on the Teklanika River, Mt. McKinley National Park, Alaska. Report to the National Park Service.

West, F. H. 1967. The Donnelly Ridge Site and the Definition of an Early Core and Blade Complex in Central Alaska. American Antiquity 32 (3): 360-382.

West, F. H. 1971. Archeological Reconnaissance of Denali State Park, Alaska. Report to State of Alaska, Department of Natural Resources, Division of Parks, Anchorage, Alaska.

West, F. H. 1973. Old World Affinities of Archeological Complexes from Tangle Lakes, Central Alaska. Paper read at the International Conference on the Bering Land Bridge and Its Role for the History of Holactic Floras and Faunas in the Late Cenozoic, Khabarovsk.

West, F. H. 1975. Dating the Denali Complex. Arctic Anthropology 12(1): 75-81.

Willey, G. R. and P. Phillips. 1970. Method and Theory in American Archaeology. University of Chicago Press, Chicago, Illinois.

Williams, J. R. and O. J. Ferrians, Jr. 1961. Late Wisconsinan and Recent History of the Matanuska Glacier, Alaska. Arctic 14: 82-90.

Wolfe, J. A. 1966. Tertiary Plants from the Cook Inlet Region, Alaska. United States Geological Survey Professional Paper 398-B. U.S. Government Printing Office, Washington, D.C.

Wolfe, J.A., D. M. Hopkins and E. B. Leopold. 1966. Tertiary Stratigraphy and Paleobotany of the Cook Inlet Region, Alaska. United States Geological Survey Professional Paper 398-A. U.S. Government Printing Office, Washington, D.C.

Wolfe, J.A. and T. Tanai. 1980. The Miocene Seldovia Point Flora from the Kenai Group, Alaska. United States Geological Survey Professional Paper 1105. U.S. Government Printing Office, Washington, D.C.

Workman, W. B. 1976. A Late Prehistoric Ahtna Site Near Gulkana, Alaska. Paper presented at the 3rd Annual Conference of the Alaska Anthropological Association, Anchorage, Alaska.

Workman, W. B. 1977. New Data on the Radiocarbon Chronology of the Kachemak Bay Sequence. Anthropology Papers of the University of Alaska 18(2): 31-36.

Workman, W. B. 1978. Prehistory of the Aishihik-Kluane Areas, Southwest Yukon Territory. Mercury Series No. 74. National Museum of Canada, Ottawa, Ontario.

11.5 - Socioeconomics

ABT Association, Incorporated. 1979. Forecasts for Western Coal/Energy Development. Western Coal Planning Assistance Project, Missouri River Basin Commission, Omaha, Nebraska.

ADCED. 1977. Visitor Census and Expenditure Survey, 1977 and Winter, 1976-1977. (Prepared by Parker Research Corporation). Alaska Department of Commerce & Economic Development, Division of Economic Enterprise, Juneau, Alaska.

ADCED. 1978. Jobs and Power for Alaska, A Program for Power and Economic Development. Alaska Department of Commerce and Economic Development, Juneau, Alaska.

*ADCED. 1979a. Numbers. Alaska Department of Commerce and Economic Development, Division of Economic Enterprise, Juneau, Alaska.

ADCED. 1979b. The Performance Report of the Alaska Economy in 1979, Volume Eight. Alaska Department of Commerce and Economic Development, Division of Economic Enterprise, Juneau, Alaska.

ADCED. 1979c. An Assessment of the Domestic Market for Alaska Wood Products. Alaska Department of Commerce and Economic Development, Division of Economic Enterprise, Juneau, Alaska.

ADCED. 1979d. What You Never Thought to Ask About Mining. Alaska Department of Commerce and Economic Development, Division of Economic Enterprise, Juneau, Alaska.

ADCED. 1980a. Community Project Matrix. Alaska Department of Commerce and Economic Development, Division of Economic Enterprise, Juneau, Alaska.

ADCED. 1980b. The Alaska Statistical Review 1980. Alaska Department of Commerce and Economic Development, Division of Economic Enterprise, Juneau, Alaska.

ADCED. 1980c. Alaska Regional Energy Resources Planning Project, Phase 2, Volume II: Hydroelectric Development. Alaska Department of Commerce and Economic Development, Division of Energy and Power Development, Juneau, Alaska.

ADCED. 1980d. State of Alaska Guide Register 1980. Alaska Department of Commerce and Economic Development, Division of Occupational Licensing, Guide Licensing and Control Board, Juneau, Alaska.

ADCED. n. d. State of Alaska Quarterly Econometric Model. Alaska Department of Commerce and Economic Development, Juneau, Alaska.

ADCED. Various quarterly issues. Information and Reporting System. Alaska Department of Commerce and Economic Development, Division of Economic Enterprise, Juneau, Alaska.

ADCED and USDA. 1977. Alaska Farm Cost of Production Survey. Alaska Department of Commerce and Economic Development, Division of Economic Enterprise and United States Department of Agriculture, Economic Research Service, Juneau, Alaska.

ADF&G. 1977. Annual Report of Survey-Inventory Activities, Part I: Black Bear, Brown Bear, and Polar Bear. Alaska Department of Fish and Game, Division of Game, Juneau, Alaska.

ADF&G. 1979. Susitna Hydroelectric Project Environmental Studies Preliminary Final Plan of Study Subtask 7.10: Fish Ecology Studies. Submitted by the Alaska Department of Fish and Game to the Alaska Power Authority, Anchorage, Alaska.

ADF&G. 1980a. Alaska Game Management Units (map). Alaska Department of Fish and Game, Division of Game, Alaska Board of Game, Juneau, Alaska.

ADF&G. 1980b. Alaska Hunting Regulations, No. 21. Alaska Department of Fish and Game, Division of Game, Alaska Board of Game, Juneau, Alaska.

ADF&G. 1980c. Alaska Trapping Regulations, No. 21. Alaska Department of Fish and Game, Division of Game, Alaska Board of Game, Juneau, Alaska.

ADF&G. 1980d. Annual Report of Survey-Inventory Activities, Part II: Bison, Caribou, Moose and Muskoxen. Alaska Department of Fish and Game, Division of Game, Juneau, Alaska.

ADF&G. 1980e. Annual Report of Survey-Inventory Activities, Part III: Deer, Elk, Marine Mammals, Mountain Goats, and Sheep. Alaska Department of Fish and Game, Division of Game, Juneau, Alaska.

ADF&G. 1980f. Annual Report of Survey-Inventory Activities, Part IV: Furbearers, Upland Game, Wolf, and Wolverine. Alaska Department of Fish and Game, Division of Game, Juneau, Alaska.

ADF&G. 1980g. 1980 Alaska Sport Fishing Seasons and Bag Limits. Alaska Department of Fish and Game, Division of Sport Fish, Alaska Board of Fisheries, Juneau, Alaska.

ADF&G. 1980h. Sport Fish Survey. Alaska Department of Fish and Game, Juneau, Alaska.

ADNR. 1980i. Susitna Basin Land Use/Recreation Atlas, Planning Background Report. Alaska Department of Natural Resources, Division of Research and Development, Land and Resource Planning Section, Anchorage, Alaska.

ADNR and USDA. Various annual issues. Alaska Agriculture Statistics. Alaska Department of Natural Resources, Division of Agriculture and United States Department of Agriculture, Palmer, Alaska.

Alaska Department of Community and Regional Affairs. 1973. Pipeline Corridor Smaller Communities Survey. Division of Community Planning, Juneau, Alaska.

Alaska Department of Community and Regional Affairs. 1974. Selected 1970 Census Data for Alaska Communities, Part V: Southcentral Alaska. Division of Community Planning, Juneau, Alaska.

Alaska Department of Community and Regional Affairs. 1976. Report of FY 75 Trans-Alaska Pipeline Impact Expenditures by State and Local Governments. Division of Community Planning, Juneau, Alaska.

Alaska Department of Community and Regional Affairs. 1980a. Alaska Taxable 1979 Municipal Property Assessments and Equalized Full Value Determinations. Division of Local Government Assistance, Juneau, Alaska.

Alaska Department of Community and Regional Affairs. 1980b. City Financial Reporting Manual, FY 1980. Division of Local Government Assistance, Juneau, Alaska.

Alaska Department of Education. 1980. 1980-1981 Alaska Education Directory. Alaska Department of Education, Juneau, Alaska.

Alaska Department of Labor. 1972. Economic Analysis, Issue 10, Volume 1. Employment Security Division, Juneau, Alaska.

Alaska Department of Labor. 1975 and 1979. Civilian Labor Force Data. Research and Analysis Section, Juneau, Alaska.

Alaska Department of Labor. 1978a. Occupational Employment Statistics: Manufacturing Industries 1977. Alaska Department of Labor, Juneau, Alaska.

Alaska Department of Labor. 1978b. Alaska Economic Outlook to 1985. Alaska Department of Labor, Juneau, Alaska.

Alaska Department of Labor. 1979a. Occupational Employment Forecast. Alaska Department of Labor, Juneau, Alaska.

Alaska Department of Labor. 1979b. Occupational Employment Statistics: Nonmanufacturing Industries 1978. Alaska Department of Labor, Juneau, Alaska.

Alaska Department of Labor. 1979c. Alaska Population Overview. Alaska Department of Labor, Juneau, Alaska.

Alaska Department of Labor. 1979d. Occupational Supply and Demand. Alaska Department of Labor, Juneau, Alaska.

Alaska Department of Labor. 1980a. Annual Planning Information, FY 1981. Alaska Department of Labor, Juneau, Alaska.

Alaska Department of Labor. 1980b. Occupational Supply and Demand. Alaska Department of Labor, Juneau, Alaska.

Alaska Department of Labor. 1980c. Occupational Employment Statistics, 1979. Alaska Department of Labor, Juneau, Alaska.

Alaska Department of Labor. 1980d. Planning Information for Vocational Education. Alaska Department of Labor, Juneau, Alaska.

Alaska Department of Labor. 1980e. Trade and Regulated Industries Occupational Employment Statistics, 1979. Administrative Services Division, Juneau, Alaska.

*Alaska Department of Labor. 1980f. Alaska Statistical Quarterly. Office of the Commission Research and Analysis Section, Juneau, Alaska.

*Alaska Department of Labor. 1981. Alaska 1980 Population: A Preliminary Overview. Administrative Services Division, Juneau, Alaska.

*Alaska Department of Labor. 1981. Laborers' and Mechanics' Minimum Rates of Pay. Alaska Department of Labor, Juneau, Alaska.

Alaska Department of Labor. n.d. Labor Market Information Directory. Alaska Department of Labor, Juneau, Alaska.

Alaska Department of Labor. n.d. Educational Institutions Occupational Employment Statistics. Alaska Department of Labor, Juneau, Alaska.

*Alaska Department of Labor. n.d. Unemployment Insurance Records 1964-1980. Alaska Department of Labor, Juneau, Alaska.

*Alaska Department of Labor. Various issues. Statistical Quarterly. Juneau, Alaska.

Alaska Department of Labor. Various issues. Alaska Economic Trends. Juneau, Alaska.

Alaska Department of Labor. Various issues. Labor Force Highlights. Juneau, Alaska.

*Alaska Department of Labor. Various annual issues. Wage Rates for Selected Occupations Anchorage, Fairbanks and Regional Areas. Alaska Department of Labor, Juneau, Alaska.

Alaska Department of Revenue. 1978. Petroleum Revenue Forecast. Petroleum Revenue Division, Juneau, Alaska.

Alaska Department of Transportation and Public Facilities. 1979. Alaska Highways Annual Traffic Report, Volume I. Transportation Planning Division, Juneau, Alaska.

Alaska Division of Agriculture, Cooperative Extension Service. Monthly. Alaska Farm Reporter. Agriculture Experiment Station, Palmer, Alaska.

Alaska Division of Economic Enterprise and the Municipality of Anchorage. 1978. Anchorage: An Alaskan Community Profile. Anchorage, Alaska.

Alaska Division of Policy Development and Planning. 1975. Bibliography of Community Planning Supplement. Juneau, Alaska.

Alaska Division of Policy Development and Planning. 1980. State of Alaska Railbelt Electrical Power Alternatives Study, Request for Proposals. Juneau, Alaska.

Alaska Miner's Association, Incorporated. 1980a. The Alaska Miner (January) Anchorage, Alaska.

Alaska Miner's Association, Incorporated. 1980b. The Alaska Miner (December) Anchorage, Alaska.

Alaska OCS Socioeconomic Studies Program. 1978. Alyeska-Fairbanks Case Study. Anchorage, Alaska.

Alaska Office of the Governor. 1978. Alaska Data Inventory Catalog. Division of Policy Development and Planning, Juneau, Alaska.

Alaska Office of the Governor. 1980. The Alaska Economic Information and Reporting System, Quarterly Report (November). Juneau, Alaska.

Alaska Office of Labor, Research and Analysis. 1980. Federal, State, and Local Government Occupational Employment Statistics. Alaska Department of Labor, Juneau, Alaska.

Alaska Pacific Bank. n.d. Alaska Business Trends: 1979 Economic Forecast. Anchorage, Alaska.

Anchorage Economic Development Commission. 1976. Anchorage Economic Report. Anchorage, Alaska.

Anderson. 1970. A Note on Economic Base Studies and Regional Econometric Forecasting Models. Journal of Regional Science 10: 325-333.

Andrews, W. H. and D. C. Geertsen. 1974. Social Dimensions of Urban Flood Control Decision. Utah State University, Logan, Utah.

Andrews, W. H., R. Burdge, H. Carpener, K. Warner, and K. Wilkinson, (ed.) 1973. The Social Well-Being and Quality of Life Dimension in Water Resources Planning and Development. Proceedings of the Conference of the University Council on Water Resources, July 10-12, 1973. Institute for Social Science Research on Natural Resources, Utah State University, Logan, Utah.

Andrews, W. H., G. Legaz, and G. Madsen. 1974. Social Impacts of Water Resource Developments and Their Implications for Urban and Rural Development: A Post-Audit Analysis of the Weber Basin Project in Utah. Institute for Social Science Research on Natural Resources, Utah State University, Logan, Utah.

Anonymous. 1980. The Milepost. Alaska Northwest Publishing Company, Anchorage, Alaska.

APA. 1980. A Report of the First Series of Community Meetings on the Feasibility Studies for the Susitna Hydroelectric Project and Other Power Alternatives. Meetings in Fairbanks, Talkeetna, Wasilla, Anchorage. Alaska.

Arctic Environmental Engineers. 1977. Solid Waste Disposal Study. Matanuska-Susitna Borough, Anchorage, Alaska.

Arctic Environmental Engineers. 1978. Solid Waste Disposal Report. Matanuska-Susitna Borough, Anchorage, Alaska.

Arizona Office of Economic Planning and Development. 1977. Description and Technical Description of the Economic/Demographic Projection Model. Arizona Office of Economic Planning and Development, Phoenix, Arizona.

Bantz, Don and Associates. n.d. Tribal Health Plan: Copper River Native Association Health Department. Anchorage, Alaska.

Battelle Pacific Northwest Laboratories. 1975. The Social and Economic Impact of a Camp Gruber Energy Center: a Report to the Federal Energy Administration, Volume III. Richland, Washington.

Battelle Pacific Northwest Laboratories. 1981. Alaska Economic Scenarios Review Document, Comment Draft Working Paper No. 21. Office of the Governor, State of Alaska, Division of Policy Development and Planning and the Governor's Policy Review Committee, Juneau, Alaska.

Baker, J. K., N. Dee and J. R. Finley. 1974. Measuring Impacts of Water Resource Developments on the Human Environment. American Water Resources Association, Water Resources Bulletin 10: 10-21.

Bendix, S. and H. R. Graham. 1978. Environmental Assessment - Approaching Maturity. Ann Arbor Science Publishers, Incorporated, Ann Arbor, Michigan.

Berry, B. J. 1967. Geography of Market Centers and Retail Distribution. Prentice-Hall, Incorporated, Englewood Cliffs, New Jersey.

Biswas, A. K. and R. W. Durie. n.d. Sociological Aspects of Water Development. Water Resources Bulletin.

Booz, Allen & Hamilton, Incorporated. n.d. A Procedures Manual for Assessing the Socioeconomic Impact of the Construction and Operation of Coal Utilization Facilities in the Old West Region. Old West Regional Commission, Washington, D.C.

Bornhoff and Associates. 1973. Palmer Comprehensive Development Plan. Matanuska-Susitna Borough, Anchorage, Alaska.

Canter, L. W. 1977. Environmental Impact Assessment. McGraw Hill Book Company, New York, New York.

Canter, L. W. 1979. Water Resources Assessment - Methodology & Technology Sourcebook. Ann Arbor Science Publishers, Incorporated, Ann Arbor, Michigan.

Chalmers, J. A. 1977. Bureau of Reclamation Construction Worker Survey. United States Department of the Interior, Bureau of Reclamation, Engineering and Research Center, Denver, Colorado.

Chalmers, J. A. and E. J. Anderson. 1977. Economic/Demographic Assessment Manual: Current Practices, Procedural Recommendations, and a Test Case. United States Department of the Interior, Bureau of Reclamation, Engineering and Research Center, Denver, Colorado.

Cheremisinoff, P. N. and A. C. Morresi. 1977. Environmental Assessment and Impact Statement Handbook. Ann Arbor Science Publishers, Incorporated, Ann Arbor, Michigan.

CH2M Hill. 1981. Socioeconomic Data Pamphlet for the Matanuska-Susitna Borough. Prepared for Overall Economic Development Program, Incorporated. Wasilla, Alaska.

Clonts, H. A. and L. P. Cain. 1976. Implications of Watershed Development on Land Value and Landowner Attitudes. Bulletin 479. Agricultural Experiment Station, Auburn University, Auburn, Alabama.

Coastal Zone Management Program Development. 1979. Alaska Federal Withdrawals. (map). United States Department of Commerce, National Oceanic and Atmospheric Administration.

Cole, T. 1979. The History of the Use of the Upper Susitna River, Indian River to the Headwaters. Alaska Department of Natural Resources, Division of Research and Development, Anchorage, Alaska.

Coleman, E. 1977. Personal Income: Some Observations on its Construction, Uses and Adequacy as a Subnational Income Measure. Paper delivered at the meeting of the American Statistical Association, Chicago, Illinois.

Community Development Services, Incorporated. 1975. An Analysis of the Socioeconomic Impacts of WNP-3 and WNP-5. Washington Public Power Supply System, Seattle, Washington.

Community Development Services, Incorporated. 1976. Socioeconomic Impact Study WPPSS 1 and 4, Volume 1: First Progress Report. Washington Public Power Supply System. Seattle, Washington.

Community Development Services, Incorporated. 1978. Socioeconomic Impact Study. Washington Public Power Supply System, Seattle, Washington.

Community Development Services, Incorporated. n.d. Socioeconomic Impact Study WNP 1 and 4, Volume 1: Final Report. Washington Public Power Supply System, Seattle, Washington.

Construction Engineering Research Laboratory. 1976. The Economic Impact Forecast System: Description and User Instruction. Technical Report N-2.

Coopers and Lybrand. 1978. Impact of Visitor's Expenditures Upon Alaska's Economy for the Year 1975. Anchorage, Alaska.

Corwin, R. et al. 1975. Environmental Impact Assessment. Freeman, Cooper and Company, San Francisco, California.

Daniels, B. H. et al. 1979. The Consideration of Social and Economic Measures in Project Evaluation - An Overview. Boston, Massachusetts.

Darbyshire and Associates. 1980. Socioeconomic Community Profiles, A Background for Planning: Delta Junction, Dot Lake, Northway, Tanacross, Tetlin, Tok. Prepared for Northwest Alaskan Pipeline Company.

Dow-Shell Group. 1981. Volume 7: Infrastructure and Socioeconomic Impacts. Anchorage, Alaska.

Eakland, P. et al. 1980. Western Gulf of Alaska Petroleum Development Scenarios Transportation Systems Analysis. Technical Report No. 37. Alaska OCS Socio-economic Studies Program, Anchorage, Alaska.

Ender, R. L. 1977. The Opinions of the Anchorage Citizen on Local Public Policy Issues. Anchorage Urban Observatory Program, Anchorage, Alaska.

Ender, R. L., J. Gerler, S. Gorski, and S. Harper. 1978. Anchorage Socioeconomic and Physical Baseline Executive Summary. Technical Report No. 124. Alaska OCS Socioeconomic Studies Program, Anchorage, Alaska.

Ender, R. L., J. Gerler and S. Gorski. 1980a. Gulf of Alaska and Lower Cook Inlet Petroleum Development Scenarios, Anchorage Socioeconomic and Physical Baseline Volume I. Alaska OCS Socioeconomic Studies Program, Anchorage, Alaska.

Ender, R. L., J. Gerler and S. Gorski. 1980b. Gulf of Alaska and Lower Cook Inlet Petroleum Development Scenarios, Anchorage Impact Analysis, Volume II: Technical Report No. 48. Alaska OCS Socioeconomic Studies Program, Anchorage, Alaska.

EPA. 1979. Alaska Petrochemical Company, Refinery and Petrochemical Facility, Appendix, Volume II: Environmental Impact Statement. United States Environmental Protection Agency, Valdez, Alaska.

EPA. 1980. Alaska Petrochemical Company, Refinery and Petrochemical Facility: Final Environmental Impact Statement. United States Environmental Protection Agency, Valdez, Alaska.

Fairbanks North Star Borough. 1979. 1979 Annual Report. Community Information Center, Fairbanks, Alaska.

*Fairbanks North Star Borough. Various Issues. Community Information Quarterly. Community Information Center, Fairbanks, Alaska.

Fairbanks North Star Borough. Various Issues. The Energy Report. Community Information Center, Fairbanks, Alaska.

Fairbanks North Star Borough. Various Issues. Community Research Quarterly, A Socioeconomic Review. Community Research Center, Fairbanks, Alaska.

Fairbanks Town and Village Association for Development, Incorporated. 1978. A Report of the Upper Tanana Regional Forum on the Impact of Construction and Operation of the Al-Can Gas Pipeline. Fairbanks, Alaska.

Fairbanks Town and Village Association for Development, Incorporated. 1979. Community Facilities Summaries. Fairbanks, Alaska.

Fairbanks Town and Village Association for Development, Incorporated, Interior Development District Association. 1980. The Overall Economic Development Program for the Economic Development District of Interior Alaska. Fairbanks, Alaska.

FERC. 1978a. Solomon Gulch Project No. 2742 - Alaska: Final Environmental Impact Statement. United States Federal Energy Regulatory Commission, Washington, D. C.

FERC. 1978b. Terror Lake Hydroelectric Project, Kodiak Island, Alaska: Application for License before Federal Energy Regulatory Commission for Kodiak Electrical Association, Incorporated. United States Federal Energy Regulatory Commission, Washington, D.C.

FERC. 1979a. Green Lake Project No. 2818 - Alaska: Final Environmental Impact Statement. United States Federal Energy Regulatory Commission, Washington, D.C.

FERC. 1979b. North Fork Stanislaus River Project No. 2049 - California: Draft Environmental Impact Statement. United States Federal Energy Regulatory Commission, Washington, D. C.

FERC. 1980a. Sultan River Project No. 2157 - Washington: Draft Environmental Impact Statement. United States Federal Energy Regulatory Commission, Washington, D. C.

FERC. 1980b. Swan Lake Project No. 2911 - Alaska: Final Environmental Impact Statement. United States Federal Energy Regulatory Commission, Washington, D. C.

Field, R., J. C. Barron and B. F. Long. 1974. Water and Community Social and Economic Perspectives. Ann Arbor Science Publishers, Incorporated, Ann Arbor, Michigan.

Finsterbusch, K. and C. P. Wolf. 1977. The Methodology of Social Impact Assessment. Dowden, Hutchinson and Ross Publishing Company, Stroudsberg, Pennsylvania.

Finsterbusch, K. 1977. Methods of Evaluating Non-Market Impacts in Policy Decisions with Special Reference to Water Resources Development Projects. IWR Contract Report 77-78. United States Army Engineer Institute for Water Resources, Fort Belvoir, Virginia.

Fison, S., D. Moore and C. Quisenberry. 1977. Energy Costs, Consumption and Impacts in Fairbanks. Fairbanks North Star Borough, Fairbanks, Alaska.

Fison, S. and C. Quisenberry. 1977. Impact Information Center Final Report. Fairbanks North Star Borough, Fairbanks, Alaska.

Floyd, F. C. and C. F. Sirmans. 1975. The Economic Impact of Recreational Land-Use in an Island Environment: A Case Study of Jekyll Island, Georgia. Skidaway Island, Georgia.

Flynn, C. B. and J. A. Chalmers. 1980. The Social and Economic Effects of the Accident at Three Mile Island: Findings to Date. Mountain West Research, Incorporated, Tempe, Arizona.

Foell, W. K. (ed.). 1979. Management of Energy/Environmental Systems. John Wiley & Sons, Chichester, United Kingdom.

Forrest, M. 1979. Fairbanks Cost of Living Update. Fairbanks North Star Borough, Community Information Center, Fairbanks, Alaska.

Glickman, N. J. 1977. Impact Analysis with Regional Econometic Models (Draft). University of Pennsylvania, Pennsylvania.

Goldsmith, O. S. 1981a. Description of Sensitivity Analysis of MAP Model Components for Railbelt Electrical Power Study, Draft Working Paper #2. Part 2: The Household Formation Model. For Battelle Pacific Northwest Laboratories. Institute of Social and Economic Research, Anchorage, Alaska.

Goldsmith, O. S. 1981b. Description and Sensitivity Analysis of MAP Model Components for Railbelt Electrical Power Study, Draft Working Paper #3. For Battelle Pacific Northwest Laboratories, Institute of Social and Economic Research, Anchorage, Alaska.

Goldsmith, S. and L. Huskey. 1980. Electric Power Consumption for the Railbelt: A Projection of Requirements, Technical Appendices. Institute of Social and Economic Research for the State of Alaska House Power Alternatives Study Committee and Alaska Power Authority, Anchorage, Alaska.

Guseman, P. K. and K. T. Dietrich. 1978. Profile and Measurement of Social Well-Being Indicators for Use in the Evaluation of Water and Related Land Management Planning. Miscellaneous Paper Y-78-2. United States Army Engineers Waterways Experiment Station, Vicksburg, Mississippi.

Hyman Resources Planning Institute. 1974. Manpower and Employment Impact of the Trans-Alaska Pipeline, Volume II, Technical Report. Prepared for United States Department of Labor, Manpower Administration, Seattle, Washington.

Idaho Power Company. 1980. Application for License, Project No. 2848: Cascade Hydroelectric Project. Idaho Power Company, Boise, Idaho.

Information Resources Press. 1977-1980. EIS-Digest of Environmental Impact Statements, Volume 1-#1 - Volume 4-#3. Information Resources Press, Arlington, Virginia.

International Engineering Company, Incorporated, Robert W. Retherford Associates Division. 1979. Tyee Lake Hydroelectric Project - Petersburg and Wrangell, Alaska: Application for License Before the Federal Regulatory Commission for the Alaska Power Authority (2 volumes). Anchorage, Alaska.

Isserman, A. 1977. The Accuracy of Population Projections for Subcounty Areas. Journal of the American Institute of Planners 43: 247-257.

Jones & Jones. 1975. An Inventory and Evaluation of the Environmental, Aesthetic and Recreational Resources of the Upper Susitna River, Alaska. United States Army Corps of Engineers, Seattle, Washington.

Jones, V. K. 1978. Payments to the Public Sector for Construction of a Nuclear Generating Station: A Case Study of Washington Public Power Supply Systems Projects WNP-3 and WNP-5. Washington Public Power Supply System, Richland, Washington.

Leistritz, F. L., D. M. Senechal and L. Low. 1980. Socioeconomic Effects of Energy Development: The Role of Impact Models in Policy Making. Paper presented at National Energy Policy Conference, May 1, 1980. University of West Virginia, Morgantown, West Virginia.

Leistritz, F.L. and S. Murdock. 1981. The Socioeconomic Impact of Resource Development: Methods for Assessment. Social Impact Assessment Series, No. 6. Westview Press, Boulder, Colorado.

Leistritz, F. L., S. H. Murdock, N. E. Toman, and T. A. Hertsgaard. 1979. A Model for Projecting Localized Economic, Demographic, and Fiscal Impacts of Large Scale Projects. Western Journal of Agricultural Economics Volume 4, No. 2.

Lerner, S. C. 1980. Energy Policy: A Potential Source of Positive Social Impacts. Paper presented at National Energy Policy Conference, May 1, 1980. University of West Virginia, Morgantown, West Virginia.

Logsdon, C., W. Thomas, J. Kruse, M. Thomas and S. Helcath. n.d. Copper River-Wrangell Socioeconomic Overview. The Institute for Social and Economic Research and University of Alaska, Agricultural Experiment Station, Fairbanks, Alaska.

Logsdon, C., K. L. Casavant and W. C. Thomas. 1977. Input-Output Tables for Alaska's Economy: A First Look. Bulletin 48. University of Alaska Agricultural Experiment Station, Fairbanks, Alaska.

Louis Berger & Associates, Incorporated. 1980. Best and Final Proposal for Isolated Industrial Facilities Development for Alaska OCS Oil and Gas Activities. Fairbanks, Alaska.

Louis Berger, Incorporated. 1973. Methodological Improvements in Measuring Economic Effects of Multi-Purpose Water Resource Projects. Office of Water Resources Research, East Orange, New Jersey.

Love, C. and R. Stafford. 1975. The Application of Modeling Methods to Socioeconomic Impact Analysis of Energy Development Projects. Scientific Paper 75-7C55-IPPAN-PI. Westinghouse Research Laboratories, Pittsburgh, Pennsylvania.

Malone, D. W. 1975. An Introduction to the Application of Interpretive Structural Modeling in Baldwin, M.M. (ed.) Portraits of Complexity: Applications of Systems Methodologies to Societal Problems. Battelle Memorial Institute, Columbus, Ohio.

Markusen, A. R. 1978. Socioeconomic Impact Models for Boomtown Planning and Policy Evaluation. Paper for Presentation at the Western Regional Science Association Meeting, February 25, 1978.

*Matanuska Electric Association, Incorporated. 1980. Alaska 2 Matanuska Power Requirements Study. Matanuska Electric Association, Incorporated, Palmer, Alaska.

Matanuska-Susitna Borough Health Planning Council. 1980. Proposed Matanuska-Susitna Borough Health Systems Plan. Matanuska-Susitna Borough Health Planning Council, Palmer, Alaska.

Matanuska-Susitna Borough Planning Department. 1978a. Ten-Year Program for School Sites. Matanuska-Susitna Borough Planning Department, Palmer, Alaska.

*Matanuska-Susitna Borough Planning Department. 1978b. Phase I: Comprehensive Development Plan. Matanuska-Susitna Borough Planning Department, Palmer, Alaska.

Matanuska-Susitna Borough Planning Department. 1978c. Phase II: Comprehensive Development Plan, Preliminary Draft. Matanuska-Susitna Borough Planning Department, Palmer, Alaska.

Matanuska-Susitna Borough Planning Department. 1979. Phase III: Comprehensive Development Plan, Preliminary Draft. Matanuska-Susitna Borough Planning Department, Palmer, Alaska.

Matanuska-Susitna Borough Planning Department. 1981. Infrastructure Report: Inventory Data. Prepared for the Dow-Shell Petrochemical Feasibility Study, Palmer, Alaska.

Matanuska-Susitna Borough School District. 1981. Prioritized Capital Project List. Matanuska-Susitna Borough School District. Palmer, Alaska.

Matanuska Telephone Association, Incorporated. 1980. Fill Report. Matanuska Telephone Association, Incorporated. Palmer, Alaska.

Matanuska Telephone Association, Incorporated. n.d. Supplemental Loan Proposal. 1978-1983. Matanuska Telephone Association, Incorporated. Palmer, Alaska.

Matchett, S., M. Savela, and J. Wirth. 1980. Copper Creek Project Draft Environmental Impact Statement Support Document: Human Environment.

Mat-Su Fire Chiefs Association. 1981. A Revised Fire Protection Plan for the Matanuska-Susitna Borough, Alaska. Prepared for the Matanuska-Susitna Borough, Palmer, Alaska.

Matz, G., B. Harding and R. Wertz. 1979. 1978 Fairbanks Energy Inventory. Special Report No. 4. Fairbanks North Star Borough, Community Information Center, Fairbanks, Alaska.

McEvoy, J. III and T. Dietz, (eds.). 1977. Handbook for Environmental Planning and Social Consequences of Environmental Change. John Wiley & Sons, New York, New York.

Michalson, E. et al., (ed.) 1974. Multiple Objective Planning for Water Resources, Volume 1: Proceedings of the UCOWR Workshop on Multiple Objective Planning and Decision-Making, Las Vegas, Nevada, July 16-18, 1974. Idaho Research Foundation, Incorporated, Moscow, Idaho.

Michalson, E. et al. (ed.) 1975. Multiple Objective Planning for Water Resources, Volume 2: Proceedings of the UCOWR Conference on Multiple Objective Planning and Decision-Making, Boise, Idaho, January 14-16, 1975. Idaho Research Foundation, Incorporated, Moscow, Idaho.

Mills, M. J. 1979. Annual Performance Report for Alaska Statewide Sport Fish Harvest Studies, July 1, 1978 - June 30, 1979, Volume 20. Alaska Department of Fish and Game, Sport Fish Division. Juneau, Alaska.

Mills, M. J. 1980. Annual Performance Report for Alaska Statewide Sport Fish Harvest Studies, July 1, 1979 - June 30, 1980, Volume 21. Alaska Department of Fish and Game, Sport Fish Division, Juneau, Alaska.

MIT. 1976. Predicting the Local Impacts of Energy Development: A Critical Guide to Forecasting Methods and Models (Draft). Massachusetts Institute of Technology, Laboratory of Architecture and Planning, Cambridge, Massachusetts.

Mitchell, A. et al. 1975. Handbook of Forecasting Techniques. Contract Report 75-7. United States Army Engineer Institute for Water Resources, Fort Belvoir, Virginia.

Mitchell, A. 1977. Handbook of Forecasting Techniques, Part I, Supplement to IWR Contract Report 75-7. Center for the Study of Social Policy under Contract to United States Army Institute for Water Resources, Fort Belvoir Virginia.

Mountain West Research, Incorporated. 1975. Demographic and Economic Projections for Rosebud County, Montana. Mountain West Research, Incorporated, Tempe, Arizona.

Mountain West Research, Incorporated. 1976. Mid-Yellowstone Areawide Planning Organization: Economic Demographic Projection Model. Billings, Montana.

Mountain West Research, Incorporated. 1977. Construction Worker Survey. Mountain West Research, Incorporated. Tempe, Arizona.

Mountain West Research, Incorporated. 1978. Bureau of Reclamation Economic Assessment Model (BREAM) Technical Description. United States Department of the Interior, Bureau of Reclamation, Tempe, Arizona.

Mountain West Research, Incorporated. 1979a. Fact Book for Western Coal/Energy Development. Western Coal Planning Assistance Project, Missouri River Basin Commission. Omaha, Nebraska.

Mountain West Research, Incorporated. 1979b. A Guide to Methods for Impact Assessment of Western Coal/Energy Development. Billings, Montana.

Mountain West Research, Incorporated. 1980. Bureau of Reclamation Economic Assessment Model (BREAM), Technical Description and User's Guide. Water and Power Resources Service, United States Department of the Interior, Tempe, Arizona.

Muller, T. 1975. Fiscal Impacts on Land Development. URI 98000. The Urban Institute, Washington, D. C.

Muller, T. 1976. Economic Impacts of Land Development: Employment, Housing and Property Values. URI 15800. The Urban Institute, Washington D. C.

Municipality of Anchorage. 1978. Population Profile. Planning Department, Anchorage, Alaska.

Municipality of Anchorage. 1979. Anchorage Recreation Facilities Committee Reports. Municipality of Anchorage, Anchorage, Alaska.

Municipality of Anchorage. 1980. Anchorage Economic Development Report. Anchorage, Alaska.

Municipality of Anchorage. Various Undated Issues. Quarterly Economic Indicators, 1:11. Planning Department, Anchorage, Alaska.

Murdock, S. H. and F. L. Leistritz. 1979a. Demographic and Economic Effects of Large-Scale Energy Development in Rural Areas: An Assessment Model In Nonmetropolitan Industrial Growth and Community Change. Lexington, Massachusetts.

Murdock, S. H. and F. L. Leistritz. 1979b. Energy Development in the Western United States. Praeger Publishers, New York, New York.

Nachmias, D. 1979. Public Policy Evaluation. St. Martin's Press, Incorporated, New York, New York.

National Research Council. 1979. Sociopolitical Effects and Energy Use and Policy, Supporting Paper 5: Study of Nuclear and Alternative Energy Systems. National Academy of Sciences, Washington, D. C.

North Slope Borough. n.d. Challenge to the Police Role in Rural Alaska: The North Slope Borough Experience. Department of Public Safety, Alaska.

Northwest Alaskan Pipeline Company, Manpower and Impact Planning Department. 1981. Gasline Planning Update. Fairbanks, Alaska.

Overall Economic Development Program, Incorporated. 1980a. Annual Overall Development Program Reports. July 1, 1979 - June 30, 1980. Prepared for Farmers Home Administration and Matanuska-Susitna Borough, Wasilla, Alaska.

Overall Economic Development Program, Incorporated. 1980b. Volume I: Annual Overall Economic Development Program Report, July 1, 1979 - June 30, 1980. Prepared for Farmers Home Administration and Matanuska-Susitna Borough, Wasilla, Alaska.

*Overall Economic Development Program, Incorporated. 1980c. Volume II: Economic Conditions, Development Options and Projections. Prepared for Farmers Home Administration and Matanuska-Susitna Borough, Wasilla, Alaska.

Overall Economic Development Program, Incorporated. 1980d. Volume III: Appendices. Prepared for Farmers Home Administration and Matanuska-Susitna Borough, Wasilla, Alaska.

Pacific Northest Laboratory and Battelle Human Affairs Research Centers. 1979. Beluga Coal Field Development: Social Effects and Management Alternatives. Prepared for United States Department of Energy, Washington, D. C.

*Policy Analysts, Limited and Dr. R. L. Ender. 1980. Mat-Su Housing and Economic Development Study: Survey Findings. Anchorage, Alaska.

*Polk, R. L. 1981. Survey conducted by the Municipality of Anchorage Planning Department, Anchorage, Alaska.

Porter, E. D. 1980. Alaska OCS Socioeconomic Studies Program. Bering-Norton Petroleum Development Scenarios Economic and Demographic Analysis, Technical Report No. 50. University of Alaska, Institute of Social and Economic Research, Anchorage, Alaska.

Porter, E. 1981. Description and Sensitivity Analysis of MAP Model Components for Railbelt Electric Power Study, Draft Working Paper #2 for Battelle Pacific Northwest Laboratories, Part 1: Regionalization Model. University of Alaska, Institute of Social and Economic Research, Anchorage, Alaska.

PRC Harris Incorporated and Alaska Consultants Incorporated. 1980. Summary: Southcentral Region of Alaska Deep-Draft Navigation Study. Anchorage, Alaska.

Reaume, D. M. 1980. Migration and the Dynamic Stability of Regional Econometric Models. Alaska Department of Commerce and Economic Development, Juneau, Alaska.

Rivkin Associates, Incorporated. 1978. Socioeconomic Impact Analysis for Juneau and the Matanuska-Susitna Borough: Potential Consequences of a New Capital City for Alaska. Prepared for the Capital Site Planning Commission. Washington, D. C.

Rogers, G. W. and J. Kreinheder. 1980. Socioeconomic Analysis for Fishery Areas and Census Division. Limited Entry Study Committee. Prepared for Alaska Legislative Affairs Agency.

Rosen, S. J. 1976. Manual for Environmental Impact Evaluation. Prentice-Hall, Incorporated, Englewood Cliffs, New Jersey.

Scott, M. J. 1979. Southcentral Alaska's Economy and Population, 1965-2025: A Base Study and Projections. University of Alaska, Institute for Social and Economic Research, Anchorage, Fairbanks, Juneau, Alaska.

Seattle City Light. 1980. South Fork Tolt River Hydroelectric Project: Draft SEPA Environmental Impact Statement. FERC Project 1959. Washington, D. C.

Seattle City Light. 1981. Copper Creek Project: Draft and Final Environmental Impact Statement. Seattle, Washington.

Shields, M. A. 1974. Social Impact Assessment: An Analytic Bibliography. IWR Paper 74-P6. United States Army Institute for Water Resources, Fort Belvoir, Virginia.

Singh, R. N. and K. P. Wilkinson. 1974. On the Measurement of Environmental Impacts of Public Projects from a Sociological Perspective. American Water Resources Association, Water Resources Bulletin, Volume 10, No. 3.

Skagit Alaska, Incorporated. 1981a. The Frontiersman (untitled). Wasilla, Alaska.

Skagit Alaska, Incorporated. 1981b. The Frontiersman: "Palmer Proves Best Hospital Site." Wasilla, Alaska.

Smith, C. R. 1970. Anticipation of Change: A Socioeconomic Description of a Kentucky County Before Reservoir Construction. Kentucky Water Resources Institute, Lexington, Kentucky.

Smith, C. R. et al. 1973. Social and Cultural Impact of a Proposed Reservoir on a Rural Kentucky School District. Kentucky Water Resources Institute, Lexington, Kentucky.

Sonnen, M. B. and L. C. Davis. 1979. Wild Rivers - Methods for Evaluation. American Water Resources Association, Water Resources Bulletin 15: 404-419.

South Central Health Planning and Development. 1979. Health Systems Plan. Anchorage, Alaska.

Stenehjem, E. J. and J. E. Metzger. 1980. A Framework for Projecting Employment and Population Changes Accompanying Energy Development. Argonne National Laboratory, Argonne, Illinois.

Stinson, D. S. and M. O'Hare. 1977. Predicting the Local Impacts of Energy Development: A Critical Guide to Forecasting Methods and Models. Laboratory of Architecture and Planning, Massachusetts Institute of Technology, Cambridge, Massachusetts.

Suchman, E. A. 1967. Evaluation Research. Russell Sage Foundation, New York, New York.

TRA/FARR. 1980a. Wasilla Comprehensive Planning Study. Matanuska-Susitna Borough Newsletter I, (April 28, 1980). Seattle, Washington.

TRA/FARR. 1980b. Wasilla Comprehensive Planning Study. Matanuska-Susitna Borough Newsletter II. (August 25, 1980). Seattle, Washington.

Tryck, Nyman & Hayes. 1975. Community Development Plan, Volumes I and II. Report for City of Delta Junction, Alaska.

Tuck, B. H. 1980. Economic Development Planning for Anchorage: A Theoretical and Empirical Analysis. Prepared for the Municipality of Anchorage Planning Department by the University of Alaska, Anchorage, Alaska.

United States Bureau of Power, Federal Power Commission. 1977. Bad Creek Project No. 2740 - South Carolina: Final Environmental Impact Statement. United States Bureau of Power, Washington, D. C.

*United States Census Bureau. 1981. Census and Current Population Reports for 1970, 1980 and 1981. United States Census Bureau, Washington, D.C.

United States Department of Commerce, Bureau of Economic Analysis. 1975. Evaluation of Economic and Demographic Data Useful in Water Resources Planning. IWR Pamphlet N. 3. United States Army Engineer Institute for Water Resources, Fort Belvoir, Virginia.

United States Department of Energy, Alaska Power Administration. 1979. Power Market Analysis: Draft. United States Department of Energy, Juneau, Alaska.

United States Department of Energy, Bonneville Power Administration. 1980. Boardman Coal Plant and Associated Transmission, Adopted Rural Electrification Administration: Final EIS (USDA-REA-EIS-77-4F). United States Department of Energy, Washington, D. C.

United States Department of Transportation, Federal Highway Administration and Alaska Department of Transportation and Public Facilities. 1980. Richardson Highway Draft Environmental Impact Statement.

United States Department of Labor. 1980. News, April 22, 1980. Bureau of Labor Statistics, San Francisco, California.

United States Nuclear Regulatory Commission. 1980. Final Supplement No. 1 to the Final Environmental Statement for Pebble Springs Nuclear Plant, Units 1 and 2, Proposed by Portland General Electric Company. Washington, D. C.

*United States Postal Service. n.d. United States Post Office Vacancy Rate Surveys, 1975-1981. U.S. Postal Service, Washington, D.C.

University of Alaska. 1973. The Ahtna Region, Background for Regional and Community Planning. Arctic Environmental Information and Data Center, Anchorage, Alaska.

University of Alaska. 1977. Copper River Region Community Folios, A Background for Planning: Cantwell, Chistochina, Chitina, Copper Center, Gakona, Gulkana, Mentasta Lake, Tazlina. Arctic Environmental Information and Data Center, Anchorage, Alaska.

University of Alaska. 1977b. Alaska Interregional Cost Differentials. Institute of Social and Economic Research, Fairbanks, Alaska.

University of Alaska. 1978. Yukon-Porcupine Regional Planning Study. School of Agriculture and Land Resources Management and the Institute of Social and Economic Research, Fairbanks, Alaska.

University of Alaska. 1980a. Alaska Review of Social and Economic Conditions: Alaska's Unique Transportation System. Institute of Social and Economic Research, Anchorage, Alaska.

University of Alaska. 1980b. Current Research Profile for Alaska, 1979. Arctic Environmental Information and Data Center, Anchorage, Alaska.

*University of Alaska. 1981. Man-in-the-Arctic Model Outputs. Institute of Social and Economic Research, Fairbanks, Alaska.

University of Alberta. 1980. Computer Models for Forecasting Socioeconomic Impacts of Growth and Development. Proceedings of Conference, April 20-23, 1980. Edmonton, Alberta.

USACOE. 1975a. Handbook of Forecasting Techniques. Contract DACW 31-75-C-0027. United States Army Corps of Engineers, Institute for Water Resources, Center for the Study of Social Policy, Fort Belvoir, Virginia.

USACOE. 1975. A Manual for Social Impact Assessment. United States Army Corps of Engineers, Seattle, Washington.

USACOE. 1977a. Dickey-Lincoln School Lakes: Environmental Impact Statement. United States Army Corps of Engineers, Waltham, Massachusetts.

USACOE. 1977b. Hydroelectric Power Development, Upper Susitna River Basin, Southcentral Railbelt Area, Alaska: Final Environmental Impact Statement. United States Army Corps of Engineers, Office of the Chief of Engineers, Washington, D. C.

USACOE. 1977c. Marysville Lake Project, Yuba River, California: Draft Environmental Impact Statement. United States Army Corps of Engineers, Sacramento, California.

USACOE. 1978. Dickey-Lincoln School Lakes Project at Dickey, Maine: Draft Environmental Impact Satement. United States Army Corps of Engineers, Waltham, Massachusetts.

USACOE. 1980a. Community Impact Reports: Chief Joseph Dam. United States Army Corps of Engineers, Seattle, Washington.

USACOE. 1980b. Environmental Impact Statement, Dickey-Lincoln Schools, Appendix C: Social and Economic Assessment. United States Army Corps of Engineers, Waltham, Massachusetts.

USACOE. 1980c. Environmental Impact Statement, Dickey-Lincoln School Lakes, Appendix C, Supplement 2: Social and Economic Assessment. United States Army Corps of Engineers, Waltham, Massachusetts.

USACOE. 1981. Report of Survey of Corps of Engineers Construction Workforce. United States Army Corps of Engineers, Engineer Institute for Water Resources, Fort Belvoir, Virginia.

USDA (SCS). 1980. Susitna River Basin Study, Willow Subbasin. Draft Report. United States Department of Agriculture, Soil Conservation Service, Anchorage, Alaska.

USDI (BLM). 1980a. Alaska OCS Socioeconomic Studies Program: Lower Cook Inlet Petroleum Development Scenarios, Local Socioeconomic Systems Analysis. Technical Report Number 46, Volume 2. United States Department of the Interior, Bureau of Land Management, Alaska Outer Continental Shelf Office, Anchorage, Alaska.

USDI (BLM). 1980b. Proposed Outer Continental Shelf Oil and Gas Lease Sale, Lower Cook Inlet - Shelikof Strait: Draft Environmental Impact Statement. United States Department of the Interior, Bureau of Land Management, Anchorage, Alaska.

USDI (BLM). 1980c. Draft Environmental Impact Statement, Lower Cook Inlet - Shelikof Strait, Oil and Gas Lease Sale #60, Index. United States Department of the Interior, Bureau of Land Management, Anchorage, Alaska.

Wakeland, W. 1976. QSIM2: A Low-Budget Heuristic Approach to Modeling and Forecasting. Technological Forecasting and Social Change 9: 213-229.

Warden, R. E. and W. Dagodag. 1976. A Guide to the Preparation and Review of Environmental Impact Reports. Security World Publishing Company, Incorporated, Los Angeles, California.

Washington Public Power Supply System. 1980a. Satsop Construction Report Quarterly Socioeconomic Report of WNP-3/5 Volume 3, Report No. 4 (October 1, 1979 - December 31, 1979). Seattle, Washington.

Washington Public Power Supply System. 1980b. Satsop Construction Project Quarterly Socioeconomic Report of WNP-3/5 Vol. 4, Report No. 1 (January 1, 1980 - March 31, 1980). Richland, Washington.

Washington State Department of Revenue. 1975. Employment Needs in the Construction Industry 1975-1985. Olympia, Washington.

Westinghouse Electric Corporation. 1974. Socioeconomic Effects of Construction and Operations of WNP-3 and WNP-5 and Alternatives to Alleviate Adverse Effects. Environmental Systems Department, Pittsburgh, Pennsylvania.

White, W. T., B. Malamund and J. Nixon. 1976. A Model for the Socioeconomic Analysis of Water Projects.

11.6 - Geology and Soils

Csejtey, B. Jr., H.L. Foster, and W.J. Nokleberg, 1980, "Cretaceous Accretion of the Talkeetna Superterrane and Subsequent Development of the Denali Fault in Southcentral and Eastern Alaska," Geological Society of America, Abstract with Programs, page 409.

Csejtey, B., Jr., W.H. Nelson, D.L. Jones, N.J. Silberling, R.M. Dean, M.S. Morris, M.A. Zamphere, J.G. Smith, and M.L. Silberman, 1980, "Reconnaissance Geologic Map and Geochronology, Talkeetna Mountain Quadrangle, Northern Part of Anchorage Quadrangle, and Southwest Corner of Healy Quadrangle, Alaska"; U.S. Geological Survey, Open File Report 78-588A, page 60.

Smith, T.E., 1974, Regional Geology of The Susitna-MacLaren River Area, Alaska Division of Geological and Geophysical Survey. Annual Report, page 356.

Turnger, D.L., and T.E. Smith, 1974, "Geochronology and Generalized Geology of the Central Alaska Range, Clearwater Mountains, and Geophysical Survey, Open File Report 72, page 11.

11.7 - Recreational Resources

Acres American, Incorporated. 1980. Susitna Hydroelectric Project Plan of Study. Alaska Power Authority, Anchorage, Alaska.

*ADNR. 1981. Estimated Facility Costs. Alaska Department of Natural Resources, Division of Parks, Anchorage, Alaska.

Anonymous. 1980. The Milepost. Alaska Northwest Publishing Company, Anchorage, Alaska.

APA. 1980. Susitna Hydroelectric Project Environmental Studies Procedures Manual Subtask 7.08: Analysis of Recreational Development. Submitted by Terrestrial Environmental Specialists, Incorporated and the University of Alaska to Acres American, Incorporated for the Alaska Power Authority, Anchorage, Alaska.

Clark, R. and G. H. Stankey. 1979. The Recreation Opportunity Spectrum: A Framework for Planning, Management and Research. General Technical Report PNW-98. United States Department of Agriculture, Forest Service, Washington, D.C.

Johnson, L. 1976. Off-Road Vehicle Use and Its Impact on Soils and Vegetation on Bureau of Land Management Lands Along the Denali Highway, Alaska: A Report on the 1975 Outdoor Recreation Survey. Agricultural Experiment Station, University of Alaska, Fairbanks, Alaska.

Jones & Jones. 1975. An Inventory and Evaluation of the Environmental, Aesthetic and Recreational Resources of the Upper Susitna River, Alaska. United States Army Corps of Engineers, Anchorage, Alaska.

Jubenville, A. 1981. Role Segregation: A Conceptual Framework for Recreation Management Research. Recreation Research Review, Volume 9. No. 1.

*USDA (FS). 1980. RIM Cost Figures for Selected Facilities. United States Department of Agriculture, Forest Service, Washington, D.C.

*USDA (FS). 1981. Chugach Cost Data Guide for Engineering and Road Construction. United States Department of Agriculture, Forest Service, Chugach National Forest, Anchorage, Alaska.

USDI (BLM). 1980. BLM Land Use Plan for Southcentral Alaska: A Summary. United States Department of the Interior, Bureau of Land Management, Anchorage, Alaska.

11.8 - Aesthetic Resources

Acres American, Incorporated. 1981. Susitna Hydroelectric Project Closeout Report Subtask 8.01: Transmission Line Corridor Screening, Final Draft. Submitted by Acres American, Incorporated and Terrestrial Environmental Specialists, Incorporated to the Alaska Power Authority, Anchorage, Alaska.

ADF&G. 1978. Preliminary Environmental Assessment of Hydroelectric Development on the Susitna River. Alaska Department of Fish and Game, Anchorage, Alaska.

ADF&G. 1981. Susitna Hydroelectric Project Environmental Studies Annual Report Subtask 7.11: Wildlife Ecology Studies - Big Game. Submitted by the Alaska Department of Fish and Game to the Alaska Power Authority, Anchorage, Alaska.

ADNR. 1981. Scenic Resources along the Parks Highway, Inventory and Management Recommendations, Susitna Basin Background Report. Alaska Department of Natural Resources, Division of Research and Development, Anchorage, Alaska.

Alaska Rural Development Council. 1977. A Revegetative Guide for Alaska. Cooperative Extension Service, University of Alaska and the United States Department of Agriculture, Fairbanks, Alaska.

APA. 1981a. Susitna Hydroelectric Project Environmental Studies Annual Report Subtask 7.07: Land Use Analysis. Submitted by Terrestrial Environmental Specialists, Incorporated and the University of Alaska to Acres American, Incorporated for the Alaska Power Authority, Anchorage, Alaska.

APA. 1981b. Susitna Hydroelectric Project Environmental Studies Annual Report Subtask 7.12: Plant Ecology Studies. Submitted by Terrestrial Environmental Specialists, Incorporated and the University of Alaska to Acres American, Incorporated for the Alaska Power Authority, Anchorage, Alaska.

APA. 1981c. Susitna Hydroelectric Project Environmental Studies Report Subtask 7.14: Access Road Environmental Analysis - Environmental, Socioeconomic and Land Use Analysis of Alternative Access Plans. Submitted by Terrestrial Environmental Specialists, Incorporated, Frank Orth and Associates and the University of Alaska to Acres American, Incorporated, for the Alaska Power Authority, Anchorage, Alaska.

APA. 1982. Susitna Hydroelectric Project Environmental Studies Report Subtask 7.09: Transmission Corridor Assessment - Environmental Assessment of Proposed Transmission Facilities East of Knik Arm. Submitted by Terrestrial Environmental Specialists, Incorporated to Acres American, Incorporated for the Alaska Power Authority, Anchorage, Alaska.

Bacon, W. R. and A. D. Twombly. 1980. National Forest Landscape Management, Volume 2: Timber. Agricultural Handbook 559. United States Department of Agriculture, Forest Service, Washington, D.C.

Binger, W. V. et al. 1978. Papers presented In Environmental Effects of Large Dams. American Society of Civil Engineers, New York, New York.

Bradshaw, A. D. and M. J. Chadwick. 1980. The Restoration of Land, the Ecology and Restoration of Derelict and Degraded Land. University of California Press, Berkeley, California.

Cook, S. 1981. An Investigation of the Recreational Potential of Water-filled Gravel Pits in Interior Alaska: Preliminary Findings (unpublished). University of Alaska, School of Agriculture and Land Resources, Fairbanks, Alaska.

Cole, T. 1979. The History and Use of the Upper Susitna River, Indian River to the Headwaters. Alaska Department of Natural Resources, Division of Research and Development, Anchorage, Alaska.

Daniel, T. C. and R. S. Boster. 1976. Measuring Landscape Esthetics: The Scenic Beauty Estimation Method. USDA Forest Service Research Paper RM-167. United States Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado.

Dean, K. G. 1980. Surficial Geology of the Susitna-Chilitna River Area, Alaska, Part 1: Susitna Basin Planning Background Report. Alaska Department of Natural Resources, Land and Resource Planning Section, Anchorage, Alaska.

Elmiger, F. J. and B. Howlett. 1969. Power Lines and Scenic Values in the Hudson River Valley. Hudson River Valley Commission, Tarrytown, New York.

Evans, M. N. (ed). 1976. Proceedings of the Surface Protection Seminar, Theme: Travel and Transportation Practices to Prevent Surface Destruction in the Northern Environment. United States Department of the Interior, Bureau of Land Management, Anchorage, Alaska.

Goldman, C. R., J. McEvoy III and P. J. Richerson. 1973. Environmental Quality and Water Development. W. H. Freeman & Company, San Francisco, California.

Gordon, R. J. 1978. Alaska National Landscapes, Commission Study 33. Federal - State Land Use Planning Commission for Alaska, Anchorage, Alaska.

Heinzenknecht, G. B. and J. R. Paterson. 1978. Effects of Large Dams and Reservoirs on Wildlife Habitat In Environmental Effects of Large Dams. American Society of Civil Engineers, New York, New York.

IUCN. 1971. Landscape Planning Papers presented at the International Symposium on the Relationship Between Engineering and Biology. IUCN Publication Paper No. 30.

Jones and Jones. 1975. An Inventory and Evaluation of the Environmental, Aesthetic and Recreational Resources of the Upper Susitna River, Alaska. United States Army Corps of Engineers, Anchorage, Alaska.

Litton, R. B., Jr. 1973. Landscape Control Points: A Procedure for Predicting and Monitoring Visual Impacts. United States Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station, Berkeley, California.

Litton, R. B. and R. J. Tetlow. 1974. Water and Landscape: An Aesthetic Overview of the Role of Water in the Landscape. Water Information Center, Incorporated, Port Washington, New York.

Lotspeich, F. B. 1971. Environmental Guidelines for Road Construction in Alaska. EPA Report No. 1610. United States Environmental Protection Agency and the Alaska Water Laboratory, College, Alaska.

Lotspeich, F. B. and A. E. Helmers. 1974. Environmental Guidelines for Development of Roads in the Sub-Arctic. United States Department of Agriculture, Forest Service, Institute of Northern Forestry, Fairbanks, Alaska.

Matanuska-Susitna Borough. 1978. Phase II Comprehensive Development Plan: Goals, Statements. Mat-Su Borough Planning Department, Palmer, Alaska.

Orth, D. J. 1967. Dictionary of Alaska Places and Names. Professional Paper 567. United States Department of the Interior, Geological Survey, Washington, D.C.

Pragnell, R. C. 1969. Scenic Road: A Basis for its Planning, Design and Management Manual. Cooperative Research Agreement PSW-62 with USDI (BLM) and USDA (FS). United States Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station, Berkeley, California.

la Societe de developpement de la Baie James and la Societe d'energie de Baie James. 1975. James Bay Hydro-electric Project: A Statement of Environmental Concerns and Recommendations for Protection and Enhancement Measures. Environment Canada, Montreal, Quebec.

*Sparrow, S. D., F. J. Wooding and E. H. Whiting. 1978. Effects of Off-Road Vehicle Traffic on Soils and Vegetation in the Denali Highway Region of Alaska In Journal of Soil and Water Conservation, Volume 33, No. 1.

Taylor, K. V. 1978. Erosion Downstream of Dams In Environmental Effects of Large Dams. American Society of Civil Engineers, New York, New York.

USACOE. 1975. South Central Railbelt Area, Alaska, Upper Susitna River Basin Interim Feasibility Report Appendix 1, Parts 1 and 2. United States Army Corps of Engineers, Anchorage, Alaska.

USACOE. 1977. Upper Susitna River Basin, South Central Railbelt Area, Alaska - Final Environmental Impact Statement, Hydroelectric Power Development. United States Army Corps of Engineers, Anchorage, Alaska.

USDA (FS). 1973. National Forest Landscape Management, Volume 1. Agricultural Handbook 434. United States Department of Agriculture, Forest Service, Washington, D.C.

USDA (FS). 1974a. National Forest Landscape Management Volume 2, Chapter 1 - The Visual Management System. Agriculture Handbook 462. United States Department of Agriculture, Forest Service, Washington, D.C.

USDA (FS). 1974b. Outdoor Recreation Research: Applying the Results. Papers presented at a workshop at Marquette, Michigan June 19-21, 1973. United States Department of Agriculture, Forest Service, North Central Forest Experiment Station, St. Paul, Minnesota.

USDA (FS). 1975. National Forest Landscape Management, Volume 2, Chapter 2 - Utilities. Agriculture Handbook 478. United States Department of Agriculture, Forest Service, Washington, D.C.

USDA (FS). 1977. National Forest Landscape Management, Volume 2, Chapter 4 - Roads, Agricultural Handbook 483. United States Department of Agriculture, Forest Service, Washington, D.C.

USDA (FS). 1979a. Our National Landscape: A Conference on Applied Techniques for Analysis and Management of the Visual Resource. General Technical Report PSW-35. United States Department of Agriculture, Forest Service, Pacific Southwest Forest Experiment Station, Berkeley, California.

USDA (FS). 1979b. Visual Character Types. Series No. R10-63. United States Department of Agriculture, Forest Service, Division of Recreation, Soils and Watersheds, Juneau, Alaska.

USDA (FS). 1980. National Forest Landscape Management, Volume 2, Chapter 5 - Timber. Agricultural Handbook 559. United States Department of Agriculture, Forest Service, Washington, D.C.

USDI (BLM). 1973. Influence of Man-Caused Surface Disturbance in Permafrost Areas of Alaska. United States Department of the Interior, Bureau of Land Management, Anchorage, Alaska.

USDI (BLM). n.d. Visual Resource Management Program. United States Department of the Interior, Bureau of Land Management, Division of Recreation and Cultural Resources, Washington, D.C.

USDI (NPS). 1976. Final EIS: Proposed Electric Distribution Line Extension to McKinley Park. United States Department of the Interior, National Park Service, Pacific Northwest Region, Portland, Oregon.

Viereck, L. A. and C. T. Dyrness. 1980. A Preliminary Classification System for Vegetation of Alaska. General Technical Report PNW-106. United States Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station, Portland, Oregon.

Wahrhaftig, C. 1965. Physiographic Divisions of Alaska. Professional Paper 482. United States Geological Survey, Washington, D.C.

Williamson, D. N. and S. W. Calder. 1979. Visual Resource Management of Victoria's Forests: A New Concept for Australia. Landscape Planning 6: 313-341.

Woodward-Clyde Consultants. 1980. Gravel Removal Studies in Arctic and Sub-Arctic Floodplains in Alaska. United States Department of the Interior, Fish and Wildlife Service and the United States Environmental Protection Agency, Anchorage, Alaska.

Zube, E. H. 1979. Assessing Amenity Resource Values. General Technical Report RM-68. United States Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado.

11.9 - Land Use

Acres American, Incorporated. 1981a. Susitna Hydroelectric Project Final Draft Closeout Report Task 8: Transmission - Transmission Line Corridor Screening. Prepared by Acres American, Incorporated and Terrestrial Environmental Specialists, Inc. for the Alaska Power Authority, Anchorage, Alaska.

Acres American, Incorporated. 1981b. Susitna Hydroelectric Project Preliminary Report Subtask 6.20: Access and Camp Facilities - Watana Construction Camp. Alaska Power Authority, Anchorage, Alaska.

Acres American, Incorporated. 1981c. Susitna Hydroelectric Project Report Subtask 2.10: Access Roads - Access Route Selection Report. Prepared by Acres American, Inc. for the Alaska Power Authority, Anchorage, Alaska.

ADF&G. 1976-1979. Harvest Tickets. Alaska Department of Fish and Game, Anchorage, Alaska.

ADF&G. 1978-1979. Sealing Records. Alaska Department of Fish and Game, Anchorage, Alaska.

Anchorage Daily News. 1981. Uncle Sam Fulfills River Rat's Fantasy (June 1, 1981). Anchorage, Alaska.

Anchorage Daily Times. 1973. Blackadar Beats Devil's Canyon Rapids (March 29, 1973). Anchorage, Alaska.

*APA. 1981. Susitna Hydroelectric Project Environmental Studies 1980 Annual Report Subtask 7.12: Plant Ecology Studies. Submitted by Terrestrial Environmental Specialists, Inc. and the University of Alaska to Acres American, Inc. for the Alaska Power Authority, Anchorage, Alaska.

APA. 1982. Susitna Hydroelectric Project Environmental Studies Report Subtask 7.09: Transmission Corridor Assessment - Environmental Assessment of Proposed Transmission Facilities East of Knik Arm. Submitted by Terrestrial Environmental Specialists, Incorporated to Acres American, Incorporated for the Alaska Power Authority, Anchorage, Alaska.

Bacon, G. 1975. Heritage Resource Along the Upper Susitna River. United States Army Corps of Engineers, Anchorage, Alaska.

Baum, W. K. 1967. Oral History for the Local Historical Society. Conference of California Historical Societies, Stockton, California.

Clawson, M. and C. Stewart. 1965. Land Use Information: A Critical Survey of U.S. Statistics Including Possibilities for Greater Uniformity. Resources for the Future, Incorporated, Johns Hopkins Press, Baltimore, Maryland.

Cole, T. 1979. The History of the Use of the Upper Susitna River, Indian River to the Headwaters. Alaska Department of Natural Resources, Anchorage, Alaska.

Davis, C. 1974. From Tape to Tape: An Oral History Manual and Workbook. Prager Publishers, New York, New York.

Dietz, E. E. 1950. Speedletter by Dietz concerning the Susitna Float Trip, November 20, 1950. Records of the United States Department of the Interior, Bureau of Reclamation, Seattle, Washington.

Dohrenwend, B. S., D. Klein and S. A. Richardson. 1965. Interviewing - Its Forms and Functions. Basic Books, Incorporated, New York, New York.

Dwight, L. and E. W. Trihey. 1981. A Survey of Questions and Concerns Pertaining to Instream Flow Aspects of the Proposed Susitna Hydroelectric Project. Prepared for Acres American, Incorporated, Buffalo, New York.

Emleton, C. (ed). 1968. Land Use and Resources: Studies in Applied Geography. Institute of British Geographers, London, England.

Fortier, E. (ed). 1960. Alaska Hunting and Fishing Guide. Rhodes and Fortier Publishers, Anchorage, Alaska.

Greiner, J. 1974. Wager with the Wind: The Don Sheldon Story. Rand McNally and Company, Chicago, Illinois.

Henning, R. A. 1976. Selected Alaska Hunting and Fishing Tales, Volume 4. Alaska Northwest Publishing Company, Anchorage, Alaska.

Irving, W. N. 1957. An Archaeological Survey of the Susitna Valley. University of Alaska, College, Alaska.

Jones, G. R. 1975. Upper Susitna River, Alaska. United States Army Corps of Engineers, Anchorage, Alaska.

Kari, J. M. 1975. Linguistic Diffusion Between Tanaina and Ahtna. International Journal of American Linguists, New York, New York.

McHarg, I. L. 1971. Design with Nature. Doubleday/Natural History Press, Garden City, New York.

R&M Consultants, Incorporated. 1981. Susitna Hydroelectric Project Preliminary Report Subtask 2.10: Access Roads - Access Plan. Submitted to Acres American, Incorporated for the Alaska Power Authority, Anchorage, Alaska.

Spadley, J. P. The Ethnographic Interview. Holt Rinehart and Winston, New York, New York.

Trihey, E. W. 1981. Instream Flow Study Plan for the Proposed Susitna Hydroelectric Project. Prepared for Acres American, Incorporated, Buffalo, New York.

USACOE. 1976. Draft Susitna Hydropower Feasibility Analysis Environmental Assessment. United States Army Corps of Engineers, Anchorage, Alaska.

USDA (FS). 1960. Fishery Resource Study, Agency Report. United States Department of Agriculture, Forest Service, Anchorage, Alaska.

USDA (FS). 1975. National Forest Landscape Management, Volume 2. United States Department of Agriculture, Forest Service, Washington, D.C.

USDI (BLM). 1940-1979. Case Card File. United States Department of the Interior, Bureau of Land Management, Anchorage, Alaska.

USDI (BLM). 1952. Susitna River Basin: A Report on Potential Development of Water Resources in the Susitna River Basin of Alaska. United States Department of the Interior, Bureau of Land Management, Anchorage, Alaska.

USDI (BLM). 1980 Navigability Reviews - State Selections for the Anchorage, Tyonek, Talkeetna, and Talkeetna Mountains Quadrangles. United States Department of the Interior, Bureau of Land Management, Anchorage, Alaska.

USDI (BLM). 1981. Report of Historical Data in the Susitna Region. United States Department of the Interior, Bureau of Land Management, Anchorage, Alaska.

USGS. 1900-1979. Mining Claim Card File, Active and Inactive Claims, Talkeetna Quadrangle. United States Geological Survey, Fairbanks, Alaska.

USGS. 1930. Mineral Industry of Alaska in 1929. Bulletin No. 824-A. United States Geological Survey, Washington, D.C.

11.10 - Alternatives

Acres American Incorporated, 1981a, Preliminary Assessment of Cook Inlet Tidal Power, Phase 1 Report, State of Alaska, Office of the Governor.

Acres American Incorporated, 1981b, Preliminary Assessment of Cook Inlet Tidal Power, Task 1 Report, State of Alaska, Office of the Governor.

Alaska Department of Fish and Game, Alaska's Fisheries Atlas, Volume I.

Alaska Department of Fish and Game, Alaska's Wildlife Atlas, Volume I, II.

Alaska Power Admininistration, 1980, Hydroelectric Alternatives for the Alaska Railbelt.

Battelle Northwest, 1978, Natural Coal Utilization Assessment. The Impact of Increased Coal Consumption in the Pacific Northwest, USDOE, BNWL-RAP-21, UC-11.

Bechtel Civil and Minerals, Inc., 1981, Chakachamna Hydroelectric Project, Interim Report.

CH_2M Hill, 1979, Review of South Central Alaska Hydropower Potential.

Commerce and Economic Development, Division of Energy and Power Development, 1980, Alaska Regional Energy Resources Planning Project Phase 2, Coal, Hydroelectric, and Energy Alternatives, Volume 1 - Beluga Coal District Analysis.

Cook Inlet Region, Inc. and Placer Amex, Inc., 1981a, Coal to Methanol Feasibility Study, Beluga Methanol Project, Volume IV, Environmental.

Cook Inlet Region, Inc. and Placer Amex, Inc., 1981b, Coal to Methanol Project, Final Report, Volume IV.

Handy-Whitman, 1978, Cost Index for Hydropower Production in the Pacific Northwest.

State of Alaska, 1972, Knik Arm Highway Crossing, Department of Highways, Anchorage.

U.S. Army Corps of Engineers, National Hydropower Study.

U.S. Department of Energy, 1980, Hydroelectric Alternatives for the Alaska Railbelt, prepared for Alaska Power Administration, Juneau.

U.S. Fish and Wildlife Service, 1962, Unpublished letter to Bureau of Reclamation.

U.S. Fish and Wildlife Service, 1978, Impact of Coal Fired Power Plants on Fish, Wildlife, and their Habitats, Biol, Service Program.