LEG. FINANCE - BILLS 1979 - 1980 1253

SB 63 cont., 1253

PROBLEMS & NEEDS

Most of the present commercial electrical power in the Southcentral Railbelt area is derived from fossil fuel thermal and turbine generation. The Anchorage-Cook Inlet area had a total installed capacity of 504.8 megawatts (MW) in 1976. Natural gas fired turbines were the predominant energy source with 434.9 MW of installed capacity. Hydroelectric capacity of 45 MW was available from the Eklutna and Cooper Lakes projects. Steam turbines comprised 14.5 MW of capacity, and diesel generation, mostly in standby service, accounted for the remaining 10.4 MW.

The Fairbanks-Tanana Valley area commercial utilities had a total installed capacity of 222.2 MW in 1976. Oil-fired gas turbine generation provided the largest block of power with a capacity of 136.6 MW. Steam turbines provided 53.5 MW of power and diesel generators contributed 32.1 MW.

Recent electrical power growth rates have been in the neighborhood of 14 percent annually, and although these rates are projected to decline to 7 percent beyond 1980, the year 2000 Railbelt power requirements are estimated to be 15 million megawatt-hours energy and 3,170 megawatts peaking capacity.

Estimated Railbelt Area Power Requirements

	1976	1980	1990	2000
Capacity (MW)	569	870	1,670	3,170
Energy (GWH)	2,550	3,980	7,620	15,000

While increased power capability is the need which precipitated the 1972 U.S. Senate Committee on Public Works resolution which authorized the Corps of Engineers feasibility study, other problems and needs have also been identified. These include the need to preserve natural areas, to conserve or enhance fish and wildlife resources, to respond to problems of flood damage and air pollution, to expand recreation opportunities, and to conserve fossil fuels.

It would be presumptuous to assume that any single water resources plan could satisfy all the water-related needs of a region. Even if the plan could respond to the full range of water-related problems, there are often economic, social, and other needs that must be recognized. It is therefore necessary to select a more limited set of compatible needs to which the water resources plan can respond. In other words, the extent to which desirable functions of a multipurpose project could be developed is highly dependent upon which various purposes are compatible.

Needs which the project development could help satisfy, but which may be contrary to the objective of power development, include the improvement of small boat and deep draft navigation conditions, augmentation of municipal water supplies, and development of an extensive irrigation system. The plans for power development are also relatively unresponsive to the desire for preservation of what could be termed the "Alaskan way of life," including prevention of further population growth, prevention of additional industrialization, and curtailment of urban expansion.

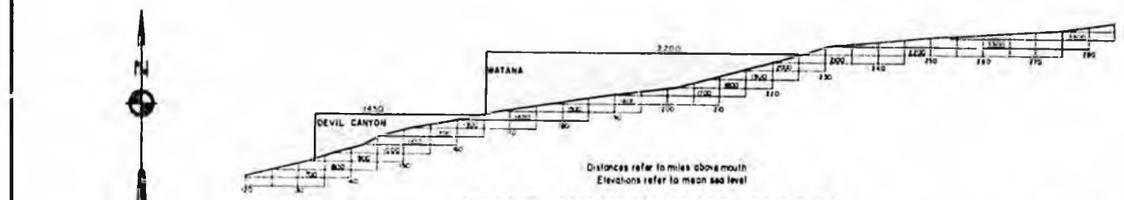
PROJECT DESCRIPTION

The plan of development recommended by the Corps of Engineers in 1976 consists of two dams and related reservoirs and powerplants to be constructed on the Upper Susitna River with transmission facilities to provide power to the Anchorage and Fairbanks load centers.

Watana and Devil Canyon were the two projects recommended in 1976. These two projects could produce 6.1 billion kilowatt hours (kWh) firm annual energy, 800 million kWh average annual secondary energy, and 1,392,000 kilowatts of dependable capacity based on a 50 percent system load factor. Watana, the first project to be built under this plan of development, would consist of an 810-foot-high earthfill structure located at river mile 165. The reservoir would extend 54 miles upstream and have a surface area of 43,000 acres. The total storage capacity would be 9,624,000 acre-feet after 50 years of sediment inflow. The useable storage capacity would be 6,100,000 acre-feet. Devil Canyon, 32 miles downstream of Watana, would be a concrete thin-arch dam with a maximum structural height of 635 feet. Construction of the Devil Canyon project after completion of Watana would be phased to meet the projected electrical energy demands of the Railbelt area. The Devil Canyon reservoir would inundate 7,550 acres and 28 miles of natural river, and would provide 1,050,000 acre-feet of storage capacity. Intake structures would be situated to allow a maximum power pool drawdown of 175 feet, but when operated in conjunction with the upstream Watana reservoir, Devil Canyon annual drawdown would normally be less than 5 feet.

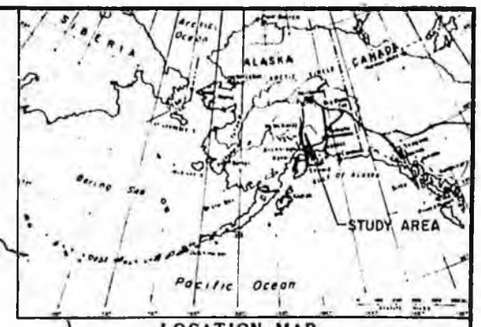
The transmission line would be approximately 365 miles in length consisting of double towers, each carrying a single conductor three-phase circuit. About 25 percent of the energy would be provided to the Fairbanks load centers, with 75 percent being utilized in the Anchorage area. A basin map shows the location of the two dams (Figures 1 and 2). Detailed layouts of Devil Canyon and Watana are shown on Figures 3 and 4.

FIGURE 1. ERTS satellite photograph of the Upper Susitna River with the general location of the Devil Canyon and Watana Projects shown in the circles. Devil Canyon project, on the left, is roughly 65 miles upstream from Talkeetna, and Watana is 32 miles above Devil Canyon. Shown in the upper right corner of the photo are the glaciers of the Alaska Range, which provide much of the flow for Susitna River.



UPPER SUSITNA RIVER PROFILE

RIVER MILES 120-290



LOCATION MAP

BASIN BOUNDARY

RECOMMENDED
A DAM AND RESERVOIR AT WATANA DAMSITE WITH TRANSMISSION FACILITIES.

RECOMMENDED
A DAM AND RESERVOIR AT DEVIL CANYON DAMSITE.

DEVIL CANYON DAMSITE

WATANA DAMSITE

GOLD CREEK

TALKEETNA

To Fairbanks

To Anchorage

To Cantwell

To Paxson

Parks Highway

Alaska RR

Devil Canyon Access Road (Proposed)

Watana Access Road (Proposed)

Portage Creek

Devil Creek

Tsusena Creek

Deadman Creek

Watana Creek

Cool Creek

Jay Creek

Clog Creek

Kosina Creek

Butte Creek

Valdez Creek

Windy Creek

West Fork

East Fork

DENALI

Denali Highway

MACLAREN RIVER

SUSITNA RIVER

SUSITNA RIVER

TYONE RIVER

OSHETNA RIVER

Tyone Lake

Susitna Lake

Lake Louise

Lake Louise Road

To Glenn Highway

SCALE

0 5 10 15 20 Miles

LEGEND

RESERVOIR

ACCESS ROAD

TRANSMISSION ROUTE

SOUTHCENTRAL RAILBELT AREA, ALASKA

UPPER SUSITNA RIVER BASIN

RECOMMENDED IMPROVEMENT

ALASKA DISTRICT, CORPS OF ENGINEERS

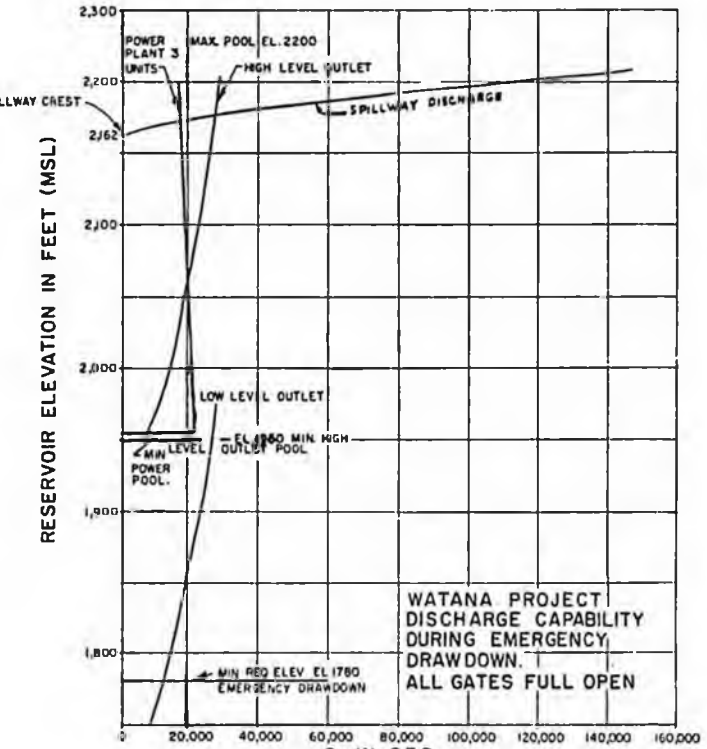
ANCHORAGE, ALASKA

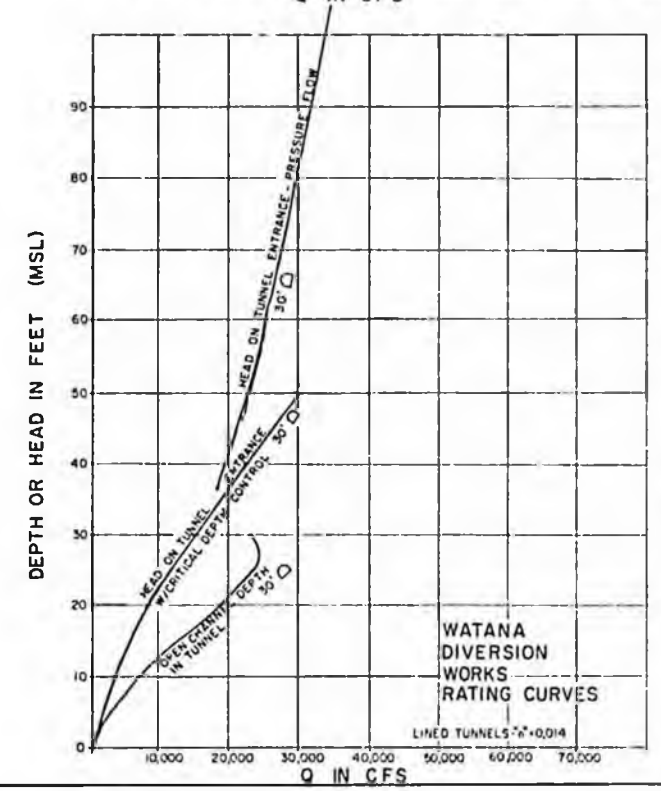
FIGURE 2

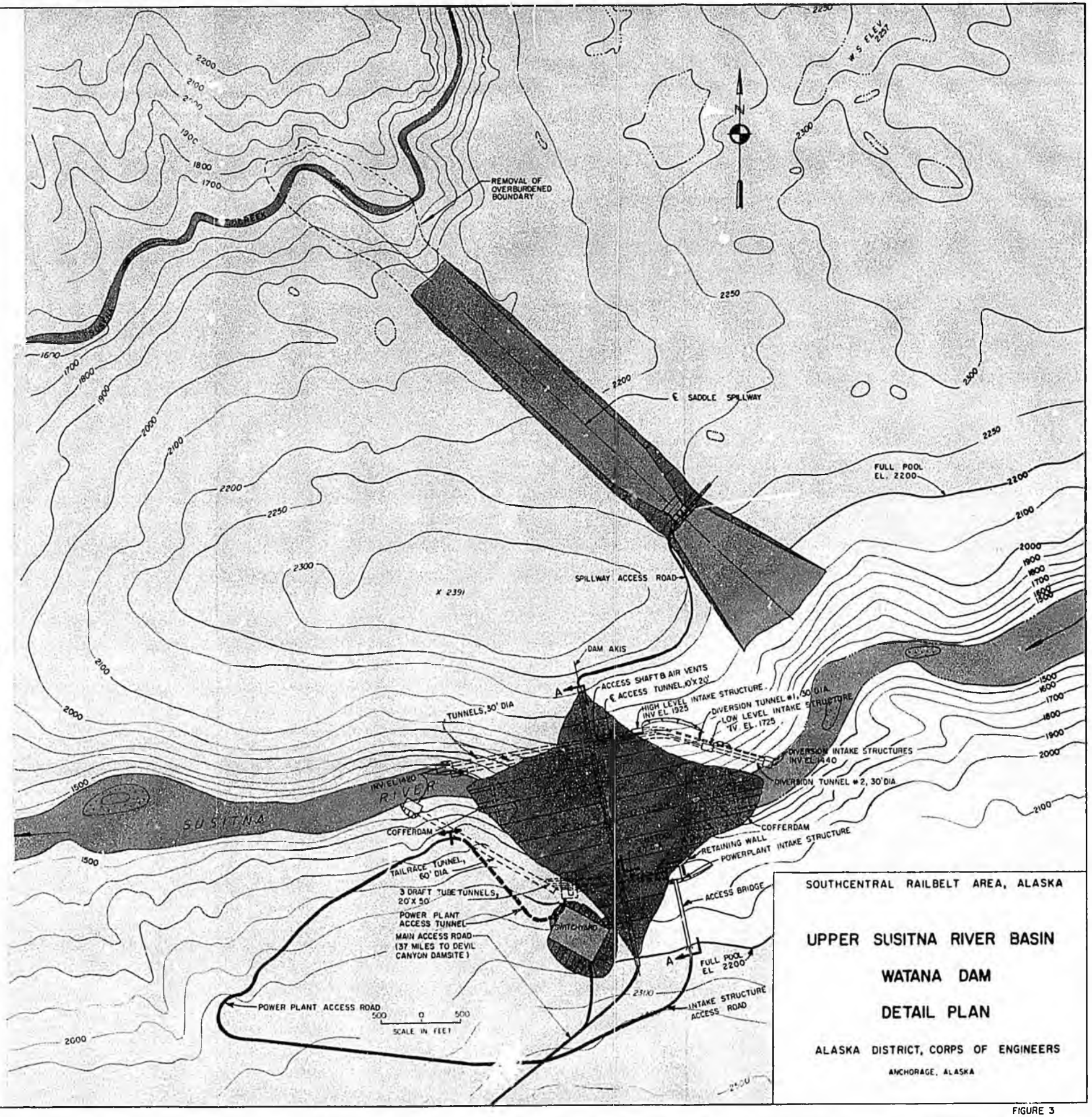
NOTES:

1. TOPOGRAPHIC CONTOURS WERE TAKEN FROM USGS TOPOGRAPHY SCALE 1:63,360, TALKEETNA MOUNTAINS (D-4), ALASKA. VERTICAL DATUM IS MEAN SEA LEVEL (MSL).

2. THERE ARE NO KNOWN EXISTING IMPROVEMENTS ON THIS PLATE.







SOUTHCENTRAL RAILBELT AREA, ALASKA

UPPER SUSITNA RIVER BASIN

WATANA DAM

DETAIL PLAN

ALASKA DISTRICT, CORPS OF ENGINEERS

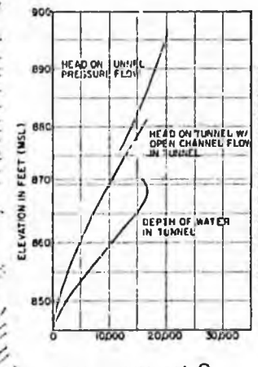
ANCHORAGE, ALASKA

FIGURE 3

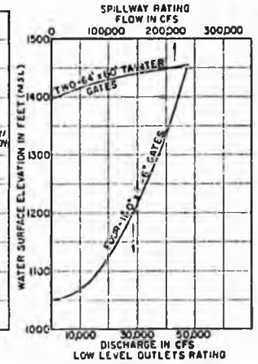
NOTES:

1. TOPOGRAPHY WAS COMPILED FROM AERIAL PHOTOGRAPHY WITH GROUND CONTROL. VERTICAL DATUM IS MEAN SEA LEVEL, (m.s.l).

2. EXISTING IMPROVEMENTS WERE CONSTRUCTED TO OBTAIN INFORMATION AND DATA FOR EARLIER STUDIES.



DEVIL CANYON 26' Ø DIVERSION TUNNEL



DEVIL CANYON RATING CURVES

SOUTHCENTRAL RAILBELT AREA, ALASKA

UPPER SUSITNA RIVER BASIN
DEVIL CANYON DAM
DETAIL PLAN

ALASKA DISTRICT, CORPS OF ENGINEERS

ANCHORAGE, ALASKA

FIGURE 4

ENVIRONMENTAL SETTING

TOPOGRAPHY

The Upper Susitna River Basin contains several topographic features which provide a conglomerate stream flow heavily influenced by specific meteorological events. The basin was shaped by volcanism, diastrophism, glacial erosion, and marine deposition. The basin, as shown in Figure 1, is a fan-shaped area comprising about 6,160 square miles and is bordered by the Alaska Range to the north, the Talkeetna Mountains to the southeast, and flat, low-relief areas to the southwest.

Most of the basin has a well-defined branching stream pattern with a main channel emanating from glacial headwaters in the extreme northern segment of the divide. Below the glaciers, the braided stream traverses a high plateau composed of aggraded alluvial sediment, and then meanders several miles south to the confluence with the Oshetna River. It then takes a sharp turn to the west and flows through a steeply cut, degrading channel until it exits the basin at Gold Creek. The contributing glacial area comprises only 4 percent of the entire basin, but summer glacial melt provides a considerable portion of the total streamflow. By contrast, the flat, glacially carved Lake Louise area in the southeastern portion of the basin provides comparatively little flow from its 700-square-mile area.

The mountains within the basin reflect the influence of the Pleistocene Ice Age, during which glacial advancement over the topography planed the mountains and gave the basin surface a rounded and smoothed appearance. The highest elevation within the basin is 13,326 feet, and the lowest elevation is 740 feet. The basin relief implies a steep channel slope; however, variability of the slope compared to other mountain streams is somewhat reversed. The aggraded channel in the upper reaches of the basin has channel slopes in the range of only 4 to 7 feet per mile, while the lower basin channel drops as much as 37 feet per mile.

Main tributaries to the Susitna River have an even higher range of channel slopes. The deeply incised river channel below the Tyone River contrasts with the many traditional Alaskan U-shaped valleys, remnants

of glacial advances. The absence of broad flood plains in the lower basin results in high stages during high runoff due to confined flow areas. The Susitna River alluvium has developed into a continuous effluent aquifer. Most of the tributary aquifers do not sustain winter flow.

CLIMATE

The climate of the Upper Susitna Basin is characterized by cold dry winters and warm but moderately moist summers. The yearly precipitation distribution shows that 64 percent of precipitation occurs from June through October. Within the Railbelt area, the climate falls into three categories: (1) a zone dominated almost entirely by maritime influences, (2) a zone of transition from maritime to continental climatic influences, and (3) a zone dominated by continental climatic conditions. The Upper Susitna Basin falls within the transitional zone. The contrast between the maritime-influenced areas of the southern Kenai Peninsula and the continental conditions at Fairbanks is marked. Within the confines of the Upper Susitna Basin, away from the moderating influence of maritime air, there are greater temperature extremes than on the coast of the Gulf of Alaska. Extreme winter temperatures are caused by polar air masses which flow in from the north.

Mean annual precipitation in lower elevations of the basin would be expected to range between 18 and 22 inches, while precipitation in higher elevations, because of orographic effects, would be expected to reach 80 inches per year. Mean annual snowfall would range from 60 inches in the lowlands to as much as 400 inches in the high mountains. Freezeup in the highest reaches of the Susitna River starts in early October, and by the end of November the lower regions of the river are icebound. The river breakup begins in early May, and within two weeks of breakup the river tributaries are free of surface ice.

BASIN STREAMFLOW

The annual streamflow patterns of the Upper Susitna River and most of its tributary streams are best described as providing perennial flow. The main tributaries of the Susitna River consist of the East and West Fork Susitna Rivers which originate in the northern section of the drainage basin, the Maclaren River which originates in the northeastern portion of the basin, and the Tyone River which emanates from the southern reaches of the basin.

The flow regime of the Susitna River is seasonal, with more than half of the yearly streamflow occurring from May through September. Summer streamflow consists mainly of snow and glacial melt combined with surface runoff from rainfall. Winter flows are restricted almost entirely to groundwater inflow. Primary water sources for the Maclaren and East and West Fork Susitna Rivers are the numerous glaciers which rim the northern basin divide in the Alaska Range.

The Tyone River contribution is mostly reservoir outflow from the multitude of lakes located within its subbasin. Winter flows begin in early November and are composed of baseflow from subsurface storage. When breakup nears in March and April, subsurface storage is depleted to the extent that many small tributaries cease flowing, and the Susitna River flow shrinks to its seasonal minimum. Following breakup, flows increase rapidly with the onset of spring snowmelt. As summer temperatures increase, glacial flow accentuated by rainfall runoff becomes the predominant river source. The cycle repeats itself with winter freezeup.

The variability of streamflow within the basin is extreme. The following table represents average annual streamflow conditions for portions of the basin above the Gold Creek gaging station.

Flow Variations in Upper Susitna River Basin

Gaging Station	Drainage Area (Sq Mi)	Percent of Gold Creek Drainage Area	Percent of Gold Creek Streamflow
Maclaren River near Paxson	280	4.5	10.0
Susitna River near Denali	950	15.4	27.6
Susitna River near Cantwell	4,140	67.2	64.8
Susitna River at Gold Creek	6,160	100.0	100.0

Nearly 38 percent of the Gold Creek streamflow originates from 20 percent of the area. This large percentage of streamflow is contributed by glaciers in the upper portion of the basin and by high precipitation runoff rates which result from impervious glaciers. In addition, it is suspected that the mountains form a geographic constraint, which causes excessive precipitation in this area in relation to the remainder of the basin.

By contrast, the Cantwell gaging station shows a runoff rate not consistent with that which could be expected below the glaciers, indicating that below the Paxson and Denali stations a large area contributes little annual streamflow. This large, low contributing area is believed to be the flat, 700-square-mile Lake Louise area. Below the Cantwell station, flow percentages increase slightly to a more nearly normal area-discharge relationship for the basin.

GEOLOGY

The geology of the Upper Susitna River Region reflects the complex processes which make up its geologic history. It has undergone subsidence, marine deposition, volcanic intrusion, mountain building, glacial planing, and erosion. In the upper reaches of the river, the valley floor is composed of reworked glacial moraine and lakebed deposits, which are thought to be approximately 200 feet thick. Materials range in size from silt to boulders. Adjacent mountains are composed of metavolcanics and metasediments (lava flows and sediments which have been changed by heat and pressure), and the bedrock beneath the valley floor is also assumed to be a complex of rocks altered from preexisting rock by pressure, heat, and changes in the chemical environment. In the midsection of the Upper Susitna, massive intrusions of granitic rock have warped and uplifted the region. Subsequent vigorous earth movement resulted in the building of the Talkeetna Mountains. Throughout this area the metavolcanics and metasediments are warped and twisted; medium-grained granite intrusives are exposed intermittently along the valley walls. At the lower end of the drainage, glacial action is evidenced by the absence of overburden materials at higher elevations and the scouring and planing of the underlying bedrock.

REGIONAL TECTONICS

Tectonics deals with rock structures and external forms resulting from large movements or deformation of the earth's crust. Two major earth tectonic features bracket the Upper Susitna Region. The Denali Fault, active during Holocene (Recent) time, is one of the earth's major fractures. It lies approximately 43 miles north of the proposed Devil Canyon damsite. A second arcuate fracture, the Castle Mountain Fault, lies some 75 miles to the south of the river basin. Bisecting the region in a northeast-southwest direction and truncated by the Denali

Fault, the Susitna Fault lies approximately 2.5 miles west of the proposed Watana Dam. Large, prominent lineaments pass through the region trending northeast-southwest, and the river valley is controlled by many of these features.

SEISMOLOGY

Since it is located in an area of major faults, it is to be expected that the Upper Susitna Basin would lie in a zone of major seismic activity. During the period of record, through the end of 1970, 262 earthquakes had been recorded within a radius of 150 miles of the proposed Devil Canyon site (Kachadoorian 1974). Of these, 229 had a magnitude on the Richter scale of less than 5.3, while 20 were between 5.3 and 7.0, eleven were between 7.0 and 7.75, and two were greater than 7.75. An evaluation of the potential exposure of the Upper Susitna damsites to seismic activity was made by the Bureau of Reclamation. In view of the recent advances in seismic technology, faults capable of influencing major design features will be reevaluated for their potential Maximum Credible Earthquake.

VEGETATION

Most of the Upper Susitna River Basin is classified as moist or alpine tundra although the area adjacent to the main river channel below the Maclaren River is classified as either upland or lowland spruce-hardwood forest. Major timber species of the canyon slopes and surrounding benchlands are birch, balsam poplar, black cottonwood, white spruce, and black spruce. Overall, timber is of poor quality, varying widely in size, but mostly small and of little or no commercial value. Two distinctly different plant communities occupy portions of the alternate transmission corridors. Bottomland spruce-poplar is confined to the broad flood plains, river terraces, and warm slopes of major rivers. Throughout the lowlands, another distinct vegetation type is low brush-bog/muskeg. Common plants include tamarack, black spruce, alder, willow, and various berries.

FISH AND WILDLIFE

Both resident and anadromous fish inhabit the Susitna Basin. Salmon are known to spawn in many of the sloughs and tributaries of the Susitna River below Devil Canyon; however, surveys indicate that salmon may be unable to ascend the turbulent Devil Canyon and thusly be prevented from migrating into the Upper Susitna River Basin. Grayling, rainbow trout, lake trout, Dolly Varden, whitefish, and burbot comprise the principal resident fish populations.

Mammals and birds found in the Upper Susitna Basin are representative of wildlife species common to interior Alaska. Important game species consist of moose, caribou, and Dall sheep. Wolves, wolverine, bear, and smaller fur bearers inhabit the basin. Birds are predominantly seasonal, and include waterfowl, raptors, and passerine species. The peregrine falcon is the only rare or endangered species presently known to frequent or inhabit the basin.

PRODUCTS OF FEASIBILITY ANALYSIS

The results of studies will be presented in a Project Feasibility Analysis Report supplemented by a series of appendices and a document supplementing the Environmental Impact Statement.

TENTATIVE DOCUMENTS

Project Feasibility Analysis, Main Report

Appendices

- Hydrology
- Power Studies
- Site Selection
- Plan Formulation
- Transmission Facilities
- Access
- Foundations and Materials
- Real Estate
- Design and Cost Estimates
- Marketing Analysis
- Environmental Studies
- Recreation
- Cultural Resources

Environmental Impact Statement (Supplement)

REPORT DESCRIPTIONS

The Project Feasibility Analysis, Main Report will be a summary document presenting the studies and investigations made to reformulate the project to meet present day conditions and to augment the preauthorization feasibility analysis where deficiencies exist. The report will

be primarily a planning document in which plan formulation, impact assessment, and cost estimates will be presented in sufficient detail to support the conclusions and recommendations made. Also the recommended plan will be described, and the economic and financial analyses summarized.

The Hydrology Appendix will document the basic hydrologic information upon which the project analysis will be based. Included will be discussions of daily streamflow, hydrology and climate within the basin and along the transmission corridor, sediment transport, erosion potential, icing, flood routing, and spillway design floods.

The Power Studies Appendix will describe the analysis of energy capabilities of the various plans studied. It will include the results of seasonal and hourly regulation studies to determine the need for a reregulation reservoir. The report will also contain head duration curves, tailwater duration curves, turbine efficiency curves, and suggested operating rule curves.

The purpose of the Site Selection Appendix will be to present the considerations resulting in specific recommendations as to dam types and heights for each site. The report will explain the mechanics of the reviewing process and the rationale for specific site selection on the basis of foundation suitability, quantity, quality, and location of construction materials, and mass-quantities and cost-height relationships.

The Plan Formulation Appendix will document the procedures and rationale by which the recommended plan of development is selected. The procedure will entail identification of planning objectives, the assessment of available alternatives and their impacts, and a comparison of alternatives from the standpoint of economic development and environmental considerations. The selected plan will be that plan which provides the greatest contributions to the study objectives.

The Transmission Facilities Appendix will present the studies involved in selection of transmission line routes, towers, conductor and hardware, substations and switchyards, and other transmission facility components. The selected scheme will be described in detail. Also included will be a transmission line reliability analysis.

The access route alternatives will be outlined and the considerations in route selection presented in the Access Appendix. Vertical and horizontal alignments will be shown, and their advantages and disadvantages in relation to grade, curvature, distance, bridge requirements, and foundations will be evaluated. Particular emphasis will be placed on the requirement for an all-weather access and on the potential winter problems of snow and ice.

The results of exploration, testing, and evaluation for geological and foundation conditions will be presented in the Foundations and Materials Appendix. Documentation will completely define the quality of the dam foundation and the extent and type of foundation treatment required for design. Location and quality of embankment materials will be shown and test results outlined with particular emphasis on strength of materials under high confining pressures and dynamic cyclic loading. Special emphasis will also be placed on regional and site geology and faulting and its relation to the potential seismicity of the area. Seismic studies will be described, including the design earthquake parameters and a dynamic soils response analysis for the embankment.

The Real Estate Appendix will contain information on land ownership and value. The report will include an overall real estate project map along with more detailed segment maps. A gross appraisal will be prepared with supporting narrative to provide technical justification for land costs.

Contained in the Design and Cost Estimate Appendix will be a discussion of dam type and height, foundation conditions, material sources, general configuration of spillway and outlet works, penstocks and powerhouse, intake systems and gates, and any other pertinent dam features. Other project components such as construction facilities and reservoir clearing will also be described. Further, it will contain the various plan cost estimates used as a basis for choosing the selected plan and also the rationale and assumptions underlying the estimates. The investigations and design associated with the first phase of construction will be relatively more detailed than that for subsequent project phases, and the accompanying cost estimates for first phase construction will therefore be more refined and reliable.

The Marketing Analysis Appendix will document the extensive investigations and analyses leading to the load growth forecast and market for Susitna power. In addition it will contain a detailed assessment of existing plant retirement, a discussion of the role of Susitna power in the long-term Railbelt energy supply system, and a financial analysis.

The Environmental Studies Appendix will serve as a reference document for the impact assessment and plan formulation process, as well as for supplementing the Environmental Impact Statement. The report will be a consolidation of the socioeconomic, biological, and water quality data collection and impact identification studies.

Narrative and plates detailing the proposed recreational development, along with the reasoning for its selection will be presented in the Recreation Appendix.

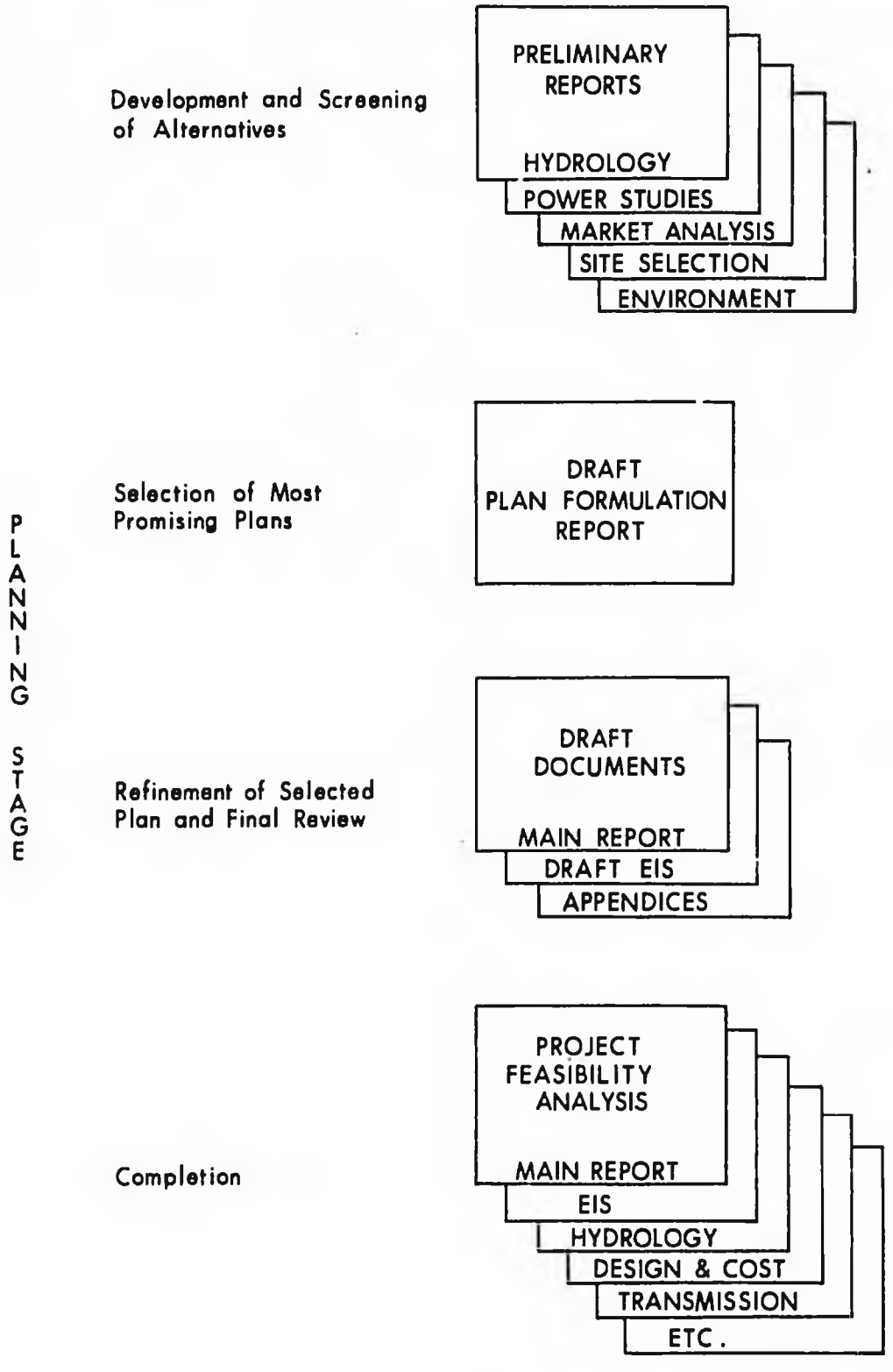
The Cultural Resources Appendix will be a reconnaissance report presenting the findings of both the archeological and historical studies. The appendix will contain information relating to the identification of archeological and historical resources located in the project area and to the probable project impact on those resources.

The Environmental Impact Statement (Supplement) will summarize the full range of environmental, economic, social, and engineering studies. Impacts resulting from the various project features will be discussed and evaluated. The report will be designed to concisely describe the tradeoffs involved among the various schemes of development and to present the rationale for any recommendations made.

DOCUMENT SEQUENCE

Preceding these final documents will be four preliminary appendices covering hydrology, power and marketability, site selection, and environmental studies. These preliminary appendices will serve as a basis for preparation of a draft plan formulation report. Following the choice of the most favorable plans through the plan formulation process, more detailed attention will be directed at formulating the selected plan with results documented in draft appendices. After appropriate review, these will be finalized along with the Project Feasibility Analysis Main Report and the Environmental Impact Statement (Supplement). The sequence of preliminary, draft, and final documents is depicted in Figure 5.

FIGURE 5: PROJECT FEASIBILITY ANALYSIS DOCUMENT SEQUENCE



PUBLIC INVOLVEMENT AND COORDINATION

The objective of public participation is to further involve the public in the project feasibility study, in order to insure that the study responds to public views and preferences to the maximum extent possible. As used here, the term "public" includes other Federal, State and local government entities and officials; public and private organizations; and individuals interested or potentially interested in the Susitna project.

SUMMARY OF PREVIOUS PUBLIC INVOLVEMENT

In conjunction with the 1976 Corps of Engineers feasibility study, numerous comments were received at public meetings and from written statements on the report findings and reccommendations. Over 65 agencies, organizations, and individuals have provided written comments or oral testimony. In general, comments focused on the need for additional studies before a final decision on construction of a project of such magnitude. The Chief of Engineers has responded to all comments received during review of his draft report and companion Environmental Impact Statement and agreed that additional studies are required before a recommendation can be made for construction. The activities outlined in this plan of study reflect public comments and concerns expressed on the 1976 feasibility report.

Comments of Governor Jay Hammond expressed in his letter of November 17, 1976, to the Chief of Engineers are quoted as follows:

> "I concur in the recommendation by the Board of Engineers report that further study effort is needed for a project of this magnitude. I agree that additional detailed studies, including those addressed by my task force, will be required to determine the significant impacts associated with the magnitude and complexity of the project. Our task force recommendations will be supplied to the District Engineer.

"The information obtained from the District Engineer concerning studies proposed in the next stage coincides well with the environmental, socio-economic and technical studies identified by the State Task Force during review of the Draft Environmental Impact Statement. As these detailed studies are addressed, coordination should be maintained with the State's designee to assure that assessments are answering those points raised in the task force report and to insure that the information developed will be adequate on which to base future State recommendations."

INTERAGENCY COORDINATION

Coordination will be carried out on a continuing basis with Federal, State, and local agencies having interest in the study. Should the planning for Susitna hydropower proceed in the joint State-Federal mode, an extremely close working relationship is envisioned between the Corps of Engineers and the State of Alaska. To ease the coordination problems inherent in a planning program of this magnitude, a single point of contact would be established for the State and a single point for the Corps of Engineers. These would be the Alaska Power Authority on the one hand, and the Alaska District on the other. This State agency would coordinate State reviews of study progress, and formulate feedback int a consolidated State position. The Alaska District would be responsible for and would coordinate all study activities, thus serving as the point of interface between the State and those engaged in accomplishing the project feasibility analysis. Included in this group would be various Corps of Engineers elements, other Federal agencies, private consultants, and State agencies, such as the Department of Fish and Game, that will provide special technical services.

In addition to the ongoing coordination with agencies at all levels of government, there will be an opportunity for formal review and comment after distribution of the draft Project Feasibility Analysis Report and accompanying draft supplemental Environmental Impact Statement. The substance of all comments received will be incorporated in the final report and impact statement supplement.

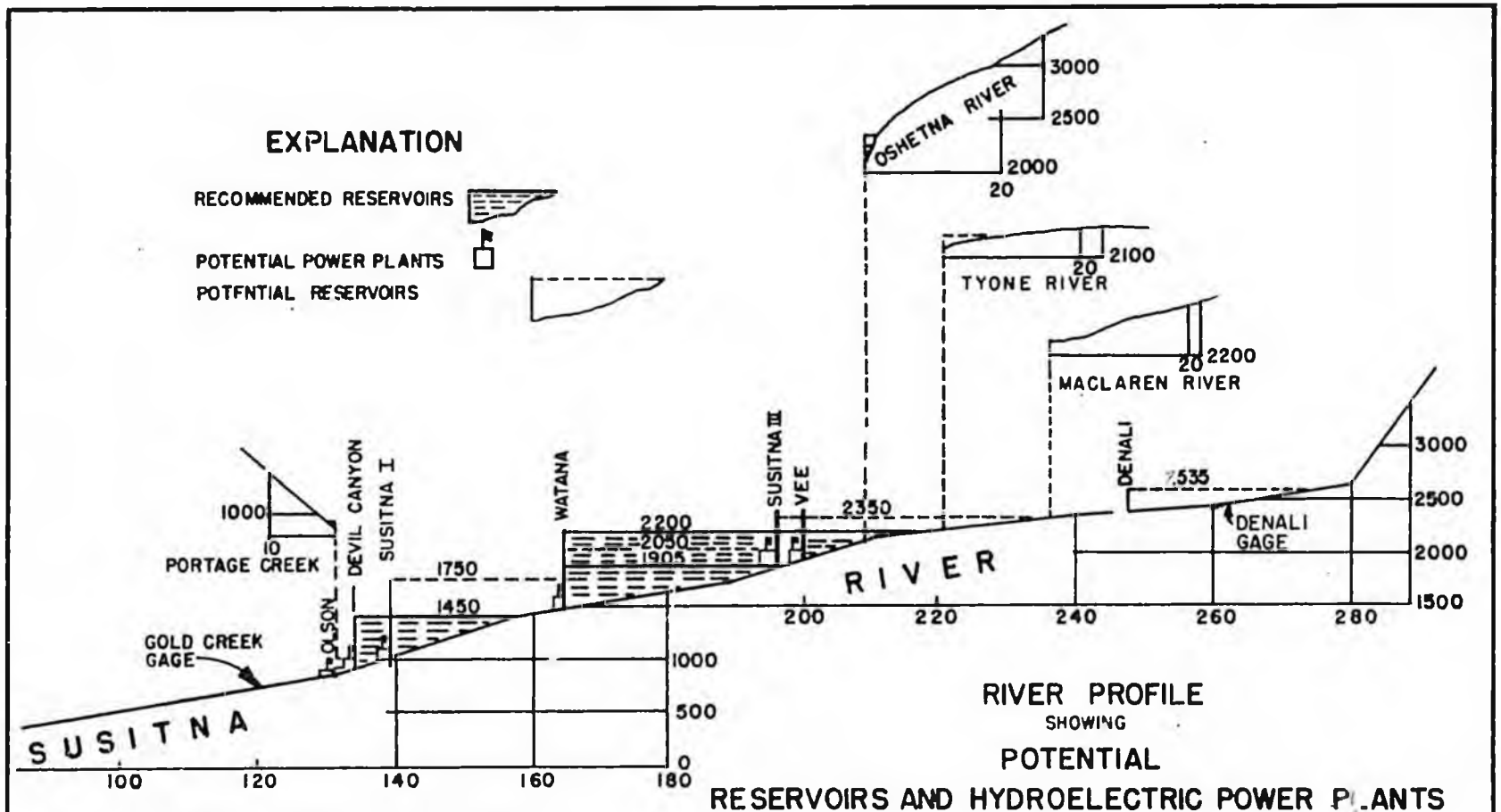
PROGRAM SUMMARY

The activities identified for accomplishment during the Project Feasibility Analysis are those that are considered necessary to establish the feasibility of developing the Upper Susitna hydropower potential; further, they outline sufficient engineering analysis to determine a reasonably accurate cost estimate for the initial features to be built, namely the transmission line, access road, and the first dam. It must be realized, however, that as the planning process evolves and new information becomes available the program must be flexible enough to allow changes in the study direction. The present work program has been based on certain specific assumptions, but the planning process will be capable of responding to what is actually a dynamic situation. In brief, initial efforts will be aimed at determining the optimal basin development; this will lead to a detailed feasibility analysis of the selected plan and then ultimately to specific feature design. Also to be examined, however, will be other basin development schemes which could be analyzed in depth if the exploratory program should uncover some overriding factor which might preclude the development of the plan first selected for detailed analysis.

An important part of the planning will be the early screening of energy alternatives to validate the choice of Susitna hydro as the most favorable alternative for the Railbelt Area. Although the results of this screening are expected to generally conform to the earlier feasibility study, the outcome is not guaranteed. For the purpose of outlining a planning program, it has nonetheless been assumed that further analysis will show hydroelectric development on the Susitna River to be the most favorable course to pursue. Further, it has been assumed for the purpose of detailing the planning program that the two-dam scheme of Watana and Devil Canyon will be the selected plan. This is a reasonable assumption since the preauthorization report upon which the two-dam selection is based is a fairly recent study. Other results from the screening would cause an alteration in the planning program, but the scope of the program outlined for the two-dam scheme is representative of the effort that can be anticipated. The cost associated with foundations and materials exploration and testing is the item most sensitive to departures from the assumed two-dam scheme or to the discovery of unexpected geological conditions. Additional requirements such as expanded environmental or archeological studies would, of course, increase the program costs.

Considering the limited number of damsites available within the Upper Susitna River Basin, the task of determining the best plan of development should be relatively straightforward. Much work has already been accomplished by the Corps of Engineers and Bureau of Reclamation in amassing baseline data upon which a sound decision can be made concerning basin development. Within the past two decades the Bureau of Reclamation has conducted a reconnaissance-level foundation exploratory program for the Devil Canyon, Vee, and Denali damsites. To this the Corps of Engineers has added a seismic refraction analysis of the Watana damsite, surfacial mapping of the basin using conventional aerial photography and ERTS imagery, and an environmental and esthetic assessment of the entire basin. Streamflow and sediment transport data has been collected by the U.S. Geological Survey, snow accumulation data has been collected by the Soil Conservation Service, and some meteorological data has been provided by the U.S. Weather Service. Also, preliminary wildlife inventories were provided through U.S. Fish and Wildlife Service. This data, along with economic evaluations by the Corps of Engineers and marketing and transmission line analysis by the Alaska Power Administration, served as the primary input to the 1976 preauthorization feasibility study on Susitna hydropower development conducted by the Corps of Engineers. During that study a number of alternative basin developments were analyzed, with the conclusion that the best plan of development would consist of Devil Canyon and high Watana as described under Project Description.

Subsequent review of geotechnical data provided by the Bureau of Reclamation has led the Corps to conclude further that, given the present state-of-the-art of large dam construction, the Denali damsite, being underlain by discontinuous permafrost and deep glacial deposits, is not a desirable site for development. Somewhat similar conditions at the left abutment of the Vee damsite make that site questionable for development as well. Early in the proposed Project Feasibility Analysis, therefore, it is anticipated that at least the Denali damsite would be definitively eliminated from consideration for development. Consequently, the only viable damsites available would be those located along a 63-mile stretch of the river between the downstream terminus of Devil Canyon gorge near Portage Creek to the Vee damsite at Vee Canyon. Within this stretch of river there have been 6 sites identified for possible development. They are: Olson, Devil Canyon, Susitna I, Watana, Susitna III, and Vee. The location of these projects within the basin is shown on Figure 6. Based on these sites a number of possible schemes for full basin development are available depending, of course, on the height of each dam in relation to the others. Combinations of dams which have been identified for possibile development, irrespective of economic or environmental feasibility, are: (1) Devil Canyon and Watana; (2) Devil Canyon, Watana, and Vee; (3) Olson, Susitna I, and Susitna III or Vee depending on the availability of a damsite at Susitna III;



RIVER PROFILE
SHOWING
POTENTIAL
RESERVOIRS AND HYDROELECTRIC POWER PLANTS

ALL DISTANCES SHOWN ARE IN MILES FROM THE MOUTH AT COOK INLET.
ALL ELEVATION ARE IN FEET AND REFER TO MEAN SEA LEVEL DATUM.

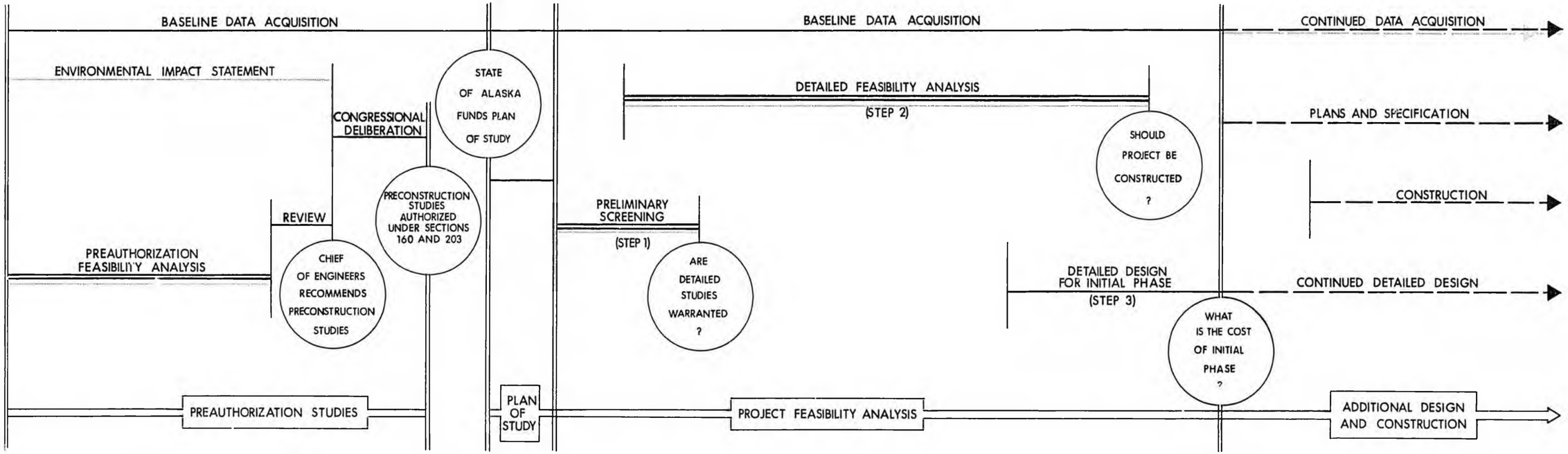
SOUTHCENTRAL RAILBELT AREA, ALASKA
ALASKA DISTRICT, CORPS OF ENGINEERS
FIGURE 6

(4) Olson, Susitna I, and Watana; and (5) Olson, Devil Canyon, and Watana. Early reconnaissance studies may indicate other sites within the basin that could lead to additional plans of development which should be studied. However, by realizing that the firm energy which can be obtained from a water resource is essentially a function of streamflow and cumulative dam heights, it is obvious that the five plans mentioned above offer a comprehensive range of alternatives from which to choose, since each plan essentially makes maximum use of the available fall of the river.

Selection of the best plan will require an assessment of all variables associated with each alternative. Power factors will entail development of the maximum dam heights consistent with the local topography and of sufficient reservoir storage to augment the normal low winter flow to meet peak power demands. Alternative plans will be screened for economic feasibility. Finally, each scheme of development will be evaluated for environmental impact and for the need for measures to preserve or enhance the environment.

The previous Corps report indicated that the cost of constructing the Devil Canyon and Watana two-dam complex including access road and transmission lines to Anchorage and Fairbanks would be $1.5 billion, based on a January 1975 price index. Obviously, delay of project development will result in an increase in total costs as inflation continues. In fact, in September 1977 dollars, the cost of constructing the project was $2.1 billion. Included in this amount are funds for Engineering and Design (E&D) of the project and ultimately Supervision and Administration (S&A) of construction. Historically, E&D and S&A costs as a percentage of total construction costs have varied with the magnitude of the project. A relatively small project might require E&D costs as high as 12 percent of the construction costs while a large project would only require 5 percent for E&D. If it is assumed that E&D for the Susitna project is approximately 5 percent, then this would represent $100 million. Allowing for price adjustments, E&D charges will cover costs incurred from the start of Project Feasibility Analysis through final engineering and design of the completed project. The greater the expenditure during Project Feasibility Analysis, a part of the design effort, the less will be required during the later design phases. Naturally the reverse is true as well. The costs identified for the Project Feasibility Analysis represent approximately 25 percent of the total E&D efforts anticipated.

The overall program for developing the Susitna River can be broken down into three major categories, which are summarized in Figure 7. These categories include the preauthorization feasibility analysis, postauthorization project feasibility analysis (highlighted in yellow), and



COLORS CORRESPOND TO TYPE ACTIVITY:

- FIELD WORK (SURVEY, EXPLORATION, BIOLOGICAL STUDIES, SEISMIC MONITORING)
- DESIGN
- PLANNING
- ENVIRONMENTAL ASSESSMENT

SOUTHCENTRAL RAILBELT AREA, ALASKA

UPPER SUSITNA RIVER BASIN

PROJECT FEASIBILITY ANALYSIS
PROGRAM SUMMARY

ALASKA DISTRICT, CORPS OF ENGINEERS
ANCHORAGE, ALASKA

FIGURE 7

finally, project construction. As can be seen from the diagram, completion of the plan of study brings the project to the threshold of the project feasibility analysis. The preauthorization report was initiated in January 1975 and was completed by the Alaska District Corps of Engineers in December 1975. Funds expended on the project by the Corps and other State and Federal agencies represent approximately $1 million for the preauthorization report. This includes the Feasibility Report, Technical Appendices, and Environmental Impact Statement. Subsequently the report and final Environmental Impact Statement was submitted to the President's Office of Management and Budget (OMB) in the summer of 1977 for their review and comment prior to transmitting the report to Congress. In September the Office of Management and Budget notified the Corps of the need to update the benefit-to-cost status prior to their recommending release to Congress. It was agreed that the Corps could conduct a supplemental feasibility update study that would primarily increase the geological data available to confirm assumptions made in developing the project cost estimates. The activity is being funded by reallocating $3 million of Corps study funds and is to be complete by January 1979.

Once again, considerable effort had been expended in previous years by the Bureau of Reclamation for geotechnical exploration, and by other State and Federal groups, for which there is no estimate of expenditures. The preauthorization study entailed a review of energy alternatives available to meet intermediate power requirements, a screening of these alternatives, and an assessment of effects for the more feasible alternatives. A number of development schemes for the Upper Susitna were analyzed, and at least three were found to be economically feasible. As an alternative to Susitna hydropower, coal was found to be the most likely future energy source for both Anchorage and Fairbanks although it would be 30 percent more expensive than Susitna power. The study established with reasonable certainty that economic feasibility of Susitna hydropower development exists, and that there are no adverse environmental impacts of such magnitude that the project should not be considered further.

Obviously, during these early studies a number of questions were raised which remain to be evaluated in more detail during the next level of analysis. Some of the major questions relate to the exposure of the dams to high seismic activity, to inflow of sediment to the reservoirs, to the validity of power projections, to the possibility of induced economic and population growth, to possible construction cost overruns, and to the possible impact on downstream fisheries. On the basis of the information contained in the preauthorization report, Congress authorized the Corps of Engineers to conduct preconstruction planning in a joint program with the State. Subsequently, on 30 June 1977 the State made funds available to the Corps to develop this Plan of Study for accomplishment of the Project Feasibility Analysis.

The activities identified in this plan of study for accomplishment during the Project Feasibility Analysis have a total estimated cost of $24.1 million over a time frame of 46 months. The cost estimate, which is based on a September 1977 price level, is a compilation of costs for performing 202 distinct activities as described in the following section, Description of Program Activities. It can be expected that cost escalation will have its effect upon the September 1977 estimates, also that cost adjustments will be necessary for individual activities as further site information is developed during the planning and design process. However, there should be a balancing effect of these adjustments within the total estimated cost. As shown on Figure 7, the Project Feasibility Analysis has been broken down into three specific steps, with each step leading to a decision as to whether or not the project should proceed based on the accumulation and analysis of a continually growing data base. These three decision points, to be reviewed periodically, will provide assurance that a mechanism exists for review of technical, environmental, and economic information in light of possible changing needs and State policies. In a manner similar to the process by which the 1976 Feasibility Report served as the basis for proceeding to the upcoming planning stage, each decision point will indicate whether or not the project remains feasible and planning should continue. The three progressive steps which make up the Project Feasibility Analysis are: (1) preliminary screening, (2) detailed feasibility studies for the selected plan of development, and (3) detailed design studies for the access road, transmission system, and first project to be built, presumably Watana. If at the conclusion of any of these decision points the project is found to lack economic or environmental justification, this, with sufficient funds for demobilization, would serve to terminate the planning process. It would further serve as the basis for assumption by the Federal Government of all costs incurred during the Project Feasibility Analysis as provided for under Section 203 of the 1976 Water Resources Development Act.

As with any large development project, the expenditure of funds is made with a degree of uncertainty that they will provide future benefits. This is indeed the case with the Project Feasibility Analysis in which some activities do not contribute directly to the planning step within which they are scheduled but are essential for timely input to one of the later planning steps. For instance, water quality data collection may not be necessary for the initial screening step, but if sufficient data is going to be available for detailed feasibility studies and detailed design, this activity must be started at the outset of the planning program. This process is already taking place, as the U.S. Fish and Wildlife Service has been provided FY-77 funds to continue certain fish and wildlife studies for the Susitna project that could not, by their nature, be meaningful unless conducted for a period of several years duration. This is true of many other studies as well. If indeed the Susitna project proves to be more feasible than other

energy alternatives, it is economically advantageous to bring it on line as early as possible. Thus, to preclude a protracted planning period, there is a certain amount of necessary overlap among the three steps.

Step 1, Preliminary Screening: This step will begin with public meetings, a review of previous reports and an update of preliminary evaluation criteria used for judging the alternatives. Those alternative energy sources which obviously fail to fulfill the evaluation criteria will be dropped from consideration. Specific to Susitna development, a number of potential damsites and combinations of different dams and heights will be evaluated to identify the most economical and environmentally acceptable plan based on preliminary assessments and calculations of benefits and costs. During this study phase, the best plan identified in the 1976 feasibility report, initial construction of Watana, followed by construction of Devil Canyon, will be reexamined. Hydropower analyses will require seasonal reservoir operation studies for each plan of development. Comparative economic analyses will require updated marketing assumptions and reconnaissance-grade cost estimates for each scheme to be analyzed. Additional data requirements over that provided in the 1976 report would include sufficient site reconnaissance of the Olson, Susitna I, and Susitna III damsites to establish a greater reliability in project design features and construction cost estimates. This step will also require a determination of the intermediate and long-term energy source that would be developed if Susitna hydropower were not constructed. The economic and environmental comparison between this nonhydro alternative and each of the hydro schemes will serve as the basis for proceeding with further studies. In addition to serving as an early point of decision regarding additional planning, the preliminary screening will produce a ranking of the various Susitna plans of development from which any recommended plan of development would be selected. This first step is estimated to cost $4.3 million and be completed in 7 months. In order to meet the overall study schedule of 46 months, field work needed in later phases of the study has been scheduled concurrently with the preliminary screening, and these costs have been included in the subtotal of $4.3 million. Some of these major concurrent activities are: (1) installation and operation of additional stream gages, (2) initiation of a hydrometeorological data collection network throughout the basin, (3) detailed mapping and surveying, (4) installation and operation of a field camp at Watana, (5) initiation and continuation of environmental inventories and studies, (6) inventory of possible cultural resources, (7) continuation of the foundation core drilling program at Watana, and (8) seismicity studies and seismic monitoring. It will also be necessary to initiate during preliminary screening some of the in-depth marketing studies that will be used in the later detailed feasibility analysis.

Step 2, Detailed Feasibility Studies: Detailed studies will be concentrated on the best plan identified during preliminary screening.

This assessment will be made using the detailed information and data obtained from the marketing, environmental, hydrological, and foundation studies. The marketing studies will entail refined cost estimates based on expanded information available from the exploratory field program. Project benefits will be determined from the power studies and production cost analysis for the selected plan and viable thermal alternatives. The marketing analysis will include studies that will serve as the basis for forecasting future development, employment and population growth, for assessing the existing and planned generation needed prior to Susitna development, and for estimating future electrical energy requirements and the seasonal distribution of the demand. The marketing analysis will also assess the long-term power system requirements, evaluate retirement of existing and planned power plants, evaluate alternative power sources, and determine financial feasibility. Power studies will primarily be aimed at refining the operation of the two-dam plan, determining the need for long-range peaking generation, and consequently, the need for a reregulation dam. While these studies will be based on full basin development, it must be realized that construction of each phase is dependent on energy demand. Consequently, while construction of Watana is presently envisioned to be followed in 5 years by construction of Devil Canyon, realization of actual energy growth rates may indicate that the second project construction should either be delayed or accelerated. This determination, however, will be made on the basis of future marketing analysis to be conducted concurrently with construction of the first project.

The majority of the biological studies which are either a continuation of existing studies or are those initiated at the outset of this feasibility analysis will be completed during the second step and will be used to assist in determining project feasibility. Some of the biological studies will require continuation through step 3 into construction to provide a base of life cycle habitat and other biological information needed to outline possible mitigation studies. The biological studies outlined in the Plan of Study are of sufficient depth to provide, at the end of step 2, a strong indication of the probable magnitude of impacts of the project and to evaluate project feasibility, but may be unable to define the magnitude of mitigation. Funds for studies beyond step 2 are not provided for in the cost estimate contained herein for the Project Feasibility Analysis Report. The Federal and State Governments recognize that there is a need for funds to maintain continuity of such studies through step 3 and beyond. If the feasibility analysis is favorable and the State decides to pursue construction jointly with the Federal Government, the Alaska Power Authority should develop a source of funding to permit continuation of the biological studies until such time as funding and authority to initiate advanced design and construction has been determined.

Environmental water quality studies will be conducted in concert and simultaneously with biological studies to provide information on water quality parameters. A portion of the hydrological studies will supplement the environmental water quality studies while the majority of the studies will provide input to the power studies and detail design.

A major portion of the exploratory program relating to foundations and construction materials will be accomplished during this phase. Regional and site-specific geologic mapping, initiated under step one, will be completed, and faulting will be defined. A seismic monitoring system will be installed, and the detailed seismic studies required for later definition of earthquake parameters and dynamic soils response analyses will be completed. An extensive drilling program will be conducted at Watana damsite to define and examine foundations and construction material sources; the voluminous drill logs and test results will be catalogued and organized for presentation. The analyses of the Watana site will also include geophysical investigations, concrete studies and sufficient feature design for embankments, cofferdams, powerhouse, spillway, and related features to permit the preparation of the necessary cost estimates. A limited amount of drilling and exploratory tunneling, as well as in-situ rock testing will be completed at Devil Canyon site, and the necessary mapping exploration and testing for the access road and transmission route will be initiated.

This second step is estimated to cost $16.7 million and be completed 25 months after completion of step one. As indicated above, additional field work would continue during this phase of the study, and these costs have been included in the subtotal of $16.7 million. Also included are concurrent activities required for detailed design studies. These design studies would begin during month 20 of the total 46 month period and would be necessary for deriving timely design and detailed cost estimates. Completion of the detailed feasibility report will provide a firm basis for recommending for or against construction of the project, whether Federally funded, State supported under Section 203, or independently financed by the State of Alaska.

Step 3, Detailed Design Studies: The last step would be detailed design of the initial dam and powerhouse, access roads, and approximately 350 miles of double-tower, three-phase transmission line and substations to deliver power to the Anchorage and Fairbanks load centers. Completion of this step would fulfill roughly 80 percent of the foundation exploration program at Watana and 50 percent of the Watana design. Most of the Devil Canyon exploratory and design program would be deferred pending a firm decision to proceed with that phase of the project. The level of design will be sufficiently detailed to permit a reasonably accurate initial project cost estimate enabling a decision on funding and initiating construction. The third step is estimated to cost $3.1 million and be completed in an additional time frame of 14

months after completion of step 2. This phase of the study process will also include the final writing of the Environmental Impact Statement Supplement, the Main Report, and the Technical Appendices.

While the three steps mentioned above provide a broad concept of the general planning process, a more detailed schedule is necessary for plan implementation. For this purpose, the activities identified in the following section have been integrated into such a schedule based on the duration and interdependence of the specific activities. This Critical Path Method (CPM) schedule is shown in Figure 9, found at the end of the report. The termination of the three planning steps are identified in the CPM as nodes 500, 672, and 1060 respectively. Again, it should be emphasized that the program is an evolving planning process, and the schedule will have to be adapted to study findings as they emerge. Further, the schedule is based on a certain assumed assignment of personnel and equipment. Reallocation of resources among the activities may become advisable as the program progresses: this would cause activity durations to change and the schedule to be modified accordingly.

Successful accomplishment of the Project Feasibility Analysis is dependent on timely funding. The CPM activities have been scheduled taking seasonal constraints into consideration with the start date assumed to be the first of May. Realization of this schedule, however, would require early indication of program initiation as well as some limited mobilization funds during the immediate months preceding the program start. This would allow the initiation of the various supply and Architectural-Engineering contracts prior to start of the field season and would allow arrangements to be made for access to the sites. Obviously, if funds became available at some time other than the assumed 1 May start date, the program schedule would necessarily need to be adjusted. With funds provided as assumed, 20 percent of the total cost is required during preliminary screening, 65 percent during the detailed feasibility analysis and 15 percent during the detailed design phase. Accumulated expenditures needed over the study period are shown on Figure 8. A summary of expenditures by year indicates the following estimated funding requirements:

Annual Funding Requirements

Months	Program Funds
1 through 12	$6,766,000
13 through 24	8,856,000
25 through 36	7,880,000
37 through 46	590,000
TOTAL	$24,092,000

The CPM schedule illustrates the accelerated but thorough nature of the project feasibility analysis, with numerous activities being started immediately upon initiation of the program. This approach insures that three summer field seasons will be available for those activities where on-site exploration and surveys are required. Several paths through the activity network are critical or near critical from the standpoint of timing. Delay of any activities along these paths will result in delay of the completion of the program. Relatively more intensive supervision should therefore be directed at these critical activities to insure that schedules are met.

Based on the preliminary schedule presented, the time frame for accomplishment of the various activities appears as Table 1 beginning on page 293.

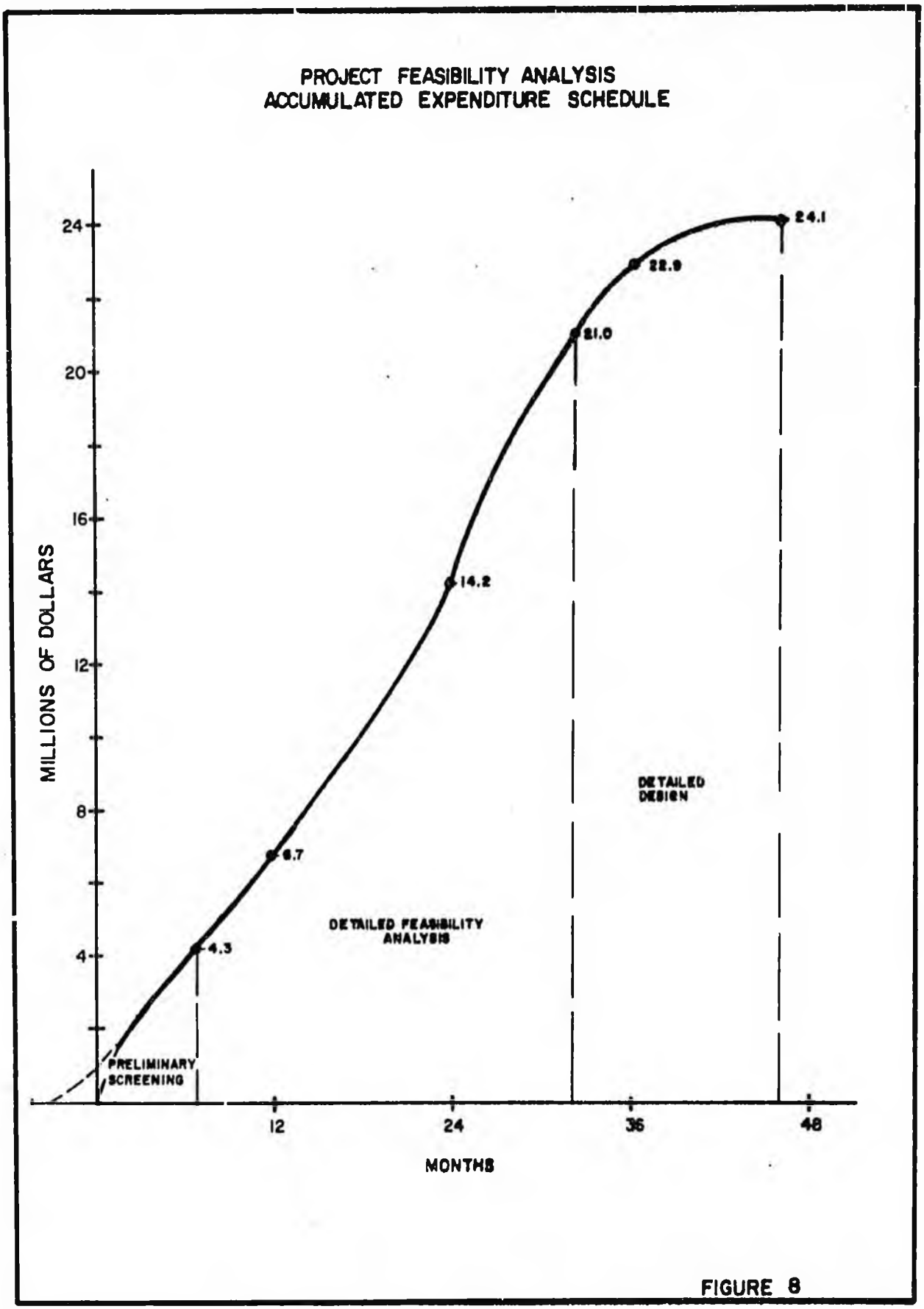

PROJECT FEASIBILITY ANALYSIS
ACCUMULATED EXPENDITURE SCHEDULE
MILLIONS OF DOLLARS
24
20
16
12
8
4
24.1
22.9
21.0
14.2
6.7
4.3
DETAILED DESIGN
DETAILED FEASIBILITY ANALYSIS
PRELIMINARY SCREENING
12
24
36
48
MONTHS

FIGURE 8

DESCRIPTION OF PROGRAM ACTIVITIES

This section contains descriptive summaries and cost estimates for each of some 201 separate activities grouped into 14 major categories. These activities and costs include all items required for the preliminary screening, for the detailed feasibility studies, and for the detailed design activities associated with the initial dam and powerhouse along with transmission lines and access road. A listing of the major categories and cost subtotals follows:

CATEGORY	ACTIVITIES	ESTIMATED COST (in $1000)
Survey	SY-1 thru SY-7	$ 1,180
Hydrology	HY-1 thru HY-27	1,295
Environmental Water Quality	EN-1 thru EN-4	330
Economic Studies	EC-1 thru EC-7	84
Recreation	R-1 thru R-4	56
Plan Formulation	PF-1 thru PF-15	124
Power Studies	PS-1 thru PS-4	198
Power Market Studies	PM-1 thru PM-13	547
Foundations and Materials	FM-1 thru FM-26	9,770
Design	D-1 thru D-39	4,001
Real Estate	RE-1 thru RE-5	59
Cultural Resources	C-1 thru C-2	110
Field Camp	FC-1 thru FC-2	1,625
Biological Studies	B-1 thru B-21	4,263
Reports, Reviews, and Public Participation	RRP-1 thru RRP-26	450
TOTAL COST		$24,092

SURVEY (SY)

THESE ACTIVITIES INCLUDE THE BASIC FIELD WORK REQUIRED TO PROVIDE TOPOGRAPHIC DATA AND RIVER HYDROGRAPHIC DATA NECESSARY FOR DETAILED DESIGN AND COST ESTIMATES, ENVIRONMENTAL ASSESSMENTS, AND HYDROLOGY AND POWER STUDIES. ALSO, THE TOPOGRAPHIC DATA WILL BE UTILIZED IN PREPARATION OF REAL ESTATE OWNERSHIP MAPS.

RIVER CROSS SECTION

1. Obtain river cross sections at preliminary sites.
2. Obtain river cross sections downstream.

MAPPING

3. Map potential reservoir sites.
4. Obtain controlled photo/topo along access route.
5. Obtain controlled photo/topo along transmission corridor.
6. Obtain controlled photo/topo at Watana damsite.
7. Obtain controlled photo/topo at Devil Canyon.

SURVEY

Activity Designation: SY-1

Activity: Obtain river cross sections at preliminary sites.

Description: This activity is to obtain river cross sections at the following sites: one each at Olson, Devil Canyon, Susitna I, Susitna III, and Vee; and three at Watana. Cross sections at Watana will be located at centerline, 1/2 mile upstream, and 1/2 mile downstream. The remainder of valley topography will come from SY-3 and will be required in the first 6 months. Field parties will obtain data necessary to determine cross sections by taking a series of soundings across the river.

Seasonal Constraint: Winter preferable

Cost: $50,000

SURVEY

Activity Designation: SY-2

Activity: Obtain river cross sections downstream.

Description: The purpose of this study is to obtain an estimated 70 river cross sections from the vicinity of the Olson damsite downstream to highway bridge #3 below Talkeetna. This activity will be in support of activities D-38, HY-21 and HY-16. These activities will be used to study the effects of various flow releases associated with the hourly power studies. The study will also provide information on tailwater rating curves and on the delineation of post-project flood plains.

Seasonal Constraint: June through October

Cost: $300,000

SURVEY

Activity Designation: SY-3

Activity: Map potential reservoir sites.

Description: This activity will entail mapping of potential reservoir sites within the Upper Susitna River Basin. Mapping should be of sufficient detail (20-foot contours) to allow determination of elevation-versus-capacity curves and elevation-versus-area curves for each reservoir. The reservoirs will include the sites of Olson (river bottom to elevation 1,100) Devil Canyon (river bottom to elevation 1,490), High Devil Canyon (river bottom to elevation 1,800), Watana (river bottom to elevation 2,260), and Vee (river bottom to elevation 2,360).

Seasonal Constraint: May through October

Cost: $460,000

SURVEY

Activity Designation: SY-4

Activity: Obtain controlled photo/topo along access route.

Description: This activity is mapping of two road access routes in order to determine design layout. Mapping requirement is for 5-foot contours with a scale of 1-inch equal to 200 feet. The areas to be flown will require photo/mapping an area sufficiently large to support the capabilities of expanding the mapping for alignment revisions.

Seasonal Constraint: May through October

Cost: $225,000

SURVEY

Activity Designation: SY-5

Activity: Controlled photo/topo along transmission corridor.

Description: This activity is for providing topographic maps, based on existing U.S. Coast and Geodetic Survey quads prepared as overlay to aerial photography mosaic. Aerial photography will be obtained at a scale of 1 inch to a mile for preparing mosaic.

Seasonal Constraint: May through September for photography

Cost: $70,000

SURVEY

Activity Designation: SY-6

Activity: Obtain controlled photo/topo at Watana damsite.

Description: This activity will entail providing survey control and manuscript mapping at the proposed damsite. Requirements for the mapping will be to place picture point aerial photography targets, establish the horizontal and vertical control, obtain aerial photography and accomplish the required mapping. Mapping contours for this activity will be based on 5-foot contour with a mapping scale of 1 inch equaling 200 feet.

Seasonal Constraint: May through October

Cost: $15,000

SURVEY

Activity Designation: SY-7

Activity: Controlled photo/topo at Devil Canyon.

Description: This activity will entail providing survey control and manuscript mapping at the proposed damsite. Requirements for the mapping will be to place picture point aerial photography targets, establish the horizontal and vertical control, obtain aerial photography and accomplish the required mapping. Mapping contours for this activity will be based on 5-foot contour with a mapping scale of 1 inch equaling 200 feet. This mapping will augment topographic data already available.

Seasonal Constraint: Field efforts, May through October

Cost: $60,000

HYDROLOGY (HY)

THESE ACTIVITIES INCLUDE BOTH FIELD WORK AND ANALYSIS. THE COLLECTION OF DATA ALLOWS A DEFINITIVE DESCRIPTION OF THE HYDROLOGY AND CLIMATE OF THE RIVER BASIN AND ALONG THE TRANSMISSION CORRIDOR. OTHER STUDIES, USING THE EXPANDED INFORMATION BASE, EXAMINE STREAMFLOW VOLUMES AND FREQUENCIES, WATER QUALITY, ICE FORMATION, AND THE TRANSPORT, ENTRAPMENT, AND DEPOSITION OF SEDIMENT. EMPHASIS IS PLACED ON COMPARING THE PRE- AND POST-PROJECT CHARACTERISTICS FOR THE PURPOSE OF DETERMINING PROJECT EFFECTS. THE HYDROLOGY STUDIES ALSO SUPPORT THE ENTIRE RANGE OF DESIGN ACTIVITIES.

IMPLEMENT A DATA COLLECTION PROGRAM.

1. Collect climatologic data for basin and transmission line.
2. Install and operate additional stream gages and continue stream gaging.
3. Collect water data.

DESCRIBE HYDROMETEOROLOGICAL SETTING OF BASIN.

4. Describe hydrometeorological setting.

CONDUCT PRE-PROJECT STREAMFLOW ANALYSIS.

5. Extend streamflow and correlate with longest record.
6. Develop annual and seasonal flow duration curves.
7. Develop peak and volume frequency curves.
8. Develop low flow frequency analysis for critical period.

CONDUCT RESERVOIR AND DOWNSTREAM SEDIMENT STUDIES.

9. Determine average annual total load.
10. Determine entrapment rates and reservoir distribution.
11. Determine reservoir suspended sediment stratification.
12. Determine effect on downstream channel.

SPILLWAY DESIGN FLOOD DERIVATION.

13. Obtain final Probable Maximum Precipitation from HMB-NWS.
14. Recalibrate basin model.
15. Determine Probable Maximum Flood and route through reservoir.

WATER SURFACE PROFILE DETERMINATION.

16. Determine water surface profiles from Talkeetna to Watana.

CONDUCT ICE STUDIES.

17. River and reservoir conditions.
18. Review literature about existing storage projects in arctic conditions.

WIND AND ICE STUDIES REQUIRED FOR TRANSMISSION LINE DESIGN.

19. Conduct literature search and limited field survey.

POST PROJECT STREAMFLOW ANALYSIS.

20. Develop post-project frequency curves.
21. Determine post-project downstream water surface profiles.

RESERVOIR FILLING SCHEDULES.

22. Develop reservoir filling schedules.

GLACIAL BALANCE STUDIES.

27. Conduct mass water yield studies.
28. Conduct mass sediment yield studies.

EVAPOTRANSPIRATION STUDIES.

25. Determine evaporation rates.

OTHER ACTIVITIES.

26. Provide preliminary spillway design flood.
27. Determine elevation versus capacity relationships.

HYDROLOGY

Activity Designation: HY-1/1a

Activity: Collect climatological data for the basin and transmission line, and continue data collection.

Description: Inaccessibility of the basin will make conventional data acquisition difficult, and a series of remote data platforms situated throughout the basin is anticipated. Helicopter operations will be necessary to install and operate the data collection platforms. Data acquired will be used for virtually all phases of the hydrology appendix, for supplementing the Environmental Impact Statement, and for design and construction of the transmission line. As a minimum, wind velocity and snow depth and density will be measured at approximately 15 locations along the proposed transmission line corridor. The majority of the anemometer sites will be located in the mountainous areas at the higher elevations along the proposed transmission line route. Appropriate anemometer sites within the Susitna Basin may also be equipped to record temperature, snow depth, and precipitation. Snow creep stations will be developed as necessary where the snow depth and density measurements indicate a potential for snow creep problems along the transmission line. Approximately 10 additional locations in the Upper Susitna Basin will be developed as precipitation, snow depth/temperature stations. Where practical, existing snow courses and stream gaging sites will be equipped to record precipitation, temperature, and other required climatological parameters. It is anticipated that an intensive climatological data-gathering and analysis program will be conducted for two years prior to construction of the project. It would be desirable to continue operating selected climatological stations within the basin after the initial design stage to develop a data base and subsequently provide information to operate the project efficiently. These selected stations should be equipped with telemetry to provide real time data for operation of the project.

Seasonal Constraint: Instrumentation should be accomplished during summer time.

Cost: $423,000

HYDROLOGY

Activity Designation: HY-2/2a

Activity: Install and operate additonal stream gages, and continue stream gaging.

Description: In order to fully evaluate the hydrologic response and variability of flow within the Susitna Basin, an extensive stream gaging network will be required. Existing stations within the Upper Susitna Basin include: Susitna at Gold Creek (U.S.G.S. station number 15-2920-00), Susitna River near Denali (station number 15-2910-00), and Maclaren River near Paxson (station number 15-2912-00). Funding for the operation of these stations should be assumed from the Cooperative Stream Gaging Program, which presently provides the funding. Installation and operation of six additional stream gaging stations would also be required. Gages would be installed on the Tyone River near its mouth, on the Oshetna River near its mouth, on the Susitna River at the former Cantwell gaging station, at the Watana damsite, at the Devil Canyon damsite, and on the Susitna River at the highway No. 3 bridge crossing below Talkeetna. The gages would be installed during the first spring, thus allowing three summers of flow measurement prior to completion of project feasibility analysis. The gages would be converted to permanent status if the projects were authorized for construction. As a result of the number of stations being proposed, correlation with the three existing stream gaging stations should be quite high, thereby allowing streamflow extension to match the existing 27-year period of record for the Susitna River at Gold Creek. The total streamflow record could then be used for reservoir operation studies, suspended sediment and bedload transport analysis, reservoir modeling and selective withdrawal studies, water surface profile determination, and a multitude of other flow quantity analyses.

Seasonal Constraint: Installation required during spring time.

Cost: $300,000

HYDROLOGY

Activity Designation: HY-3/3a

Activity: Collect water data.

Description: Water studies are dependent upon a successful data collection program. Physical sampling will concentrate on suspended sediment and bedload samples to be taken at the stream gaging stations. Frequency of sediment sampling should be sufficient to develop with reasonable accuracy a total load-rating curve to be used in on-going sediment studies.

Seasonal Constraint: None

Cost: $60,000

HYDROLOGY

Activity Designation: HY-4

Activity: Describe the hydrometeorological setting of the basin.

Description: This activity will be used to present and synopsize the hydrometeorological setting of the Upper Susitna River Basin. It will include an evaluation of other descriptions of the area and an interpretation and discussion of the data collected under HY-1 and HY-2. A number of generalized graphs depicting the extremes and averages associated with precipitation, temperature, snowfall, radiation, wind, etc., will be prepared. This information will assist in feature design and in construction activities. It will also provide information to be used in supplementing the Environmental Impact Statement.

Seasonal Constraint: None

Cost: $8,000

HYDROLOGY

Activity Designation: HY-5

Activity: Extend streamflow to match longest historical records.

Description: The purpose of this activity will be to extend the shorter streamflow periods of record of the Denali, Cantwell and Maclaren gages, as well as the six new gages, to match that of the long-term Gold Creek gage. This will provide a good data base for the specific Devil Canyon and Watana damsites and a sufficient indication at other possible damsites for system power studies. Monthly streamflow will be required for seasonal regulation studies; however, daily streamflow would be desirable for impact assessment of the selected plan of development. Streamflow extension would be accomplished by a multiple regression analysis with Gold Creek streamflow and other physiographic and hydrologic parameters. In order to assess the long-term annual water budget of the Upper Susitna Basin, an attempt will be made to correlate annual runoff with other measured physical parameters. The short-term stations will be used to determine the variability of streamflow throughout the basin on a seasonal basis. If strong correlation can be gained with long-term stations, flow duration curves can be developed for the short-term stations which will aid in determining sediment yield throughout the basin.

Seasonal Constraint: None

Cost: $10,000

HYDROLOGY

Activity Designation: HY-6

Activity: Develop annual and seasonal flow duration curves.

Description: Upon extension of the streamflow records to match those of the long-term station at Gold Creek, seasonal and annual flow duration curves will be developed for all stream gaging stations within the Upper Susitna Basin and major adjacent tributaries. This information will assist in characterizing the variability of streamflow throughout the study area. In addition, it will provide insight into the extent of the groundwater alluvium. This information will be invaluable in describing the environmental setting associated with fish and wildlife studies. In addition, it will provide construction contract information regarding the risk of initiating specific construction activities. Finally, the curves will provide insight about the various sources of flow which constitute the Susitna River and its tributaries.

Seasonal Constraint: None

Cost: $2,000

HYDROLOGY

Activity Designation: HY-7

Activity: Develop peak and volume frequency curves.

Description: Peak and volume frequency curves will be developed for Susitna River at Gold Creek, near Denali, near Cantwell, and for the Maclaren River near Paxson. This will require extension of the three latter stations' periods of record to match that of the Gold Creek streamgage. The frequency curves will be based on an annual series analysis utilizing the Log Pearson Type III distribution with an expected probability adjustment.

Protection of various construction features and diversion tunnels will be based on the results of this study. A determination regarding the level of protection that should be provided during construction will be necessary. This will be based on the anticipated loss to life and property both at the construction site and downstream, which would result without a higher level of protection during construction.

Seasonal Constraint: None

Cost: $2,000

HYDROLOGY

Activity Designation: HY-8

Activity: Develop low flow frequency analysis for critical period streamflow.

Description: The purpose of this activity will be to determine the severity of the low-flow critical period upon which the firm energy and dependable capacity of the recommended plan of river development is based. The analysis will be made after completion of seasonal reservoir regulation studies for the recommended plan. Since pre-authorization reservoir regulation studies have indicated that the critical period may span 32 months or more, it will not be possible to conduct a meaningful low-flow frequency analysis based on the relatively short streamflow period of record (27 years). Thus, the streamflow record will be extended stochastically, followed by an accumulation of critical-period duration flow volumes which will lead to development of a low-flow frequency curve to be created in accordance with procedures similar to those outlined under Chow's Handbook of Hydrology. The frequency curve will indicate the severity of the recommended plan's critical period flow volume. Also developed would be lesser duration volume low-flow frequency curves. Synthetic streamflow will be developed using "HEC-4 Monthly Streamflow Simulation" computer program.

Seasonal Constraint: None

Cost: $10,000

HYDROLOGY

Activity Designation: HY-9

Activity: Determine average annual total sediment load.

Description: This activity will entail a sediment sampling program which will determine suspended and bed load transport rates for a variety of flows. Also to be obtained would be gradation curves. This would lead to the development of a total sediment rating curve which can then be incorporated into an annual flow duration curve which will provide an estimate of the average annual sediment which will be deposited in the proposed reservoirs. This in turn will indicate the anticipated loss in reservoir storage as a result of sediment entrapment behind the dams.

Seasonal Constraint: Almost all samples will be taken during the summer field seasons.

Cost: $35,000

HYDROLOGY

Activity Designation: HY-10

Activity: Determine sediment entrapment rates and distribution within the reservoirs.

Description: Distribution of sediment within the proposed reservoirs is a function of the reservoir configuration, water temperature, sediment size, variation of inflow, fall velocities and a number of other variables. The distribution of sediment can limit the economic life of a reservoir by encroachment on the usable storage space and on the outlet works. Distribution of this sediment inflow will be calculated using Hydrologic Engineering Center computer program numbers 23-J2-L264 and 723-62-L2470.

Seasonal Constraint: None

Cost: $20,000

HYDROLOGY

Activity Designation: HY-11

Activity: Determine stratification of suspended sediment in reservoir.

Description: While it is anticipated that the reservoirs will entrap 95 percent of the sediment inflow, that which remains in suspension will be released to the downstream channel. Under natural conditions the Susitna River contains heavy sediment concentrations during the summer and minimal concentrations during the winter. Thus, uncontrolled water releases could have the effect of enhancing the summer water quality downstream, but decreasing the winter quality. This study, then, would address the potential for development of sediment stratification zones within the reservoir which conceivably could be flushed during the summer, thus allowing clear releases during the winter. This study would have to be coordinated with temperature and water-quality reservoir modeling studies. Study would incorporate the Waterways Experiment Station "WESTEX" computer model.

Seasonal Constraint: None

Cost: $15,000

HYDROLOGY

Activity Designation: HY-12

Activity: Determine effect of sediment degradation on downsteam channel.

Description: As the natural river sediment is trapped within the reservoirs, the downstream load-carrying capacity of the river will have to be satisfied by sediment lifted from the natural channel. This could result in excessive downstream channel erosion, which could have detrimental environmental effects. Field work for this activity will involve collection of information regarding existing armored areas and potential areas for channel degradation. The study will be conducted using HEC-6, and HEC program #723-G2-L2470.

Seasonal Constraint: This would be a summer operation.

Cost: $20,000

HYDROLOGY

Activity Designation: HY-13

Activity: Obtain final Probable Maximum Precipitation from National Weather Service.

Description: In order to develop the Probable Maximum Flood which will serve as the Spillway Design Flood for the recommended plan of development, it will be necessary to obtain information on Probable Maximum Precipitation, Critical Snow Pack and Critical Temperature Sequence. For the pre-authorization report, tentative values were obtained from the Hydrometeorological Branch of the National Weather Service (HMB-NWS) in Washington, D.C. For the Feasibility Analysis efforts it will be necessary to develop more definitive values in order to refine the Spillway Design Flood derivation. HMB-NWS is normally funded for such activities, and only a nominal charge would be required for coordination. It should be understood, however, that if this project is State funded, the National Weather Service may require reimbursement for the services.

Seasonal Constraint: None

Cost: $1,000

HYDROLOGY

Activity Designation: HY-14

Activity: Recalibrate basin model.

Description: In order to insure that the dams will have spillways of sufficient hydraulic capacity to protect against overtopping, each spillway will be designed to pass a flood which represents the worst possible combination of hydrometeorological events which could reasonably be expected for the Upper Susitna drainage basin. The flood derived from this analysis is termed the Spillway Design Flood (SDF). The SDF will be derived from an analytical model of the river basin. The model is a deterministic computer program which simulates portions of the hydrologic cycle in an attempt to generate long periods of daily or hourly streamflow hydrographs. The model used in the pre-authorization report was the Streamflow Synthesis and Reservoir Regulation (SSARR) program developed by the North Pacific Division, Corps of Engineers. Development of the SDF will be accomplished in two phases. The first will entail model calibration, and the second will be SDF determination. Model calibration will entail reconstitution of historic streamflow hydrographs based on data input obtained from the data collection network outlined under HY-1.

Seasonal Constraint: None

Cost: $25,000

HYDROLOGY

Activity Designation: HY-15

Activity: Determine probable maximum flood and route through reservoir.

Description: Upon calibration of the SSARR basin model, the Probable Maximum Precipitation and other critical weather data obtained from NWS-HWS will be put into the model, for determining the Probable Maximum Flood. A number of scenarios will be used to insure that the most severe flood is obtained. The flood hydrograph for each project will be routed through the respective reservoir based on a number of spillway capacity curves. This will serve as the basis for spillway sizing necessary to maintain an economical and safe freeboard.

Seasonal Constraint: None

Cost: $15,000

HYDROLOGY

Activity Designation: HY-16

Activity: Determine water profiles from Talkeetna to Watana.

Description: This activity will entail a determination of the water surface profile for a variety of flows from below Talkeetna to the vicinity of Watana damsite. In order to accomplish this task, it will be necessary to procure river cross-sections at one mile intervals, and, through the use of the HEC-2 Backwater Curve computer program, develop backwater curves that can be matched against recorded flow at Gold Creek and other gages to be activated.

Seasonal Constraint: None

Cost: $25,000

HYDROLOGY

Activity Designation: HY-17

Activity: River and reservoir ice studies.

Description: Breakup of the headwaters of the reservoirs will result in release of ice which may be expected to pose problems in the upper reaches of the impoundments in the form of jamming, flow blockage, and ice forces. The scope of these problems will be assessed and impact on operations will be evaluated. Field observations of present natural breakup will contribute to an estimate of the extent of the problem.

Operation of a major power plant causes higher discharges during winter months, together with discharge variations. Both of these discharge conditions cause changes in the ice regime of the downstream waters. The purpose of this study is to assess the magnitude of these ice problems to include evaluation of open water reaches, potential production of frazil ice in the open water reaches, potential for flooding and damage due to ice jams, and possible operational and design means to reduce these problems. The study will require mapping of the downstream river reaches, identification of critical sites for ice jamming, inventory of damage-prone structures, and analysis of length of open water as a function of release temperatures and weather. A number of additional ice studies have been identified and should be accomplished prior to final design and construction. The studies identified herein represent those necessary for evaluation of project feasibility and impact assessment. Some of the costs associated with data collection in support of ice studies are included under the three main data collection programs.

Seasonal Constraint: Much data gathering can only be accomplished at specific times during the year.

Cost: $130,000

HYDROLOGY

Activity Designation: HY-18

Activity: Literature survey of existing storage projects in arctic and sub-arctic environments (Ice related studies).

Description: A number of projects in environments as harsh as those in the Susitna Basin have been built in the northern parts of Scandanavia, the Soviet Union, and in the Alps in Switzerland. Technical literature is replete with descriptions of these projects, although not necessarily in English. A compilation of the best of these publications is a necessity in an undertaking of this magnitude.

Seasonal Constraint: None

Cost: $20,000

HYDROLOGY

Activity Designation: HY-19

Activity: Conduct literature search and limited field survey regarding icing considerations in transmission line design.

Description: An investigation into the frequency of occurence and accumulation of rime icing on the transmission line and supporting structures needs to conducted. The study will include a literature review and interviews with climatologists, engineers and maintenance personnel from power companies with transmission lines near the proposed transmission line. The study may also include field investigations.

Seasonal Constraint: Wintertime operation

Cost: $15,000

HYDROLOGY

Activity Designation: HY-20

Activity: Develop post-project frequency curves.

Description: This activity will assist in determining the reduction in flooding downstream from the projects and the associated reduction in flood damage to downstream communities and structures. It will aid in assessing the effect which can be anticipated on the downstream environment. This will be accomplished by integrating daily peak flow events into the seasonal reservoir regulation studies and then developing peak frequency curves in the traditional manner. This will be accomplished only for the recommended plan.

Seasonal Constraint: None

Cost: $1,000

HYDROLOGY

Activity Designation: HY-21

Activity: Determine post-project downstream water profiles.

Description: This study will be conducted in conjunction with post-project frequency curve determinations (HY-20) and hourly simulated operation studies. The major purpose of these studies will be to determine the downstream impact from flow release necessary to meet a variety of power demands, and the river profiles associated with a reduction in peak flows as a result of reservoir regulation. These studies will be accomplished only for the more feasible plans of development. The general method of analysis will entail routing the results of the HY-20 studies to points downstream and then determining backwater curves using the HEC-2 computer program or an unsteady-state model. The more detailed studies will be associated with routing variable flow releases for power purposes. In this case, a series of daily load shapes will be assumed in consonance with a number of downstream flow conditions. The releases will be routed downstream allowing the development of a series of stage hydrographs. The study will indicate the attenuation effect on flow releases as channel storage and tributary inflow begin to predominate. This will indicate the possible need for a re-regulation dam downstream, or possible reregulation from the most downstream power project. These studies would be conducted using the HYSYS computer program and by a finite-difference steady-state flow model.

Seasonal Constraint: None

Cost: $20,000

HYDROLOGY

Activity Designation: HY-22

Activity: Develop reservoir filling schedules.

Description: Because of the seasonal nature of the streamflow within the Upper Susitna Basin, and further, because of the large volume of the Watana reservoir, it would be necessary to establish filling schedules to insure an adequate downstream release in consonance with efficient reservoir filling. The study would entail a reservoir regulation analysis, based on historic streamflow record, in which the reservoir is filled for various downstream flow demand rates under average and critical inflow conditions. An attempt will be made to establish the optimum season that the filling should begin, and the seasonal variability of flow releases necessary for the downstream environment and power demand. Any project developed downstream from Watana would probably not require a similar filling schedule because of its comparatively small reservoir volumes.

Seasonal Constraint: None

Cost: $9,000

HYDROLOGY

Activity Designation: HY-23

Activity: Glacial mass water yield studies.

Description: A large amount of flow of the Upper Susitna River is derived directly from the glacial headwaters in the mountains of the Alaska Range. The water from the glaciers will be advantageous to hydropower in some cases, but possibly detrimental in others. The glacier runoff is guaranteed flow for decades even if drought conditions should occur, because the glaciers are precipitation already in the basin and readily available for runoff each year. On the other hand, glacier outbursts can cause unusual rises in flow at any time of the year. The amount of glacier-derived water and sediment would increase significantly should any of the large glaciers in the basin surge. Both Susitna and West Fork, the two largest glaciers, are surging glaciers and both can be expected to surge within the life of the project.

This activity will consist of establishing reference points on the glacier and measuring water balance and ice dynamics for these specific glaciers. Data will also be gathered on glacial storage and runoff.

Seasonal Constraint: Seasons will constrain some data collection activities.

Cost: $55,000

HYDROLOGY

Activity Designation: HY-24

Activity: Glacial mass sediment yield.

Description: Most of the sediment within the Susitna River originates from the headwater glaciers. Previous studies based on historical data have indicated that this sediment load will have a very minor effect on the project. This is primarily because of the large proposed reservoirs in relation to the estimated average annual sediment load. However, should the glaciers surge, they can impart significantly greater sediment loads than that of the average annual load. Hence, it is necessary to attempt to quantify the magnitude of potential sediment load which could be anticipated should the glaciers surge. Glacier sediment yield could best be measured at stream gaging stations, and it would be best if sediment measuring sites were measured independently. This in consonance with aerial photography should provide sufficient information for definitive estimates.

Seasonal Constraint: Summertime operation for data collection.

Cost: $55,000

HYDROLOGY

Activity Designation: HY-25

tivity: Determine evaporation rates.

Description: Using climatological data from the basin (air temperature, dew point, surface water temperature, wind speed), evaporation rates for the water surfaces can be estimated. Evapotranspiration rates for the land surfaces again can be estimated using climatological data (temperature and dew point have to be measured at at least two levels). These estimated values, which are of great importance as the evaporated water is not available for energy production, can be checked against the difference of precipitation and runoff, which should also give the evaporation rate if ground water movements and storage changes are neglected. Data collection necessary to accomplish the activity is included under activity HY-1

Seasonal Constraint: None

Cost: $10,000

HYDROLOGY

Activity Designation: HY-26

Activity: Provide preliminary spillway design flood.

Description: Prior to project layout for the various hydro schemes that will be analyzed under preliminary sceening, it will be necessary to provide preliminary flood values so that the project spillways can be properly sized for reconnaissance-grade cost estimate purposes. Most of this information can be obtained from the pre-authorization feasibility report; however, new values may be needed for some of the projects not prevously analyzed in depth.

Seasonal Constraint: None

Cost: $1,000

HYDROLOGY

Activity Designation: HY-27

Activity: Develop elevation versus capacity curves.

Description: Based on the 20-foot contour maps, this activity will entail measuring the volume and area of the various reservoirs to be studied during preliminary screening and later during detailed feasibility analysis. This information will be used in the reservoir regulation studies and in the impact assessment.

Seasonal Constraint: None

Cost: $8,000

ENVIRONMENTAL (EN)

THESE ACTIVITIES INCLUDE BOTH FIELD WORK AND ANALYSIS. THE COLLECTION OF DATA WILL ALLOW FOR A DEFINITIVE DESCRIPTION OF WATER QUALITY.

WATER QUALITY STUDIES

1. Collect chemical and biological water quality data.
2. Reservoir temperature stratifation studies and water quality modeling.
3. Analyze spillway and outlet works for dissolved gas production.
4. Assess erosion potential in active storage zone.

ENVIRONMENTAL

Activity Designation: EN-1/1a

Activity: Collect chemical and biological water quality data.

Description: Water quality studies are dependent upon a successful data collection program. Water quality data parameters should initially be sampled a minimum of once every 2 or 3 days. The sampling frequency can be lengthened if the initial sampling demonstrates that there is little change with time and discharge. Some parameters could be measured with remote monitors. Water quality data to be monitored would be dissolved oxygen, B.O.D., C.O.D., pH, phosphorous, nitrogen, nitrate, and specific conductance.

Seasonal Constraint: None

Cost: $140,000

ENVIRONMENTAL

Activity Designation: EN-2/2a

Activity: Reservoir temperature stratification studies.
Reservoir water quality modeling.

Description: These studies would lead primarily to the design of the multi-level power intake structures for the Devil Canyon and Watana projects. A project constructed without provision for multi-level withdrawal would result in a reservoir thermal regime which, when released to the downstream channel, would produce an annual temperature pattern completely reversed from the normal condition. Since temperature is perhaps the greatest normal physical parameter which affects downstream water quality from both a chemical and biological standpoint, it is imperative that the reservoirs' temperature releases not cause detrimental downstream effects. In conjunction with the temperature releases, it will be necessary to insure that the downstream dissolved oxygen levels are also maintained at an acceptable level. Attainment of these two goals can be met through a computer modeling of the reservoir to determine the optimum number and spacing of the proposed multi-level intake structures. Physical data required for this type of study would include the reservoir geometry, reservoir operating procedure, natural temperature regime, and annual reservoir inflow and outflow.

Seasonal Constraint: None

Cost: $150,000

ENVIRONMENTAL

Activity Designation: EN-3

Activity: Analyze spillway and outlet works for dissolved gas production.

Description: Experience gained from operation of water projects in the Pacific Northwest indicates that the most efficient spillway and outlet works design from the standpoint of hydraulic dissipation of energy is not necessarily the most advantageous means of maintaining downstream water quality. Care must be taken to insure that the design does not impart excessive amounts of dissolved gasses to the downstream channel, which could possibly have a detrimental affect on resident and anadromous fisheries. The Devil Canyon gorge should be analyzed to determine its natural capability to dissipate dissolved gasses for a range of flows. Much work has been accomplished in this area, and it should be possible to insure that dissolved gasses will not pose a problem for the selected plan.

Seasonal Constraint: Water monitoring during the summer months.

Cost: $20,000

ENVIRONMENTAL

Activity Designation: EN-4

Activity: Assess erosion potential in active storage zone.

Description: The purpose of this study will be to develop a preliminary soil erosion hazard map for the Susitna hydroelectric reservoir clear zone. Mapping will be accomplished utilizing black and white aerial photography along with ERTS imagery, with sufficient ground truth mapping to confirm the identification of soil types. All soil types will be classified in the clear zone as to their potential erosion hazard. The cost associated with mapping is included under survey requirements. In addition, much mapping is presently being accomplished by the Bureau of Land Management and Soil Conservation Service.

Seasonal Constraint: Summer ground truthing.

Cost: $20,000

ECONOMICS (EC)

THE ACTIVITIES IN THIS CATEGORY ARE DIRECTED AT DETERMINING AND ASSESSING THE SOCIO-ECONOMIC EFFECTS OF THE PLANNED DEVELOPMENT FROM LOCAL, REGIONAL, AND STATEWIDE PERSPECTIVES. IMPACTS ASSOCIATED WITH FLOODING AND WITH THE UTILIZATION OF OTHERWISE UNEMPLOYED LABOR IN PROJECT CONSTRUCTION ARE GIVEN SPECIAL ATTENTION, WHILE THE REMAINDER OF THE ACTIVITIES ADDRESS ALL OTHER EFFECTS, SUCH AS LIVELIHOOD, LIFESTYLE, AND COMMUNITY.

MISCELLANEOUS ECONOMIC STUDIES.

1. Perform employment benefit analysis.
2. Prepare flood damage prevention analysis.

SOCIO-ECONOMIC IMPACT STUDIES.

3. Conduct preliminary socio-economic impact studies for initial screening of alternatives.
4. Develop detailed profiles of socio-economic conditions in the immediate project area, the region, and the State.
5. Forecast future "without-project" conditions.
6. Forecast future "with project" conditions.
7. Identify and evaluate significant socio-economic effects.

ECONOMIC STUDIES

Activity Designation: EC-1

Activity: Perform employment benefit analysis.

Description: Employment of otherwise unemployed or underemployed manpower in construction and installation of a proposed plan is considered a beneficial contribution to national economic development objectives. This category of benefit is conceptually an adjustment to the cost of a project, because there is no economic cost associated with the use of an otherwise unemployed resource. Benefits attributable to unemployed and underemployed labor used in construction and installation of a plan will be included in total plan benefits, but projects will be formulated and scaled without consideration of employment benefits. First, the estimated number of employed and unemployed construction workers in the region will be determined with the assistance of the State Department of Labor. Next, an estimate will be made of the number of construction workers required for other construction projects in the region. This estimate will be made after consultation with State and Federal planners as well as knowledgeable individuals in the construction industry. The labor costs and manpower requirements associated with the proposed project will be estimated, with detailed consideration for all major skill categories. The State Department of Labor will be contacted to determine average regional wage rates for each of the major skills identified. The next step will be to estimate the proportion of project wage payments for each skill that will go to otherwise underemployed or unemployed workers. Finally, the total of wage payments to otherwise unemployed or underemployed labor will be converted to an average annual basis.

Seasonal Constraint: None

Cost: $5,000

ECONOMIC STUDIES

Activity Designation: EC-2

Activity: Prepare flood damage prevention analysis.

Description: Though limited, the incidental flood control benefits will be estimated and included in total project benefits. Construction of the Susitna project will reduce flood stages along the Susitna River downstream from the proposed Devil Canyon dam. The purpose of this activity will be to evaluate the savings, if any, in property damage and loss that will result from the reduction of flood stages. In accomplishing this analysis, the extent of the affected area will be delineated based on hydrological studies of stream discharge volume and frequency and water profiles downstream from the project. The characteristics of the flood plain will be determined together with the present land use patterns. Based on forecasts of regional economic activity, land-use demand will be estimated and land use with and without the project will be projected. The nature of flood damages will be assessed, and flood damages with and without the project will be estimated. Finally, flood damage prevention benefits will be computed as the difference between damages with and without the project. Benefit categories that will be considered will include land-use intensification and location benefits as well as the reduction of property damages resulting from inundation. The econmic feasibility of providing flood control storage will be determined.

Seasonal Constraint: None

Cost: $12,000

ECONOMIC STUDIES

Activity Designation: EC-3

Activity: Conduct preliminary socio-economic impact studies for initial review of alternatives.

Description: For the purpose of preliminary screening, a general socio-economic conditions profile will be constructed from available reports. Also, future conditions will be projected utilizing available reports or standard forecasting techniques. Both of the preceding will be limited to standard socio-economic parameters and will in general be an overview. Impacts that various alternative plans may have in these projections will be discussed in a general fashion. This analysis will permit comparison of plans, pinpointing of areas of concern for later study, and identification of communities or areas requiring detailed analysis.

Seasonal Constraint: None

Cost: $11,000

ECONOMIC STUDIES

Activity Designation: EC-4

Activity: Develop detailed profiles of socio-economic conditions in the immediate project area, region, and the State.

Description: This and the following economic studies outline a thorough investigation of socio-economic impacts for use in the detailed feasibility analysis.

The "immediate project area" is that area receiving direct long- and short-term impacts of construction and operation of the project. A profile of existing conditions will be developed from the perspective of the individual and of the local governments. Descriptions will include public services, tax structure, property values, population distributions and trends, local employment data, life styles, community relationships, land use programs, etc. The "region" will include the area directly affected by utilization of project outputs. The profile will emphasize those socio-economic factors affected by this utilization, including population distributions and trends, employment/unemployment data, current power usage patterns, industrial base, and generalized regional conditions. Where necessary, specific factors will be separated from the more general and given special attention. Similar "State-wide" socio-economic conditions and parameters will be presented for comparison. In addition, areas likely to specifically constitute an impact to the State will be addressed, including tax structure and financial conditions. Regional and State profiles can draw heavily on the base study completed under activity PM-2.

Seasonal Constraint: None

Cost: $15,000

ECONOMIC STUDIES

Activity Designation: EC-5

Activity: Forecast future "without-project" conditions.

Description: To assess project impacts a long-term forecast of future conditions "without the project" will be required for the immediate project area and the region. The forecast for the immediate project area will be completed after interviews with local officials, consideration of local desires and aspirations, review of land use and other programs, and utilization of standard forecasting techniques. The results will be translated to parameters consistent with the socio-economic profile. The regional "most probable future" will be obtained largely from other study efforts (activities PM-3 and PM-4), and should only require tailoring to be consistent with profile data. One area of additional forecasting effort will be in those situations where specific industrial or other specialized impacts are anticipated. Primary effort will be toward local projections needed for impact analysis. Regional projections will draw on activities PM-3, 4, 7, & 9.

Seasonal Constraint: None

Cost: $15,000

ECONOMIC STUDIES

Activity Designation: EC-6

Activity: Forecast future "with-project" conditions.

Description: The plans reviewed during the detailed feasibility analysis will be assessed to identify impacts they might have on local or regional conditions. This will require a forecast of both short-term conditions during and just after project construction and long-term estimates during the life of the project. Short-term forecasts will estimate how immediate project area conditions are expected to change, including: additional requirements placed on local public services, changes in population and employment characteristics, specific industry impacts, and changes in community relations. Long-term forecasts of "with project conditions" will involve both immediate project and regional areas. Local conditions are expected to be affected primarily by physical presence and operation of the project, along with holdover effects from construction activity. Regional conditions will be affected more by development differences that occur because of type, cost, and timing of a plan. Where specific regional impacts (e.g., the coal industry) are observed, special emphasis will be required.

Seasonal Constraint: None

Cost: $20,000

ECONOMIC STUDIES

Activity Designation: EC-7

Activity: Identify and evaluate significant socio-economic effects.

Description: This activity will identify, describe and measure, when possible, the significant socio-economic impacts of each plan, and validate the results via public and agency review. After completion of a socio-economic profile and the with/without project forecasts of local and regional conditions, the impacts will be ordered so that significant impacts can be selected. A columnar impact/project format has usually been used so all alternative plans can be displayed side by side for ease of comparison. Input from the public and appropriate agencies will be requested to assure that all significant impacts have been addressed. The results of this activity will be presented in the Environmental Studies Appendix.

Seasonal Constraint: None

Cost: $6,000

RECREATION (R)

THESE ACTIVITIES ARE INCLUDED FOR THE PURPOSE OF DETERMINING THE DEMAND FOR VARIOUS TYPES OF RECREATION THAT COULD BE ASSOCIATED WITH THE HYDROELECTRIC DEVELOPMENT, FORMULATING AND EVALUATING VARIOUS RECREATION PLANS, AND FINALLY SELECTING THE MOST PROMISING RECREATION SCHEME.

RECREATION PLAN

1. Conduct data search and evaluation.
2. Conduct supply and demand analysis.
3. Develop alternative plans for public recreation and related resources uses.
4. Conduct cost/benefit evaluation of alternative plans and select final plan.

RECREATION

Activity Designation: R-1

Activity: Conduct data search and evaluation.

Description: A preliminary data search will be performed to insure that all available information pertinent to subsequent study activities is located and documented. This search will primarily concentrate on data available from other agencies concerning recreation market analysis and project recreation development potential and constraints.

Seasonal Constraint: None

Cost: $5,000

RECREATION

Activity Designation: R-2

Activity: Make supply/demand analysis of the recreation market area, and determine market area needs for outdoor recreation opportunities and facilities.

Description: The recreation market area will be defined and mapped to account for both day-use and overnight-use visitors. The market area's present and projected socio-economic characteristics will be described and evaluated to assess their effect upon the recreation needs and requirements of the market area consumer. The recreation activity preferences of the market area consumer will be determined and described utilizing available data as well as through a public involvement program. Existing and planned outdoor recreation facilities within the market area will be inventoried, described, and mapped. This will require close coordination with the State of Alaska Division of Parks, other Federal and State agencies, and private entrepreneurs. Current and projected market-area recreation demands will be determined, based upon evaluation of the above factors. Comparative analysis of supply and demand relationships will provide insight into facility/opportunity surpluses or deficiencies within given increments of time.

Seasonal Constraint: None

Cost: $20,000

RECREATION

Activity Designation: R-3

Activity: Develop alternative plans for public recreation and related resources uses.

Description: The outdoor recreation facility/opportunity needs of the market area consumer will be synthesized with the physical and biological features of the project. Initial and future outdoor recreation development alternatives and alternatives for other related resource uses will be described and mapped. Alternatives so described will relate to market area recreation needs and to the constraints, potentials, and capabilities of the project's resources. Initial and future levels of visitor attendance will be determined for each alternative plan by calculating instantaneous use, turnover factors, seasonality, and ratios of activity duplication. Ultimate use, or maximum practical use, will be calculated in recognition of limitations imposed by low demands and resource capacity. Development measures for enhancing environmental quality and aesthetics associated with project structures, roads, and other features will be planned and described in detail. A public involvement program will be required, together with close and continued coordination with the State. Field inspections of the project area will be important aspects of this activity.

Seasonal Constraint: Field inspections must be conducted during the summer months.

Cost: $15,000

RECREATION

Activity Designation: R-4

Activity: Evaluate costs and benefits of alternative plans for public recreation and related resource uses, and select best alternative.

Description: The information generated in activities R-2 and 3 will be evaluated in order to attach dollar values to the phased development alternatives. Development costs as well as the operation, maintenance, and replacement costs for each alternative must be amortized in order to determine the average annual costs for these functions. Benefits will be determined through economic analysis for projected attendance in conjunction with each alternative to arrive at average annual attendance. User-day values will be assigned to these attendance figures to arrive at average annual benefits. Selection of the final alternative will depend upon public input as well as upon the desires and financial capabilities of the State of Alaska.

Seasonal Constraint: None

Cost: $16,000