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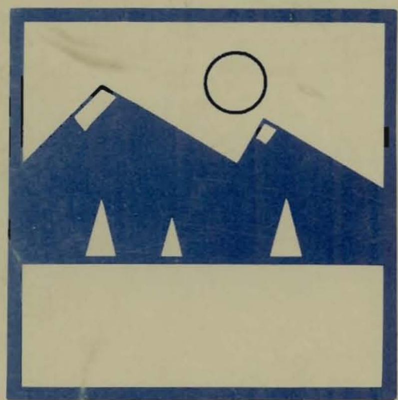
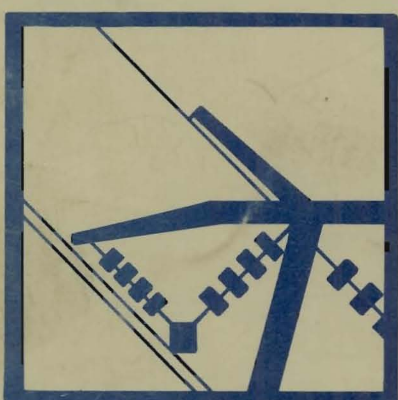


ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT



PLAN OF STUDY

FEBRUARY 1980

ACRES AMERICAN INCORPORATED

ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

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FEBRUARY 1980

ACRES AMERICAN INCORPORATED

ALASKA POWER AUTHORITY

February 4, 1980

AN OPEN LETTER TO THE PUBLIC AT LARGE AND
TO ALL INTERESTED AGENCIES AND ORGANIZATIONS.

I am particularly pleased to provide for your review and comment the detailed Plan of Study for the Susitna Hydroelectric Project. The document itself is both comprehensive and complex, since it deals with a program which, if completed, will have far-reaching implications for the State of Alaska.

A series of steps has been taken during the past year to identify all and select one of those public agencies and private consulting firms with experience in the development of major hydroelectric projects. Your assistance, particularly in the selection process, has been invaluable; and I extend to you the appreciation of the Board of Directors of the Alaska Power Authority.

Governor Jay Hammond approved the recommendations of the Board of Directors and an agreement was signed with Acres American Incorporated on December 21, 1979, to undertake a major feasibility study leading to the preparation of a license application to the Federal Energy Regulatory Commission. Acres has had extensive experience in successful hydroelectric developments in northern regions and has assembled a team which draws heavily upon the contributions of Alaskan firms and which includes strong representation by Alaskan Natives whose selected lands lie within the proposed project area.

As you review the attached plan, I hope you will keep in mind two important thoughts:

1. The fact that a feasiblity study is to be undertaken does not necessarily mean that a hydroelectric project of any kind will ever be constructed on the Susitna River. It will provide the basis, however, upon which an informed decision can be made as to whether the State could or should proceed in the matter.

2. The publication of this plan does not permanently fix the manner in which the proposed work is to be accomplished. On the contrary, I regard it as a dynamic document which will, I hope, be steadily improved with your assistance. It has already undergone an important metamorphosis as a result of testimony and correspondence received during the past four months, and I have no doubt that further editions will be responsive to your suggestions and comments.

ALASKA POWER AUTHORITY

I have planned public meetings for early March in Anchorage, Fairbanks, and Talkeetna. I hope you will plan to attend one of those sessions because I believe you will find it informative. More important, though, it will offer a real opportunity to influence the course of the work early in its conduct. If you are unable to attend, your ideas are still needed; I hope you will address them to Nancy Blunck, Public Participation Officer for the Alaska Power Authority. The State will benefit much from a continuing interactive process.

As you will note in reviewing the plan, additional public meetings and workshops are scheduled. I will keep you informed as to dates and times, and I will also make it a point to provide you with progress reports and descriptions of various work elements from time to time.

Sincerely,

Eric P. Yould
Executive Director

The Bureau of Land Management has offered coordination and explanations which will be useful in satisfying certain important permit requirements.

Staff members of other Alaska agencies such as the Department of Economic Development, Department of Commerce, and the Department of Environmental Conservation have kindly furnished us with statistical data and with vital information regarding plans for the future in Alaska.

The Fish and Wildlife Service and the National Marine Fisheries Service have offered advice to our environmental planners as the basis for understanding their roles in our satisfaction of FERC regulations.

We have been impressed with the professionalism displayed by the Alaska Power Authority in devising the program for possible selection of a private engineering firm and especially in their impartiality as they scrupulously provided assistance and advice to the various competitors in this exciting endeavor.

Once the original version of this Plan of Study had been submitted to the Alaska Power Authority, it was reviewed with care by organizations and individuals noted above and by numerous others. Many individuals took the time to testify to the Board of the Power Authority, and offers of assistance have come from most of them. This revised version of the Plan includes a new Section A4 which describes the manner in which such inputs have been handled to date. We gratefully acknowledge the help so generously given by all those mentioned in Section A4.

Other individuals and groups too numerous to mention have contributed as well. To all who have supported the Acres effort, sincere appreciation is extended. We are delighted to know that such a high degree of cooperation exists throughout the State of Alaska and within the organizations of others having interests there. Our confidence in our ability to successfully implement this POS has been enhanced immeasurably as a result.

ACKNOWLEDGEMENT

This Plan of Study could not have been produced without major contributions from each corporate member of the Acres team. Frequent cross country journeys, long hours devoted to preparation of inputs, and an unusual degree of effort from various administrative support staffs have together been instrumental in completing the assigned task--and much of the work has been an out-of-pocket expense for each corporate member. In addition to this enthusiastic support, however, a number of other individuals and organizations have cooperated fully and advised sagely.

The Alaska District, U.S. Army Corps of Engineers, has made available for our perusal all of the materials which have been collected to date in support of their own feasibility study and subsequent field exploration program. The genuine interest displayed by the District in providing this information and in offering many hours of explanation from already busy staff members is deeply appreciated.

A group of concerned citizens and representatives of environmental groups was kind enough to offer their time to express issues which they regard as important. The session spent with them was most helpful as we prepared plans for environmental studies in particular and for other tasks in general.

The Alaska Department of Fish and Game has met with us on a number of occasions. The thoughtful efforts of that organization in developing a program necessary to achieve project objectives and in discussing ways and means to achieve it without compromising ADF&G's own requirement for maintaining objectivity have been necessary and important.

The Federal Energy Regulatory Commission has been kind enough to provide us with advance information regarding possible regulatory changes soon to be promulgated.

Individual consultants who would serve as principal investigators for environmental studies and others who have agreed to become candidates for external review boards have been extremely helpful in laying out this plan.

The University of Alaska, through its various institutes and individual faculty members, has made its extensive capabilities known to us and has offered advice and assistance in planning for their use.

The Alaska Department of Natural Resources has provided a program to us for the conduct of certain in-stream studies for our consideration.

Discussions with various utilities during prior visits in November 1978, and subsequently have been helpful to our understanding of the power market.

The Alaska Power Administration has provided valuable information about power surveys, transmission line planning, and unique operational experiences at existing hydroelectric projects under their control in Alaska.

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A.1.1 - Introduction

This Plan of Study was originally prepared by Acres American Incorporated on September 11, 1979 in response to the Request for Proposal issued on June 25, 1979, by Mr. Eric Yould, Executive Director of the Alaska Power Authority. A series of presentations by competing consulting engineering firms on September 27, 1979, and public testimony accepted by the Board of Directors of the Alaska Power Authority (APA) on September 28, 1979, preceded the selection of Acres American Incorporated as the recommended Consultant to the State of Alaska in the event the State should later choose to proceed on the Susitna Hydroelectric Project without federal involvement. By unanimous resolution on November 2, 1979, the Board recommended to Governor Jay Hammond that the State enter into a contract with Acres American Incorporated to conduct a feasibility study and prepare a license application to the Federal Energy Regulatory Commission (FERC).

In response to suggestions from interested citizens as well as public and private organizations and agencies, a number of revisions have been made to the original Plan of Study (POS). This version has been prepared for the purpose of providing an opportunity for further public review and comment prior to proceeding with major portions of the work. Subject to the approval of APA, further revisions will be made subsequent to public meetings to be conducted in March 1980 and from time to time thereafter in response to the legitimate concerns of interested individuals and organizations. Certain major changes from the original POS are detailed in subsequent sections. Briefly stated, these include:

(i) The preparation of demand forecasts is a sensitive and crucial task. Issues such as when--or even if--a Susitna Project is needed cannot be resolved without such efforts. To ensure total objectivity in forecasting and to avoid any question of conflict of interest, the State of Alaska has entered into a separate contract with the Institute of Social and Economic Research (ISER) to develop independent forecasts.

(ii) Significant increases in the amount of effort devoted to environmental matters and particularly to fishery studies have been introduced in response to comments from the Alaska Department of Fish and Game and the U.S. Fish and Wildlife Service.

(iii) To ensure objectivity in the conduct of the public participation program, the public information officer and his or her assistants will be employees of the Alaska Power Authority rather than of Acres American Incorporated.

(iv) The level of effort associated with marketing and finance has been reduced in the first phase of the study, thereby deferring certain financing subtasks until initial questions as to project viability and concept have been more thoroughly addressed.

(v) Some changes have been made in logistical and administrative support efforts both to accommodate the increased level of environmental activity and to ensure efficiency and responsiveness as the study progresses.

(vi) Tabulations have been added for the purpose of providing more explicit details regarding man-hours and expenses to be associated with each subtask.

(vii) Additional effort has been prescribed for in-stream flow studies downstream of Talkeetna in response to concerns expressed by the Alaska Department of Natural Resources.

(viii) The original plan to construct an airfield at the proposed Watana camp site has been deferred in favor of using helicopters to support field activity during the first year and possibly throughout the study period. This approach offers the advantages of reducing capital expenditures prior to reaching an initial GO-NO-GO decision and of minimizing environmental changes in the camp area.

Because of the magnitude of the proposed effort and the diversity of skills required to accomplish it, Acres American Incorporated has assembled a group of subcontractors who will contribute to satisfaction of the overall program objectives. Major participants in the Acres team include R&M Consultants, Inc.; Woodward Clyde Consultants; Terrestrial Environmental Specialists, Incorporated; Cook Inlet Region Incorporated/ Holmes and Narver, Incorporated; Salomon Brothers; and Frank Moolin Associates.

The gestation period for giant projects tends to be long. Wild bursts of enthusiastic effort followed by periods of genuine apathy (or total despair, depending upon whose vantage point is selected) are common. Development of the Susitna River has so far followed that classic pattern.

As early as 1952, the Bureau of Reclamation published a report identifying a large number of potential hydroelectric power sites in Alaska, noting pointedly the strategic advantages enjoyed by the Susitna River because of its proximity to Anchorage and Fairbanks. Even then, Devil Canyon was perceived as <u>the</u> place to install a large dam. It was--and is--a steep, narrow rock walled canyon through which silt laden grayish waters swirl and churn and turn to white froth as they rush for the sea. Updates by the Bureau led to proposed authorization in 1961 of Devil Canyon and Denali--a site far up-river of Devil Canyon, astride extensive wet lands and marshy areas, where the Susitna draws strength from relative placidity before it attempts the inevitable plunge through miles and miles of canyons.

Another giant project was under active contemplation in the early sixties and its mind boggling size, together with the engineering challenges it offered, were especially exciting in a brand new state and during the space technology wars then being waged. The Rampart hydro project would have created a pool larger than the State of Connecticut if it had ever been built.

While the Rampart studies put the Susitna project in limbo for a while, a number of long time Alaskans worried about the risks of such a venture. As fate and thoughtful argument would have it, Rampart is unlikely to be built at any time in this century.

Susitna was delayed long enough, though, to allow for discovery and development of then economical natural gas production. By the time the warnings of energy doomsayers were beginning to be heard and felt in 1973, the Susitna project once again began to appear attractive. The Bureau of Reclamation updated its earlier studies in 1974, recommending a four dam system, and the U. S. Army Corps of Engineers launched a major pre-feasibility study which led to a recommendation in 1976 by the Chief of Engineers that the Susitna Project be authorized. The Corps plan recommended two high dams, the first of which would be built as a massive earthfill gravity structure 810 feet in height at the Watana site more than 30 miles upstream of Devil Canyon. The second Corps dam was to be a 635-foot-high thin arch concrete structure which would sweep across the canyon from rock abutment to rock abutment--essentially the same as the Bureau's Devil Canyon proposal.

By June 1978, the Corps of Engineers had prepared a plan of study requiring 24 million dollars and offering a program leading to completion of a detailed feasibility study. Further investigations by the Corps confirmed the adequacy of the Watana site, though they did reveal that some changes were required in particular for the spillway arrangement.

Data, analyses and reports collected and prepared by the Corps of Engineers will be used throughout the course of the work to be undertaken by Acres American Incorporated. Even so, it is likely that new load forecasts will differ from those earlier offered by the Corps of Engineers. In addition, expanded alternatives studies, continuing geotechnical and seismic investigations, vigorous public involvement, and thorough environmental inventories and assessments can significantly affect the range of conclusions which might be derived from the work. It follows that the earlier development plan may not necessarily prove to be the optimum. This Plan of Study describes a series of tasks and subtasks, along with reasons for these, and provides information regarding organizational matters. A new concept for development, if development is found appropriate, will begin to emerge by the end of the first year of study.

A.1.2 - Primary Objectives of Study

(i) Establish technical, economic and financial feasibility of the Susitna Project to meet future power needs of the Railbelt Region of the State of Alaska.

(ii) Evaluate the environmental consequences of designing and constructing the Susitna Project.

(iii) File a completed license application with the Federal Energy Regulatory Commission.

A.1.3 - Specific Objectives of Study

To meet the primary objectives of the study, the following specific objectives are proposed:

(i) Determine the future electric power and energy needs of the Southcentral Railbelt Area, based upon independent analysis by ISER.

(ii) Assess alternative means of meeting the load requirements of the Railbelt Area.

(iii) Prepare an optimal development plan for the Susitna Project wherein power costs and probable impacts are minimized, safety is enhanced, and financing is achievable.

(iv) Establish a definitive estimate of the total cost of bringing power on line, together with a statement of cash flow requirements.

(v) Evaluate the physical, economic, and financial risks of the Susitna Project and determine ways and means to avoid or minimize their consequences.

(vi) Evaluate existing environmental and social factors as they now exist in the proposed project area, assess the impacts of the proposed project, enhance environmental values to the extent possible, and recommend mitigating measures.

(vii) Estimate the annual system power costs in the Southcentral Railbelt with and without the project, study the integration of Susitna power into the Railbelt utility systems, and assess power marketability.

(viii) Prepare a complete license application and file this with the Federal Energy Regulatory Commission.

(ix) Ensure that the needs and desires of the public are known, keep interested parties and the public informed, and afford an opportunity for public participation in the study process.

(x) Determine an optimal program for achieving financing, including resolution of issues regarding tax-exempt status of bonds which may later be offered.

(xi) Minimize the costs incurred by the State of Alaska in successfully achieving the above objectives or alternatives in reaching the earliest practicable conclusion that development of the Susitna Project is or is not in the best interests of the State.

(xii) Maximize opportunities for equal employment opportunities for Alaskans and for involving in the work members of those Native Corporations in the region.

A.1.4 - Primary Aspects for Susitna Project Requiring Study

(i) Introduction

As with any major hydroelectric project, the number of investigations and substudies required to achieve the primary objectives noted in paragraph A.1.2 above is significant. Each of these requirements is described in terms of precise tasks and subtasks in Section A5. Even so, a number of primary aspects, particularly insofar as they address major concerns, deserve to be highlighted.

(ii) Power Studies

While this Plan of Study had necessarily to be written on the assumption that project feasibility will in fact be demonstrated, we are well aware of the importance of demonstrating that a need for significant increases in power generating capacity does truly exist in the Railbelt Area and that this need can best be satisfied by the Susitna Project. Indeed, it is clear that the absence of need or the discovery of a better means of satisfying it if it exists will represent prima facie evidence that development of the project is not in the best interests of the State. Power studies will be undertaken to examine and define a range of load forecasts and to assess possible alternatives or groups of alternatives which together could satisfy the projected demand.

We will avail ourselves of intimate knowledge of Alaska in general and the Railbelt in particular through employment of the Alaskan office of Woodward-Clyde Consultants (WCC) to assist in conducting power studies. Load forecasts will be developed independently by ISER and will form the basis upon which demand curves and load duration curves are prepared. The study of non-hydro alternatives by WCC (reviewed by Acres Thermal Power Division) and of hydro alternatives by Acres will be enhanced through use of the General Electric Optimum Generation Program Series (sophisticated computer models designed to permit multiyear analysis of generation system mixes) which we have successfully used in the past for a comprehensive study of alternatives to the Dickey Lincoln School Lakes Project in New England.

(iii) Financing Plan

Successful financing of giant projects is inevitably a complex and time-consuming task. Our own expertise in this area, as evidenced by participation in the successful financing of the Churchill Falls Project where Mr. J. G. Warnock managed the team responsible for bond support documents, will be available to the financial consultants of the Salomon Brothers. This well known investment banking firm has managed or co-managed 655 issues of tax-exempt bonds in the total amount of $48.3 billion since January 1, 1974. Dr. C. P. Chapman will manage risk analysis studies. His unique capabilities in that area have been demonstrated time and again for large projects including some in sub-arctic environments.

(iv) Ice Engineering

The study of ice engineering has necessarily been an important part of Acres' efforts for past projects in recent years. Our successful involvement in hydroelectric projects throughout North America, with a total installed capacity of over 14,000,000 kW, is a matter of record. Assistance in ice engineering studies will be provided as well by R&M whose hydrologic investigations of rivers and streams throughout Alaska has been significant. Our conceptual designs for minimizing the problems associated with frazil ice, ice jams, ice shelving and the like will be subjected to exhaustive modeling after license application has been made and during the preparation of detailed designs. Problems associated with permafrost are also familiar to the Acres organization; our staff has extensive experience in developing unique and effective methods of dealing with such problems in connection with large power projects in subarctic regions.

(v) Earthquake Engineering

Of the many potential risks associated with the Susitna Project, those associated with seismic problems are probably the most significant. Certainly, no single area of concern is likely to have more immediate catastrophic consequences if the engineering work has not been done thoroughly and well. Not only is it important to design all structures to survive unscathed in the event of an earthquake, but it is also essential to determine the extent to which creation of reservoirs on the Susitna River will itself induce earthquakes.

Our approach to this problem is twofold: first, we have engaged the Woodward-Clyde Consultants to undertake extensive seismic studies. WCC has operated in Alaska for over ten years and has amassed a considerable data base on geological and geotechnical conditions, faulting, and seismicity of the Anchorage and Railbelt Areas. WCC has also had extensive seismic experience with major dam and power projects elsewhere. Secondly, we have recommended a list of eminent professional engineers whose accomplishments are recognized worldwide as the basis for selection by the Power Authority of one or more external review boards. The engineering board would be provided funds on the order of $1 million with which to undertake confirmatory or additional studies. Acres would offer coordination services and administrative support, where appropriate, to the board(s), but authority to select, remunerate, terminate and to direct their activities would remain with the Power Authority.

(vi) Project Management/Construction Management

In order to provide Alaskan-experienced project and construction management capability in the POS team, Acres will combine with its in-house resources the additional resources of the Frank Moolin and Associates, Inc. organization. This company presently operates out of Fairbanks, Alaska and provides executive project and construction management experience to the energy industry. The Moolin team provides many years of "hands-on" experience on varying sizes and types of projects, including recent responsibility for construction of the Trans-Alaska Pipeline, a $4.2 billion effort. Members of the organization provide an unusual, multi-disciplined, combination of energy, industry and heavy construction experience. In addition, conditions unique to planning managing and constructing projects on the Alaskan scene are familiar to all of these individuals.

SECTION A2 - STUDY APPROACH

SECTION A2 - STUDY APPROACH

A.2.1 - Discussion of Problems to be Resolved

(i) Introduction

In formulating a logical approach to study of a major hydroelectric development in a relatively hostile climate and environmentally sensitive region, it is necessary to identify the particular problems which must be addressed and to place these in proper perspective with the more routine elements of technical and economic feasibility assessment. The objective is to arrive at an optimal development which recognizes and allows for all constraints imposed, and addresses such vital issues as environmental acceptability at the proper stage to allow it be considered adequately through public participation and other processes to satisfy licensing procedures. The financial viability of the project is, of course, also a vitally important consideration which lies beyond the strict technical and economic parameters of the proposed development. The approach taken in the overall studies must lead to a confident determination of the financibility (or otherwise) of the project.

We have identified a number of potential problem areas early in our planning efforts as the basis for ensuring that the final Plan of Study will provide adequate measures for dealing with them.

(ii) Optimal Development

Millions of dollars have been spent to date in an effort to determine just which of many concepts will lead to optimal development. Optimization, like beauty, though, is in the eyes of the beholder. The Bureau of Reclamation selected a four-dam system to be established on the Susitna River. The Corps of Engineers has succeeded in obtaining authorization to conduct detailed feasibility studies for a two-dam system which would provide essentially the same amount of power as that for four dams of lesser height. The Corps approach benefitted from the Bureau of Reclamation's work and built upon it. The Acres approach will continue that refinement process. In so doing, though, it must account for certain potential problems:

(a) Load Forecast Accuracy

There has been a nationwide slackening of historically high load-growth rates for electric utility systems since the energy crisis of 1973. It can no more be assumed that this trend will continue throughout the next decade or two than it can be assumed that longer term historical patterns will once again assert themselves. The State must, nonetheless, develop load forecasts in whose accuracy a high level of confidence can be placed.

(b) Alternatives to Susitna Development

Implicit in the search for optimal development is the identification of all reasonable alternatives. We must acquire strong and reasonably definitive knowledge of alternatives to the Susitna Project for satisfying projected load forecasts.

(c) Alternatives for Development of the Susitna River

In the event that no alternative to Susitna Development is found to be superior in terms of technical, economic, and environmental considerations, we will need to assure the Power Authority that the Corps of Engineers concept or some other is the most appropriate. The days when a simple economic test led to plan selection have long since passed.

(iii) Data Acquisition

Significant portions of the total cost of the Plan of Study are devoted to the acquisition of additional data. Field studies in the areas of survey, geotechnical, hydrology, environmental, seismicity, and transmission will demand a base of support and proper means of site access and egress in addition to time and equipment for the purpose. Certain important problem areas include:

(a) Seasonal and Weather Constraints

Most data collection will have to be accomplished during relatively short summer seasons, resulting in high peak loads on camp facilities (a major consideration in the Logistical Plan in Section A8) and in particular on demands for certain equipment (including drilling, special survey, gaging, seismic instruments) not necessarily in great abundance in Alaska--at the very time that other projects in the State simultaneously require like items.

(b) Study Period

The relative brevity of the proposed 30 month study period does not allow for training personnel to operate in a relatively harsh sub-arctic environment.

(c) Coordination of the Program

The variety of investigations conducted at the same time in the same general area and subject to severe, albeit important, land use restrictions demands an unusual degree of coordination and management of the data acquisition effort (see also (ix) below).

(iv) Financial Risk

It must be recognized at the outset that several aspects of the Susitna Hydroelectric Project will inevitably imply substantial risk to potential investors. It will be necessary, therefore, to address all real and perceived risks with a high degree of intensity, limiting or disposing of as much of the exposure as possible to build a realistic level of confidence in the project. There will, no doubt, be residual risks for the potential investor to consider but attitudes to these will be significantly affected by the way in which the Alaska Power Authority can demonstrate that all potential problems have been diligently examined and fully addressed.

(a) Superposition of a Large Project on a Small System

In the case of Susitna, a very major, capital-intensive project undertaking is being considered for addition to an existing utility base of relatively limited facilities and fixed assets. The financial approach must therefore be on the basis of Project Financing where funding is raised on the assured revenue and cash flow generated, usually, from a long term sales contract, in this case for purchase of power and energy.

(b) Risk of Meeting Anticipated Power Output

The nature of the financing approach has a bearing on many aspects of the overall study plan for Susitna. It requires, for instance, that hydrological and energy assessments are made with a particularly high level of confidence and that risks of shortfall are carefully examined.

(c) Design Risks

A high level of confidence must be achieved in the adequacy of engineering design and in the construction costs involved in meeting the requirements imposed. The estimates should be at a level allowing for a relatively high likelihood of an "under-run" on total costs including contingency provisions. The most careful judgment must be applied to assessing likely increases in material, labor and equipment costs to allow for confident definition of a provision for escalation.

Construction and contracting practice must be developed which avoids or even eliminates over-run exposure. These and many other aspects of the plan for development must be all the more intently addressed to meet the need of a project of the extent of Susitna.

(v) Design Problems

Our own experience in planning, design, and construction management of large engineering projects in North America and particularly in sub-arctic environments has made us acutely aware of certain design problems which must be addressed early in the process of total project development. These include:

(a) Seismicity

The Susitna River flows in a region of known high seismic activity. Acquiring knowledge of the precise nature and extent of this activity must necessarily be a prelude to designing earthquake resistant project features. In addition, the question of the effect of large reservoirs on the Susitna River in stimulating earthquakes must be studied in some detail. Because of the potential for catastrophe, careful and thoughtful evaluations of seismic efforts by others appear to be necessary.

(b) Ice

It will be necessary to ensure that icing problems do not interfere with operation of the completed hydroelectric project as well as to determine how downstream ice conditions with the project will differ from those without. The effect of ice shelving in the reservoirs or ice jamming must also be addressed.

(c) Slope Stability

The nature of the project area is such that proposed reservoirs tend to be long and narrow. Landslides, avalanches, and side slope failures are especially to be guarded against.

(d) Siltation

It will be necessary to consider the rate at which sediment load fills dead storage space in the upper reservoir of the system, since the risk of losing energy production due to losses in active reservoir storage must be eliminated. Downstream of any dams, the effect of changes in sediment content will require evaluation as well. In the latter evaluation, it will be important to determine the extent to which relatively clearer sediment starved summer flows will pick up additional load from the river bed downstream.

(vi) Environmental Impact

There is no doubt that the level of effort to be applied to environmental studies is necessarily significant, because little is known of the total environmental resources in the project area and the superposition of a giant project on the Railbelt will have social consequences which must be determined. Certain problem areas of note include:

(a) Complete Cycle Studies

Definitive evaluations in the environmental area frequently require successive multi-season data acquisition efforts. In the case of the fishery resource, for example, a five year program is indicated. Yet, license application is scheduled less than three years hence.

(b) Getting up to Speed

The unique nature of the environment in the project area is best studied by those who have earlier gained familiarity with sub-arctic regions in general and Alaska in particular. The proper individuals must be identified lest lengthy training periods consume valuable study time.

(c) Relationships with ADF&G

We recognize the great expertise of ADF&G in certain areas and we believe certain environmental studies can best be accomplished if undertaken directly by ADF&G. Even so, it is imperative that the necessary review, evaluation and approval function which ADF&G must also perform be objective. Procedures must be worked out to preserve this objectivity.

(d) Information Exchange

As environmental data are collected and impacts are assessed, it will be necessary to ensure that provisions are made for information exchange and for contributions from the many interested individuals and groups whose particular focus will be on environmental issues.

(e) Interpretations of NEPA

A major battleground in the recent past between project proponents and opponents has been the National Environmental Policy Act. Major projects in the past would almost certainly travel a route of court litigation to determine compliance with the Act. The litigation has centered upon the Environmental Impact Statement, FERC application Exhibit W. The recent Council on Environmental Quality's Requirements for Environmental Impact Statements should clarify the review process at the Federal level; however, problems still exist in agency interpretation and between the state and federal governments.

(f) Mitigation

The Fish and Wildlife Coordination Act requires that an applicant coordinate with Federal and State fish and game agencies to prepare a fish and wildlife plan. A meaningful mitigation plan must be based on up-to-date information. At a minimum, 2 years of data should be available prior to the development of a mitigation plan. This requirement will not allow for a complete mitigation plan to be submitted as part of the license application. Considering the pristine setting of the project area and migratory and habitat patterns of such resources as caribou herds and moose, preparation of and agreement on the mitigation plan will be a major effort in project development. The FERC must resolve disagreements on the adequacy of the mitigation plan prior to issuing a license. A great deal of time can be involved in the series of correspondence, meetings or formal hearings if needed to resolve the conflict.

(g) Conflicting or Overlapping Authority

Along these same lines are compliances with the Anadromous Fish Act and the Endangered Species Act. As these acts are administered by different agencies (Fish and Wildlife Service and National Marine Fisheries Service, respectively), approval by one does not necessarily ensure approval by the other. For example, a method of fish transportation (if required) around the dam may not be acceptable to both agencies. Proposed operation of the reservoirs may also fall into conflict over maintenance of minimum downstream release and fluctuating release volumes.

(h) Historic Preservation Concerns

Exhibit V of the license application requires the applicant to show consultation with the Advisory Council on Historic Preservation and the State Historic Preservation Officer and to preserve and enhance the historic values of the project area. Field searches will also be conducted to identify significant cultural resources. Numerous problems could be associated with cultural resources sites within the project area.

(vii) Licensing

Prior to constructing the Susitna Hydropower Project, extensive coordination and consensus agreements must take place between the project developer and numerous Federal government agencies. Several permitting processes will need to executed. However, the focal point of the efforts will most probably be the preparation and action relative to the Federal Energy Regulatory Commission (FERC) license application. The license would allow the applicant to construct and eventually operate the proposed facility for a period of up to 50 years. The licensing process is fairly complex as noted by the fact that the current average major license review time is approximately seven years from time of application to approval.

(a) Complexity of Review Process

The reason for the length of time and complexity of review lies in the fact that the FERC and the reviewing agencies have a number of requirements under existing statutes which must be satisfied prior to taking action upon an application. Additionally, the statutes, under certain circumstances, provide conflicting authorities between review agencies and the FERC.

(b) Intervenors

Compounding the review difficulty is the special status of intervenors in the process. The FERC's authorization laws and administrative practice give enormous powers to the project intervenor to delay the process with a series of hearings on legal questions pertaining to project licensing. Essentially, the burden of proof of compliance with the listed statutes will fall upon the developer.

(c) Land Rights Issues

Even at this stage of project formulation, several pitfalls within the licensing process can be foreseen. Land rights for construction and access to the project could be a problem, particularly with the complexity of the Alaska native land rights, and use of federal lands under the Federal Land Policy and Management Act. At this time, the U. S. Departments of Interior and Agriculture are developing regulations for administering the Act. As the regulations will be relatively new during planning and development of the Susitna project, administrative and legal problems associated in compliance with the Act can be expected.

(d) Water Resource Development Plan

Section 10(a) of the Federal Power Act requires that the project be best adapted to a comprehensive water resource development plan for the project area. In the case of the Susitna project, compliance will mean that the need for the project and all alternatives to the project have been carefully studied to determine that this development is indeed in the best interests of the public.

(e) New Regulations

We have determined that FERC will shortly issue new proposed draft regulations for licensing a major hydroelectric project. It will be necessary to review new procedures and respond to required changes while the planned study is in progress.

(viii) Problems in Public Participation

There is a distinct difference between the concepts of public information and public participation. The former is designed to let the public know what is happening (sometimes, unfortunately, to let the public know only what the planner wants it to think is happening). The latter not only includes public information as a subset, but also provides a means for the public to become involved in and influence the course of work. For an effort as large as the Susitna Hydroelectric Project and with impacts extending effectively into perpetuity, public participation--including accurate public information-- is an imperative. The attendant problems are significant.:

(a) Conflicting Interests.

Taken alone, the motivations and objectives of individuals and organizations who have been involved to date on the Susitna Project are generally sincere and relatively easily understood. Considered collectively, however, they represent clear conflicts. It follows that it will be virtually impossible to satisfy every desire. Problems will almost certainly arise in determining what hierarchy of concerns is to be established. How will federal interests in accelerated development of energy resources be reconciled with those of citizens who would preserve the Alaskan quality of life? Of recreational interests in preserving a natural river with those of consumers who seek ways and means to stabilize the cost of electric energy? The following list of special interests is not exhaustive:

-- Utility interests, including concerns about ability to meet energy demands, prospects for recovery of capital investments, profits for investors.

-- Alaskan native groups, particularly those which have selected lands in the Susitna River Basin.

-- Fisheries industries whose concerns about impacts on future catch, particularly of anadromous fish, have not yet been fully addressed.

-- Downstream residents concerned especially about changes the Susitna Project will impose upon their way of life.

-- Consumers of electric power in the Southcentral Railbelt.

-- Marketers of alternative energy resources.

-- Conservationists who perceive the Susitna Project as likely to spur unwanted growth.

-- Industrial and commercial interests who perceive stabilization of energy costs as important to future progress.

-- Workers interested in employment opportunities arising directly or indirectly from construction of dams on the Susitna.

-- Agencies charged with maintenance and preservation of Alaskan wildlife, including in particular the Alaska Department of Fish and Game and the Federal Fish and Wildlife Department.

-- Railbelt residents who seek assurances that a Susitna Project will neither induce earthquakes nor fail catastrophically if one does occur.

-- And others.

(b) Impacts on Schedules

A proper public participation program necessarily requires that provisions be made to permit time for review and comment at various points as the study develops. Accommodating review time requirements, particularly in cases where proceeding on a new task depends upon a favorable decision having been made on results of the previous task, can serve to delay scheduled completions.

(c) Changing to Accommodate the Public Interest

True public participation requires not only that the public be informed and that they be allowed to offer comment, but also that their legitimate inputs be incorporated into the work. Thus, provisions must be made to properly address new issues as they arise and to take action where required. It is almost inevitable that an effective public involvement program will require that the plan of study be dynamic. An increased risk that costs will be incurred and scheduled completion times will be extended as new courses of action are pursued must be regarded as a problem area.

(d) Communications in Alaska

The large area over which power would be distributed, relatively undeveloped road nets, and remoteness of many of the areas to be affected by the Susitna Project combine to create unusual pressures on effective communications. It follows that any proposed public participation program must be designed to afford reasonable involvement opportunities even for those who have no practical means to attend meetings or make regular visits to information centers in large metropolitan areas.

(ix) Control and Coordination

We have assembled a team whose individual corporate members bring strong special skills to bear upon satisfaction of the various project objectives. The danger associated with such an assemblage is that control and coordination problems increase in complexity as a result. It becomes important then, that early steps be taken and procedures established so that the synergism promised by putting the team together is not lost through failures in management. Two areas in particular are worthy of consideration:

(a) Planning, Control and Management of the Study Itself

Provisions must be made to avoid costly redundant efforts as well as to ensure that each and every task and action is budgeted for and accomplished.

(b) Planning the Eventual Construction Program

The matter of timely and efficient constructibility of a proposed major project can be an extremely costly problem area if it is not attended to throughout the planning and design process.

A.2.2 - Proposed Approach to Solution of Problems

(i) Introduction

Given the size and complexity of the proposed project, it should come as no surprise that the problem areas noted above and others as well demand carefully developed, often innovative, solutions. In general we believe a certain pervasive discipline must be a part of our approach to the project as a whole and to each of the necessary tasks and subtasks individually.

Briefly stated, we recognize a series of steps as virtually universally applicable:

(1) Define the problem
(2) Establish objectives
(3) Describe the work necessary for achieving the objectives at minimum cost
(4) Assign responsibility to the appropriate team or subteam leaders
(5) Ensure each leader has sufficient qualified persons to do the work
(6) Make the necessary physical resources and logistic support available
(7) Schedule the activities to ensure resource commitments and overall project schedule are appropriate
(8) Collect the necessary data
(9) Evaluate the data
(10) Draw conclusions
(11) Provide expert review
(12) Define new problems
(13) Establish flexible procedures to permit rescheduling and new resource commitments as necessary when new problems or scope changes arise.

While these steps will apply in general, certain specific comments as regards problems identified in paragraph A.1.1 above are noted in succeeding subparagraphs.

(ii) Optimal Development

(a) Load Forecast Accuracy

The business of predicting the future inevitably involves varying degrees of uncertainty. We plan to reduce this uncertainty to an acceptable level through the use of proven analytical econometric models developed in the State at the University of Alaska precisely to support the type of predictive efforts required. ISER will lead this work, supported by Professors T. L. Husky and O. S. Goldsmith. ISER will establish a range of forecasts together with assumptions associated with their development. This approach will, of course, allow us to test the implications of various growth scenarios on project viability and timing, as well as permit evaluation of reasonable alternatives.

(b) Alternatives to Susitna Development

Definition of reasonable alternatives demands that a marriage of appropriate technical knowledge of each alternative to intimate knowledge of Alaska be accomplished. Acres has strong hydro-electric experience as well a large thermal power development group. WCC (Alaska) furnishes capabilities in analysis of non-hydro alternatives as well as an Alaskan presence. Our intention is to study the widest possible range of alternatives and to test various combinations which might satisfy load forecasts. This testing process will be facilitated through the use of sophisticated computer models which we have used in prior alternative studies of major hydroelectric projects.

(c) Alternatives for Development of the Susitna River

While much time, effort and thought has gone into the earlier Corps of Engineers studies, we will nonetheless take a fresh look at possible alternative ways of developing the Susitna Basin. These studies will include, for example, consideration of a long power tunnel extending downstream from the Watana site. Our project team includes a number of personnel who are skilled in the art of hydroelectric planning and we have included a Concept Planning team within our Feasibility Studies task force.

(iii) Data Acquistion

We recognize the requirement for large field investigating teams. It follows that proper field support facilities will be necessary. Our logistics plan at Section A8 provides details in that regard. The matter of equipment demands in Alaska is a serious one. Not only must the proper type of drilling, measuring, instrumenting and sampling devices be available when and as needed, but also they must in many cases be modified to permit use in remote sub-arctic regions. R&M is the only organization of its kind in Alaska. R&M's special surveying and drilling equipment and extensive Alaskan experience contributes much to our confidence in our ability to complete the proposed work on time and on schedule. In addition, most other principal investigators have had extensive experience in sub-arctic environments and all have made preliminary arrangements for equipment needs. Coordination will be facilitated through the establishment of an Alaskan project office headed by a senior Acres engineer who has himself led similar efforts in the past for major projects in Canada.

(iv) Financial Risk

We have chosen the investment banking firm of Salomon Brothers whose strong experience in tax-exempt bonding matters will be extremely important in preparation of plans for successful project financing. Mr. J. G. Warnock's own successful experience as the leader of the bond documentation team on the Churchill Falls project provides an important strength on the Acres team. The study effort for financial planning will be shared equally by Salomon Brothers and Acres. In addition, we have planned an extensive risk analysis program for ensuring that we identify and minimize various financial and design risks. Certain special considerations pertain:

(a) Multidisciplinary Involvement

It will be clear that to deal adequately with the matter of financial risk it has to be considered from very many viewpoints inevitably involving a multidisciplinary approach.

Traditionally, engineers alone were engaged in the early planning and consideration of hydroelectric power sites with other interests - such as financial, insurance, labor relations, etc. - joining in later when feasibility had all but been established. Such a procedure was quite practicable when hydroelectric sites clearly justified development on their own merit, economics were not in question, and environmental constraint unheard of. Nowadays, despite rapid escalating costs of fuel generated power alternatives, hydroelectric power generation is often marginal in power supply economics and development faces constant uncertainty as to whether any installation could be justified at all in the face of environmental constraint and objections.

Into this aura of uncertainty major projects such as Susitna are being launched. It is clear that only the highest standard of management and dedication to an ultimate belief in proper development of renewable resources will lead such a project to implementation. Methods and approaches are, however, available and well tested which will assist the process markedly. Basic to the successful approach is a broad interdisciplinary involvement from the start. Engineers must be effectively backed up by a team of financial specialists, economic analysts, environmentalists, insurance experts, construction managers, labor relations specialists, etc. No longer is it practical for a single engineering discipline to carry a project from initial concept to commitment to construction in a program of relatively isolated concentration on the physical aspects of the site.

We advocate, therefore, a carefully planned close involvement of the engineering team with all the other disciplines and specialists which, when integrated to a sum of effort over the preliminary phases of a project, can build the basic confidence which overcomes the apparent and growing constraints. Fundamental to the approach we recommend, is a close integration of engineering, financial and insurance speciality input from the start.

(b) Technical/Economic Relationships to Power Contract Negotiations

Fundamental to the success of any plan to develop the Susitna project is the focus of contract for the sale of energy and capacity from the completed plant. In order to provide the adequate debt service a contractual arrangement is necessary which calls for "take or pay" obligations on the part of the energy purchases. This and other basic elements of the power contract can have a profound effect on the viability of the project.

It might be suggested that this is not an engineering problem but one for the marketing/utility negotiation team alone. But not necessarily so; it is the engineer who can contribute vital knowledge to the assessment of the reliability of energy supply over the years of the contract. He also has to balance the values of various capacity factors for the planned plant. He has to assess, furthermore, the changing role that may be attributed to the facilitation as time passes. It is necessary to view power system planning on a "dynamic basis."

Economists play their succinct role too. Much of the forecasting of likely market conditions falls to their judgment. They have to assess likely future variations in fuel and energy aspects of alternative generation. Cost escalation on construction has a heavy bearing on a hydroelectric project and is amenable to careful judgment by economic specialists.

(c) Risk Assessment and Contingency Planning

In order to protect the project capital structure, allowances have to be made for contingencies, provisions for escalation in costs and for a completion guarantee. The first two of these items are basic elements of the capital cost budget while the third is usually dealt with as a standby financing arrangement. In arriving at prudent allowances for contingencies on very major projects, it is becoming increasingly desirable to determine these as a result of a carefully conducted risk analysis. Modern methods are available, which have been adequately tested on large undertakings, to determine the likely confidence level of estimates both of costs and schedule (which itself has cost implications).

The approach planned for Susitna would employ up-to-date techniques of risk assessment and contingency planning which on the one hand would permit the reduction to a minimum of "real money" over-run allowances and employ to the maximum extent possible measures to mitigate risk.

The study contributes substantially to the determination of the "residual risk," which, in a project of the nature of Susitna, remains to be covered by insurance or by a conscious acceptance by the owner that it will be covered in some other way should adverse circumstances prevail. The capacity of the international insurance market method to assume greater levels of insurance has improved as the size of major projects has increased. The type of approach recommended is intended to lead to the most favorable practicable basis for insurance provisions.

(v) Design Problems

Special design problems demand special attention, for time and effort devoted to their resolution prior to construction pay handsome dividends in terms of correction costs avoided later and in terms, as well, of securing the necessary degree of confidence on the part of investors, environmental interests, State authorities, and the public in general.

(a) Seismicity

We have noted earlier the importance of seismicity studies and of designing earthquake resistant structures. So important do we regard this area that we have planned for exhaustive investigations supported by modern sophisticated instrumentation. Acres has dealt with seismicity issues with great success in the past on a number of major hydroelectric and other power projects. WCC will conduct the seismicity studies for the Susitna Project, with careful review provided by the Acres team. While the WCC expertise in this area is unquestionable, we have been particularly careful to provide the means and the resources to seek confirmation by objective experts whose duties will be conducted quite apart from the Acres team. We have chosen an approach which calls upon a proposed external board (or boards) to commission those confirmatory or additional studies which they regard as essential to rendering an expert opinion on how well our own designs are responsive to earthquake concerns. Funds are available for the purpose.

(b) Ice

Ice studies are provided for in the study program to assess the current icing conditions found naturally in the Susitna basin without the project. Field investigations and surveys will also produce vital information, including appropriate in-stream hydrographic surveys and flood plane cross-sections downstream of the proposed dam sites. As design concepts are evaluated, we will draw upon the expertise of members of the Acres team who have countered operational icing problems on past projects. In this regard, for example, our mechanical engineering staff will pay particular attention to the possibility that frazil ice may interfere with generation flows. A separate Ice Studies team has also been included within our Feasibility Studies organization. The nature and extent of the potential for ice jamming and ice shelving in the reservoirs will be detailed and close coordination will be maintained with those involved in environmental studies to ensure that impacts of ice formations on wildlife migration and survival are understood.

(c) Slope Stability

Field investigations by R&M will provide a source of data for evaluating slope stability. The extent of permafrost in the dam and reservoir areas and the resulting potential for slope instability will be carefully investigated by the Project Team. The combined expertise of R&M and Acres will be directed toward the design of countermeasures as appropriate and risk studies will consider the consequences of unanticipated slope failures and snow slides.

(d) Siltation

Earlier Corps of Engineers studies have indicated that the deposition of sediment in the Watana reservoir will be entirely in the dead storage area throughout the proposed operating period for the project. We will conduct necessary studies to confirm those earlier findings and to better determine the expected rate of siltation. Changes in silt load patterns downstream of the dams will also be examined from both environmental and water quality standpoints.

(vi) Environmental Impact

Our overall approach to a proposed extensive environmental program relies upon the coordination of a series of individual studies conducted by individuals whose entire professional careers have been devoted to particular subject areas. A number of consultants, several with considerable sub-arctic and/or Alaskan experience in pertinent areas of study, will participate in the work. The coordination effort will be accomplished primarily by TES whose own staff will augment the consultants' efforts. Certain specific matters highlighted above as problems will be resolved as follows:

(a) Complete Cycle Studies

The program to be conducted by ADF&G is comprehensive and will provide the information necessary for impact evaluation. The fact that the program extends beyond the proposed point for license application need not represent a deterrent, because our discussions with Mr. Ronald Corso of FERC have indicated that, provided the application itself describes what continuing studies will be conducted, it can be filed before they are completed.

(b) Getting up to Speed

Selection of consultants and, in appropriate areas of study, of ADF&G to perform base line data acquistion work has been accomplished based on the criterion that each of the Principal Investigators must have experience in sub-arctic environments, preferably in Alaska.

(c) Relationships with ADF&G

Our approach to the issue of ensuring the ADF&G maintains its proper status as an objective reviewing and approving authority while concurrently undertaking investigatory tasks involves a unique concept. Each of the field studies and reports to be produced by ADF&G will be produced for and funded directly by the Power Authority. None of our organization charts or concepts includes ADF&G as a subsidiary or subcontractor to Acres. ADF&G's involvement is assumed to occur in accordance with the following scenario:

(1) Base line studies will be performed by ADF&G for big game and fisheries including data collection, analysis and interpretation.

(2) TES and its consultants develop the environmental assessment.

(3) ADF&G reviews and comments upon TES work and appropriate modifications are recommended.

(4) Mitigation measures are proposed by TES (in some cases relying on data furnished to APA by ADF&G).

(5) ADF&G reviews proposed mitigation plans and offers comments.

(6) TES updates earlier submission.

(7) ADF&G approves.

This procedure will be followed as necessary throughout the period prior to FERC license approval.

(d) Information Exchange

Our approach to involvement of environmental interests external to the Acres team includes a series of eight workshops, each one of which will be partially or fully devoted to environmental matters. Six of the workshops are scheduled in advance and two are funded but not scheduled, to permit flexibility in response to issues of opportunity.

(e) Interpretations of NEPA

We will maintain our close review of recent CEQ actions as well as our monitorship of FERC license processing. We intend as well, through our Alaska Project Office, to maintain continuous close liaison with appropriate State agencies. State agencies will be invited to participate as well in workshop sessions.

(f) Mitigation

The scenario for seeking State approval for mitigation measures has been summarized in subparagraph (c) above. It is our intention to have, prior to license application, an agreed-upon approach to preparing a mitigation plan during the post-application phase. The license application will include a preliminary analysis of mitigation alternatives and a proposed plan of action to develop an actual mitigation plan during post-application studies. This approach will allow for the preparation of a plan based on sound data and also provide an opportunity for input by appropriate agencies before a detailed plan is finalized.

(g) Conflicting or Overlapping Authorities

By seeking the involvement of Federal and State agencies throughout the study period and especially in workshop sessions, we seek to minimize conflicts.

(h) Historic Preservation Concerns

We will schedule necessary consultations on historic preservation matters with appropriate federal and state agencies. Our plans to ensure archeological reconnaissance prior to site disturbance will also contribute to our satisfaction of problems in this area.

(vii) Licensing

Paragraph A.2.1 identified numerous difficulties which can occur in obtaining a FERC license. Although the list touches upon the problems which appear applicable to Susitna, others can arise during the lengthy process.

Our approach to the licensing issue calls for the establishment of a small team whose entire efforts will be devoted to coordinating the preparation of the total application as well as to maintaining frequent contact with FERC. Whereas individual exhibits will be generally prepared as outputs of other tasks, this focal point for licensing work will provide the means to minimize later interventions by anticipating sensitive issues in advance. Of particular importance will be the impact of new draft regulations when they are published. The early indications are that some cost savings may accrue as a result of simplifications in procedures. Even so, the Plan of Study is necessarily based on satisfaction of current regulations. We will propose changes at a later date if appropriate.

Particularly important in the licensing of a large project such as Susitna is the effective scheduling of preparatory activities. Plate A.2.1 indicates our proposed scheduling of all activities which we propose to undertake prior to submission of the license application, and afterwards. The essential philosophy of our proposed approach is to involve FERC as soon as possible and to initiate contacts with all concerned local, state and federal agencies and individuals well in advance of the submission. Yet the submission must respond adequately to the requirements laid down by FERC. We confidently project a 30 month period to fully complete the data acquisition requirements for submission of a compliant license application to FERC. We base these projections on our experience and discussions with FERC staff. License activities are discussed in detail in Task 10, Section A5 of this POS.

(viii) Public Participation

The overall objectives of the public participation program are twofold: to keep the public fully informed and to provide a means whereby the public can influence the work. These objectives will be satisfied in general by conducting a thorough and enthusiastic public information program which includes multi-media exposure, scheduled events, resources set aside to capitalize on unforeseen information opportunities, and a total commitment to establishment of a continuously available and accessible information office; and the provision for dynamic planning. It is this latter facet of the public participation program which distinguishes it from more conventional approaches. Simply stated, we have built into the study process a provision for incorporating newly identified actions as well as independent review procedures. Our plan of study is an excellent blueprint for licensing. Public input and the sage advice of independent panels of experts cannot help but improve the plan--and thus, the study--as the work proceeds. Our specific approach to resolution of previously identified problems is as follows:

(a) Conflicting Interests

A series of milestones, including all public meetings and workshops, will become the trigger for preparation of action lists. Each substantive comment or concern will be translated into a specific action or will be recommended for rejection by the project manager. Proposed actions with significant impacts on time, schedule, or concept will be referred to APA for specific approval. Other actions of lesser apparent consequences will be routinely processed and undertaken, with APA kept fully informed. Those comments and concerns which are recommended for rejection will be referred for consideration (along with reasons for recommending rejection) to APA and to the appropriate external review board. (Note that both engineering and environmental review boards have been proposed.) The proposed actions as well as recommended rejections will represent the study team's best efforts to resolve conflicting interests and concerns. Even so, there is no reasonable way to ensure that all publicly expressed desires will be satisfied. Creation of an action list will provide the vehicle so that every concern is at least explicitly considered and deliberations of external review boards will provide further recourse for those who disagree with the position taken by the project manager.

(b) Impacts on Schedule

The extensive public participation program described in detail in Task 12 (Section A5) and illustrated on plates in that section has been designed to permit maximum public review and comment activities without disrupting the progress of the study. By publishing monthly progress reports available for review at the Public Participation Office, by conducting frequent workshops open to the public, and by allowing ample review periods for important reports prior to public meetings, we believe that it will be possible to maintain the agreed schedule and ensure maximum public participation.

(c) Changing to Accommodate the Public Interest

Whereas it is both possible and proper to plan for review periods under the assumption that the proposed plan of study will proceed as originally prepared, there is no way to predict with certainty the extent to which actions introduced through the public participation program will influence schedules and costs. To minimize problems which may occur in this area, we have sought to involve the public immediately upon commencement of the study effort and to establish continuous coordination procedures for various interested agencies, with particular attention to those charged by statute with protection of environmental resources and those to be involved in distribution and sale of electric power. Flexibility has been built into the plan of study to allow for accommodating a reasonable number of changes to be introduced through the public involvement program.

(d) Communications in Alaska

In recognition of the extensive area which would be served by the proposed project, provisions have been made in the public participation program to allow for broad information coverage as well as the widest possible involvement. Each regularly scheduled public meeting is actually a set of three meetings to be held in Anchorage, Fairbanks, and Talkeetna. A total of eight workshops, each one of which may involve separate sessions with utilities, regulatory agencies, and environmental interest organizations, are planned. Locations for workshops will be chosen with a view toward maximizing public exposure. Indeed, the public participation plan is founded on the principle of taking aggressive action to seek public involvement rather than passive tolerance of public interests. No matter when or where meetings are scheduled, though, it is inevitable that some interested individuals will simply be unable to attend. We will have broad information coverage and our proposed information office will receive comments and suggestions at any time during the course of the study. Actions developed as a result of these latter inputs will be treated in a fashion similar to those introduced during or incident to formal meetings and workshops.

(e) Role of APA

To ensure total objectivity in the conduct of this program, it will be carried out by employees of the Power Authority.

(ix) Control and Coordination

A number of approaches to the development of a successful large-project management plan have been tried in the past. We believe, from this experience, that sponsors of large projects are beginning to recognize the importance of first developing a program planning guide for the management of these projects.

The tendency in the past has been to inundate a project with a relatively large number of planners and managers. There is nothing wrong with large numbers of managers and planners, when they are needed, but we believe that the larger and more complex a project, the more important it becomes to have a small group generating the plan. Our experience on large projects has revealed that a relatively small number of planners actually prepare the specifications for the plan. That is, during a preliminary planning phase, they should develop in considerable detail the specific elements that the project manager or construction management contractor or the management organization are to prepare during the planning period. Whether a large project is located in an area that lacks local services and therefore depends upon outside support, or in an area with an existing, well-developed service base, an extensive planning effort is required to handle the great number of parallel and similar organization concepts required to effectively manage the project. We are prepared to include such a planning effort as a product of the POS.

(a) Planning, Control and Management of the POS

Clearly, the POS, with funds in excess of $8 million already allocated and an eventual expenditure of over $20 million, qualifies as a large project and dictates the need for a more than casual approach to the planning and control. A business-oriented approach will be required to deliver, cost effectively, the final products of the POS. Effective "front-end" planning and the early involvement of the project management team is a key determinant of the project's success. Cost/schedule/financial control development and the preparation of corporate/administrative policies and procedures must parallel and be a part of front end planning and design. Effective implementation of the controls and procedures and the participation, acceptance and commitment to follow through to project completion must be incorporated into the program. We are committed to provide these services through the assignment of a relatively small group of well-qualified individuals to the POS team. In particular, the extensive Alaskan experience in large project management offered by FMA will be vital elements in our planning, control and management efforts.

The proposed schedule for undertaking this POS is presented in Plate A2.1.

(b) Planning the Eventual Construction Program

Certainly the multi-billion dollar construction phase of the Susitna hydropower project qualifies as a "giant" project and comes complete with the myriad of problems associated with "giant" projects. In this respect, the ability of the POS team to effectively plan this monumental project may prove to be the most important product of the the POS. The Acres/Moolin team provides a unique combination of talent and concepts to support this planning effort.

A.2.3 - Proposed Program

The effective resolution of the problems to be dealt with in meeting the overall study objectives requires the development of a carefully integrated program of study, design and exploration. The study will be undertaken in a series of interrelated and interdependent tasks as follows:

Task 1 - Power Studies
Task 2 - Surveys and Site Facilities
Task 3 - Hydrology
Task 4 - Seismic Studies
Task 5 - Geotechnical Exploration
Task 6 - Design Development
Task 7 - Environmental Studies
Task 8 - Transmission
Task 9 - Cost Estimates and Schedules
Task 10 - Licensing
Task 11 - Marketing and Finance
Task 12 - Public Participation
Task 13 - Administration

Each of these tasks has been broken down into a manageable number of subtasks (See Section A5). The level of effort and timing allows for progressive determination of project feasibility with minimum expenditure of funds.

A.2.4 - Potential Difficulties and Anticipated Methods of Handling

Several of the products that are developed as a part of Task 13--Program Administration are going to be the basic documents that will implement the POS. To stress how important they are would be to belabor the obvious; these products establish the basic course for the project and will be used to enunciate strategy and policy decisions throughout the POS. The key to the effectiveness of these programs is the early implementation and acceptance by all members of the project team.

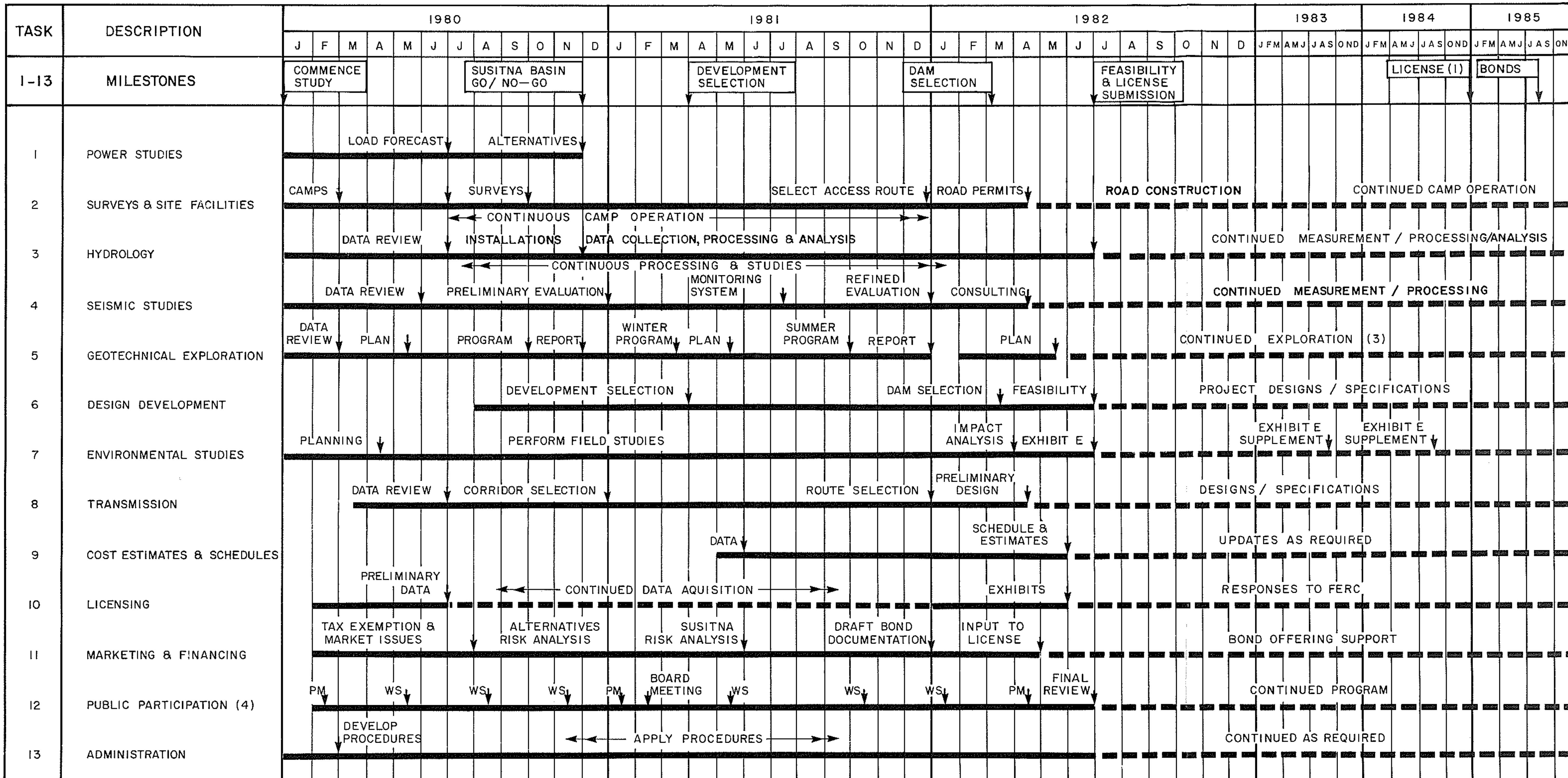
It is extremely important that the interface and responsibilities of each of the subcontractors be spelled out in excruciating detail. This is best done by listing the numerous functions that have to be performed and then making sure that each of these functions is assigned to a specific team. This sounds simple, but it requires a considerable effort and an in-depth understanding of the scope of work to tabulate all the required functions.

Working with government agencies requires some special precautions. There is a tendency, when submitting plans of operations, to propose exaggerated plans or solutions to make them sound as good as possible. These plans must be scrutinized, before submission, for reasonableness and cost effectiveness, to ensure that conditions that cannot later be tolerated are not proposed. It is equally important that the government agencies also participate in the preparation and review of such plans so that constraints may be identified and planned for.

The subject of constraints is of particular importance to the planning and estimating phases of the project. Constraints, if adequately understood in the early stages, can be tolerated. Constraints, if they come up after the start of construction, result in breaks in cadence, work stoppages, poor utilization of equipment and manpower and direct impacts to cost and schedule. Constraints can appear in the form of government mandates, environmental/climatic conditions, and design changes necessitated by the discovery of new data as construction proceeds. Regardless of their cause, every effort must be made during the planning stages to identify constraints by working directly with government and other agencies and convincing these agencies to participate in, accept and commit themselves to this effort. In addition, the cost and benefits of constraints must be developed, as the constraints are being identified, to allow APA and government officials to fully assess the impacts involved.

There must also be a close relationship between the planning and the obtaining of permits from government agencies. Included in the Project Planning Guide should be a schedule of submissions that identify what permits are required at what point in time and when each submission will be made. This will go a long way towards easing the acquisition of the myriad of permits required.

The foregoing remarks are necessarily general in nature. Sections A5, A6 and A8 of the POS describe in some detail the potential difficulties foreseen at this time in specific areas of the study and the proposed methods of overcoming them.



LEGEND: ↓ REPRESENTS SUBTASK COMPLETION

NOTES: (1) TENTATIVE BASED ON COMPLETION OF ENVIRONMENTAL STUDIES AND PLANS FOR INVESTIGATION

(2) ACCESS TRACK CONSTRUCTION IS ASSUMED TO COMMENCE IN 1982 FOR PURPOSES OF "FAST-TRACK" PROJECT COMPLETION ONLY. COSTS ARE INCLUDED IN ACTIVITIES UNDERTAKEN AFTER SUBMISSION OF LICENSE APPLICATION.

(3) GEOTECHNICAL EXPLORATION IS ASSUMED TO CONTINUE THROUGH 1988 FOR PURPOSES OF "FAST-TRACK" COMPLETION. COSTS ARE INCLUDED IN ACTIVITIES UNDERTAKEN AFTER SUBMISSION OF LICENSE APPLICATION.

(4) PM = PUBLIC MEETING ; WS = WORKSHOP

ACRES

SUSITNA HYDROELECTRIC PROJECT

PLAN OF STUDY

PLATE A2.1: SUMMARY SCHEDULE

* REVISED

SECTION A3 - BUDGET SUMMARY

SECTION A3 - BUDGET SUMMARY

Summaries of estimated study costs and man-hours for periods through submission of the FERC license application (June 30, 1982) and subsequently through receipt of license (tentatively estimated as January 1985) are presented in Tables A.3.1 through A.3.16. These summaries are presented by Task and, in Table A.3.15, quarter. All costs are in 1979 dollars, effective through the first quarter of 1980, with escalation beyond that date assumed at a rate of 8.5 percent per annum.

Two alternatives are possible after a license application has been submitted. One approach would accelerate the "on line" date for a potential project by advancing detailed design and associated activities sufficient to permit starting construction virtually immediately after a license is received. The second approach focuses only on those activities essential to award of license, deferring commencement of construction until some time thereafter. Section A6 describes both alternatives. Table A.3.16 provides cost information for the second, more conservative, alternative.

SUSITNA HYDROELECTRIC PROJECT - ALASKA POWER AUTHORITY

Addendum to POS
December 18, 1979

TABLE A 3.1 COST ESTIMATE - TASK 1, POWER STUDIES

Consultant	Subtask -	1.01	1.02	1.03	1.04	1.05	1.06	Totals Manhours	Totals Costs
ACRES	Manhours	50	70	540	740	70	280	1,750	
	Manhour Cost	$ 1,700	$ 2,500	$ 19,000	$ 26,000	$ 2,500	$ 10,000		$ 61,700
	Disbursements*	1,300	1,500	3,000	4,000	500	2,000		12,300
	Subtotal	$ 3,000	$ 4,000	$ 22,000	$ 30,000	$ 3,000	$ 12,000		$ 74,000
WCC	Manhours	350	450	790		1,200		2,790	
	Manhour Costs	$ 22,200	$ 28,700	49,300		$ 77,000			$177,200
	Disbursements	10,000	15,000	15,000		13,000			53,000
	Subtotal	$ 32,200	$ 43,700	$ 64,300		$ 90,000			$230,200
TES	Manhours			320		1,430		1,750	
	Manhour Cost			$ 8,900		$ 40,400			$ 49,300
	Disbursements			1,100		4,600			5,700
	Subtotal			$10,000		$45,000			$ 55,000
	TOTAL MANHOURS	400	520	1,650	740	2,700	280	6,290	
	TOTAL COSTS	$35,200	$47,700	$96,300	$30,000	$138,000	$12,000		$359,200

*Including Alaska Office Expense

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TABLE A 3.2 COST ESTIMATE - TASK 2, SURVEY AND SITE FACILITIES

Consultant	Subtask -	2.01	2.02	2.03	2.04	2.05	2.06	2.07	2.08	2.09	2.10	2.11	2.12	2.13	2.14	2.15	2.16	Totals Manhours	Totals Costs
ACRES	Manhours			285	30	15	30	75	630	430	860	25	15	115	200	205	260	3,175	
	Manhour Cost			$10,000	$1,000	$500	$1,000	$2,600	$22,000	$15,000	30,000	$800	$500	$4,000	$7,000	$7,200	$9,000		$110,600
	Disbursements*							400	3,000	5,000	5,000	200		800	500	1,000	1,000		16,900
	Subtotal			$10,000	$1,000	$500	$1,000	$3,000	$25,000	$20,000	$35,000	$1,000	$500	$4,800	$7,500	$8,200	$10,000		$127,500
R&M	Manhours			945				1,430	7,500	6,300	4,570	100	100	40			4,290	25,275	
	Manhour Cost			$33,000				$50,000	$262,000	$220,000	$160,000	$3,600	$4,000	$1,500			$150,000		$884,100
	Disbursements							10,000	238,000	90,000	40,000	400	1,000	400			30,000		409,800
	Subtotal			$33,000				$60,000	$500,000	$310,000	$200,000	$4,000	$5,000	$1,900			$180,000		$1,293,900
CIRI/H&N	Manhours		53,500		370	255	340							230			54,695		
	Manhour Cost		1,870,200		$13,000	$9,000	$12,000							$8,000					1,912,200
	Disbursements				2,000	1,000	2,000							1,800					6,800
	- Camp Facilities		1,901,900																
	- Fuel		400,000																
	- Food		200,000																2,501,900
	Subtotal		$4,372,100		$15,000	$10,000	$14,000							$9,800					$4,420,900
DIRECT COSTS	Local Lodge		$382,500																
	Air Transportation		$510,000	$1,123,800															
	Subtotal		$892,500	$1,123,800															$2,016,300
	TOTAL MANHOURS		53,500	1,230	400	270	370	1,505	8,130	6,730	5,430	125	115	385	200	205	4,545	83,145	
	TOTAL COSTS		$5,264,600	$1,166,800	$16,000	$10,500	$15,000	$63,000	$525,000	$330,000	$235,000	$5,000	$5,500	$16,500	$7,500	$8,200	$190,000		$7,858,600

*Including Alaska Office Expenses

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TABLE A 3.3 COST ESTIMATE - TASK 3, HYDROLOGY

Consultant	Subtask -	3.01	3.02	3.03	3.04	3.05	3.06	3.07	3.08	3.09	3.10	Totals Manhours	Totals Costs
ACRES	Manhours	60		330	3,270	740	1,800	45	350		180	6,775	
	Manhour Costs	$2,700		$15,000	$87,200	$19,600	$48,100	$2,000	$9,300		$8,000		$191,900
	Disbursements*												
	- Travel	1,200			1,700	1,000	1,500		1,700		1,000		8,100
	- Consultants					7,500	5,000						12,500
	- Computer Services				7,200	2,500	5,500		1,500				16,700
	- Communications	300			1,000	800	1,000		1,000		1,000		5,100
	- Reproduction	200			200	200	200		500		500		1,800
	Subtotal	$4,400	-	$15,000	$97,300	$31,600	$61,300	$2,000	$14,000	-	$10,500		$236,100
R&M	Manhours	135	3,440	13,930	480	850	1,050	830		320	1,710	22,745	
	Manhour Costs	$5,600	$69,700	$468,900	$16,800	$29,600	$37,100	$30,200		$11,800	$60,000		$729,700
	Disbursements												
	- Consultants			5,000									5,000
	- Computer Services		2,000	16,000	2,500	5,000	5,000	5,000		2,000			37,500
	- Communications	300	500	1,700	1,500	1,000	1,000	500		300			6,800
	- Reproduction	200	3,000	1,000	500	500	500	500		200			6,400
	- Laboratory			125,000							1,000		126,000
	- Equipment			208,000							45,000		253,000
	Subtotal	$6,100	$75,200	$825,600	$21,300	$36,100	$43,600	$36,200	-	$14,300	$106,000		$1,164,400
Direct Costs	Fixed Wing Aircraft			$ 44,000				$			$ 4,000		$ 48,000
	Helicopter			350,000				7,500			20,000		377,500
	Subtotal			$394,000				$7,500			$24,000		$425,500
	TOTAL MANHOURS	195	3,440	14,260	3,750	1,590	2,850	875	350	320	1,890	29,520	
	TOTAL COSTS	$10,500	$75,200	$1,234,600	$118,600	$67,700	$104,900	$45,700	$14,000	$14,300	$140,500		$1,826,000

* Including Alaska Office Expenses

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TABLE A 3.4 COST ESTIMATE - TASK 4, SEISMIC STUDIES

																	Totals	
Consultant	Subtask -	4.01	4.02	4.03	4.04	4.05	4.06	4.07	4.08	4.09	4.10	4.11	4.12	4.13	4.14	4.15	Manhours	Costs
ACRES	Manhours	30	110	30	30	80	220	60	110	30	30	140	280	30	-	440	1,620	
	Manhour Cost	$ 900	$3,600	$ 900	$ 900	$2,700	$7,200	$1,800	$3,600	$ 900	$ 900	$4,500	$ 9,000	$ 900		$14,000		$51,800
	Disbursements*	100	400	100	100	300	800	200	400	100	100	500	1,000	100		2,000		6,200
	Subtotal	$1,000	$4,000	$1,000	$1,000	$3,000	$8,000	$2,000	$4,000	$1,000	$1,000	$5,000	$10,000	$1,000		$16,000		$58,000
WCC	Manhours	1,240	2,520	440	880	2,880	3,720	680	920	1,240	240	3,240	3,920	240	160	120	22,440	
	Manhour Cost	$53,000	$158,000	$17,000	$37,000	$115,000	$128,000	$26,000	$36,000	$51,000	$9,000	$127,000	$135,000	$ 9,000	$6,000	$4,500		$ 911,500
	Disbursements	4,000	95,000	-	15,000	5,000	10,000	5,000	4,000	10,000	-	10,000	8,000	2,000	1,000	500		169,500
	Subtotal	$57,000	$253,000	$17,000	$52,000	$120,000	$138,000	$31,000	$40,000	$61,000	$9,000	$137,000	$143,000	$11,000	$7,000	$5,000		$1,081,000
	TOTAL MANHOURS	1,270	2,630	470	910	2,960	3,940	740	1,030	1,270	270	3,380	4,200	270	160	560	24,060	
	TOTAL COSTS	$58,000	$257,000	$18,000	$53,000	$123,000	$146,000	$33,000	$44,000	$62,000	$10,000	$142,000	$153,000	$12,000	$7,000	$21,000		$1,139,000

* Including Alaska Office Expenses

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TABLE A 3.5 COST ESTIMATE - TASK 5, GEOTECHNICAL EXPLORATION

Consultant	Subtask →	5.01	5.02	5.03	5.04	5.05	5.06	5.07	5.08	Totals Manhours	Totals Costs
ACRES	Manhours	315	1,200	420	3,850	875	6,580	1,250	5,250	19,740	
	Manhour Costs	$10,000	$39,500	$ 15,000	$154,000	$35,000	$260,000	$50,000	$191,500		$755,000
	Disbursements*	3,000	500	120,000	17,500		17,500		8,500		167,000
	Subtotal	$13,000	$40,000	$135,000	$171,500	$35,000	$277,500	$50,000	$200,000		$922,000
R&M	Manhours	1,265		85	5,530	600	10,500	640		18,620	
	Manhour Costs	$10,000		$3,000	$189,000	$21,000	$367,850	$22,500			$613,350
	Disbursements										
	- Drilling/ Geophysical				436,000		610,150				
	- Equipment				15,000		25,000				
	- Clearing				50,000		50,000				
	- Laboratory				21,000		80,000				1,287,150
	Subtotal	$10,000		$3,000	$711,000	$21,000	$1,133,000	$22,500	-		$1,900,500
Direct Cost	Helicopter**				$272,000		$526,000				$798,000
	TOTAL MANHOURS	1,580	1,200	505	9,380	1,475	17,080	1,890	5,250	38,360	
	TOTAL COSTS	$23,000	$40,000	$138,000	$1,154,500	$56,000	$1,936,500	$72,500	$200,000		$3,620,500

* Including Alaska Office Expenses
** Includes Task 7 Requirements

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TABLE A 3.6 COST ESTIMATE - TASK 6, DESIGN DEVELOPMENT

Consultant	Subtask -	6.01	6.02	6.03	6.04	6.05	6.06	6.07	6.08	6.09	6.10	6.11	6.12	6.13	6.14	6.15
ACRES	Manhours	1,325	2,055	1,790	425	415	1,785	1,260	910	1,105	1,100	3,515	3,225	940	545	2,085
	Manhour Costs	$45,750	$57,300	$55,450	$12,200	$12,850	$52,250	$37,250	$27,700	$33,050	$32,850	$109,050	$95,550	$30,050	$16,400	$64,550
	Disbursements	4,250	5,700	4,950	1,200	1,150	5,150	3,750	2,700	2,950	2,850	10,950	9,450	2,950	1,600	6,450
	Subtotal	$50,000	$63,000	$60,400	$13,400	$14,000	$57,400	$41,000	$30,400	$36,000	$35,700	$120,000	$105,000	$33,000	$18,000	$71,000
R&M	Manhours	130														
	Manhour Costs	$4,500														
	Disbursements	500														
	Subtotal	$5,000														
	TOTAL MANHOURS	130														
	TOTAL COSTS	$55,000	$63,000	$60,400	$13,400	$34,000	$57,400	$41,000	$30,400	$36,000	$35,700	$120,000	$105,000	$53,000	$18,000	$71,000

Consultant	Subtask -	6.16	6.17	6.18	6.19	6.20	6.21	6.22	6.23	6.24	6.25	6.26	6.27	6.28	6.29	6.30	6.31	Totals Manhours	Totals Costs
ACRES (Cont'd)	Manhours	1,890	2,315	2,590	1,215	1,950	1,800	1,980	2,710	2,655	815	3,005	2,955	550	1,945	1,865	1,290	54,010	
	Manhour Costs	$59,050	$78,200	$74,500	$33,300	$55,450	$50,900	$57,250	$77,400	$75,500	$25,000	$86,500	$84,700	$17,750	$54,650	$52,800	$40,800		$1,606,000
	Disbursements	5,950	7,800	7,500	3,300	5,550	5,100	5,750	7,600	7,500	2,500	8,500	8,300	1,850	5,350	5,200	4,200		158,000
	Subtotal	$65,000	$86,000	$82,000	$36,600	$61,000	$56,000	$63,000	$85,000	$83,000	$27,500	$95,000	$93,000	$19,600	$60,000	$58,000	$45,000		$1,764,000
R&M (Cont'd)																		130	$5,000
	TOTAL MANHOURS																	54,140	
	TOTAL COSTS	$65,000	$86,000	$82,000	$56,600	$61,000	$56,000	$63,000	$85,000	$83,000	$27,500	$95,000	$93,000	$19,600	$60,000	$58,000	$65,000		$1,769,000

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TABLE A 3.7 COST ESTIMATE - TASK 7, ENVIRONMENTAL STUDIES

Consultant	Subtask -	7.01	7.02	7.03	7.04	7.05	7.06	7.07	7.08	7.09	7.10	7.11	7.12	7.13	7.14	7.15	Totals Manhours	Totals Costs
ACRES	Manhours	700	25		35	30	90	20		90	150	170			20	60	1,390	
	Manhour Costs	$27,100	$1,000		$1,500	$1,100	$4,100	$ 700		$4,100	10,400	$ 7,900			$1,000	$2,600		61,500
	Disbursements*	22,400	1,000		2,000	1,700	1,900	300		1,900	208,600	6,100			1,000	1,900		248,800
	Subtotal	$49,500	$2,000	-	$3,500	$2,800	$6,000	$1,000	-	$6,000	219,000	$14,000	-	-	$2,000	$4,500		310,300
TES	Manhours	10,820	2,845		200	795	875	1,050	320	1,120	14,680	2,890	2,985		785	1,350	40,715	
	Manhour Cost	$255,100	$126,100		$6,600	$29,000	$33,900	$27,500	$8,400	$31,500	$456,500	$123,100	$91,900		$22,200	$39,000		$1,250,800
	Disbursements	58,300	12,800		1,000	5,900	6,300	6,300	2,100	4,800	87,800	28,200	21,000		6,000	9,300		249,800
	Subtotal	$313,400	$138,900	-	$7,600	$34,900	$40,200	$33,800	$10,500	$36,300	$544,300	$151,300	$112,900	-	$28,200	$48,300		$1,500,600
F.O.A.	Manhours					3,400											3,400	
	Manhour Cost					$102,700												$102,700
	Disbursements					25,700												25,700
	Subtotal					$128,400												$128,400
U of A	Manhours						17,320	1,500	200			17,020	18,800				54,840	
	Manhour Cost						$410,600	$52,300	$6,900			$266,600	$315,300					$1,051,700
	Disbursements						72,900	16,000	4,700			72,900	61,300					227,800
	Subtotal						$483,500	$68,300	$11,600			$339,500	$376,600					$1,279,500
ADF&G**	Subtotal										$1,444,600	$1,312,000						$2,756,600
C.A.& M.B.	Manhours										2,400	1,660					4,060	
	Manhour Cost										$90,000	$80,800						$170,800
	Disbursements										6,000	8,500						14,500
	Subtotal										$96,000	$89,300						$185,300
Direct Cost	Equipment for Subtask 7.10										$409,600							$409,600
	TOTAL MANHOURS	11,500	2,870		235	4,225	18,285	2,570	520	1,210	17,230	21,740	21,785		805	1,410	104,405	
	TOTAL COSTS	$362,900	$140,900	-	$11,100	$166,100	$529,700	$103,100	$22,100	$42,300	$2,713,500	$1,906,100	$489,500	-	$30,200	$52,800		$6,570,300

* Including Alaska Office Expenses
** Manhours and Labor Costs not Available Separately

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TASK A 3.8 COST ESTIMATE - TASK 8, TRANSMISSION

Consultant	Subtask -	8.01	8.02	8.03	8.04	8.05	8.06	8.07	Totals Manhours	Totals Costs
ACRES	Manhours	2,300	3,900	5,600	2,200	2,300	2,100	900	19,300	
	Manhour Cost	$75,700	$130,300	$185,500	$73,000	$76,800	$68,500	$28,000		$637,800
	Disbursements*	7,500	20,500	19,500	4,500	4,500	10,500	2,500		69,500
	External Consultants			$1,000	$1,000		$20,000			$22,000
	TOTAL MANHOURS	2,300	3,900	5,600	2,200	2,300	2,100	900	19,300	
	TOTAL COSTS	$83,200	$150,800	$206,000	$78,500	$81,300	$99,000	$30,500		$729,300

* Including Alaska Office Expense

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TABLE A 3.9 COST ESTIMATE - TASK 9, COST ESTIMATES & SCHEDULES

Consultant	Subtask -	9.01	9.02	9.03	9.04	9.05	Totals Manhours	Totals Costs
ACRES	Manhours	225	530	1,320	995	355	3,455	
	Manhour Costs	$ 9,100	$18,100	$47,700	$31,800	$11,900		$118,600
	Disbursements*	900	1,900	5,300	3,200	1,100		12,400
	Subtotal	$10,000	$20,000	$53,000	$35,000	$13,000		$131,000
FMA	Manhours	300	60	480	540	170	1,550	
	Manhour Cost	$ 9,400	$1,800	$14,900	$16,900	$5,300		$48,300
	Disbursements	600	200	1,100	3,100	700		5,700
	Subtotal	$10,000	$2,000	$16,000	$20,000	$6,000		$54,000
	TOTAL MANHOURS	525	590	1,800	1,535	525	5,005	
	TOTAL COSTS	$20,000	$22,000	$69,000	$55,000	$19,000		$185,000

* Including Alaska Office Expense

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TASK A 3.10 COST ESTIMATE - TASK 10, LICENSING

												Totals	
Consultant	Subtask -	10.01	10.02	10.03	10.04	10.05	10.06	10.07	10.08	10.09	10.10	Manhours	Costs
ACRES	Manhours	230	630	25	1,430	715	2,430	630	130	885	115	7,220	
	Manhour Cost	$8,000	$22,000	$ 900	$50,000	$25,000	$85,000	$22,000	$4,500	$31,000	$4,000		$252,400
	Disbursements*	1,000	3,000	100	6,000	2,500	10,000	3,000	500	4,000	1,000		31,100
	Legal Review	-	10,000	-	-								10,000
	Subtotal	$9,000	$35,000	$1,000	$56,000	$27,500	$95,000	$25,000	$5,000	$35,000	$5,000		$293,500
	TOTAL MANHOURS	230	630	25	1,430	715	2,430	630	130	885	115	7,220	
	TOTAL COSTS	$9,000	$35,000	$1,000	$56,000	$27,500	$95,000	$25,000	$5,000	$35,000	$5,000		$293,500

* Including Alaska Office Expense

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TABLE A 3.11 COST ESTIMATE - TASK 11, MARKETING & FINANCING

Consultant	Subtask -	11.01	11.02	11.03	11.04	11.05	11.06	11.07	11.08	11.09	11.10	11.11	Totals Manhours	Totals Costs
ACRES	Manhours	1,600	900	270	370	160	-	80	350	40	-	-	3,770	
	Manhour Cost	$67,300	$38,400	$10,500	$14,500	$6,100	-	$3,800	$14,000	$1,800	-	-		$156,400
	Disbursements	10,800	7,400	4,500	4,500	3,900	-	1,200	6,000	1,200	-	-		39,500
	Subtotal	$78,100	$45,800	$15,000	$19,000	$10,000	-	$5,000	$20,000	$3,000	-	-		$195,900
WCC	Manhour Cost & Disbursements			$2,500										$2,500
FMA	Manhour Cost & Disbursements				$5,500									$5,500
SALOMON BROTHERS	Fee	$21,400	$45,800					$71,300	$5,000	$35,700				$179,200
	TOTAL MANHOURS												3,770	
	TOTAL COSTS	$99,500	$91,600	$17,500	$24,500	$10,000	-	$76,300	$25,000	$38,700	-	-		$383,100

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TABLE A 3.12 COST ESTIMATE - TASK 12, PUBLIC PARTICIPATION

Consultant/ Authority	Subtask -	12.01	12.02	12.03	12.04	Totals Manhours	Totals Costs
ACRES	Manhours	-	1,285	1,140	285	2,710	
	Manhour Cost	$ -	$45,000	$40,000	$10,000		$ 95,000
	Disbursements*	121,500	14,800	6,100	64,500		206,900
	Subtotal	$121,500	$59,800	$46,100	$74,500		$301,900
CIRI/H&N	Manhours		170	150		320	
	Manhour Cost		$6,000	$5,000			$11,000
	Disbursements		1,000	800			1,000
	Subtotal		$7,000	$5,800			$12,800
WCC	Manhours		170	300		470	
	Manhour Cost		$6,000	$10,000			$16,000
	Disbursements		1,000	1,500			2,500
	Subtotal		$7,000	$11,500			$18,500
TES	Manhours		1,270	300		470	
	Manhour Cost		$6,000	$10,000			$16,000
	Disbursements		1,000	1,500			2,500
	Subtotal		$7,000	$11,500			$18,500
FMA	Manhours		170	150		320	
	Manhour Cost		$6,000	$5,000			$11,000
	Disbursements		1,000	800			1,800
	Subtotal		$7,000	$5,800			$12,800
R&M	Manhours		170	300		470	
	Manhour Costs		$6,000	$10,000			$16,000
	Disbursements		1,000	1,500			2,500
	Subtotal		$7,000	$11,500			$18,500
	TOTAL MANHOURS					4,660	
	TOTAL COST	$121,500	$94,800	$92,200	$74,500		$383,000**

* Including Alaska Office Expense

** Other Public Participation Program costs in the amount of $220,000 are included in non-discretionary funds.

SUSITNA HYDROELECTRIC PROJECT - ALASKA POWER AUTHORITY

Addendum to POS
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TASK A 3.13 COST ESTIMATE - TASK 13, ADMINISTRATION

Consultant	Subtask -	13.01	13.02	13.03	13.04	13.05	13.06	13.07	13.08	13.09	Totals Manhours	Totals Costs
ACRES	Manhours	35	50	40	840	1,940	15	740	15	1,150	4,825	
	Manhour Costs	$1,300	$1,800	$1,500	$29,500	$68,000	$500	$26,000	$500	$45,100		$174,200
	Disbursements *	200	400	200	3,500	8,000	-	3,000	-	20,700		36,000
	Subtotal	$1,500	$2,200	$1,700	$33,000	$76,000	$500	$29,000	$500	$65,800		$210,200
FMA	Manhours	50	60	45	930	2,130	15	1,125	30	40	4,425	
	Manhour Costs	$1,600	$2,000	$1,500	$29,700	$68,400	$500	$36,000	$1,000	$1,300		$142,000
	Disbursements	200	200	200	3,500	8,000	-	4,000	200	200		16,500
	Subtotal	$1,800	$2,200	$1,700	$33,200	$76,400	$500	$40,000	$1,200	$1,500		$158,500
R&M	Manhours									220	220	
	Manhour Costs									$10,000		$10,000
	Disbursements									700		700
	Subtotal									$10,700		$10,700
TES	Manhours									1,880	1,880	
	Manhour Costs									$50,300		$50,300
	Disbursements									15,800		15,800
	Subtotal									$66,100		$66,100
CIRI/H&N	Manhours									300	300	
	Manhour Costs									$15,000		$15,000
	Disbursements									5,000		5,000
	Subtotal									$20,000		$20,000
WCC	Manhours									40	40	
	Manhour Costs									$2,000		$2,000
	Disbursements									200		200
	Subtotal									$2,200		$2,200
	TOTAL MANHOURS										11,690	
	TOTAL COSTS	$3,300	$4,400	$3,400	$66,200	$152,400	$1,000	$69,000	$1,700	$166,300		$467,700

* Including Alaska Office Expense

ALASKA POWER AUTHORITY - SUSITNA HYDROELECTRIC PROJECT

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Table A 3.14 - ESTIMATE SUMMARY

	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6	Task 7	Task 8	Task 9	Task 10	Task 11	Task 12	Task 13	Total
Acres American, Inc.														
Manhour Costs	$ 61,700	$110,600	$191,900	$ 51,800	$755,000	$1,606,000	$ 61,500	$637,800	$118,600	$252,400	$156,400	$ 95,000	$174,200	$4,272,900
Disbursements	12,300	16,900	44,200	6,200	167,000	158,000	248,800	91,500	12,400	41,100	39,500	206,900	36,000	1,080,800
Subtotals	$ 74,000	$127,500	$236,100	$ 58,000	$922,000	$1,764,000	$310,300	$729,300	$131,000	$293,500	$195,900	$301,900	$210,200	$5,353,700
Direct Costs														
ADF&G Equipment		$	$		$		$409,600							$ 409,600
Lodge		382,500												382,500
Air Transportation		1,633,800	425,500		798,000									2,857,300
Subtotals		$2,016,300	$425,500		$798,000		$409,600							$3,649,400
Subcontractors														
CIRI/H&N	$	$4,420,900	$	$	$	$	$		$		$	$12,800	$20,000	$ 4,453,700
WCC	230,200			1,081,000							2,500	18,500	2,200	1,334,400
TES (Incl. Subs)	55,000						3,093,800					18,500	66,100	3,233,400
FMA									54,000		5,500	12,800	158,500	230,800
R&M		1,293,900	1,164,400		1,900,500	5,000						18,500	10,700	4,393,000
Salomon Brothers											179,200			179,200
ADF&G							2,756,600							2,756,600
Subtotals	$285,200	$5,714,800	$1,164,400	$1,081,000	$1,900,500	$5,000	$5,850,400	-	$54,000	-	$187,200	$81,100	$257,500	$16,581,100
Non-Discretionary														
APA Administration*	$						$					$	$287,500	$287,500
APA Public Participation												220,000		220,000
ISER	30,000													30,000
Land Use*													90,000	90,000
ADF&G Coordinator							187,500							187,500
Native Inspector*													120,000	120,000
External Review*													1,000,000	1,000,000
Subtotals	$30,000	-	-	-	-	-	$187,500	-	-	-	-	$220,000	$1,497,500	$1,935,000
GRAND TOTALS	$389,200	$7,858,600	$1,826,000	$1,139,000	$3,620,500	$1,769,000	$6,757,800	$729,300	$185,000	$293,500	$383,100	$603,000	$1,965,200	$27,519,200

*Assumed to be allocated under "general administration", Task 13.

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SUSITNA HYDROELECTRIC PROJECT - ALASKA POWER AUTHORITY

Table A 3.15 ESTIMATED STUDY COSTS BY QUARTER

Task No.	Task Description	1980: 1	2	3	4	1981: 5	6	7	8	1982: 9	10	TOTALS
1	Power Studies	$ 41,400	$ 95,800	$ 155,000	$ 67,000	$	$	$	$	$	$	$ 359,200
2	Surveys & Site Facilities	2,697,350	1,304,550	1,348,350	339,950	420,350	467,050	505,300	287,450	244,150	244,100	7,858,600
3	Hydrology	204,350	65,650	131,200	162,800	250,800	208,800	224,350	206,650	204,350	167,050	1,826,000
4	Seismic Studies	42,800	189,700	290,200	168,100	28,100	117,500	146,400	94,100	32,800	29,300	1,139,000
5	Geotechnical Exploration	54,500	570,000	654,500	177,500	491,200	712,400	693,400	152,500	67,500	47,000	3,620,500
6	Design Development	-	7,900	72,300	78,600	111,400	166,900	258,900	486,800	483,300	102,900	1,769,000
7	Environmental Studies	670,700	968,900	726,700	727,300	674,500	675,200	666,400	650,400	443,300	366,900	6,570,300
8	Transmission	12,100	45,700	47,700	47,600	36,400	109,350	129,650	135,550	135,550	29,700	729,300
9	Construction Cost Estimate & Schedule	-	-	-	-	-	48,600	13,200	13,200	46,600	63,400	185,000
10	Licensing	62,600	27,900	15,100	15,100	15,100	15,100	15,100	28,000	26,900	72,600	293,500
11	Marketing & Financing	-	-	-	-	39,400	39,400	46,400	111,900	94,700	51,300	383,100
12	Public Participation	38,300	38,300	38,300	38,300	38,300	38,300	38,300	38,300	38,300	38,300	383,000
13	Administration	228,300	26,600	26,600	26,600	26,600	26,600	26,600	26,600	26,600	26,600	467,700
	Subtotal	4,052,400	3,341,000	3,505,950	1,848,850	2,132,150	2,625,200	2,764,000	2,231,450	1,844,050	1,239,150	25,584,200
	Non-Discretionary Amounts											
	APA Administration	28,700	28,800	28,700	28,800	28,700	28,800	28,700	28,800	28,700	28,800	287,500
	APA Public Participation	22,000	22,000	22,000	22,000	22,000	22,000	22,000	22,000	22,000	22,000	220,000
	ISER	15,000	15,000	-	-	-	-	-	-	-	-	30,000
	Land Use	9,000	9,000	9,000	9,000	9,000	9,000	9,000	9,000	9,000	9,000	90,000
	ADF & G Coordinator	19,000	19,000	19,000	19,000	19,000	19,000	19,000	19,000	19,000	16,500	187,500
	Native Inspector	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	120,000
	External Review	-	-	-	-	20,000	180,000	200,000	200,000	200,000	200,000	1,000,000
	Subtotal	105,700	105,800	90,700	90,800	110,700	270,800	290,700	290,800	290,700	288,300	1,935,000
	Escalation 8-1/2% on Tasks 1 - 13	0	70,996	149,003	117,864	181,233	283,522	362,084	343,643	326,397	250,308	2,085,050
	Subtotal	4,158,100	3,517,796	3,745,653	2,057,514	2,424,083	3,179,522	3,416,784	2,865,893	2,461,147	1,777,758	29,604,250
	Cumulative Cash Flow	4,158,100	7,675,896	11,421,549	13,479,063	15,903,146	19,082,668	22,499,452	25,365,345	27,826,492	29,604,250	

Revisions

January 7, 1980

TABLE A3.16 - BUDGET SUMMARY POST LICENSE APPLICATION STUDIES (1979)

(Cost data contained within this table applies to work necessary to support successful award of a license from FERC. Activities such as detailed design, construction contract packages, and work on an access road discussed as part of a "Fast Track" system in Section A6 would require additional expenditures.)

Task No.	Task Name	Cost
1	Power Studies	-
2	Surveys & Site Facilities	$3,025,000
3	Hydrology	500,000
4	Seismic Studies	100,000
5	Geotechnical Exploration	-
6	Design Development	-
7	Environmental Studies	4,810,500
8	Transmission	-
9	Construction Estimates & Schedules	-
10	Licensing	430,000
11	Marketing and Financing	200,000
12	Public Participation	250,000
13	Administration	$ 100,000
	Subtotal	$9,415,500
Non-discretionary amounts (Include private land use payments, Native Inspector, APA coordination, and ADF&G environmental coordinator)		617,500
	Grand Total	$10,033,000

SECTION A4 - RESPONSE TO PUBLIC COMMENT

SECTION A4 - RESPONSE TO PUBLIC COMMENT

A.4.1 - Introduction

The original version of this Plan of Study (POS) was submitted to the Alaska Power Authority on September 11, 1979. Concurrently with that submission, more than 50 copies were distributed to certain State and Federal Agencies as well as to public interest groups. Two opportunities for public testimony were provided at Alaska Power Authority Board Meetings on September 28 and November 11, 1979. In addition, written comments have been received that resulted from a series of face-to-face discussions with interested individuals. Finally, Plans of Study submitted by other qualified engineering firms have been reviewed with a view toward identifying ideas which could improve the original proposed approach.

The introduction to Section A1 highlighted certain major changes which have been incorporated in this edition of the Plan of Study. The purpose of this section is to provide a more detailed summary of comments, responses, and actions taken since September 11, 1979. Because a strong participation program has been planned from the start, it is certain that further changes to the POS will be made from time to time to ensure that the work to be performed is responsive to the needs and desires of the public. It follows that this plan is--and must be--a dynamic document.

Even before the first POS was prepared, public involvement had commenced. A meeting was held in July 1979 in the offices of APA to permit concerned citizens to familiarize prospective consulting firms with key issues and concerns. That first meeting was of value in formulating the original POS.

Annex A to this Section, which appears on the following pages, is a memorandum prepared to document the manner in which public response has been handled since the POS was submitted in September 1979.

ANNEX A TO SECTION A4

TABLE OF CONTENTS

1 - INTRODUCTION

Since the submission on September 11, 1979, of Acres proposed Plan of Study (POS) for the Susitna Hydroelectric Project, concerns and constructive criticisms have been voiced by numerous individuals, groups, and agencies (see Tables 1.1 and 1.2). It is the purpose of this Annex to address these concerns and to describe changes to the POS where considered warranted or reasons no changes were made. Also, as requested by the Alaska Power Authority (APA) the POS's proposed by Harza and IECO have been evaluated with the intention of extracting useful components which could improve the Acres POS.

TABLE 1.1: LIST OF SOURCES OF WRITTEN POS COMMENTS

1. Thomas Trent, Department of Fish & Game
2. Dave Sturdevant, Department of Environmental Conservation
3. Don McKay, Fish and Wildlife Service
4. Paul Lowe, Alaska Center For Environment
5. John Adams, Fairbanks Environmental Center
6. Suzanne Weller, Trustees For Alaska
7. Pat Wennekens, Alaska Conservation Society
8. Lawrence Kimball, Dept. of Community and Regional Affairs
9. Clarissa Quinlan, Division of Energy and Power Development
10. Gary Hickman, U.S. Fish and Wildlife Service
11. Al Carson, Department of Natural Resources
12. David Hickok, University of Alaska
13. Robert Cross, Alaska Power Administration
14. Robert Mohn, Alaska Power Authority

TABLE 1.2: LIST OF SOURCES OF VERBAL POS COMMENTS

1. Robert Cross, Alaska Power Administration
2. Thomas Stahr, Anchorage Municipal Light and Power
3. Paul Lowe, Alaska Center for Environment
4. Patricia Anderson, Private Citizen
5. Brian Rogers, Alaska State Legislator
6. Al Carson, Department of Natural Resources
7. Dave Sturdevant, Department of Environmental Conservation
8. John Adams, Fairbanks Environmental Center
9. Suzanne Weller, Trustees For Alaska
10. Pat Wennakins, Alaska Conservation Society
11. Troy Sullivan, Highlake Lodge
12. Don McKay, U.S. Fish and Wildlife Service
13. Dale Rusnell, Department of Commerce
14. Christopher Estes, Alaska Department of Fish and Game
15. Thomas Trent, Alaska Department of Fish and Game

2 - COMMENTS ON ACRES' POS

2.1 - Written Comments

Numerous groups and agencies have reviewed the original POS and have directed written comments to APA (see Table 1.1). The manner in which they are addressed in this version of the POS is described below.

Task 1 - Power Studies

T1.1 Comment: The load forecasting and the feasibility study should be separated.

Response: The entire feasibility study, to include the electrical demand forecast and the assessment of alternatives, was originally conceived as a single package to be conducted by the most capable engineering team available. In a separate action, the Alaska legislature funded an independent study that included energy demand forecasting for the Susitna Project market area. Due to the existence of this parallel and potentially redundant effort and because of several comments suggesting an independent demand forecast, the forecast originally programmed has been eliminated from the Acres plan. The forecast developed by the Institute for Social and Economic Research (ISER) under contract to the legislature will be adopted for use by Acres in Task 1, Power Studies. Subtask 1.01 has been rewritten to reflect this change.

T1.2 Comment: There is a need for a comprehensive conservation study.

Response: The importance of conservation and its potential effect on demand cannot be understated. This matter will be handled in the following manner:

(1) A Power Alternatives Study coordinated by the Alaska House Power Alternatives Committee includes a specific study contract with the Alaska Center for Policy Studies which will manage an analysis of:

- the end uses of energy in the Railbelt Area
- a determination of the potential for energy conservation and the use of renewable energy sources
- a discussion of the social, economic and political measures necessary to achieve the conservation and renewable energy potential
- work on conservation legislation for the 1980 session

(HB 364). This effort is expected to be an important source of data input for conduct of Task 1, Power Studies.

(2) Work by ISER includes development of a range of electricity use projections through the year 2005. The projections will be constructed in such a way that estimates of the impact of various conservation measures can be integrated into the analysis. Such measures would derive from studies such as that noted at (1) above.

(3) Conservation efforts can also affect the shape of daily load curves. Reduction of peak demand at certain critical hours in the day, for example, may prevent the total amount of required generating capacity from increasing as rapidly as it would under a "no-conservation" approach. Subtask 1.02 includes an assessment of conservation efforts on load forecasts. In addition Subtask 1.03 includes an assessment of certain forced conservation effects in its analysis of "non-structural" alternatives.

(4) The Power Alternatives Study Report (Subtask 1.06) will document the findings in other subtasks under Task 1 and will provide information explaining how conservation efforts have entered into the total demand equation.

T1.3 Comment: The study of alternatives to the Susitna Project and the feasibility study of the project itself should be separated.

Response: It has been decided not to separate these studies for several reasons:

(1) The competing engineering firms were evaluated on the basis of their qualifications to analyze the full range of alternatives. Acres, augmented by Woodward Clyde Consultants, has been found to be highly skilled in carrying out such evaluations of power system expansion and is expected to produce the comprehensive and complete study results needed.

(2) The alternative studies being conducted by various groups and firms under contract to the Alaska Legislature will provide both useful base data and an effective check on Acres' results.

(3) The cost of the overall study program will be minimized by avoiding the coordination, liaison and duplication of effort inherent in a split of "alternatives" and "project feasibility" studies.

T1.4 Comment: The POS needs consideration of locally oriented and decentralized power systems with emphasis on renewable resources.

Response: Subtask 1.03, Identification of Power Alternatives, includes evaluation of locally oriented and decentralized power systems, including those which would utilize renewable resources. The cost per unit of electrical energy provided by each will be determined. Subtask 1.04, Selection of Viable Expansion Sequences, will determine the total system costs with and without Susitna and will produce apparent optimum programs (including combinations of decentralized contributors) for various demand ranges. Impact assessments under Subtask 1.05 will compare the environmental consequences of developing such apparent optimums. An important Alternative Power Source Risk Analysis will be conducted in Subtask 11.03, and the consequences and probabilities of power interruptions from decentralized vs. large centralized systems will be evaluated.

T1.5 Comment: An overall energy budget should be considered for all alternatives to the Susitna Project.

Response: It is assumed that this "energy budgeting" means the consideration of energy consumed in developing and operating each alternative power source in comparison to the energy produced by the source. This type of analysis is not considered a useful exercise and has not been added to the program. Energy, just like concrete, steel or manpower, is an input in the construction and operation of a project. The value of all inputs is reflected in the construction and operation cost estimates. Similarly, the value of energy output is reflected in the calculation of project benefits.

T1.6 Comment: The POS does not give sufficient attention to system-wide costs with and without the Susitna Project.

Response: Subtask 1.04, Selection of Viable Expansion Sequences, has as its objective the determination of total system costs with and without Susitna for alternative load ranges. The description of this subtask has been written to clarify the emphasis which will be placed on this important issue. The very real costs of environmental consequences cannot always be measured in dollars. Thus, Subtask 1.05 is designed to provide a measure of impacts associated with apparent least cost approaches to satisfying future demand.

Task 2 - Surveys and Site Facilities

T2.1 Comment: There is inadequate attention to the logistics of getting study teams into the field.

Response: The point is well taken. Subsequent to the preparation of the original POS, a number of activities have taken place. The Logistical Plan (Section A8) has been revised to expand descriptions of field support activities and newly added Plates A.8.1 and A.8.2 provide some further information as to camp location and layout. The original POS had foreseen the construction of an airfield early in the first year of field work. This new version of the POS now includes a new Subtask 2.03, Resupply and Emergency Service, which provides for helicopter support and defers airfield construction--perhaps to the time that a license is awarded by FERC. It is planned that a coordinator of logistic efforts, including both personnel transportation and camp resupply, will be designated prior to the time that the camp opens. Nonetheless, logistical problems associated with access and egress in a remote region will require and receive continued attention of Project Management throughout the course of the Study.

T2.2 Comment: The POS is weak in evaluation of existing data and lacks specific justification for undertaking new data programs. (This comment also applies to Tasks 3, 4 and 5.)

Response: With respect to Site Surveys, the proposed program has been formulated by Acres after assessment of all the existing survey information which is available to Acres. The proposed program is considered the minimum necessary for FERC license application.

The data collection programs described in Tasks 3, 4, and 5 will be tailored to provide the data not already available from previous investigators or other resources. Subtasks 3.01 (Review of Available Material), 4.01 (Review of Available Data) and 5.01 (Data Collection and Review) have been specifically included in the POS to provide a basis for development of cost-effective data collection programs. In short, every effort will be made to ensure that advantage has been taken of work by others.

Task 3 - Hydrology

T3.1 Comment: The POS requires more emphasis on hydrological and climatological data collection programs.

Response: The relative dearth of hydrological and climatological data is a matter of concern. Plates T3.1 and T3.2 offer graphic depictions of proposed data collection stations. In addition, the original POS was deficient in that it did not properly account for important hydrological studies in the Lower Susitna River. Subtask 3.10 has been added to the new POS to provide for such work.

T3.2 See T2.2

Task 4 - Seismic Studies

T4.1 Comment: The POS requires as thorough a seismic study as possible.

Response: Agreed. Comprehensive and thorough seismic studies are absolutely essential. The entirety of Task 4 is concerned with this vital issue. Even so, the risks are judged to be of such significance that the proposed external review panel is to be provided with a sum of $1,000,000 for application on those further studies deemed necessary to confirm the adequacy of seismic investigations as well as to undertake such other confirmatory or additional work as may be required to accept confidently or to refute study findings.

T4.2 Comment: The POS should include the delineation of areas subject to flooding due to seismically induced dam failures.

Response: The concern is legitimate and must be addressed before a project is ever constructed. During the first 30 months, downstream hydrology will be studied under Task 3 and aerial photography and mapping will take place as a part of Task 2. Once a development concept begins to emerge under Task 6, Base Plan Risk Analysis under Subtask 11.04 will assess the probabilities and consequences of seismic failures and other possible risks. Subtask 11.05 provides for extension and revision of this initial Base Plan Risk Analysis. Once a license application to FERC has been made, follow-on work during the licensing processing period will include the suggested aerial delineation.

T4.3 See T2.2

Task 5 - Geotechnical Exploration

T5.1 See T2.2

Task 6 - Design Development

T6.1 Comment: Task 6 is very ambitious and may not be attainable within the proposed time frame.

Response: It is agreed that considerable work in Task 6 must be completed in a fairly short span of time. Even so, Acres asserts that it can be accomplished to the degree of detail necessary for FERC license application, provided the requisite field programs are accomplished. It must be remembered that the effort will not be aimed at producing detailed designs, but rather to investigate various alternative project arrangements to ensure that the optimal plans are selected. The level of detail necessary at this stage is reflected in the man-time and cost estimates for this task.

Once a license application has been submitted, detailed design can commence. The degree of urgency associated with expediting such effort (see the "Fast Track" approach in Section A6) will largely be determined as a result of the completion of Task 1, Power Studies.

Task 7 - Environmental Studies

T7.1 Comments received by various environmental agencies have been discussed at length with those agencies, notably ADF&G and F&WS. The POS has been extensively modified to reflect these discussions.

As may be noted in review of the modified POS, Task 7, Environmental Studies, has more than doubled in terms of text dealing with its description and the resources devoted to the task have been increased from $4.8 million to $6.6 million.

Task 8 - Transmission

T8.1 Comment: Insufficient attention has been focused on the transmission system and its environmental impacts.

Response: It is considered that the POS as currently proposed is adequate to cover transmission aspects prior to FERC license submission. Consideration will be given to any additional environmental studies warranted during the period following submission of the FERC license application. APA has also initiated other studies in connection with the transmission intertie.

As may be noted in Subtask 7.09, a number of earlier studies addressing an intertie between Anchorage and Fairbanks with or without Susitna have already been conducted. As stated in comment T2.2 above, existing data will be used to the maximum extent possible to avoid incurring unnecessary costs for redundant work. As transmission line studies proceed under Task 8, the public will be kept informed as to progress and preliminary findings. Furthermore, to allay concern in this regard, the preliminary results of Subtask 8.01, Transmission Line Corridor Screening, will be available for consideration at the second public meeting scheduled in early 1981. Should the initial perception of insufficiency of attention still exist at that time, the matter will be reviewed; and, if necessary, the level of effort will be increased.

Task 10 - Licensing

No comments.

Task 11 - Financing

No comments.

Task 12 - Public Participation

T12.1 Comment: There is a need for public involvement before the POS is finalized.

Response: This second edition of the POS is being widely distributed for public scrutiny and comment. The public meeting scheduled to take place in early March will provide an opportunity for strong public involvement. Indeed, no portion of the POS will be regarded as having been "finalized" until that portion of the program has been completed. The POS should most certainly be a dynamic document; and it will change throughout the course of the work, both because technical efforts in one Subtask will influence the approach to the next and because public input, particularly through the unique "Action List" program (see Subtask 12.05), will produce meaningful changes.

T12.2 Comment: There is a need for an independent public involvement program.

Response: The public participation program has been modified in response to this comment. The Alaska Power Authority has engaged a public participation officer and staff and will be responsible for its management. Acres will support the program through its involvement in all public meetings and workshops, technical inputs for action list work and for various project brochures, and in other ways as desired by APA. It is considered inappropriate to make the program independent of APA itself, since such an approach would tend to limit important daily interaction between project and public participation staffs.

T12.3 Comment: There is a need to demonstrate how public input is affecting the plan of study as well as future decisions.

Response: Subtask 12.05 (Prepare and Maintain Action List) has been devised to implement this requirement. Maintenance of the Action List will provide a positive system for ensuring all issues are addressed, to permit up-to-date status reports on progress and procedures for addressing issues, and to ensure that all necessary actions arising from the public participation program are assigned by name to team members.

The proposed "action list" is admittedly new and untried. Even so, APA is committed to making every reasonable effort to ensure its success. There is every reason to believe that it will most certainly demonstrate how public input is affecting the plan of study as well as future decisions.

T12.4 Comment: The POS does not consider an adequate degree of coordination with the Matanuska-Susitna Borough.

Response: Agreed. The first version of the POS did refer to Borough interests, but the emphasis was not sufficiently strong. Subtask 7.05, Socioeconomic Analysis now provides for coordination with the Matanuska-Susitna Borough. Other specific contacts and coordination with the Matanuska - Susitna Borough are noted in Subtasks 7.07, Land Use Analysis and Section A8, Logistical Plan. Coordination between Acres and Mr. L. H. Kimball, Director of the Division of Community Planning, and with the Matanuska - Susitna Borough is planned.

To further ensure input from the vantage point of the Borough, at least one public meeting will be scheduled to take place in the Palmer/Wasilla area.

T12.5 Comment: The time frame of the study is too short for public discussion and input on alternatives to the Susitna project.

Response: The time frame is short, but a number of measures are provided to satisfy public participation needs. The proposed POS includes three public meetings and eight workshops over the 30-month study period. The first public meeting in March 1980 will provide an opportunity for the public to recommend how alternatives should be studied, and the second in early 1981 will provide for public comment on the Power Alternatives Study to be completed under Subtask 1.06. Between these two events, several workshops have been scheduled and interested members of the public are invited to observe and to offer comments at those times. In addition, information materials produced in Subtask 12.04 will provide for public review of ongoing work in the alternatives study. Public input will be accepted and acted upon throughout the course of the work.

To further enhance opportunities for public discussions and input, a full time power systems planner will now be included on the staff of the Acres Project Office in Anchorage. He will be available for local response to questions and comments. His attendance as an invited speaker or participant in other gatherings dealing with this subject is also planned.

Task 13 - Administration

T13.1 Comment: There are considerable management problems inherent in coordinating as many study participants as are included in Acres POS.

Response: The point is well taken. To provide for heavy Alaskan involvement as well as to ensure that highly qualified firms are used for tasks demanding great expertise, a large team has been assembled. Extensive procedures are described in Task 13 for management, control, and coordination of diverse concurrent activities. Even so, the task will not be an easy one. Fortunately, however, Acres offers experience in managing large teams in the successful completion of giant projects in sub-arctic regions. In addition, heavy reliance will be placed on the skills and knowledge of Frank Moolin & Associates (whose Trans Alaska Pipeline System management experience is substantial).

General Comments on the POS

G.1 Comment: The 30-month time frame of the study is too short and should provide a mechanism for review, redirection and continuation of selected projects post-FERC license application.

Response: It is clear that study effort should not terminate upon submission of the license application. Indeed, certain critical tasks, particularly in the environmental area, must continue if a license is ever to be awarded. Section A6, Post-License Application Submission Activities, has been revised so that this new POS now clearly distinguishes between those activities which would be required if the project were to be expedited ("Fast Track") and those necessary only to satisfy FERC needs (License Only"). Some additions to Section A6 also include expanded descriptions and level of effort in the evnironmental area and increased activity for downstream flow studies. Prior to completion of the first 30 months of work, it may be reasonably anticipated that a detailed Plan of Study for the following phase will be prepared. Such a document will provide for the suggested mechanism.

G.2 Comment: Interagency coordinating mechanisms need to be refined with clear delineation of how information from the various disciplines will be synthesized.

Response: New subtasks have been added to Task 13 to take specific cognizance of the need for interagency coordinating mechanisms. Subtask 13.11, ADF&G Support, has been prepared to provide for continuous daily contact and coordination with that Agency by locating key ADF&G personnel within the proposed project office. Subtask 13.10, Project Office Operation, includes the procedures for effecting interagency coordination. These procedures will be incorporated into an overall project procedures manual which will become the guide for use by all project personnel. Appropriate portions of the proposed manual will be made available for comment by those with whom coordination is to be effected, and the manual will be updated from time to time to ensure that it provides for satisfaction of all coordinating requirements.

G.3 Comment: There is a need for a formal interagency review committee.

Response: Agreed. As of the time of preparation of this version of the POS, a formal interagency review committee is being formed. It is anticipated that, by the time of the first public meeting in early March, details will be available as to its composition and functions. Subtask 12.03 also provides for a total of eight scheduled coordination work sessions for interagency discussions and resolution of important issues.

G.4 Comment: It is advisable to separate the planning and design responsibilities.

Response: The contract which APA and Acres have entered into provides only for the preparation of a feasibility study and license application to the FERC. No commitment to Acres has been made beyond this initial planning stage, so that APA retains the option of engaging another consulting or government agency to provide detailed design and construction management. Even so, cost and schedule implications will arise if a change is made at the end of the first 30 months of work. The time and associated costs involved in "getting up to speed" and reviewing all previous activities and concepts prior to undertaking detailed design could be significant if the services of Acres are terminated at that stage. These and other considerations will be taken into account by the APA Board when it formulates a resolution at a later date on how best to proceed.

G.5 Comment: There is a need to tailor the POS to the needs of the decision maker.

Response: All information developed in the study will be documented in the form of summary and comprehensive reports which will be in the most appropriate form for efficient use by decision makers.

In addition, Task 11, Marketing and Financing, provides for the preparation of a project overview documentation which is intended to assist the decision maker in assessing diverse aspects of the work. Indeed, this relatively recent innovation in support of giant projects is intended to place all the technical, commercial, economic, financial, contractual, environmental, and other aspects in proper perspective and to demonstrate how vital problems are being addressed. The introduction to Task 11 and Subtask 11.01 provides further details on project overview documentation.

G.6 Comment: There must be an acknowledgement of the state liability program.

Response: The contract between APA and Acres was reviewed, prior to its execution, by legal consultants to the APA Board as well as by State agencies concerned with these matters. Changes were made to original drafts, and the final contract is consistent with all the comments received during its preparation.

G.7 Comment: The overall program is very ambitious and may not be completed in the proposed time frame.

Response: Acres has assured APA that, while the study will require a great deal of hard work, the program can be accomplished in the proposed time frame provided unforeseen circumstances do not arise. Achievement of the program goals, however, will require continued cooperation from all concerned agencies and organizations as well as from the interested public.

2.2 - Verbal Comments

Acres has been provided the transcripts of the hearing on September 28, 1979, on the Susitna Feasibility Study so that all criticisms of Acres' proposal may be considered in arriving at a final version of the POS (see Table 1.2). Several of these comments have already been addressed in Section 2.1 above. The remainder are summarized and discussed below.

Task 1 - Power Studies

T1.7 Comment: A very detailed, comprehensive study of alternatives is necessary.

Response: Task 1, Power Studies, has been modified to increase efforts associated with the study of alternatives in the following manner:

(1) A full time power systems planning engineer has now been included on the Anchorage Project Office staff. (See also comment T1.8 below.)

(2) A summary of activities to be undertaken concurrently by others (particularly the Power Alternatives Study coordinated by the Alaska House Power Alternatives Committee) is included in paragraph A.5.2(v). These related studies will be closely monitored, and findings will be considered or incorporated in the Susitna alternatives studies.

(3) As earlier mentioned, ISER will develop projections of possible future energy consumption trends. Coordination of the Susitna work effort with the ISER work is covered in Subtask 1.01 (a new subtask).

In addition, Subtask 11.03 provides for an alternative Power Source Risk Analysis.

T1.8 Comment: Acres' POS is inadequate in terms of assessing alternatives to the Susitna development.

Response: The point is well taken, and changes have been made to the original POS to account for it. (See comment T1.7 in the preceding paragraph.) The level of effort for the modified study of alternatives is intended to confirm whether or not the Susitna development should be pursued to supply the future growth in demand for electricity in Alaska. It should be noted that a power systems planning engineer has been assigned full time to the Project Office in Alaska during the conduct of alternative studies. This represents a significant increase in the effort originally planned for alternatives studies and will ensure that public comments or questions can be addressed at any time on this important issue.

Task 2 - Surveys and Site Facilities

T2.3 Comment: The availability of the "Highlander Lodge" located some five miles from the Devil Canyon site should be considered in providing camps for the field programs.

Response: Use of existing camp facilities will be considered. All such facilities which are available and shown to be a cost effective alternative will be utilized to the fullest extent possible. Table A.3.2 now includes a line item for lodge costs in the event that use of lodges is found to be in the best interests of successful and economical project completion.

Task 3 - Hydrology

T3.3 Comment: Full advantage should be taken of the University of Alaska's knowledge of river ice conditions.

Response: Acres intends to retain experts from the University of Alaska in assessing the river ice problems on the Susitna.

Task 5 - Geotechnical Exploration

T5.2 Comment: There is a concern on the competence of R&M Consultants Inc. for a job of this magnitude.

Response: This comment is apparently based on Anchorage Municipal Light and Power's experience with R&M on a recent job. It is Acres' understanding that the cost overrun on this job was due to circumstances beyond R&M's control.

Task 6 - Design Development

T6.2 Comment: There is a concern that the tunnel scheme proposed by Acres is not feasible.

Response: This may be true. At this point in time, the tunnel concept is an unproven scheme which must be studied in more detail to determine both its economic and technical feasibility. Even so, such attractive features as reduced environmental impact and increased productivity in winter construction months make study of this scheme a worthwhile undertaking.

Task 7 -<u>Environmental Studies</u>

T7.2 Comment: There should be a study of the possible change in climate due to the formation of reservoirs on the Susitna River.

Response: Although not specifically highlighted in Acres' POS, this impact on the region's climate will be addressed in broad terms in Subtask 7.03, Evaluation of Alternatives.

As may be deduced from the preceding question, there is a possibility that the tunnel scheme will be found feasible. In that event, of course, reservoir surface area would decrease. It follows that meaningful study of potential impacts on climate depends upon selection of a development concept and delineation of proposed reservoir areas. Initial broad evaluations during Subtask 7.03 would be refined during the period following submission of the license application to FERC.

T7.3 Comment: There is a concern on the objectivity of the Alaska Department of Fish and Game in their participation in the study.

Response: ADF&G, in their role as a State agency for monitoring and controlling environmental disturbances, are obviously the best qualified and equipped agency for gathering of baseline data for the areas affected by the project. APA has, therefore, contracted with ADF&G to undertake this work. Any other involvement by ADF&G will be restricted to their customary role of review and approval of environmental assessments, proposals for mitigating measures, and permit applications.

Task 8- <u>Transmission</u>

T8.2 Comment: There is a need for a study on the risk of transmission line outage.

Response: Agreed. This need will be addressed in two ways:

(1) Subtasks 8.02, Electric Systems Studies, and 8.04, Tower, Hardware and Conductor Studies, will assess alternative transmission schemes and will produce estimates as to reliability.

(2) Subtasks 11.03 and 11.04 are risk analyses which will include assessment of risks and consequences associated with outages.

As noted in an earlier comment, an important consideration in weighing major alternatives of centralized and decentralized generating systems has to do with risks and consequences of outages.

General Comments

G.8 Comment: The time frame for the study is too short.

Response: If the Susitna project is proven to be economically feasible, the field data collection program will continue after the 30-month period presently planned. As noted in earlier comments, Section A6 now provides for two alternatives for work after license application is made. Even in the "Fast Track" case, it is anticipated that the minimum period before a construction start on any project feature will be at least five years. It is anticipated that the public participation program will continue throughout.

G.9 Comment: The POS's submitted by all three consultants should be combined into a single comprehensive plan.

Response: The more desirable aspects of the Harza and IECO proposals, where appropriate, have been reviewed and taken into account in the revised POS (see Sections 3 and 4). In addition, the Corps of Engineers' plan of study was valuable as a reference source in preparation and subsequent modification of this POS.

G.10 Comment: A comprehensive field program is needed.

Response: Agreed. The data collection programs outlined in Tasks 2, 3, 5 and 7 have been designed to ensure that the stated need is satisfied. This modified version of the POS now includes significantly more descriptions and resources for Task 7, Environmental Studies. Task 2, Surveys and Site Facilities, has been changed to improve field support services. A new Subtask 3.10 has been added to Task 3 to provide for further downstream flow studies on the Susitna.

G.11 Comment: There should be an external review of the basic assumptions, methodologies and final results of the Susitna Study.

Response: External review of the study is necessary. To this end, three external mechanisms are planned:

(1) The proposed external review panel of world-renowned experts will provide a necessary check on the basic assumptions, methodologies and study results.

(2) The public participation program will give the public the opportunity to comment on and influence the study.

(3) The study of the projected load growth of Alaska will be undertaken by the Institute of Social and Economic Research as an external consultant.

G.12 Comment: The feasibility study should be postponed until the alternatives to Susitna are fully assessed.

Response: Indications to date are that the Susitna development is economically attractive and will be needed at an early date to satisfy the electrical load growth of Alaska. To postpone the feasibility study may result in the ultimate delay of the project at the cost of having to develop more expensive alternatives in the interim, or even of incurring short term power shortages relative to the small potential savings involved. If the feasibility of the Project can be established, then it is desirable to obtain the FERC license with the minimum of delay. Even so, the proposed program has been devised to minimize expenditures prior to completion of alternatives studies while still accomplishing licensing of the project at the earliest possible date. In this latter regard, for example, the original plan to build an expensive airfield during the initial field investigation period has now been changed in favor of using helicopter support of field activity while the study of alternatives is being addressed.

3 - ASSESSMENT OF HARZA PROPOSAL

The proposal submitted by Harza Consultants to APA has been assessed with the intention of extracting those portions which could be used to improve the Acres plan.

In general, the Harza plan of study is similar to that of Acres. Many of the apparent differences are a result of different emphasis in the presentation of the plans of study. It is Acres' opinion that all major tasks proposed by Harza are already included in the Acres POS, where they are organized and scheduled in a comparable or more comprehensive manner. Specific differences in the proposals are discussed below.

3.1 - Specific Differences in the Proposals

(a) Harza proposed to engage an Alaskan resident with a thorough background of Alaskan attitudes, customs, etc., as the manager of their "Public Information and Participation Program."

Acres agrees with this approach and had intended to do the same. The current POS now reflects the fact that an Alaskan resident has now been hired by the Alaska Power Authority as the Public Participation Officer.

(b) Harza recommends the formation of a "Technical Advisory Committee" composed of representatives of interested groups and agencies for a "two-way communication between the project planners and interested state and federal agencies." The Acres POS provides for a series of workshops designed to provide "two-way communications" as suggested. In addition, a formal interagency review committee is in the process of being established.

(c) Harza's proposed mapping of the Susitna River appears to be more comprehensive and detailed than that of Acres.

Acres research has shown that a considerable amount of survey data is already available. Aerial photography and subsequent mapping is very expensive, and will consequently be kept to the minimum required for evaluating project alternatives. Acres considers that their mapping program is adequate to augment the existing data envisaged. If specific development schemes prove to be attractive in this feasibility study, more detailed mapping in the post-FERC license period may be necessary.

(d) Harza proposes to make a comprehensive inventory of existing generating facilities and transmission lines.

Although this is not listed as a specific item in Acres POS, it was intended to form part of the groundwork of Subtask 1.04, Selection of Viable Expansion Sequences, and has been included in the cost estimate of that item.

(e) In their proposal, Harza emphasizes their intention of developing a concept of staged development of the Susitna River. They describe six major schemes which will be investigated thoroughly.

The basis of the Acres POS is essentially that the substantial amount of competent work which has alredy been done by USBR and the Corps of Engineers should at this point be assumed to be correct and that the Corps' most recently proposed scheme is near-optimal. Acres' detailed proposals were, therefore, developed on the basis of this previous work; and the POS will refine and build upon it rather than start afresh. However, in the event that the Acres study of alternatives (Subtask 6.03) indicates that other development schemes are more desirable, Acres' POS will have to be modified to include a more thorough search and refinement of the optimal plan.

(f) Harza's POS includes the use of the "WQRRS" computer model developed by the Corps of Engineers to analyze the water quality in the reservoir(s) and the Susitna River.

It is Acres' opinion that use of this model will not produce meaningful results without extensive field data for its calibration. Therefore, although some analytical modeling of the thermal stratification in the reservoir is planned in the pre-FERC license application period, refined modeling of the water quality has been reserved for the post-FERC license application period when adequate basic data will begin to become available.

(g) Harza proposes to study "Riparian Habitats." The objective of this will be to characterize the interrelationships between the maintenance of willow/moose habitat in the downstream flood plain and seasonal flooding characteristics.

In coordination with ADF&G and DNR, Acres has revised its original POS to add downstream flow studies (Subtask 3.10) and to change the environmental program to satisfy this requirement.

(h) Harza proposes a "Recreation Resources Study" to inventory and evaluate the recreation resources within the Susitna River Basin for the purpose of assessing the impacts that the project might have on them.

Although it is not specifically discussed in the Acres proposal, it is intended that such a study would form the necessary groundwork for Subtask 7.08, Analysis of Recreation Development. The estimated cost of this Subtask has been included for this work.

(i) Harza proposes to assess the potential impact of project alternatives on the aesthetic and visual resources, and to identify measures to ensure that project works blend with the surrounding environment. Two computer programs developed by Harza for this purpose will be used to evaluate the visual impacts.

The environmental impact assessments of the proposed development, including aesthetic and visual resources, will be achieved by competent experts in a conventional manner under the Acres POS.

(j) Harza proposes to develop a "Resources Inventory" and a "Project Data Management Program."

Although this approach to tabulation of project data has not been proposed specifically in Acres' POS, it is intended that a comparable, methodical cataloging of such data will be carried out as necessary for the complete documentation of study results.

(k) Harza proposes a Project Sponsor who would maintain periodic liaison with APA and provide a communications channel to Harza management for evaluation of the performance of the project team as a whole.

Although not originally proposed by Acres as a formal part of the project team structure, such a communications channel has been made available for APA through the Project Sponsor to the senior management of Acres.

4 - ASSESSMENT OF IECO PROPOSAL

4.1 - General

IECO's proposed POS has been reviewed in detail. Each task outlined by IECO has been critically and objectively assessed and compared with those previously formulated by Acres. In general, the two POS's are quite similar, although in many areas Acres' plan provides more detail. Several Tasks apparently considered necessary by IECO have not been detailed specifically in Acres' proposal. These Tasks are discussed below.

4.2 - Task C-4-9 - Aquatic Resources-Upper Cook Inlet Estuary

In this task, IECO proposed to develop a mathematical model of the Cook Inlet and to use it to assess the potential impact from upstream development. Although Acres intends to assess the impact on the estuary, it will be done not by mathematical model but by more reliable and proven empirical methods. It is Acres' opinion that at this early stage of the project, without adequate basic data, the use of such a sophisticated tool would not provide meaningful results.

4.3 - Task C-4-17 - Air Quality and Noise

As part of this Task, IECO proposes to evaluate measures to minimize potential impacts to air quality and noise that could occur during the construction of a Susitna project.

Although Acres' POS includes an evaluation of the impact of alternative power sources (thermal plants in particular) on air quality, this has not been specifically addressed with respect to construction of hydroelectric projects on the Susitna. Such impacts, considered minimal at this time, will be assessed in Task 7, Environmental Studies.

4.4 - Task C-4-21 - Public Safety

The purpose of this task will be to describe any impacts resulting from accidents and natural catastrophes which might occur, and provide an analysis of the capability of the area to absorb predicted impacts.

Although such a work item has not been specifically included in Acres' POS, it is expected that such impacts would have to be described for public meetings and workshops, and it is considered that sufficient funds are included in Task 12, Public Participation, to cover this.

4.5 - C-4-22 - Visual Resources

IECO proposes a separate task at a considerable cost ($70,000) to:

- Determine the significant visual effects of the Watana and Devil Canyon structures.
- Simulate the appearance of the structures and suggest mitigation measures for undesirable visual impacts.
- Establish criteria for scenic quality which provides a basis for comparative evaluation of proposed project features and alternative energy sources.

Although such an item has not been specifically included in Acres' POS it is intended that visual impacts of the projects will be evaluated in Task 7, Environmental Studies.

4.6 - D-4-1 - Develop Comprehensive Watershed Model

Acres does not consider that development of such a model will be necessary during pre-license application studies. Acres proposes to refine the work already conducted by the U.S. Army Corps of Engineers with the SSARR watershed model, and thus avoid the heavy cost of developing and calibrating a new model.

4.7 - D-4-2 - Develop Specific Models for Arctic Conditions, D-4-3 - Calibrate and Verify Models

Acres does not consider that this will be necessary. Acres will draw primarily from "off-the-shelf" models which have already been developed on Acres' previous jobs where Arctic conditions have been a problem. Some work may be necessary, however, to calibrate these models to the specific conditions encountered in the Susitna Basin.

4.8 - D-5-4 - Glacial Water Balance, E-5-3 - Mass Balance and Dynamic Behavior of Glaciers

IECO proposes to launch a detailed assessment (at a cost of $158,000) of the glaciers in the Susitna Basin.

Although Acres considers that some evaluation of the glaciers is necessary (as included in Subtask 3.04 (vi)), it would be more appropriate to have a moderate investigative effort at this early stage. If more comprehensive study appears warranted, it can be planned and implemented after submission of the FERC license application.

4.9 - E-3-2 - Shear Wave Hammer Testing of the Watana and Devil Canyon Sites

This is not considered necessary during pre-licensing submission activities. The proposed Acres program for seismic and geotechnical exploration is sufficient to support concept designs.

4.10 - E-8-4 - Conduct Mass Concrete Tests

IECO proposes to expend some $40,000 on conducting laboratory tests to develop a mass concrete design mix and to check the suitability of available materials to obtain the desired concrete mix.

Acres considers that such effort should be reserved only for the later design stage of the project. For the feasibility study, Acres will draw on their extensive experience with concrete mixes for northern construction to evaluate the appropriate composition.

4.11 - D-6-6 - Downstream Hazards from Dam Failure

In this task, IECO plans to evaluate downstream hazards of dam failure because of a catastrophic event.

This effort is included as a part of Risk Analyses to be conducted under Task 11.

4.12 - Hydrology

IECO has included $1.8 million for hydrologic studies, compared to $1.6 million for Acres. This difference is mostly due to IECO's estimate of $340,000 for developing sophisticated mathematical models which Acres believes to be unnecessary at this time.

SECTION A5 - DETAILED ACTIVITY DESCRIPTIONS

SECTION A5 - DETAILED ACTIVITY DESCRIPTIONS

A.5.1 - Introduction

As discussed in Section A2 it is proposed to achieve the objectives of the Susitna Plan of Study by undertaking a program of work divided into the following 13 tasks:

Task 1 - Power Studies
Task 2 - Surveys and Site Facilities
Task 3 - Hydrology
Task 4 - Seismic Studies
Task 5 - Geotechnical Exploration
Task 6 - Design Development
Task 7 - Environmental Studies
Task 8 - Transmission
Task 9 - Construction Cost Estimates and Schedules
Task 10 - Licensing
Task 11 - Marketing and Financing
Task 12 - Public Participation
Task 13 - Administration

Within each of these tasks, a series of subtasks has been identified as shown on the Master Schedules, Plates A7.1 and A7.2. Plate A2.1 is an overall summary schedule for the entire Plan of Study. More detailed schedules and logic diagrams for some specific areas of the study appear under individual subtask description in this section of the POS. In the following subsections the Scope Statements for Tasks and Subtasks are presented and discussed. A complete listing of all subtasks with associated costs is presented in Section A3 - Budget Summaries.

Throughout this section of the proposal, reference will be found to "Design Transmittals". This term is used by Acres to describe a formalized document prepared to present the engineer's or designer's response in definitive terms as to how he interprets a statement of work and how he intends to proceed with the detailed engineering.

A.5.2 - TASK 1: POWER STUDIES

(i) Task Objectives

To determine the need for power in the Alaska Railbelt Region, to develop forecasts for electric load growth in the area, to consider viable alternatives for meeting such load growth, to develop and rank a series of feasible, optimum expansion scenarios and finally to determine the environmental impacts of the selected optimum scenarios.

(ii) Task Output

The primary output of Task 1 will be a report dealing with the selection and ranking of optimum system expansion scenarios for the Alaska Railbelt Region. The final version of this report will be submitted for review and approval by Alaska Power Authority on or about Week 48 of the Study. Preliminary findings of the study will be discussed with Alaska Power Authority on or about Week 30 of the Study. Such a discussion will center on whether or not work on the Susitna Development should continue or whether another, possibly more viable alternative should be examined. Design transmittals outlining intermediate stages of the power studies will also be issued as indicated on the logic diagram, Plate T1.1.

(iii) List of Subtasks

Subtask 1.01 - Review of the ISER Work Plan and Methodologies
Subtask 1.02 - Forecasting Peak Load Demand
Subtask 1.03 - Identification of Alternatives
Subtask 1.04 - Selection of Viable Expansion Sequences
Subtask 1.05 - Expansion Sequence Impact Assessments
Subtask 1.06 - Power Alternatives Study Report

(iv) Subtask Scope Statements

The primary purpose of Task 1 as discussed in Section (ii) above is the establishment and documentation of appropriate load forecasts for the Alaska Railbelt area and the development of optimum system expansion sequence scenarios to meet this forecast. The evaluation of these factors for the Railbelt Region and the relationship and scheduling of Task 1 to the remaining twelve tasks of the overall Plan of Study are illustrated in the master schedule, Plate A7.1. This portion of the study will be undertaken in essentially three parts. The initial phase will include evaluation of the various projected energy consumption scenarios developed by independent study teams. From these forecasts, the Acres team will develop kilowatt load forecasts appropriate for the low, medium, and high growth rate scenarios. The second portion of Task 1 will deal with the development of optimum mixes and sequences of feasible alternative sources for meeting future power demands. These mixes will be developed with and without the Susitna Project, which at this stage will be assumed for study purposes to be that developed by the Corps of Engineers. The third section of the study will deal with the preliminary comparative environmental and socioeconomic impacts of the developed optimum mixes on the Railbelt Region.

In order to meet the overall objectives of the Plan of Study as stated in Section A2 above, other activities of the program will proceed in parallel with Task 1. These will essentially involve Task 2 - Surveys and Site Facilities, Task 3 - Hydrology, Task 4 - Seismic Studies and Task 5 - Geotechnical Exploration. For logistical reasons, these activities will have been initiated on the assumption that the Susitna Project will be that which proves to be the optimum development for Alaska Power Authority. However, the Task 1 power studies may determine otherwise. Under such circumstances, the ongoing studies would be halted pending discussions with Alaska Power Authority to determine the future course of action most appropriate. On the other hand, should Task 1 studies confirm the earlier studies undertaken by the Corps of Engineers and others that the Susitna Project, with dams at Watana and Devil Canyon is the appropriate means of meeting future load growth in the Railbelt area, the study will continue as planned.

(v) Concurrent Studies by Others

Concurrent with work undertaken by the Institute of Social and Economic Research (ISER) and by the Acres team, a number of studies bearing on Task 1 efforts will be accomplished by others. A full-time power system study representative from the Acres team will be stationed in Alaska during the first year of the work and he will closely monitor these concurrent activities as a portion of his total duties. Some particular efforts which should enhance the quality of Task 1 work include:

(1) A Power Alternative Study coordinated by the Alaska House Power Alternatives Committee is now in progress. Specific Study contracts include:

(a) Power Market Demand Projections--by the University of Alaska Institute for Social and Economic Research.

The section of the study is being done in cooperation with the Power Authority. They have shared in the design of the contract, and will participate in the funding. This portion of the study will also serve as the power market demand projection for the Susitna Phase I of Study (see Subtask 1.01).

The particulars of the scope of work include methodological review, data collection and updating, economic projections, assessment of interfuel substitution possibilities, electricity use projections, and an assessment of possibilities, electricity use projections, and an assessment of the probabilities of the various scenarios and projections.

The institute will hold a workshop in December to review the assumptions behind the economic projections, and will cooperate with a variety of other committee consultants.

(b) Review of the ISER Demand Work

Dr. Bradford Tuck, an economist with the University of Alaska School of Business, and Energy Probe, of Toronto, will separately analyze and criticize past demand projections as well as the work ISER is undertaking for the committee.

(c) Potential of Conservation and Renewable Energy

The Alaska Center for Policy Studies will manage the various portions of this section of the study. The work will include an analysis of the end uses of energy in the Railbelt area, a determination of the potential for energy conservation and the use of renewable energy sources, a discussion of the social, economic and political measures necessary to achieve the conservation and renewable energy potential, and work on conservation legislation for the 1980 session (HB 364). A variety of subcontractors will carry out the specific tasks.

(d) Natural Gas

This portion of the study will address institutional limitations on the future use of natural gas for power generation, the future price and availability of gas, the efficiency of gas-fired generation facilities, and the potential for the use of natural gas in direct consumer applications. A proposal by economist Greg Erickson is pending.

(e) Overview

This section would address the historical background of the supply of electric power in the railbelt, survey the basic policy questions at stake in the Susitna decision, delineate financing questions and address the decision-making structure for Susitna and other power alternatives. A proposal by economist Arlon Tussig is pending.

(f) Sociocultural Impacts

This section would investigate the effect of the construction of the Susitna dam on both the local area and Alaska, and relate those effects to both a historical and a normative context. A proposal by the Arctic Environmental and Data Center of the University of Alaska is pending.

(g) Other Sections of the Study

Additional work is contemplated in the areas of coal-fired generation. A review of the adequacy of Phase I study of environmental impacts is also contemplated.

(2) Assessments of hydroelectric and other electric generation potential throughout the State and particularly in or near the Railbelt Area, to be undertaken by others from time to time under contract to APA.

(3) Ongoing work by the Alaska District, U.S. Army Corps of Engineers, on the Bradley Lake Project and other hydroelectric studies.

(4) Studies undertaken for the Alaska Power Administration, including in particular a study of wind generation potential in the Cook Inlet Region.

Subtask 1.01 - Review of the ISER Work Plan and Methodologies

(a) Objective

Critically review the work plan and the methodologies developed by the University of Alaska's Institute of Social and Economic Research (ISER) for forecasting energy demands.

Review and comment upon those written documents prepared by ISER as a part of its study. These documents will include, but will not be limited to, those documents listed under section (b) of this Subtask.

Reach a thorough understanding of the assumptions used by ISER in its work.

Exchange information with ISER regarding data needed by the Acres team in its subsequent work.

Ensure adequate data output by the ISER through coordination efforts.

(b) Approach

ISER is under contract with the State of Alaska's Legislative Affairs Agency to develop projections of the possible future energy consumption trends for the Railbelt Region. As a part of this work, it is responsible for developing the methodologies used for the projection; for the collection of data used in its models; for producing projections detailing the energy consumption trends for six categories of consumers in three distinctly different areas of the Railbelt. The six categories of consumers for which individual growth projections will be made are:

- Residential
- Commercial
- Non self-supplied industrial
- Self-supplied industrial
- Potential industrial
- Users who cannot be supplied by the urban power grids.

The three geographical areas which will be studied individually are:

- The Anchorage-Cook Inlet area which forms the southwestern section of the Railbelt Region. This area will include the Kenai Peninsula.

- The Fairbanks-Tanana Valley area, lying to the north.

- The Glenallen-Valdez area which is the southeastern area under study.

These three study regions are relatively distinct areas of load concentration.

The approach taken by the ISER, as broadly described in its contract with the Alaska Legislative Affairs Agency, and as further defined in its "Detailed Work Plan" dated November 14, 1979, consists of four major areas of effort:

(1) A review of available econometric forcasting methods and models. The most apparently suitable model will be selected for further use in ISER work. A written report will be produced describing the advantages and disadvantages of the methods which were studied.

(2) A review of the available electrical energy consumption forecasting methods. The most apparently suitable method will be selected for further use in ISER work. A written report will document the advantages and disadvantages of the methods which were studied.

(3) Data needed for implementation of the forecasts of 1 and 2 above will be collected and analyzed to determine its limitations and potential uses. A written report will describe the data collection and the uses to which it will be put in future work.

(4) Incorporation of all appropriate data into the econometric and electric energy use forecasting models. These models will then be used to predict electrical energy consumption through the year 2005. Inputs to the models will be varied to produce values of energy consumption growth at the most likely level, the highest probable level, and the lowest probable level.

As a general rule, the scenario method implies a consistent description of a system's evolution by fixing, through exogenous assumptions, the evolution of the scenario components: those variables characteristic of the system. The components selected by the ISER as well as the assumptions upon which the decisions to select those components lie will be critically reviewed.

Finally, the electricity use projection methodology developed by ISER and the steps involved in its use, namely model design, regression equation, and forecasting, will be examined.

Model design involves the selection of the independent variables which affect model output and the formulation of the mathematical relations between those variables.

Estimation of the form taken by the regression equation involves the use of historical data. Limitations in the data may, in some cases, preclude the use of otherwise relevant variables. Availability of data will be studied.

A statistical analysis of the model's accuracy and validity will be undertaken.

The responsibility for incorporation of the WCC recommendations, as well as the validity of the model and the accuracy of its projections, will be that of ISER.

(c) Discussion

It is the responsibility of the Acres team to carefully evaluate the steps undertaken by the ISER in developing its energy consumption projections. Undoubtedly, to successfully accomplish subsequent Task 1 work, it is imperative that the Acres team have a thorough understanding of, and a high degree of confidence, in the work of ISER. This can come only by close cooperation between members of ACRES team and those involved in the ISER work.

ISER submitted a detailed work plan to the Alaska Power Authority (APA) dated November 14, 1979. This work plan will be reviewed and modifications will be suggested to ISER if it is deemed appropriate. The energy and econometric modeling methodologies and the development scenarios proposed by ISER will be reviewed for the validity of their assumptions.

(d) Schedule

Weeks 1 through 12

Subtask 1.02 - Forecasting Peak Load Demand

(a) Objective

Derive scenarios describing a reasonable range of load (kW) and load duration curve forecasts for the system through the year 2010. Prepare data in a form adequate for incorporation in the power system model to be developed in Subtask 1.04.

(b) Approach

Based on projections of energy (kWh) consumption as developed by ISER (see Subtask 1.01), annual power (kW) demands for each of the three defined Railbelt Regions will be forecast through year 2010. The forecasts will include both peak load levels and the shape of the load demand over time in the form of load duration curves. To ensure that the maximum accuracy of the system model is realized, load duration curves will be developed for both typical weekend and midweek days. These data will be produced separately for each of the three geographic areas of the study region and for each of the six consumer groups within each of those regions.

(c) Discussion

As noted in Subtask 1.01, ISER will prepare projections of future energy consumption in the Railbelt area. ISER will not predict peak power demands (kW) or load duration curves.

It shall be the responsibility of WCC, under the supervision of Acres, to produce these data in a manner which is consistent with the economic, social, political and technical assumptions made by the ISER when developing their energy consumption forecasts.

It is intended that the forecasts to be developed by WCC satisfy the dual purpose of filling out ISER data into a total picture of electrical demand for the study period and of providing detailed data to Subtask 1.04 for direct utilization in the generation planning model. This required data will include consideration of load shapes on a monthly basis as well as typical daily load shapes for week-day and weekend occurrences.

Load duration curves describe the percentage of time that a power system operates at any fraction of its full power level. Load duration curves can be developed on an annual, seasonal, monthly or even a daily basis. A load duration curve can be interpreted to yield the average power level for the time period described by the curve. The average-to-peak ratio is known as the load factor of the system.

Several methods can be used to produce peak load (kW) forecasts once energy (kWh) consumption predictions have been made. The basic procedure is to divide the energy consumption (kWh) of a given time period by the product of that period's length (in hours) and its load factor, to obtain power (kW).

For the above discussion, it is evident that a crucial point in producing credible load forecasts is the development of the load duration curves. The available methods and the degree to which they will be applied to the system under study, will be reviewed to determine their suitability to the problem at hand.

(d) Output

Since the subsequent Task 1 work is dependent upon the efforts of this Subtask, it is imperative that the data produced by this work is accurate, complete and in a readily usable form. Discussions of all methods used and assumptions made must be produced in report form to support the power and load duration data.

For use in the system modeling work of Subtask 1.04, the following data are required:

- Month-to-annual peak load ratios for full 12 month period.
- For typical weekend and midweek days, hourly-to-monthly load ratios, arranged in descending order, month to month.
- Per unit peak load ratios associated with the 0, 20, 40 and 100 percent points on the monthly load duration curve month by month.
- Peak power level, annual.
- The year-to-year variations of the quantities a - d, above.

To remain consistent with earlier work, data outputs will be broken down along the same geographical and consumer lines as the energy predictions of the ISER.

(e) Schedule

Weeks 8 through 26

Subtask 1.03 - Identification of Power Alternatives

(a) Objective

Identify and select for evaluation purposes alternative power sources appropriate for inclusion in future Alaska Railbelt Region load-growth scenarios.

(b) Approach

This subtask will be subdivided into two further work packages:

- Non-hydro alternatives
- Hydro and tidal alternatives

These packages will be undertaken concurrently, non-hydro alternatives being developed by Woodward-Clyde Consultants, Anchorage and hydro and tidal alternatives by Acres American and TES. Each package will include appropriate analyses to identify which (if any) energy sources would be viable alternatives to the Susitna Project. The evaluation will include an initial review of the March 1978 "Analysis of Future Requirements and Supply Alternatives for the Railbelt Region" published by Battelle Laboratories.

In deciding if a particular system or group of systems could be a viable alternative, five basic factors must be considered:

- Anticipated demand (location and amount) that the Susitna Project must supply,

- The maximum amount of power (or reduction in demand for power) that could be supplied to the Alaska Railbelt Region by each alternative,

- The cost per unit of electricity supplied by each alternative,

- Construction and licensing schedule of each alternative,

- The non-cost impact of implementing each alternative.

The intent will be to examine the widest possible range of alternatives while relying, as much as possible, on published data.

(c) Non-hydro Alternatives

The non-hydro alternatives to be examined include "traditional" energy sources such as coal or gas-fired steam turbines, combustion turbines (including combined cycle design), diesel electric systems and nuclear power plants (however, it is most unlikely that the nuclear alternative will receive serious consideration in Alaska). Studies undertaken to date for the Railbelt Region suggest that development of the Beluga and Nenana coal fields are likely to prove to be the largest viable alternative resources. Published data already developed by Woodward-Clyde Consultants on behalf of the Golden Valley Electric Association will be used in the proposed study. "Non-traditional" alternatives will include solar generation, wind biomass, geothermal, and energy from wood and municipal waste. The Alaska Power Administration is presently pursuing a study of the potential offered by wind generation in the Cook Inlet Region. The results of this study will be utilized in the evaluation of non-hydro alternatives.

Conservation measures of various kinds may be regarded as "non-structural" alternatives. To the extent that conservation can produce a reduction in total energy demand, it leads to changes in demand projections. The ISER model will be structured to permit consideration of the effects of conservation on demand projection. Another kind of conservation effort also is possible. Rather than yielding absolute reductions in annual energy demand, it can smooth out otherwise extreme load fluctuations occuring on any given day. This latter kind of conservation effort can permit more efficient use of existing generation resources, thereby deferring the need for future expansion.

Whereas the strategy of reducing total demand will influence demand forecasts, the "smoothing out" type of conservation must be considered in this subtask. This consideration will take into account not only voluntary measures, but also certain forced measures to include time of day pricing (an economic incentive to use energy consumptive appliances during off-peak hours), demand controls (such as devices to limit the maximum amount of electric energy provided to a particular distribution point) and more efficient use of existing system resources (such as providing interties between generating stations which would otherwise independently deal with different peak load requirements.

Consideration will also be given to the impact of possible changes in government policy with regard to uses of Alaskan natural gas, the possible "non-action" alternative, possible conservation legislation (HB364), and the construction of an Anchorage-Fairbanks transmission intertie alone, in lieu of the project.

(d) Hydro and Tidal Alternatives

The hydro alternative will not necessarily involve a single conventional hydro project and may consist of a group of smaller hydro projects with, for instance, a gas-turbine installation to provide firm capacity backup or some similar combination meeting the screening criteria--along with conservation measures which could serve to limit projected growth.

Within the Southcentral Railbelt of Alaska, the Susitna and Copper River drainage basins and other small rivers, including Crescent, Chakachatna, Beluga, Yentna, Skiventna Chulitna, Talkeetna, Bradley (Creek) and Love were identified in the 1976 Alaska Power Survey by the Federal Power Commission as having significant conventional hydropower potentials. This study identified 23 projects, including Devil Canyon, Watana and Vee on the Susitna, with a potential installed capacity for all 23 sites of 8,419 megawatts. There are currently indications that the 70 MW Bradley Lake Project in the Kenai Peninsula may be developed in the foreseeable future. Current studies are also being undertaken with the Alaska Power Administration to identify "small hydro" potential.

The above references, in addition to other earlier work by the Bureau of Reclamation and Corps of Engineers and the most recent national Hydropower Study inventory by the Corps of Engineers, will be used to develop an overall scope of available hydro potential in the region. The sources will also be used to develop a specific alternative which could satisfy projected load demands at least as well as the Susitna Project. Published reports on the potential for development of the tidal power resources of the Cook Inlet Region will be reviewed for consideration of this alternative.

(e) Discussion

The analysis of energy supply alternatives for the Railbelt Region requires input from Subtask 1.02 as well as the forecasting work performed by the ISER as described in Subtask 1.01. These efforts describe the anticipated need for the power and energy which will be consumed in the Railbelt Region, regardless of its ultimate source.

The load duration curves, the distribution of power demand over a given period of time, are also an important part of the alternatives study. Depending upon the general shape of the load duration curves, various alternatives may be recognized as being particularly attractive to meet the future needs of the Railbelt Region.

Concurrent with the demand estimation phase (Subtask 1.02), an evaluation will be made of the amount of energy that can be supplied by each of the technologies considered. This will involve a preliminary review of the estimated amount of each energy resource available in Alaska, including such items as coal and oil reserves, solar, wind and tidal patterns and geothermal as well as other hydroelectric resources. The estimates for developing technologies will also include the availability date for commercial use. Preliminary cost estimates will be developed for each technology (cost/unit energy) based on the many existing studies (for example see "California Electricity Generation Methods Assessment Project", 1976). These cost estimates may vary with the amount of energy delivered, reflecting the necessity to use scarcer resources.

The supply estimates for each alternative will be compared to the projected demand to determine what percentage of the demand each alternative can meet. It may be that some alternatives cannot supply any of the demand at reasonable cost. These can be immediately eliminated from consideration. Or, it may be that a technology is cost effective but cannot meet the total expected demand. In this case, several technologies will be combined to make a single alternative system to compare with the Susitna project.

The most viable technologies (or groups of technologies) will then be reduced to a set of well-defined power generation alternatives for more detailed analysis. The analysis will include a detailed cost analysis of each alternative (still based primarily on published studies). This cost analysis will include capital costs (including transmission system), operation, maintenance and fuel cost, capacity factor estimation and potential for concurrent operations such as waste heat distribution. The emphasis will be on consolidating and correlating information from various sources to allow a consistent comparison of alternatives.

A scheduling analysis will be conducted to determine when the technology(s) for the alternative will be available and what lead times are necessary for construction. Finally, a comprehensive evaluation will be made to identify the non-cost impacts of each alternative. These impacts are likely to include environmental impacts (air quality, water quality and ecology); public health and safety impacts; socioeconomic impacts (such as a "boom-bust" cycle of population during plant construction); and the licenseability of specific alternatives to the extent that no insurmountable legal or environmental barriers are evident.

Non-cost concerns will be organized into a set of attributes for measuring the overall desirability of each alternative and combined with cost and scheduling concerns to evaluate each alternative.

These attributes will be designed to cover the range of identified concerns while not overlapping with one another. Each attribute will have an associated scale (or measure) to identify the level of achievement of each alternative with respect to attribute.

Scales will be designed to be meaningful to decision makers and to be measurable using existing data as much as possible. If no natural scale (such as dollars for the cost attribute) exists, constructed (judgmental) scales will be used. The results of this analysis can be presented in a matrix showing the level achieved on each attribute for each alternative.

(f) Schedule

Weeks 20 through 35

Subtask 1.04 - Selection of Viable Expansion Sequences

(a) Objective

To determine the total system costs of selected future Railbelt Region expansion sequences, both with and without incorporation of the Susitna Hydroelectric Project, and rank the preferred generation expansion scenarios.

(b) Approach

The most straightforward method of evaluating the potential economic benefit of a hydroelectric project in a given system expansion scenario is to compare capital investment and system operating costs on an annual basis, throughout the term of the study, for two scenarios: one without the benefit of the proposed hydro project; the other with it.

A number of mathematical models are available to facilitate the vast number of calculations involved in this type of study. In simplified terms, the user of such a model provides the program with data which includes the characteristics of the forecasted loads and the characteristics, availability and costs of generation sources which will be available throughout the period of the study. The model then selects the generation sources available to it to satifisy the projected load in the most economical manner.

To evaluate the economics of a given project, a comparison may be made of total annual costs of the two system scenarios on a year-by-year basis throughout the study period. If the system with the hydro project available is less costly throughout the planning period, the project is obviously attractive (though not necessarily selected, because impacts must also be accounted for). Conversely, if this system is more expensive in all years, then the project is unattractive.

It is possible, indeed likely, that the outcome of an economic evaluation would prove not to be so clear cut. It may be that the system incorporating the hydro plant would be more expensive in some years of the study, and less expensive in others, than the system without that project. In this situation, it would be necessary to perform comparisons between present worth values of operating cost for systems represented by the two scenarios.

Although such a strategy may provide a valid economic comparison, the results may be inconclusive. This is most likely to occur in the case of a hydro project having a capacity which is relatively small when compared to its connected system. The economic comparisons may produce a relatively small difference in two large numbers.

(c) Selection of Model

In the search for a usable generation planning computer model, three characteristics of the model are paramount:

- Flexibility -- does the model allow for a varied combination of alternatives?

- Accessibility -- is the model presently available and can it be used with a minimum of learning time?

- Reliability -- is the model actively maintained by its supplier and has it been used by other utility planners?

A preliminary survey of the market has revealed one model which satisfies all three criteria. Other models may be available, but these are generally developed either by or for specific utilities to solve their particular problems or they are so intricate so as to require special training for their use.

The computer model selected by Acres for this study is the General Electric Optimized Generation Program, Version Five (OGP-V). Several of Acres' staff have become familiar with the use of this program on other studies similar to the Susitna alternatives evaluations. The model is currently being used by Acres for the evaluation of small hydro sites in the eastern U.S. Earlier versions of the model, OGP-III and OGP-IV were used in studies performed for the U.S. Army Corps of Engineers in evaluating alternatives for New England Power Supply scenarios through the year 2000. This study was part of the Environmental Impact Statement for the proposed 944 MW Dickey-Lincoln School Lakes Project in Maine.

(d) OGP-V

The OGP-V program combines three main factors of the generation expansion planning decision process: system reliability evaluation, operations cost estimation, and investment cost estimation. The program begins by evaluation of the power system reliability in the first study year by means of one of two methods -- either a percentage-of-reserves calculation or the computation of the loss of load probability (LOLP).

When the system demand level rises to the point at which either the user-specified reserve level or the LOLP criteria is violated, the program "installs" new generating capacity. The program will add generation capacity from a user-provided list of available sources. As each possible choice is evaluated, the program carries out a production cost calculation and an investment cost calculation, and eliminates those units or combinations of units whose addition to the system results in higher annual cost than other units or combinations. The program continues in this manner until the least-cost system addition combination is determined for that year. In cases where operating cost inflation is present, or where outage rates vary with time, OGP-V has a look-ahead feature which develops levelized fuel and O&M costs and mature outage rates out to ten years ahead of the "present" time. Once the apparent least-cost additions to the system necessary to satisfy reserve or LOLP criteria have been selected, the optimum system is described.

(e) Discussion

Load forecasting and daily load variation data generated in Subtask 1.02 will be used as input to the computer model together with the following technical and economic planning criteria:

- generation capacity and energy reserve requirements
- retirements of older units
- cost of money
- economic discount rate
- insurance and tax rates
- economic lifetime of equipment
- effects of cost escalation
- period of analysis

This data will be established in consultation with Alaska Power Authority, other utilities in the Railbelt Region and other pertinent agencies. The analysis will be carried out at the base rate with sensitivity testing over the possible range for selected alternatives.

One of the benchmarks against which the economics of a power generating facility may be measured is the economics of its alternatives. In many cases, it is possible to identify specific alternatives against which a given project may be directly compared. Most generating projects are intended for a specific operating regime within the power system, such as base-, intermediate-, or peak-load operation. For such sources, it is a relatively straightforward task to evaluate the cost of operating a specific alternative.

Hydroelectric projects, due to their hydrologic characteristics, must be evaluated in a somewhat different manner. A hydro project can be subject to significant seasonal variations in its generation capacity. Factors such as rainfall patterns and springtime snowpack runoff can work to make baseload and peaking benefits available from the same hydroelectric project. Also, although initial studies of the Devil Canyon-Watana installations were based upon fifty percent annual capacity factor (1,394 MW, 6,100,000 MWh/yr), some base-load (greater than 80 percent capacity factor) and some peak-load (less than 10 percent capacity factor) energy can be expected to be available. The way in which such additional capacities become available complicates the evaluation of a hydroelectric project.

Conventional base-load plants such as coal-fired or nuclear steam plants are commonly built to take advantage of the economies of scale available to large plants of this type. Conversely, peaking plants are usually relatively small (less than 100 MW). The base-load energy produced by even a large hydro plant may be available only at such a small capacity as to make comparison with the conventional alternatives meaningless. For example, if the Susitna project, with its 1,394 MW output at 50 percent can produce only 125 MW at capacity factors greater than 80 percent, it is difficult to make comparisons with base-load nuclear or coal plants with capacities on the order of 500 MW or larger. In the same sense, hydrologic conditions may make a great deal of capacity available at a given site for very short periods of time as peaking energy. Such large amounts of surplus energy may make meaningful comparisons between the hydro project and its conventional alternatives (combustion turbines) difficult.

Thus, the Susitna Project will be evaluated in the light of its effect upon the mix of alternatives in the power system and any possible deferment of capital expenditures for other facilities. To properly take into account the capacity variations of the projects, its operation within a power system will be analyzed on a monthly, or at least a seasonal, basis. More detailed analyses could be performed to define exact operating procedures, but such detail is not justified in a long-term planning study.

(f) Schedule

Weeks 26 through 40

Subtask 1.05 - Expansion Sequence Impact Assessments

(a) Objective

To compare, from an environmental standpoint, the consequences of developing the selected alternative expansion scenarios in the Alaska Railbelt Region, including historical, socioeconomic and other factors.

(b) Approach

The approach to review and assessment alternatives will be to primarily utilize existing data, and available aerial photography of the selected or potential source sites whenever and wherever sufficient information is already available. However, it may be necessary to gather limited site-specific data for the assessment, since the environmental resources of many of the more remote portions of the study corridor have not been inventoried. The key to this approach is the use of staff who have an in-depth knowledge of both fish and wildlife habitat requirements and a short-term and long-term effects of impact-producing actions of construction and operation of various facilities in Alaska.

The environmental consequences of developing alternative energy sources are highly dependent upon numerous factors including energy resource, collection method, site location characteristics, site fish and wildlife characteristics, land-use patterns, and facility construction and operation designs. A thorough assessment of the impacts of optimum generation expansion mixes is also dependent upon an understanding of the habitat requirements of local fish and wildlife during their life history; a knowledge of limiting habitat factors; and sensitivities such as fish overwintering areas, and nesting and feeding habitats of endangered or threatened fauna.

The significant impact-producing actions will vary with the alternative being assessed. At times, the selected site location will be the prime factor, while for other alternatives, the short-term or long-term air quality or water quality perturbations, or wildlife habitat degradation may be the overriding factor. Some of the more significant potential concerns are discussed below.

The environmental evaluation of the selected hydroelectric and tidal power development alternatives (if any) will identify the associated potential impact issues, and their relative magnitudes. Such issues will involve the relative sizes of reservoirs and impacts on water quality and fish and wildlife habitats in particular. The environmental analysis will be performed on the basis of available data, which will be compiled for this purpose. Transmission facilities associated with the hydro alternative sites will be included in this environmental analysis.

The intensity of analysis required for comparison of the hydroelectric alternatives will be less than that required for the primary alternative (unless, of course, preliminary analysis demonstrates an apparent preference for a particular alternative set). Field investigations will not be undertaken to confirm the potential magnitude of impacts of the alternatives.

With coal-fired power plants, such as those associated with the Beluga and Nenana field, the collection of large quantities of coal through surface mining would create environmental concerns. These concerns are related primarily to large-scale, long-term habitat alterations affecting fish and wildlife. The operation of coal-fired plants would also create problems relating to air quality, cooling water discharges, and run-off from fly ash ponds. However, plants can be designed to successfully mitigate (though not eliminate) these concerns.

New gas or oil-fired power plants require construction of pipelines that at least lead to short-term concerns associated with river crossings, wetlands disturbance, and habitat alterations. On-site facilities can cover large acreages, and operation can create air quality problems related to nitrogen emissions and winter steam plumes.

Wood-produced energy would also cause air quality problems such as those currently found in the Fairbanks area. Such plants would furthermore require clear-cutting of vast acreages of timber. This may not be environmentally wise due to the slow regeneration times required for timber production and hence would lead to long-term wildlife habitat alterations. Potentially severe impacts to stream habitats and local fish populations would also result.

(c) Land and Water Use

Land ownership in the vicinity of the alternatives will be identified as federal (including agency jurisdiction), state, borough, private and Native Corporation. Land ownership status may be in transition due to the Alaska-Native Claims Settlement Act and State Selection under the Statehood Act. Land management plans and regulations affecting alternatives will be evaluated. The various federal, state and local agencies, and some Native Corporations will have land classification and management systems governing activities that are allowed on those lands and waters being managed. Stipulations concerning allowable activities could affect the feasibility of alternatives to Susitna. Land and water use patterns (historical, current and proposed) will be documented in order to evaluate impacts and potential use conflicts posed by Susitna alternatives.

Unique features in the vicinity of alternative projects, such as recreation areas and aesthetic/visual resources, also will be identified. The presence of popular recreation areas and unusual aesthetic quality may present impact and feasibility problems, particularly when on public lands.

(d) Socioeconomic Characteristics

Demographic data, historic, current and projected, will be evaluated to estimate the impact created by the influx of construction and operations work forces. Employment characteristics of the work force in the vicinity of alternative projects will also help to evaluate positive and negative impacts created by project implementation. This information would include employment and unemployment by region and skill classification, and wage rates (also regional and skill specific).

Financial characteristics of any borough or municipal governments in alternative project areas will be considered. Tax revenue, mill rates, and tax base data will help estimate potential impacts. Housing characteristics, such as available stock (including rental units) and vacancy rates, will be utilized for impact evaluation. Community infrastructure could be impacted by implementing alternatives to the Susitna project. Current loads on infrastructural systems (i.e., electricity, water, sewage) service areas, and system capacity will therefore be considered.

Transportation systems potentially affected by project alternatives will be identified. Data will include current traffic estimates, capacity, area of service, and intermodal connections.

Sociocultural characteristics could be an issue in several project areas. Life style, ethnic traditions and subsistence use patterns of biological resources will be documented.

(e) Archeological and Historical Resources

Existing archaeological and historical sites will be inventoried in alternative project areas, as available data allow. The State Historical Preservation Office maintains a statewide file of known sites and will be utilized in this effort.

(f) Schedule

Weeks 30 through 45

Subtask 1.06 - Power Alternatives Study Report

(a) Objective

Prepare power alternatives study report for Susitna Hydroelectric Project.

(b) Approach

The power alternatives study report will address:

- Load forecasting for the Railbelt Region
- Selection of alternative energy and/or power generation scenarios
- Evaluation of viable expansion sequence scenarios
- Recommended expansion sequence

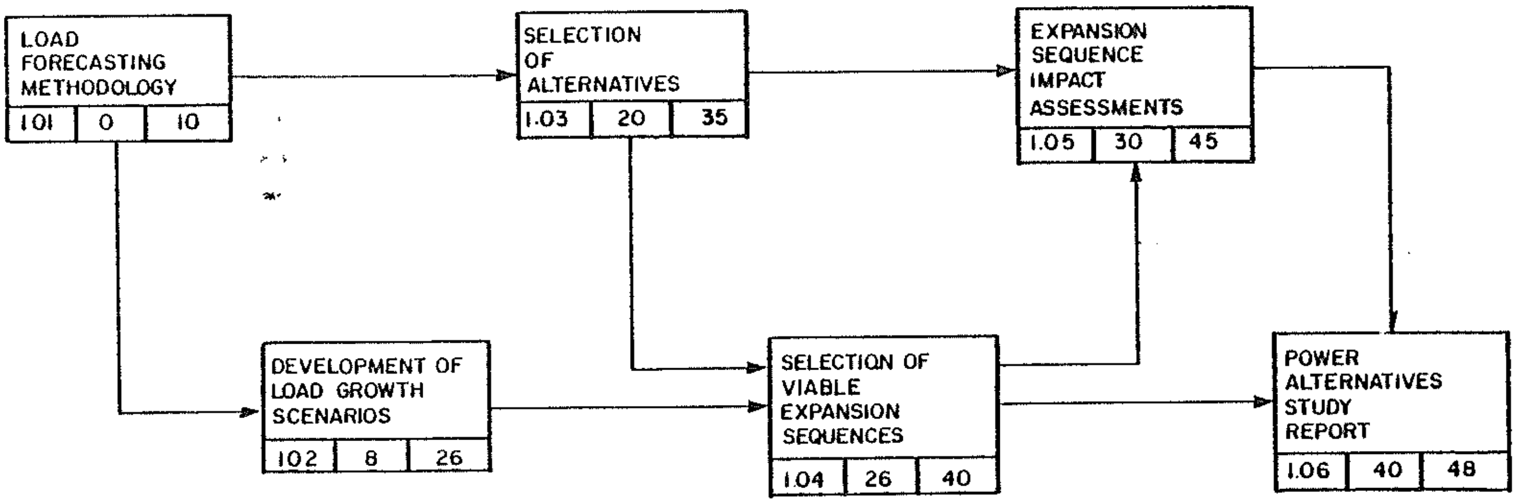
The report will document the findings of Subtasks 1.01 through 1.05 and incorporate the transmittal prepared under Subtask 1.02.

(c) Discussion

This report will seek to address the fundamental issues of the "need for power" and selection of the optimum future Railbelt Region electrical power supply scenario through the year 2010. If the Susitna Project is to be justified as a viable and licensable development, this report has to provide the fundamental basis for such justification. Alternatively, if the Susitna Project should not proceed, this report must provide the rationale for a decision to cease further investigations. The report will initially be prepared in draft form for submission to Alaska Power Authority for review, and subsequently made available to all concerned parties for comment and discussion under the Task 12 Public Participation Program.

(d) Schedule

Weeks 40 through 48



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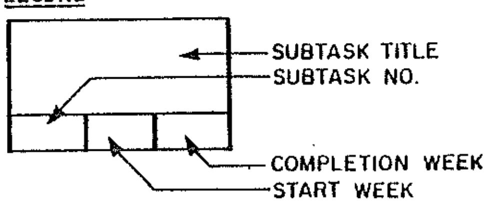


SUSITNA HYDROELECTRIC PROJECT

PLAN OF STUDY

PLATE T1.1: TASK 1 LOGIC

A.5.3 - TASK 2: SURVEYS AND SITE FACILITIES

(i) Task Objectives

To provide for safe, cost effective, and environmentally acceptable logistical support of all project field activities; to conduct those surveys necessary to furnish data for use in other subtasks which must be performed prior to licensing; to resolve real estate issues associated with the proposed project in sufficient detail to permit preparation of Exhibit F of the FERC license application; and to undertake initial studies of proposed reservoir areas and access roads.

(ii) Task Output

The primary outputs of this task will be major portions of certain exhibits required for FERC license application and data which will be necessary inputs for many of the remaining exhibits. Specifically, this task will contribute to Exhibit D (demonstrating evidence of compliance with State water and land use laws), Exhibit E (providing water rights data and plans for perfecting rights to use water for project operation), Exhibit F (statement of land ownership). In addition, surveys and mapping will be essential portions of Exhibit J (general project map) and Exhibit K (detailed project map showing boundaries, survey data, land ownership, and feature locations). In addition to the data collection and exhibit preparation, a number of tangible products will be acquired or constructed and will generally be suitable for use during the post- application phase and beyond. In this latter category are included camp facilities, airfield, and similar semi-permanent items.

(iii) List of Subtasks

Subtask 2.01 - Provision for Land Use Payments and Directed Inspection Services

Subtask 2.02 - Provision of Field Camps and Associated Logistic Support

Subtask 2.03 - Resupply and Emergency Service

Subtask 2.04 - Land Status Research

Subtask 2.05 - Land Acquisition Analysis

Subtask 2.06 - Right-of-Entry

Subtask 2.07 - Site Specific Surveys

Subtask 2.08 - Aerial Photography and Photogrammetric Mapping

Subtask 2.09 - Control Network Surveys

Subtask 2.10 - Access Roads

Subtask 2.11 - Map and Photo Search

Subtask 2.12 - Field Reconnaissance of Reservoir Areas

Subtask 2.13 - Marketability and Disposal Study for Reservoir Area

Subtask 2.14 - Cost Estimates for Reservoir Clearing

Subtask 2.15 - Slope Stability and Erosion Studies

Subtask 2.16 - Hydrographic Surveys

(iv) <u>Subtask Scope of Statements</u>

Section A.8 of this plan of study provides a logistical plan describing measures, procedures, considerations, and responsibilities incident to the conduct of effective logistic operations. Subtasks 2.01 through 2.03 are generally concerned with implementation of field operations under that plan in a safe, economical, and environmentally acceptable manner. Task 13, Administration, provides for an in-state project office as the essential link between field operations and concurrent efforts to be undertaken in Alaska and elsewhere. This project office will not only facilitate essential procurement, communication, and coordination of logistical support, but also it will ensure that data generated in the field is properly and expeditiously routed to various points where it will be processed, interpreted, and evaluated.

Subtasks 2.04 through 2.06 deal with real estate aspects. It is by no means clear at the time of preparation of this plan of study just which of several land interest will predominate at any given stage in the study process. Thus, it is all the more essential that careful attention to real estate details be paid early and continuously.

Land survey activities are generally provided for in Subtask 2.07 through 2.09 and hydrographic survey in Subtask 2.16. Only such mapping and control as is necessary for license application will be accomplished in the initial 30 months after notice to proceed is given. It follows, then, that some survey activity may be expected to occur in succeeding months prior to granting of the license.

Subtasks 2.10 through 2.15 deal in general with lands whose current conditions will be permanently changed in the event that the proposed project is ultimately constructed. Technical implications of actual conditions discerned along alternative access roads and within potential reservoir areas are assessed in this group of subtasks. Surveys and route selection studies associated with transmission lines are separately provided for under Task 8.

It is clear that a certain risk is associated with incurring the relatively large expenditures in accomplishing this task.

It is entirely possible that concurrent efforts dealing, for example, with possible alternatives under Task 1 or environmental impacts under Task 7 may lead to a decision at the end of the twelfth month to abandon the Susitna Hydroelectric Project in favor of some other choice or combination of choices for satisfaction (or, indeed, if appropriate, consciously forcing growth limits through nonsatisfaction) of forecasted load requirements. We will minimize the risk insofar as practicable by delaying those field subtasks which can reasonably be delayed as long as possible without jeopardizing plans for filing the FERC license application by mid-1982.

Subtask 2.01 - Provision for Non-Discretionary Payments

(a) Objective

Make explicit provision for certain budget items not subject to discretion of the engineer.

(b) Approach

Several budget items are included in this plan of study to account for APA's directions in that regard. Specifically, the costs for land use payments to affected Native Corporations in the amount of $36,000 per year, full time inspection services to protect native interests in the amount of $3,000 per month, and funds for study coordination and review by APA in the amount of $100,000 per year.

(c) Discussion

The APA Request for Proposal, dated June 25, 1979, directed that the above items be included. The requirement to fund a full time Susitna Coordinator in the Alaska Department of Fish and Game and to set aside $1 million for an independent review including seismic risk analysis and other confirmatory studies is accounted for elsewhere in this plan of study.

(d) Schedule

Throughout entire period.

Subtask 2.02 - Provision of Field Camps and Associated Logistic Support

(a) Objectives

Provide acceptable living accommodations for assigned field personnel and necessary visitors and provide a base for field operations in the most economic and efficient manner.

(b) Approach

There will be a permanent base camp at Watana. To the extent that accommodations are required at Devil Canyon, an existing lodge will be used or austere tent facilities will be temporarily operated. All the design work and the procurement of modular units and attendant life support system (power plants, water plant, sewage treatment plant and communications system) will be done immediately after contract award. The Watana camp will be sized to accommodate a maximum of 42 people and its layout will be based on previous camps designed for Alaskan conditions. This "off the shelf" approach will help reduce costs. The modular units and equipment will then be transported overland from Denali Highway. The Watana camp will be erected in late February, 1980, and operations will begin by March, 1980. This camp will be the main base of field operations as well as the point of in-depth study of the Watana site and the surrounding area.

The Watana camp will be operated and maintained on a continual basis from March, 1980 through June, 1982. The Devil Canyon facilities will be occupied as required by the field support schedule (June through September, 1980 and 1981).

The Watana camp will be constructed from modular units and will have complete water and sewer treatment systems. It will have warehouse, shop, recreational, office, food service, laundry, and fuel storage facilities. It will also have sheltered electrical generators and an incinerator. The dormitory, food service, and recreation buildings will be interconnected with Arctic walkways.

A variety of cost comparison alternatives will be evaluated prior to start of field operations. Should any of these alternatives be found to be cost effective, they will be included in the field plan. The alternatives to be evaluated include:

(1) Utilization of Arctic type sewage treatment plant, with chlorinated effluent, in lieu of a sewer treatment plant with a lagoon system for waste water effluent. This approach will depend upon obtaining the necessary permit for the Arctic type plant.

(2) Utilizing a lake as the water supply in place of drilling a water well.

(3) The elimination of some or all the Arctic walkways and reconfiguring the camp to minimize exposure to the most severe ambient conditions.

(4) Burying solid waste instead of incineration if the proper permit can be obtained.

A potential way to reduce program cost is through a consolidated logistics effort. Consolidated logistics management would ensure the minimal utilization of supply aircraft and vehicles, consistent with the field schedule and quantity of materials to be transported. We will continuously monitor and adjust the overall logistics operation to minimize costs and environmental disruption. The principal Acres representative (Chief Engineer for Alaskan Operations--CEAO) will have responsibility and authority for such efforts and may, if economics can be effected thereby, designate a single logistics manager from within the Acres team.

(c) Discussion

It will be noted that meeting the planned FERC application target at 30 months after notice to proceed requires the earliest possible commencement of field operations. Certain key assumptions implicit in our plan for establishment of a permanent camp near the Watana damsite prior to break-up include the following:

(1) Funds will be made available immediately after contract award to permit expedited procurement of "long lead" items.

(2) The important requirement for archeological reconnaissance and associated clearances prior to disturbing natural conditions generally cannot be satisified until snow cover is gone from the proposed camp area. We assume that the first stage camp construction and initial operation will be conducted in areas previously checked out for earlier Corps of Engineers activities. Only so much of the semi-permanent camp near Watana as can be erected on archeologically cleared land will be installed initially. Remaining modules and supplies to be brought in while the ground is frozen will be stored until after break-up. Archeological reconnaissance to permit expansion will be undertaken as a matter of priority as soon as conditions are favorable for that work.

(3) Ownership for project lands will be transferred to Cook Inlet Region Incorporated prior to commencement of field activities.

(4) The cooperation of various permitting agencies and organizations in expediting necessary early permits will be secured.

The camp accommmodation requirements in a remote Alaskan environment cannot be underestimated. The size of camp proposed has been determined as the minimum size necessary to undertake the required field work (surveys, geotechnical exploration, hydrologic and seismic monitoring, and environmental studies) in the proposed time frame.

The capital cost of erecting a semi-permanent camp capable of accommodating peak loads of 40 people or so and average loads of 20 to 30 is significant. Whereas the initial contract will cover a period of only 30 months, it may be anticipated that field activities will be required on a continuous basis for some years after license application is made. Thus, the camp is expected to remain in place to support post-application studies and investigations.

(d) Schedule

Throughout project period.

Subtask 2.03 - Resupply and Emergency Service

(a) Objective

Provide responsive and reliable resupply and emergency service capability with minimum environmental degradation.

(b) Approach

As soon as possible after the camp has been put in place, a helicopter pad will be constructed nearby. During the initial year of camp operation, helicopters will be employed to transport personnel, perishables, certain consumables, equipment, and miscellaneous items to and from the camp site. Helicopter support will be furnished both from Anchorage and from Talkeetna, with the bulk of the effort from the Talkeetna terminus. An average of one large helicopter flight daily (such as by Bell 205A-1) will be required for this purpose. By the end of the first year of work, an evaluation of the need for construction of an airfield at the camp site will be made and an assessment of the environmental consequences of its construction will be accomplished. In the event that a decision is then made not to construct an airstrip, camp resupply and emergency service will continue to be accomplished by helicopters.

Development of a properly sized and designed airstrip could serve to expedite subsequent operations at the project site. Site selection can best be obtained through a repetitive process of evaluation, beginning with several alternatives and eliminating those that do not meet the necessary requirements.

The scope of work during the initial airstrip design activity (if an airfield is later found to be needed) would be Airphoto study, aided by evaluation of existing boring logs and topographic maps. If an airstrip is found to be justified, a field check of this initial study will be made prior to making the final selection of the airstrip site. The design phase is envisioned as being completed in three stages. The initial stage will consist of providing tentative drawings for the airstrip and related facilities, such as access roads to material sources needed in its construction. The subsequent phase will provide drawings suitable for construction purposes as well as a cost estimate for the construction of the facility.

Time dependent requirements such as permits, wind direction information, archeological studies, and the stockpiling of initial construction supplies will be started as soon as possible.

The airstrip will continue to function after FERC license application has been made. Indeed, assuming that the project is shown to be viable, the airstrip will continue to serve throughout the period during which the proposed dam is constructed (and beyond that, perhaps during operation of the project some years hence). It follows that design, arrangement, and construction will be accomplished in such a way that later expansion or permanent surfacing will be possible.

(c) Discussion

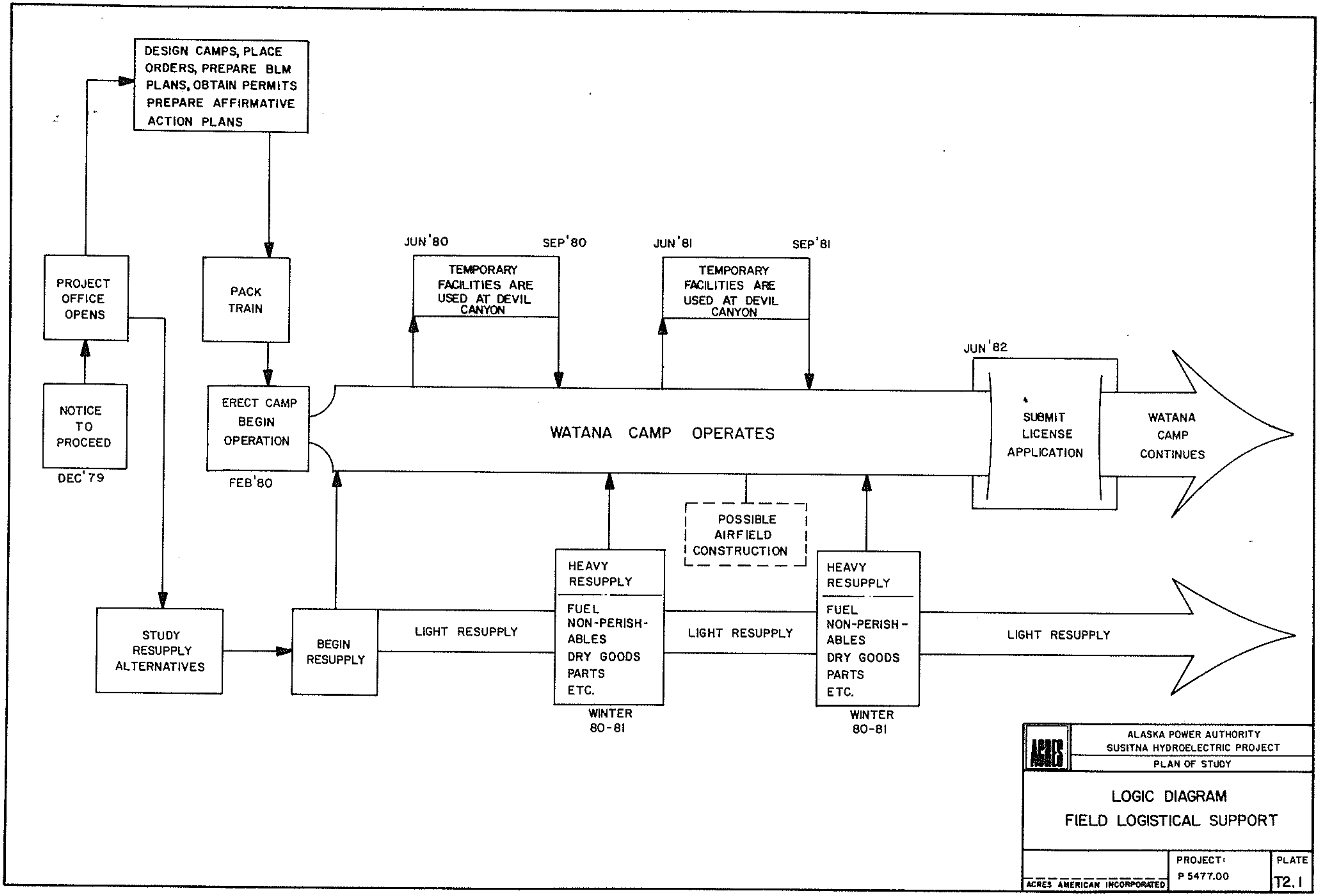
The first version of the POS (September 11, 1979) envisioned construction of an airfield during the first year of the project. A careful re-evaluation of this approach became necessary, however, when it was determined that overland transportation during the summer months--even by Rolligon--may be counter indicated because of the fragility of the vegetation over which all-terrain vehicles would pass. The inability to remove heavy construction equipment until the following winter (when Rolligons or cat trains could negotiate the terrain) resulted in extremely high costs associated with rental of idle equipment. In addition, the fact that a Go-No-Go decision is scheduled for the end of the first year suggests that capital investments should be minimized to the extent possible until it becomes clear that a project is in fact warranted. Thus was it determined that the alternative of helicopter support is preferable during 1980.

If after the first year it is clear that hydroelectric development of the Susitna River is in the best interests of the State of Alaska, the question of airfield construction must once again be evaluated. While feasibility study effort can proceed using helicopter support continuously and using overland heavy resupply in the winter, it is nonetheless true that an airfield will eventually be required for support of activities during later construction stages. Once the high initial cost of an airfield is incurred, subsequent resupply by fixed wing aircraft becomes less costly than exclusive helicopter usage. Through the public participation program (Task 12), the views of the public at large and of all interested agencies will be solicited prior to reaching a decision on airfield construction.

The level of effort provided in cost tabulations in Section A3 will be assigned to helicopter costs until an affirmative decision is made to build an airfield. Remaining portions of budgeted costs for this subtask will then be assigned to airfield construction work. In the event that no airfield is built during the first 30 months of effort, costs for air transportation in Task 2 are sufficient to cover resupply and emergency service.

(d) Schedule

Weeks 9 through 130 (See also Plate T2.1)


DESIGN CAMPS, PLACE ORDERS, PREPARE BLM PLANS, OBTAIN PERMITS PREPARE AFFIRMATIVE ACTION PLANS
PROJECT OFFICE OPENS
NOTICE TO PROCEED
DEC'79
PACK TRAIN
ERECT CAMP BEGIN OPERATION
FEB'80
JUN'80
SEP'80
TEMPORARY FACILITIES ARE USED AT DEVIL CANYON
JUN'81
SEP'81
TEMPORARY FACILITIES ARE USED AT DEVIL CANYON
JUN'82
WATANA CAMP OPERATES
SUBMIT LICENSE APPLICATION
WATANA CAMP CONTINUES
POSSIBLE AIRFIELD CONSTRUCTION
STUDY RESUPPLY ALTERNATIVES
BEGIN RESUPPLY
LIGHT RESUPPLY
HEAVY RESUPPLY
FUEL NON-PERISH-ABLES DRY GOODS PARTS ETC.
WINTER 80-81
LIGHT RESUPPLY
HEAVY RESUPPLY
FUEL NON-PERISH-ABLES DRY GOODS PARTS ETC.
WINTER 80-81
LIGHT RESUPPLY
ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT
PLAN OF STUDY
LOGIC DIAGRAM
FIELD LOGISTICAL SUPPORT
ACRES AMERICAN INCORPORATED
PROJECT: P 5477.00
PLATE T2.1

Subtask 2.04 - Land Status Research

(a) Objectives

Identify ownership and other interests in and adjoining the project area and associated transmission corridors and provide information needed for power project planning, land acquisition analysis, and for obtaining rights-of-entry to conduct field studies.

(b) Approach

Ownership information will be gathered from the tax assessor and land recorder, BLM, the State Division of Lands, and Native Corporations. Lands will be categorized by general ownership category (private land, State land, U. S. land, and Native land) and status maps at an appropriate scale will be prepared. Other factors affecting land status, such as third party rights, State or Federal agency designations, or limited interest rights will be indicated.

(c) Discussion

Cook Inlet Region, Inc. has already collected a substantial portion of the information required. The cost of completing this task will be reduced substantially because this information and the corporation's land status research capability will be utilized.

(d) Schedule

Weeks 0 through 15

Subtask 2.05 - Land Acquisition Analysis

(a) Objectives

Identify lands which must be acquired or for which right-of-way permits or easements must be obtained and estimate land acquisition costs and right-of-way permitting requirements.

(b) Approach

Once plans for the siting of all elements of the power project have been developed, a detailed inventory of private and public lands on which facilities are to be built will be prepared. Each private land owner will be identified and the amount and market value of land to be acquired by either easement or purchase will be estimated. The amount of public land required will be broken down by agency land holder and an estimate of the cost of right-of-way permits will be made. Evidence of title will be secured as needed. All third party rights will be identified and evaluated in terms of impact on acquisition costs.

(c) Discussion

Cook Inlet Region, Inc. has already collected a substantial portion of the information required. The cost of completing this task will therefore be minimized.

(d) Schedule

Weeks 61 through 73

Subtask 2.06 - Right-of-Entry

(a) Objectives

Provide the information needed to obtain right-of-entry to private lands as required for reconnaissance, surveying, and other field investigations; acquire necessary rights-of-entry.

(b) Approach

On the basis of the overall field plan, the private lands to be entered will be determined and the appropriate land owners will be identified.

Permits required for entry and use of public lands will normally be obtained by CIRI/H&N in response to requirements of individual investigating teams.

(c) Discussion

Obtaining rights-of-entry will more efficiently be accomplished when done by one project associate rather than by each individual team member. This will also assure that the needed rights-of-entry have been obtained and that no trespass occurs. And beyond that, of course, it provides a positive means to ensure that redundant applications are not filed--an important consideration to permittor and permittee alike.

A number of activities regarding permits have taken place during the first month of the study. Table A5.1 provides status of this work as of January 21, 1980.

(d) Schedule

Throughout project period with most emphasis during initial six months.

TABLE A5.1

SUSITNA PERMIT/PLANT REVIEW SUMMARY

ANTICIPATED AND REQUIRED DOCUMENTATION, REVIEW, AND APPROVAL

JANUARY 21, 1980

	Permit/Plan Review	Anticipated Completion of Documentation	Required ACRES AMERICAN Submittal/Approval		Required APA Submittal/Approval		Required Lead Agency Submittal/Approval		Other Remarks
(1)	DEC Solid Waste	12/17/79	12/18/79	12/22/79	12/27/79	12/27/79	12/31/79	2/18/80	If no public hearing is required, we anticipat approval by mid-March for permits (1) through (5), or approximately 2 weeks behind.
(2)	DEC Water Supply Development & Treatment	12/17/79	12/18/79	12/22/79	12/27/79	12/27/79	12/31/79	2/18/80	
(3)	DEC Wastewater	12/17/79	12/18/79	12/22/79	12/27/79	12/27/79	12/31/79	3/03/80	
(4)	DNR Water Rights	12/17/79	12/18/79	12/22/79	12/27/79	12/27/79	12/31/79	2/18/80	Initial permit documentation incorporated into DEC permit package.
(5)	DFG Anadromous Fish	12/17/79	12/18/79	12/22/79	12/27/79	12/27/79	12/31/79	3/03/80	Previously determined not required. Later discussions with DFG indicated DEC package wou be suitable for application.
(6)	BLM Overland	1/09/80	1/10/80	1/10/80	1/10/80	1/10/80	1/11/80	1/31/80	Formal addendum submitted on January 16, 1980. Expect approval as scheduled.
(7)	COE Wetlands	2/10/80	2/11/80	2/18/80	2/19/80	2/22/80	2/25/80	4/30/80	Required for Watana Camp runway (cut and fill operations) construction May, 1981.
(8)	EPA Spill Prevention	2/14/80	2/15/80	2/18/80	2/18/80	2/20/80	2/21/80	3/24/80	Not required until after six months of Watana Camp operation.
(9)	State or Federal Field Permits	TO BE DETERMINED AS SCOPE OF FIELD INVESTIGATIONS IS REFINED. Field permits will be submitted on an annual basis.							

Subtask 2.07 - Site Specific Surveys

(a) Objective

Provide "on the ground" surveys of specific areas which require a higher level of accuracy than can otherwise be obtained through photogrammetric mapping.

(b) Approach

Two field surveyed cross sections will be obtained at each dam site consisting, essentially, of an accurate profile perpendicular to the river on a predefined axis.

The site survey of the airstrip, if found necessary after the first year, will be conducted using conventional survey techniques to establish topography of such accuracy as to allow construction plans to be prepared. This activity includes the construction lay-out surveys for building of the airstrip and it is covered under Subtask 2.03.

The site survey will be required of the temporary camp to facilitate design of the camp, sewage disposal system and water supply. This activity is covered under Subtask 2.02.

A site survey at each dam site will be conducted "on the ground" at a location contemplated for switchyards-transformer pads to facilitate the design of those facilities but will not require construction staking during this study phase.

(c) Discussion

These site specific survey efforts will augment photogrammetric mapping. They must be conducted reasonably early in the study process since the results will be required for subsequent design studies and field construction of certain temporary facilities. Crews involved in the work will be furnished lodging and air transportation, the costs for which are separately included under Subtask 2.02. The long experience of R&M Consultants, Inc., in similar work throughout the State has resulted in R&M's acquisition of equipment tailored for use in remote, harsh environments as well as in the develop of field procedures well suited to the instant requirement.

(d) Schedule

Weeks 9 through 12, and 22 through 26

Subtask 2.08 - Aerial Photography and Photogrammetric Mapping

(a) Objective

Provide contour mapping of both Devil Canyon and Watana Dam and Reservoir sites, photography and contour mapping of access corridors, photography of transmission corridor, photography to be used by geologists in terrain unit mapping, photography to be used in the environmental studies of the project area and photography of the Susitna River downstream to Talkeetna for use by hydrologists.

(b) Approach

Partial mapping of the Watana Dam Site has previously been accomplished through efforts of the Army Corps of Engineers. Photography exists on the Devil Canyon Dam Site but no contour mapping has been accomplished.

The Corps of Engineers' effort, as stated above, will be evaluated and augmented, as required, by additional mapping of the dam sites at a scale of 1" = 200' with a contour interval of 2 feet.

The reservoir sites, camp and airport sites, switchyard sites, access corridors, transmission corridor and lower Susitna River downstream to Talkeetna will be paneled (targeted), survey tied to horizontal and vertical control and aerial photographed. Contour mapping by photogrammetrical methods will be performed at a mapping scale of:

Watana and Devil Canyon Reservoir Sites---1" = 400' with 10' contours
Watana and Devil Canyon Dam Sites---------1" = 200' with 2' contours
Alternative Access Routes-----------------1" = 400' with 10' contours
Field Camp and Airstrip-------------------1" = 400' with 10' contours

Certain activities essential to eventual detailed design will be deferred until after license application has been filed. These include contour mapping by photogrammetrical methods at mapping scales of:

Switchyards-------------------------------1" = 200' with 5' contours
Selected Access Route---------------------1" = 200' with 5' contours
Selected Transmission Route---------------1" = 200' with 5' contours

The lower Susitna River and transmission corridor will be photographed and ortho photos prepared prior to license application but no contour mapping is anticipated until later in the program.

All aerial photography that is to be used for contour mapping of 1" = 200' must be taken during the spring or fall of the year when snow is not present on the ground and when deciduous vegetation is without leaves. Fortunately, the pre-application requirements in this area are relatively modest.

Existing contour mapping previously performed by the Corps of Engineers must be correlated to accurate vertical datum as current datum used was determined from V.A.B.M. (Vertical Angle Bench Mark) and is only accurate to plus or minus 15 feet.

(c) Discussion

The aerial photography and mapping program described herein is considered the minimum necessary to satisfactorily prepare necessary exhibits for FERC license application. Even so, the costs of such efforts are not insignificant. Thus, any additional measures which may serve to further reduce costs are important. In this regard, we will make a detailed and comprehensive assessment of all photography flown to date by the Corps of Engineers and others to ensure that duplication of previous efforts does not occur.

We are aware that some unprocessed aerial photographic data has been collected in the past two years by the Corps. Its usefulness for partial satisfaction of the subtask objective has yet to be evaluated.

The output of this subtask will produce much of the base map and other data required for FERC Exhibits J and K, general and detailed project maps respectively. The requirement for 10' contours is explicit under FERC regulations for Exhibit K. Should new regulations relax that rule, effort will be adjusted accordingly.

(d) Schedule

Weeks 3 through 39

Subtask 2.09 - Control Network Surveys

(a) Objective

Provide a more frequent interval of horizontal and vertical survey control than currently exists in the project area.

(b) Approach

Both U.S.C. & G.S. and recently conducted private control network schemes will be expanded for use on site specific surveys, photo control surveys and cadastral surveys of otherwise protracted township and section surveys. The control network will also be used to expand State Plane and Universal Transverse Mercator grid values to all project surveys.

The frequency of high order survey monuments of known precise horizontal values are all but non-existent in the project area.

Utilizing "one second" theodolites, medium to long range electronic distance measuring devices and helicopter supported ground crews, a chain of high accuracy control monuments will be established on each side of the river basin from the upper reaches of Watana Reservoir site to the lower end of Devil Canyon. This network will serve as the "spine" of all subsequent survey activity and mapping effort.

A precise level circuit will be run extending from the existing U.S.C. & G.S. circuit up to the Parks Highway-railroad, up river through both the Devils Canyon Dam site and the Watana Dam site and tying to the existing U.S.C. & G.S. circuit along the Denali Highway.

This level circuit will be the first precise level circuit ever run in the area and will be the basis for all vertical elevations used on the project.

Helicopter support for this subtask is included within Subtask 3.03.

(c) Discussion

The effort required in establishing control network surveys is significant. In less remote regions in the lower 48 states, such activity will normally have been conducted by others well in advance of hydroelectric project planning. Thus, it is unusual that a feasibility study must bear the cost of such an undertaking. Even so, the work is imperative, for the uncertainty associated with current locations and elevations as found on existing topographic maps is simply too great to support precise planning incident to determination of project viability. Whether or not a project is ever constructed on the Susitna River, though, the establishment of a control network will provide significant residual value for the State of Alaska.

(d) Schedule

Weeks 5 through 30

Subtask 2.10 - Access Roads

(a) Objectives

Define alternative access routes; evaluate technical, economic, and environmental factors for each, and recommend best alternative.

(b) Approach

Access roads will be required during construction to dam sites, quarries and borrow pits. Effort will be made to minimize grades, number and size of borrow pits, unwanted access, and limit environmental constraints at the smallest cost and time to the project.

Geological studies and surveys are discussed under other task headings.

For this portion of the work it is anticipated that three separate routes will be considered in detail. Two of these routes will originate from the Park's Highway and extend to the east to the dam site. One route will follow the north bank of the Susitna River to the dam site. The other route will follow the south bank of the Susitna River. The third route to be considered will come from the northeast from the Denali Highway. It is further anticipated that one of these routes will be selected to be considered as a possible railroad access route. In addition, a sub-alternative to be considered in the Parks Highway routings will be one which envisions the establishment of a railhead (near Gold Creek, for example) as the western terminus of the access road.

The preliminary study portion of this phase of the work will entail reviewing photos and existing maps of the possible access routes as well as the complete review of all work already completed by the U.S. Army Corps of Engineers. Once this work is completed, it is anticipated that all three corridors selected for possible access routes will have low level aerial photography flown. Once this photography is available, detailed analyses of the photos coupled with existing data will result in initial route selection. During this process those problem areas identified by the low level aerial photography will be investigated in the field to determine solutions. Following this work cross comparisons of preliminary design will be accomplished so as to finalize selection of the best access to the project. Environmental data collection and impacts analysis of alternative routes--and, in more detail, of the selected route--will be accomplished as a part of Task 8 - Environmental Studies. Sufficient detail will be developed to permit preparation of a preliminary cost estimate. Selection of a best route will consider all aspects and will draw heavily as well on inputs from the public participation program outlined in Task 12.

Subsequent to license application, full control will be established along the access route that has been selected and once again low level aerial photos will be flown and mapping will be accomplished to a five foot interval at a scale of 1 inch = 200 feet. Once this information has been obtained, the detailed design of an alignment within the route corridor will be accomplished. In conjunction with this detailed alignment study, possible material sites will also be investigated. Once the final alignment has been established, the drilling program to establish geotechnical and geological criteria will be initiated. Upon the completion of that phase, further investigations will be necessary to remedy any problems discovered by the geotechnical information. After this phase is completed the final costing for the selected alignment with the proposed plan and profile sheets and a written report will be presented.

(c) Discussion

The selection of access roads involves consideration of diverse factors and neither technical ease of development nor economic considerations alone will necessarily be the deciding factor. Indeed, fundamental questions regarding eventual plans for controlling access to the project and the fragility of the environment itself will be extremely important. In this regard, an access road which connects only with a railhead (to be established, for example, near Gold Creek) would better facilitate controlling visitor access than would a connection with any of the highways. There is little doubt that conflicting interests will need to be addressed. It is certain that Native villages and the Cook Inlet Region, who will eventually acquire surface and subsurface rights in the project area, will have to be heeded. It is certain, too, that the impacts on local fish and game populations will have to be weighed and assessed. In short, this subtask will provide for the collection of engineering data, the preparation of preliminary economic data, the evaluation of environmental data collected on other tasks, and the selection of the apparent best choice when all factors are considered in their proper perspectives.

(d) Schedule

Weeks 52 through 100

Subtask 2.11 - Map and Photo Search

(a) Objective

Conduct a preliminary assessment of the reservoir areas as the basis for identifying proper locations for pursuing an optimum field reconnaissance program.

(b) Approach

All aerial photography, satellite photography, existing topographic maps, geologic maps, and other available field information will be reviewed by selected members of the project team. This review will concentrate on the identification of particular areas which require verification or evaluation in the field during a site inspection. Based upon this review, a program for conduct of subsequent field reconnaissance efforts will be planned in detail.

(c) Discussion

Depending upon ultimately selected dam height and sites, reservoirs can be upwards to 100 miles in length. It is neither necessary nor practical in the pre-licensing phase to conduct detailed extensive investigations of every square foot in this extensive area. Even so, a proper assessment of the implications of inundation in the project area will be necessary. Based upon this assessment, cost estimates involved in preparing lands for eventual inundation can be derived. In addition, there may be ways and means to reduce environmental impact if judicious use of materials recovered from reservoir areas is planned in the project construction.

(d) Schedule

Weeks 16 through 26

Subtask 2.12 - Field Reconnaissance of Reservoir Area

(a) Objectives

Make on-the-ground checks to verify adequacy of information obtained during the map and photo search; more precisely delineate dimensions of those portions of the reservoir area which are likely to require special attention during the ultimate construction of the project.

(b) Approach

The field reconnaissance team will be furnished with marked-up maps produced during Subtask 2.11. By making on-the-ground inspections, the team will be able to ascertain the extent of clearing required as well as estimate size, nature and density of various trees to be removed. In addition, some initial estimates will be made of soil types, particularly as they would affect slope stability. To the extent that surficial inspection will reveal it, the field team will seek borrow areas in reservoirs in order to minimize eventual environmental impact outside reservoir areas.

(c) Discussion

A portion of the field reconnaissance effort can actually be accomplished by helicopter, as the reconnaissance team overflies reservoir areas and checks the general shape and location of vegetative growth to be removed, verifying that it has been accurately reflected in the initial subtask.

Some on-the-ground verifications will be required. The whole effort, insofar as field reconnaissance is concerned, is primarily geared toward producing a reasonable estimate of the effort required in preparing various areas for eventual inundation. In this regard, for example, it becomes important to verify the size, nature, diameter of trees because marketability will be studied. The question of slope stability and protection is naturally pertinent since the reservoir level particularly behind Watana Dam is expected to fluctuate on an annual basis by as much as 150 feet. This latter question is separately addressed in Subtask 2.15.

(d) Schedule

Weeks 26 through 34

Subtask 2.13 - Marketability and Disposal Study for Reservoir Area

(a) Objectives

Study alternative means for disposing of vegetative material to be removed from the reservoir area.

(b) Approach

Enquiries will be made of various companies dealing in timber in Alaska with a view toward determining the extent to which timber harvested from the proposed reservoir areas may be marketable. In the event that the costs of recovery exceed market values, an assessment will be made of intangible benefits which may still suggest that attempting to sell cut timber is the appropriate option. Other alternatives for disposing of materials to be removed will be considered, to include burial as well as burning. Native villages whose lands border or actually overlap with proposed reservoir areas will be consulted during the course of the study with a view toward seeking their desires on timber disposal.

(c) Discussion

It is important to note that economics will not be the only determinant in the evaluation of alternative means for disposing of vegetative materials. Indeed, ultimate disposition may be directed far more by other factors than by apparent least cost alone. Even so, for purposes of estimating costs for licensing, it will be sufficient to represent the probable least cost method of undertaking the work. Native villages owning surface rights to the affected areas will be directly affected by this work. CIRI will coordinate the input of the villages.

Data gathered during the previous subtask regarding sizes, types and quantities of trees as well as slope conditions and general accessibility will be used. Alternatives such as helicopter logging, construction of logging roads and use of hovercraft will be considered. There is a distinct and important interface between this study and environmental studies conducted in the same area. Summary impacts will be described to indicate the most serious consequences of burial, burning, and removing. While data collection during previous subtasks will have been accomplished during the summer period, the marketability and disposal study itself can be conducted at any time thereafter.

(d) Schedule

Weeks 34 to 48

Subtask 2.14 - Cost Estimates for Reservoir Clearing

(a) Objective

Determine reservoir clearing costs.

(b) Approach

This subtask is not independent of the marketability study which precedes it in this Plan of Study. For each marketing alternative, there could be a different clearing approach. Thus, a series of successive iterations of cost estimates will be necessary until the proper combination of marketing approach and its related clearing technique has been found. An estimate will then be made of the costs of doing the clearing so that the net profit or loss on timber marketing can be determined.

(c) Discussion

It will be necessary during this task to separate clearing costs for reservoirs associated with each of the proposed dams. This will permit subsequent evaluations of a range of alternative phasing for separate dams in the system.

(d) Schedule

Weeks 34 to 48

Subtask 2.15 - Slope Stability and Erosion Studies

(a) Objectives

Estimate the extent to which cleared slopes will maintain stability; estimate the risk that continued reservoir operation will cause one or more slopes to fail; and estimate costs of minimizing slope failure risks.

(b) Approach

Field data collected during the reconnaissance under Subtask 2.12 will be used as the basis for analyzing the potential for slope stability problems. To the extent that such problems appear to exist, alternative means of slope protection will be considered. It will be assumed that slope protection will be required if there is a danger of failure during continued operation.

(c) Discussion

Risk estimates developed during this study will be used ultimately in the risk analysis to ensure that all potential difficulties have been accounted for. The costs of providing appropriate slope protection necessarily become a part of the total project cost estimate to be considered ultimately in determining project financibility and viability.

Subsequent to submission of the license application, much more detailed and vigorous erosion control studies will be required to minimize damage caused by a concentrated flow of water over newly constructed slopes or in areas where the natural vegetative cover has been removed. The objective of this post-application task will be to issue recommendations and delineate problem areas where an added degree of caution should be exercised. A two part study is contemplated to fulfill these needs. This task will be limited to the general site earthwork and is not intended to address erosion of the downstream channel of the dam site.

Input from the first phase of the detailed erosion study will come from an evaluation of soil types obtained from project test borings and laboratory test data. Air photo studies will also be used. It is presently anticipated that a sufficient number of test borings will have been drilled in other project tasks to accomplish this study without additional test borings. Nevertheless, samples of surficial soil may be collected for identification and classification purposes, and laboratory tests may be performed.

A report describing areas of varying degrees of erosion susceptibility will be prepared. Some of the factors that will be considered in this evaluation will be the soil type and its consistency. Included in this report will be a discussion of erosion control for general site grading.

(d) Schedule

Weeks 47 to 54

Subtask 2.16 - Hydrographic Surveys

(a) Objective

Provide field and aerial survey data relating to the river gradient and cross sectional configuration of the active flood plain.

(b) Approach

Through the use of deferential level circuits, 60 miles of river will be profiled from the lower portion of Devil Canyon, downstream, to the confluence of the Susitna, Talkeetna and Chulitna Rivers near the town of Talkeetna.

Pre-set picture panels for aerial photogrammetry will be tied to the profile level circuit for later use in river cross sections.

Cross sections of the river's active flood plain will be measured at selected intervals and based on elevations established during river profiling.

The true interval and relationship of river cross sections to the river and other cross sections will be determined photogrammetrically and geometrically from pre-set picture panels (crosses) that can be identified in the aerial photos.

(c) Discussion

Careful study of downstream hydrographic conditions is a vital part of the total data collection effort, particularly because project operation will produce changes in the flow regime. Subsequent environmental studies will rely on the data produced here for use in the study of potential impacts on fisheries as well as on moose browse now growing in certain low areas subject to regular inundation when the project operates. In addition, as design studies progress, determinations will be made as to the need for re-regulation structures.

(d) Schedule

Weeks 5 through 17 and 36 through 48

A.5.4 - TASK 3: HYDROLOGY

(i) Task Objectives

To undertake and report on all hydrologic, hydraulic, ice,and climatic studies necessary to complete the feasibility design of the Susitna project and to provide sufficient documentation for the FERC license application.

(ii) Task Output

- Data Index System

  A data index system listing all the available hydrologic and climatologic data will be compiled and circulated. Hard copy of the more relevant data items will be stored in the project office in Anchorage and copies made available to those requesting it.

  All the additional hydrologic and climatologic field data collected as part of this study will be documented on either computer printout sheets or typewritten tables.

- Written Sections and Drawings for Inclusion in the FERC License Application

  Exhibit H - proposed reservoir operating rules, predicted reservoir behavior, and downstream water quality and flow conditions.

  Exhibit I - dependable power flow, critical design low flow period, flow duration curves and tailwater rating curves.

  Exhibit K - reservoir shorelines for maximum and minimum reservoir water levels and reservoir water level area and capacity curves.

  Exhibit L - spillway design flood and capacity and freeboard allowance.

- Hydrologic Appendices to Engineering Report

  The detailed technical appendices will contain sections on the following types of studies: hydrology (resource and floods), reservoir operation, hydraulic, sediment yield, river morphology, ice engineering, climatic studies for transmission line design, and hydrologic and hydraulic studies for the access road.

- A Series of Design Transmittals

  These will summarize the pertinent design parameters obtained from the studies outlined above.

(iii) List of Subtasks

3.01 - Review of Available Material
3.02 - Field Data Index and Distribution System
3.03 - Field Data Collection and Processing
3.04 - Water Resources Studies
3.05 - Flood Studies
3.06 - Hydraulic and Ice Studies
3.07 - Sediment Yield and River Morphology Studies
3.08 - Climatic Studies for Transmission Line
3.09 - Access Road Studies
3.10 - Lower Susitna Studies

(iv) Subtask Scope Statements

The scheduling of the above subtasks is presented in Section A7, Plate A7.1. The activities have been specifically scheduled to make maximum use of the field data as it becomes available and to provide the necessary input to the other components of the studies.

Arrangements have been made to enlist the services of Dr. R. Carlson to act as consultant to Subtask 3.05 (Flood Studies). We propose to make similar arrangements with Dr. T.E. Osterkamp of the Geophysical Institute, University of Alaska to act on the ice engineering related aspects of Subtasks 3.06 (Hydraulic and Ice Studies) and 3.03 (Field Data Collection and Processing). Contact will also be made with the U.S.G.S. office in Anchorage to determine what assistance they can provide both in terms of expert advice on field equipment selection and operation (Subtask 3.03) as well as reactivation and operation of some of their discontinued gauging stations (Subtasks 3.03 and 3.10).

A detailed discussion of the objectives, the approaches and the costs and schedules associated with the subtasks follows.

Subtask 3.01 - Review of Available Material

(a) Task Objectives

Assembly and review of all available reports, maps and studies relating to hydrologic aspects of the Susitna and neighboring basins, and abstraction of hydrologic design parameters required for the planning studies concerned with alternative hydro sites, including small hydro development.

(b) Approach

All available reports, maps and other pertinent documents will be obtained and reviewed. Detailed discussions will be held with individuals and agencies who have been engaged in the past and who are currently engaged in studies in the Susitna basin and surrounding areas, (e.g., staff at the University of Alaska, APA, the Hydrology Section of the U.S. Corps and the USGS office staff in Anchorage).

All information on mean annual flows, seasonal distribution of flow, reservoir drawdown and firm and installed capacity will be abstracted. If necessary, manual adjustments will be made to these parameters to ensure that standardized parameters are available for each site and that similar approaches are applied to defining firm power and installed capacity.

This task will be performed jointly by R&M and Acres.

(c) Schedule

Weeks 1 through 26

Subtask 3.02 - Field Data Index and Distribution System

(a) Objectives

Establish a formal data indexing and distribution system to keep the study team and all other parties concerned with the project fully updated on the status of available hydrological and climatologic data.

(b) Approach

The field data acquisition requirements for the proposed study are substantial. A data index describing all the currently available hydrologic and climatologic data will therefore be compiled. All new data collected by other organizations within the basin and by the study team will be added to the index. It is proposed to update the index every six months.

Hard copy of the available data will be obtained and stored. Copies of selected items of data will be dispatched to project team members and other concerned parties on request. All new field data collected by the project team will be stored on computer facilities and/or in tabulated form. Copies of this information will be issued to those requesting it.

(c) Discussion

It will not be possible to obtain and store hard copy of some of the detailed climatic data collected at the existing complete meteorologic stations or from the proposed automatic climate stations. However, provision will be made to access these data files and abstract from them data in summarized form as required by the project staff.

This work will be done by R&M.

(d) Schedule

Setup: Weeks 5 through 13
Operation: Weeks 14 through 130

Subtask 3.03 - Field Data Collection and Processing

(a) Objective

To supplement the available streamflow and climatologic data within the Susitna River Basin and along the proposed transmission corridors.

(b) Approach

The data collection program outlined in this section has been specifically tailored to provide adequate input to the design of the project and to meet the requirements of the FERC licensing procedure.

- Field Data Specifications

It is proposed to produce formal specifications for all the hydrologic and climatologic field data to be collected. This will facilitate the detailed planning of the field program and will allow the various technical disciplines associated with the study to derive maximum benefit from the data collection program.

During the early stages of the study, data specifications will be drawn up by a multidisciplinary team responsible for environmental, hydrologic, hydraulic and ice engineering aspects of the study during the initial field trips in the area. These specifications would be submitted to Federal and state agencies for comment to ensure that maximum benefit is derived from the field program.

The specifications will describe items to be collected, list the type of equipment to be used, the accuracy to be achieved, the frequency of the observations and the rate at which the information is to be processed and published.

Discussions will be held with the consultants to the study based in the University of Alaska to explore the possibility of applying satellite or high-level aircraft photography to improve accuracy of estimating the spatial distribution of the snow cover. It should be noted that no budget has been provided for undertaking this type of work should it prove feasible.

- Field Data Collection

To ensure that adequate data is available for the feasibility design and license application and subsequent preliminary engineering, an early start must be made with field data collection. A tentative program has been developed and is summarized in Table A5.2. Provisional locations of data collection points are shown in Plates T3.1 and T3.2.

A permanent field crew of two people will be assigned to install and operate the equipment and to retrieve the data. Extensive use will be made of helicopter transport to access the remote stations. A fixed-wing aircraft will be used in the aerial ice cover surveys and to service some of the remote snow course and climatic stations.

During the first half of 1981, the field data specifications will be reviewed and amended in the light of one year's experience in the field. It is anticipated that the location of the transmission line corridor will have been selected and that some of the automatic climatic, in-cloud icing, and freezing rain stations may have to be relocated. The additional three automatic climatic stations, as well as the additional in-cloud icing, freezing rain and snow creep stations will be installed.

- Field Data Processing

  Field data processing will be concerned with the following:

  -- abstracting and storing information on the charts obtained from the automatic climatic stations and water level recorders
  -- calculating water and sediment discharges from field observations
  -- laboratory analyses of water quality and sediment samples
  -- documentation of the ice cover observation program
  -- documentation of the snow course data, transmission line icing, freezing rain, snow creep and glacial measurements.

  Some of this data processing will be carried out on a computer; the remainder will be dealt with manually.

  A technician will be responsible on a full-time basis for all the data processing. Additional technical assistance will be available as and when required.

(c) Discussion

This task will be undertaken by R&M with review by Acres. Important aspects associated with Table A5.2 are as follows:

- The program has been based on the assumption that the Devils Canyon and Watana Dam site will be the selected project sites.

- The initial location of the climatic stations is based in the assumption that the transmission route will be located along the railway linking Fairbanks and Anchorage. Should an alternative transmission corridor be selected during 1980, the climatic stations installed along the rail route will be relocated during 1981. This is not anticipated to cause any delays in the study as the data obtained during the first year could be used to obtain preliminary design criteria for the alternative route. Provision has been made in the cost estimates to cope with relocation of the stations.

TABLE A5.2 - PROPOSED HYDROLOGIC FIELD DATA COLLECTION PROGRAM

Station Type	Measured Parameters: Parameter	Measured Parameters: Type of Equipment	Time Between Observations	Time Between Station Visits	Number of Stations Installed: 1980	Number of Stations Installed: 1981	Type (and Quantity) of Major Equipment to be Purchased
Gaging[4]	Water level	Chart or tape recorder	Continuous	Summer: 2-4 weeks	3 (2 new at project sites, reactivate USGS Station 2915 on the Susitna River)	None	Water level recorders (3 + 1 spare) Current meters (2) Boats (2) Cable ways (2) Ice augers (2)
	Water discharge	Cable way or boat and current meter	Summer: 2-4 weeks Winter: 2-3 months	Winter: 1 month			
Water level	Water level	Staff gauge and peak level indicator	Summer: 2-8 weeks Winter: 2 months	As in previous column	8	None	Staff gauges Peak level indicators
Sediment discharge[5]	Suspended sediment concentration Bed material size	Suspended sediment sampler	As for water discharge	As in previous column	4 (3 involve supplementary measurements at USGS stations 2910, 2912, 2920).	None	Suspended sediment samplers (3) Bed material samplers (2)
Snow course	Snow pack depth and water equivalent	Conventional snow survey equipment and/or snow pillows	2-4 weeks during winter months	As in previous column	4	None	Conventional snow survey equipment (1 set). Snow pillows (4 + 1 spare)
Water quality	Temperature, turbidity, conductivity, dissolved oxygen, pH	Field measuring equipment	Summer: 1 month Winter: 2-3 months	Summer: 1 month Winter: 2-3 months	3	1	Meters (1 set)
	Alkalinity CO_2	Grab samples and laboratory analysis in field camp	As above	As above			Titration kit
	Total and ortho phosphorus Total and kjeldahl nitrogen Total dissolved and suspended solids Trace metals	Grab samples and laboratory analysis in Anchorage	As above	As above			Freezing equipment in field camp (1)
Climatic (automatic)	Wind speed and direction Relative humidity Temperature Rain/snow (unheated gauge)	Automatic weather station	Continuous	Monthly	5	3	Automatic weather stations (9 + 2 spare)

TABLE A5.2 - PROPOSED HYDROLOGIC FIELD DATA COLLECTION PROGRAM (Cont'd)

Station Type	Measured Parameters: Parameter	Measured Parameters: Type of Equipment	Time Between Observations	Time Between Station Visits	Number of Stations Installed: 1980	Number of Stations Installed: 1981	Type (and Quantity) of Major Equipment to be Purchased
Climatic[1] (automatic with heated gauge plus some observer information)	As above, plus solar radiation Evaporation pan Visibility (heated gauge)	Automatic weather station plus some observer information	Continuous	Daily	1	None	
In cloud icing	Ice buildup on a transmission line	Short section of transmission line, 6 feet long mounted 5 feet above ground	Only during or immediately after icing conditions	Sporadic	3	2.	Short section of transmission line
Freezing rain	Ice buildup during a precipitation event	Horizontal steel plate,	Only during or immediately after freezing rain	Sporadic	3	2	Steel plates
Snow creep	Snow creep	Snow markers and survey equipment	2-4 weeks during winter months	Monthly during winter months	3	5	Snow markers
Ice cover[2] (Ground survey)	Ice thickness	2-5 auger holes for measurement	Summer: none Winter: 1 month	Summer: none Winter: 1 month	8-12	0-4	Ice penetrometer
	Ice competence	Visual inspection and/or penetrometer device					
Ice cover[3] (Aerial survey)	Extent of ice cover	Visual and photographic records	During break-up period - one to several days	--	--	--	Camera equipment
	Location of ice jams		During freeze-up period - weekly	--	--	--	--
Glacial	Ice surging/ recession & glacial surface features	Survey, visual & photographic records	Two months	Two months	--	--	Survey markers

Footnotes:

(1) Located at the permanent Watana field camp.
(2) Locations to be firmed up after initial field trips and review of field data collected by Geophysical Institute, University of Alaska. Anticipate 6-8 stations on the Susitna River and 2-4 on important tributaries.
(3) As for Note 2. Anticipate to cover entire reach from MacLaren - Susitna River junction to confluence of Chulitna River.
(4) It is assumed that the existing cable at Vee can be upgraded for use.
(5) It is porposed to undertake only sporadic visits to the station at VEE (i.e. at gage 2915).

- An additional five automatic climatic stations will be held in reserve during the first year. It is intended to utilize two of these as spares. The three others will be installed during 1981 along the selected transmission line to improve estimation of the spatial variation in design parameters.

- Discussions have been held with the staff responsible for the snow course surveys at the Soil Conservation Service in Anchorage. As a result the locations of the additional four snow course stations depicted in Plate T3.1 were selected. These discussions also indicated that snow pillows have been operated very successfully and should function well at the proposed locations. Only a minimum amount of measurement using conventional snow survey equipment will be necessary.

- The proposed sediment station at the Vee site (see Plate T3.1) will not be operated on a continuous basis. A limited number of observations will be taken and used to assess whether the sediment discharges at Vee and Gold Creek are correlated. If these analyses indicate no correlation, then the sediment observations at Vee will be increased during Phase 2.

- We do not propose to use bed load samplers during this phase of the work. Although the Heli-Smith type sampler has been successfully used by the USGS on the Tanana River, it is doubtful whether it would operate in the coarse sediments of the Susitna. However, this aspect will be reviewed once more detailed information on the bed material is available. If deemed practical and useful, a bedload sampler could be employed during Phase 2 to firm up estimates of bedload.

(d) Schedule

Field Data Specifications and Review - Weeks 14 through 22
Weeks 70 through 74

Equipment Installation - Weeks 23 through 35
Weeks 75 through 82

Field Data Collection - Weeks 31 through 130

Field Data Processing - Weeks 36 through 130

Subtask 3.04 - Water Resources Studies

(a) Objectives

To develop all the necessary water resource parameters such as monthly flow data, design low-flow characteristics, etc., at the reservoir sites and to study long-term reservoir operation.

(b) Approach

(i) Streamflow Extension

Multiple regression analyses will be used to develop monthly streamflow sequences at the Watana, Devil Canyon and other sites being considered within the Susitna basin. The aim is to improve on the correlations previously achieved in the U.S. Corps of Engineers studies. The gauging station at Gold Creek (2920) will be used as the master station. However, attempts will be made to see whether meaningful correlations can be achieved by using longer-term stations outside the study area (e.g., Matanuska River at Palmer, 2840). Both monthly and annual flows will be correlated and climatic parameters such as monthly/annual temperature and preciptation will be introduced to determine whether they improve the correlations. Extrapolation of mean annual flow and the seasonal variation of flow to ungauged locations will be done using factors developed from drainage basin area and other physiograpic and climatic parameters (e.g., area covered by glaciers, lakes and swamps, mean annual precipitation, and mean annual temperature).

Acres will undertake these analyses.

(ii) Low-Flow Frequency: Duration Analysis

Utilizing the above information, analyses will be carried out to produce curves relating volume of runoff in low-flow periods of different durations ranging up to several years to the frequency of occurrence. These curves will be used to determine firm power and energy from the proposed developments during specified critical low flow periods.

Acres will undertake these analyses.

(iii) Reservoir Filling and Operation Studies

It is proposed to set up the Acres' multireservoir water balance computer model for the Susitna basin. This is a particularly versatile model, and allows easy application to different reservoir systems. Reservoir operation rules are specified as input data, thus allowing considerable flexibility in studying alternative rules and priorities. The model can operate with time periods varying from a week to several months, and can incorporate power generation and load stacking.

This model will be used to undertake reservoir operation and energy generation studies, and the analyses required to determine filling schedules. The basic input data to the model will be derived from the studies discussed in (i) and (ii) above.

Acres will undertake the work.

(iv) Statistical Analysis of Pre- and Post-Project Streamflow

Flow duration curves are required for the FERC license application and the determination of annual sediment yields at various locations within the basin. Seasonal and annual duration curves will be evaluated using the natural monthly streamflow data derived in (i) above and for the post-project flows simulated using output from the multi-reservoir model discussed in (iii) above.

Recorded natural daily streamflow data at a limited number of gauging stations within the basin will be utilized to describe typical flow variations within the calendar months.

Once the project layouts have been finalized, the flow duration curves described above will be redeveloped for post-project flow conditions downstream from the damsites. Based on a knowledge of the daily plant operating characteristics, the effects of discharge fluctuations within typical months will be described.

Acres will undertake the studies.

(v) Evaporation Studies

Desk studies will be undertaken to refine the estimate of net evaporative loss from the reservoir surface area. Based on available climatic and evaporation data within the Susitna basin and the vicinity regional estimates of gross evaporation from an open water surface will be made and extrapolated to the damsites. Available streamflow and precipitation data will be used (again on a regional basis) to estimate the pre-project evapotranspiration rate from the reservoir area and subtracted from the open water evaporation to yield the net effect of the reservoir.

R&M will undertake these studies.

(vi) Glacial Studies

The results of field surveys for detecting glacial movement and the aerial inspections and information obtained from aerial photographs will be evaluated to determine whether the glacier was noticably moving and if there was potential for a lake dump. The USGS studies on the Black Rapids Glacier will be reviewed and general information abstracted and used to assist in this evaluation.

Should these studies indicate that changes in the glaciers water and sediment yield could occur, or that a lake dump could develop, a more comprehensive long-term glacial observation and study program would be planned for implementation during Phase 2.

R&M and Acres would jointly undertake this study.

(c) Discussion

The streamflow extension (Section (i)) analyses will be based on available streamflow data up to the end of the 1978-1979 year, i.e., October 1979. The data obtained during the first 12 months of the field program will be utilized to check on the validity of the extrapolation factors used to derive streamflow data for ungauged sites. If deemed necessary, these factors will be revised and the appropriate adjustments made to the streamflow data.

(d) Schedule

Weeks 21 through 120

Subtask 3.05 - Flood Studies

(a) Objectives

To provide design flood peaks and hydrographs for design of the project and for assessing pre- and post-project flood conditions in the Susitna River reaches located down and upstream of the Watana and Devil Canyon damsites.

(b) Approach

(i) Regional Flood Peak and Volume Frequency Analysis

A localized regional flood peak and flood volume analysis will be undertaken for the Matanuska, Susitna (including the Yentna) and Chakachatna River basin; i.e., the entire Cook Inlet basin. All gauging stations with periods of records longer than 7 to 8 years and with drainage basin areas larger than approximately 250 square miles will be incorporated in the analysis.

Annual maximum and seasonal maximum flood peaks will be abstracted from the records. It is proposed to use two seasons: the season during which significant ice cover is present and the ice-free season. The flood peak data will be subjected to frequency analysis using the Log Pearson Type III distribution (or alternatively the three-parameter Lognormal distribution which has been found to work well in northern climates). These individual frequency curves will be utilized to develop regional frequency curves as well as regression equations for predicting design flood peaks at ungauged locations within specified homogeneous flood regions. The definition of homogeneous flood regions will be based both on statistical tests (e.g., Langbein) as well as visual plots of single station frequency curves.

In developing regression equations, use will be made of physiographic parameters such as drainage basin area, area covered by glaciers and lakes or swamps, mean late winter snow cover, mean spring temperatures, etc. The results obtained will be compared to those presented in the broad-based regional study recently completed by Lanke (USGS, Water Resources Investigations 78-129).

A flood-volume frequency analysis will be undertaken for the streamflow records on the Susitna at Gold Creek (2920) and at Cantwell (2915). A screening process will be undertaken to determine which of the flood types are the most critical:

- spring floods
- high mountain snow melt - rainfall events (June/July)
- summer rainfall events.

The annual maximum flood volumes associated with the critical type will be abstracted from the streamflow data files and subjected to a frequency analysis. Analyses will also be conducted to determine whether a relationship exists between the ratio of the flood peak to the flood volume and to develop typical flood hydrograph shapes. The results of these calculations will be used to develop design flood hydrographs for the proposed reservoir sites on the Susitna. Extrapolation to the ungauged sites will be accomplished by using drainage area ratios or factors involving other physiographic and climatic parameters.

R&M would undertake this work and Acres would act in a review capacity.

(ii) Probable Maximum Flood Determination

The approach adopted by the Corps of Engineers in their feasibility studies in developing the Probable Maximum Flood (PMF) is appropriate for this stage of the study. The SSARR watershed model used was reasonably well calibrated considering the paucity of available data. Recalibration would not be warranted until the proposed new climatic stations (Subtask 3.03) have been installed and operated for at least two years. It is therefore proposed to undertake a detailed review and revision of the input parameters to the Corps of Engineers model. Several runs will then be undertaken with the model to test for sensitivity of output to changes in input data and to revise the estimate of the PMF if necessary. The key input parameters that would be reviewed include:

- probable maximum precipitation
- initial snow cover
- temperature sequence
- loss rates or loss functions.

It is assumed that the consultants would have access to the Corps of Engineers model in rerunning the SSARR model.

Acres will undertake this work.

(iii) Reservoir Flood Routing

In-house computer programs will be used to route design floods through the proposed reservoir system. These studies will be used to size the required service and emergency spillways and to produce the downstream post-project flood hydrographs required for the downstream water level and ice studies (Subtask 3.06).

Acres will undertake this work.

(c) Discussion

During Phase 2, more extensive analyses will be undertaken to firm up the design flood estimations (see Section A6.3). This will include recalibration of the SSARR model or, if deemed more appropriate, the application of an alternative computer model such as the more sophisticated Hydrologic Simulation Package (HSP) developed by Hydrocomp or the National Weather Service model.

(d) Schedule

Weeks 21 through 120

Subtask 3.06 - Hydraulic and Ice Studies

(a) Objective

The determination of water levels and ice cover conditions upstream and downstream from the project sites under flood and low-flow conditions corresponding to pre- and post-project conditions.

(b) Approach

Computer model simulations will be carried out to compute the pre-project to predicted post-project conditions and to provide input to the civil layout and system operation studies. This will ensure that potential problems such as the maintenance of a stable ice cover, ice jamming and flooding, etc. can be dealt with during the project planning and design process. The results of the studies will also be utilized in the environmental studies (Task 7) to assess potential environmental impacts.

(i) River Channel Water Levels and Flows

We propose to utilize the following three basic computer programs to study the water level and ice regime in the Susitna River from just upstream of the Watana site to Talkeetna.

- HEC-2 - (Acres modified version, incorporating an ice cover)

- Ice Cover Process Model - This is a computer program which has been developed in-house by Acres specifically for hydropower generation studies in northern climates. It simulates the growth and decay of a stable ice cover on a channel containing flowing water.

- One-Dimensional Dynamic Flow Model - Acres has several in-house versions of this program which is capable of simulating the dynamic response of a channel to a time varying flow input.

All of the above models are one-dimensional flow models. Table A5.2 indicates which of the Susitna River reaches these models will be applied to and the purpose of the simulations to be carried out.

The ice cover observations and the ice cover thickness and strength measurements undertaken by the Geophysical Institute and made during the course of this study will be utilized for:

- calibrating the ice cover process model
- determining typical ice cover conditions to be simulated with the backwater program (HEC-2)
- assessing where potential ice jams could occur.

The studies outlined in Table A5.3 deal with the Susitna River only as far downstream as Talkeetna. It is proposed to use a less rigorous approach to assess the effects of the proposed project on flow in the river channel downstream from Talkeetna (see Subtask 3.10). Should these analyses indicate that more detailed studies are required, they will be done during Phase 2.

As soon as the topographic survey information of the Susitna reaches concerned becomes available and sufficient water level observations are obtained (Subtask 3.03), the flow models will be set up and calibrated. The simulation exercise will then follow and continue on through the project design studies (Task 6).

Acres and R&M will jointly undertake the foregoing studies. R&M will concentrate on the river reach downstream from the Devil Canyon damsite as this aspect could be usefully combined with flood-plain mapping work they may be undertaking in the area.

Acres will direct the work undertaken by R&M.

(ii) Reservoir Freeboard

The required reservoir freeboard for wind conditions will be evaluated. The wind data collected in the basin during the first 18 months will be utilized to extrapolate design wind conditions to the reservoir sites.

Acres will undertake this work.

(iii) Slide Induced Reservoir Surge

It is proposed to undertake a literature review of previous work done in this area. Of particular interest will be the mathematical and physical modeling work done by B.C. Hydro on the Downie slide and Revelstoke dam and their work on the Mica slide. Information obtained from this review plus the results of the reservoir seismic studies (Task 4) will be used to assess the nature and magnitude of the potential problems and to establish some preliminary design criteria. Should further detailed study be necessary, a suitable methodology and scope of work would be developed for application in Phase 2.

Acres will undertake this work.

(iv) Reservoir Temperature Regime

An in-house computer model will be utilized to simulate the vertical temperature stratification within the proposed reservoirs for a typical year. This model will be calibrated according to our experience with such models, other studies on similar projects, and utilizing the results of similar work being conducted at the University of Alaska.

TABLE A5.3

PROPOSED APPLICATION OF ONE-DIMENSIONAL FLOW MODELS TO THE SUSITNA RIVER

Study No.	River Reach	Model	Purpose of Simulations
1	Upstream of Watana	HEC-2, Ice Cover Process Model	To study the establishment of the stable ice cover on the Watana Reservoir
2	Watana Dam site to Talkeetna	HEC-2, Ice Cover Process Model	To study the ice cover and water level regime downstream of Watana prior to construction of Devil Canyon Dam and to calculate tailwater rating curves
3	Watana Dam Site to Devil Canyon site	HEC-2, Ice Cover Process Model	To study the ice cover regime at the Devil Canyon Reservoir
4	Devils Canyon site to Talkeetna	HEC-2, Ice Cover Process Model, Dynamic Flow Model	To study the ice cover and water level regime in the reach below Devil Canyon and to calculate tailwater rating curves
5	Watana and Devil Canyon site during the diversion stage of construction	HEC-2, Ice Cover Model Process	To design an adequate diversion system

NOTES:

The word "regime" implies the following:

- ice cover - nature and timing of growth
  - stability
  - decay and jamming

- water level - low flow conditions
  - flood flow conditions

Output from this model will be utilized to assist in the selection of the levels of the offtakes for the discharge structures and to predict changes in the downstream water temperatures.

Acres will undertake the work.

(c) Discussion

The foregoing approach, particularly the application of the backwater program incorporating an ice cover and the ice-cover process model, has been developed based on our extensive experience with design of hydroelectric facilities in northern climates, particularly on the Nelson River in Manitoba. The type of problems we anticipate with ice in the Susitna project and the methods that could be adopted to deal with them are discussed in Section A2.2.

(d) Schedule

Weeks 40 through 120

Subtask 3.07 - Sediment Yield and River Morphology Studies

(a) Objective

Determination of the rate of sediment accumulation in the proposed reservoirs and prediction of the effects on the downstream river channel morphology.

(b) Approach

(i) Sediment Yield and Deposition

The U.S. Corps of Engineers total sediment yield studies described in the 1975 feasibility report will be updated by incorporating all new data on sediment discharge that have since become available. A literature review will be undertaken to confirm the reservoir trap efficiency figures used and to develop an appreciation of the spatial distribution of the deposited sediment in the reservoir. State-of-the-art settlement theory will be used to determine average sediment concentration in the reservoir at various times of the year. This latter information will be required to determine the quality of the water released from the reservoir.

(ii) River Morphology

A thorough review of previous work done in the Susitna Basin and other Alaskan rivers and available field data for the Susitna River will be undertaken. An air photo mosaic will be prepared for the reach between Devil Canyon and Talkeetna. Historical photographs will be studied to assess past regime changes both in the main river channel and the tributaries.

Studies will be undertaken to determine a suitable regime-type equation. With the aid of this formula and input from the reservoir simulation studies (Subtasks 3.04 and 3.05) expected morphologic changes will be assessed. The more pronounced changes will be illustrated on the air photo mosaic.

(c) Discussion

The reservoir sediment calculations will be revised during Phase 2, once several seasons of additional field data have become available.

The state of the art in modelling the distribution of deposited sediment is not yet sufficiently advanced to produce reliable estimates of the spatial distribution of sediment within a reservoir, unless extensive calibration studies are undertaken and a large amount of field data is available. During Phase 2 of the study an assessment will be made as to the adequacy of the available data to calibrate such a model, and a decision will be made whether or not to undertake such modelling.

R&M will undertake the work described in this subtask and Acres will act in a review function.

(d) Schedule

Weeks 40 through 120

Subtask 3.08 - Climatic Studies for Transmission Line

(a) Objective

To provide climatologic design criteria for the design of transmission lines. These include ice-cover thickness and wind speed.

(b) Approach

Preliminary design criteria will be evaluated during the early stages of the study. Utilizing available climatic information and experience obtained in other northern transmission line projects, design parameters will be established; i.e., wind speeds, icing conditions (frequency and thickness of accumulation) and temperature conditions.

Input will be obtained from an experienced staff meteorologist to assist in developing these parameters. An attempt will be made to develop a general perception of the spatial variation in these parameters for input to the transmission-line route-selection studies.

During the second year of the study, as the climatic field data becomes available, a more detailed approach will be adopted to confirm the design criteria. An in-cloud icing model is available in the Acres computer library and has been used to calculate ice loads for the design of a transmission line from Ocean Falls to Kemano in northern British Columbia.

We will use this model to predict ice cover thickness for specified design climatic conditions. A check on model accuracies will be made by comparing model results with measured ice accumulations from the Field Data Collection Program (Subtask 3.03) and using data from other sources such as the in-cloud ice accumulation data which is available (4 years, 42 events) for McLean Mountain, British Columbia. Determination of freezing rain accumulation will be based on the data collected in the field and obtained from other sources such as the first order meteorological stations in Alaska, the Yukon and northern British Columbia.

Acres will undertake this subtask.

(c) Discussion

To estimate risks of combined wind and ice loads for various return periods, two meteorological events must be considered. On the routing sections which would carry the line to high elevations, in-cloud ice accumulation is likely to represent the most severe condition. Where the line would follow valley floors, freezing rain or drizzle would result in maximum loads. In-cloud icing produces rime accumulation having a density of about 0.6 g/cm^3, as does the occurrence of freezing drizzle. Freezing rain results in glaze icing with a density of about 0.9 g/cm^3.

(d) Schedule

Preliminary Design Parameters - Weeks 14 through 25
Detailed Studies - Weeks 70 through 82

Subtask 3.09 - Access Road Studies

(a) Objective

To provide the necessary design flood peaks and to evaluate the capacity of the required hydraulic structures such as bridges and culverts.

(b) Approach

For design floods associated with larger basins, the results of the regional flood studies (Subtask 3.05) will be used. For the smaller catchments measured flood flows from small catchments will be utilized to develop regional flood peak relationships. Summer rainfall statistics will be evaluated and utilized with a rational type formula to calculate design summer flood peaks.

(c) Discussion

Hydraulic calculations, using standard techniques and design curves will be employed to evaluate the necessary size of the hydraulic structures. Bridge size and abutment shapes and alignments will be determined so as to minimize the effect on the drainage of water and general and local scour.

R&M would perform this subtask.

(d) Schedule

Weeks 52 through 100

Subtask 3.10 - Lower Susitna Studies

(a) Objective

To estimate the flow regime, sediment regime and morphological characteristics of the lower Susitna River under natural conditions, and a preliminary determination of morphological impacts which could result from flow regulation and sediment trapping at the Susitna project.

(b) Approach

This task will comprise the three following components:

(i) Flow and Sediment Measurements

Assessment of impacts on the Susitna River below Talkeetna requires basic information on the proportion of flow and sediment which is contributed from the area above the proposed dams. Although this can be estimated approximately by analytical methods based on the sparse records available, it will be confirmed by direct field measurements. In addition to the existing U.S.G.S. gauging station on the Susitna River below the confluence with the Yentna River, it is proposed to select three additional gauging sites in consultation with the Department of Natural Resources (DNR). It is tentatively envisaged that these will be located on the following sites:

(1) Chulitna River near Talkeetna (see Plate T3.1)
(2) Susitna River between the Parks Highway Bridge and the Delta Islands
(3) Yentna River near the Susitna confluence.

Measurement of river discharge, water levels, water temperatures, and suspended sediment concentration will be conducted for a period of at least one year. This will provide information for estimating the natural contribution of flow and sediment from the basins upstream of the project sites to the lower Susitna reaches on a seasonal basis.

(ii) River Observations and Aerial Photographs

A potential impact of flow regulation on the highly graded lower Susitna River is the dewatering of side channels and sloughs which may be good fish habitats. To be able to assess this potential impact, the following additional information will be collected:

- aerial photography of the river from the mouth to Talkeetna
- aerial observations and oblique photographs of the river under various conditions:
  - before and during spring breakup
  - at various flow magnitudes during the summer
  - before and during the ice formation period.

(iii) Interpretation of Data

The data collected on the lower Susitna River will be analyzed in conjunction with the flow regulation and sediment studies described in Subtask 3.04, Water Resources Studies, and 3.07, Sediment Yield and River Morphology Studies.

A preliminary evaulation of the potential morphological changes, and impact on the river characteristics due to flow regulation will be made during the early part of 1981. If considered necessary at this stage, an expanded field data collection and study program aimed at evaluating impacts in more detail will be developed in conjunction with the DNR and presented for consideration to APA. Should an expanded program not be necessary the program outlined here will be continued and the preliminary assessments completed by the end of the study period.

R&M will undertake the work and Acres will act in a review capacity.

(c) Discussion

The lower Susitna River is an important multi-purpose resource which must be considered in planning the Susitna project. However, at this point in the study, it is considered prudent to minimize the level of investigation until

(1) The power studies confirm that the Susitna project is indeed the best alternative for Railbelt power requirements.

(2) Project studies have progressed to the point where definite regulatory patterns and effects on sediment transport can be identified.

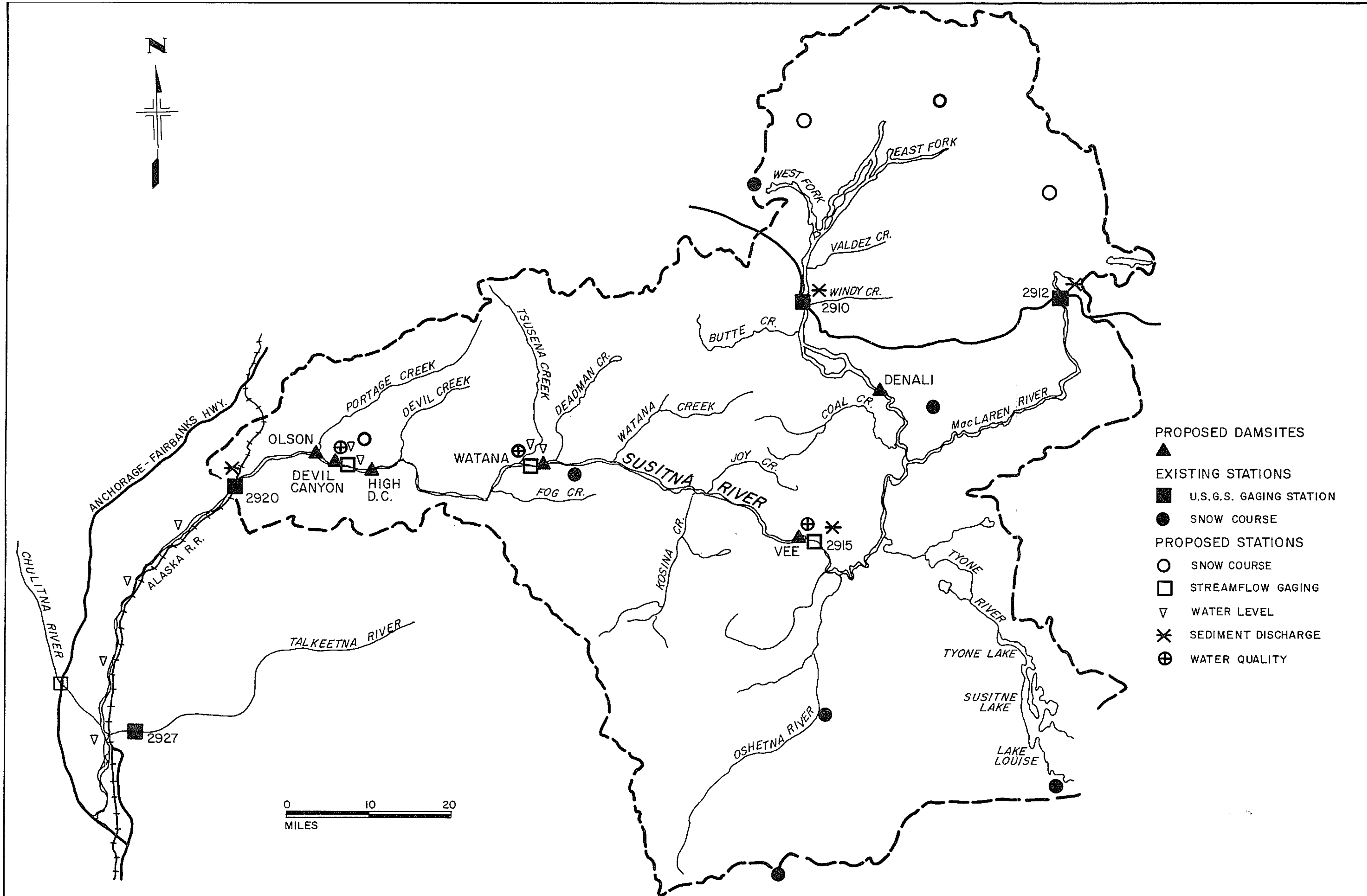
(3) Preferred areas of fish habitat in the lower Susitna River have been identified (see Subtask 7.10, Fish Ecological Baseline Studies and Analysis).

(4) Better knowledge on the morphological effects of the project on the upper Susitna River is obtained.

This subtask has been developed after extensive discussions with DNR.

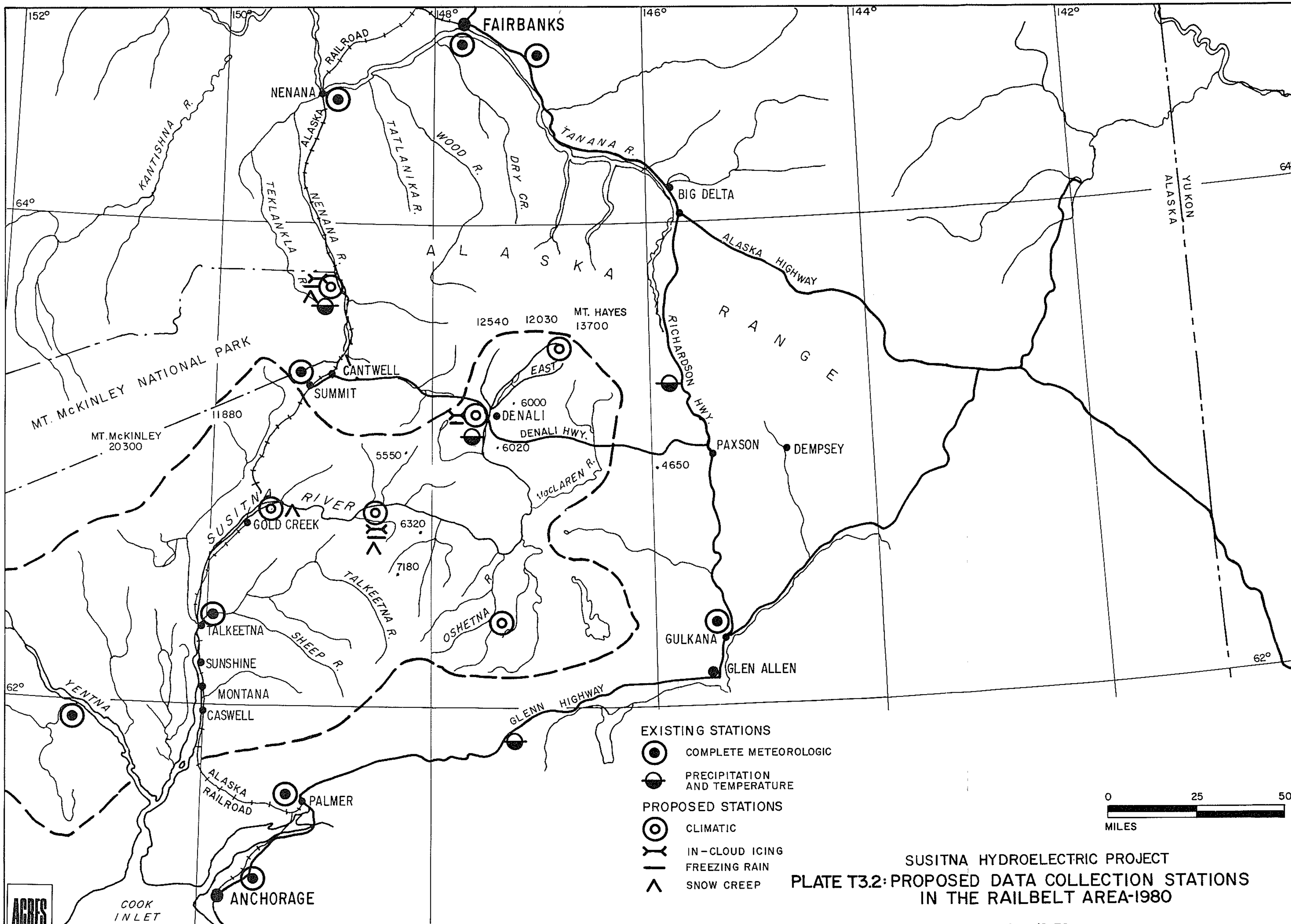
(d) Schedule

Weeks 31 through 126.



SUSITNA HYDROELECTRIC PROJECT

PLATE T3.1: PROPOSED DATA COLLECTION STATIONS IN THE SUSITNA BASIN-1980



SUSITNA HYDROELECTRIC PROJECT

PLATE T3.2: PROPOSED DATA COLLECTION STATIONS IN THE RAILBELT AREA-1980

5-77/5-78

A.5.5 - TASK 4: SEISMIC STUDIES

(i) Task Objectives

To determine the earthquake ground motions which will provide the seismic design criteria for the major structures associated with the Susitna Hydroelectric Project, to undertake preliminary evaluations of the seismic stability of proposed earth-rockfill and concrete dams, to assess the potential for reservoir induced seismicity and landslides, and to identify soils which are susceptible to seismically-induced failure along the proposed transmission line and access road routes.

(ii) Task Output

The data collection programs and studies outlined in this task will be sufficiently comprehensive for FERC license applications.

Thorough presentations of conclusions, evaluations and data are also desirable for projects that are being carefully reviewed by permitting agencies. Complete reporting of the seismic geology and seismology investigations will be made with this philosophy as a guide. This task will be conducted primarily by Woodward-Clyde Consultants with review by Acres and field support by R&M Consultants. The ground motion study data will be utilized in Task 6 for design studies. Identification of seisimically susceptible soils for the road and transmission routes will be inputs to Task 2 and 8 studies. Field activities will be coordinated with the Task 5 activities.

The primary products of this task will include:

- Technical reports containing thorough documentation of all work done during the first year.

- Final technical reports containing thorough documentation for all studies during the first two years.

- Monthly management reports during the course of the investigation.

The technical reports will be accompanied by geologic maps showing locations of all controlling features, fault lines, etc.

Management reports will deal with technical and financial progress with respect to plan.

(iii) List of Subtasks

Subtask 4.01 - Review of Available Data
Subtask 4.02 - Short-term Seismologic Monitoring Program
Subtask 4.03 - Preliminary Reservoir Induced Seismicity
Subtask 4.04 - Remote Sensing Image Analysis
Subtask 4.05 - Seismic Geology Reconnaissance
Subtask 4.06 - Evaluation and Reporting
Subtask 4.07 - Preliminary Ground Motion Studies
Subtask 4.08 - Preliminary Analysis of Dam Stability
Subtask 4.09 - Long-term Seismologic Monitoring Program
Subtask 4.10 - Reservoir Induced Seismicity
Subtask 4.11 - Seismic Geology Field Studies
Subtask 4.12 - Evaluation and Reporting
Subtask 4.13 - Ground Motion Studies
Subtask 4.14 - Dam Stability
Subtask 4.15 - Soil Susceptibility to Seismically-Induced Failure

(iv) Subtask Scope Statements

Task 4 activities will be crucial in establishing the safety of dams and other structures under potential earthquake or induced seismicity conditions. The FERC license application for the selected Susitna project components must demonstrate convincingly that the maximum credible earthquake has been identified and the major structures have been properly designed to safely cope with such conditions.

Task 4 activites will be initiated immediately upon commencement of studies and will be designed to provide an effective basis for design of dams and other structures prior to submission of the FERC license application.

Task 4 activities have been subdivided into a total of fifteen packages arranged to include a program of field and office studies and installation of a monitoring system to adequately satisfy the most stringent requirements of dam safety. These activities will be appropriately coordinated with parallel geotechnical exploration and dam design efforts.

Subtask 4.01 - Review of Available Data

(a) Objective

To acquire, compile and review existing data and identify the earthquake setting of the Susitna River basin area.

(b) Approach

Data obtained under this subtask will be used to plan the details of the seismologic investigations (Subtasks 4.02, 4.03, 4.09 and 4.10) and the seismic geology field reconnaissance (Subtask 4.05). Available geological, seismological, and geophysical data for the region will be gathered from sources such as Woodward-Clyde files, the Department of Geologic and the Geophysical Institute of the University of Alaska, the Alaska Geological Survey, the U.S. Geological Survey and the major colleges and universities involved in research pertinent to the project. In addition, researchers with on-going programs of study will be contacted and the current status of their research will be obtained by discussions and written correspondence.

The acquisition of geological data will be concentrated on structural features of the earth that may represent major active faults. The geomorphic expressions of these features will also be identified from the available data.

Geophysical data regarding the structure of the earth will be acquired and reviewed. Regional gravity and magnetic data are particularly useful in identifying major discontinuities in the crust of the earth. These discontinuities may be along faults that could produce large earthquakes and surface fault ruptures. If available, other types of geophysical data such as seismic refraction, seismic reflection and electrical resistivity may also be of use in identifying major active faults.

Seismological data will be acquired for the project area. This data includes historical information on past earthquakes, instrumental data from the Geophysical Institute of the University of Alaska, and regional instrumental data from the U.S. Geological Survey.

The geological, seismological and geophysical data will be compiled in order to obtain a thorough current knowledge of the tectonics of the Susitna River area. The end product will consist of maps that identify faults, lineaments, and epicenter clusters or alignments identified by others. These maps will provide a basis for the proposed geological and seismological studies.

In addition to the data acquired for the project area, data relating to reservoir-induced seismicity will also be compiled. The world-wide data on reservoir-induced seismicity will provide a partial basis for evaluating whether or not induced earthquakes may be generated in the Susitna River area. Woodward-Clyde Consultants has an extensive file on world-wide data on reservoir-induced earthquakes, and is currently being retained for further research in reservoir-induced seismicity by the U.S. Geological Survey.

The specific products of this subtask include:

- Historical earthquake map and catalog

  A catalog of reported earthquakes with magnitude 4.0 and larger from 1899 to the present will be prepared for the region within 200 miles of the site. For the larger earthquakes in the period, the geologic and engineering effects will be discussed. Data quality as a function of time will be evaluated to estimate the completeness level of the catalog with respect to magnitude, focal depth and spatial location.

- Summary of recent regional monitoring

  Microearthquake monitoring by the University of Alaska Geophysical Institute and the U.S. Geological Survey will be reviewed and summary plots of seismicity data will be prepared. Results and interpretations based on these data will be reviewed with appropriate personnel in governmental and academic organizations. Of particular importance is evaluation of the accuracy of focal depth determinations based on these network studies.

- Tectonic model

  Based on available seismologic and geologic data, a preliminary kinematic tectonic model will be developed for the region within approximately 200 miles of the site. This model will be modified as needed by studies in later subtasks and will provide the basis for understanding the interrelated geologic source areas for future earthquake activity in the Alaskan interior. Applications and implications of seismic gap theory will be considered.

(c) Discussion

The seismicity and seismic sources of the Alaskan interior have only recently begun to be studied in significant detail. Interest in the seismicity of continental Alaska was stimulated by the major 1964 earthquake and involved the initiation of regional microearthquake monitoring and the augmentation of geological investigations to improve understanding of the tectonics of Alaska.

The seismological environment of the Susitna Project is characterized by two major earthquake sources:

- shallow earthquake activity occurring along crustal faults such as the Denali fault, with depth of focus less than approximately 12 miles; and

- earthquake activity in a Benioff zone which has a depth range of 30 to 90 miles and is associated with the subduction of the Pacific plate beneath Alaska.

Geological studies are used, along with seismological data, to investigate the shallow earthquake sources. The deeper-focus earthquake sources are not directly expressed at the earth's surface and must be investigated using seismological data combined with a kinematic understanding of the present-day tectonic activity of the Alaskan interior. The occurrence of past large earthquakes within the region, such as the 1904 and 1912 magnitude 7 to 8 earthquakes, indicates that both the shallow and deeper seismic zones may have the potential for generating earthquakes with ground motions significant to the project.

The Susitna River area is within a zone of active seismicity that extends from the Aleutian trough on the south into central and northern interior Alaska. Woodward-Clyde Consultants has previously conducted regional studies of seismic geology and seismicity over broad regions of Alaska. The past regional evaluations have been for the Trans-Alaska Pipeline System, the proposed Offshore Continental Shelf regions surrounding Alaska, and for the proposed Alcan Gas Pipeline. These past regional studies provide data regarding the earthquake sources in Alaska, and they also provide up-to-date knowledge of the current status of research in the area.

(d) Schedule

Weeks 0 through 22

Subtask 4.02 - Short-term Seismologic Monitoring Program

(a) Objective

Establish initial monitoring system, obtain and analyze basic seismologic data on potential earthquake sources within the Susitna River area and supply information required to implement a more thorough long-term monitoring program (Subtask 4.09).

(b) Approach

This subtask involves two major packages of work:

(1) Analysis of Existing Data

Further limited analysis of existing regional earthquake data will be undertaken to enable sufficiently accurate and appropriate selection of maximum earthquake sources and associated attenuation relationships. Source studies will be carried out on several of the largest historical earthquakes, including the 1904 and 1912 events, in order to constrain their location, local depth and causative geological structure. The maximum earthquake potential of the subduction zone beneath the Susitna site is poorly understood, and it will be of significant value to use the historical data to properly characterize this source. These studies will also be directed to the evaluation of the seismic attenuation characteristics of deeper earthquakes to enable the proper utilization of the results of the Alaskan OASES study by Woodward-Clyde Consultants (1978) and other studies in selecting appropriate attenuation relationships required for Subtask 4.07 and 4.13.

(2) Establishment of a Monitoring Network

Since the study area is in a remote but seismically active area additional detailed earthquake source data will be collected by installing and operating a localized microearthquake recording network.

The network will be established and operated during the summer of 1980. The area covered will include the region within approximately 30 miles of the dam sites. Eight to ten recorders with station spacing of 5 to 10 miles will be installed to record microearthquake activity down to magnitude of 1.0 or less. Low-power radio telemetery will be used to make the field operation as efficient as possible. Helicopter support will be used for installation and maintenance.

Initial station deployment will be guided by the information obtained during the data review (Subtask 4.01). It will be required to monitor known significant geologic features, such as the Susitna fault.

During the course of the study, some of the stations may be moved to study specific areas of activity. Data analysis will be carried out to locate active seismic sources and evaluate their spatial extent and focal depth. These analyses will also be used to establish causative stress orientations based on focal mechanism studies, to evaluate seismic attenuation, and to evaluate the statistical features of the microearthquake activity.

Specific results to be obtained relative to source and wave propagation assessment include the association of larger earthquakes (such as the 1904 and 1912 events) with probable source structures, depth determination of the Benioff Zone of deeper seismic activity and attenuation characteristics of subduction zone earthquakes. Seismic source location in terms of maximum earthquake potential in the Benioff Zone will be performed. Comparisons will be made with seismic activity in other comparable tectonic areas to assess attenuation and maximum earthquake potential. The scope of these studies will be modified as necessary on the basis of the results obtained as the work progresses.

Liaison will be maintained with data collection by the University of Alaska Geophysical Institute and the U.S. Geological Survey. The recording period is initially planned as three months; however, if this should need to be modified, appropriate recommendations will be made during the course of the study.

(c) Discussion

The present location and focal mechanism level using the Geophysical Institute network is approximately magnitude 2-1/2 or larger. The data obtained from the proposed monitoring program will supplement the existing regional network operations and will provide needed accuracy and detection threshold. In addition, the results obtained will provide the information needed to accurately site the long-term network stations (Subtask 4.09) and to select appropriate instrumentation. They will also aid in planning the seismic geology reconnaissance (Subtask 4.05).

(d) Schedule

Weeks 21 through 52

Subtask 4.03 - Preliminary Reservoir Induced Seismicity

(a) Objective

Evaluate the potential for the possible future occurrence of reservoir-induced seismicity (RIS) in the Susitna Project area.

(b) Approach

The results of this evaluation will be used to establish scenarios of possible outcomes of the occurrence reservoir induced seismicity. Woodward-Clyde Consultants has recently completed a major analysis of geologic, seismologic and hydrologic factors associated with past cases of reservoir-induced seismicity. The results of this study also will be applied to the known factors for the Susitna project in order to statistically relate the Susitna Project to the potential for RIS. The resulting potential will be evaluated in terms of possible scenarios for the occurrence of induced activity, and the possible outcome of such occurrences will be discussed.

This analysis will result in a quantitative assessment of the potential for the occurrence of reservoir-induced seismicity as a result of the damming of the Susitna River. A comparison will be made of depth, volume, regional stress, geologic setting and faulting at the Susitna dam sites with the same parameters as the world's deep and/ or very large reservoirs. Based on this comparison, the probability of reservoir-induced seismicity at the Susitna dam sites will be assessed.

A description of known cases of RIS emphasizing the relationship between filling of the reservoir and the length of time to the first and largest earthquakes and the relevance of these data to the Susitna dam sites will be discussed.

Scenarios will be presented that discuss possible courses of action that can be taken if RIS is anticipated or detected during filling of the reservoir.

(c) Discussion

The activities associated with this task will be closely coordinated with the hydraulic studies aimed at assessing the potential impact on the reservoir water level of a reservoir-induced slide. (See Subtask 3.06).

(d) Schedule

Weeks 23 through 50

Subtask 4.04 - Remote Sensing Image Analysis

(a) Objective

Select and interpret available remote sensing imagery to identify topographic features that may be associated with active faulting.

(b) Approach

Data obtained under this subtask will be used during the Seismic Geology Reconnaissance (Subtask 4.05) and the Seismic Geology Field Studies (Subtask 4.11) to identify youthful faults that may produce future earthquakes and future surface fault ruptures. Remote sensing imagery and aerial photography relevant to approximately 100 km radius about the dam site will be selected for a lineament analysis. This remote sensing data includes available Landsat, SLAR (side-landing airborne radar), Skylab photography; high altitude U-2, or RB-57 color infrared photographs, and black-and-white aerial photographs. The remote sensing and high altitude imagery and aerial photographs will be interpreted in terms of the geology, geomorphology and structure of the study region.

Interpretation will help to identify lineaments and other features that may be related to active faults. Seismicity clusters and alignments identified during the seismicity evaluation in Subtask 4.02 will be compared with the lineaments identified by the imagery interpretation and the known faults on existing maps to assess the possible relationship of the epicentral locations, surficial lineaments and mapped faults. The imagery interpretation will be conducted by geologists experienced in lineament evaluation and in the recognition of features associated with active faults. It will be important to distinguish these lineaments from similar features that result from non-tectonic geologic processes.

(c) Discussion

The activities in this task will be closely coordinated with the photo interpretation studies being conducted for the dam site, reservoir and constructed material areas (Subtask 5.02) to ensure that information requests and analyses are not duplicated. Following an initial aerial and ground reconnaissance it may be decided that low-sun-angle aerial photography should be acquired for specific geomorphic features that may be fault-related. For this purpose, low-sun-angle color infrared and black-and-white photography at a scale of approximately 1:24,000 is proposed. This has proven exceedingly valuable in delineating subtle topographic features that may be fault-related. The long shadows cast by the low-sun-angle highlight subtle topographic features related to faults, such as scarps or offsets, that would be undetectable with conventional vertical aerial photographs.

Color infrared photography has also proven extremely useful in delineating subtle features in the terrain such as a contrast in vegetation or in surface moisture. Such features are often associated with faults where ground water is either closest along the fault zone or on only one side of the fault.

A map of lineaments within 100 km of the project area will be produced as a guide for Subtasks 4.05 and 4.11. The lineament map will be supplemented by mapped faults from Subtask 4.01, in order to compare known faults with lineaments of various origins.

(d) Schedule

Aerial photographs will be ordered during the first month. The analysis will be performed during weeks 10 through 26.

Subtask 4.05 - Seismic Geology Reconnaissance

(a) Objective

Perform a reconnaissance investigation of known faults in the Susitna River area, and of lineaments that may be faults, identify active faults and establish priorities for more detailed field investigations.

(b) Approach

This task will utilize the data obtained from Subtask 4.01 and the aerial photographic interpretations outlined in Subtask 4.04 as a basis for planning aerial and ground reconnaissance.

The aerial reconnaissance will systematically cover all lineaments and faults identified in previous subtasks. A field analysis will be made in order to identify whether or not each feature may be an active fault capable of impacting the project area due to its being aassociated with a large earthquake or capable of producing a future surface fault rupture. Features within 60 miles of the project area will be studied during the reconnaissance, with each lineament and fault being identified by number. In addition, regional reconnaissance of major features such as the Denali fault and the Castle Mountain fault which may extend as far as 200 miles from the project area will be investigated. Interpretations regarding the origin of each feature will be made by expert seismic geologists with past experience on similar projects. Those features that are interpreted to originate from youthful faulting, or features of unknown origin that may be due to youthful faulting, will be studied further in the field and subjected to reconnaissance-level geologic mapping.

The reconnaissance-level geologic mapping will be oriented toward identifying whether or not the bedrock units near the feature suggest the presence or absence of a fault. In addition, the Quaternary geomorphic surfaces and stratigraphic units in proximity to each feature will be studied to aid in identifying whether or not faulting has occurred in young units. The reconnaissance-level mapping, at a scale of 1:63,360, will aid in identifying those features that will require detailed study during the field season of 1981.

These activities will be coordinated with the geologic mapping tasks associated in Subtask 5.04.

(c) Discussion

The Susitna River area is in a complex tectonic area that is poorly known geologically. Previous work by Kachadoorian and Moore emphasized the structural complexity of this area, and the large number of linear features at the surface that may be due to faulting or to other origins. These surface features require field investigation to identify their origins. In order to identify the origins of some features, it may require detailed mapping, trending, borings, or geophysical data. Despite thorough investigations, however, it may not be possible to obtain definitive information regarding the origins of all the lineaments.

Woodward-Clyde Consultants has conducted seismic geology reconnaissance investigations over large regions of Alaska and in many other seismically active areas of the world. Based upon that experience, we estimate that reconnaissance-level investigations as proposed in this subtask will define the origins of about 90 percent of the lineaments identified on remote sensing images. If these features are considered to be controlling faults for the design of dams and other important facilities, further detailed investigations will be undertaken in the Seismic Geology Field Studies, Subtask 4.11.

The products of this subtask will consist of a map that identifies recently active faults and features of unknown origins that may be faults significant to one or more dam sites and other critical facilities. In addition, all field observations will be tabulated for each lineament studied, and preliminary estimates of the maximum credible earthquake and faulting, along with the recurrences of faulting, will be made for each active fault and other features that may be faults.

(d) Schedule

Weeks 24 through 39

This task can begin after Subtask 4.04 is complete. Subtask 4.02 should either proceed concurrently with this subtask or it should precede this subtask.

Subtask 4.06 - Evaluation and Reporting

(a) Objectives

Complete a preliminary evaluation of the seismic environment of the project, define the earthquake source parameters required for earthquake engineering input in design and document the studies in reports suitable for use in design studies (Task 6).

(b) Approach

The approach of this subtask will be to provide a probabilistic analysis of earthquakes concerning control of active faulting, and to estimate maximum credible earthquakes for each active fault. These analyses will be completed by an interdisciplinary team utilizing the reconnaissance-level information obtained from Subtask 4.01 to 4.05. Reporting will be in a format suitable for use in selecting the design basis earthquakes, and will include thorough documentation that will be suitable for FERC and peer group review.

(c) Discussion

A panel of leading experts in seismology investigation and seismic design of major structures will be convened during this activity to review and comment on all study work undertaken and the findings thereof.

Overall management and coordination of Subtasks 4.01 to 4.05 is also incorporated in this subtask.

(d) Schedule

Weeks 18 through 52

Subtask 4.07 - Preliminary Ground Motion Studies

(a) Objective

Undertake a preliminary estimate of the ground motions (ground shaking) to which proposed project facilities may be subjected during earthquakes.

(b) Approach

The ground motion characteristics to be estimated include peak parameters (peak accelerations, velocities, and displacements), response spectra (describing the frequency content of ground shaking) and significant duration (describing the time duration of strong ground shaking). This initial assessment of ground motions will be made using information from the seismic geology (Subtask 4.05) and seismology (Subtask 4.02) studies. The ground motion estimates will be refined if necessary on the basis of additional information gathered during the second year. (See Subtask 4.13).

In consideration of ground motions, the terms "seismic exposure" and "seismic risk" are sometimes used interchangeably. However, for the purposes of this proposal they have two distinctly different meanings:

- "Seismic Exposure" is used to define the nature of the earthquake-induced ground motion characteristics at a specific site;

- "Seismic Risk" is used to define the risk as the probability of structural damage or destruction by an earthquake at the project site. It reflects the degree to which the structure has been designed to cope with earthquakes.

Ground motions will be estimated using a probabilistic approach, usually called a seismic exposure analysis. In this approach, the probability of exceeding various amplitudes of ground motion is estimated, taking into account the frequency of occurrence of earthquakes from all significant seismic sources and the attenuation of ground motion from each source to the locations of project facilities. Earthquakes of various magnitudes, up to the magnitudes of maximum credible events, will be considered. Attenuation relationships will be derived from examination and analyses of earthquake recordings made in similar tectonic environments and in similar subsurface geologic conditions, including available recordings from Alaska. WCC has recently conducted a comprehensive state-of-the-art analysis of seismic exposure in Alaskan offshore areas (OASES, 1978). The results and data of this previous study, which included assessment of activity for major onshore faults (e.g., Denali Fault, Castle Mountain fault) as well as offshore faults (e.g., Benioff zone), will be extremely valuable to the progress study.

The end products of this subtask will consist of estimates of the probability of exceedence during selected time periods (e.g., 100 years) of various levels of ground motions at the locations of each proposed major dam and other major facilities. For the long transmission lines and major access roads, the probability estimates will be given for appropriate segments of the systems. Probability levels and corresponding amplitudes of ground motions that may be considered in selecting project seismic design criteria will be discussed. For the dams, ground motion criteria will be consistent with ground motions associated with maximum credible earthquakes. For less critical project components, ground motion characteristics having a higher probability of exceedence would be used as design criteria.

(c) Discussion

It is widely recognized that neither the occurrence of future earthquakes nor the resulting ground motions at a site can be predicted with great accuracy even when the best available data and technology are employed. The fact is recognized in the above approach and considerable attention will be devoted to determining the reliability of the estimated design criteria.

The key interrelationships of this subtask and others are the following:

Projections of earthquake recurrence and identification of maximum credible earthquakes is an essential input to this subtask and will be accomplished in Subtask 4.06. The results of this subtask constitute essential input to Subtask 4.08 (Preliminary Analysis of Dam Stability) and Subtask 4.15 (Identification of Soils Susceptible to Seismically Induced Failure Along the Transmission Line and Access Road Routes).

The products of this task include the following:

- Estimates of the probability of exceedence during selected time periods (e.g., 100 years) of various degrees of ground motion at the location of each proposed major dam and other major project components.

- A discussion of and recommendations for project ground motion design criteria.

(d) Schedule

Weeks 24 through 52

Subtask 4.08 - Preliminary Analysis of Dam Stability

(a) Objective

Make preliminary evaluations of the seismic stability of proposed earth, rockfill and/or concrete dams during maximum credible earthquakes.

(b) Approach

These evaluations will be of a conceptual nature and will be undertaken as input to Task 6 design studies and determinations of the impact of seismicity on dam costs; i.e., on the requirements for design and/or treatment of foundations, design of dams, construction materials and placement requirements.

The preliminary evaluation of the adequacy of designs of earth and rockfill dams to resist seismic ground shaking will involve the following steps:

- Evaluation of strength characteristics under seismic loading conditions of in situ soils left in place in earth or rockfill dam foundations.

- Evaluation of key static and dynamic properties of embankment materials. Particularly important properties are the static and cyclic strength characteristics and permeability.

- Assessment of the potential for landsliding and large deformations through embankment or concrete dams and foundation during or following seismic ground shaking.

The cyclic strength characteristics of foundation soils will be assessed on the basis of field boring data and laboratory index and classification test data. For unfrozen sands in the foundation, blow counts from standard penetration tests (SPT's) in borings will be used to evaluate the resistance of the soils to liquefaction. Properties of embankment materials will be estimated on the basis of general description, grain size distributions and compaction requirements of proposed borrow materials. This information will be supplemented by the experience of the project staff and information obtained from published data. In addition, approximately six dynamic cyclic tests of proposed embankment or foundation materials are planned. The results of these tests will be compared with data for similar materials available in published literature and in the files of WCC.

The potential for landsliding in the embankments and their foundations will be analyzed using simplified analytical approaches and experience in similar studies. The key evaluations that are needed for the assessment of dam behavior are:

- the potential for generation and dissipation of excess pore water pressures in the materials during and following an earthquake (strongly dependent on permeability).

- the potential for sliding using conventional stability analysis approaches and taking into account the effect of seismically-induced pore pressures on soil and rockfill strengths.

(c) Discussion

The execution of this subtask will involve an iterative approach. For the initial designs, the experience of the project team will be used to establish broad guidelines for material selection and design. These designs will be evaluated for seismic stability. These results will then be used to modify, if necessary, the designs which in turn may be checked by a second evaluation.

The interrelationships of this subtask to others are the following:

- input is required from Subtasks 4.07 - Preliminary Ground Motion Studies, Task 5 - Geotechnical Exploration and Task 6 - Design Development. Task 6 input will be particularly required from the subtasks dealing with preliminary designs of dams and descriptions of construction materials and placement requirements.

- outputs of this subtask will be used as input to Task 6 - Design Development, particularly for preliminary dam design.

The products of this subtask are:

- Preliminary evaluation of the seismic stability of embankment cross sections subject to maximum credible earthquake loading.

- Recommendations for changes in preliminary embankment cross sections, material compaction requirements, and foundation treatment if required for increasing seismic stability.

- Preliminary evaluations of requirements for design of concrete dams (arch or gravity, as required).

The required dynamic analyses of the embankments will be undertaken under Task 6 activities. Woodward-Clyde Consultants will provide ongoing consulting services for these analyses, under Subtask 4.14.

(d) Schedule

Weeks 50 through 85

Subtask 4.09 - Long-term Seismologic Monitoring Program

(a) Objective

Develop a long-term seismologic monitoring program to provide a continuing source of seismological data for refinement of the seismic design aspects of the project during the detailed design phase.

(b) Approach

Based on the experience gained with the short-term seismologic monitoring program (Subtask 4.02) a detailed program of long-term monitoring and data analysis will be designed for implementation prior to the license award. This program will be designed to determine the background level of seismic activity on shallow crustal faults pertinent to the evaluation of possible reservoir-induced seismicity. Emphasis will therefore be placed on providing an inexpensive, reliable data collection facility and flexibility analysis procedures.

(c) Discussion

The long-term seismologic monitoring program will be developed on the understanding that arrangements will be made by APA for continued operation of the system and evaluation of data through construction of the Susitna Project and beyond. Appropriate documentation and operating manuals will be prepared for this purpose.

(d) Schedule

Weeks 100 through 130

Subtask 4.10 - Reservoir-Induced Seismicity

(a) Objective

To refine the estimate for the potential for reservoir induced seismicity made in Subtask 4.03.

(b) Approach

The additional field data collected in Subtask 4.11 will be incorporated in a reassessment of the work done in Subtask 4.03.

(c) Schedule

Weeks 83 through 91

Subtask 4.11 - Seismic Geology Field Studies

(a) Objectives

Perform seismic geology field studies to identify faults that may be active and in the vicinity of the selected dam sites.

(b) Approach

These data will be used in the final evaluation to identify the maximum credible earthquakes on each fault, and the recurrence of faulting and earthquakes along each fault. The results of this subtask will be used as input to Subtask 4.12 - Evaluation and Reporting. Planning of the field studies will be based on the results of Subtask 4.05 - Seismic Geology Reconnaissance and of Subtask 4.04 - Remote Sensing Image Analyses. We will also ensure that field studies be pursued at features that may affect project design at selected dam sites.

The subtask will include the following investigations which will be specifically designed for each feature to be studied:

- geologic mapping at a scale of 1:24,000.
- trenching of selected features
- borings
- test pits
- geophysical investigations
- age dating.

Compared to the work done in Subtask 4.05, the geologic mapping will include more detailed Quaternary data, and bedrock mapping at selected places along specific lineaments and geologic features (e.g. the Susitna fault and other features that may be fault-related). Age-dating studies will be undertaken to aid in the identification and correlation of geologic units. Trenches excavated across features that may be fault-related, or borings on either side of these features, will be used to aid evaluation of these features. The trenching (or boring) sites will be selected during the geologic mapping phase and will be located in areas considered suitable for assessing the nature of the faults and the degree of fault activity.

It is currently anticipated that approximately three trenching sites will be identified, with two trenches at each site. One site will be located along the Susitna fault, and an additional three sites along other features that are preliminarily identified as controlling features. During the course of the study, geophysical investigations (including seismic refraction lines and gravity or magnetic surveys) will also be undertaken to aid in locating and evaluating the faults and the nature of the faulting.

(c) Discussion

All of the field exploratory work outlined above is incorporated in Subtask 5.06.

The data derived from these geologic studies on controlling features will be evaluated to assess the potential of these features as seismic sources. This process will include refining the estimate of the maximum magnitude of an earthquake that may occur along the feature, the frequency of occurrence of seismic events along the feature, the focal mechanism of the event, the distances from the dam sites at which the event may occur and the type of faulting and the amount of fault displacement that may occur on these features. This data will form the basis for design values derived in Subtask 4.12.

Products derived from this Subtask will include:

- Documentation, tabulation, and an assessment of lineaments, mapped faults, and epicenter locations identified as potential controlling features,

- A map (scale 1:24,000) of the selected controlling features in the vicinity of the dam site,

- A geologic map (scale 1:24,000) and selected areas along the controlling features,

- Trench logs or core data of excavations or borings undertaken to evaluate the controlling features,

- The interpretation of geophysical data collected along the controlling features,

- Estimates of the maximum earthquake, the type of faulting and the amount of displacement that may occur during that event, the distance of the earthquake from the damsites and the frequency of occurrence of earthquakes of that magnitude along each controlling feature,

- An evaluation of significant, related seismic effects that may occur in the dam site and reservoir area.

(d) Schedule

Weeks 64 through 95

Subtask 4.12 - Evaluation and Reporting

(a) Objectives

To refine the evaluation of the seismic environment and the earthquake source parameters derived in Subtask 4.06, complete the reporting of all the fieldwork and studies undertaken in Subtasks 4.01, 4.05 and 4.09 to 4.11, and provide coordination and management to Subtasks 4.09 to 4.11.

(b) Approach

All the additional field data collected for the Long-Term Monitoring Program - Subtask 4.09, Reservoir-Induced Seismicity - Subtask 4.10 and Sesimic Geology Field Studies - Subtask 4.11 will be utilized to refine the preliminary evaluations undertaken in Subtask 4.06. The same basic methodologies as employed in Subtask 4.06 will be used.

The seismic review panel will again be convened during this subtask.

(c) Schedule

Weeks 52 through 104

Subtask 4.13 - Ground Motion Studies

(a) Objectives

Refine the estimate of ground motion characteristics made in Subtask 4.07.

(b) Approach

Based on the additional information gathered during the second year of the study, the work done in Subtask 4.07 will be reviewed, and, if necessary, appropriate adjustments will be made.

(c) Schedule

Weeks 75 through 104

Subtask 4.14 - Dam Stability Consulting Services

(a) Objective

To provide consulting assistance to the Acres design group engaged in the feasibility design of the dams.

(b) Approach

During the feasibility design stage Acres will undertake all the necessary dynamic analyses required to complete the design of the dams under Task 6 - Design Development Activities. WCC will act in a general consultancy role and respond to specific questions raised by the Acres' team. The seismic review panel will also be consulted under this subtask.

(c) Schedule

Weeks 85 through 120

Subtask 4.15 - Soil Susceptibility to Seismically-Induced Failure

(a) Objective

Identify those areas along the transmission line and major access road routes that appear to be underlain by soils particularly susceptible to seismically-induced ground failure such as liquefaction or landsliding.

(b) Approach

The intent of this subtask is not to provide detailed design-level evaluations of soil failure potential. Rather it is to identify those areas having conditions that could significantly affect costs of transmission lines or access roads by requiring rerouting, special designs or contingency measures.

This subtask will be accomplished by a review of the geologic mapping, soils data, topographic data and estimated seismic ground motions (Subtask 4.07) along the routes. The identification of failure-susceptible soils will be accomplished mainly on the basis of experience in performance of soil deposits during earthquakes. Simplified analytical approaches and empirical correlations will be used to aid in assessing the potential for liquefaction of unfrozen, saturated, cohesionless sands. Possible remedial measures for areas of high failure potential will be briefly described. These include rerouting, special foundations, soil excavation and/or filling.

(c) Discussion

The results of this subtask will enable estimates to be made of additional costs required for design and construction of facilities due to seismicially-induced soil failure potential. However, if the consequences of failure are not too severe, and/or if the probability of damaging earthquake ground motions is low, it may be appropriate to utilize conventional designs but to provide contingency plans and budgets for repairs. For example, considerable lateral spreading and settlements of access roads might be acceptable consequences during an earthquake but would generate additional repair cost to the project.

Inputs to this subtask will be obtained from Subtask 4.07 - Ground Motion Studies, Subtask 5.04 - Field Program 80, and Subtask 5.06 - Field Program 81. Outputs from this task will be utilized in the design and costing of these facilities.

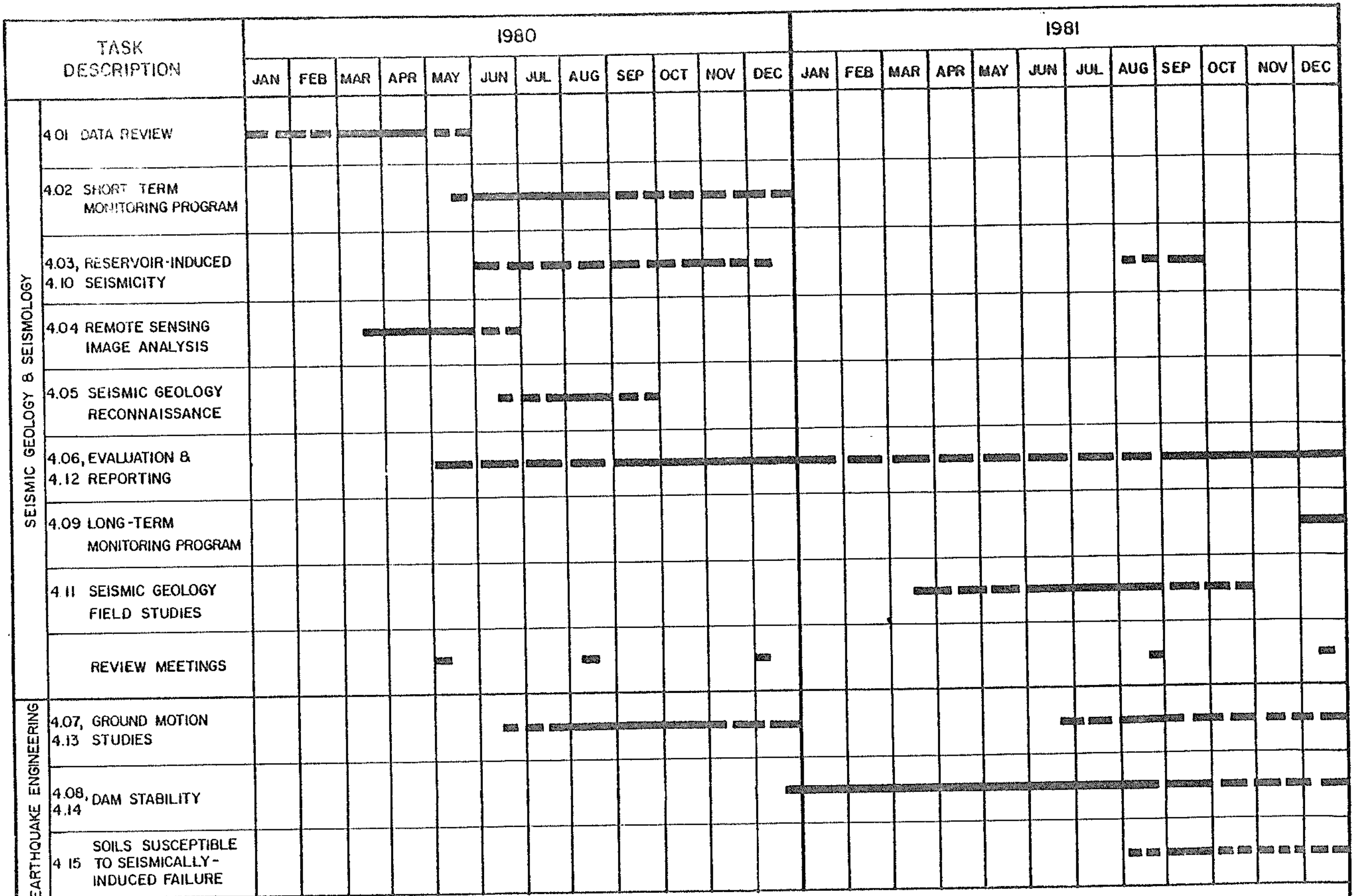
The products of this subtask are:

- Delineation on maps and/or in tabular form of areas having high potential for seismically induced ground failure.

- Brief descriptions of possible remedial measures for facilities in areas of high failure potential.

(d) Schedule

Weeks 83 through 104 (See Plate T4.1)



SUSITNA HYDROELECTRIC PROJECT

PLAN OF STUDY

PLATE T4.1: TASK 4 SCHEDULE

A.5.6 - TASK 5: GEOTECHNICAL EXPLORATION

(i) Task Objectives

To determine the surface and subsurface geology and geotechnical conditions for the feasibility studies of the proposed Susitna Hydroelectric Project, including the access roads and the transmission lines.

(ii) Task Output

The Task 5 studies will be designed to provide input to the Task 6 design studies and will provide support to the Task 4 studies.

The primary outputs of Task 5 will consist of comprehensive documentation of geotechnical exploration undertaken at the Devil Canyon and Watana sites, reservoirs, and access roads and transmission line routes. This documentation will include the following:

- geologic maps
- geologic sections
- descriptive and graphic borehole logs
- descriptive test trench logs
- field inspection borehole and test trench logs
- photogeologic maps
- borehole rock core photographs
- low level air photointerpretation
- seismic and resistivity bedrock profiles
- radar imagery interpretation maps
- geotechnical exploration program summaries (1980, 1981, 1982)
- data summaries for
  - -- in-hole seismic testing
  - -- borehole camera studies
  - -- laboratory testing.
- geotechnical exploration summary reports (1980, 1981)

(iii) List of Subtasks

Subtask 5.01 - Data Collection and Review
Subtask 5.02 - Photointerpretation
Subtask 5.03 - Exploratory Program Design (1980)
Subtask 5.04 - Exploratory Program (1980)
Subtask 5.05 - Exploratory Program Design (1981)
Subtask 5.06 - Exploratory Program (1981)
Subtask 5.07 - Exploratory Program Design (1982)
Subtask 5.08 - Data Compilation

(iv) Subtask Scope Statements

For the purposes of this Plan of Study, the geotechnical exploratory programs are essentially divided into first-, second- and third-year stages (1980, 1981 and 1982). Exploratory work to be undertaken in 1982 and beyond is not included in Task 5 activities. Preparation of the program for 1982 is nevertheless included on the understanding that the 1982 program will be initiated prior to submission of the FERC license application, but is not an essential prerequisite to that submission. The 1980 geotechnical exploration program will be designed to identify and investigate in limited detail those geological and geotechnical conditions which will significantly affect the feasibility of the proposed dam projects. Limited preplanning opportunities and climatic constraints are such that investigations in 1980 will be somewhat limited in scope, and the data limited in detail. Emphasis will therefore be placed on identifying and investigating to the maximum extent the most adverse geotechnical conditions encountered.

The objectives of the 1981 geotechncial exploration program will be to investigate in more detail those geological and geotechnical conditions, both general and adverse, which will significantly affect the design and construction of the proposed dam projects. Exploration along the routes selected for the access roads and transmission lines will also be undertaken in 1981. Although the scope of the exploratory work and the data produced in 1981 will still be somewhat limited, the exploratory program will be designed to establish with reasonable confidence the feasibility and total cost of the project, access roads and transmission lines. The exploratory program in 1982 will be yet more detailed. This and subsequent programs will be aimed at providing greater certainty in the design of major dams and structures with a view towards further ensuring the safety of structures while minimizing potential project cost overruns due to unforeseen geotechnical design conditions. The geotechncal exploration programs will be specifically designed to be complementary to the work already completed.

The geotechnical exploration programs in the field will also be severely constrained by difficulties of access and maneuverability of equipment imposed by weather conditions and the requirements for environmental preservation. Full account has been taken of these constraints in developing this Plan of Study.

A detailed discussion of the individual subtasks follows. It should be stressed that the exploration program design is based on the assumption that Watana and Devil Canyon are the selected sites.

Subtask 5.01 - Data Collection and Review

(a) Objective

Collect and review all existing geological and geotechnical data pertaining to the Susitna Project area, including the access road and transmission line corridors and the Susitna River basin.

(b) Approach

Data to be collected at this stage include, but are not limited to the following:

- previous regional and site geological mapping and studies
- published or unpublished geological and geotechnical data and reports from federal, state, academic or private sources
- air photos and high level ERTS photos of the project area, including the proposed access road and transmission line
- geophysical survey, remote sensing and seismicity studies and data pertaining or relevant to the project

A short field visit will be made to the proposed damsites for preliminary geologic interpretation. This will assist in making the preliminary damsite and dam alignment selections in Task 6. This in turn will determine the design of the exploratory investigation program. The data and results of review will be assembled into a brief report with appropriate appendices. These documents will be made available for subsequent use by all project design and study groups.

Borehole rock cores from previous investigations will also be examined in Anchorage. Contacts will be made with the University of Alaska to gather geologic and geotechnical data. A check will be made for mining interests in the project areas. Data pertaining to geological and geotechnical problems associated with the construction of large embankments, access roads and transmission lines will be collected. Discussions will be held with the U.S Corps of Engineers concerning details of the past field studies.

This task will be undertaken by Acres' Anchorage staff with appropriate support from R&M Consultants.

(c) Schedule

Week 0 through 9

Subtask 5.02 - Photointerpretation

(a) Objective

Perform air photointerpretation and terrain analysis of the Watana and Devil Canyon damsite areas, reservoir areas, construction material borrow areas and access road and transmission line corridors, and identify adverse geological features and geotechnical conditions that would signficantly affect the design and construction of the project features.

(b) Approach

Photointerpretation will be based on available air photography obtained under Subtask 5.01, and new aerial photos of a larger scale obtained under Task 2 for the damsites, reservoirs, and construction materials borrow areas, access road and transmission line corridors.

The initial photoanalysis will utilize existing air photos obtained either from private or government sources. These photos are believed to be high level and consequently small scale. They will, however, serve to establish preliminary surface geology, including geomorphology, geologic history, glacial geology, lithology and stratigraphy, structural geology, permafrost characteristics and geohydrology and engineering geology. Land forms will be identified. Alluvial or glaciofluvial deposits of previous sand and gravel, glacial deposits of impervious till and floodplain deposits of poorly drained, compressible silty materials will be located. The distribution, quality and stratigraphic relationships of rock types will be identified.

Photo analysis will also be used to generally delineate or infer permafrost areas and buried channels. Groundwater regimes will also be studied and unstable and/or erodible slopes identified.

A short field study will be required to verify the photointerpretation analysis. This will be performed early in the first field season (1980).

(c) Discussion

New air photos produced under Task 2 will be available at the end of the first field season. These low level, high resolution, large scale photos will have two purposes:

- preparation of second year exploratory investigation program
- production of accurate topographic maps on which to base subsequent geological mapping and design studies.

Photointerpretation under this subtask will be undertaken by Acres' Anchorage staff and closely coordinated with the photointerpretation work done by WCC (Subtask 4.05) in order to eliminate unnecessary duplication of work.

The results of photointerpretation will be documented in the form of brief summary reports and appended photographs and maps to highlight the principal findings.

(d) Schedule

Weeks 5 through 41

Subtask 5.03 - Exploratory Program Design (1980)

(a) Objective

Design the geotechnical exploratory investigation programs for 1980 for Watana and Devil Canyon damsites, dam construction materials, and reservoir areas, and along the access road route.

(b) Approach

The design of the various exploratory investigations will be based on the results of the data collection and review study (Subtask 5.01) and the air-photo interpretation study (Subtask 5.02). Input from the preliminary access road studies under Task 2 will also be required.

Generally, these exploratory investigations will consist of geologic mapping, auger drilling and sampling, test trenching, seismic and resistivity studies, airborne radar imagery techniques and laboratory testing. In cases where environmental damage is a problem or accessibility is poor, test trenches will be replaced by shallow auger drilling by helicopter. The design will specify the following details:

- area to be geologically mapped
- position and extent of seismic and resistivity lines
- areas to be investigated by airborne radar imagery techniques
- types and numbers of laboratory tests.

Investigations for access roads will be confined to geologic mapping and radar imagery. Table A5.4 and A5.5 detail the type and extent of investigations and laboratory testing that are currently proposed elsewhere. The design of the exploratory investigations will be flexible enough to permit changes during the execution of the work. These changes will become evident as the field studies proceed.

(c) Discussion

Work under this subtask will be performed by Acres' Anchorage staff with support in logistical planning provided by R&M and close liaison with WCC.

In the design of the exploratory investigations, full advantage will be taken of the extensive investigations previously undertaken. These include drilling, test pitting, geologic mapping and seismic surveys by the US Corps of Engineers at Watana damsite, and the drilling investigations and seismic studies at Devil Canyon by the US Corps of Engineers and the US Bureau of Reclamation.

- Watana Site

At the Watana damsite area, 17 boreholes have been drilled for a total of 3,340 feet and 11 boreholes have been drilled, totalling 1,815 feet in the right bank spillway and buried channel area. Reconnaissance reservoir mapping and fault mapping has been performed by Kachadoorian. A total of 19 auger and diamond drill

TABLE A5.4

PROPOSED GEOTECHNICAL EXPLORATORY PROGRAM - 1980

Area	Exploration	PROJECT STRUCTURES/FACILITIES: Devil Canyon Dam & Reservoir	PROJECT STRUCTURES/FACILITIES: Watana Dam & Reservoir
Damsite	Geologic Mapping	yes	yes
	Geophysical (seismic and resistivity)	3 - 900 ft. lines at buried channel site 3 - Oblique 450 ft. lines across river channel 2 - 1,000 ft. lines on right abutment	1 - 5,000 ft. line at proposed spillway site 2 - Oblique 1,500 ft. lines across river within upstream portion of dam
	Diamond Drilling	1000 ft.	600 ft.
	Airborne radar imagery	+ 3,500 ft. at right and left abutment and saddle dam site	+ 4,000 ft. at right and left abutments
Dam Construction Materials		One established and two new borrow areas	Four established and two new borrow areas
	Geologic Mapping	yes	yes
	Portable Auger Drilling	20 - 10 ft. deep holes in the two proposed borrow areas	20 - 10 ft. deep holes in the two proposed borrow areas
	Geophysical (seismic and resistivity)	2 - 1,000 ft. lines in the two proposed borrow areas	2 - 1,000 ft. lines in the two proposed borrow areas
	Test Trenches	30 trenches in the three borrow areas	30 trenches in threen of borrow areas
	Airborne Radar Imagery	6 - 1,000 ft. lines in the three borrow areas	8 - 1,000 ft. lines in four of the borrow areas
Reservoir Basin	Geologic Mapping	yes	yes
	Portable Auger Drilling	10 - 10 ft. deep holes	10 - 10 ft. deep holes
	Geophysical (seismic)	2,000 ft.	6,000 ft. at site of right bank relict channel
	Diamond Drilling	100 ft.	100 ft.
	Airborne Radar Imagery	10,000 ft.	20,000 ft.

TABLE A5.5

PROPOSED GEOTECHNICAL EXPLORATORY PROGRAM - 1981

		POWER STRUCTURES/FACILITIES		
Area	Type of Exploration	Devil Canyon Dam & Reservoir	Watana Dam & Reservoir	Other
Damsite	Geologic Mapping	yes	yes	
	Diamond Drilling	4 holes in right abutment (power-house and dam) 4 holes in left abutment (saddle dam and diversion tunnel) 3 holes in riverbed*	2 holes in relict channel, right abutment 2 holes in right abutment spillway and dam) 2 holes in left abutment (power-house and dam)**	
	In-hole Seismic	1500 ft.	1000 ft.	
	Borehole Camera	1500 ft.	1200 ft.	
	Test Trenching	15 trenches	15 trenches	
Dam Construction Materials		Three borrow areas from 1980 program plus two new areas	Six borrow areas from 1980 program plus two new areas	
	Auger Drilling	10 - 30 ft. deep holes	12 - 30 ft. deep holes	
	Diamond Drilling	10 - 50 ft. deep holes in five borrow areas	12 - 50 ft. deep holes in six borrow areas	
	Test Trenching	30 trenches in two new areas	30 trenches in two new areas	
Reservoir Basin	Geologic Mapping	yes	yes	
	Portable Auger Drilling	10 - 10 ft. deep holes	10 - 10 ft. deep holes	
	Diamond Drilling	3 - 100 ft. deep holes, 1 - 200 ft.	3 - 100 ft. deep holes, 1 - 200 ft.	
	Geophysical/Seismic	1000 ft.	1000 ft.	
	Reservoir Slope Monitoring	1 - 200 ft. slope indicators	1 - 200 ft. slope indicator	
Access Road Route (Approx. 50 miles)				ACCESS ROAD
	Geologic Mapping			yes
	Airborne Radar Imagery			10 miles (20% of total length)
	Portable Auger Drilling			25 - 10 ft. deep holes
	Hollow Stem Auger / Diamond Drilling			15 - 50 ft. deep holes

holes and 26 test pits have been made in the construction material areas. A total of 69,600 feet of seismic surveys has also been completed.

These investigations have tentatively shown the Watana site to be suitable for an earth and rock-fill dam. The dam foundation contains small shear zones but no major shear zones have been found. Construction materials appear to be available and suitable. Although the important Susitna fault traverses the reservoir, no active faults have as yet been proven in the reservoir. There has been a suggestion that the Tsusena Creek alignment downstream of the dam may represent discontinuity of some kind. Discontinuous permafrost exists locally. Overburden depth in the riverbed at the site appears to be less than 80 feet. A deep buried and potentially leaky channel exists in the right abutment.

Further studies at Watana are required to prove the absence of major faults in the riverbed and in the abutments, to delineate permafrost zones and identify its characteristics, prove the availability and suitability of the construction materials, confirm good quality rock in the spillway and powerhouse area and define the buried channel and identify its geohydrologic properties.

- Devil Canyon Site

At the Devil Canyon damsite, 13 boreholes totalling 1,350 feet have been drilled in the dam area and another eight boreholes totalling 735 feet have been drilled in the left abutment buried channel area. Nineteen test trenches have been excavated in potential borrow areas. A total of 3,300 feet of seismic surveys have been performed. Although there has been little geologic mapping of the abutments at Devil Canyon, the investigations have shown this site to be suitable for a concrete gravity structure.

Major shear zones have not been found in the dam foundation area but minor shear zones are present. Although no active faults have been found in the reservoir, a deep buried channel exists in the left abutment. Some potential construction material areas have been identified.

Further studies at Devil Canyon are required to prove the absence of major faulting in the riverbed and abutments or active faults in the reservoir. Studies are also needed to determine the site geology in more detail, to delineate and evaluate the left abutment buried channel and to prove the availability and suitability of construction materials.

(d) Schedule

Weeks 12 through 20

Subtask 5.04 - Exploratory Program (1980)

(a) Objective

Perform initial surface and subsurface investigations at Watana and Devil Canyon sites and reservoir areas and access road routes to establish general and specific geological and foundation conditions.

(b) Approach

The program will essentially be designed to

- obtain more details on the surface and subsurface geology and foundation conditions at the Watana and Devil Canyon damsites.
- complete the preliminary evaluation of the availability and suitability of the various construction materials required, i.e. fine and coarse aggregate, fine and coarse rockfill, impervious earth fill, pervious and semipervious granular fill and riprap.
- determine the surface geology and geotechnical conditions in limited detail to the Watana and Devil Canyon reservoir areas.
- provide preliminary geologic assessments of the proposed access road routes.

Field work programs will generally be designed by Acres' Anchorage office personnel with input from the Buffalo design group as needed. Seismologic input will be provided by WCC and logistical support by R&M. All field operations will be performed by R&M with appropriate technical inspection and supervision by Acres and to a lesser extent the WCC staff.

(c) Damsites

The proposed exploratory investigations will supplement previous work in establishing general and specific surface and subsurface geologic and foundation conditions at the Devil Canyon and Watana damsite areas.

The investigations will comprise geologic mapping, diamond drilling, geophysical, seismic and resistivity studies and airborne radar imagery, to substantiate and augment the available information on

- depth, distribution, type, stratigraphy and properties of overburden
- distribution, type, quality, degree of weathering and permeability of bedrock
- location, orientation, width, continuity, filling characteristics and capability of major discontinuities in bedrock such as faults

- orientation, frequency, opening, continuity and filling of joints in bedrock

- permafrost characteristics including location, temperature profile and soil type

- groundwater regime

Emphasis will be placed on locating and studying adverse geological features. Such features will include faults, excessive depths of overburden in riverbeds and buried channels which will signficantly effect the design and cost of a dam project at a given site.

The geologic mapping at Watana and Devil Canyon damsites will be undertaken to supplement and verify the previous geological mapping carried out by the U.S. Corps of Engineers and the U.S. Geological Survey (Kachadoorian).

The photointerpretation (Subtask 5.02) will be checked in the field, and adverse geologic features and conditions suggested in the photointerpretation will be investigated on the ground. The geologic mapping will utilize the most recent topographic maps. Aerial photos and survey lines normal to the river will be used as reference in the field. The geologic mapping will be performed primarily by Acres' Anchorage office personnel with assistance from R&M.

Geophysical seismic refraction and resistivity studies will be carried out primarily to determine bedrock depth in deep overburden areas such as buried relict channels and the riverbed area. This work will be done at both damsites. Seismic work can be misleading in permafrost regimes and resistivity provides a reasonable alternative.

Bedrock depth profiles will be prepared from these studies. Airborne radar imagery will be used to delineate the areas of permafrost. The geophysical work, including the interpretation, will be undertaken by R&M, with review and liaison by Acres' Anchorage office personnel.

(d) Construction Materials

The exploratory investigations for construction materials will comprise geological mapping, portable auger drilling, geophysical seismic and resistivity studies, test trenching and laboratory testing.

The geologic mapping, drilling, trenching and geophysical work will generally be used to establish the limits, depth, stratigraphy, type and properties of the borrow materials. The limits, type and properties of potential quarry rock will be similarly determined. The explorations will also serve to verify the photointerpretation and previous studies by the Corps of Engineers. Groundwater and permafrost conditions will be investigated and extensive soil sampling undertaken. Rock outcrops will be mapped and test trenches excavated by small track-mounted backhoes to a depth of about 13 feet.

Geophysical techniques such as seismic refraction and resistivity will be used to prove the depth of the potential borrow materials and the groundwater depth. Airborne radar imagery or low sun angle air photos will be used to assist in identifying the permafrost areas.

A moderate amount of laboratory testing of the borrow material will be conducted at this stage. The testing will comprise routine soil identification tests including unit weight, moisture content, consistency, Atterberg limits and gradation.

Standard Proctor compaction tests will also be performed on pervious and impervious material and permeability of compacted impervious materials assessed. Some dynamic shear strength tests under high confining pressures will also be performed on impervious and pervious materials. Potential concrete aggregate samples will be tested for sodium sulfate soundness, acidity and Los Angeles abrasion characteristics.

All field exploration work under this subtask will be undertaken by R&M. Laboratory testing on borrow material will be performed by R&M with some assistance from WCC .

Design liaison, supervision and review will be provided by Acres' Anchorage office personnel.

(e) Reservoir Areas

The exploratory investigations to be carried out for the reservoir areas will include geologic mapping, portable auger drilling and geophysical seismic refraction surveys.

The primary aim will be to map those geological features and geotechnical conditions in the reservoir area which may seriously affect the reservoir performance. Such features may include previous buried channels or faults in the reservoir rim which may jeopardize the reservoir watertightness, faults which may be activated under reservoir impounding and natural slopes which may become unstable or erodible with reservoir impounding or reservoir drawdown.

The geologic mapping will be on a reconnaissance scale. The air-photo interpretation (Subtask 5.02) will be checked on the ground and specific adverse features suggested in the photointerpretation will be investigated. The distribution, type and properties of overburden and bedrock materials will be checked against the photointerpretation. Portable auger drills will be used to drill shallow holes to assist in establishing the subsurface geology and geologic history. Low sun angle air photos or airborne radar imagery techniques will be utilized to help delineate general permafrost areas which may cause unstable slopes once the reservoir is impounded. Specific test areas will be identified in which auger borings utilizing a modified CRREL core barrel will be used to sample permafrost. Thermal probes will be installed in the holes to determine temperature profiles.

No buried channels have been found to date in the reservoir rim. If such channels are suggested in the photointerpretation, geophysical seismic studies will be initiated to determine the depth and nature of the overburden and channel widths.

A relatively minor amount of laboratory testing will also be undertaken in this phase. This will comprise routine soils identification tests on those samples taken in the reservoir studies.

All field and laboratory work undertaken under this subtask will be performed by R&M. Design liaison, supervision and review will be provided by Acres' Anchorage office personnel.

(f) Schedule

Weeks 20 through 40

Subtask 5.05 - Exploratory Program Design (1981)

(a) Objective

Design the geotechnical exploratory investigation programs for 1981 for Watana and Devil Canyon damsites, dam construction materials and reservoir areas, and for the selected access road and the transmission line routes.

(b) Approach

The design of the 1981 program will be determined to a large extent by the results of the 1980 investigations and other preliminary design activities in progress.

The 1981 investigations will be by means of a confirmation of the 1980 program of geologic mapping, auger drilling and sampling, test trenching, seismic and resistivity studies, airborne radar imagery techniques and laboratory testing. In addition, diamond drilling and in-hole seismic, borehole camera and instrumentation studies will be performed. The program will be designed to obtain more detailed information on the subsurface geology in general, on rock mass deformation properties, rock mass jointing characteristics and slope movement. Locations, depths and inclinations of the boreholes and methods and priorities of drilling will be defined, together with identification of which holes will be tested by in-hole seismic methods or studied by borehole camera.

The design of the exploratory investigations for the access road and transmission line will also be performed in this subtask. The access road and transmission line corridors will traverse terrain varying from flat, wet marshland and soft overburden to dry, sloping rock hillsides. No field investigations have been performed to date on the access road or transmission line.

Explorations along the selected transmission and access road routes will include drilling and sampling. To comply with environmental constraints, it is anticipated that this exploration will be undertaken using track-mounted hollow-stem auger drill rigs during the winter months of February and/or March. In wooded areas, helicopter supported auger rigs will be used to permit access. Exploratory investigations for the road will include delineation of areas of permafrost, unstable slopes, soft foundations and availability and suitability of construction materials. Investigations for the transmission line will be similar but will also be planned to determine probable tower foundation conditions.

Tables A5.4 and A5.5 outline the details of the proposed 1981 investigation and testing program as currently anticipated.

Design of the 1981 field program will take full account of the constraints necessary to comply with federal and state permit requirements.

(c) Discussion

The program envisaged at this time has been based on selection of the Watana and Devil Canyon sites for development. Preparation of the program design will be closely coordinated with activities of Tasks 2, 4, 6 and 8. This will ensure that the data obtained will provide cost effective input to the selected locations and designs of major structures, particularly the dams.

The field exploration data will be used to confirm or appropriately modify the adopted design criteria for embankment construction materials and foundations. Emphasis will be placed on ensuring the safety of structures and the minimization of potential construction cost overruns.

Work under this subtask will be performed by Acres' Anchorage staff with support in logistical planning provided by R&M and close liaison with WCC seismic investigations.

(d) Schedule

Weeks 59 through 70

Subtask 5.06 - Exploration Program (1981)

(a) Objective

Complete surface and subsurface investigations at Watana and Devil Canyon sites, reservoir areas, access roads and transmission line routes to the extent necessary to provide adequate data to confirm project feasibility and for submission of the FERC license application.

(b) Discussion

This program will essentially be designed to

- complete the investigation of the surface and subsurface geology and foundation conditions at the Watana and Devil Canyon dam site to a level sufficient to ensure safety of design of major structures and foundations and reliable project construction cost estimates.

- establish detailed geological conditions and geotechnical properties of potential construction material sources to ensure the adequate availability of embankment fill.

- undertake a detailed evaluation of the geological features and geotechnical conditions in the Watana and Devil Canyon reservoir areas to ensure the safety and integrity of the impoundments.

- to determine the surface and near surface geology and foundation conditions along the selected access road and transmission line routes to ensure technical and economic feasibility for submission of the FERC license application.

Field work programs will generally be designed by Acres' Anchorage Office personnel with input from the Buffalo design group as needed. Seismologic input will be provided by WCC and logistical support by R&M. All field operations will be performed by R&M with appropriate technical inspection and supervision by Acres and WCC staff as necessary.

(c) Damsites

The proposed exploratory investigations at the dam sites will comprise geologic mapping, diamond drilling, geophysical in-hole seismic testing, borehole camera studies, test trenches and laboratory testing.

The exploratory methods used in this program will be involved in collecting detailed information to augment and complement that obtained in 1980. The surface geological mapping will be completed. Outcrops will be located by survey and mapped in detail. Adverse geological features will be further investigated on the surface. Exploratory drilling will be performed at both sites in the various structure areas on both abutments and in the riverbed to determine foundation conditions. Diamond drills of the Longyear 34 type or equivalent will be used. Split-spoon and Shelby tube sampling, as well as standard penetration tests will be performed in the overburden. NX-size core will be drilled and double-tube core barrels will be employed for maximum core recovery.

Some boreholes will penetrate to a depth equal to the head to evaluate deep seated conditions. Permeability testing will be performed and piezometers will be installed. Major discontinuities suggested by previous drilling or surface mapping will be further explored by drilling and verified. Potential leakage channels, the depth of weathered rock on the abutments and the depth of overburden in the riverbed will be probed by drilling. Riverbed drilling at each site will be undertaken during the winter months to take advantage of the ice cover. Drills will be moved by helicopter. Drilling operations will be performed by R&M with inspection and review by Acres' Anchorage office personnel.

The evaluation of the foundation rock conditions will be further supplemented by in-hole geophysical testing and borehole camera studies. The in-hole geophysical testing which will be done by R & M will provide a relative measure of the rock quality, and more specifically, the deformation modulus. The borehole camera studies which will be done by Acres will serve to evaluate the in-situ rock jointing characteristics.

Permafrost conditions will be closely studied with the assistance of thermal probes installed in boreholes. Test trenches will be used to assist in the geological mapping process.

Laboratory testing will be carried out for the purpose of describing the overburden characteristics. Samples of foundation overburden material which may be left in place beneath the dam structure will also be tested for static and dynamic shear strength under high confining pressure. Samples of weak, clay-filled seams in the rock will be taken and subjected to direct shear strength testing. Samples of rock core will be subjected to sonic velocity and for unconfined uniaxial compressive strength tests. Laboratory sonic velocities will be compared to the field in-hole geophysical testing. Samples of jointed rock also will be tested for frictional shear strength along discontinuities. Most of the laboratory testing will be performed by R&M with some assistance from WCC and technical supervision by Acres' Anchorage office personnel.

(d) Construction Materials

The exploratory investigations will essentially comprise diamond drilling, test trenching and laboratory testing. Some geologic mapping and geophysical studies will also be undertaken. Emphasis will be placed on firming up the quantity estimates and proving the quality of available borrow materials. New borrow areas may also be explored. Drilling will be carried out in both borrow areas and potential rock quarries. Split-spoon and Shelby tube sampling and standard penetration tests will be performed. Drills will be moved by helicopter. Drilling will be done by R&M, with inspection and review by Acres.

A considerable amount of laboratory testing of the borrow material samples will be undertaken in addition to the routine soil identification tests, Proctor compaction testing, permeability testing and concrete aggregate testing, including static, dynamic and direct shear strength testing. Strength tests will consist of consolidated undrained tests with pore pressure measurements on pervious and impervious materials. The dynamic tests also will be done under high confining pressure and on pervious and impervious material. A limited number of direct shear tests may be made on impervious materials.

Laboratory testing on the borrow materials will be performed mainly by R&M with assistance from WCC and technical inspection by Acres.

(e) Reservoir Areas

To avoid unnecessary duplication of work, this task will be closely coordinated with the WCC Task 4 studies.

The investigations to be carried comprise geologic mapping, auger and diamond drilling, seismic refraction surveys, reservoir slope monitoring and laboratory testing. Adverse features identified in the 1980 program will be further explored.

A minor amount of laboratory soil identification testing will be undertaken for the reservoir studies. These tests will provide data which will assist in establishing the geology.

With the exception of the geologic mapping, all of the reservoir investigations will be done by R&M, with technical supervision by Acres.

(f) Access Road Routes

The exploratory investigations along the selected access road corridors will comprise geologic mapping and airborne radar imagery studies to amplify the 1980 work. In addition, in 1981 portable auger and hollow-stem auger, diamond drilling and laboratory testing work will be undertaken.

Preliminary access route selection studies will be undertaken in Task 2 and detailed designs under Task 6. The field investigations will be designed to achieve a minimum level geological and geotechnical understanding of the conditions along the selected route on a reconnaissance scale. This will permit an assessment of the general conditions as well as those problems likely to affect the design and construction of the access road significantly. Feasibility cost estimates will then be facilitated.

Exploratory investigations will generally concentrate on the surface and near surface soil and rock distribution, types and properties, permafrost limits, groundwater conditions, potential landslide areas and the availability and suitability of construction materials. Potential bridge sites will require more detailed studies of the abutment foundation conditions.

The type of investigation and scope of work for a particular type at a given site will depend on the anticipated foundation conditions, as determined by air-photo interpretation and geological inference, and the foundation requirements.

The general study approach will be first to perform the hollow-stem auger drilling and sampling at designated sites during the winter months. A track-mounted drill can best carry out this work with least cost and environmental damage, except in wooded areas as previously indicated. Later, in the snow-free season, geological mapping, airborne radar imagery, portable auger drilling and sampling will be done. The mapping will establish the general overburden and bedrock geology (surface distribution, types and properties) and will verify the photointerpretation. The airborne radar imagery will be used to delineate areas of permafrost and freedraining granular deposits. Shallow auger holes will probe the near-surface geology. Soil samples from the winter and summer drilling will be selected for routine laboratory identification tests as well as unconfined compressive strength tests and Proctor compaction tests.

The laboratory work and most of the exploratory work will be performed by R&M with geological mapping and technical supervision by Acres' Anchorage office staff.

(g) Transmission Line Routes

The exploratory investigations along the transmission line will comprise geologic mapping, airborne radar imagery studies, portable auger, hollow-stem auger, diamond drilling and laboratory testing.

The most feasible transmission line route will be selected in Task 8. The basic approach adopted to geotechnical explorations will be similar to that for the access road route.

The investigations will be performed with specific tower foundations in mind, i.e., anchored footings in rock, spread or mat footings in granular deposits, piles or caissons in silt and clay. Sections of transmission line on well-drained, granular deposits of rock will require less detailed study. Detailed drilling and sampling, however, will be done in areas of soft, compressible or thaw-unstable foundations. Vane shear strength testing will be required in soft compressible foundations. In these potential problem areas, information will be required on the type, stratigraphy and properties of the soil foundation. Foundations of towers at points of line direction change will require special attention due to the most stringent foundation requirements. Foundations of towers at the ends of long spans or on potentially unstable slopes will also require special attention.

R&M will perform the field explorations and laboratory testing with geologic mapping and technical supervision by Acres.

(h) Schedule

Weeks 56 through 91

Subtask 5.07 - Exploratory Program Design (1982-1984)

(a) Objective

Design of the geotechnical exploratory investigations program for 1982-1984 to obtain basic design data for Watana damsite, dam construction materials and reservoir area, and for the selected access road and transmission line routes.

(b) Approach

A great deal of exploratory information will have been obtained prior to 1982 and a substantial amount of safe, reliable, project component designs undertaken prior to submission of the FERC license application. Although this work will be adequate to ensure project feasibility with a reasonable level of confidence, further exploratory work is essential to minimize the possibility of unforeseen conditions which could potentially impact the safety and cost of major structures. This exploratory work will provide the necessary input to the ongoing detailed design work through commencement of project construction. Based on the Corps studies to date, it is currently anticipated that construction of the Watana diversion scheme will be the first activity to follow award of the FERC license. The adopted diversion scheme will in turn depend to a large extent in the layout of the major project components. It is therefore anticipated that following submission of the FERC license application for the Susitna Project, further exploration investigations will be necessary to fully determine in detail all significant geologic and geotechnical factors affecting the following:

- the diversion tunnels and cofferdams
- the dam and other major structure foundation treatment and designs
- the availability of adequate supplies of cofferdam construction materials
- subsurface design conditions at the proposed locations of underground structures
- the potential for ground instability as a result of erosion adjacent to diversion tunnel spillway and tailrace discharges
- the watertightness and integrity of the reservoir
- design of access roads

(c) Discussion

The extent and scheduling of this additional exploratory work will be influenced to a great extent by the findings of the 1980 and 1981 programs and the development of project designs. This subtask will be undertaken in late 1981 and early 1982 with a view to ensuring continuity of exploratory work in 1982 and beyond. The major portion of this subtask will be undertaken by Acres' Anchorage office staff with appropriate input and support by WCC and R&M.

The scheduling of the 1982-1984 program will be significantly affected by the availability of access facilities. Although certain portions of the program can be accomplished within the same environmental constraints as those undertaken in 1980 and 1981, other portions of the 1982-1984 program will require the access road to be available for use. Thus, for the purpose of this plan of study, it is assumed that the access road will be designed and the necessary permits obtained by commencement of the 1982 construction season.

For purposes of this plan of study, it has been assumed that the selected access road route will commence at a staging area to be constructed at the railroad at Gold Creek and essentially follow the left bank of the Susitna River to the Watana site. Bridges will be required at several ravine and river crossings. Bridge abutment foundations will be somewhat more closely investigated than the general alignment of the road. Slightly modified routes and bridge sites also may be investigated. New borrow areas may be studied. Proposed high rock and soil cuts will be explored for stability. Further drilling may be required to firm up the permafrost characteristics.

The 1982-1984 program of exploratory investigations for transmission lines will comprise further hollow-stem auger drilling and sampling, vane shear testing, laboratory testing and geological mapping, if necessary. These tools will be used to obtain considerably more data on the general and the geotechnical conditions which affect the design of the transmission line.

Pump well testing in the riverbed will be required in areas of deep and pervious riverbed overburden. This testing will be used to estimate representative permeability values for design of riverbed excavation dewatering systems.

The 1982-1984 laboratory testing program will be designed to determine reliable values for the overburden properties. These data, together with standard penetration test data will be essential in defining the extent of removal of materials under the proposed dams.

(d) Construction Materials

More diamond drilling, trenching and laboratory testing will also be required in the construction material areas. This program will be designed to further substantiate the availability and properties of rockfill, impervious, semipervious and pervious earthfill, rockfill and rip-rap materials. Sampling will again be done by split spoon or Shelby tube. Laboratory testing as described in Table A5.5 will be expanded to include several large triaxial shear strength tests in earth and rockfill under high confining loads.

(e) Reservoir Areas

The proposed 1982-1984 investigation program will be designed to amplify the information obtained in 1980 and 1981. Final drilling and instrumentation will be completed in the reservoir areas. The program will include diamond drilling, reservoir slope monitoring and laboratory testing. These exploratory tools will be used to obtain detailed data on geotechnical conditions in potential problem areas such as pervious buried channels in the reservoir rim or unstable rservoir slopes. Further geological mapping may be required for adverse features identified in the 1981 program. Potentially unstable slopes will continue to be monitored together with piezometric levels.

A relatively small amount of laboratory testing will be undertaken for the reservoir area in this phase.

(f) Access Roads and Transmission Lines

The scheduling of the remaining exploration for the access roads is such that this work will have to be completed in early 1982. For transmission lines, on the other hand, the program can be spread over a longer period without affecting overall scheduling of the project. The data requirements for the design of the roads and transmission lines, although fewer than for the dams, are similar in scope. Minimum detailed information on the overburden properties such as compressibility, shear strength, permeability and compaction characteristics, and rock quality and strength (for the bedrock), will be required for the basic design.

Thus, for the access road and transmission line areas, additional foundation drilling, sampling and laboratory testing will be required in this program. Firm quality and quantity estimates of construction materials will be required for the access road. In the transmission line, drilling and sampling will be required for each tower foundation. Foundation drilling for the access roads and transmission lines is best undertaken in the winter months by means of a track-mounted, hollow-stem auger diamond drill.

(g) Schedule

Weeks 95 through 120

Subtask 5.08 - Data Compilation

(a) Objective

Assemble all geotechnical exploratory data into documents suitable for inclusion in relevant project reports and licensing documentation.

(b) Approach

Data to be compiled will include the following:

- air-photo interpretation
- geologic mapping
- seismic and resistivity data
- borehole logs
- auger hole logs
- test trench logs
- airborne radar imagery data
- laboratory test data

The test trench logs will be prepared to describe the overburden in the borrow areas. Laboratory testing data will be incorporated into these logs. Seismic and resistivity profiles will be prepared to show the ground surface and the bedrock topography. This information will be combined and used to prepare preliminary site geology maps and sections which will form the basis for the preliminary geotechnical assessments to be performed in Task 6. The maps and sections will show the overburden and bedrock surface distribution, types and characteristics, faults, jointing, permafrost areas, potentially unstable slope or poor foundation areas and buried channels. Geologic maps will range from reconaissance scale in the reservoir areas to limited detail in the damsite areas.

Borehole and test trench logs for the 1982 program will be used to substantiate and improve the geological maps and sections and to show surface and subsurface geology and geotechnical conditions of importance to the design and construction of the dams, access roads and transmission lines.

(c) Discussion

Although R&M and WCC will provide some input to this subtask, all final compilation of data will be undertaken by Acres in its Anchorage and Buffalo offices.

Compiled data will be attached to the periodic reports issued as the work progresses. Detailed reports summarizing all the exploratory investigations will be prepared at the end of each exploration season.

(d) Schedule

Weeks 5 through 125

A.5.7 - TASK 6: DESIGN DEVELOPMENT

(i) Task Objectives

To undertake planning studies, to evaluate, analyze and review all previous engineering studies related to hydroelectric development of the Upper Susitna River Basin and to develop preliminary engineering design and cost information for Watana and Devil Canyon Dam sites with all associated intake, outlet works, spillways and power facilities to allow preparation of a project feasibility report.

(ii) Task Output

The primary output of Task 6 will be a logical and systematic development of the requisite project features. Alternative sites for dams and power developments will be evaluated. Alternative arrangements at each site will also be considered. One such alternative will involve a 30-mile long power tunnel from Watana to Devil Canyon to eliminate the high dam at that site. A Development Selection Report will be issued on or about Week 65 of the Study for review and approval by Alaska Power Authority. Preliminary findings of the study will be discussed on or about Week 50, in order to establish whether or not work on two dam sites should continue or whether more viable alternatives exist and should be examined. Design transmittals will be at appropriate points in the study. All necessary input from parallel tasks including hydrology, geotechnical, economic, seismic, survey, and environmental studies will be factored into the planning studies and the development of the various features of the project. Engineering evaluation criteria and project definition will be developed. If sites are found to be technically viable, economically feasible and environmentally acceptable, additional studies and investigations will be conducted to establish the feasibility of the project and the optimum scale and sequence of development.

(iii) List of Subtasks

Subtask 6.01 - Review of Previous Studies
Subtask 6.02 - Investigate Tunnel Alternative
Subtask 6.03 - Evaluate Alternative Susitna Developments
Subtask 6.04 - Evaluation of Arch Dam at Devil Canyon Site
Subtask 6.05 - Development Selection Report
Subtask 6.06 - Watana/Devil Canyon Staged Development Alternatives
Subtask 6.07 - Preliminary Watana Dam Alternatives
Subtask 6.08 - Preliminary Devil Canyon Dam Alternatives
Subtask 6.09 - Establish Watana Design Criteria
Subtask 6.10 - Establish Devil Canyon Design Criteria
Subtask 6.11 - Preliminary Design Watana Dam
Subtask 6.12 - Preliminary Design Devil Canyon Dam
Subtask 6.13 - Dam Selection Report
Subtask 6.14 - Spillway Design Criteria
Subtask 6.15 - Watana Spillway Alternatives
Subtask 6.16 - Devil Canyon Spillway Alternatives
Subtask 6.17 - Preliminary Design Watana Spillway
Subtask 6.18 - Preliminary Design Devil Canyon Spillway

Subtask 6.19 - Spillway Selection Report
Subtask 6.20 - Access and Camp Facilities
Subtask 6.21 - Watana Diversion Scheme
Subtask 6.22 - Devil Canyon Diversion Scheme
Subtask 6.23 - Optimize Watana Power Development
Subtask 6.24 - Optimize Devil Canyon Power Development
Subtask 6.25 - Optimize Dam Heights
Subtask 6.26 - Preliminary Design Watana Power Development
Subtask 6.27 - Preliminary Design Devil Canyon Power Development
Subtask 6.28 - Power Development Report
Subtask 6.29 - Watana General Arrangement
Subtask 6.30 - Devil Canyon General Arrangement
Subtask 6.31 - Feasibility Report

(iv) Subtask Scope Statements

Plate T6.1 illustrates the interrelationship of various subtask studies and the logical input of various other tasks. The subtasks have been specifically arranged to make maximum use of input from various other tasks including Tasks 1 through 5 and 7 through 9. A detailed discussion of the objectives, the methodologies and associated costs and scheduling for each subtask follows. Note that for the purpose of this plan of study, it has been assumed that only Watana and Devil Canyon sites will be considered for additional field exploration and analysis. However, in the initial subtasks, all possible sites and modes of development on the Susitna will be examined to confirm that the Watana/Devil Canyon arrangement is the most appropriate.

Subtask 6.01 - Review of Previous Studies and Reports

(a) Objective

Assemble and review all available engineering data, siting and economic studies relating both to the Susitna hydropower development and to alternative potential sites.

(b) Approach

Reports and also field reconnaissance studies generated by various agencies including USBR, the Corps of Engineers, Kaiser and others will be reviewed to assess the design assumptions for the sites. Information obtained from these reports, including reservoir storage and power head, site evaluation, geologic and seismic conditions, topographic features and other special physical and environmental constraints, will be tabulated. Total potential for power development at each site and the associated costs will be assembled in tabular form; costs will be updated to current levels for comparison. Sites studied will include all those identified in the previous reports.

Layouts for all sites and special constraints for each site will be identified. All conceptual design parameters will be developed to update the cost of each site to a uniform level in order to rank the sites. The task will include the indexing of all basic information that could be used in analysis under Subtask 6.03. Indexing will include all basic information on nature, type and extent of geotechnical investigations previously completed, maximum level of development considered for each site, type and size of dam selected, type and size of spillway considered for each site studied, and on-line dates considered in the previous reports. Other data to be indexed will include reservoir storage, average, maximum and minimum flow, regulated flow, power capacity and energy development at each site, equivalent construction costs and other factors, such as special environmental and seismic impact on each site.

(c) Discussion

The level of study previously undertaken for each site varies considerably, not only with respect to geotechnical investigations and preliminary planning, but also in relation to hydrologic and economic assessment. Project ranking techniques and cost updating criteria will necessarily have to include additional cost parameters and analysis. These data will be used at the specified level of development as an input to Task 6.03.

In order to meet the overall objectives of the subtask, a critical review and assessment will be made of all technical information on power capacities; and other constraints for the development of each site will be identified. Previous work has identified six dam sites for which ranges of heights and power installation have been considered. These sites will be analyzed in order to select the projects which are both technically feasible and economically attractive for initial construction and are compatible with the plan for hydropower development of the entire basin. It is likely that some of the sites will be rejected in initial screening because of poor foundations or because of very high cost of development. Previous studies have demonstrated that the Watana and Devil Canyon sites are probably the most favored; but if the studies under this task indicate otherwise discussions with the Alaska Power Authority will be scheduled immediately.

All cost data from the previous reports will be updated to 1980 cost levels. As project costs are highly dependent not only upon site foundation conditions, size of spillway and outlet works, but also upon whether a low level outlet is provided, costs will be adjusted to a common design.

(d) Schedule

Weeks 25 through 40

Subtask 6.02 - Investigate Tunnel Alternatives

(a) Objective

To investigate the feasibility of a scheme for development of the Susitna River eliminating the Devil Canyon project by the substitution of a tunnel-supplied power plant fed from the Watana dam site.

(b) Approach

A preliminary review of the proposed Watana/Devil Canyon development of the Susitna River suggests that a feasible alternative, which would allow the elimination of the major reservoir formed by the Devil Canyon dam, would comprise the construction of a power tunnel starting at, or near, the currently proposed Watana site and terminating at a power plant near the proposed Devil Canyon site as illustrated in Plate T6.2.

In addition to the reduced environmental impact brought about by the elimination of the Devil Canyon dam and lake, the tunnel alternative would eliminate a major dam, reduce the size of one power plant, and allow a much larger proportion of the construction work to be located underground, shielded from severe Alaskan winters.

Potential disadvantages of the tunnel alternative include loss of power output due both to head losses in the tunnel and to the necessity to maintain flow in the river between Watana and the lower power plant tailrace. The considerable length of the tunnel would require the provision of several construction adits with corresponding environmental impacts during construction.

In order to make an initial assessment as to whether this alternative should be carried forward into more detailed evaluation, the following activities are proposed:

(1) On the basis of the material assembled in Subtask 6.01, a number of tunnel alternative arrangements will be identified. Some preliminary concepts are shown in Plate T6.2. Several others incorporating different tunnel alignments and intake/power plant locations will be identified.

(2) These initial alternatives will be subjected to a gross screening to eliminate those least likely to meet economic, technical or environmental requirements. Preliminary layouts will be developed for those remaining and major dimensional and design characteristics will be established.

(3) Preliminary quantity and cost estimates will be prepared for the selected tunnel alternatives, together with corresponding cash flows.

(4) Estimates of capacity and energy for each of the alternatives will be developed.

(5) The most attractive of the tunnel alternatives will be compared from the technical, economic, and environmental standpoints with other options for the river development identified in Subtask 6.03.

(c) Discussion

The tunnel alternative to the Devil Canyon project would appear, from initial review, to have some rather attractive features which may warrant careful evaluation. From the environmental standpoint, the elimination of the large Devil Canyon reservoir must be a significant step. This may, of course, be offset to some extent by the increased live storage to be provided at Watana and by the possible wider spread of construction activity during tunnel construction. Initial "order of magnitude" cost estimates seem to indicate at least a trade-off level of cost for the tunnel alternative, without assessing the impact on the schedule and power generation capabilities of the long power tunnel.

(d) Schedule

Weeks 30 through 50

Subtask 6.03 - Evaluate Alternative Susitna Developments

(a) Objective

To identify the most appropriate scheme for development of the Susitna River on the initial basis of technical feasibility and cost.

(b) Approach

Primary input for this subtask from the cost and technical standpoints will be derived from the review of previous studies (Subtask 6.01) and from the investigation of the "tunnel alternatives" (Subtask 6.02). Further input will be provided from the hydrological studies undertaken in Task 3 and from the public participation program carried out under Task 12. This subtask will involve the development, comparison and subsequent ranking of all reasonably feasible combinations of sites and power facilities identified either in the previous studies or in the course of Acres studies to this time. Economic parameters for a range of dam heights and power installations will be developed for each site and for the complete river development; these will be analyzed by computer to identify the most promising scheme.

Specific activities will include:

- Evaluation of six previously identified sites including Susitna I and II, Denali, Vee, Watana and Devil Canyon and other sites, for which data will be obtained from the review of literature (Subtask 6.01).

- Data on rated head, regulated flow, yield and power available from previous reports for these sites will be developed and the value and cost of power for each site will be compared. Only previous layouts and engineering information generated will be evaluated.

- Data on foundation conditions, availability of construction materials, limits of development of each site, access conditions, seismic and environmental conditions for each site will be reviewed in site-ranking studies.

- Sites with extremely poor foundation conditions and other serious constraints related to seismic or environmental impact will be rejected.

- A summary report on this ranking study will be prepared.

(c) Discussion

By this stage of the study, costs of alternative power and energy will be available for economic comparison and development of cost-benefit ratios of each individual site, and by combination for each set of developments discussed above. It would appear from previous studies that the combination of Watana and Devil Canyon sites is the most promising development, and it is expected that the results of this work will verify this. However, if the results of the study indicate otherwise, the layout, costs and details of the alternative arrangement will be brought to the same level as the studies for the 1979 report by the Corps of Engineers for the Watana and Devil Canyon sites. The evaluation will rank the sites or the combination of various sites with power capability at each, and establish associated costs and cost-benefit ratios for each combination studied. Alternatives will include combinations of Watana dam sites and power tunnels. The results of these studies will be documented in the form of a memorandum which will form a basis for further studies. The report will explain the mechanics of the evaluation process and the rationale of specific site and combinations of sites, foundation suitability and availability of construction materials. Economic comparisons from cost/benefit analysis will indicate the environmental impact on each such site. The selected alternative will be that which proves to be the most favorable for development of the Upper Susitna Basin.

(d) Schedule

Weeks 40 through 60

Subtask 6.04 - Evaluation of Arch Dam at Devil Canyon Site

(a) Objective

To make a preliminary assessment of the feasibility of an arch dam at the Devil Canyon site.

(b) Approach

The original development at the Devil Canyon site recommended by the Corps of Engineers incorporated a 635 foot high double curvature thin arch dam with a crest length of 1,370 feet. Following critical comment by the OMB, the Corps, in their Supplemental Feasibility Report (1979), proposed an alternative which would replace the arch dam with a more costly gravity dam. The primary rationale was the reduced sensitivity of the gravity dam to foundation and abutment conditions.

We will critically review the feasibility of an arch dam at the Devil Canyon site from both economic and technical aspects, as well as the overall safety aspect.

The review and evaluation will comprise the following:

- Assembly and review of all available material relating to the arch dam design recommended in the Corps' report and earlier in Bureau of Reclamation reports.
- A critical examination of all geotechnical data relating to the foundation and abutment conditions at the proposed dam site. These data may well include further information obtained in the course of the ongoing field investigations.
- A critical review of the seismic conditions at the site, particularly in the light of material developed in the course of Task 4 Seismicity Studies.
- A review of current design practice in relation to high arch dam design in seismically sensitive areas.
- The development of the draft design of an arch dam appropriate to the conditions at Devil Canyon. Design will be accompanied by associated schedule and cost estimate, including impact on associated structures.
- Review of proposed design by Special Consultants and modifications as required.
- Final evaluation of feasibility of the arch dam from the technical, economic and safety standpoints and development of a recommendation as to whether an arch dam or another design of dam should be carried through to the licensing documentation.

(c) Discussion

The arch dam design at Devil Canyon was supplemented with an alternative conventional gravity design by the Corps in the 1979 Supplemental Report. Economic feasibility of the project using more conservative design approaches was demonstrated. An underlying concern regarding the safety of arch dams in high zones is evinced by the recent decision regarding the Auburn dam.

However, it is of interest to note that as reported in a recent issue of Water Power and Dam Construction, April 1979, not one failure of a concrete dam directly caused by earthquakes has ever been recorded. Linear analytical techniques for evaluation of the response of concrete structures to seismic forces have evolved, the most widely used being the finite element technique. Acres recently utilized this technique to evaluate the Karun high arch dam proposed in Iran with a height of 325 meters. In general, concrete dams perform very well when subjected to earthquakes. Of the types available, arch dams generally have proven to perform the best and buttress dams have been subject to the severest damage because of abrupt change in section and the resultant stress concentrators.

The V-shape canyon with a ratio of 2.15 (width at crest level--1,370 feet to depth--635 feet) is favorable for a double curvature arch dam. As an example, the experience of dam building in Japan can be cited. The average seismic intensity experienced at various types of Japanese dams (in 12 point scale) is:

- gravity dams 9.8
- arch and arch gravity 10
- rockfill dams 8.5

Such high arch dams as Kurobe (186 m), Nagovado (155 m), Iagisawa (131 m), Takane (130 m), Kawamata (120 m) and others were built in areas with earthquake intensity 10 to 11 points.

There are a number of approaches which can be used to condition the abutments of arch dams to weaknesses of the rock. Stresses in the foundation may be reduced, not only by increasing the abutment thickness of the arch, but also by using abutment pads. In addition to being a very satisfactory means of spreading arch thrusts, abutment pads provide an efficient means of bridging faults and other weaknesses in the foundation. Abutment pads are applied on the world's highest arch dams at Ingury (U.S.S.R. 271 m) and were proposed for the Auburn dam (U.S.A. 209 m).

Severe weather conditions will cause serious problems for both dam types. Besides the necessity to prevent freezing and cracking of concrete during construction, a serious consideration will be consolidation of the dam body and rock base.

In Russian dams built in Siberia, grouting joints between monoliths were replaced by slots 1.2 m wide backfilled with concrete after cooling the monolith below the average annual temperature (the average annual temperature in the core of the dam is 2°C to 3°C higher than the average annual temperature of the area). If the area average temperature is below zero, the concrete should be cooled to a temperature of not more than +1 to +2°C. Such a procedure involves a long time and high cost. The Russian Mamakan and Zeya dams are hammerhead type (buttress type). This type of dam provides easy access to the slots from the hollow spaces. Concreting of the slots is performed after warming up the surfaces of slots by means of electric heaters. After filling the reservoir, the temperature of the dam body will rise and the concrete plugs will be compressed.

Another problem is prevention of the negative effect on the stress state of the dam caused by freezing of the downstream part of the dam. Static analysis and model tests performed for gravity dams located in Siberia (annual average temperature -2°C to -4°C) showed that for the winter, the frost can penetrate to the center of the dam, causing opening of the horizontal joints and, as a consequence, tensile stresses on the upper face of the dam (reductions in the compressive stresses of up to 30 percent were demonstrated). For this reason, hammerhead or massive buttress dams with heating inside the hollows were built in Russia (Mamakan, Zeya, Bratsk, Buchtarma) instead of massive gravity dams. At the Mamakan dam, the electric heating system is in operation for one to one and a half months a year, and the capacity of the heaters is 80 kW. Another method of preventing freezing is to insulate the downstream face of the dam.

Consolidation of an arch dam is much easier because arch dams do not have longitudinal construction joints. Concreting of the slots after cooling the monolith below the average temperature will produce an effect similar to heating gravity monoliths. In general, arch dams, since they are more flexible and smaller volume working structures, can cope more easily with severe temperature conditions than gravity dams.

Nonetheless, some improvements of the presently proposed arch dam are likely to be necessary.

(1) An abutment pad should be used. It functions as a transition structure between arch and rock, and as such, may be thickened, widened and reinforced as necessary. In addition, the abutment pad may be used to improve symmetry of the canyon profile.

(2) A two-centered dam layout with two separate pairs of lines of centers, one for each side of the dam, should be used to cope with the unsymmetrical shape of the canyon.

(3) The slenderness of the dam is $\frac{85.6}{635} = 0.135$ (base thickness to height), and it requires reevaluation in light of seismic and temperature conditions.

The slenderness coefficient should probably be increased to 0.16 and the base thickness to 0.16 x 635 = 101.6 feet (31 m).

Note, however, that even if it is considered that an earthfill, rockfill dam or concrete-gravity dam should be considered for FERC licensing application, some background information should be developed for an arch dam. Later studies may possibly indicate technical feasibility or economic and environmental desirability, and the option to revert to the arch design should be maintained open for as long as possible.

(d) Schedule

Weeks 45 through 65

Subtask 6.05 - Development Selection Report

(a) Objective

To document the results of the initial studies undertaken to establish the optimum development of the Susitna River.

(b) Approach

This task will essentially comprise the detailed documentation of the work undertaken in Subtask 6.03 to compare and evaluate alternative means of developing the full hydroelectric potential of the Susitna River. The end product report, in addition to providing APA with an interim recommendation as to the continued direction of the study, will be an essential vehicle for the transmission of information to other tasks of the overall study, and in particular to Task 7 - Environmental Studies, Task 8 - Transmission Studies and Task 9 - Cost Estimates and Schedules.

The principal activites in this subtask will comprise the following:

- Assembly and review of material developed in Subtasks 6.01 through 6.03.

- Assembly and review of material developed in other parallel tasks to date, with particular reference to environmental studies (Task 7), and to Tasks 3 through 5 covering hydrology, seismicity and geotechnical exploration. Of particular interest from these parallel studies will be the preliminary identification of major impacts on the feasibility of various alternatives under study.

- Assembly of a draft report incorporating the key findings of the studies to date and putting forward draft recommendations for the direction of continuing studies.

- Detailed review of the draft report with APA and Engineering Review Panel.

- Finalization and issue of report.

(c) Discussion

This report will be developed in close consultation with the APA and will be issued as a public document. A key facet will be the recommendation, arising from the studies in Subtask 6.01 through 6.03, as to whether or not the Watana/Devil Canyon combination is the most appropriate mode of development of the Susitna River. The balance of the study program set out in this Plan of Study has been assembled on the assumption that Watana/Devil Canyon will be selected. Should this not prove to be the case, a major reassessment will have to be made of the scope, cost and schedule for the balance of the work program leading to license application.

(d) Schedule

Weeks 50 through 65

Subtask 6.06 - Watana and Devil Canyon Staged Development

(a) Objective

Review the potential for staged development of Watana and Devil Canyon to best meet projected power and energy requirements and develop a staged construction plan.

(b) Approach

It is to be expected that the rate of load growth in the geographical area to which the Susitna Project will contribute will be such that it may be possible to obtain significant economies by a carefully-staged sequence of construction and power facility installation. This construction sequencing will have to be appropriately integrated with basic construction scheduling, diversion and impounding requirements for the two developments. The starting point and primary source of input data for this subtask will be the evaluation of alternative modes of development completed under Subtask 6.03. The principal activities to be undertaken include:

- From the power studies undertaken in Task 1, the anticipated rate (or range of rates) of load growth will be established and agreed upon with APA.

- Using the scheme of development recommended in Task 6.04 as a basis, a series of alternative sequences of development will be assembled. These alternative sequences will incorporate phasing of dam, power plant and transmission construction designed to match the rate(s) of load growth obtained above.

- Preliminary cost estimates will be developed for each stage of each of the development sequences.

- Estimates will be prepared of power and energy output throughout each sequence of development.

- Construction cost estimates will be converted to annual cash/flow figures.

- The comparative economics of the various sequences will be compared on a net present worth basis using Acres' ECON computer program to identify the most economic alternative. The comparisons will be made for a range of interest and discount rates.

- Other aspects of the two or three most attractive alternatives will be examined to assess potential environmental impacts.

- The most appropriate sequence of development for preliminary design of the Watana and Devil Canyon projects will be selected and design transmittal for APA review will be prepared.

(c) Discussion

The ultimate sequence of development could involve partial-height dam construction, as well as partial installations of power plant capacity. Those sequences which involve operation at intermediate water levels will require not only that special provisions be made in intake and spillway designs, but also that the units be capable of continuous, reliable and efficient operation at part head. Preliminary layout sketches will have to be prepared for each of the stages of development for each sequence, both to ensure that any potential construction or design problems are identified and to provide a basis for the take-off of preliminary quantities and costs.

Although it is obviously unwise to prejudge the issue at this stage, it may well be that any attempt to extend the construction/installation schedule to match the load demand will prove to be uneconomical because of the high costs associated with extended maintenance or restarting of a construction operation in the severe environment of the Susitna River sites. Costs associated with construction in this climate will be factored into the economic analyses.

(d) Schedule

Weeks 60 through 75

Subtask 6.07 - Preliminary Watana Dam Alternatives

(a) Objective

Establish the most appropriate type of dam for the Watana Site.

(b) Approach

On the assumption that the preliminary studies completed in Subtasks 6.01 through 6.03 show that the two-dam Watana/Devil Canyon scheme of development is preferred, this subtask will review all previously available data, and new information developed in the course of this program of study to determine the most appropriate design for the Watana Site. The following specific activities are envisaged:

- Assemble all available information for the Watana dam site with regard to the following:

  -- topography (from Task 2)
  -- soil conditions (Task 5)
  -- rock conditions (Task 5)
  -- construction materials (Task 5)
  -- seismic conditions (Task 4)

- Develop preliminary design of alternative dams; these may include:

  -- concrete gravity/buttress
  -- concrete arch
  -- rockfill/earthfill

- Prepare preliminary layout sketches of the selected designs and obtain preliminary estimates of principal quantities, including:

  -- excavation (soil and rock)
  -- grouting
  -- concrete and formwork
  -- rockfill/earthfill
  -- special fill materials such as transition or core material

- Review impact of alternative dam designs on other structures including:

  -- diversion tunnels and associated cofferdams
  -- spillway and outlet works
  -- intake/power tunnel/powerhouse systems

- Develop first-order cost estimates to measure ultimate effect on overall cost of the facility for the various types of dam

- Develop preliminary cost estimates for alternative types of dam, giving appropriate recognition to costs associated with:

  -- material sources
  -- weather conditions
  -- labor availability

- Prepare construction schedules for the alternative types of dam, and prepare annual cash flow estimates for the dams and for the significant costs associated with ancillary structures. Prepare summarized present-worth comparison of costs.

- Review "other" factors, such as unknown foundation conditions, construction considerations, seismicity and environmental effects which might influence the selection of dam type.

- Assemble and assess results of subtask analyses, and select type of dam for recommendation to the Engineering Panel and APA for ongoing studies.

(c) Discussion

The design proposed by the Corps of Engineers for the Watana dam comprises an 810 foot high rockfill structure with an inclined central impervious core; the core, and a "semi-porous fill" zone, is flanked by two fine/coarse filter zones. The Corps reports indicate that explorations to date have demonstrated the availability of sufficient quantities of material for the core and semi-pervious zones, and suggest that rockfill for the shells will be obtained from the excavations for the spillway and from quarries opened for the purpose.

The purpose of this subtask essentially will be to review the dam selection made by the Corps in the light of the preliminary studies and additional field exploration carried out to date during this study program. It is, of course, recognized that a rockfill/earthfill dam, which can be constructed from locally available materials and which may be less sensitive to unknown foundation conditions, is most likely to be the best choice for a site of this type. However, it will be appropriate to make a careful review of this selection before proceeding further with the design program to ensure that certain other features of concrete-type dams, such as reduced intake, spillway and diversion costs, might not offset the apparent advantages of the rockfill/earthfill design.

(d) Schedule

Weeks 60 through 75

Subtask 6.08 - Preliminary Devil Canyon Alternatives

(a) Objective

Establish the most appropriate axis and type of dam for the Devil Canyon Site.

(b) Approach

If the preliminary studies completed in Subtasks 6.01 through 6.03 show that the two-dam Watana/Devil Canyon scheme of development is preferred, this subtask will review all available data, collected previously and new information developed in the course of this program of study to determine the most appropriate design for the Devil Canyon Site. Subtask 6.04 provides input for reviewing the feasibility of an arch dam at Devil Canyon. After the most favorable alternative is selected, various axes for the dam will be selected for economic comparison. The following specific activities are envisaged:

- Assemble all available information for the Devil Canyon dam site with regard to the following:

  -- topography (from Task 2)
  -- soil conditions (Task 5)
  -- rock conditions (Task 5)
  -- construction materials (Task 5)
  -- seismic conditions (Task 4)

- Develop preliminary design of alternative dams; these may include:

  -- concrete gravity/buttress
  -- concrete arch (using, if appropriate, material developed in Subtask 6.04)
  -- rockfill/earthfill

- Prepare preliminary layout sketches of the selected designs and obtain preliminary estimates of principal quantities, including:

  -- excavation (soil and rock)
  -- grouting/draingage
  -- concrete and formwork
  -- rockfill/earthfill
  -- special fill materials such as transition or core material

- Review impact of alternative dam designs on other structures including:

  -- diversion tunnels and associated cofferdams
  -- spillway and outlet works
  -- intake/power tunnel/powerhouse systems

  Develop first-order cost estimates to measure ultimate effect on overall cost of the facility for the various types of dam

- Develop preliminary cost estimates for the alternative types of dam, giving appropriate recognition to costs associated with:

  -- material sources
  -- weather conditions
  -- labor availability

- Prepare construction schedules for the alternative types of dam, and prepare annual cash flow estimates for the dams and for the significant costs associated with the ancillary structures. Prepare summarized present-worth comparison of costs.

- Review "other" factors, such as unknown foundation conditions, construction considerations, seismicity and environmental effects which might influence the selection of dam type.

- Assemble and assess results of subtask analyses, and select type of dam for recommendation to Engineering Panel and APA for ongoing studies.

(c) Discussion

The original design recommended by the Corps of Engineers for the Devil Canyon site was a double curvature arch dam; as discussed in Subtask 6.04. This was subsequently supplemented by an alternative conventional gravity dam to ensure that the estimate contained sufficient cost to allow construction of either type should site conditions allow. The feasibility of the construction of an arch dam will be re-examined specifically in Subtask 6.04, and should results of that work indicate no reason why it should be eliminated from further contention, it will be included among the alternatives examined here.

(d) Schedule

Weeks 60 through 75

Subtask 6.09 - Establish Design Criteria for the Watana Development

(a) Objective

To establish preliminary design criteria for the Watana hydroelectric development.

(b) Approach

Documentation of the following criteria related to the design of the Watana development will be initiated in this subtask:

- Hydraulic:
  - reservoir levels
  - storage volumes
  - rule curves
  - power flows

- Geotechnical:
  - foundation conditions
  - foundation treatment requirements
  - construction materials properties
  - seismic design conditions
  - slope stability requirement, soil and rock

- Structural:
  - loading conditions
  - uplift pressures
  - wind loads
  - temperature conditions and loads
  - material design properties
  - stability analysis procedures

- Mechanical:
  - turbine design requirements
  - power plant mechanical systems
  - gate design requirements
  - crane design requirements

- Electrical:
  - generator design requirements
  - power plant electrical systems
  - transmission requirements
  - ancillary electrical equipment requirements

- General:
  - design codes and standards
  - special Alaska or site-related requirements
  - transportation limitations
  - ice conditions

(c) Discussion

It is anticipated that the assembly of this design criteria document will be undertaken over the period that the designs of the dam, spillway and power plant are developed, and that this document will provide the foundation of the design program in work subsequent to the license applications.

(d) Schedule

Weeks 80 through 95

Subtask 6.10 - Establish Design Criteria for the Devil Canyon Development

(a) Objective

To establish preliminary design criteria for the Devil Canyon hydroelectric development.

(b) Approach

Documentation of the following criteria related to the design of the Watana development will be initiated in this subtask:

- Hydraulic:
  - reservoir levels
  - storage volumes
  - rule curves
  - power flows
- Geotechnical:
  - foundation conditions
  - foundation treatment requirements
  - construction materials properties
  - seismic design conditions
  - slope stability requirement, soil and rock
- Structural:
  - loading conditions
  - uplift pressures
  - wind loads
  - temperature conditions and loads
  - material design properties
  - stability analysis procedures
- Mechanical:
  - turbine design requirements
  - power plant mechanical systems
  - gate design requirements
  - crane design requirements
- Electrical:
  - generator design requirements
  - power plant electrical systems
  - transmission requirements
  - ancillary electrical equipment requirements
- General:
  - design codes and standards
  - special Alaska or site-related requirements
  - transportation limitations
  - ice conditions

(c) Discussion

It is anticipated that the assembly of this design criteria document will be undertaken over the period that the designs of the dam, spillway and power plant are developed, and that this document will provide the foundation of the design program in work subsequent to the license applications.

(d) Schedule

Weeks 80 through 95

Subtask 6.11 - Preliminary Design of Watana Dam

(a) Objective

To prepare the preliminary design and associated cost estimate and construction schedule for the Watana Dam.

(b) Approach

This subtask will be initiated once the preliminary study of alternative dam sections, undertaken in Subtask 6.08, has been completed and approved. The primary input to this subtask, once the type of dam has been established, will be the results of the field investigations (Task 5) and the seismic studies (Task 4). Cost estimating data will be provided through Task 9. Specific activities to be undertaken will include:

- Assembly and review of most recent field and seismic study data;

- Preparation of a preliminary layout of the dam dimensioned to meet the basic requirements of the project design criteria;

- Development of appropriate preliminary design details, including grouting and pressure relief provisions, foundation and abutment preparation as required by the basic dam design within the context of the geotechnical conditions;

- Preparation of preliminary stability analyses for the critical conditions set out in the preliminary design criteria document (Subtask 6.09). Geotechnical design parameters to be provided on the basis of results obtained from the laboratory tests carried out in Task 5. Specific conditions will depend upon the type of dam selected, but for a rockfill dam with a central core, would typically include:

  -- end of construction conventional slope stability analysis
  -- analysis of rapid drawdown conditions utilizing residual pore pressures, and conventional stability analysis
  -- evaluation of maximum W.L. and seismic loads by dynamic analysis, utilizing excess pore pressure generation application tests
  -- examination of stress and deformations by finite element analysis

- Review and adjustment of design to accommodate anomalies indicated in the course of the stability studies undertaken above

- Reservoir studies, including:

  -- reservoir slope stability assessment in relation to thawing permafrost and generation of high pore pressures
  -- reservoir slope stability during seismic events, including impact on liquefaction-sensitive soils and mass instabilities
  -- snow slide assessment

- Computation of quantities and development of estimate of cost for the dam and associated cofferdams and diversion tunnels

- Development of dam construction schedule

- Preparation of material for input to dam selection report

(c) Discussion

In the development of the dam design, the following key aspects will be taken into account:

(1) Foundation and Abutment Conditions

Study of foundation and abutment conditions will include assessment of the available information on overburden, bedrock, structural geology including identification of local shear zones, faults and joint sets and the consolidation and strength characteristics. Based on the parameters from the assessment, the design will determine foundation seepage, permanent pressure relief, foundation treatment, consolidation and curtain grouting requirements, abutment stability, shaping of abutments, overburden and rock excavation requirements and excavation dewatering. Special considerations will be given to excavation of loose riverbed alluvium, talus materials near abutments.

(2) Construction Materials

Study in detail the availability and suitability of construction materials and their methods of exploitation for earth/rockfill and concrete dams and other associated concrete structures. Various sources of impervious material as well as a rock quarry for rockfill materials and concrete aggregates will be investigated in the field. Evaluation of the field data and laboratory test results will be done to determine the suitability of the construction materials and the parameters to be used in the design. Placing problems of impervious fills due to wet weather and cold climatic conditions will be studied on a preliminary basis. Shear behavior of impervious and shell materials will be studied under dynamic and high-confining stresses.

(3) Seismic Effects

Damages to dams during earthquakes can occur as deformation of the embankment collapses slopes, cracks cores and loosens the soil masses. Conventional methods cannot be employed for anything other than the collapse of slopes. In order to study the other two problems, it will be necessary to study the stresses and deformations produced in embankments at the time of an earthquake. The magnitude of deformations and stresses that develop will depend on the time of occurrence of inertia forces induced by the sudden ground displacements during an earthquake. A logical method of design requires:

- a determination of the variation of inertia forces with time
- an assessment of the embankment deformations and stresses induced by these forces.

Simplified numerical techniques which are comparable to dynamic finite element analysis, such as the Characteristic Method in combination with other simplified methods, will be used for the seismic analysis.

The ground motion characteristics, the cyclic stress-strain data and the dynamic material properties obtained from Task 4 studies will be utilized in the seismic design of earth/rockfill dams and embankments. The following measures will be included in the design to preclude the possibility of failure or major damage during an earthquake:

- avoidance of major faults in the foundation
- provision of sufficient vertical and horizontal drainage
- provision of ample freeboard
- use of wide transition zones of filter materials which are not vulnerable to cracking
- use of wide cores of materials with self-healing and erosion resistant properties
- appropriate provisions for handling wave effects due to earthquakes or landslides into the reservoir
- provision of appropriate crest details to minimize erosion
- appropriate measures to prevent slope failures or sliding of the dam on its foundations
- construction of well-compacted cofferdams to buttress main section

(4) Permafrost Studies

Permafrost studies will include application of the state-of-the-art in permafrost to the dam design, assessing the data from the field investigations and determining permafrost conditions on foundation and abutments and on the proposed foundation treatment such as grouting.

(5) Dam Sections

The design of dam fill sections will involve study of layouts, zoning arrangements for earth/rock-fill dams, optimization of dam slopes, requirements for filters, drains and slope protection riprap. Detail stability analyses, static and dynamic will be done for various loading conditions such as end of construction, long-term steady seepage and rapid drawdown. Dynamic loading conditions will be studied as mentioned in Section 3 under seismic effects. The design will include settlement and seepage analyses in the fill and foundations and determination of the type and scope of instrumentation to measure the performance of the structure.

(6) Construction Sequence and Method

The study will evaluate the effects of construction sequence and methods such as staged construction on cost and schedules. Also, it will determine effects on materials availability, method of placement and design of dam zoning and cofferdams and other river closure procedures. Construction period will be largely influenced by climatic conditions in the project region. This will particularly affect the placing of impervious fills and overall construction time of the structure. The study will include assessing the number of wet days during a construction season and the number of days of freezing in a year that will prohibit placing.

(d) Schedule

Weeks 85 through 110

Subtask 6.12 - Preliminary Design of Devil Canyon Dam

(a) Objective

To prepare the preliminary design and associated cost estimate and construction schedule for the Devil Canyon dam.

(b) Approach

This subtask will be initiated once the preliminary study of alternative dam sections, undertaken in Subtask 6.08, has been completed and approved. The primary input to this subtask, once the type of dam has been established, will be the results of the field investigations (Task 5) and the seismic studies (Task 4). Cost estimating data will be provided through Task 9. Specific activities to be undertaken will include:

- Assembly and review of most recent field and seismic study data;

- Preparation of a preliminary layout of the dam dimensioned to meet the basic requirements of the project design criteria;

- Development of appropriate preliminary design details, including grouting and pressure relief provisions, foundation and abutment preparation as required by the basic dam design within the context of the geotechnical conditions;

- Preparation of preliminary stability analyses for the critical conditions set out in the preliminary design criteria document (Subtask 6.10). Foundation design parameters are to be provided on the basis of results obtained from the laboratory tests carried out in Task 5. Specific conditions will, of course, depend upon the type of dam selected, but for a concrete gravity dam would typically include:

  -- conventional stability and sliding analyses and stress distribution on foundation
  -- determination of response of the concrete dam to seismic forces
  -- examination of stress and deformations by finite element analysis

- For the embankment section stability analyses as discussed in Subtask 6.11 will be performed.

- Review and adjustment of design to accommodate anomalies indicated in the course of the stability studies undertaken above

- Reservoir studies, including:

  -- reservoir slope stability assessment in relation to thawing permafrost and generation of high pore pressures
  -- reservoir slope stability during seismic events, including impact on liquefaction-sensitive soils and mass instabilities
  -- snow slide assessment

- Computation of quantities and development of estimate of cost for the dam and associated cofferdams and diversion tunnels

- Development of dam construction schedule

- Preparation of material for input to dam selection report

(c) Discussion

In the development of the dam design, the following key aspects will be taken into account:

(1) Foundation and Abutment Conditions

Study of foundation and abutment conditions will include assessment of the available information on overburden, bedrock, structural geology including identification of local shear zones, faults and joint sets, and consolidation and strength characteristics. Based on the parameters from the assessment, the design will determine foundation seepage, permanent pressure relief, foundation treatment, consolidation and curtain grouting requirements, abutment stability, shaping of abutments, overburden and rock excavation requirements and excavation dewatering. Special consideration will be given with regard to excavation of loose riverbed alluvium, and talus materials near abutments.

(2) Construction Materials

Study in detail the availability and suitability of construction materials and their methods of exploitation for earth/rockfill and concrete dams and other associated concrete structures. Various sources of impervious material as well as rock quarry for rockfill materials and concrete aggregates will be investigated in the field. Evaluation of the field data and laboratory test results will be done to determine the suitability of the construction materials and their parameters to be used in the design. Placing problems of impervious fills due to wet weather and cold climatic conditions will be studied on a preliminary basis. Shear behavior of impervious and shell materials will be studied under dynamic and high-confining stresses.

(3) Seismic Effects

For the concrete dam, the seismic impact and response will be evaluated by dynamic, finite element techniques commonly adapted for such analyses. Stress concentration and deformation in the body of the dam or at the foundation will be evaluated. Damages to dams during earthquakes can occur as deformation caused by shear failure in the concrete section of the dam.

The seismic effect on the embankment section is discussed in Subtask 6.11 and is not repeated here.

(4) Permafrost Studies

Permafrost studies will involve application of the state of the art in permafrost to the dam design. Data from the field investigations will be assessed to determine permafrost conditions in foundation and abutments, and to establish the proposed foundation treatment such as thawing, grouting, etc.

(5) Dam Sections

The design of concrete dam sections will involve study of layouts, jointing pattern and other concrete details,and for the fill dam, zoning arrangements, optimization of dam slopes, requirements for filters, drains and slope protection riprap. Detailed stability analyses, static and dynamic will be done for various loading conditions such as end of construction, long-term steady seepage and rapid drawdown. Dynamic loading conditions will be studied as mentioned in Task 4 under seismic effects. The design will include settlement and seepage analyses in the fill and foundations and will determine the type and scope of instrumentation to measure the performance of the structure.

(6) Construction Sequence and Method

The study will evaluate the effects of construction sequence and methods such as staged construction on cost and schedules. Also, it will determine its effects on materials availability, method of placement and design of dam zoning and cofferdams and other river closure procedures. The construction period will be largely influenced by varying climatic conditions in the project region. Acres is particularly experienced in cold weather construction techniques for large dams. These conditions will most certainly affect the placing of impervious fills and concrete and the overall construction time of the structure. The study will include assessing the number of wet days during a construction season and the number of days of freezing in a year that will prohibit placing.

(d) Schedule

Weeks 85 through 110

Subtask 6.13 - Dam Selection Report

(a) Objective

Prepare a report summarizing the results of the study dealing with the selection and preliminary design of dams and reservoirs for the Susitna Development.

(b) Approach

The primary input to this report will be derived from the preliminary design development studies undertaken under Subtasks 6.11 and 6.12. The report will address the following principal topics for each of the dams considered:

- principal hydraulic, geotechnical and structural design criteria
- selection of type of dam
- geology and foundation conditions
- staged construction considerations
- basic design concept
- stability analyses
- diversion and construction conditions
- construction materials
- reservoir conditions
- construction schedule
- estimate of cost

The report will be submitted in draft form to the Engineering Panel and to APA for review prior to finalization.

(c) Discussion

This report, which will contain major technical input to the license application, will provide a focus not only for the work undertaken in a number of the previous subtasks in Task 6 but also for data developed in other primary tasks such as Tasks 4 - Seismic Studies and Task 5 - Geotechnical Exploration.

(d) Schedule

Weeks 100 through 115

Subtask 6.14 - Spillway Design Criteria

(a) Objective

To establish the basic spillway and diversion design criteria for the Watana and Devil Canyon dam sites.

(b) Approach

Basic design criteria will be established and reviewed with APA and other State and Federal Agencies. These basic criteria define the accepted degree of risk to flood damage and include:

- Landslides. Landslide events due to seismicity or other causes are more difficult to deal with quantitatively. It is also often uneconomic to allow sufficient freeboard to prevent overtopping due to a reservoir slide. On the Mica dam project in British Columbia this was the case, and the reservoir crest was specifically designed to withstand a limited amount of overtopping. We will undertake a brief study to determine the freeboard requirement for such slide events and assess the economic impact of providing adequate freeboard versus protecting the dam crest. Input to this study would be derived for the study outlined in Task 3. Based on the results of this study the required freeboard and crest protection will be recommended.

- Spillway design flood. A design flood hydrograph of a high probability of succeedence such as the 10,000 years flood. The service spillway would be sized to accommodate the flood without the reservoir water level encroaching on the required dry freeboard.

- A catastrophic flood event. Normally specified as the probable maximum flood. The service spillway and, if required, emergency spillways would be designed to pass this flood but reservoir levels would be allowed to rise to dam crest level.

- Spillway cavitation criteria. A specification of the magnitude of design flood hydrograph above which limited cavitation/erosion damage will be accepted.

- Downstream erosion criteria. A specification of the magnitude of design flood above which erosion damage requiring subsequent remedial work will occur downstream.

- Freeboard criteria. A specification of the severity of the climatic and reservoir landslide event for which adequate dry freeboard is required. Climatic events which affect freeboard are high winds and it is usual to specify a design wind velocity having a return period of say 100 years.

- Diversion flood criteria. Brief economic studies will be undertaken to determine the economic level of flood protection during the diversion stages . Hydrologic and hydraulic input would be derived from the Task 3 studies and would include open water flood conditions as well as flood levels under ice cover and ice jam conditions.

- Low level outlet criteria. A study will be undertaken to determine the requirement for a low level outlet and, if necessary, the capacity for such an outlet. Aspects to be considered include:

  -- downstream water quantity and quality requirements

  -- control of reservoir filling rate

  -- requirement for emergency drawdown.

Once these basic criteria are finalized the information will be issued as a design transmittal.

(c) Discussion

The design criteria described above are those usually adapted by Acres for the design of large dams and we recommend them for the Susitna Project.

(d) Schedule

Weeks 70 through 80

Subtask 6.15 - Watana Spillway Alternatives

(a) Objective

Examine alternative potential spillway arrangements for the Watana site, and select the most appropriate for subsequent design development.

(b) Approach

Primary input for this study will be obtained from:

- Task 3 - Hydrology
- Task 5 - Geotechnical Exploration
- Subtask 6.14 - Spillway Design Criteria

Specific activities will include:

- Assembly and assessment of input data
- Preliminary layout of alternative spillway arrangements to meet the requirements set out in the design criteria document within the constraints imposed by the dam and other facilities
- Take-off of quantities and computation of costs of alternative arrangements
- Examination of operational aspects of the spillway alternatives and identification of possible measures required to mitigate adverse effects
- Selection of most appropriate spillway arrangement on the basis of net cost and operational characteristics

(c) Discussion

Since the energy head to be dissipated in the spillway works at Watana could be as much as 700 feet, and the safety of the entire development will depend upon the proper operation of the spillway, the selection and design of this facility will be one of the most critical aspects of the design development program. The selection of the optimum spillway arrangement will depend to a large extent on the ambient economics of the dam and spillway combination, not only in relation to the physical layout, but also in relation to the potential provision of rockfill for the dam construction from the excavations for the spillway chute.

In the current Corps of Engineers' designs, the spillway chute discharges at right angles to the alignment of Tsusena Creek, which may be less than attractive from the hydraulic standpoint; however, realignment may prove to be difficult to achieve without involving major excavations. Present indications are that the geology of the left (south) bank is marginally "better" than that of the right bank, and it may be possible to locate an improved orientation on this bank. However, any scheme which involves a shorter and steeper chute will almost certainly require concrete linings to prevent erosion under high velocity flows: This of course, will involve major additional costs and raises the spectre of cavitation and erosion damages experienced at so many other high-head spillway installations.

The spillway crest control structures will be of conventional concept, designed to accommodate appropriate ice loads/bubbler systems. One or more gates may require heating if spillway operation during freezing weather is required. If alternatives involving steep chutes are considered, then it will be necessary to examine various forms of energy-dissipating structures, such as chute blocks, stilling basins, and the like.

(d) Schedule

Weeks 80 through 95

Subtask 6.16 - Devil Canyon Spillway Alternatives

(a) Objective

To examine alternative potential spillway arrangements for the Devil Canyon site, and select the most appropriate for subsequent design development.

(b) Approach

Primary input for this study will be obtained from:

- Task 3 - Hydrology
- Task 5 - Geotechnical Exploration
- Subtask 6.14 - Spillway Design Criteria

Specific activities will include:

- Assembly and assessment of input data
- Preliminary layout of alternative spillway arrangements to meet the requirements set out in the design criteria document within the constraints imposed by the dam and other facilities
- Take-off of quantities and computation of costs of alternative arrangements
- Examination of operational aspects of the spillway alternatives and identification of possible measures required to mitigate adverse effects
- Selection of most appropriate spillway arrangement on the basis of net cost and operational characteristics

(c) Discussion

The most recent (1979) Corps of Engineers design for the spillway at Devil Canyon calls for a conventional arrangement discharging over the central section of the concrete gravity dam. For the originally proposed arch dam at this site, the Corps has proposed a ski-jump spillway arrangement discharging at the left abutment of the dam with the lip of the jump some 300 feet above downstream river level.

The ultimately selected arrangement of spillway will, of course, be heavily influenced by the type and arrangement of dam selected, and may in turn affect the selection of the dam. Various aspects influencing the selection of a chute-type spillway arrangement are discussed under Subtask 6.15 above. Design considerations affecting conventional spillway structures are well documented in the literature.

(d) Schedule

Weeks 85 through 95

Subtask 6.17 - Preliminary Design of Watana Spillway

(a) Objective

To design the spillway facilities and associated features for the Watana project.

(b) Approach

From the studies in Subtasks 6.14 and 6.15, the information on spillway design criteria and most suitable locations will be available to develop this subtask. We will critically review foundation conditions of the site and examine previously generated data for the project. Design tasks will include:

- Foundation design of the spillway, ogee section, piers, spillway channel and the chute structure including rock excavation, rock reinforcement, concrete dental work and pressure relief facilities.

- Hydraulic design to determine optimum gate dimensions and gate operating procedures. Development of a spillway operating rule curve based on headwater elevations in the reservoir and gate opening, detailed tailwater curve data and hydraulic profiles to satisfy all operating conditions expected at the project. Determination of the shape and height of piers, walls and chute block.

- Structural details and design of bridge, piers, gates, stoplogs, spillway channel walls and slab chute structures considering normal maximum headwater conditions, and seismic and extreme weather conditions.

- Design of gate facilities to operate under extreme weather and ice conditions. Both bubble formations and heating of necessary elements will be considered for the purpose of adequate cost provision in the estimate.

- Preliminary hydraulic and structural analyses of size, shape, and thrust requirements of the chute block; shape and trajectory of the jet under various flow and tailwater conditions will be reviewed to develop satisfactory solutions. Preliminary study of jet impact will be made and data will be developed for hydraulic modelling of the facilities.

- Appropriate arrangement and design of electrical/mechanical facilities for hoist operation under all conditions including emergency conditions will be developed.

- Safety of the spillway structure as an independent unit and as an integral part of the overall project will be checked.

- If the dam is an embankment structure adjacent to the spillway, the retaining walls will be designed and hydraulic approach conditions will be reviewed.

(c) Discussion

The review of flood routing studies for project design flood, probable maximum flood and other floods generated from Task 3 will provide data on the rule curve for operations of the spillway facility. Gate operation procedures will be developed to suit all flood conditions expected at the site. Flood rule curve data will provide relationships of gate opening and headwater elevation in the reservoir without topping the structure. Hydraulic profiles of the spillway channel will be determined from the gate, and size and type of chute will be designed to perform satisfactorily in all conditions with minimum environmental impact and consideration for safety of the dam and reservoir.

(d) Schedule

Weeks 90 through 115

Subtask 6.18 - Preliminary Design Devil Canyon Spillway

(a) Objective

To design spillway facilities and associated features for the Devil Canyon Project.

(b) Approach

This subtask involves critical review of the recommended arrangement of the spillway and design having regard to foundation conditions, location of the spillway and design project features compatible to these conditions. Design will include:

- Foundation design of the spillway, ogee section, channel and the chute structures will include rock excavation, rock reinforcement, concrete dental work and pressure relief facilities.

- Hydraulic design will define gate operating procedures and spillway operating curve based on the relationship of headwater surface elevation and gate opening. Preliminary hydraulic profile for variable flow will define the height and size of the piers, walks and geometery and configuration of ogee section and the chute block.

- In case a concrete gravity dam is selected at Devil Canyon, several kinds of energy dissipation structures will be evaluated including ski-jump, stilling-basin and chute-types and preliminary design will be made of the most suitable facility recommended for the project. Should an arch dam be recommended for the Devil Canyon project site a plunge pool-type facility would be the most suitable arrangement.

- Structural details and design will be drawn up for bridges, piers, gates, stoplogs, spillway channel walls and slab chute structures, considering seismic and extreme weather conditions imposed on the site.

- Design will include provision in the facilities for gate operation under ice conditions and extreme low temperatures and provision will be made for heating certain facilities for satisfactory performance of gates, hoists and guides.

- Hydraulic analyses will determine configuration of the chute and its hydraulic performance including impact trajectory of the jet for various flows, and pressure determination near the chute. Data will be developed for a hydraulic model testing program.

- Design will consider electrical and mechanical facilities for power hoist operation of gates under all weather conditions.

- The geometry and the trajectory of the jet and its impact on landing soil will be evaluated. Hydraulic model data will be developed for testing in the later phases of the detailed design of the project.

(c) Discussion

Energy dissipation of about a 600-foot head at the Devil Canyon site makes the design of the spillway structure critical. Dispersion of waves from the flood-regulated releases of the upstream Watana dam will need careful evaluation of its impact on the valley walls.

Extreme weather conditions at the project site will require special design consideration during the preliminary stage. Preliminary drawings from which quantities will be taken off will be prepared. The design will be accompanied by the associated schedule and cost estimate including impact on associated structures. The design will be compatible with the hydraulic requirements and will conform with the technical, economic and safety standards.

(d) Schedule

Weeks 95 through 115

Subtask 6.19 - Spillway Selection Report

(a) Objective

To prepare a report presenting the results of studies of alternative spillway design concepts for the Watana and Devil Canyon Sites and the selection and development of preliminary designs in each case.

(b) Approach

The spillway selection report will be assembled to document the results of Subtask 6.14 through 6.18 dealing with consideration of alternatives and preparation of preliminary designs for the Watana and Devil Canyon Spillways. Primary input to the report will be provided by memoranda prepared during the course of those studies to summarize the work undertaken, together with appropriate drawings, cost estimates and schedules.

Specific topics to be addressed in the report will include:

- basis of design flood analysis
- selected design floods
- selected spillway capacity
- selection of spillway type
- selection of discharge facilities
- flood routing analysis
- alternative spillway locations
- preliminary hydraulic design and rating curves
- optimization of crest widths/elevations
- downstream erosion control
- preliminary structural designs
- preliminary stability analysis
- foundation treatment
- construction cost and schedule summaries
- flood control and operational safety
- icing considerations

(c) Discussion

The report also will include a review of the interrelationship of the two reservoirs during floods and the advantages and disadvantages of adopting remote control operation. The technical, economic and environmental issues involved in the selected designs will be discussed together with recommendations for further studies to be undertaken prior to construction, including hydraulic modelling. Discussions also will be presented on equipment contract packaging alternatives.

The report will provide basic input to final design of spillway structures, including structural and hydraulic analyses, geotechnical conditions and hydraulic design of the spillways. The report will also address other problems needing further investigation for the detailed design such as geotechnical design, ice jamming conditions and constraints, seismic loading, possible requirements for heating and other construction problems in extreme climatic conditions.

(d) Schedule

Weeks 110 through 120

Subtask 6.20 - Access and Camp Facilities

(a) Objective

To develop preliminary designs, arrangement drawings and cost estimates for permanent camp and access road facilities for construction and operation of the Devil Canyon, Watana and related project facilities.

(b) Approach

The results of access road route selection studies, surveys undertaken in Task 2, and geotechnical exploration in Task 5 will provide basic input to this task. The initial camp facilities also developed under Task 2 will provide the basis upon which the camp designs will be developed.

Ongoing Task 6 design activities together with Task 9 construction and resource scheduling input also will be used in the development of camp design.

Preliminary alignment profiles for roads and associated horizontal and vertical curve design criteria will be developed. Road width, loading criteria and data will be based on the heaviest and largest items of power plant equipment to be shipped to the site.

Preliminary plans and profiles will define cut and fill slopes based on geotechnical data and include designs for culverts and bridges. Bridge and culvert alignments and designs will be based on preliminary topographic, geologic and hydrologic input at each location. Tunnels may be used where appropriate. A total of 27 miles of access road to the Devil Canyon site from the area of Highway No. 3 or railroad close to Gold Creek, are envisioned. An additional 37 miles of road will be required from the Devil Canyon site to the Watana site. Access roads will be required to the airstrip to each power plant and other power facilities and to the dam and spillway for each site.

(c) Discussion

Permits required for construction of access roads and camp facilities will be obtained by CIRI/H&N, who will also provide support in the development of camp designs.

Access road and permanent camp facilities will probably be required at each of the damsites. At least one permanent camp facility with all-weather road access to all permanent installations will be necessary to support project operation and maintenance.

Permanent camp facilities will include permanent housing and recreation, medical and shopping facilities. This work will form the basis of permitting and contract documents for access roads scheduled to be constructed between 1982 and the end of 1987.

(d) Schedule

Weeks 70 through 80

Subtask 6.21 - Watana Diversion Schemes

(a) Objective

To examine alternatives and select a river diversion plan to satisfy the construction schedule requirements for construction of the Watana dam, outlet works, spillway, power plant and reservoir, and prepare conceptual designs, drawings and cost estimates for the selected scheme.

(b) Approach

The Watana diversion scheme will depend to a large extent on the type and size of dam selected for the ultimate development and for any intermediate stages of construction.

For a large earth or rockfill dam of the size currently proposed at Watana, the diversion scheme will comprise some combination of upstream and downstream cofferdams and an appropriate arrangement of tunnels, intakes and outlet structures to divert the flow. Consideration will be given to alternatives involving channel diversion schemes in the riverbed area during a portion of the construction period. For possible concrete dam alternatives considered under Subtask 6.07, somewhat different design concepts will be involved. These would most likely include diversion of river flow directly through or over partially completed dam structural elements.

Activities undertaken in this subtask will include the following:

- Selection of diversion design flood and development of other design criteria

- Study of alternative cofferdam design concepts, heights and placement methods

- Study of alternative tunnel alignments, sizes, methods of construction and lining requirements

- Review of requirements for flow control and conceptual design of intake and outlet structures

- Consideration of icing problems upstream and downstream of the damsite area

- Review of foundation cut-off and treatment requirements

- Consideration of requirements for dewatering of dam foundations

- Evaluation of methods of tunnel closure for reservoir impoundment

- Conceptual designs, drawings and cost estimates for the selected diversion scheme

- Diversion flood routing analyses.

(c) Discussion

The selected scheme will provide safe arrangements for dam construction at minimum cost. Consideration will be given to utilization of permanent project features such as power and tailrace tunnels as diversion facilities.

Input to this subtask will include the proposed dam construction schedule, diversion flood flow criteria, geotechnical exploration data and the type and location of the main dam and associated features. Diversion flood hydrographs and tailwater rating curves for these studies will be based on Task 3 output. The flood hydrograph data will be reviewed and selected for consistency with the risks associated with construction of the Watana dam. Diversion studies will determine the height of the upstream and downstream cofferdams with associated sizes of the diversion tunnel selected for the scheme. These studies will be used to determine an economical combination of size of the diversion tunnel and the cofferdam height.

The severe weather conditions at this site and the imposed restrictions on the construction schedule associated with the relatively well defined seasonal flow variations of the river will impose certain limitations on development of the design of the diversion scheme.

The crest elevation of the upstream diversion dam proposed in the 1979 Corps of Engineers report is about 100 feet above the existing river bed. The embankment of this cofferdam therefore appears to be founded on about 50 feet of gravel and other pervious materials. Construction of the embankment of the diversion dam itself is thus a major task and would probably require its own smaller cofferdam. A slurry trench or cut-off arrangement will probably be required to limit seepage.

Diversion dewatering problems under the core of the main dam will be aggravated because of the required excavation and removal of more than 50 feet of riverbed material.

(d) Schedule

Weeks 85 to 95

Subtask 6.22 - Devil Canyon Diversion Schemes

(a) Objective

To examine alternatives and select a river diversion plan to satisfy the construction schedule requirements for construction of the Devil Canyon dam, outlet works, spillway, power plant and reservoir, and prepare conceptual designs, drawings and cost estimates for the selected scheme.

(b) Approach

The Devil Canyon diversion scheme will depend to a large extent on the type and size of dam selected for the ultimate development and for any intermediate stages of construction. The scheme will be greatly influenced by the pattern of releases from the upstream Watana development which will probably already be in place.

For a concrete dam of the size currently proposed at Devil Canyon, the diversion scheme will probably comprise some combination of upstream and downstream cofferdams and an appropriate arrangement of tunnels, intakes and outlet structures to divert the flow. Consideration will be given to alternatives involving diversion of river flow directly through or over partially completed dam structural elements during at least a portion of the construction period. For possible rockfill dam alternatives considered under Subtask 6.08, somewhat different design concepts will be involved.

Activities undertaken in this subtask will include the following:

- Selection of diversion design flood based on Watana releases and development of other design criteria
- Study of alternative cofferdam design concepts, heights and placement methods
- Study of alternative tunnel alignments, sizes, methods of construction and lining requirements
- Diversion flood routing studies
- Review of requirements for flow control and conceptual design of intake and outlet structures
- Consideration of icing problems upstream and downstream of the damsite area
- Review of foundation cut-off and treatment requirements
- Consideration of requirements for dewatering of dam foundations
- Evaluation of methods of tunnel closure for reservoir impoundment

- Conceptual designs, drawings and cost estimates for the selected diversion scheme

- Consideration of concrete dam construction methods and risks involved in diversion of river flow through partially completed elements.

(c) Discussion

The selected scheme must provide safe arrangements for dam construction at minimum cost. Consideration will be given to utilization of permanent project features such as tunnels, power and tailrace as diversion facilities.

Construction planning and design of diversion facilities will take due account of these factors.

During spring and early summer, discharges from Watana spillway could impose severe limitations and design constraints for the development of the diversion plan for the Devil Canyon site.

Input to this subtask will include the proposed dam construction schedule, appropriate flood-flow criteria, geotechnical exploration data and the type and location of the main dam and associated features. If appropriate, diversion studies will determine the height of the upstream and downstream cofferdams with associated sizes of the diversion tunnel selected for the scheme. These studies will determine a reasonably economical combination of size of the diversion tunnel and the cofferdam height. Tailwater rating curves for these studies will be based on Task 3 output. The flood hydrograph data will be reviewed for its application and appropriately modified in accordance with the risks associated with such a high dam.

(d) Schedule

Weeks 85 to 95

Subtask 6.23 - Optimize Watana Power Development

(a) Objective

To study alternative Watana power plant locations, types and sizes, and associated intake, power conduit and outlet facilities within the context of selected dam and spillway arrangements, and select the optimum power development concept.

(b) Approach

The three major components of project cost at Watana are the dam, the spillway and the power development facilities. To this point in Task 6 studies, work will concentrate on establishing the requirements for feasible optimum dam and spillway design concepts. These studies generally will be developed on the basis of engineering judgment and experience and previous report data. This will not detract from the overall objective of this POS in that the further improvements and economies which may be made in the design of the power facilities are not likely to affect the overall technical and economic feasibility of the project significantly.

The location, type and size of the power plant associated with the selected dam and spillway structures will be considered in more detail. The installed capacity and annual generation data developed under Subtask 6.03 will be re-examined in the light of updated total project cost and any additional hydrological data which may have been developed. Additional available geotechnical data will be considered in designating alternative power plant locations and re-evaluation of power development costs.

Subjects of study will include the following:

- Confirmation of tailwater rating curves and hydraulic head computations

- Determination of optimum plant capacity and energy outputs as part of the Railbelt Region power system

- Surface and underground, left or right abutment, powerhouse locations

- Number, size and lining requirements for penstocks, tailrace tunnels and surge tank

- Number, type, size and setting of units

- Location and number of transformers

- Switchyard and cabling requirements

Selection of the optimum power development will be made on the basis of technical feasibility and safety at minimum cost.

(c) Discussion

The optimum scheduling of hydroelectric installations developed under Task 1 will be reviewed as input to this Subtask.

For the head and size of unit contemplated at Watana, vertical Francis units directly connected to synchronous generators are the most likely installation. Depending on the desired staging of development, modern trends generally suggest that fewer, larger units are most likely to provide maximum opportunities for economy of scale. Discussions will be held with manufacturers in determining the probable optimum size of unit. No problems are anticipated in selecting units at the size and head envisaged. A summary of recent large Francis unit designs is presented in Table A5.6.

The 1979 Corps of Engineers design for Watana indicates an underground power plant location. The scheduling advantages of such an installation are considerable in that year-round construction is facilitated. Nevertheless, surface alternatives may offer some advantages particularly in some of the possible limitations imposed by spillway location priorities.

(d) Schedule

Weeks 90 through 110

TABLE A5.6

TYPICAL LARGE FRANCIS UNITS

Plant	Location	No. of Units	Unit Output	Head	Year in Operation
Churchill Falls	Canada	11	480 MW	1025 ft	1972
Grand Coulee III	Wash., USA	6	3 - 600 MW 3 - 700 MW	285 ft	1977
Guri	Venezula	10	650 MW	380 ft	UC
Itaipu	Brazil	18	780 MW	388 ft	UC
Ludington*	USA	6	343 MW	361 ft	1973
Bath County*	USA	6	357 MW	1079 ft	UC
Mica	Canada	4	625 MW	600 ft	1977
Cobora Bassa	Mozambique	5	484 MW	372 ft	1977
Pauld Alfonso	Brazil	5	425 MW	369 ft	UC

* Francis Reversible Pump-Turbines
UC - Under Construction

Subtask 6.24 - Optimize Devil Canyon Power Development

(a) Objective

To study alternative Devil Canyon power plant locations, types and sizes, and associated intake, power conduit and outlet facilities, within the context of selected dam and spillway arrangements, and select the optimum power development concept.

(b) Approach

As in the case of the Watana site (Subtask 6.23), Task 6 studies will initially concentrate on establishing the requirements for feasible optimum dam and spillway design concepts at Devil Canyon.

The location, type and size of the power plant associated with the selected dam and spillway structures will be considered in more detail. However, space restrictions in the narrow Devil Canyon will impose constraints on available powerhouse locations. The installed capacity and annual generation data developed under Subtask 6.03 will be re-examined in the light of updated total project cost and any additional hydrological data which may be developed. Additional available geotechnical data will be considered in alternative power plant locations and re-evaluation of power development costs.

Subjects of study will include the following:

- Impact of time release patterns from Watana

- Confirmation of tailwater rating curves and hydraulic head computations

- Determination of optimum plant capacity and energy outputs as part the Railbelt Region power system

- Surface and underground, left or right abutment, or integral dam powerhouse locations

- Number, size and lining requirements for penstocks, tailrace tunnels and surge tank (if required)

- Number, type, size and setting of units

- Location and number of transformers

- Switchyard and cabling requirements

Selection of the optimum power development will be made on the basis of technical feasibility and safety at minimum cost.

(c) Discussion

The optimum Devil Canyon power development will be significantly influenced by Watana plant operations.

As at Watana, for the head and size of unit contemplated at Devil Canyon, vertical Francis units directly connected to synchronous generations are the most likely installation. Discussions will again be held with manufacturers in determining the probable optimum size of unit.

The 1979 Corps of Engineers design for Devil Canyon also indicates an underground power plant location. The scheduling advantages of such an installation are considerable in that year-round construction is facilitated. Nevertheless, surface alternatives may offer some cost advantages, particularly if a power plant constructed integrally with the dam proves to be feasible.

(d) Schedule

Weeks 90 through 110

Subtask 6.25 - Optimize Dam Heights

(a) Objective

To consider alternative heights of selected Devil Canyon and Watana dam structures and associated development design concepts and select the optimum.

(b) Approach

At this point in the study the opportunity will be taken to reassess the costs and benefits of each development to confirm or modify the design concepts previously adopted. The Subtask will essentially be undertaken on the basis of the results of previous Task 6 studies of the dams, spillways and power developments. The following activities will be included:

- development of preliminary conceptual designs for alternative dam heights with associated spillway and power development modifications

- re-evaluation of development construction costs, power and energy outputs and system economics incorporating the modified development

- selection of the optimum development concept

- if necessary, modifications to conceptual designs and cost estimates of dams and spillways

(c) Discussion

This will essentially be the final step in the determination of project feasibility and in selection of the optimum development at each site in terms of maximum net benefits. In selecting the optimum development, due consideration will be given to relevant environmental issues.

(d) Schedule

Weeks 105 to 115

Subtask 6.26 - Preliminary Design Watana Power Development

(a) Objective

To develop preliminary conceptual designs, drawings and cost estimates for Watana power plant, intake, power conduits and outlet works.

(b) Approach

Preliminary designs, drawings and cost estimates will be prepared for the selected optimum power development facilities at Watana including:

- General arrangement
- Powerhouse arrangement
- Valve chambers
- Powerhouse crane
- Access and control room facilities
- Transformer area
- Draft tubes and gates
- Bus ducts and cable shafts
- Intakes and gates
- Penstocks and surge tank (if required)
- Tailrace and outlet structure
- Switchyard and transmission arrangements

The work will also include the following activities:

- Establish the turbine head and capacity rating and mechanical equipment required

- Establish the generator rating and other electrical equipment requirements

- Determine arrangement of mechanical and electrical equipment in the powerhouse layout for the most efficient use of space

- Prepare electrical single-line diagram

- Make preliminary analyses of transient pressures in the power conduit

- Design preliminary penstock steel/concrete lining

(c) Discussion

Studies will be made of the geotechnical aspects of the underground structures such as the powerhouse, tunnels and penstocks, with appropriate input from exploratory work. The assessment of geotechnical problems and the design analysis will be sufficient in depth to establish technical feasibility and to determine realistic capital cost and schedule requirements. The objective of these studies will be to locate a structurally sound block of rock within which the major openings may be sited with confidence.

As an extension of the field program, the assessment will include rock quality studies identifying and evaluating significant geological features such as faults, foliation, shear zones, principal joint systems, groundwater and seepage regimes. During this process, basic design parameters such as shear strength and rock modulus will be evaluated. Based on assessment and evaluation of the studies, the basic design criteria for rock excavation, rock reinforcement, rock support lining requirements and pressure relief systems for major openings to ensure rock mass stability will be confirmed.

The size of major openings such as the underground powerhouse will be largely dictated by mechanical and electrical equipment, hydraulic requirements, and orientation and shape of the openings. The design optimization of the geometry will depend on the strength characteristics of the mass rock relative to the stresses that may be imposed. Finite element stress analysis may be necessary during later project design phases after submission of the license application to check the stability of the openings.

Ice jamming conditions and other severe weather construction and post-construction conditions will be examined to provide a facility which is fully integrated with the hydraulic system of the conduits and power plant, and can serve under all weather conditions.

Preliminary concepts will be developed for structural details, along with concrete pour and jointing details and consideration of construction methods. To cope with water quality and environmental problems due to reservoir stratification, the intake structure should be capable of drawing water from several different levels. The conceptual design of an intake structure with various levels of withdrawal, power inlet transitions, emergency gates, and trashrack details will be undertaken. Information obtained from manufacturers for specific mechanical and electrical equipment items with associated costs and characteristics will be used in the conceptual layout drawings and also for the cost estimate.

Preliminary conceptual designs of gates, bridges, energy-dissipating structures, tunnels and all other hydraulic structures will be made to provide reliable cost data.

(d) Schedule

Weeks 95 to 115

Subtask 6.27 - Preliminary Design Devil Canyon Power Development

(a) Objective

To develop preliminary conceptual designs, drawings and cost estimates for Devil Canyon power plant, intake, power conduits and outlet works.

(b) Approach

As for the Watana Power Development, work under this Subtask will include preliminary designs, drawings and cost estimates for the selected optimum power development facilities at Devil Canyon. These will include:

- General arrangement
- Powerhouse arrangement
- Valve chambers
- Powerhouse crane
- Access and control room facilities
- Powerhouse crane
- Transformer area
- Draft tubes and gates
- Bus ducts and cable shafts
- Intakes and gates
- Penstocks and surge tank (if required)
- Tailrace and outlet structure
- Switchyard and transmission arrangements

The work will also include the following activities:

- Establish the turbine head and capacity rating and mechanical equipment required

- Establish the generator rating and other electrical equipment requirements

- Determine arrangement of mechanical and electrical equipment in the powerhouse layout for the most efficient use of space

- Prepare electrical single-line diagram

- Provide preliminary analysis of transient pressures in the power conduit

- Design preliminary penstock steel/concrete lining

(c) Discussion

As for Watana, the geotechnical aspects of the design of underground structures such as the powerhouse, tunnels and penstocks will be carefully assessed with due consideration of the results of exploratory work. The assessment of geotechnical problems and the design analysis will be sufficient in depth to establish technical feasibility and to determine realistic capital cost and schedule requirements.

The assessment will include identification of design parameters such as shear strength and rock modulus and evaluation of significant geologic features such as faults, foliation, shear zones, principal joint systems, groundwater and seepage regimes. The basic design criteria for rock excavation, rock reinforcement, rock support lining requirements and pressure relief systems for major openings to ensure rock mass stability will be confirmed.

The size of major openings such as the underground powerhouse will be largely dictated by mechanical and electrical equipment, hydraulic requirements, and orientation and shape of the openings. Finite element stress analysis may be necessary during later project design phases after submission of the license application to check the stability of the openings.

Evaluation of the impact of conjunctive operation of Devil Canyon and Watana will be undertaken, including the effects of ice jamming and other severe weather construction and post-construction conditions.

To cope with water quality and environmental problems due to reservoir stratification, the intake structure should be capable of drawing water from several different levels. The conceptual design of an intake structure with various levels of withdrawal, power inlet transitions, emergency gates, and trashrack details will be undertaken. Information obtained from manufacturers for specific mechanical and electrical equipment items with associated costs and characteristics will be used in the conceptual layout drawings and also for the cost estimate.

Preliminary conceptual designs of gates, bridges, energy dissipating structures, tunnels and all other hydraulic structures will be made to provide reliable cost data.

(d) Schedule

Weeks 95 to 115

Subtask 6.28 - Power Development Report

(a) Objective

To prepare a report presenting the results of studies of optimization of power development alternatives for the Watana and Devil Canyon Sites and the selection and development of preliminary conceptual designs in each case.

(b) Approach

The power development report will be assembled to document the results of Subtasks 6.06 and 6.23 through 6.27. The report will deal with consideration of alternatives and preparation of preliminary designs for the Watana and Devil Canyon power developments, including intakes, penstocks, surge tanks, power plants, tailrace, switchyard and transmission facilities for each site. Primary input to the report will be provided by memoranda prepared during the course of those studies to summarize the work undertaken, together with appropriate drawings, cost estimates and schedules.

Specific topics to be addressed in the report will include the following:

- staged power development considerations
- selection of generating capacity of installations
- geotechnical design considerations
- hydraulic design parameters
- conceptual design of power developments
- single-line diagrams
- cost estimates and schedules
- mechanical equipment selection
- electrical equipment selection
- accessory electrical equipment
- miscellaneous power plant equipment

(c) Discussion

The technical and economic issues involved in the selected designs will be discussed together with recommendations for further studies to be undertaken prior to construction. At least one of the power plants will incorporate an underground cavern installation. The selection of location and geologic considerations for the underground facilities will be fully discussed. Recommendations will be presented for equipment and construction contract packaging alternatives to be considered.

The report will provide basic input to final design of power development structures, including structural and hydraulic analyses, geotechnical conditions and hydraulic design of the intake, penstock and tailrace facilities. The report will address other problems needing further investigation for the detailed design such as geotechnical design, ice jamming conditions and constraints, seismic loading, possible requirements for heating and other construction problems in extreme climatic conditions.

(d) Schedule

Weeks 110 through 120

Subtask 6.29 - Watana General Arrangement

(a) Objective

To prepare general arrangement drawings for the Watana development for inclusion in the FERC license application.

(b) Approach

In this subtask the complete general arrangement of the Watana dam project will be developed. These arrangements will be based on preliminary designs prepared under preceding Task 6 activities for the major project components, including:

- reservoir area
- dam and access facilities
- spillway control structure and access facilities
- spillway discharge facilities
- intake structure and access facilities
- power plant and access facilities
- penstocks and surge tank (if required)
- tailrace arrangement
- switchyard and transmission facilities
- site access and camp facilities

The arrangement will be prepared in the form of reservoir and damsite area layout drawings appropriate for inclusion in the FERC license application.

(c) Schedule

Weeks 110 to 120

Subtask 6.30 - Devil Canyon General Arrangement

(a) Objective

To prepare general arrangement drawings for the Devil Canyon development for inclusion in the FERC license application.

(b) Approach

In this subtask the complete general arrangement of the Devil Canyon project will be developed. These arrangements will be based on preliminary designs prepared under preceding Task 6 activities for the major project components, including the following:

- reservoir area
- dam and access facilities
- spillway control structure and access facilities
- spillway discharge facilities
- intake structure and access facilities
- power plant and access facilities
- penstocks and surge tank (if required)
- tailrace arrangement
- switchyard and transmission facilities
- site access and camp facilities

The arrangement will be prepared in the form of reservoir and damsite area layout drawings appropriate for inclusion in the FERC license application.

(c) Schedule

Weeks 110 to 120

Subtask 6.31 - Project Feasibility Report

(a) Objective

To prepare report documenting the procedures followed in the evaluation of feasibility of the Susitna Hydroelectric Project, including the results of technical and economic studies, conceptual designs, preliminary environmental assessments and recommendations for the future development of the project.

(b) Approach

This report will assemble the results and documentation from all work undertaken in Task 6 and pertinent aspects of all other tasks. Previous reports prepared under Task 6 will be condensed into a single document, including The following:

Subtask 6.05 - Development Selection Report
Subtask 6.13 - Dam Selection Report
Subtask 6.19 - Spillway Selection Report
Subtask 6.28 - Power Development Report

The feasibility report will form the basis of the FERC license application and provide Alaska Power Authority with all technical and economic information necessary to decide whether or not to proceed, and how to proceed with the project.

Specific topics to be dealt with in the report will include the following, for each of the Watana and Devil Canyon sites:

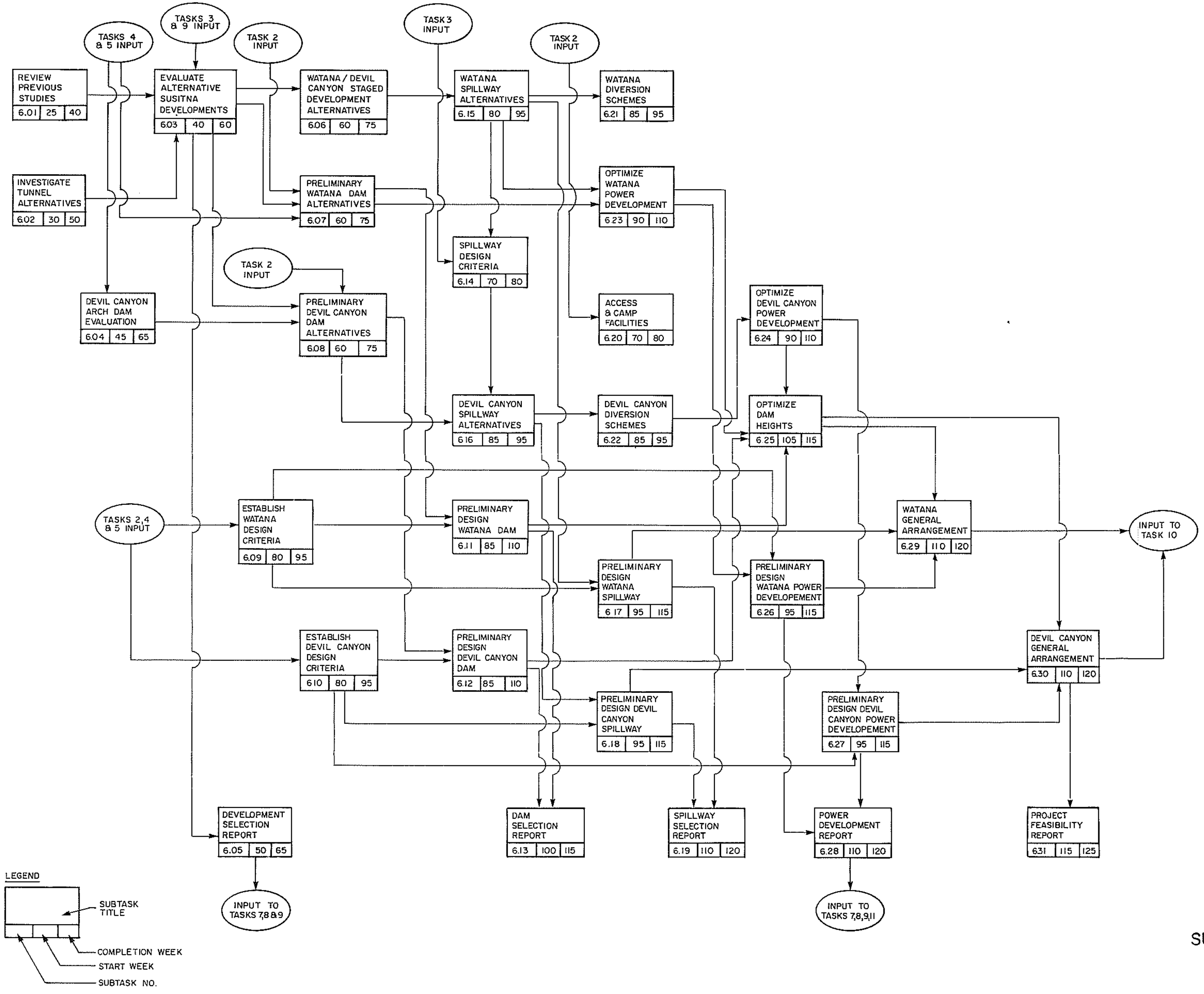
- Description of project
- Basic project data
- Design criteria
- Project staged development concepts
- Dam alternatives
- Consideration of Devil Canyon arch dam design
- River diversion schemes
- Spillway alternatives
- Power development alternatives
- Conceptual project designs and drawings
- Cost estimates and schedules
- Transmission
- Construction contract packaging
- Environmental considerations
- Power marketing studies
- Project feasibility assessments
- Recommendations for project development

(c) Discussion

The feasibility report will be submitted for comment by the external review panel and the Alaska Power Authority prior to completion and issue to the public. The report will form the basis of continued development and financing of the Susitna Project to meet the future power needs of the Railbelt Region.

(d) Schedule

Weeks 115 through 125 (See Plate T6.1)

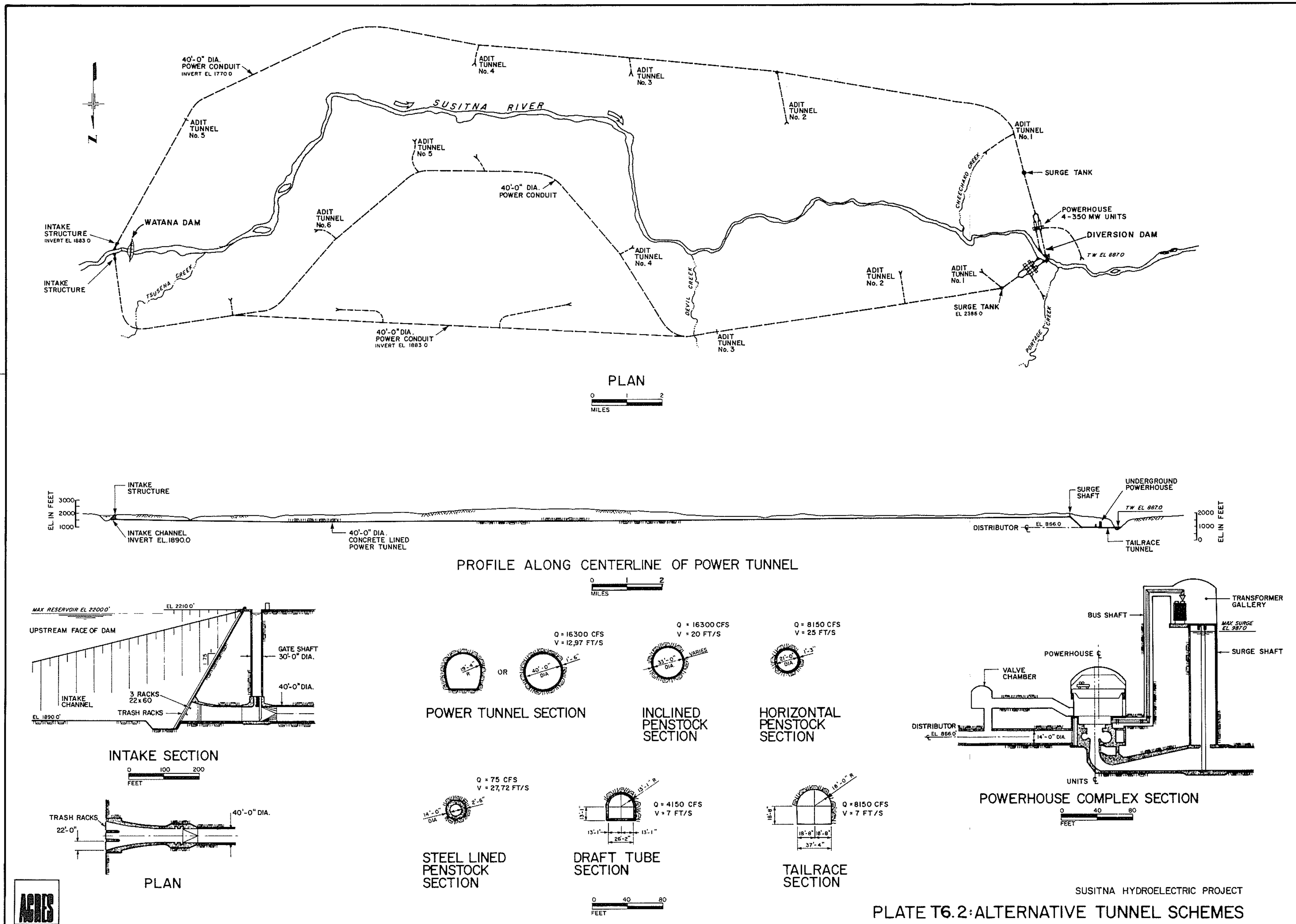


ACRES

SUSITNA HYDROELECTRIC PROJECT

PLAN OF STUDY

PLATE T6.1: TASK 6 SCHEDULE



SUSITNA HYDROELECTRIC PROJECT

PLATE T6.2: ALTERNATIVE TUNNEL SCHEMES

A.5.8 - TASK 7: ENVIRONMENTAL STUDIES

(i) Task Objectives

The environmental program is designed to evaluate primarily the Susitna Hydroelectric Project and associated facilities, with respect to environmental impacts. To accomplish this, a comprehensive program of studies has been developed in the following disciplines: socioeconomics, archaeological and historical resources, geology, land use and recreation, water resources, fish ecology, wildlife ecology and plant ecology. Access roads, site facilities and transmission corridors will also be studied for environmental compatibility.

The overall objective of the environmental studies is to describe the existing environmental conditions, evaluate alternatives in light of the existing conditions and, for the selected alternatives, predict future conditions with and without the proposed project so that changes (impacts) caused by the project may be assessed. To accomplish this overall objective, the following activities will be completed by the environmental study team:

(a) Assist the design team in selecting the best alternatives for power generation, access road and site facility locations and power transmission corridor based on the environmental impact of the proposed facility.

(b) Prepare the exhibits required to support the FERC license application.

(c) Respond to intervenors' petitions, inquiries from local, state and Federal agencies, and public participants at the request of APA.

(d) Assist APA in obtaining Water Quality Certification.

(e) Respond to other environmental needs of APA or the project engineerng team as they occur throughout the study.

(f) Supervise and coordinate both the field and office activities of all the environmental consultants including liaison with ADF&G as authorized by APA.

(g) Monitor all field activities for environmental acceptability.

During preparation of the FERC license application, intensive baseline and impact-related investigations will be performed with the work progressing from general to specific in a timely manner as the project definition is developed. Because of the magnitude of the proposed action, the life cycle of some of the resources to be studied and the time required to evaluate alternatives and develop design specifications, environmental studies will be required beyond the time of license application. Thus, one objective of the early studies is to initiate baseline studies and to develop detailed plans of study for the further environmental impact analysis that will be completed after the license application submission, but prior to a final FERC decision on the license application.

This approach will allow for a refinement of the environmental program at approximately the midpoint of its duration. It will also minimize unproductive expenditures in the event that the project is determined to be infeasible or a new scheme is proposed as the primary alternative. For the purposes of the environmental plan of study, a two-dam scheme (Watana and Devil Canyon) in the Upper Susitna Basin was assumed to be the best alternative, and studies will commence accordingly. If a different scheme is selected as the primary alternative, the program will need to be restructured and costs and schedule adjusted accordingly.

(ii) Task Output

The Alaska Power Authority will be provided with quarterly progress reports describing in summary the activities, results, and conclusions of the studies in progress or to be performed. Annual reports describing in detail the results and conclusions will be prepared. The annual reports will be used to prepare the environmental exhibit (Exhibit E) for the FERC license application. The pre-license application program is based upon an understanding that the forthcoming revision of FERC requirements (for Exhibit E) will demand less intensive environmental analysis at the license application stage than do the existing requirements for Exhibits W, R, S, and V.

Subsequent study outputs will include written testimony and responses to interrogatories. Oral testimony at public hearings will be provided as required. The results of the studies completed after license application submission, including refinement of the impact analysis, are to be presented in two annual supplementary environmental reports for submission to FERC.

At the request of the APA, environmental documents necessary to obtain approval of an EIS, Water Quality Certifications or other required permits will be prepared.

(iii) List of Subtasks

Subtask 7.01 - Coordination of Environmental Studies
Subtask 7.02 - Monitoring of Field Activities for Environmental Acceptability
Subtask 7.03 - Evaluation of Alternatives
Subtask 7.04 - Water Resources (Quality) Analysis
Subtask 7.05 - Socioeconomic Analysis
Subtask 7.06 - Cultural Resource Investigation
Subtask 7.07 - Land Use Analysis
Subtask 7.08 - Recreation Planning
Subtask 7.09 - Susitna Transmission Corridor Assessment
Subtask 7.10 - Fish Ecology Studies
Subtask 7.11 - Wildlife Ecology Studies
Subtask 7.12 - Plant Ecology Studies
Subtask 7.13 - Geological Analysis
Subtask 7.14 - Access Road Environmental Analysis
Subtask 7.15 - Preparation of FERC License Application Exhibit

(iv) Subtask Scope Statements

The primary objective of Task 7 is described in Section A.5.8(i). The subtasks required to respond to this objective are divided into activities undertaken prior to submission of the FERC license application, Subtasks 7.1 through 7.15, and those activities on which continuing work is to be performed after submission of the FERC license application, as described in Section A6.

Subtasks 7.1 through 7.14 may be further subdivided into:

(a) Management and monitoring functions that continue throughout the project, Subtasks 7.1 and 7.2.

(b) Those activities initiated and completed prior to license application submission, Subtasks 7.3, 7.4, 7.13 and 7.14.

(c) Those activities for which baseline studies are largely completed and substantial impact analyses are initiated during the preparation of the license application, Subtasks 7.5 through 7.9. These subtasks are then completed after the license application is submitted to FERC.

(d) The ecological studies that require extensive, long-term field programs, and that are planned and initiated during the early stages of the project, Subtasks 7.10 to 7.12. During this early time period, the primary effort is directed toward data collection and compilation with little detailed analysis being undertaken. The data collection is continued after the license application is submitted until the four or five years of data required to form an adequate base is accumulated. An intensive data analysis and impact assessment is then completed. Sufficient data analysis will take place during the early time period to guide and follow-up baseline studies and ensure that no gaps exist in the data base being compiled.

If any deficiencies in an original program plan are detected, the analysis performed during the early time period will be used to modify the plan and redirect the emphasis of the field studies as required.

Subtask 7.15 is the culmination of the early activities, i.e., preparation of Exhibit E of the license application.

The following discussions are summaries of the work to be completed during each of the environmental subtasks. More detailed descriptions of the pre-license application scope of work for some of the more complex environmental studies (Subtasks 7.05, 7.06, 7.07, 7.08, 7.10, 7.11 and 7.12) are also presented. A detailed description of the fish and wildlife studies to be performed by the Alaska Department of Fish and Game to complement Subtasks 7.10 and 7.11 is included in the appropriate subtask description.

Subtask 7.01 - Coordination of Environmental Studies

(a) Objective

The objectives of this subtask are:

(1) to ensure that all environmental Plans of Study are executed in a coordinated, controlled manner in accordance both with the scopes of work and compliance schedules;

(2) to coordinate the implementation of all discipline-specific environmental Plans of Study;

(3) to maximize study effort and efficiency through organized inter-discipline coordination in accordance with the subtask responsibility statements;

(4) to ensure that all project efforts are non-duplicative and cost-effective; and

(5) to provide the Alaska Power Authority and third-party interests with a framework for communication on all environmental matters.

(b) Approach

Dr. John W. Hayden, Environmental Division Manager of Acres, and Mr. Jeffery O. Barnes, President of Terrestrial Environmental Specialists will provide management for all environmental studies conducted for the Susitna Project. Mr. Barnes will be responsible for obtaining the services of qualified subcontractors to perform the discipline-specific tasks necessary for the licensing of the project. As the prime contractor, Acres is solely responsible to APA for the cost, schedule and quality of all work, thus, subcontract agreement between TES and their subcontractors shall be submitted to Acres' Project Manager for final review and approval. TES will provide the day-to-day technical guidance of and coordination among their subcontractors to ensure their compliance with both time schedules and cost estimates and to assure technical satisfaction of licensing requirements.

A preliminary environmental studies schedule appears in this Plan of Study. A detailed schedule of all environmental activities will be developed early in the study program. The final schedule will be coordinated with the engineering studies to ensure timely input from Tasks 1, 2, 3, 5, 8 and 12. The environmental studies schedule will identify the tasks to be accomplished, the length of time allocated for subtask accomplishment and project milestones. The final schedule will be submitted through Acres' Project Manager to APA for review, comment and approval.

Quality control procedures previously utilized by Acres and TES will be implemented to ensure the uniformity and accuracy of data collected in support of the environmental programs. These procedures will be established and put into effect at the outset of the study and will be rigorously followed throughout the course of study.

The division of responsibilities for the accomplishment of subtask objectives will also be clearly defined at project initiation. Technical, inter- and intra-discipline meetings will be held on a regular basis throughout the study effort to facilitate understanding of subtask duties. Meetings for the purpose of keeping engineering personnel, the APA, and third party interest groups abreast of environmental study activities and findings will also be held on a regularly scheduled basis.

(c) Discussion

Management and administration of the environmental studies will be accomplished through the formulation of a three-tiered management pyramid with the third (or lowest level) being the working level. At the top will be the Environmental Study Managers (ESM) consisting of Dr. Hayden and Mr. Barnes. Next in command will be the Environmental Study Directors (EPD) consisting of the Principal Director, Dr. Vincent J. Lucid, Director of Environmental Studies for TES and the Deputy Director, Ms. Cathie Baumgartner, Vice President of TES. Beneath them appear the Group Leaders for the environmental disciplines and/or the Principal Investigators.

Administration of environmental studies will be handled by the Environmental Study Managers. They will be responsible for ensuring the successful completion and applicability of that portion of the FERC application pertaining to environmental matters. They will have the following duties and responsibilities:

(1) Ensure the fulfillment of contract requirements,

(2) Ensure coordination with all technical aspects of the overall study,

(3) Conduct liaison with regulatory agencies and interested third parties,

(4) Recommend approval/disapproval on all project cost and/or work scope changes to Acres Project Manager,

(5) Keep the following personnel and agencies informed of pertinent decision and/or environmental activities:

- Project Manager, Acres
- Appropriate Engineering Group Leaders
- Local, state and federal agencies, as designated by Acres Project Managers, (including APA, ADF&G, USFWS, BLM, ADNR, Corps and others).

(6) Provide monthly progress reports to Acres' Project Manager,

(7) Approve minor Project Work Scope adjustments with an information copy to Acres' Project Manager, and

(8) Review, approve, and recommend release and distribution of reports to Acres' Project Manager.

The Environmental Study Managers will provide direction for the timely initiation of the environmental studies and other project activities on an as-needed rather than a day-to-day basis for maximum study schedule and cost efficiency.

Administration of all day-to-day project activities will be the responsibility of the Environmental Study Directors. Their responsibilities will include, but not be limited to the following:

(1) Developing comprehensive quality control procedures applicable in all phases of the environmental effort,

(2) Approving the initiation of all environmental sampling efforts,

(3) Providing problem resolution on an as-needed basis,

(4) Supervising expenditures and cost-accounting procedures and audit invoices,

(5) Providing design recommendations to the Acres' Project Manager, and

(6) Reviewing and approving all reports for internal action and transmit final copies to the ESM for appropriate disposition.

The management and administration of all technical programs will be the responsibility of the Environmental Study Directors. However, they may delegate this authority and responsibility to Group Leaders when appropriate. The Group Leaders will be responsible to perform the following:

(1) Ensure completeness and effectiveness of discipline-specific studies in meeting study objectives,

(2) Provide direction of and assistance with the initiation of all field sampling efforts,

(3) Maintain active supervision of project staff efforts on a day-to-day basis,

(4) Recommend approval/disapproval of adjustments to discipline-specific studies,

(5) Maintain a detailed status report of all discipline-specific studies to insure conformance with program objectives,

(6) Approve minor program/sampling procedure adjustments to make the program more compatible with existing conditions,

(7) Inform the ESD of program activities on a regularly scheduled basis,

(8) Provide design recommendations to ESD.

Principal Investigators (PI) will share some of the duties previously identified as Group Leader responsibilities, especially with respect to the conduct of the field sampling efforts. In addition, each PI will, as a minimum:

(1) recommend modifications to cost and/or discipline-specific study efforts based upon sampling results; and

(2) provide monthly progress and activity status reports either to the Group Leader or the ESD.

The proposed environmental Plan of Study is designed to meet the needs of the Susitna Project license application to FERC. However, flexibility and judgment affecting study details should be reserved for the purpose of matching study efforts to an ever-changing public demand for environmental quality protection and to changing regulatory requirements and attitudes.

(d) Schedule

Weeks 1 - 130

Subtask 7.02 - Monitoring of Field Activities for Environmental Acceptability

(a) Objective

To keep the environmental impact of surface-disturbing and all other field activities to a minimum.

(b) Approach

Surface-disturbing activities of any kind will be monitored by a field representative. This representative will also coordinate certain activities within the environmental discipline and may coordinate activities among groups to avoid conflicts. Of particular concern is the unintentional disturbance of an important archaeological or historical site or an environmentally sensitive area.

(c) Discussion

As the environmental, geotechnical and other study programs are implemented, a certain amount of field sampling and testing will be required. A field representative will be on hand to outline areas that are sensitive to disturbance and also to monitor surface-disturbing activity while it is occurring. This monitoring will ensure compliance with existing environmental regulations. In certain instances, mitigation measures will be recommended to reduce impacts.

The field representative will also have a certain amount of coordination responsibilities. This will include coordinating sampling locations of the various groups. Conflicts could arise, for example, if one group plans to clear an area for testing purposes, while another group is in the process of collecting biological data that would be affected by such clearing. Although conflicts may not always be avoidable, the field representative will be responsible for keeping track of present or proposed sampling programs and notifying groups when conflicts may occur.

(d) Schedule

Weeks 8 through 130

Subtask 7.03 - Evaluation of Alternatives

(a) Objective

To compare, from an environmental standpoint, the various alternatives for power generation and associated transmission facilities.

(b) Approach

The environmental evaluation of power development alternatives will identify the potential impact issues, and their relative magnitudes, associated with alternative developments. The engineering staff of Acres and WCC will identify and describe the alternatives, and the environmental staff of TES (hydroelectric alternatives) and WCC (non-hydro alternatives) will perform the environmental analysis on the basis of available data, which will be compiled for this purpose. Since the impact issues associated with the two-dam scheme for the Upper Susitna have already been identified, this scheme will be used as the standard against which other alternatives will be measured.

(c) Discussion

The evaluation of alternatives will be completed as part of Task 1 - Power Studies.

Subtask 7.04 - Water Resources Analysis

(a) Objective

The primary objective of the water resources analysis is to generate data that will be used to determine whether the anadromous and resident fisheries in the Susitna River or Cook Inlet will be enhanced or adversely impacted by the proposed project. To achieve this objective the following study areas must be addressed:

(1) Changes in river discharge characteristics due to flow regulation,

(2) Changes in water quality due to impoundment, including sediment load, temperature, dissolved gas production, and chemical constituents,

(3) Changes in wintering conditions along the river due to increased low flow during the winter and changes in ice conditions.

A secondary objective of the water resources analysis will be to assist in estimating the benefits to land use, recreation and flood prevention balanced against the inundation of approximately 50,000 acres above the two dams.

(b) Approach

Accurate baseline water quantity and quality data are essential for predicting the effect of the Susitna Project on the fisheries of the Susitna River and for assuring that construction, filling and operation of the hydroelectric project can be accomplished while achieving possible beneficial environmental effects.

The water quantity and quality information needed will be taken from the engineering studies, particularly Task 3 - Hydrology, from the fisheries study, and from the water quality studies and geological studies to be done by R&M as part of Task 3 and Task 5 - Geotechnical Exploration.

(c) Discussion

Water quality conditions will be affected above and below the dam sites. Stratification conditions within the reservoirs could cause temperature and dissolved gas problems within the reservoir and downstream. The supersaturation of nitrogen and other atmospheric gases could cause gas bubble disease in the downstream fishery. Previously unknown outcrops of soluble metal compounds could be inundated by the reservoirs causing problems to the resident or developing fish populations. Flow characteristics that are essential for upstream migration of salmon to the spawning grounds and for proper conditions for overwintering of both salmon and resident fish species will be studied as part of Subtask 7.10.

Most of the technical data required will be available at the completion of Task 3 - Hydrology. However, to ensure that the correct data is collected in a format useful to this subtask, early coordination of the requirements of this subtask, with the lead personnel responsible for the field and office studies completed under Task 3, will be accomplished. Information relative to parameters to be tested, frequency and location will be provided as input to the hydrologic and water quality field studies to be conducted by R&M. Data relative to sediment loads, dropout rates and resuspension, as well as streambed degradation downstream of Devil Canyon Dam will also be requested from the hydrological and geological studies group.

Finally, these data will be combined with input from the fisheries subtask (Subtask 7.10) to assess the impact of the Susitna Project on the fisheries. The data will also be used in Subtasks 7.07 and 7.08 relative to land use and recreational development analysis.

It is anticipated that all activities on this specific subtask will be completed before the FERC license application is submitted. However, final use of the data in other subtasks will not occur until after the license application has been submitted.

At the present time, no distinct water quality program is proposed for the time period after license application submission other than that to be conducted as part of the engineering studies and the in-situ measurements taken by ADF&G in conjunction with fish sampling. If early studies reveal a need for further water quality analysis, a program will be developed and proposed at that time.

(d) Schedule

Weeks 26 through 130

Subtask 7.05 - Socioeconomic Analysis

(a) Objective

To identify and describe the existing socioeconomic conditions and to determine which are most likely to be impacted by the Susitna Hydroelectric Project, as required under the Federal Energy Regulatory Commission regulations. Subsequent to the submission of the FERC license application, the detailed analysis and assessments of the socioeconomic impacts related to the Susitna development will be completed.

(b) Approach

The completion of the socioeconomic analysis is not a prerequisite to submission of the FERC license application. Thus, the work packages to be completed have been divided into those that are scheduled to be completed prior to application submission (1 to 4 below) and those work packages that may be completed during a later time period (discussed in Section A6). The work packages to be completed are

(1) literature search

(2) socioeconomic profile development

(3) preliminary socioeconomic impact studies

(4) forecast of future socioeconomic conditions in the absence of the Susitna Project

(5) forecast of future socioeconomic conditions with the Susitna Project

(6) identification and evaluation of significant socioeconomic project impacts

(7) assessment of economic aspects of important commercial, recreational and subsistence fish and wildlife resources without the project

(8) determination and evaluation of project impacts on important commercial, recreational and subsistence fish and wildlife resources

(9) assessment of social significance of the economic impacts of the project on important commercial, recreational and subsistence fish and wildlife resources.

Impact studies of projects similar to the proposed project will be identified and evaluated in the first work package. Socioeconomic profiles covering the immediate vicinity of the project, broader regions, and the state are developed in the second work package.

The socioeconomic conditions most likely to be impacted by the Susitna Project are identified and described in depth. For the identified socioeconomic conditions, forecasts of future conditions are made. These forecasts will serve as a baseline for the preliminary socioeconomic impact studies as well as the detailed socioeconomic impact assessments of project impacts to be completed in work package 6 during the post-license application studies.

In the post-license application studies, potential impacts of the project will be determined by comparing the forecast "with the project" to the baseline forecast. This analysis will yield quantitative estimates for impacts as well as qualitative descriptions of impacts.

(c) Discussion

Impact studies of hydroelectric projects similar to the proposed Susitna Project will be reviewed. These reviews will provide a range of impacts which may be expected to result from the proposed project.

Next, the following types of detailed socioeconomic profiles will be developed for the local area and for the general area, where applicable:

- Population totals and distribution, current and projected,
- Housing stock, by type of unit and price/rent levels,
- Employment and income levels,
- Tax rates and revenues by type of jurisdiction,
- Public facilities, availability, adequacy, and cost,
- Land-use patterns and trends,
- Business activity, level, and trends,
- Education, enrollment trends, capacity, revenues, and costs,
- Transportation facilities, by type,
- Attitudes toward life style and quality of life,
- Attitudes toward growth,
- Fish and wildlife resource use patterns.

These profiles will also include the range of impacts which may be expected in the Alaskan environment. The range of impacts for large hydroelectric projects combined with those in the Alaska environment will constitute a comprehensive list of potential impacts which may result from the proposed Susitna Project.

In the final work package to be completed before license application submission, relevant socioeconomic conditions are forecast. This forecast is made assuming the Susitna Project will not be undertaken. It includes only those areas which would be impacted by the Susitna Project.

(d) Schedule

Weeks 8 through 117.

(e) Detailed Scope of Work

Table A5.7 summarizes the proposed scope of work for Phase I of the study (pre-license application). The work packages mentioned above are divided into work items, and intermediate products resulting from several of these work items are identified.

Discussion in this subsection focuses upon work items from the Outline Summary of the Phase I Scope of Work (Table A5.7) which require further explanation. The work item approach and methods, and the relationship of work items within a work package are the main topics developed. In addition to the four work packages described below for Phase I, the Phase I scope of work includes a refinement and documentation of the Phase II plan of study for inclusion in the FERC license application.

(1) Literature Review

a. Socioeconomic impact studies for hydroelectric projects similar to the range of proposed projects for the Susitna vicinity will be identified. A consultant(s) with extensive familiarity with socioeconomic studies will be provided with a data compilation format. The purpose of this format will be to acquire data concerning the consultant's past work in socioeconomic impact analysis. In addition the consultant(s) will furnish strategies for further identification of relevant studies.

Bibliographies and major entities such as the Army Corps of Engineers and the Alaska Department of Fish and Game will be consulted to identify further hydroelectric and related studies. It is anticipated that the major source of bibliographies will be those found in the studies initially identified.

b. All studies will be placed in a similar data format to facilitate extraction of impacts, by nature and degree. The format will be developed, studies will be reviewed, and the format will be implemented. Data particularly relevant to Alaska will be highlighted in the format.

c. General socioeconomic conditions in the local area (immediate vicinity of the range of alternative dam sites), the region (the area surrounding the immediate dam-site vicinity, including Matanuska-Susitna Borough, and the Fairbanks/Tanana and Anchorage/Cook Inlet regions) and the State will be reviewed. This review will include the following:

TABLE A5.7

OUTLINE SUMMARY OF THE SOCIOECONOMIC SCOPE OF WORK - PHASE I

WORK PACKAGE	WORK ITEM	PRODUCT
1. Literature review	a. Identify socioeconomic impact studies for similar hydroelectric projects (include foreign studies)	1-a. List of socioeconomic impact studies similar hydroelectric projects
	b. Determine the nature and extent of studies' impacts	1-b. Table showing socioeconomic impacts, by project, type, and degree
	c. Review general socioeconomic conditions in the local and generalized areas[1], and State of Alaska	1-c. Draft profiles of socioeconomic conditions, by areas and state
	d. Assess relevance of studies' impacts for local and generalized areas, and for the State of Alaska	1-d. Partial list of potential Susitna Project impacts, by areas and state
2. Socioeconomic profile development	a. Identify potential impacts peculiar to the local and general areas, and the state	2-a. Table showing potential Susitna Project impacts, by areas and state
	b. Determine conditions[2] most likely to be impacted, by areas and state	2-b. Table showing conditions most likely to be impacted, by areas and state
	c. Develop data collection guides	
	d. Collect data and information on most vulnerable conditions at area and state level	
	e. Compile data and information	

1. The local area is in the immediate vicinity of the Project while the generalized area includes the region surrounding the local area, including Matanuska-Susitna Borough, as well as the Fairbanks/Tanana and the Anchorage/Cook Inlet regions.

2. Conditions will be described by social and economic variables such as population, per capita income, employment, housing, taxes, government services, etc.

TABLE A5.7 Cont'd:

WORK PACKAGE	WORK ITEM	PRODUCT
	f. Develop profiles of socioeconomic conditions likely to be impacted, by areas and state	2-f. Profiles of socioeconomic conditions likely to be impacted, by areas and state
3. Preliminary socioeconomic impact studies	a. Identify conditions most likely to be impacted, by alternative,[3] and areas and state	3-a. Table showing most vulnerable conditions by alternative, and areas and state
	b. Determine the nature and degree of potential impacts, by alternative, and areas and state	
	c. Compare and contrast impacts of alternative projects, by alternative, areas and state	3-c. Table showing nature and degree of impacts by alternative, and areas and state
	d. Evaluate potential impacts of selected alternative (preliminary)	3-d. Text discussion supported by tables
4. Forecast of future socioeconomic conditions in absence of Susitna Project	a. Identify studies which forecast socioeconomic conditions in Alaska in the absence of significant hydroelectric power development	4-a. List of socioeconomic conditions forecast studies
	b. Select studies which have geographically disaggregated results for further consideration	4-b. List of socioeconomic conditions forecast studies with significant geographical disaggregation
	c. Develop and apply study methodology evaluation criteria	
	d. Select study(s) and study(s) results for adoption	4-d. Partial forecast of future socioeconomic conditions in absence of Susitna Project

3. If at this stage of the study one of several alternative types of dam projects has been selected, then the work items of this work package will apply solely to the selected alternative.

TABLE A5.7 Cont'd:

WORK PACKAGE	WORK ITEM	PRODUCT
or, if necessary	e. Revise study(s) methodology to allow for proper geographic disaggregation and/or new factors of change	
	f. Implement revised methodology	4-f. Forecast of future socioeconomic conditions in absence of Susitna Project

- a review of current major assessments of Alaska demographic, social and economic conditions, by region,

- a review of literature pertaining to the Alaska social/cultural environment,

- interviews with recognized authorities on Alaskan economic and social conditions, including but not limited to:

  Mr. Lawrence Kimball, Jr., Alaska Department of Community and Regional Affairs

  Dr. David Kresge, Harvard University and The Institute of Social and Economic Research, University of Alaska

  Dr. David Reaume, Alaska Department of Commerce and Economic Development

  Mr. Bob Richards, National Bank of Alaska

Regional and local authorities including those of the Matanuska-Susitna Borough, will also be contacted. Finally, profiles of general socioeconomic conditions will be developed with local, regional, and state geographic orientations.

d. The relevance of impacts, identified and characterized in work item 1b. for the State of Alaska will be assessed at local, regional, and state levels. This assessment will yield a list of impacts, by geographic area, type, and degree, which may be relevant for the Susitna Project impact studies.

(2) Socioeconomic Profile Development

The purpose of this work package is to develop detailed profiles of socioeconomic conditions most likely to be impacted by a broad range of alternative hydroelectric projects and associated facilities. Attention is focused only on those conditions[1] which are highly vulnerable.

a. Potential impacts peculiar to the local area, region, and state will be determined. This list of impacts will be combined with those of work item 1d. to provide a complete list of potential impacts for the broad range of alternative projects.

b. Next, potential impacts on the list will be assessed for their relevance to the Susitna Project at the local, regional, and state levels. Some of the less relevant potential impacts will drop out; what will remain is a list of socioeconomic

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1 Socioeconomic condition will be described by social and economic variables. The range of variables considered for the impact analyses will include at the minimum the variables mentioned in Exhibit W, components 2.3, 3.1.3, 3.2.3, 5.1, and 7.3. Only those relevant for the Susitna Project will remain for treatment in subsequent tasks. Reasons for eliminating variables from the Exhibit W set will be elaborated.

conditions most likely to be impacted by the broad range of alternative projects.

c. Data collection guides will be developed to gather information necessary to support the production of detailed profiles of socioeconomic conditions most likely to be impacted.

d. Data collection guides will be implemented; information will be gathered at local, regional, and state levels.

e. Information will be compiled in a format conducive to profile development.

f. Detailed profiles will be developed from the information presented in e. above and also from the general profiles developed in 1c.

(3) <u>Preliminary Socioeconomic Impact Studies</u>

For hydroelectric alternatives to be evaluated in Subtask 7.03, potential socioeconomic impact issues and their relative magnitudes will be identified in work item 2b. Other Susitna Project Team members will then provide a narrow range of alternative dam projects. It is anticipated that as few as one or two alternative projects will remain at this state of the study. There will be substantial physical specification and other information made available on each alternative project by these team members, including transmission corridors and access road routes.

a. Socioeconomic conditions most likely to be impacted will be identified for each alternative, by local area, region, and state. Conditions that might be impacted include population, employment, fish and wildlife resources, business activity, land-use patterns, tourism, housing, taxes, and availability of government services (education, fire and police protection, transportation, etc.) and utilities. The table developed in work item 2b. will be used extensively (conditions most likely to be impacted by alternative projects).

b. The nature and degree of potential impacts will be determined for each alternative by local area, region, and state. Potential impacts for each alternative will be shown in matrix form at local, regional, and state levels of geographic aggregation. To the extent available information permits, an attempt will be made to show impacts by project phase.[2] To determine potential impacts, the economic and social implication of each alternative will be measured quantitatively. The nature and degree of potential impacts will also be determined by project phase according to the character of available information.

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[2] Each alternative dam project has 4 phases:
Testing
Conceptualization and Design
Construction
Operating

c. The impacts of alternative projects will be presented in matrix form by local area, region, and state. This form of presentation will be useful in screening the alternative projects for socioeconomic considerations. In the accompanying text discussion, emphasis will be placed on preliminary evaluation of the impacts associated with the alternative selected.

d. After one of the alternative projects is selected, and upon completion of work package 4 (below), the potential impacts of the selected alternative will be subjected to preliminary analysis. Anticipated deviations in the baseline forecast of economic and social conditions will be discussed. Such deviations will be further refined and elaborated in Phase II (post-license application studies).

(4) Forecast of Future Socioeconomic Conditions in the Absence of the Susitna Project

a. Studies and methods for forecasting Alaskan socioeconomic conditions will be identified and investigated by interacting with knowledgeable public and private economists. A list of studies and forecasting approaches will be developed. Next the studies will be evaluated using, as a minimum, the following criteria:

- geographic disaggregation of results,
- methodology,
- forecast of conditions (variables),
- recency of study.

The chosen methodology(s) will be modified to be consistent with the criteria. The revised methodology(s) will be implemented to produce a baseline forecast of socioeconomic conditions.

Subtask 7.06 - Cultural Resources Investigation

(a) Objective

To identify the archeological and historical resources of the project study area and to propose mitigation measures to lessen the impact of ground-disturbing preconstruction and construction activities.

(b) Approach

The Cultural Resource Investigation is designed to fulfill the cultural resource obligation for both the licensing and construction phases of this project, through pre-license application (Phase I) and post-license application (Phase II) efforts.

Cultural resources experts at the University of Alaska Museum will execute an intensive five-step research effort specifically to satisfy both state and federal legislation pertinent to cultural resources. The five steps are

(1) preparation for field studies,
(2) reconnaissance level archeological survey of project areas,
(3) intensive testing of archeological and historic sites discovered during Step (2),
(4) final report preparation, and
(5) registration of all collections in accordance with state and federal requirements pertinent to the preservation of antiquities.

(c) Discussion

As the Susitna Hydropower Project is a federally licensed project for the State of Alaska, the legal framework and authority for the consideration of cultural resources are spelled out in a number of federal and state regulations. As early as 1906 the Antiquities Act (P.L. 59-209) directs the preservation of cultural resources on public lands. The Historic Preservation Act of 1935 (P.L. 74-292) requires the preservation of properties "of national historical or archeological significance and authorized interagency, intergovernmental, and interdisciplinary efforts for the preservation of such resources." The Reservoir Salvage Act of 1960 (P.L. 86-523) provides for the recovery and preservation of "historical and archeological data" that might be lost or destroyed as a result of the construction of federally funded or licensed dams, reservoirs, and attendant facilities and activities. This law was extensively amended in 1974. The Historic Preservation Act of 1966 (P.L. 89-655) declares it to be a national policy to preserve and protect historic and prehistoric sites, buildings, and objects of natural significance. Continuing with this policy the National Environmental Policy Act of 1969 (P.L. 91-180) requires evaluation of the effects of major federal actions on the environment including cultural resources. The Archeological and Historic Preservation Act of 1974 (P.L. 93-291) is an amendment to the Reservoir Salvage Act of 1960. The 1974 Act provides for the protection of historic and archeological sites

> ....which might otherwise be irreparably lost or destroyed as a result of (1) flooding, the building of access roads, the erection of workman's communities, the relocation of railroads and highways, and other alterations of terrain, caused by the construction of a dam of any agency or (2) any alteration of the terrain caused as a result of any federal construction project or federally licensed activity or program. (Sec.1).

Section 7 of the Act authorizes up to one percent of the total budget of a federally funded or licensed project to be allocated for archeological survey, recovery, analysis and publication. Executive Order 11593 directs all federal agencies to make an inventory of historic and prehistoric properties under their control and to nominate eligible properties to the National Register of Historic Places, and to give priority inventory to federally-owned properties to be transferred and/or altered.

The Alaska Historic Preservation Act of 1975 reflects the same spirit concerning cultural resources as the federal regulations. It is the general policy of the State of Alaska that before any construction of public improvement of any nature is undertaken by the state, by a governmental agency of the state, or by a private person under contract with or licensed by the state, the cultural resources must be considered.

Specific cultural resource preservation efforts are required by federal and state law to satisfy licensing requirements for the Susitna Hydropower Project. These tasks include as a minimum (1) Identification and documentation of cultural resources within project areas and (2) formulation and explication of recommendations for mitigation for each historic or archeological site identified. However, the initial studies essential to meet licensing requirements may have direct impact on cultural resources which may pose immediate adverse effects. Examples of such activities are construction of camps to house study personnel, test holes to locate proposed borrow areas, access roads to study locales, etc.

Any proposal to identify cultural resources and make recommendations for preservation must be structured in such a fashion as to permit mitigation of potential damage to archeological and historic sites during the course of the impact study. If such mitigation procedures are not incorporated into the proposed action for historic preservation, needless delays and unnecessary additional costs will be inevitable. This has been repeatedly demonstrated in other large construction projects which have required the identification and mitigation of cultural resources for licensing. This Plan of Study foresees this need and provides methods by which these delays can be avoided. The proposed historic preservation efforts should be conceptually divided into (1) the effort necessary to obtain the license, (2) the effort necessary to mitigate possible adverse effects during the course of the study essential to obtain the license, and (3) effort necessary to mitigate damage to all historic and prehistoric sites that will be impacted by the construction.

(d) Schedule

Weeks 8 through 117.

(e) Detailed Scope of Work

(1) Synopsis

The University Museum will execute a five-step research effort specifically designed to satisfy both state and federal legislation pertinent to cultural resources.

The five steps are as follows:

Step I — Essential prefield season tasks: literature review, analysis of the data base, development of a research design and sampling strategy, recruitment of personnel and staging for field work.

Step II — Reconnaissance-level archeological survey of project areas based on priorities determined by the sequence of construction events. The needs of the specific study teams engaged to satisfy licensing requirements will obtain highest priority. It is impossible at this point to project temporal and fiscal requirements for mitigation efforts for adversely affected sites during the course of pre-license studies. Mitigation efforts, if required, will be conducted on a cost reimbursable basis during this step.

Step III — Intensive testing of archeological and historic sites discovered during Step II. This testing effort is essential to determine both the horizontal and vertical dimensions of specific sites, and to estimate with reasonable accuracy the kinds of materials contained within them. This information is necessary to delineate mitigation measures for any sites potentially subject to adverse effects. Step II tasks may continue simultaneously with Step III activities.

Step IV — Final report preparation. The final report will at a minimum provide the location and description of every archeological and historic site recorded during the course of the study. It will also provide recommendations for mitigating adverse effects to sites which may be subject to disturbance or destruction during construction activities based upon the data derived from Steps II and III. The Phase I report will be based on all information that is available at the end of two years of investigation, and will discuss as many sites as possible. Information not available at this time will be reported in a subsequent report as a part of the Phase II effort. The Phase I report will provide a description of the types of information that would be forthcoming in subsequent reports.

Step V — All recovered artifactual material and supporting documentation will be deposited with the University of Alaska Museum and will be retained as public information within the State of Alaska. The collections and supporting documentation will be registered and recorded in accordance with state and federal requirements pertinent to the preservation of antiquities.

Effective historical preservation efforts must be coordinated with other aspects of the Susitna Hydropower Project. The University Museum will make every reasonable attempt to anticipate the needs of the project pertinent to cultural resources. However, it will be the responsibility of the prime contractor to coordinate between subcontractors and to provide the scheduling information essential to anticipate and deal effectively with these needs.

(2) Discussion of Steps

a. Prefield Season Tasks

Prior to initiating field investigations during the summer of 1980, the University of Alaska Museum will execute the following tasks:

- Apply for, and secure a Federal Antiquities Permit and state documents that may be necessary for the archeological portion of the project. (Office of Archeology and Historic Preservation, Interagency Services Division, National Park Service, U.S. Department of the Interior, Washington, D.C. 20204; State Archeologist's Office, State of Alaska, Department of Natural Resources, State Division of Parks, Anchorage, Alaska).
- Conduct an exhaustive literature review of available documents that pertain to the history, prehistory, ethnography, geology, flora, fauna, and late Pleistocene and Holocene geology of the areas covered by this project. Museum staff will utilize the resources of the University of Alaska Library and Archives, data files of the University Museum, and records at the State Office of History and Archeology. Consultation with other professionals who have worked in or have knowledge of the study area will be utilized as necessary.
- The results of the literature search will be used to synthesize the regional and local cultural chronology of the study area as well as to provide the basis for the research design.
- Air photos of the study area will be examined and their interpretation will focus on the identification of probable areas containing cultural resources.

- Known historic and archeological sites will be plotted on 1:63,360 scale maps. Each resource will be specifically identified. A preliminary aerial reconnaissance of the project area will be conducted.

- Utilizing the information base produced by the above research, a research design will be developed to include a sound professional sampling strategy specifically designed for the unique needs of this project.

- Following formulation of the research design and sampling designs, the Principal Investigator and Project Supervisor will recruit essential personnel for the field portion of this project.

It is estimated that these prefield season tasks will take approximately five months. Upon completion of the prefield tasks (Step I), the necessary personnel and data base will be utilized for the reconnaissance level survey (Step II), and for mitigation of adverse effects on cultural resources which may possibly be affected as a result of the licensing study.

b. Archeological Reconnaissance

The purpose of this step is to identify, locate, and inventory archeological and historical sites. These sites will later be subject to more intensive study. As specified in 36 CFR 66 in the Federal Register, Vol. 42 No. 19, a reconnaissance level survey should be used only as a preliminary tool prior to intensive survey. The information gathered during Step II of this project will form the data base for intensive survey in Step III.

As it is not the intent of a reconnaissance level survey to cover 100 percent of the study area, preselected areas identified in the research design (Step I) will be selected for survey. Within these areas field crews will implement surface and subsurface testing procedures in order to locate, document, and inventory historic and prehistoric sites that may occur in the study area. This site-specific data will be used to develop and direct Step III studies. Aerial reconnaissance will be conducted at the preselected areas in order to enhance site location during Step II. Available aerial photographs, as well as LANDSAT photos, will be reviewed for all preselected areas to aid in locating potential site areas.

During Step II the dam impoundment areas and associated facilities will be field surveyed. The proposed primary transmission route will be field surveyed at a later date, as part of the post-license application studies.

Based on both state and federal guidelines as discussed in an earlier section, it is possible that preconstruction studies may have an adverse impact on cultural resources. These include, but are not limited to, the installation and operation of seisimic monitoring systems, the examination of foundation conditions for access roads and transmission lines, borrow pit exploration and testing, geophysical subsurface investigation, exploration and testing for dam site locations, testing in association with the construction of an airstrip, construction of access roads into the study area, movement of heavy equipment into and within the study area, or any other preconstruction activities that would create subsurface disturbances and hence have the potential of destroying cultural resources.

During Step II every effort will be made to work with other professionals involved in the Susitna Hydropower Project, to see that an archeological survey is conducted early in each ground disturbing activity so as to be compatible with the needs of other portions of the project. If any archeological sites are found during the course of the survey in areas slated for subsurface disturbance during preconstruction activities, it will be necessary to undertake immediate mitigating measures.

All archeological and historical sites that will be adversely impacted by the licensing study for this project will be mitigated in connection with the regulations of the Advisory Council on Historic Preservation. These measures include avoidance, preservation, and excavation. If excavation is recommended, then it will be necessary to deploy a crew to each site specified for this procedure. As it is not known how many and how large these sites might be, a line item for excavation cannot be included in this proposal. Instead, it is proposed that if it should become necessary to excavate any site that will be adversely impacted by preconstruction studies, the cost of additional personnel and equipment will be covered on a cost reimbursable basis.

c. Intensive Survey

Step III consists of intensive testing of sites located during the reconnaissance survey (Step II) of the project. Grids will be established at each site and a sampling scheme applied for testing. Each square selected for test excavation will be systematically excavated and all artifacts and features recorded, using standard archeological field methods. Site maps and soil profiles will also be prepared. Photographs will be taken to document artifacts and features in situ as well as to document the site and its location. Site limits will be delineated and data will be recovered for analysis and evaluation. Based on the analysis of this material, National Register criteria will be applied to see if the site is eligible for inclusion in the National Register of Historic Places as specified in the federal regulations that apply to this project.

Intensive testing will also provide the means for evaluating the effects of the preconstruction and construction phases of the Susitna Hydropower Project on cultural resources. Each site will be evaluated and recommendations as to mitigating measures will be made and incorporated into the final report. Field crews, and teams consisting of three archeologists, will focus Step III efforts on the dam sites, impoundment areas, access roads, staging areas, camps, borrow pits, and other potential ground disturbance areas.

d. Analysis and Report Preparation

This step is an integral part of each step of the project. It entails compilation of the individual reports for the other steps of the project as well as synthesizes all data recovered and makes appropriate recommendations for mitigation, if necessary. Step IV is specially aimed at the final analysis of the project in terms of sites located and documented during the other steps. The final report will include the location, description, and a mitigation recommendation for each site reported during Steps I, II, and III. Step IV will include mitigation recommendations, if necessary, for the sites located, and an estimated budget for an archeological excavation that must be done prior to the start of actual construction of the Hydropower Project as specified by federal and state regulations. The overall effectiveness of the research design, field procedures, and analysis will be discussed. A full-scale report, including sections on the vegetation, fauna, geology, history, prehistory, and native population will be part of the report.

As presently scheduled, the FERC license application will be prepared prior to the completion of the Cultural Resources Analysis. The cultural resources section of the exhibit will be based on the Phase I Final Report. This report will include recommendations on as many sites as possible and will be based on all the information that is available at the time of report preparation (i.e. after two years of investigation). There are, however, constraints which will make it impossible to provide certain critical information until Phase II. One such constraint is the time required to obtain radio-carbon determinations from samples collected during the 1981 field season.

The Phase I final report will include a description of information to be provided during Phase II. In addition, a Plan of Study for Phase II of the Cultural Resources Investigation will be developed near the end of Phase I. The Plan of Study will be formulated on the basis of needs that become apparent during Phase I.

e. Recording of Recovered Collections and Supporting Documentation

Recording of recovered artifactual material and associated contextual data will be an ongoing program throughout the duration of the project. With the University of Alaska Museum performing the archeological investigations, there will be no packaging and shipping costs to the designated repository or necessity to inventory the incoming collection. All recovered material and supporting documentation will be housed at the University of Alaska Museum and registered in accordance with state and federal requirements pertinent to the preservation of antiquities.

Subtask 7.07 - Land Use Analysis

(a) Objective

To evaluate past, present and future land-use trends; to facilitate the identification of the major changes in land use that would result with the development of the project, and to make preliminary identification of these changes.

(b) Approach

The approach is basically a comparison of land use trends to determine the major effects of the project will have on the future land use of the area, and employs a modification of the McHarg Overlay Technique. McHarg has basically used the superimposition of overlays showing specific resource values to determine where there is least conflict with existing values. The modification will be to develop overlays which graphically depict Propositions A-C below; and through superimposing them, one would arrive at the Actual Change in Land Use Caused by the Project. The historical land use trends will be described; the present land use of the project area will be examined, and an attempt will be made to isolate the factors and management decisions that have resulted in the land use that exists. The future land use of the area without the project will be predicted on the basis of interviews with Mat-Su Borough officials, landowners, land management and resource agencies, and a consideration of the resource potentials and limitations. Unique and significant scenic and natural features of the area will also be identified for consideration during the impact analysis.

The changes that will be attributed to the project in the future, and the significance of these changes cannot be evaluated without consideration of the changes that would occur without the project. The evaluation process is illustrated below:

Proposition A (Change from present land use)

	Area land use with project
(minus)	Area land use without project
(equals)	Overall change caused by project

Proposition B (Future land use without project)

	Future land use (based on projections of long-term trends)
(minus)	Present land use
(equals)	Future change without project

Proposition C (The actual change caused by project)

	Overall change caused by project
(minus)	Future change without project
(equals)	Actual change caused by project

(c) Discussion

An assessment of the effects of particular land uses on a specific environmental setting is not a simple, one-for-one relationship. When one disrupts an essentially pristine environment to develop a modern industrial project such as the one proposed for the Upper Susitna River Basin, many environmental disturbances occur. Some of these disruptions are predictable. However, others may occur which are not anticipated because there are few, if any, previous experiences on which the experts can rely. One then begins to rely on theoretical models, integration techniques, and other technological thought to give a "best judgment" as to what might take place if certain proposed actions (dam building, transmission lines, roads, etc.) are implemented. Land-use analysis is one way of obtaining overview of the systematic effects of a proposed development; the specific details of the project are then filled in by the specialists on the team. This land-use analysis will evaluate the change in the present use of the land caused by the proposed project and will provide the basis for summarizing the overall impact of the project, including the dam, reservoir, transportation access, and transmission corridor. This analysis is designed to provide information (baseline and impact assessment) that will satisfy FERC license application requirements.

(d) Schedule

Weeks 8 through 117

(e) Detailed Scope of Work

(1) Synopsis

a. Year 1: Present Land Use

1. Detailed field procedures manual will be developed.

2. The study area will be defined to encompass the actual area covered by the project including the dams, reservoir, road, transmission corridor, and the contiguous land influenced by these developments.

3. Prior land use (map 1a-c)
   (a) Prior to white man
   (b) Early white man through World War II
   (c) World War II to present.

4. Present land use (map 2)
   (a) Aerial photo and topographic map reconnaissance of present land use
   (b) Aerial and ground reconnaissance of present land use
   (c) Inventory of unique scenic/natural features.

5. Discussion with present landowners
   (a) Landownership (map 3)
   (b) Existing resource management programs (map 4)
   (c) De facto programs (map 4)
   (d) Communicate land-use concerns of landowners to project specialists concerned with particular technical fields.

6. Review access transportation system and transmission line corridor in terms of location and design as it affects other land uses, as an input into the selection and design process.

b. Year 2: Future Land Use Without Project (map 5)

1. Map anticipated landownership changes. If all native and state selections have not been conveyed, a "best estimate" of landownership changes will be made.

2. Interview landowners and managers, borough officials, and state and federal agencies on long-range objectives, existing proposals for other land uses, and projects (other than the hydroelectric one) already being planned within the boundaries.

3. Plot anticipated changes and reconcile differences in these based on landownership rights, supporting legislation, and the probability of implementation of the particular programs. The overlap and potential conflict between projected changes will be analyzed using the McHarg overlay technique.

4. Using preliminary project design information, aerial photo and aerial reconnaissance, and data generated by other disciplines, an estimate of what changes in land use will probably occur will be made.

(2) Discussion of Steps

a. Identification of Study Area

The first step in the land-use analysis will be the identification of the project area boundaries. These boundaries will include adjacent lands that will be affected or influenced by the project, as well as the access transportation system and transmission corridors when the routes for these facilities have been identified.

The downstream effects will also be considered in the overall land-use analysis. The boundaries will include the following zones:

1. Project Zone (actual occupied by project).
2. Management Zone (land acquired for management purposes such as watershed, recreation, etc.).
3. Influence Zone (that contiguous land whose use patterns would be influenced by development that takes place within Zones 1 and 2).

b. Prior Land Use

Past land use will be described through a review of historical documents using archives, development of oral history using interviews, and review of administrative files of managing agencies. The documentation of the historical overview of land use including the pre-white man, early white man, and modern eras is essential to understanding land-use trends if they are to be adequately extrapolated into the future.

c. Present Land Use

The present land-use of the project area will be determined by utilizing a number of sources of information. These sources will include aerial photo and map reconnaissance, vegetation cover maps produced by the Plant Ecology team, discussions with landowners and government officials, and a field review of specific land uses identified through the reconnaissance and discussions. A preliminary list of potential agency contacts is presented in the next section. Existing resource management programs, either planned or de facto (they exist but were not planned by the agent) will be identified and described in detail. As a part of the total reconnaissance, unique scenic and natural features within the project boundaries will be identified and described. The preliminary location and design of the access transportation system and transmission corridor will be evaluated by the land-use team in terms of long-term effects on land use. Furthermore, the land-use team will identify concerns raised by the landowners and agencies and communicate these concerns to TES, who will make them known to the appropriate disciplines.

d. Future Land Use Without the Project

Regardless of the status of the project, certain future changes will take place within the project boundary. The land-use team will describe these changes through documented landownership changes, landowner or agency interviews to ascertain long-range objectives, projects on the drawing board, and projects already underway. These will possibly show some overlap and subsequently will be reconciled based on the existing landownership rights, supporting legislation, and a best estimate of the probability of the implementation program (if it is not already funded). It is essential that we account for those changes that would have occurred without the project in order to determine the real effects of the hydroelectric project.

e. Preliminary Identification of Project Impacts

Realizing that certain conclusions will be based on preliminary location and design of the project structures and systems, the actual change in land use caused by the project will not be totally analyzed until Phase II (post-license application) when the final locations and designs are selected. The major impacts or changes that are expected to occur as a result of the project will, however, be identified preliminarily at the end of Phase I (i.e., prior to license application). This preliminary identification of changes will be developed after evaluating the results of the office and field reconnaissance, the interviews with landowners and land managing and planning agencies, and available data generated by other disciplines including at least the wildlife ecology, plant ecology, and socioeconomic groups. The preliminary identification of project impacts will not represent a detailed description of the impacts that will be associated with the project; instead it will be utilized in the development of the Phase II Plan of Study to assure that adequate attention is given to those concerns and potential impacts that are expected to be most relevant and significant with respect to the construction and operation of the project.

(3) Preliminary List of Agency Contacts

FEDERAL

U.S. Department of the Interior

Bureau of Mines........................Mineral Potential

Heritage Conservation &
Recreation Service.....................River Survey and Use

U.S. Fish & Wildlife Service...........Endangered species management (Peregrine falcon)

U.S. Department of Agriculture

Soil Conservation Service..............Susitna Basin Water Study

U.S. Corps of Engineers.....................Regional water planning

Federal Aviation Administration.............Present & future airport facilities

STATE

Department of Natural Resources

Division of Lands	State land management
Division of Geological & Geophysical Surveys	Geologic hazards
Division of Parks	Recreation planning
Department of Fish and Game	Land use related to hunting and fishing, key habitat
Department of Community and Regional Affairs	Regional planning
University of Alaska	University land management
Department of Transportation & Public Facilities	Transportation planning

MUNICIPAL

Matanuska-Susitna Borough	Management of Borough Lands
Trapper Creek Community Council	Community interest
Montana Creek Community Council	Community interest
Homemakers Club-Talkeetna	Community interest

PRIVATE

AHTNA, Inc.	Native land use and management on Upper Susitna
Cook Inlet Region Inc.	Native land use and management on Middle Susitna
Talkeetna Air Taxi	Historical and present land use
Other air taxi services ....)	Historical and present land use
Ackland Helicopter Service ....)	
Tokosha Citizens Council ....)	
Montana Creek Dogmushers ....)	

Subtask 7.08 - Recreation Planning

(a) Objective

To prepare a detailed master area plan that will optimize public recreational use of the project lands and water, in a manner that will

(1) provide the maximum variety of activities and levels of development consistent with the quality of the recreation experiences to be offered. User perceptions of the desired kinds of experiences and appropriate levels of development will be measured within the region;

(2) analyze the environmental setting so that the proposed recreation development is consistent with the experiences to be offered, the access transportation system, the water impoundment, and other land uses;

(3) balance the development of facilities with the capacity of the natural resources to sustain that use;

(4) identify and incorporate into the total plan the unique scenic and natural features within the project boundaries;

(5) conform to planning guidelines and objectives of the managing agencies; and

(6) maximize compatibility with the proposed operation of the project and other public uses of the land.

(b) Approach

The basic approach is to develop specific planning objectives for a master area plan based on the perceptions of the public, the limitations of the resource, and the planning guidelines of the managing agencies. A two-phased planning approach will be utilized. The first phase of the subtask will generate information that will be used in Phase II (post-license application), when the master area plan will be developed. The Phase I planning effort will be accomplished as shown in the following steps:

(1) Literature review (complete review of pertinent periodicals and texts, and agency publications relating to Alaska, including the Statewide Comprehensive Outdoor Recreation Plan);

(2) Mail questionnaire (on the perception of Alaskans to various types and levels of development);

(3) Preliminary assessment of resource potential for recreational use.

(c) Discussion

There may be some controversy generated by the proposed Susitna Hydroelectric Project, but few people know the area intimately and can speak with authority on the potentials or limitations of the area for other uses. It is relatively isolated, yet close to the greater Anchorage area (nearly 60 percent of the State's population) and only three quarters of a day's drive from Fairbanks. Uses of the area, other than for hydroelectric development, must be considered to demonstrate the potential of the area.

This subtask offers a mechanism for providing recreational opportunities at the proposed project. This will be an important element in the evaluation of the project since the recreational use of the area will affect many of the environmental impacts associated with the project, including socioeconomics, fisheries, wildlife, and land use. The level of recreational development and the use generated by the provision of public facilities will be important considerations in the determination of these impacts.

Most recreation planning decisions relate to the development of access to the area; consequently, the access road, types of facilities, and level of development are critical decisions in encouraging specific types of recreational opportunities and levels of development.

(d) Schedule

Weeks 52 through 117

(e) Detailed Scope of Work

(1) Literature Review

An extensive literature review will be conducted to identify and make use of existing pertinent information and data. This literature search will include a complete review of the appropriate periodicals and texts, as well as agency publications related to Alaska, including the Statewide Comprehensive Outdoor Recreation Plan. The review will examine the existing literature on reservoir planning in relation to recreation, river recreation, supply-demand modeling, systematic approaches to recreation program planning, and agency publications on participation patterns, changing socioeconomic factors, and user perceptions of specific recreational experiences.

(2) Projection of Recreational Use

It will be necessary to predict the initial and future recreational use that can be expected to occur at the facilities that are provided as a part of this project. Forecasting is at best a hazardous enterprise, but predicting the levels of participation in various recreational activities is an essential ingredient in recreation planning. The types and numbers of facilities to be provided and the appropriate level of management cannot be determined without an estimate of predicted use.

The projections of participation are made more difficult in this case by the size of the area, the limitation of comparison to similar opportunities within the region, and minimal past-use data. The uniqueness of the area and lack of available data preclude the use of many methods of projecting participation and suggests the use of the "judgment" method. To predict initial and future use of the facilities, all available data related to historical, present, and projected use trends will be analyzed. Indicators and basic causal factors, such as trends in population, income, leisure and mobility, will be evaluated. The prime potential market areas of Anchorage, and secondarily, Fairbanks, will be given particular consideration.

In conjunction with this, a mail questionnaire will be sent to 2,000 Anchorage-Fairbanks residents to assess their perceptions of the appropriate levels of recreational development at the proposed reservoirs and their willingness to participate at those levels of development. The questionnaire will be designed to determine the combination of access and facilities (based on descriptions) that people would respond to best, in terms of indicating a willingness to participate. This will provide an aggregate estimation of participation, in various activities, based on varying levels of recreational development. The design of the questionnaire will be critically reviewed and be pretested prior to distribution. Dr. Jordan Louviere, University of Iowa, has tentatively agreed to assist in the development and analysis of the questionnaires. The number of questionnaires to be distributed was determined on the basis of a desired level of accuracy and an assumed rate of response. The mailing will be divided between Anchorage and Fairbanks in proportion to population. One follow-up is planned and a second will be used if necessary.

(3) Preliminary Assessment of Resource Potential for Recreation

A preliminary assessment of the resource potentials will be completed in this phase. An initial evaluation of the project area will be completed in the laboratories, using vertical aerial photography to isolate potential sites. The project lands will be evaluated on the basis of general resources capabilities, levels of access, and anticipated management problems (such as natural hazards). This initial evaluation will determine the zones that have greatest potential for development. Selected suitable areas, potential visitor attractions and related management concerns will be located on a base map and evaluated during a field reconnaissance. The summer field season will be spent assessing the potentials and the inherent limitations of the areas.

Subtask 7.09 - Susitna Transmission Line Assessment

(a) Objective

To provide input into the selection of an environmentally sound half-mile wide transmission line corridor from the Susitna Project area to load center substations in or near both Anchorage and Fairbanks.

(b) Approach

The corridor will be selected by means of the following process:

(1) Conduct literature search for pertinent data sources,

(2) Concurrently with (1), obtain aerial photography and land-based photography for the study area routing analysis,

(3) Review alternative routes proposed by previous studies and select project-specific alternative corridors,

(4) Conduct site-sensitive avoidance routing analysis on alternative routes,

(5) Provide input into the selection of a primary, half-mile wide corridor,

(6) Define criteria for establishing and conducting final design and location analyses.

(c) Discussion

A wealth of data dealing with the selection and evaluation of transmission line corridors exists with respect to the Susitna Project (note list of previous studies at end of discussion). Several studies have been obtained and reviewed. They will serve as a basis for initiating project investigations. All data sources pertinent to a routing impact analysis will be obtained and catalogued for further reference.

Aerial photography exists for much, if not all, of the proposed routing analysis study area. In addition, other photography available for the study area, including land-based photography, will be sought. Many sensitive or unique areas within the Central Railbelt area have been photographed during previous studies, including many areas within the transmission corridor study area. All such available photographs will be catalogued and stored for further reference.

Transmission line corridors proposed by other studies will be reviewed and recommendations as to their environmental acceptability will be provided. Criteria will be established for the purpose of avoiding, where possible, areas such as wetlands, steep mountain slopes, scenic vistas and population centers.

The criteria will be applied to all alternative route segments. Following an analysis of the data, a primary corridor approximately ten miles wide will be selected.

Additional criteria will be established to provide rationale for further refinement of the primary corridor. Items such as access, clearing requirements, soils limitations (where applicable) and restoration requirements, to name a few, will be factored into the analysis process. The end result of this effort will be a proposed primary corridor a half-mile wide between the project and both Anchorage and Fairbanks.

TES will assist Acres in the selection of both the ten-mile and half-mile primary transmission line corridors. Based upon the alternative routes proposed by Acres, TES will conduct the necessary environmental analysis and identify sensitive areas. TES will also provide environmental input into the development of criteria to be utilized for further corridor refinement studies.

List of Previous Studies

1) International Engineering Company, Inc., Anchorage-Fairbanks Transmission Intertie - Economic Feasibility Study Report April 1979.

2) Robert W. Retherford Associates, North Slope Natural Gas Transport Systems and Their Potential Impact on Electric Power Supply and Uses in Alaska, March 1977.

3) U.S. Army Corps of Engineers, Southcentral Railbelt Area, Alaska, Upper Susitna River Basin Interim Feasibility Report, (Appendix I, Part II (G) Marketability Analysis, (H) Transmission System, (I) Environmental Assessment for Transmission Systems, December 1975.

4) Kozak, Edwin, under the direction of J. R. Eaton, Performance Characteristics of a 350-Mile Electric Power Transmission Line (Fairbanks to Anchorage), A project in EE 494, Department of Electrical Engineering, University of Alaska, June 1973.

5) Ch2M-Hill, Electrical Generation and Transmission Intertie System for Interior and Southcentral Alaska, 1972.

6) Federal Power Commission, Alaska Power Survey, 1969.

7) Alaska Power Administration, Alaska Railbelt Transmission System, working paper, December 1967.

8) The Ralph M. Parsons Company, Central Alaska Power Study, undated.

9) The Ralph M. Parsons Company, Alaska Power Feasibility Study, 1962.

(d) Schedule

Weeks 1 through 130

Subtask 7.10 - Fish Ecology Studies

(a) Objective

To determine the relative abundance and distribution of adult anadromous fish populations in the Susitna River, determine the distribution and relative abundance of selected resident and juvenile anadromous fish populations in the Susitna River, determine the spatial and seasonal habitat requirements of anadromous and resident fish species during each stage of their life histories, determine the impact the Susitna hydroelectric project will have on the fishery resources and describe any required mitigation. This is the primary objective of both the pre-license application and post-license applica- tion studies.

(b) Approach

The Alaska Department of Fish and Game will be responsible for field data collection, data reduction, progress reports, and complete annual reports based upon an in-depth procedures manual accepted by the Alaska Power Authority. The ADF&G program will consist of using recently developed techniques for the collection and analysis of field data. The use of side-scanning sonar fish counters and electrophoresis for the anadromous fish program, and the in-stream flow analyses for the habitat studies, are examples. ADF&G is familiar with the field conditions in Alaska and should provide an effective base for the studies.

A TES Operations Office will be established in Anchorage for the coordination and quality assurance of the studies. As part of the quality assurance function, TES personnel will frequently accompany ADF&G field crews into the study area for the purpose of observation of sampling activities. TES will also review and comment on the ADF&G reports, and will perform the impact assessment. A preliminary impact analysis will be done prior to license application using the data available. However, many of the fishery studies will not be completed until after license application. The anadromous fishery studies will be extended to include a complete life cycle of the fish, as much as five years. The final impact study on the fisheries will be prepared during the post-license application period when the data are available.

(c) Discussion

The major impacts on the fishery resources of the Susitna River as a result of hydroelectric development are expected to be due to habitat changes. Alteration of the normal flow regimes and the physical and chemical water characteristics are likely to have the greatest impact.

Many of the physical and chemical studies necessary for an understanding of the effects on the resident and anadromous fish below the dam, as well as resident fish in the impoundment areas will be completed in Task 3 - Hydrology. However, intensive baseline data collection on the fish of the Susitna River must also be performed using the plan of study developed by ADF&G with input from Acres and TES. Resident fish populations will be studied in relation to their habitat requirements. Studies of fish populations in the proposed impoundment areas including rare and endangered species will be included. Additionally, migrational usage of the Susitna River by salmon species as well as main-stream spawning observations and rearing information will be collected.

During the first phase of this project the following studies are planned to begin. These are described in detail in (e) below.

(1) Stock Assessment of Adult Anadromous Fish

The following areas will be examined:

- Cook Inlet Area. Investigation of the contribution of the Susitna River salmon stocks will begin using scale pattern analyses and electrophoresis techniques.

- Cook Inlet to the Confluence of the Yentna River. Migrational movement of salmon stocks will be assessed including differentiation of the Susitna and Yentna stock contribution, timing, movements related to stream flow, and utilization of the mainstem river for spawning.

- Yentna River to Talkeetna. Migrational movements of salmon stocks will be assessed including numbers of adult salmon utilizing this area for spawning, timing of migration, relation of movements to stream flow, and recreational use of the stocks.

- Talkeetna to Devil Canyon. Abundance, migrational movement as related to flow, timing, and recreational usage will be investigated.

(2) Stock Assessment of Adult Resident Fish and Juvenile Resident and Anadromous Fish Populations

The following areas will be investigated:

- Cook Inlet to Talkeetna River Confluence. The occurrence and composition of resident and juvenile anadromous stocks, as well as apparent seasonal changes in occurrence, relative abundance, and habitat-type utilization will be defined.

- Talkeetna River Confluence to Devil Canyon. The occurrence and composition of resident and juvenile anadromous stocks as well as apparent seasonal changes in occurrence, relative abundance, and habitat-type utilization will be defined.

- Devil Canyon to Tyone River Confluence. The occurrence and species composition of fish stocks, as well as seasonal changes in abundance of fish and habitat-types utilized by fish will be investigated. The possible presence of salmon stocks above Devil Canyon will also be investigated as part of this study.

(3) Seasonal and Spatial Habitat Studies of Anadromous and Resident Fish Species During Each Stage of Their Life Histories

The following areas will be investigated:

- Cook Inlet to Talkeetna River Confluence. Seasonal habitat requirements for incubation, rearing, spawning, and passage, as well as seasonal relationships between flow regimes and physical and biological habitat characteristics will be defined.

- Talkeetna River to Devil Canyon. The study in this section is an investigation of fish habitat in the area immediately downstream of the proposed dam site.

- Devil Canyon to Tyone River. The study in this section is an investigation of fish habitat to be affected by the proposed impoundments.

TES, using the information gathered on the water quality by R&M and fishery resources by ADF&G will evaluate the potential impact of the hydroelectric project on the Susitna River fisheries. A preliminary assessment will be made on the basis of data collected during 1980 and 1981. However, many of the fishery studies will continue beyond the scheduled time of license application. Thus, post-license application submission studies will be required to describe the baseline situation adequately and to permit a detailed assessment of the impact of the proposed project on this important resource.

(d) Schedule

Weeks 26 through 130.

(e) Detailed Scope of Work

Individual study proposals are designed to provide the necessary background information to enable proper evaluation of impacts. Six general objectives have been outlined:

1. Determine the relative abundance and distribution of adult anadromous fish populations within the drainage.

2. Determine the distribution and abundance of selected resident and juvenile anadromous fish populations.

3. Determine the spatial and seasonal habitat requirements of anadromous and resident fish species during each stage of their life histories.

4. Determine the economic, recreational, social, and aesthetic values of the existing resident and anadromous fish stocks and habitat.

5. Determine the impact the Devil Canyon project will have on the aquatic ecosystems and any required mitigation prior to construction approval decision. This is the primary objective of both Phase I and II studies. This will be discussed in detail in the Phase II work when it is written.

6. Determine a long-term plan of study, if the project is authorized, to monitor the impacts during and after project completion. This is also an objective of Phase II.

Work on objectives 1, 2 and 3 will be undertaken during 1980 and 1981.

The study areas are generally categorized within the following locations:

- Cook Inlet area
- Cook Inlet to the Yentna River confluence
- Yentna River to the Talkeetna River confluence
- Talkeetna River confluence to the Devil Canyon dam site
- Devil Canyon dam site to the Tyone River confluence

Scaling of the proposed studies with respect to timing, geographic locations, and intensity has been done with consideration of the resource knowledge available for each of the geographic locations identified above.

1. Stock Assessment of Adult Anadromous Fish Populations

Objective

To determine the relative abundance and distribution of the anadromous fish populations within the Susitna River drainage.

Study Approach

Adult anadromous fisheries studies will be divided into five major geographical areas. All studies, however, will be interrelated. The following outlines baseline studies required for each area and general work plans.

(1) Cook Inlet Area. Contribution of the Susitna River salmon to the Cook Inlet fisheries - quantitative separation of stocks

a. Objectives

The objectives of this study area are to

- identify the proportion of the Susitna River salmon stocks harvested by the commercial and recreational fisheries; and
- determine quantitatively that portion of the total catch produced in the Susitna River drainage.

b. Background

The major area of salmon resource competition is within the Upper Cook Inlet area; i.e., that area north of the latitude of Anchor Point. The Susitna River salmon stocks are intermixed with other large salmon stocks produced from the Kenai Peninsula and west side of Cook Inlet.

All five species of Pacific salmon are harvested in Upper Cook Inlet. The majority of these salmon pass through the area at the same time, thus creating a mixed species and mixed stock fishery. Any feasibility study of the Susitna River project will require an assessment of the contribution of the Susitna River salmon populations to the commercial and recreational fisheries.

c. Work Plan

Commercial catch data is available through the Alaska Department of Fish and Game. Final statistical runs are available through 1976 and preliminary data is available through the current year's harvest.

Identification and separation of the various stocks of salmon will be by scale pattern analysis and/or electrophoresis. Differences in scale patterns have already been found to exist in sockeye and coho salmon populations in Cook Inlet, and the Susitna River stocks have been statistically separated from the other major Cook Inlet stocks. Data is, however, only available for one age class. Chum and pink salmon stocks have not successfully been separated on the basis of scale pattern analysis in other areas, due to the absence of freshwater growth. Electrophoretic techniques would be employed for stock identification of these species. An analysis of length-weight relationships may provide sufficient data for these two species.

The program requires the regular collection of scales and tissue samples from the commerical catch and from the major salmon producing areas (known escapement samples). Expansion of the ongoing Alaska Department of Fish and Game Stock Separation Program would provide the necessary data base for stock assessment of sockeye, coho, and chinook salmon. Cost estimates and design of this program are based on incorporating these studies with ADF&G programs. If a separate program is designed, additional funding would be required for sampling crews and laboratory equipment and analysis.

Sampling design would be divided into two major components: collection of scales and laboratory and computer analysis of scale patterns.

A minimum of 250 scales per species and age class will be obtained during each fishing period. Known escapement samples would be obtained from existing research and management programs. Three additional cannery sampling crews (2 people each) will be required to obtain scale samples. Staff time will be required to design a program for chinook salmon. Existing crews should, however, be adequate to conduct sampling.

The ADF&G scale laboratory would be used to process samples. A supervisor and a second shift would be added to the staff to maximize the use of existing equipment. A digitizing station would have to be added to the existing microcomputer. Additional computer time would be required.

The feasibility of separating pink and chum salmon stocks by electrophoretic techniques probably could be determined after one sampling season. If this technique is unsuccessful it will be discontinued and other methods will be evaluated. Analysis could best be done by the University of Alaska. A minimum of 1000 fish samples per fishery should be obtained for each species. Known escapement samples will have to be collected. Three sampling crews will be required.

(2) Cook Inlet/Susitna River confluence to the Yentna River confluence. Stock assessment of the adult salmon populations.

a. Objectives

These studies are to provide the following:

- escapement data, by salmon species, into the lower Susitna River,
- differentiation of the Susitna and Yentna River stock contribution,
- timing of the salmon migrations,
- movements as related to stream flow and water quality,
- utilization of the mainstream river for spawning.

b. Background

Total escapement information for the Susitna River drainage is generally lacking. Various methods have been utilized by the Alaska Department of Fish and Game since 1974. Recent developments in side-scan sonar have provided the most valuable tool, to date, for evaluating in-season escapement by species. Emphasis has, however, been on sockeye salmon.

c. Work Plan

Commercial Fisheries Division of the Alaska Department of Fish and Game currently operates an escapement project in the vicinity of Susitna Station as a part of their ongoing sockeye salmon research program. Expansion of this program will provide the necessary escapement data required for the Susitna Hydro Project baseline studies. Sonar counters and fishwheels will be operated from May through mid-October to determine escapement by species. This would require funding of the existing project beyond its normal operating dates. Data from this program will be correlated to the Stock Separation program within Cook Inlet and additional escapement studies in the upper Susitna River.

A sonar escapement enumeration program will be required in the lower Yentna River to differentiate between Yentna and Susitna River production. Comparative analysis of the Yentna River escapement data and the mainstem Susitna River sonar data will be made to determine stock contribution of each system. Two side-scan sonar counters and two fishwheels (for species apportionment) will be deployed on the Yentna River.

All salmon captured in the fishwheel at the Susitna site will be marked with a color- and number-coded Peterson disc tag. Marked fish will be recaptured upstream to provide an assessment of stocks utilizing this area.

Migrational timing data would be obtained from fishwheel catch data at the sonar site.

Scale samples will be obtained from the fishwheel catch to provide a known data base for Cook Inlet stock separation studies. A minimum of 40 samples per day will be required for each species.

Migrational characteristics may vary greatly for each salmon species and must therefore be determined for each separately. Data obtained from these studies may also be useful in the final selection of proposed sonar projects and deployment of gear.

Coordination with and assistance from USF&WS Research Section will be required throughout the project.

Eulachon, an anadromous smelt, utilize the lower mainstem Susitna and Yentna Rivers for spawning. The extent of utilization of the mainstem river will be documented and evaluation of the populations will be made.

(3) Yentna River confluence to Talkeetna. Stock assessment of adult salmon populations

a. Objectives

The objectives of these stock assessment studies are to determine the following:

- numbers of adult salmon utilizing this area for migration and spawning,
- migrational timing of the adult salmon,
- recreational utilization of these stocks,
- movement of salmon as related to stream flow and water quality.

b. Background

Many of the important recreational use areas occur within this area of the river. These areas have road access on the east side of the river and receive high use via aircraft transportation on the west side. All five species of adult salmon utilize this area for spawning and migration. Due to the braided nature of the Susitna River in this area many impacts are expected to be seen due to alterations of stream flow.

c. Work Plan

One side-scan sonar project will be established within this area of the river. Seasonal apportioned counts by species will be compared to the lower Susitna and Yentna River sonar projects to determine importance of this area to the entire drainage. Fishwheels and possibly other sampling gear will be used to apportion sonar counts.

The sonar project will be located between the Yentna River confluence in the vicinity of Sunshine. This program will provide information on 1) the importance of this area of the river for spawning; 2) the extent to which this area is used for migration to spawning areas upstream of Talkeetna; and 3) the contribution of these salmon stocks to the total Susitna River drainage. A total of two side-scan sonar counters and four fishwheels will be required.

All salmon captured in the fishwheels at the "Sunshine site" will be marked with a color- and number-coded Peterson disc tag. Marked fish will be recaptured upstream to provide an assessment of stocks utilizing this area.

Migrational timing will be determined by fishwheel catches at the sonar projects and survey crews.

Recreational utilization of these salmon stocks will be determined partially by ongoing ADF&G creel census programs. Expansion of these programs will be required to monitor all species adequately. The creel-census programs will also provide data on migrational timing and tag recoveries.

Movement of salmon through this geographic area will be monitored by remote sensing devices for radio-tagged fish. Sonar counters may also provide horizontal distribution data for the area.

Alaska Department of Fish and Game survey data will be used to determine chinook salmon escapements into major tributaries. These surveys may have to be expanded to assure adequate coverage of major tributaries.

(4) Talkeetna to Devil Canyon Dam site. Stock assessment of adult salmon populations

a. Objectives

The objectives within this study area are to determine the:

- abundance of adult salmon;
- stock assessment of the Susitna-Chulitna-Talkeetna stocks;
- migrational timing of the salmon stocks;
- recreational utilization;
- movement of salmon stocks through this area as related to stream flow and water quality.

b. Background

Population estimates of salmon species utilizing the Susitna River above the Chulitna River confluence were estimated during the 1974, 1975, and 1977 field seasons based on tagging and subsequent recovery of fish. These studies indicate a portion of the salmon tagged are not destined to spawn above the tagging site, but rather below it. The importance and extent of this milling behavior in the upper river areas requires definition. The alterations in flow and water quality in the mainstem river after project completion could significantly affect this behavior and consequently spawning success.

Observations of spawning areas between the Chulitna and Susitna River confluence upstream to Portage Creek during fall surveys indicate that a reduction in flow to proposed post-construction levels would prevent access to many important spawning areas.

c. Work Plan

Salmon escapement estimates will be determined by a tag and recovery program in this area. Fish marked at the "Sunshine site" will be recovered by ground survey crews upstream from the Chulitna River confluence.

Surveys of major spawning areas between Talkeetna and Devil Canyon dam site will be conducted in conjunction with juvenile studies to determine distribution.

Escapement estimates will be compared to sonar project located in the lower river, primarily the "Sunshine Site", and will provide information on importance of the upper river for spawning and also contribution of the Talkeetna and Chulitna river salmon stocks to the entire drainage.

Migrational timing of salmon stocks utilizing this area will be determined by stream surveys.

Recreational use within this area will be determined by a creel-census program.

(5) Devil Canyon Dam Site to the Tyone River confluence. Stock assessment of adult salmon populations

a. Objective

To determine if salmon utilize that area of the Susitna River above Devil Canyon.

b. Background

Studies conducted during the late 1950's indicate that Cook Inlet salmon stocks are unable to ascend the Susitna River beyond Devil Canyon, the latter being a natural water velocity barrier to migration (U.S. Department of the Interior, 1957). Reports from local residents of salmon observations above Devil Canyon indicate that this should be investigated further.

c. Work Plan

Surveys and escapement sampling will be conducted in the proposed impoundment areas between the Denali Highway and Devil Canyon during periods of peak adult salmon abundance. Initial observations will be conducted by aerial surveys to document the presence or absence of adult salmon. Surveys will be done in conjunction with resident fish investigations. Data obtained will be utilized to determine necessary mitigation measures.

2. Stock Assessment of Adult Resident Fish and Juvenile Resident and Anadromous Fish Populations

Objectives

To determine the relative abundance and distribution of adult and juvenile resident fish and juvenile anadromous fish populations.

Study Approach

Adult and juvenile resident fisheries studies will be divided into three major geographical areas. All studies, however, will be interrelated. The following outlines baseline studies required for each area and general work plans.

(1) Cook Inlet/Susitna River confluence to the Talkeetna River confluence. Stock assessment of the resident and juvenile anadromous fish populations

a. Objectives

- Determine specific occurrence and species composition of resident and juvenile anadromous stocks throughout the year within the Susitna River mainstem and within the reaches of tributary streams regularly influenced by the Susitna River. Of particular importance to this study are the Alexander Creek, Flat Horn Lake, Deshka River, Willow Creek, Iron Creek, and Rabideux Creek tributary systems;

- Define any apparent seasonal changes in occurrence and relative abundance of resident and juvenile anadromous species at the confluence of tributary systems and the Susitna mainstem;

- Develop suitable sampling techniques for the collection and determination of relative abundance of resident and juvenile anadromous species in the Susitna mainstem throughout the year;

- Define and describe habitat type utilization by resident and juvenile anadromous species throughout the year and under varying hydrologic conditions.

b. Background

This reach of the Susitna River encompasses many important fish producing and recreational fishing tributaries and is an area of critical environmental concern because of the possible seasonal use and migration between clearwater tributaries and the Susitna river. Studies of these seasonal migrations and the distribution of resident and juvenile anadromous fish in and to habitats in the Susitna River are essential. The studies will be initiated for selected streams and for a prescribed distance upstream throughout the year. Expansion or retirement of these studies would depend on confirmation for migration and habitat use by resident and juvenile anadromous fish in the Susitna River. If confirmation of these movements and distribution to the Susitna is positive, the basic inventory will, in conjunction with the study task on habitat evaluation, identify specific year-to-year study locations for ongoing programs required to determine fishery impacts on the fish populations.

While the time frame allotted for accomplishment of these four objectives is 30 months, we feel that these same objectives should remain ongoing through the termination of the project with appropriate adjustment and redirection being made as resultant data are analyzed.

Also we see that it is imperative to incorporate the hydrologic studies as an integral component in achieving our stated study goals.

c. Work Plan

The initial year of this study, 1981, will comprise essentially two field operations: a summer and a winter program on the Susitna River.

A crew of three biologists, utilizing a riverboat as their primary means of transportation, will operate in the Susitna mainstem and tributary systems during the ice-free months, May through October. Their responsibilities will include

- Sampling using established techniques and their adaptations including gill nets, minnow traps, adult traps, angling, seines, and electrofishing;

- Developing suitable techniques for sampling the Susitna mainstem. Particular emphasis will be placed on the design of an effective stationary fish trap;

- Classifying in terms of depth, velocity, turbidity and substrate types in conjunction with the sampling of resident populations. It is essential that close cooperation be maintained between hydrologic and fisheries research;

- Tagging adult resident fish and note species, size, date and location of capture;

A crew of four biologists will carry out fisheries research during the winter months. This facet of the field operations will be based on road access until such time as the mainstem Susitna ice condition has stabilized sufficiently to provide safe transportation via snowmachine. This crew will perform the following operations:

- Survey in the proximity of areas surveyed during the previous summer using established sampling techniques such as gill nets and minnow traps. As ice conditions improve and data is analyzed, this effort will be expanded to include as much of the study area as possible.

- Design an effective resident species adult trap for use in this study area, as established sampling techniques meet with limited success when applied under a cover of ice in the river environment.

- Classify habitat in terms of ice cover, depth, velocity turbidity, and substrate in conjunction with sampling of resident populations.

A project leader is included in this segment with responsibilities for organizational functions and oversight of entire Susitna Basin study and analysis of data and report preparation.

Following the first season's determination of resident and juvenile anadromous fish occurrence, areas of greatest availability and suitable methods of capture, the 1982 program will be directed largely to the same areas and intensified with respect to relative abundance and preferred habitat utilization. The 1982 study plan will again consist of two segments: summer field operations and winter field operations.

A crew of three biologists utilizing a riverboat as their primary means of transportation will operate in the Susitna mainstem and tributary systems during the ice free months to

- Confirm previous seasons data base with regard to occurrence and species composition.

- Determine relative abundance of resident stocks in predetermined locations by seasonal period and further establish patterns of intrasystem migration.

- Further define preferred habitat parameters.

- Continue to tag adult resident fish and record any recaptures from previous year.

A crew of four biologists will carry on the initial year's study from January through April. This four-man crew will begin the second field season in December of 1982. Following the first season's determinations the program will be expanded to include additional areas, will be intensified at one or two predetermined locations and will continue to determine habitat requirements.

A project leader position will continue through 1982. Responsibilities will include coordination of field activities and data analysis and report writing.

(2) Talkeetna River confluence to Devil Canyon. Stock assessment of the resident and juvenile anadromous fish populations

a. Objectives

The objectives of programs within this study area are to

- Determine specific occurrence and species composition of resident and anadromous stocks utilizing the mainstem Susitna River and its major tributaries;

- Define seasonal changes in occurrence and abundance of resident and anadromous species within the mainstem Susitna River and its tributaries;

- Define habitat types utilized by resident anadromous fish species, seasonally throughout this year, at varying hydrologic conditions, both within the mainstem Susitna River and the major tributaries; and

- Establish the impacts of flow regulation upon the habitat which currently meets seasonal requirements of resident and anadromous fish stocks within the study area.

b. Background

This study area includes the mainstem Susitna River and a number of important clearwater tributaries which have indigenous populations of resident game fish and provide spawning and rearing habitat for anadromous species. Several of the more important lateral tributaries are Portage Creek, Indian River, Gold Creek, and Fourth-of-July Creek. All are located in the upper reaches of the study area and in the general vicinity of the railroad crossing at Gold Creek.

Five species of Pacific salmon, chinook, choh, sockeye, pink and chum are native to this portion of the study area. The most important resident fish species within this area are Arctic grayling and rainbow trout; however, burbot, whitefish, Dolly Varden, and various other species are also present.

While a higher degree of reliability in knowledge of possible flow, water quality, and stream morphology changes exists in this reach because of previously collected baseline data, baseline studies on resident and juvenile anadromous fish must be initiated to detail specific occurrence, distribution, and seasonal migration and habitat use of the Susitna River, as well as to document the population sizes of resident fish.

c. Work Plan

Due to limited access to much of the Susitna River upstream of Talkeetna, and related high cost of transportation, work proposed for 1981 is limited to the Indian River - Portage Creek - Gold Creek area. This area is accessible by railroad and can be investigated by a single field crew located in the Gold Creek area. These investigations will be extended downstream into other areas in the second and third years of study.

A four-man crew will be located in the Gold Creek or Indian River area housed in a local cabin or tent camp, and provided with a river boat and Zodiac-type raft to conduct the following activities:

- Establish the occurrence and species composition of resident and anadromous fish stocks utilizing the mainstem Susitna River during the period May through October of 1981. This work will entail intensive netting, electro-shocking, trapping, or use of set lines or other suitable collection methods within the mainstem reach from Fourth-of-July Creek upstream to Portage Creek. Some of these collection devices are expected to require modification or development as the season progresses.

- Perform similar sampling by net, electro-shock, trap or angling within the Indian River, Portage Creek, Gold Creek, and Fourth-of-July Creek Tributaries. A program of fish tagging will be implemented to define intra-system movement.

- Creel census anglers utilizing these four streams to determine harvest of resident fish by a) species, b) age class, c) size, d) seasonal period, and e) area of availability. The creel census will also help with recovery of tagged fish.

- Conduct the adult anadromous studies in this area in cooperation with the anadromous program.

Following the first season's determinations of resident and anadromous fish occurrence, areas of greatest availability, and suitable methods of capture, the 1982 program will be directed to the same areas and intensified to include population estimations and preferred habitat utilization.

A similar two-man crew will be located in the Indian River or Gold Creek area, depending upon which seems more appropriate as a result of the first year study. The same equipment will be utilized. Study objectives for 1982 will be as follows:

- Determine relative abundance of resident and anadromous fish stocks in Indian River and Portage Creek at predetermined locations, by seasonal period, and further define intra-system movement and migrations. These studies will necessitate an intensified tag and recovery program to provide instantaneous population estimates at specific seasonal periods and also will necessitate numerous aerial surveys. While the methods with which to accomplish this work may be more apparent after the first year's efforts, it is considered likely that trapping devices or a statistically designed angling scheme may be most appropriate.

- Conduct similar studies in appropriate sections of the mainstem river and side channels during spring, summer, and fall. Techniques for this work segment will be similar to those used in the first objective.

- Define habitat utilization of resident and anadromous species both within the mainstem and the Gold Creek, Fourth-of-July Creek, Indian River and Portage Creek tributaries as related to hydrologic conditions.

  Areas of resident and anadromous fish preference will be surveyed in terms of flow, substrate, turbidity, depth, etc. to determine if these parameters are responsible for instream movements and distribution. These data will be correlated with historical climatological data and mainstem flows. Particular emphasis will be placed upon this facet during periods when mainstem flows approach the proposed regulated flow.

- Determine mid-winter occurrence and distribution of resident and juvenile anadromous fish species both in Indian River and the mainstem Susitna River.

  As Indian River is the only major accessible upper tributary stream during mid-winter, these studies will be limited to it.

  The mainstem river is characterized as being extremely dangerous to work in mid-winter due to poor ice conditions. As deemed possible, netting, trapping, and set lines will be utilized to determine occurrence and distribution of resident species during the winter months and to recapture fish tagged earlier in the year.

  Winter sampling of both the tributary and mainstem will be conducted during November and December on a field trip basis, on a monthly schedule. No permanent camp is contemplated.

It is expected that by the end of 1982 field season estimates of the magnitude of intra-system migrations, by time, will be possible, as will population estimates of resident fish available at the mouths of the two tributaries throughout the sport angling season. Population estimates will be formulated for the two years' runs of salmon. It is further expected that habitat requirements or needs dictating spring/fall migrations of resident and juvenile anadromous fish will be definable, as will be the role played by the mainstem Susitna River.

(3) Devil Canyon to the Tyone River confluence. Stock assessment of resident and anadromous fish populations

a. Objectives

The objectives in this study area are to

- Determine specific occurrence and species composition of fish stocks utilizing the mainstem Susitna river and its major tributaries;
- Define seasonal changes in occurrence and abundance of fish species within the mainstem Susitna River and tributaries;
- Define habitat types utilized by fish species, seasonally throughout the year, at varying hydrologic conditions, both within the mainstem Susitna River and major tributaries;
- Establish the impacts of inundation upon the aquatic habitat of the clearwater tributaries necessary to sustain the indigenous fish species; and
- Conduct complete hyrological surveys at the tributary mouths and at predetermined locations on each tributary.

b. Background

This area of study includes the more than fifty miles of the mainstem Susitna River and tributary streams, which will be either totally or partially inundated by construction of the Devil/Watana Hydroelectric Complex.

This portion of the Susitna River drainage lies in a truly wilderness setting, is roadless, is inaccessible except by boat or light aircraft, and is only moderately utilized by recreational anglers at this time. Angling in this reach of the Susitna River system can be termed a "quality experience".

This area has obvious identifiable habitat and biological impacts due to eventual inundation of segments of the clearwater tributaries feeding the impoundment. Critical habitat needs, as well as recreational fishing opportunities, are provided primarily at the mouths of these respective tributaries.

c. Work Plan

A three-man crew will work in the proposed impoundment area during the ice-free months, utilizing a helicopter and light aircraft for transportation throughout the study area. The study crew will be housed in a temporary/portable field camp. Investigations will be directed to

- Conduct extensive on-the-ground surveys of Goose, Jay, Kosina, Watana, Deadman, Tsusena, and Fog Creeks, and the Oshetna River. These investigations will include hydrological surveys and will determine the types of aquatic habitat currently available to resident species.

- Determine the types, magnitude, and location of aquatic habitats which will be lost upon inundation, by respective stream. Geographical features blocking upstream migration will be noted. Conversely, stream areas which will benefit in terms of improved access to fish stocks, upon impoundment, will be recorded.

- Conduct extensive netting, trapping, and fish collection to determine the specific occurrence, and composition of, resident species occupying these eight tributarial waters. As possible, efforts will be directed to determine the extent of seasonal intra-seasonal migrations.

- Tag all adult fish captured for determination of intra-system movement and migrations.

Upon completion of the first year's (CY-81) assessment of aquatic habitats and biological distribution of fish species within the impoundment area tributaries, investigations will be directed to the upland lake areas and the mainstem Susitna proper.

A two-man field crew will again operate with a transportable field camp, utilizing helicopter and light aircraft for transportation. Investigations will begin as soon as "ice-out" occurs in the spring and continue until freeze up in the fall.

Studies in CY-1982 will be directed to

- Survey fish utilizing selected tributarial stream mouths throughout the season to determine intra-system movements of resident fish, and their reliance upon the mainstem river during the critical winter months. Tentative stream selections are Kosina, Jay, and Watana Creeks. A semi-permanent camp will be located in the vicinity of these stream mouths, and the individual streams will be sampled for fish occurrence on an established sampling schedule throughout the season.

- Survey upland lakes associated with mainstem Susitna River tributary streams for fish population and related biological data. Habitat information will also be collected from inlet and outlet streams, and be used later in determining the impacts to seasonal migrations and biological requirements of resident fish as a result of impoundment, road construction, and transmission corridor placement.

- Determine resident fish occurrence and distribution within the mainstem Susitna River throughout the spring-summer-fall periods. This work will be accomplished by the same field crew utilizing a chartered boat for transportation on a predetermined sampling schedule. Nets, trot lines, traps, etc., will be used to determine fish presence.

- Continue collection of complete hydrological data.

It is anticipated the single two-man crew will be capable of performing all the above tasks. Determination of mainstem fish occurrence and distribution will be accomplished by two or three scheduled week-long trips through the impoundment area.

The upland lake surveys will be accomplished during "non-sample" periods at the tributary mouths. Close coordination will be necessary, as will helicopter support at frequent intervals.

3. Seasonal and Spatial Habitat Study

Objective

Determine the spatial and seasonal habitat requirements of anadromous and resident fish species during each stage of their life histories.

Study Approach

Spatial and seasonal habitat studies will be divided into three major geographical areas. Sampling upstream of the Susitna-Talkeetna River confluence will be conducted primarily by fisheries study groups. Design of sampling programs will be done by the habitat studies supervisor. These studies will be performed in addition to work proposed by DNR, but will be done in close cooperation and coordination with that agency and other tasks performed by consultants as a part of the overall Susitna hydro-feasibility study. If the DNR instream flow study is not funded, ADF&G will need to increase its budget in the amount that DNR requested in order to perform the required work. It is anticipated that other agencies such as the USGS and USFWS will also provide support for these instream flow studies.

The following baseline studies are required for each study area:

(1) Cook Inlet to the Talkeetna-Susitna River confluence. Spatial and seasonal habitat requirements of fish populations

a. Objectives

The objectives within this study area are to

- define essential seasonal habitat requirements for incubation, rearing, spawning, and passage of anadromous and resident fish populations;
- define the seasonal relationships between flow regimes and essential physical and biological habitat characteristics;
- define the relationships between the tributary and slough physiochemical and biological habitats within the mainstem Susitna River at various flow regimes;
- develop state-of-the-art capabilities to evaluate habitat characteristics in this difficult reach of river; and
- generate data essential for evaluating the effects of various flow regimes on terrestrial and riparian habitat.

b. Background

This reach of the Susitna River provides important habitat for rearing, incubating, spawning, and migrating resident and anadromous fish species. Unfortunately, its physical characteristics also make it one of the most difficult to evaluate. Studies of seasonal habitat characteristics will be coordinated on an annual basis with the life history and distribution fish studies (both anadromous and resident).

Expansion or determination of these studies will depend upon determination and confirmation of the seasonal habitat requirements between various life history stages of the resident and anadromous fish and the relationship of seasonal habitat to various discharges.

If positive confirmation is provided by the habitat study in conjunction with other biological studies, specific year-to-year study locations should be identified for ongoing programs to determine the effects of the project on the fish and wildlife resources in this portion of the basin.

c. Work Plan

Three field operations will be accomplished in the initial year of the study. These are mainstem seasonal instream flow measurements, tributary seasonal instream flow measurements, and collection of other physiochemical and biological habitat data.

A crew of biologists utilizing a customized riverboat as their primary means of transportation will operate in the mainstem and selected tributary systems during the ice-free months May through October to

- procure equipment;
- establish and refine large river instream flow measurement techniques;
- collect instream flow data in terms of depth, velocity, wetted perimeter, and substrate; and
- collect water quality data as related to discharge.

(2) Talkeetna River confluence upstream to Devil Canyon. Spatial and seasonal habitat requirements of fish populations

See Resident Fish Study Proposal.

(3) Devil Canyon damsite upstream to the Tyone River confluence. Spatial and seasonal habitat requirements of fish populations

See Resident Fish Study Proposal.

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Subtask 7.11 - Wildlife Ecology Studies

(a) Objective

The primary objective of this subtask is to accurately determine the impact the proposed Susitna Project will have on the wildlife resources of the Upper Susitna River Basin. In order to accomplish this objective, it will be necessary to 1) determine the species present, their distribution and relative abundance; 2) gather sufficient data to develop an understanding of the relationship between key wildlife species and the distribution, quality and seasonal utilization of habitat components; and 3) determine the predator-prey relationships that exist in the terrestrial system.

(b) Approach

The general philosophy upon which the approach to the wildlife ecology program was developed is that the wildlife community represents a system; this system is connected by means of a complex variety of interrelationships, and is influenced by the nature and distribution of plant communities. In order to assess the impact of the Susitna Project on any one component of the system it is necessary to have at hand baseline data on all members of the system. To achieve the objectives of this study, an appropriate approach has been developed for each section. Following is a summary of the approach that will be taken in regard to big game, furbearers, and birds and non-game mammals.

(1) Big Game

The big game studies have been divided into the following categories: population studies, habitat studies, impact assessment and mitigation measures.

Prior to the development of an impact assessment, a detailed survey of current big game populations will be conducted. Population data will be collected by the Alaska Department of Fish and Game. Species to be surveyed by ADF&G include: moose, caribou, bear, wolf, wolverine, and Dall sheep. Seasonal distribution, abundance, and habitat preference movement patterns will be determined for each big game species by ADF&G.

An extensive habitat analysis will also be conducted. The habitat effort will be performed primarily as a part of the Plant Ecology Studies (Subtask 7.12). Although much of the data collected under the habitat analysis will be applicable to several big game species as well as the other wildlife disciplines, the major emphasis will be placed on moose habitat. Phase I (pre-license application) of the big game habitat study will be limited primarily to the production of vegetation cover/habitat maps that will provide acreage, location, and distribution information on major habitat types.

During the first year of the study, an expert will be selected to perform the big game impact assessment. The person selected for this effort will be highly qualified and totally objective. Approval of the APA will be secured prior to finalizing any arrangement. The impact assessment will deal with both short- and long-term impacts. The impact zone will include the entire Upper Susitna River Basin as well as downstream portions of the Susitna River.

Phase I of this study will also include the consideration and identification of possible mitigating alternatives. To prepare an actual mitigation plan during Phase I, without the benefit of a sound data base, would most likely result in the production of a plan based on speculation rather than facts. Therefore, during 1982, TES will submit a proposal and cost estimate to develop a detailed mitigation plan.

(2) Furbearers

The furbearer study effort during the pre-application phase will be a two-year survey and will include an extensive survey of populations within the project region. This will include a literature search, as well as the identification of key species, general abundance levels, and the location of preferred habitats and areas of notable abundance. A preliminary assessment of impacts will also be prepared at the conclusion of Phase I.

(3) Birds and Non-Game Mammals

An extensive approach as well as an intensive approach will be used for these studies. The extensive bird study will cover a large portion of the Upper Susitna Basin and will determine the presence of possibly unexpected species or unexpected concentrations of species. Intensive census sites will be located in the upland and wetland habitats and will provide data on bird species composition and density in each of the most extensive habitats of the region, providing, among other things, an indication of habitat uniqueness and productivity.

A survey of non-game mammals will be conducted, primarily in the proposed impoundment area, and will provide useful data on many important prey species, such as hares, voles, and mice. Sampling efforts will be coordinated with the avian study and will utilize similar sampling areas and habitat data.

(c) Discussion

In dealing with a large area such as the Upper Susitna River Basin, and attempting to develop an adequate understanding of potential impacts and possible mitigative measures, it is necessary to study the entire faunal community and delineate the complex interrelationships that exist among the components of the terrestrial system. We realize that certain portions, or species, within the system are considered important by certain groups or agencies. This plan of study has been designed to concentrate on such important species; however, regardless of the importance of these species, they are all part of the total community system and a satisfactory understanding of any member of the system cannot be developed without investigating the entire system.

In the case of many species a minimum of 4 or 5 years is needed to gain a thorough understanding of population dynamics. Many species, particularly small to medium-sized mammals, demonstrate cyclic changes in density; and thus a 1- or 2-year study is highly restrictive in perspective. Likewise, larger species such as moose and caribou, demonstrate different movement patterns and habitat needs under various weather conditions. Thus the wildlife data collected during Phase I will enable the preparation of only a preliminary impact assessment. Studies proposed after the licensing application is submitted are designed to satisfy the time requirements of some aspects of the Susitna Wildlife study and assure that adequate consideration of the basic research needs are addressed. A refined and more thorough impact prediction, as well as a consideration of mitigation alternatives, will result from proposed Phase II efforts.

(d) Schedule

Weeks 1 through 117

(e) Detailed Scope of Work

(1) Big Game

Although TES proposes to approach the impact evaluation of the wildlife resources of the Upper Susitna River Basin by considering all components of the faunal community, we recognize that big game species have a unique importance in this case. There is little doubt that to the people of Alaska, and to the major resource agencies, big game is a very valuable resource and is thus of major consideration in the impact analysis for the Susitna Project.

a. Population Studies

Prior to the development of an impact assessment, a detailed survey of current game populations will be conducted. Population data will be collected by the Alaska Department of Fish and Game as presented in (4) below. Species to be surveyed by ADF&G include: moose, caribou, bears, wolf, wolverine, and Dall sheep. Seasonal distribution, abundance, habitat preference and movement patterns will be determined for each big game species by ADF&G. A variety of techniques will be used during this portion of the study and will include aerial surveys and radio-telemetry. While the major emphasis will be placed on the Upper Susitna Basin and the impoundment area, the moose population studies will also include the riparian areas downstream from Talkeetna.

b. Habitat Studies

In addition to population data collected on big game by ADF&G, an extensive habitat analysis will be conducted by TES. The habitat effort will be performed primarily as a part of the Plant Ecological Studies. Habitat data will be needed in order to accurately predict the impact of the proposed project, as well as to determine changes that can be expected to take place in the absence of the project. Although much of the data collected under this effort will be applicable to several species, the major emphases will be on moose habitat.

Phase I of the big game habitat study will be limited primarily to the production of vegetation cover/habitat maps that will provide acreage, location, and distribution information on major habitat types. The Upper Susitna Basin will be mapped at a scale of 1:250,000. Vegetation cover/habitat maps at a scale of 1:63,360 will then be produced for an area 10 to 12 miles on both sides of the Susitna River, from the proposed site of Devil Canyon dam to the confluence of the McClaren River. The downstream floodplain south to Talkeetna will be mapped at a scale of 1:25,000. The classification system to be utilized for the mapping is the system developed by Dryness and Viereck. The mapping will be to the third and fourth level of this system. Additional details concerning the vegetation cover/habitat mapping efforts are discussed in Subtask 7.12.

The quantitative information required for more detailed impact predictions concerning moose habitat will be obtained during the Phase II effort. This will include an estimate of available browse, productivity of key browse species, browse quality and utilization by moose. Data of this nature will be collected in portions of both the Upper Susitna Basin and downstream floodplain. Portions of the study area identified during the Phase I moose population studies as critical wintering areas will be used for the quantitative browse studies.

An associated aspect of the habitat study will be a plant succession study to be conducted during Phase I. This study will attempt to gain an understanding of successional trends and the factors influencing successional changes. This information will be useful in predicting changes, especially in regard to moose habitat, that are likely to occur with or without the project. Additional details concerning plant succession studies can be found in Subtask 7.12.

c. Impact Assessment

TES will obtain the services of an individual, or group, to perform an independent impact assessment on big game. We will utilize the first part of 1980 to determine which individual is best qualified to assist on this aspect of the study effort. The two criteria that will be applied in the selection process are (1) expert qualifications in dealing with the species involved, and also familiarity with these species in similar subarctic ecosystems, and (2) independence from any interest or concerns with the study area or the political aspects of Alaskan wildlife resource management.

The impact assessment will deal with both short-term impacts, such as construction activity, as well as long-term impacts which could involve disruption of movement patterns or predator-prey dynamics. The impact zone on these species will probably include the entire Upper Susitna River Basin as well as downstream portions of the Susitna River. In order to determine accurately the impact of the project it will be necessary to predict long-term changes in habitat and population levels that can be expected to occur without the proposed project.

Of paramount importance throughout the impact zone will be the location and distribution of preferred habitat, particularly in regard to potential barriers created by the impoundments. This will be of prime importance to moose and caribou, species whose annual habitat needs vary from season to season and also differ under various weather conditions. As associated concern, particularly in regard to wolves, and to a lesser extent bears, will be the location of denning sites. Whether or not traditionally used wolf dens are flooded, or disturbed by human activity, will likely influence the abundance, at least in the near future, of wolves in the Upper Susitna Basin.

d. Mitigation

Assuming that the net effect of the Susitna Project on big game will be of a negative nature, it will be necessary to consider mitigative measures that can be taken. Mitigative measures can be grouped into two categories. First are efforts that can be implemented to reduce the impact of the project on the game populations within the study area or impact zone. The second type of mitigative measures involve the improvement of habitat outside of the impact zone to increase game populations to an extent which would compensate for losses attributable to the Susitna Project.

In either case, it will require the collection of at least two years' data before enough is known about likely impacts so that a mitigation plan can be formulated. This plan of study includes time and expenses to consider and identify possible mitigative alternatives. However, at this time, based on the available information, it would have been premature and highly speculative to propose a full-scale effort to develop a mitigation plan. Therefore, it is recommended that during 1982 TES, through Acres, submit to the APA a proposal and associated cost estimate to develop a mitigation plan. At that point sufficient information, both of a biological and engineering nature, will exist upon which to structure a well designed program to address the issue of mitigation for big game.

(2) Furbearers

Furbearers will be investigated for a period of two years during Phase I and for three additional years during Phase II. The following species of furbearers will be considered: red fox, coyote, pine marten, mink, river otter, lynx, beaver, and muskrat. Studies of furbearers will be synchronized with field and laboratory investigation conducted by project personnel preparing vegetation cover/habitat type maps and conducting studies of project impacts upon other terrestrial mammals and birds. Utilization of data from other disciplines such as hydrology and socioeconomics will be required to accurately predict the impact of the Susitna Project on furbearers.

Phase I (1980 and 1981) will focus on collecting essential data for a generalized assessment of the project upon furbearer population. The first portion of Phase I will entail the identification and review of existing information concerning furbearers in the Susitna Valley. During the early months of 1980, libraries with northern reference collections in Alaska, Canada and the contiguous 48 states will be searched to gather background information. Biologists, trappers, and others with knowledge of the Susitna Valley will be interviewed to obtain data to supplement published literature. Field techniques will be tested and, where needed, new techniques developed at this time. Extensive field surveys will start in late February and March 1980. Additional field surveys will be conducted in late February and March 1981, summer 1980 and 1981, and early winter (November-December) 1980 and 1981.

Field work will be conducted on a number of study sites in representative habitats in and adjacent to the impoundment zones and downstream areas likely to be altered by the proposed development. Study sites will include predominant vegetation types and major physiographic features. Furbearer abundance and habitat preferences will be determined by transect and scent station surveys. Aerial surveys will be used to locate terrestrial furbearer signs and beaver lodges and dams. Floats of the river in summer will be conducted to count furbearers directly and to correlate tracks on sandbars with winter tracks in the same areas. Seasonality of use will be determined where possible. Interviews of trappers and other persons with knowledge of the area will be conducted to supplement field surveys. Relative abundance of each species of furbearers will be correlated with the major types of habitat, utilizing the University of Alaska computer system. Assessments of probable impacts will be based upon predictable changes in habitat and anticipated human use of the area if construction proceeds.

(3) Birds and Non-Game Mammals

The overall objective of the studies proposed below is to determine what species of birds and non-game mammals use the Upper Susitna River Basin in the vicinity of the proposed impoundments and to determine on a seasonal basis the habitats in which they are found and their abundance. This data can then be used to evaluate habitat potential in the area, to extrapolate population data for given geographic or habitat units within the region, and to evaluate possible mitigative measures, should they prove necessary.

a. Extensive Avifauna Survey

A survey of the avifauna of the Upper Susitna River Basin will be conducted within an approximate 10-mile band on either side of the river, from Gold Creek to the upriver location above which the impoundment will not influence the current habitat. Particular attention will be paid to long-lived species, those that are particularly sensitive to human disturbance, those subject to hunting pressure, and any endangered species.

All habitats of the region will be visited on a regular basis throughout the migration and summer periods, and all birds seen or heard will be recorded. This activity will provide data on seasonal use of the entire region by birds and provide a basis for determining the relative abundance of species within habitats as well as a general indication of habitat productivity.

One or two aerial surveys will be made each year to search for evidence of large nesting raptors such as the osprey, bald and golden eagles, peregrine falcon, and gyrfalcon. Aerial surveys of waterfowl will also be conducted over wetland areas periodically throughout the migration and summer seasons.

b. Intensive Avifauna Census

Census plots will be established during 1980 in each of the major terrestrial habitats in the vicinity of the proposed dam sites. Wherever possible, these plots will be square 10-ha plots on sites of uniform habitat. Censusing will be done with a modification of the territory mapping method. During the breeding season (1981), 7-9 censuses will be conducted on each plot; 1 or 2 censuses will be conducted during the winter months (1980 and/or 1981). The habitat for each bird census plot will be sampled in detail during 1980, using the point-centered quarter method, with modifications to include sampling of ground cover and shrub vegetation.

For each of the major habitats censused, avian species composition and density will be calculated. For each of the more common bird species in the upland habitats, determination of habitat preferences will be attempted through the use of multivariate statistical techniques (1982 only).

These data on habitat productivity and avian habitat preferences will provide insights into the effects of construction activities and subsequent impoundments on the avifauna of the region. It should be possible, through extrapolation, to roughly estimate the number of birds of each species that will be displaced from terrestrial habitats as a result of habitat destruction caused by construction and impoundments. It will also be possible to predict what species will be attracted to the region after construction, based on habitat changes caused by construction (revegetation) or changes in water level.

c. Non-Game Mammal Survey

During 1980 trapline transects will be established in each of the major terrestrial habitats in the vicinity of the proposed dam sites and in several wetland habitats. Censusing of shrews, voles and mice will be conducted using the North American Census of Small Mammals snap-trapping technique. Two parallel transects will be established, each a straight line 289 m long, consisting of 20 trap stations. At each station, a maximum of three snap-traps and one pitfall trap will be set for three consecutive nights. One late-spring/early-summer, one fall, and possibly one winter census will be conducted on each of the habitat plots. Sampling will be conducted during 1980 and 1981 of Phase I and continued through Phase II (1982 and 1983). Habitat data at each trap site will be gathered in coordination with that gathered for the avian studies, using the point-centered quarter method, with additional variables used to quantify ground cover and other microhabitat variables. If a winter census is made, snow cover characteristics will be sampled (e.g., snow depth, density and hardness, layering, etc.).

For each of the habitats censused, mammal species composition and relative abundance will be calculated. For each non-game mammal species of sufficient sample size, quantification of macro- and micro-habitat preferences will be attempted.

More general methods will be used to quantify the presence of such species as the little brown bat, collared pika, snowshoe hare, hoary marmot, arctic ground squirrel, red squirrel, and flying squirrel. Within the study plots, the relative amount of sightings and sign (burrow entrances, cone "middens", scat, etc.) will be tabulated, and attempts will be made to locate and map any concentrations of hoary marmot and arctic ground squirrel.

Some random trapping will be conducted, as time and opportunity permit, in other parts of the Upper Susitna River Basin and in lesser habitats not covered by the main plots, in order to permit the detection of species in the area that may not occur on the intensive plots.

(4) Detailed Description of ADF&G Big Game Studies

a. Moose distribution, movements and habitat use in the vicinity of proposed impoundments.

Objectives

To identify moose subpopulations using habitat that will be inundated by proposed impoundments, the seasonal distribution, movement patterns, size and trends of those subpopulations, and the timing and degree of dependency of those subpopulations on habitat to be impacted by the Susitna Hydroelectric Project.

Background

Preliminary studies indicated that several loosely defined subpopulations of moose inhabit proposed impoundment areas for all or part of the year. Most moose studied exhibited altitudinal migration patterns, spending summers at higher elevations often outside the proposed impoundment areas and winters at lower elevations often within or adjacent to impoundment areas. Therefore the most severe impacts of the Susitna Hydropower project on moose upstream from Devil Canyon are expected to result from inundation of and blockage of migrations to critical winter range. Since some moose migrate to summer range up to 60 miles from their winter range, reductions in the capacity of winter range may result in reduced densities of moose over a vast area.

The basic approach of this study is to identify the subpopulations of moose using potential impoundment areas and to quantify their dependence on those areas. For example, winter range of each subpopulation will be delineated and the proportion of available winter range that will be lost will be estimated. Factors such as browse production, quality and availability under varying environmental conditions will be considered. Since environmental conditions influencing these factors vary from year to year it will be necessary to continue these studies for several years.

Both the short term impact on the present moose population and the longer term loss of potential population size will be estimated by determining the size and trends of the existing population and assessing its status in relation to the present capacity and trends of the range.

The relationship between moose habitat and moose population is complex. It is difficult to quantify this relationship and impractical to attempt to measure all aspects over the entire impact area. Therefore it will be necessary to conduct intensive studies in only portions of the area to estimate the relative capacity of certain habitat types under certain environmental conditions. These estimates will then be extrapolated to the entire impact area on the basis of more extensive moose population studies and habitat maps.

Data derived directly from the moose will be collected under this subtask while data derived from the moose's habitat will be collected under other subtasks, particularly 7.12 Plant Ecology.

It is anticipated that by the end of Phase I the basic distribution and movement patterns of the major moose subpopulations will be known. The present number of moose using the study area will be estimated. A rough estimate of the percentage of winter habitat used during the winter of 1980-81 that will be lost should be possible. It should be possible to estimate the scope and a range of magnitude of poten tial impacts. Studies must be continued through Phase II to determine impacts under a wider variety of environmental conditions and to test and refine the estimates made at the end of Phase I.

Procedures

Approximately 60 moose will be radio-collared during the first year of study. Most of these will be collared in March 1980 when moose are on winter range and most likely to be in or near proposed impoundment areas. Subsequent collaring operations will be conducted as needed to replace collars and to fill data gaps. Moose will be collared from Devil Canyon to the confluence of the Maclaren and Susitna Rivers; however it is anticipated that most will be collared in the vicinity of the proposed Watana impoundment which is expected to impact more moose than the Devil Canyon impoundment. Radio-collared moose will be relocated at least twice a month to delineate seasonal ranges. More intensive monitoring will be conducted as needed to determine migration patterns and calving areas and to delineate critical winter range. The specific location, habitat type, activity, and association with other moose will be recorded for each relocation. Habitat type will be classified according to the system that will be used in habitat mapping under subtask 7.12.

Periodic systematic aerial surveys will be made during winter to further delineate winter ranges and quantify the relative use of specific areas and habitat types in and out of proposed impoundment areas. To the extent possible moose will be classified by sex and age class as an aid in identifying segregation patterns and determining population trends.

Moose numbers will be estimated through quadrat sampling techniques during later winter.

The long and short term nutritional status of moose captured for collaring will be assessed through established techniques using morphometric measurements, condition classification, blood chemistry and hair mineral element levels.

Relationship to Other Subtasks

Procedures for recording and handling data will be coordinated with those of other wildlife studies to ensure efficiency in later impact analysis.

Personnel and logistics will be coordinated among all big game studies. In particular wolf and wolverine tagging will be coordinated with moose tagging and when feasible several species will be radio-tracked on the same flight.

Moose studies will be closely coordinated with plant ecology studies. Moose distribution data collected between January and March 1980 will be used to delineate areas for detailed habitat mapping and for selection of intensive vegetation study areas. These habitat maps will be used in the analysis of moose distribution data. It is anticipated that continual coordination between investigators of both subtasks will be maintained to ensure efficiency of study design and compatability of data.

Snow conditions strongly influence moose movements and browse availability. Requirements for snow data will be determined on the basis of final project design and selection of detailed vegetation study areas. If possible these needs will be coordinated with those of the hydrologic field data collection program. It may be necessary to establish additional stations solely on the basis of moose study needs.

b. Moose distribution, movements and habitat use downstream from Devil Canyon.

Objectives

To identify moose subpopulations using habitat that will be altered by changes in stream flow below Devil Canyon, the seasonal distribution, movement patterns, size and trends of those subpopulations, and the timing and degree of dependency of those subpopulations on habitat to be impacted by altered flow regimes of the Susitna River.

Background

Islands and bars in the Susitna River are heavily used by moose during winter, particularly in years of deep snow. A major factor making these areas attractive to moose appears to be the maintenance of vegetation in a subclimax stage by the existing flow regime of the river. The mechanism setting back plant successive is not known. Periodic flooding may be the dominant factor but other factors such as siltation, normal channel erosion, ice scouring and soil moisture may also be important.

Alteration of the Susitna River flow regime by the Susitna Hydroelectric Project will probably result in changes in vegetation downstream. The nature and magnitude of these changes are unknown but could be significant to moose and other species of wildlife. It is possible that even minor changes in flow such as dampening of extreme flood levels by a few inches could alter many acres of critical moose winter range. Such alterations could influence moose abundance over a large area.

Because of the many unknowns, assessment of the impact of the Susitna Hydroelectric Project on moose populations in the lower Susitna River drainage will require synthesis of information from several disciplines including hydrology, geomorphology, plant ecology and wildlife ecology. Under ideal circumstances a systematic progression of studies starting with hydrology and ending with wildlife ecology should be followed. However, the schedule time frame for developing the Susitna Hydroelectric Project is incompatible with this approach. Therefore it will be necessary to conduct a number of studies simultaneously.

The basic approach will be to identify mechanisms of impact and roughly estimate the potential magnitude of impact during Phase I. If significant impacts are identified the studies will be redesigned to produce a more reliable estimate of impact and to provide an initial assessment of mitigation possibilities.

Studies of the effects of water conditions on moose habitat will be conducted under Subtask 7.12 Plant Ecology. It is anticipated that by the end of Phase I these studies will indicate if substantial changes will be caused by the predicted post-construction flow regime. A habitat map, which will also be prepared under Subtask 7.12 during Phase I, will provide a basis for preliminary estimates of acreages that might be altered. If significant vegetation changes are indicated by the Phase I studies these estimates will be refined during Phase II.

The dependency of moose on habitat subject to alteration will be assessed under this subtask. During Phase I moose wintering areas on and adjacent to the river will be delineated and the relative use of various habitat types, particularly those subject to periodic flooding, will be determined. This will provide the basis for a preliminary estimate of the proportion of winter range that may be altered; however, this estimate will be valid only for the environmental conditions existing during the winters of 1979-80 and 1980-81.

Characteristics of moose use of habitat subject to flooding will be determined by more intensive study of moose using one or more limited study areas. These study areas will include areas selected for intensive vegetation studies. Movements of individual moose will be monitored to determine whether habitat subject to flooding is used transiently by large numbers of moose or more regularly by smaller numbers. Moose use of specific plots being studied under Subtask 7.12 will be assessed through direct observation and pellet group counts.

Seasonal ranges of moose wintering on the intensive study area will be superficially delineated to indicate the approximate geographic scope of any impacts that are identified.

If Phase I studies indicate that the Susitna Hydroelectric Project will cause significant alteration of habitat downstream and that alteration of this habitat is likely to result in significant changes in moose distribution and numbers, Phase II studies will be designed to delineate moose subpopulations using the entire area of potential habitat alteration and to predict the impact on each subpopulation.

Procedures

The following procedures are for Phase I studies only:

Existing data on moose distribution and movements adjacent to the lower Susitna River will be compiled. Sources will include historic fall sex and age composition counts, records of road and railroad kills, and incompletely analyzed data on a major winter die-off that occurred along the river in 1970-71.

Periodic systematic aerial surveys will be made during winter to delineate winter ranges and quantify the relative use of specific areas and habitat types adjacent to the Susitna River. To the extent possible moose will be classified by sex and age class as an aid in identifying segregation patterns and determining population trends.

A limited number of moose (up to 20 during 1980) will be radio-collared in areas selected for intensive vegetation study (see Subtask 7.12). These moose will be relocated approximately weekly while they are in the vicinity of the river to determine the pattern of use of specific habitats. They will be relocated approximately monthly at other times of year to roughly delineate other seasonal ranges and ensure continued contact with each animal.

Pellet group counts will be conducted within the intensive study areas to provide a quantitative comparison of moose use of specific habitats that will also be studied under Subtask 7.12.

Relationships to Other Subtasks

Procedures for recording and handling data will be coordinated with those of other wildlife studies to ensure efficiency in later impact analysis.

Moose studies will be closely coordinated with plant ecology studies. Moose distribution data collected between January and March 1980 will be used to delineate areas for detailed habitat mapping and for selection of intensive vegetation study areas. These habitat maps will be used in the analysis of moose distribution data. It is anticipated that continual coordination between investigators of both subtasks will be maintained to ensure efficiency of study design and compatability of data.

Snow conditions strongly influence moose movements and browse availability. Requirements for snow data will be determined on the basis of final project design and selection of detailed vegetation study areas. If possible these needs will be coordinated with those of the hydrologic field data collection program. It may be necessary to establish additional stations solely on the basis of moose study needs.

c. Wolf distribution, abundance, habitat use and prey selection.

Objectives

To identify wolf packs occupying areas that will be impacted by the Susitna Hydroelectric Project, the territories of each pack and identify den sites, rendezvous sites and major feeding areas, the numbers of wolves and rates of turnover for each pack, and the food habits of each pack.

Background

Recent studies indicate that the Nelchina Basin supports moderate densities of wolves. Wolves may be affected by the Susitna Hydroelectric project if critical portions of a pack's territory are inundated or if the abundance or condition of prey is altered.

Limited available data indicate that portions of the territories of several packs may be inundated. Since all parts of a pack's territory may not be equally important to the maintenance of the pack, the effect of this loss of territory may vary from pack to pack. Therefore it is necessary to delineate the territories of each pack and determine the degree and nature of use of areas within proposed impoundments.

A major factor influencing wolf numbers and distribution is prey availability. Recent studies in other parts of the Nelchina Basin indicate that large ungulates, particularly moose, are the most important prey of most packs of wolves. Since moose and caribou tend to be migratory it is possible that the Project will result in reduced prey availability in the territories of wolf packs many miles from the impoundments.

An assessment of the impact of the Project on wolves requires a knowledge of prey populations. Therefore wolf studies will be closely coordinated with studies of potential prey species.

Initially studies will be concentrated on wolf packs that are likely to be directly impacted through loss of territory. If studies of prey species indicate that prey densities are likely to be altered in other areas, the wolf study will be expanded to delineate packs in those areas.

Procedures

Several members of each wolf pack will be radio-collared. Each radio-collared wolf will be relocated at least twice a month. More frequent relocations will be made when necessary to provide specific information such as location of dens and rendezvous sites. Territories will be delineated by plotting relocations on maps. Numbers of wolves in each pack will be monitored continuously by direct observation of radio-collared wolves and other wolves accompanying them.

Habitat selection will be determined by recording the habitat type and activity of the wolves for each sighting made.

Standardized track count censuses will be conducted after fresh snowfalls to provide additional information on wolf distribution and numbers and identify packs not radio-collared.

Food habitats will be determined by observation of kills located during radio-tracking flights and analysis of scats collected at dens. When possible the age, sex and condition of prey will be determined.

Relationship to Other Subtasks

Procedures for recording and handling data will be coordinated with those of other wildlife studies to ensure efficiency in later impact analysis.

Personnel and logistics will be coordinated among all big game studies. In particular wolf and wolverine tagging will be coordinated with moose tagging and when feasible several species will be radio-tracked on the same flight.

Data from studies of prey, particularly moose and caribou, will be used in modification of design of wolf studies. Studies of both predators and prey will be closely coordinated so that interactions between species which might influence impacts of the Susitna Hydroelectric Project can be identified.

d. Wolverine distribution, abundance, movement patterns and habitat use.

Objectives

To determine the distribution and abundance of wolverines in the vicinity of proposed impoundments.

To determine movement patterns and home range size of wolverines.

Background

Little is known about wolverine movement patterns and habitat requirements. A basic understanding of these questions is necessary before impacts of the Susitna Hydroelectric Project can be addressed. For example, if wolverines have well defined home ranges and strict habitat requirements, impacts might be quite different than if they have large and loosely defined home ranges and are able to exploit a wide variety of habitat types.

Observations made in the vicinity of the study area indicate that techniques that will be employed in the wolf study could be adapted to provide the necessary basic information on wolverines.

Since very little is known of wolverines at the present time, it is anticipated that only rough estimates of the mechanisms and potential magnitude of impacts will be possible at the end of Phase I. At that time it may be necessary to redesign studies to provide a more reliable basis for assessment of impact.

Procedures

The distribution and abundance of wolverines will be assessed through track counts and direct observations made during wolf census surveys.

Wolverine (up to 10 in 1980) will be radio-collared and relocated approximately twice per month to determine movement patterns and home range.

Habitat selection will be determined by recording habitat type and activity for each sighting made.

Relationship to Other Subtasks

Procedures for recording and handling data will be coordinated with those of other wildlife studies to ensure efficiency in later impact analysis.

Personnel and logistics will be coordinated among all big game studies. In particular wolf and wolverine tagging will be coordinated with moose tagging and when feasible several species will be radio-tracked on the same flight.

Personnel from the University of Alaska are expected to have opportunities to collect additional information on wolverines in the course of studies directed at other furbearers. All aspects of both studies will be coordinated to maximize data collection with a minimum of duplication of effort.

e. Bear distribution, movements, abundance and habitat use.

Objectives

To determine the distribution and abundance of black and brown/grizzly bears in the vicinity of proposed impoundment areas, seasonal ranges, including denning areas, and movement patterns of bears, and seasonal habitat use of black and brown/grizzly bears.

Background

Much of the Nelchina Basin is known to support high densities of brown/grizzly bears. Black bears are believed to be less abundant and less widely distributed. The main mechanism of impact affecting bears is likely to be direct loss of habitat, particularly seasonally important feeding areas or denning areas. Some bears may be indirectly affected through reduction in ungulate densities in areas outside of proposed impoundments as moose, and perhaps caribou, constitute a major portion of bears' diet during summer in adjacent areas. Shorter term impacts will result from bear-human conflicts which are likely to occur when field facilities are established for the Susitna study program and subsequent dam construction if the project is approved.

Studies in other parts of Alaska indicate that bears have specific habitat and food preferences. These preferences often vary seasonally in a manner that suggests very specific seasonal habitat requirements. While both species of bear sometimes occur in close proximity, their habitat requirements are probably different. Therefore the impact of inundation of bear habitat may not be in direct proportion to the number of acres lost and the impact on one species of bear may be quite different from that on the other.

Procedures

Adult bears will be radio-collared in and adjacent to the proposed impoundment areas. Approximately 35 bears will be collared the first year. Incidentally caught bears too small to be radio-collared will be marked with visual tags. Black bears and brown/grizzly bears will be marked in the approximate proportion of their occurrence in the area. At this time it is not known if significant members of black bears will be found.

Radio-collared bears will be relocated periodically throughout their active period to delineate seasonal ranges and determine movement patterns. The den location for each radio-collared bear will be recorded each year.

All observations of both marked and unmarked bears will be recorded. For each sighting the location, habitat type, activity and association with other animals will be recorded.

Information on seasonal food habits will be gathered through observations of bear feeding and to the extent possible through scat analysis.

Relationship to Other Subtasks

Procedures for recording and handling data will be coordinated with those of other wildlife studies to ensure efficiency in later impact analysis.

Personnel and logistics will be coordinated among all big game studies. When feasible several species will be radio-tracked on the same flight.

f. Caribou herd identity, migration patterns and habitat use.

Objectives

To delineate calving areas, the numbers and sex and age composition of caribou occupying habitats on both sides of proposed impoundments at different seasons, and migration routes and the timing of major movements in the vicinity of proposed impoundments.

Background

The distribution and movement patterns of the Nelchina caribou herd were extensively studied during the 1950's and 1960's. At that time large numbers of caribou regularly crossed proposed impoundment areas during migrations between seasonal ranges, particularly on their migration from calving areas south of the Susitna River to summer range north of the river and subsequent fall migrations to the east. Early assessments of the impact of various Susitna hydroelectric proposals suggested that impoundments could block migrations and isolate caribou from portions of their traditional range.

A number of major changes have occurred during the last decade which limit the value of data collected prior to 1970. The herd suffered a major decline in the early 1970's, dropping from an estimated peak of over 70,000 to less than 10,000. The herd is currently increasing and estimated to number 20,000. Current management plans call for stabilizing the herd at the present level. Movement patterns appear to have become quite variable from year to year. While movements across proposed impoundment areas still occur it is not clear whether they are as significant to the population as they were thought to be in past years.

Location of calving areas is believed to be the most consistent characteristic of caribou distribution and movement patterns. The traditional concept of a herd assumes a well defined common calving area. The Nelchina herd still uses its traditional calving area south of the Susitna River, however, in the last few years there have been indications of significant numbers of caribou north of the river during the calving period. These caribou may represent a subherd with all sex and age classes represented or they may be segments of the main herd that are not involved in calving.

If a new subherd exists the "need" to migrate across the proposed impoundment areas may be reduced. But if different sex and age classes are on opposite sides of the river at that time of year the need to migrate would be great.

It is not likely that caribou would be completely excluded from any part of their range other than those areas that are inundated. However, even a partial barrier to movements could result in reduced use of portions of the present range and increased use of other portions. If the desire to migrate along routes blocked by impoundments is strong, caribou may attempt to cross impoundments. Potential hazards such as ice shelves and mud flats could increase mortality rates among caribou attempting to cross.

Unfortunately there is no way to predict with confidence the reaction of caribou to impoundments. The caribou impact assessment will necessarily be more subjective than those for other big game species. The approach of this study is to describe the existing patterns of caribou distribution, movements and habitat use. This should provide a basis for estimating the importance of specific migration routes to the present population and for determining the availability of alternative migration routes.

Procedures

Aerial surveys will be made to delineate distribution of caribou on both sides of proposed impoundments and to determine if calving is occurring north of the Susitna River.

Post-calving concentrations on both sides of the river will be censused by commonly used photo extrapolation techniques to determine the proportion of the herd occupying habitat north of the river.

Sex and age composition counts will be made in spring and fall as part of the census procedure. These counts will also indicate if the sex and age of caribou using habitat on one side of the river are different from those using habitat on the other side.

Caribou (up to 40 in 1980) on both sides of the river will be radio-collared. Collars will be placed on animals in different groups of caribou scattered throughout the herd. The frequency of relocation of radio-collared caribou will vary depending on the location and activity of the caribou. Relatively low levels of monitoring will be maintained when caribou are away from the impoundment areas or are sedentary to provide basic information on seasonal ranges and habitat use and to ensure continued contact with collared individuals. The frequency of monitoring will be increased when caribou are close to impoundment areas, particuarly during migrations.

Habitat type will be recorded for all caribou sightings.

Relationship to Other Subtasks

Procedures for recording and handling data will be coordinated with those of other wildlife studies to ensure efficiency in later impact analysis.

Personnel and logistics will be coordinated among all big game studies. In particular individuals working on other species will record caribou observations and periodically scan radio frequencies in the vicinity of impoundments to assist in identifying periods when intensive caribou monitoring is needed.

g. Distribution and abundance of Dall sheep.

Objectives

To determine the distribution and abundance of Dall sheep adjacent to proposed impoundments.

Background

Relatively isolated groups of Dall sheep inhabit mountainous areas on both sides of the proposed Watana impoundment. At present it is not believed that sheep regularly use habitat that will be inundated or that they regularly migrate through areas which will be inundated. It is possible that the Watana impoundment might further isolate groups north of the river from larger adjacent populations south of the river, and thereby reduce the possibility of repopulation should these groups decline in the future.

The main concern is the effect of disturbance during construction of hydroelectric generation and transmission facilities. It may be possible to zone construction activities in both time and space to minimize this disturbance. The purpose of this study is to provide a basis for decisions on such zoning.

Procedures

Aerial surveys will be made to delineate seasonal ranges including rutting and lambing areas.

Relationship to Other Subtasks

Since the scope of this study is limited, only minor coordination of personnel and logistics will be necessary.

Subtask 7.12 - Plant Ecology Studies

(a) Objective

To map and characterize the vegetation cover/habitat types occurring in the areas to be affected by the proposed Susitna Hydroelectric Project and to predict impacts that will result from the proposed facilities.

(b) Approach

The Phase I (pre-license application) portion of the plant ecology studies will concentrate on the production of vegetation cover/habitat type maps. These cover maps will be used in the plant ecology, wildlife ecology, and land use studies, and perhaps other disciplines. Phase I of the plant ecology studies will also include literature reviews, qualitative assessments of the major plant communities, succession studies, endangered species surveys, preliminary impact assessments, and the development of a Plan of Study for Phase II (post-license application).

The plant ecology studies will require coordination and input from other studies proposed by the Acres team. The coordination will primarily be involved with personnel performing the faunal and hydrological studies. Coordination with federal and state agencies is also anticipated.

(c) Discussion

The characteristics of vegetation/habitat types within an area is not only used for the prediction of impacts on plant communities, but also in predicting wildlife habitat removal and changes in land use patterns. Since the type maps will be utilized in a number of different studies, their development will be closely coordinated with the personnel involved in these studies. The Dyrness and Viereck Classification system modified to reflect the needs of other disciplines will be used as a basis for the mapping effort. Types will be mapped on LANDSAT and high altitude (U2) photography. The scale of the photography and level of mapping will vary depending on the area under consideration. The map scales and corresponding areas of coverage proposed are 1:250,000 for the entire upper basin; 1:63,360 for an area 10 to 12 miles on either side of the river from Devil Canyon to the McLaren River, floodplain below Talkeetna, and associated facility corridors; and 1:25,000 for the impoundment areas, floodplain between Devil Canyon and Talkeetna, and selected sampling areas below Talkeetna. Ground verification and qualitative assessments will be performed following the initial mapping efforts. Sensitive habitats, especially wetlands and those containing endangered or threatened species of plants, will be emphasized, and any natural landmarks (U.S. National Park Service Programs) in the area will also be noted. Literature reviews, a succession study, surveys for threatened and endangered species, and preliminary impact assessments will also be part of the Phase I Study. A review of published literature and ongoing research will be performed to elucidate data voids, uncover supplemental information, and support findings. The succession study will be directed toward elucidating the temporal changes in riparian communities and the causal factors involved in these changes. This information will aid in the prediction of impacts on faunal species, especially moose. Although there are no plant species presently listed for Alaska by federal or state authorities as endangered or threatened, twenty-seven species are under review by the U.S. Fish and Wildlife Service for possible protection. For these species distribution and habitat information will be assembled from literature and herbaria sources. Known stations and potential habitats for these species in the study area will be searched to determine the present status.

The proposed studies will be initiated early in 1980. Field work will be performed in the June to September period of both 1980 and 1981. Field sampling for the succession study and the mapping effort for the transmission and access corridors will be performed in the latter part of 1981.

Impacts on vegetation will be preliminarily assessed on the basis of information gathered prior to license application. The prediction of vegetation impacts at this stage will rely primarily on vegetation cover/habitat type maps. Acreage of the various cover types to be destroyed or altered will be estimated.

(d) Schedule

Weeks 8 through 117

(e) Detailed Scope of Work

(1) Literature Review

Comprehensive searches of the scientific literature will be made to generate a bibliographic and actual data base of the Susitna Region and on similar types of vegetation in Alaska and adjacent Canada. These studies will consist of literature searches in standard bibliographic sources (Biological Abstracts, Wildlife Review, etc.), data collation from literature on methods and other studies of Alaskan vegetation, government institution reports, and vegetation impact studies in other northern regions.

Methods used in quantitative ecological studies of boreal forest or taiga in other northern regions will be included in the searches. Literature dealing with the effect of water level changes on riparian vegetation will also be reviewed.

The data base review will also include a review of pertinent ongoing or proposed research. This information may be used to supplement or support findings of the proposed plant ecology studies and may perhaps require a redirection of efforts.

Part of the data base review will also include coordination with personnel involved in other aspects of the Susitna Hydroelectric Project. Input will be requested from other associated disciplines on schedule, methods, and types of data being collected. Vegetation information on data will be disseminated at the request of personnel in associated disciplines when it is available. It is anticipated that data exchange will primarily be involved with personnel in the hydrological and faunal studies.

(2) Vegetation Cover/Habitat Mapping

LANDSAT imagery and high altitude (U2) photography will be used to map vegetation/habitat types in the Susitna River Basin. The vegetation is primarily boreal forest types and upland tundra. This type of photography has proved adequate to delineate the types occurring in the area according to recent experience of staff of the Alaska Agricultural Experiment Station, in conjunction with the River Basin Cooperative Survey.

Vegetation cover/habitat maps will be produced at various scales. The entire Upper Susitna Basin will be mapped at a scale of 1:250,000. LANDSAT imagery will be used as a basis for this mapping. Much of this area has already been mapped for the Denali Planning Unit Remote Sensing Project. It is anticipated that these existing maps will be incorporated into the proposed mapping effort, with any areas that are not currently mapped being covered under the proposed mapping effort. These vegetation maps will, however, be modified so that the classification scheme will more appropriately match that envisioned for the proposed mapping effort.

Vegetation cover/habitat maps, to a scale of 1:63,360 will be produced for an area 10 to 12 miles on either side of the Susitna River from the Devil Canyon Dam site to the confluence of the McLaren River. Imagery enlarged to a scale of 1:63,360 will be utilized for this mapping effort. This area will be mapped primarily for use by personnel involved in the faunal studies, especially the big game studies. USGS topographic maps, which are available for this area at the 1:63,360 scale, will be useful in field orientation when used in conjunction with the cover maps. If possible, the cover maps will be printed over their corresponding topographic maps for use by field personnel.

The impoundment area and the downstream floodplain from Devil Canyon to Talkeetna will be mapped at a scale of 1:25,000, since these will be the primary areas of direct impact. Some selected moose habitat areas upstream and downstream will also be mapped at this scale for use in the moose habitat and successional studies. This mapping effort is detailed in later sections. The photography to be utilized for the 1:25,000 mapping will be enlarged from existing color infrared (CIR) obtained from NASA U2 flights. This scale was selected because the U.S. Geological survey is mapping Alaska at this scale. Also, an enlarged scale of this nature has been requested by the Alaska Department of Fish and Game for use in the big game studies.

The two remaining areas for which vegetation cover/habitat maps will be produced will be the downstream floodplain below Talkeetna and the selected transmission line and access road corridors. In these areas, maps will be produced at a scale of 1:63,360. Much of the downstream floodplain has already been mapped by the Soil Conservation Service as a part of the Susitna River Basin Comprehensive Study, and their mapping will be incorporated in the proposed mapping effort. The downstream floodplain is being investigated primarily because of potential changes in flow regimes after the dams are constructed. Alterations of flows may result in changes in successional trends, which may affect the potential of this area to provide key habitats for important wildlife species, such as moose. Additional mapping and studies specific to successional trends are discussed in greater detail in the sections entitled Moose Habitat Evaluation and Succession Studies.

The classification system to be utilized for the mapping is the system developed by Dyrness and Viereck. The mapping will be to the third and fourth level of this system. It is anticipated that this system will be modified to increase its application and usefulness for faunal studies. An attempt will be made to factor in parameters, such as physiognomy (overall growth form), that will help attain this goal. Several of such parameters have been identified by the U.S. Fish and Wildlife Service during the River Basin Survey. Personnel involved in this study will be contacted for their input into the proposed classification scheme.

Preparation of the vegetation cover/habitat maps will begin in early 1980 with the acquisition of LANDSAT and presently available CIR aerial imagery. These photographs will yield delineation of vegetation types in the Susitna River Valley which will be preliminary and require extensive field verification. The initial mapping effort will attempt to delineate the occurrence of wetland areas. This will be done to aid in the compliance with Section 404 of the Clean Water Act prior to surface disturbing activity.

Field verification of vegetation types will be performed during the 1980 and 1981 field seasons. Respective land areas covered by each vegetation/habitat type in the impoundment areas will be determined by manual planimetry or computer integration from the LANDSAT imagery. A table showing the acreage of each vegetation type and percent of total study area acreage will be prepared.

The vegetation mapping will begin at the commencement of the study. The different vegetation cover/habitat maps will be completed at different times during the Phase I effort. At the present time, the following schedule is anticipated: the 1:63,360 moose zone map at 3 to 6 months from start of study; the 1:25,000 direct impact area map at 9 to 12 months from commencement; and the 1:250,000 upper basin map at 12 to 16 months from initiation of study. A schedule for completion of the mapping for the downstream floodplain and moose habitat studies is presented in the Succession Studies section.

(3) Qualitative Assessment

For the Phase I studies, the descriptions of the major plant communities/habitat types will be based largely on qualitative assessments of the types mapped. These assessments basically involve walk-throughs of each type in the field with observational information obtained on characteristics, such as: dominant species composition, species abundance, estimated heights, estimated percent cover, unique trends or mosaics, etc. Relationships of types to topographic, geologic, and edaphic factors will also be noted. A list of the plant species encountered during these assessments will be produced, with identifications checked in floristic works available at this time and known collections of Alaskan plants in herbaria.

The qualitative assessments will probably be performed during the 1980 and 1981 field seasons in conjunction with ground truth surveys for the cover mapping and/or endangered or threatened plant species surveys. In order to avoid snow cover, the field season will be from June to September.

(4) Moose Habitat Evaluations

Impact prediction for several animal species will be dependent, to a certain extent, on the vegetation cover/habitat maps. This is especially true for important big game species such as moose. However, the total acreage of habitat, especially key winter habitat, is not the only factor involved. Total available browse, browse quality, utilization, community trends, and other factors that are based on the information obtained from literature and quantitative vegetation sampling methods are necessary for the prediction of impact on moose.

Phase I of the habitat study will be limited primarily to the production of vegetation cover/habitat maps that will provide acreage, location, and distribution information on habitat types for use in faunal studies. The areas to be mapped, map scales, and classification scheme have resulted to a certain extent, as detailed in the vegetation cover/habitat mapping section, from input of the personnel involved in the faunal studies. The quantitative information required for more detailed impact predictions will be obtained during the Phase II effort.

The one exception is the quantitative data that will be collected during the successional studies. Details on this effort are provided in the following section.

(5) Succession Studies

The succession studies will be directed primarily towards identifying the interrelationships between the existing river characteristics and the perpetuation of key moose habitat in the floodplain of the Susitna River. Certain vegetation cover/habitat types, especially willow and balsam poplar types, found on the floodplain of the Susitna River provide important winter moose habitat. These types are thought to be maintained by certain river characteristics, such as annual or catastrophic flooding. The proposed project will alter the flow regimes of the river and may, therefore, cause changes in the types of vegetation that will eventually dominate that area. This may, in turn, either increase or decrease the capacity of the area for important wildlife species, such as moose.

The area of most concern for the succession studies will be the downstream floodplain below Talkeetna. What the impact will be in this area is not known, because of the present lack of biological information on these systems and the absence of defined flow regimes that will result from the proposed action. It will be the purpose of the succession studies to attempt to establish historical trends in succession for this area and to identify causal factors in sufficient detail that will permit a knowledgeable prediction of the magnitude of the downstream impacts.

The approach that will be used for the succession studies will be to gather information from specific literature surveys; interpret existing current and historical aerial photographs for changes in vegetation over time; relate the vegetation changes in hydrological changes, topography, soils and perhaps other physical factors; and collect information on age and community structure for selected habitats of various ages.

Specific searches will be performed for pertinent published literature and ongoing research on succession. Literature on selected important species will be collected and reviewed. For these species information on root systems, ability to withstand flooding, shade tolerance, ability to pioneer areas, etc., will be important in the succession studies. Part of the literature review will also include the identification of types and sources of available historical aerial photographs and hydrological information.

The vegetation mapping effort for the succession studies will basically involve the production of vegetation cover/habitat maps from current and variously-aged aerial photographs, a comparison of vegetation changes over time, and an investigation of the relationships of these changes with hydrological changes and other physical factors, such as topographic and edaphic.

The vegetation cover/habitat type mapping will be performed on selected historical aerial photographs. Information on the type, age, coverage and other factors related to the usefulness of the historical aerial photographs will be reviewed in conjunction with the available historical hydrological information in order to select the aerial photographs that will be utilized. The 1:25,000 photographs to be used in the impoundment areas will form the base for the current aerial photographs.

The vegetation mapping for the succession studies will not be performed for the entire floodplain area, but in selected sampling areas. It is anticipated that these areas in bands running across the floodplain perpendicular to the long axis of the river will be mapped at a 1:25,000 scale between Talkeetna and the mouth of the Yentna River. The number and location of these bands will be based on a number of biological and physical factors, including moose utilization, vegetation types, soils, hydrological sampling locations, and river characteristics.

Once the mapping in these selected bands is completed for all the different-aged aerial photographs involved, a comparison of the changes that have occurred over time will be made. These maps will be analyzed with past hydrological information, such as flood flow records and other information on physical factors to see if correlations exist among the different factors involved.

The succession studies will require a certain amount of field sampling. The sampling will be directed towards aging communities, gathering observational information, and determining species composition and structure of the communities.

Community age information will be obtained by counting the number of annual rings on cores of the dominant woody vegetation. The additional sampling methods to be utilized for this portion of the study will be selected during the first year following literature reviews and input from personnel involved in faunal studies. The field sampling will be performed primarily during the 1981 field season. Areas to be sampled will be selected in the impoundment area and the downstream floodplain. In the downstream floodplain the sampling areas will probably be within the selected bands that will be mapped as part of the mapping effort.

Data gathered from the succession studies will be used in the preliminary impact prediction of the proposed action. Information on flow regimes and predicted changes in hydrological characteristics downstream will be utilized in an attempt to answer the downstream impact question. This effort will be performed in the latter part of 1981 when succession information is available and flow regimes from the project have been defined.

(6) Corridor Selection

The selection process for the transmission and access road corridors is detailed in Subtasks 7.09 and 7.14, respectively. Input from the plant ecological studies will be made into these tasks. In the initial route selection analysis, the alternative routes will be evaluated on a superficial basis for major vegetation constraints (e.g. stations of proposed endangered species, unique habitats, etc.). Once the primary routes have been selected for these facilities, they will be cover mapped as detailed in the Vegetation Cover/Habitat Maps section. This mapping effort is anticipated to be performed in the latter part of 1981.

(7) Endangered Species Surveys

Presently there are no plant species listed by federal or state authorities as endangered or threatened in Alaska. However, twenty-seven species are being reviewed by the Fish and Wildlife Service for protection under the Endangered Species Act of 1973. For these species distribution and habitat information will be assembled from literature and herbaria sources. Known stations and potential habitats for these species in the study area will be searched to determine the present status.

(8) Impact Assessment

All identified potential impacts of the proposed projects on vegetation will be discussed in the reports. The accuracy of impact predictions will vary depending upon the area under consideration. For the impoundment areas and access road and transmission line rights-of-way, accurate values of the total acreage of each vegetation type to be affected (inundated or traversed) by the proposed facilities can be determined. The effect of the proposed facilities on downstream floodplain vegetation will be more difficult to accurately predict.

In the downstream area plant ecological information will be used in conjunction with various physical data to aid in predicting changes. Depending upon the accuracy with which the botany personnel feel that they can predict vegetation changes, a map indicating type and extent of changes may be produced. Supplementary field information required for predicting impacts will be acquired during the 1981 field season.

(9) Phase II POS Development

The license application submission to the FERC in 1982 will contain a Plan of Study for the Phase II plant ecology studies. The development of this POS will be a part of the Phase I effort and will be based on the experience and knowledge gained in the Phase I effort.

Subtask 7.13 - Geological Analysis

This subtask will be completed as part of the studies conducted under Task 5 - Geotechnical Exploration.

Subtask 7.14 - Access Road Environmental Analysis

(a) Objective

To provide input into the selection of an access road route that will be environmentally sound and to provide an impact assessment of the preferred route.

(b) Approach

This subtask will initially involve the comparison of alternative routes. Major environmental constraints will be mapped along the various proposed alternative routes. One preferred route will then be selected that will be feasible from environmental, economic and engineering viewpoints. Direct and indirect impacts of the proposed action will be discussed in the environmental report.

(c) Discussion

The first part of this subtask will be the screening of alternative routes. The screening process will be a coordination effort between R&M Consultants, Inc., Acres and TES. R&M and Acres will initially propose various viable alternative routes or areas where viable alternatives could be proposed. TES will then provide a map or a discussion of the various major environmental constraints, (cultural resources, critical wildlife habitats, wetlands, habitat for endangered or threatened species, etc.) in these areas. A proposed route will then be selected taking environmental, engineering and economic concerns into consideration.

Once a proposed route is selected, more detailed environmental information will be collected for that specific route. Examples of environmental information include a vegetation cover map, wildlife habitats, available biological information for any water bodies crossed and other pertinent environmental information.

Impacts of the proposed access road will be presented. The impacts of associated activities, such as the acquisition of fill material, will be addressed. Socioeconomic, land use, and recreation impacts related to increased access to the area will also be discussed.

The comparison of alternative access roads will be performed primarily in the first year. More detailed information on the proposed route will be collected during the second summer.

(d) Schedule

Weeks 1 through 112

Subtask 7.15 - Preparation of FERC License Application Exhibit

(a) Objective

To compile and organize the reports of all the various environmental disciplines into one environmental report required for the license application submission to the Federal Energy Regulatory Commission.

(b) Approach

The collation and organization of the various environmental reports into a license application environmental report will require keeping abreast of the changes in regulations, report format and implementation procedures throughout the project period. An environmental report commensurate with the regulations in effect during the time of submission will then be prepared.

(c) Discussion

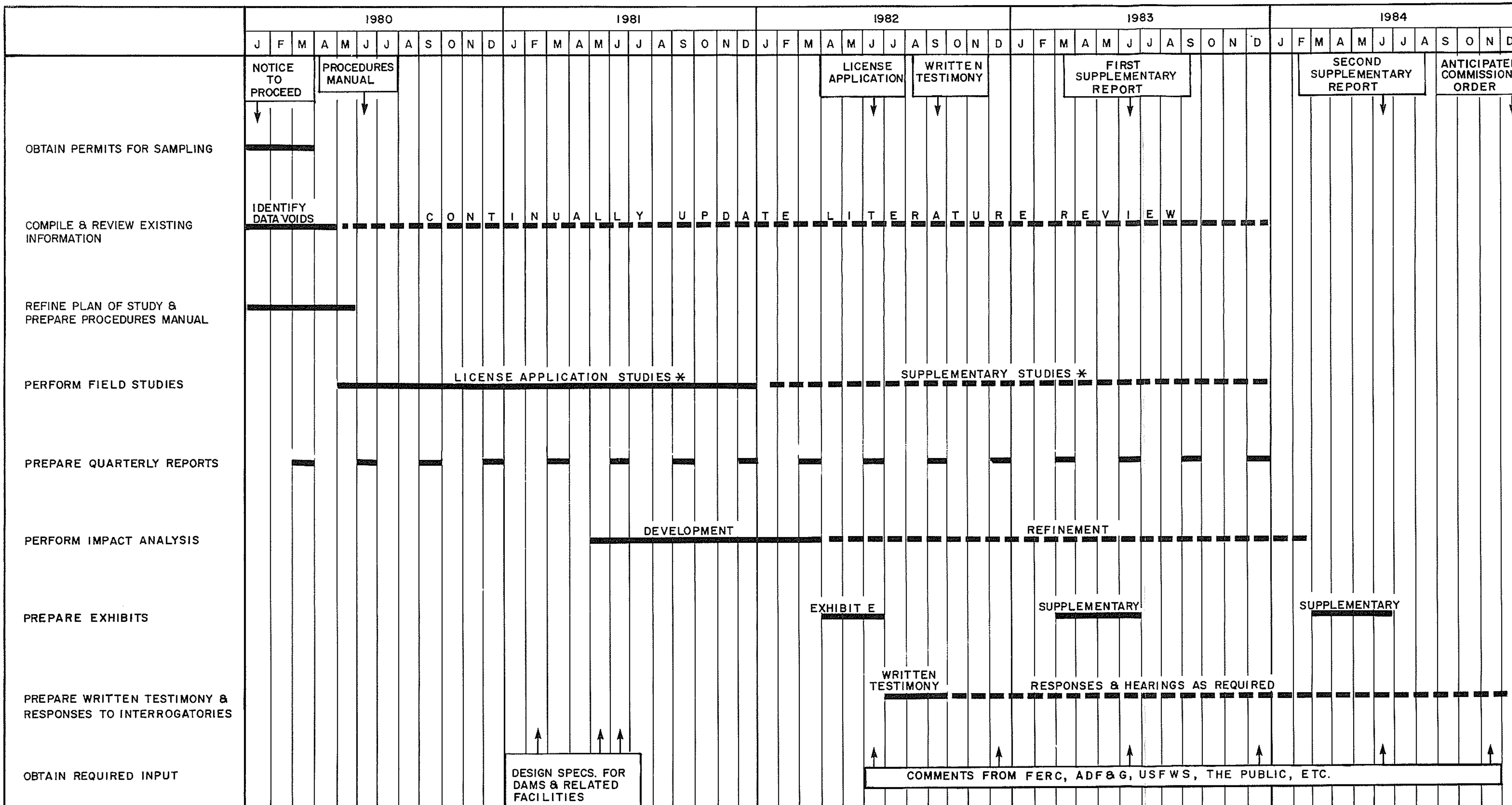
An environmental impact statement for the proposed Susitna River Project is required under various Commission Orders of the FERC, and in accordance with the National Environmental Policy Act (NEPA). Presently the FERC regulations pertinent to the environmental studies are Exhibits R, S, V and W. For major hydroelectric projects, these Exhibits are currently being reorganized into Exhibit E-Environmental. Officials of FERC are not certain as to when the reorganization will be completed, but it will be effective before application submission for the Susitna Project.

As the project progresses any revised environmental legislation pertinent to the proposed project will be obtained. These regulations will be reviewed and action taken to insure compliance as part of the Coordination Subtask (7.01).

Regulations in effect at the time of the permit application will be used for preparation of the exhibit for the environmental report. Although the format of the environmental report will depend upon the revised regulations, it is anticipated that the FERC environmental report outline will follow the recently effective (July 30, 1979) Implementation of Procedural Provisions promulgated by the Council on Environmental Quality. Certain parts of the reports for the various disciplines will be summarized or reorganized to meet the requirements. Sections tying different disciplines together will also be prepared.

(d) Schedule

Weeks 109 through 126 (See Plate T7.1)



* LICENSE APPLICATION STUDIES

SOCIOECONOMICS
CULTURAL RESOURCES
LAND USE
RECREATION
WATER QUALITY
FISHERIES
WILDLIFE
PLANT ECOLOGY

* SUPPLEMENTARY STUDIES

(ALL DISCIPLINES, AS REQUIRED)

ACRES

SUSITNA HYDROELECTRIC PROJECT
PLAN OF STUDY
PLATE T7.1: TASK 7 SCHEDULE

A.5.9 - TASK 8: TRANSMISSION

(i) Task Objectives

To select the transmission route and produce conceptual designs and cost estimates for the FERC license application for the following project components:

- Transmission line linking the project damsites to Fairbanks and Anchorage, with potential intermediate stations to feed local communities

- Substations, with particular reference to the two major terminals at Fairbanks and Anchorage, together with a suitable design for intermediate load points

- Dispatch center and communications system

(ii) Task Output

During 1980

Issue a design memorandum outlining the results of the Acres review of the 1979 IECO report and a preliminary screening of the routes identified in that report.

During 1982

Basic design information dealing with the following aspects:

- Transmission-line voltage level

  - .Tower types
  - .Route map
  - .Conductor data
  - .Insulation levels
  - .Construction access
  - .Construction schedule
  - .Cost estimates

- Substations

  - .Single-line diagram for each main type of substation
  - .General arrangement drawings
  - .Transformer criteria
  - .Circuit-breaker criteria
  - .Outline of relay protection philosophy
  - .Cost estimates

- Dispatch Center and Communications

  - .Location and size of center
  - .Level of automation proposed for remote stations
  - .Extent of real-time functions required
  - .Type of communication channel proposed together with appropriate data transmission rates
  - .Basic type of software
  - .Man-Machine interface

In addition, descriptions of the design studies will be written for inclusion in the Project Feasibility Report, and documention for the FERC license application will be prepared.

(iii) List of Subtasks

8.01 - Transmission Line - Corridor Screening - 1980

8.02 - Electric Systems Studies

8.03 - Transmission Line - Route Selection - 1981

8.04 - Tower, Hardware and Conductor Studies

8.05 - Substations

8.06 - Dispatch Center and Communications

8.07 - Transmission Line Cost Estimate

(iv) Subtask Scope Statements

Our basic approach to the work outlined in this task will initially be to review the 1979 IECO reports with respect to their approach and their level of detail. Following this, we will undertake more detailed study and conceptual design up to a level appropriate for FERC license and for basic technical and economic feasibility.

Included in this work will be the utilization of such geologic (Task 5) and climatologic (Task 3) field data as can be obtained during that study period. We also propose an extensive field reconnaissance during 1980 plus mapping a limited selection of key sections of the various corridors (Task 2).

The field reconnaissance, review of the IECO studies, and preliminary screening of the corridors will take place during 1980 (Subtask 8.01). During this period we will also start the electric system studies (Subtask 8.02). During 1981 the general location of the transmission line route(s) within the selected corridor(s) will be established (Subtask 8.03) and conceptual designs produced. Design studies and cost estimates for the Towers, Hardware and Conductors (Subtask 8.04), Substations (Subtask 8.05), and Dispatch and Communications Center (Subtask

8.06) will also be developed. Particular attention will be devoted to producing feasibility-type cost estimates and to reconcile the differences between previous estimates made by IECO and the Alaska Power Administration.

Subtask 8.01 -Transmission Line Corridor Screening - 1980

(a) Objective

To review the 1979 IECO report initially, to eliminate some of the less attractive corridors, to identify such considerations of route selection that may require additional work and to plan the 1981 field data collection.

(b) Approach

This activity will involve an extensive field reconnaissance of selected potential corridors. We also anticipate being given full access to all available IECO data with regard to system studies (load flow, etc.) and also structural studies of towers if such exist. This subtask would also include a detailed review of the economics of a dc alternative.

Once the above-mentioned review studies are completed, a preliminary screening study will be undertaken to eliminate the obviously less desirable corridors from further consideration. The corridors selected for further study will be identified as bands on the one-inch-to-one-mile mapping and made available as input for the biological and foundations studies. The centerline of these bands will be marked upon existing photography coverage. This, together with the marked-up one-inch-to-one-mile maps, will be used to direct the high aerial photographic program which will provide specific coverage along the potential routes.

The preferred corridors will be made available in time for the start of the 1981 summer survey season so that the required geological exploration and mapping work can be undertaken. For this stage of the work, we propose to define a number of key sections of the various corridors for mapping in the 1981 season. Such sections will be chosen as being typical of the various features of the corridor, muskeg, permafrost, steep grades, etc. For the purposes of the present submission, we propose that each section be between 5 and 10 miles in length and that up to 10 such sections be mapped.

(c) Discussion

The prescreening activities will be carried out on the basis of the following considerations:

- Review of all background data (USBR, IECO,etc.).
- Assessment of differential costs as determined by geological or climatic considerations.
- Relative assessment of environmental considerations, land use, etc.
- Review of power system related aspects such as the number of intermediate load points to be served.

We anticipate that this prescreening process will allow us to eliminate approximately 75 percent of the currently identified routes.

(d) Schedule

Weeks 11 through 52

Subtask 8.02 - Electric System Studies

(a) Objective

To ensure that the electrical aspects of the project design are integrated with the existing Railbelt area power systems and to design an electrical power system which is reliable and economic.

(b) Approach

The following steps will be carried out:

- Review all previous studies (including source data and computer outputs if available)

- In the event that no load-flow studies have as yet been done, the following data would be obtained from the APA and other utilities:

  -- generating station plant capacity
  -- transmission line impedances
  -- substation transformer capacities and loads

- Obtain information from the load forecasting study (Task 1) including details of the following:

  --existing load conditions
  --historical load growth
  --load and energy projections
  --daily and annual load duration curves
  --location of load centers

- Meet with APA, the Alaska Power Administration and the Railbelt utilities to obtain system data and review of proposed future expansion at the utility level.

- Determine economic and security criteria and review with APA.

- Determine main and intermediate substation locations and capacities.

- Establish transmission line requirements, including most economical voltage levels together with conductor sizes and appropriate spacings.

- Perform preliminary load flow studies to verify transmission system configuration and parameters.

- Determine line energizing and compensation requirements.

- Establish general electrical equipment specifications such as:

  --insulation levels
  --equipment ratings and connections
  --transformer tap ranges
  --switchyard single-line diagrams

Acres has developed a comprehensive set of computer programs which will be employed to assist the foregoing studies. These programs include:

- Load-flow - Newton Raphson Method (Acres Program No. EL 012)
- Three-Phase Short Circuit (Acres Program No. EL 020)
- Transient Stability (Acres Program No. EL 030)
- Dynamic Stability (Acres Program No. EL 034)
- Transmission Line Dynamic Overvoltages (Acres Program No. EL 831)
- Conductor Thermal Current Rating (Acres Program No. EL 834)

The studies will identify the basic transmission line requirements and characteristics of electrical substation equipment, generation equipment and relay protection.

(c) Discussion

We anticipate that during 1980, load-flow studies would be made for a variety of preliminary system configurations. During 1981, these load flow studies would be refined to represent the preferred system. During the latter period, short circuit and stability studies would also be carried out.

A study of potential grounding problems associated with permafrost as experienced at Prudhoe Bay and the effect on protective ground relaying would also be undertaken.

(d) Schedule

Weeks 20 through 120

Subtask 8.03 - Transmission Line - Route Selection 1981

(a) Objective

To identify two selected routes, each about a half-mile wide, one from the project sites to Anchorage and the other to Fairbanks.

(b) Approach

The alternative corridors carried forward from Task 8.01 will be subjected to a further process of elimination and a final route selected. Input to this task will be obtained from the following:

- Preliminary environmental studies (Task 2) including aesthetic considerations
- Land use studies (Task 7)
- Mapping of key sections (Task 2)
- Climatological studies (Task 3)
- Identification of seismic problems (Task 4)
- Geotechnical exploration (Task 5)
- Geotechnical footing design (Task 6)

The possible advantages to be obtained from a staged construction sequence will be evaluated. If appropriate, separate routes for future stages will be identified. The result of this study will be the selection of a complete route, approximately a half-mile wide.

(c) Discussion

In arriving at the final route selection, the following potential design difficulties peculiar to cold climates will be taken into account.

Damage to footings due to frost heave and muskeg conditions. It is known that such problems have been encountered on other transmission lines, specifically on the 230-kV lines between Twin Falls and Labrador City. In designing the 735-kV Churchill Falls lines, Acres successfully solved these problems by the choice of guyed towers and the careful selection of routes and anchor details.

The possible effect of permafrost conditions on route selection will also be taken into account.

The possible need to contend with extremely high wind velocities such as those encountered at Snettisham will be reviewed. Such winds cannot normally be accommodated in the design of the transmission line. This problem can be solved by rerouting and stockpiling a number of spare towers.

(d) Schedule

Weeks 60 through 120

Subtask 8.04 - Tower, Hardware and Conductor Studies

(a) Objective

To select the most appropriate tower configuration, hardware and conductor arrangements for the line.

(b) Approach

The existing data contained in previous studies, particularly the 1979 IECO report, will be taken into account in developing the following.

(1) Design Criteria

We will establish basic design requirements using the data from field studies and system studies. These include climatologic (Task 3), geotechnical (Task 6) and electrical parameters (Subtask 8.02).

(2) Towers

We will establish security levels and other line performance levels and select overload factors for various loading conditions. Nonclimatological load parameters; i.e., broken wire, construction loads etc., also will be determined.

We will conduct a study of tower-types this will involve a preliminary review of the different types and construction materials available and the associated transportation requirements. The types considered include rigid and guyed towers and wood-pole H-frames. The geometry of tower outlines based on electrical clearances will be developed. Based on this study, a representative range of tower types will be determined. In the event that a staged construction sequence is found to be desirable, the relative economics of double-circuit towers versus two single-circuit towers will be assessed.

Tower loads will be established. Those include average span, wind span, weight span, broken wire and stringing and maintenance requirements.

(3) Footings

Design criteria will be determined from the results of geotechnical field investigations. We would undertake conceptual designs of alternative types of footing for the family of tower types selected.

(4) Miscellaneous System Features

The conductor would be selected taking into account electrical requirements (including evaluation of losses) and mechanical strength.

The environmental effect of audible conductor noise and RIV and TIV will be assessed.

The basic insulation level (BIL) will be established and the type, number and configuration of insulators selected.

In the event that wood-pole construction is selected, the possible economy of eliminating the overhead ground will be considered.

Line hardware, the choice of arrangement for suspension, dead end and jumper assemblies will be selected. Grounding requirements will be determined and suitable arrangements for line and towers developed.

(c) Discussion

Acres has extensive experience in transmission line design for regions with cold climates, deep frost penetration of the ground and permafrost conditions. This will provide a solid base for developing a sound design for the various elements of the transmission system.

Optimization of the design will be assisted by our "in-house" computer program TROP which is a transmission optimization program. This program is supplied with the basic design requirements as input data and determines conductor sags, tensions, tower loads, voltage gradients, losses (including corona), for a series of alternative situations involving variations in conductor type and size, span length and climatological conditions. On the basis of conceptual cost information, it is used in the evaluation and choice of the most economical conductor size and the optimum average span for the line analyzed.

(d) Schedule

Weeks 81 through 120

Subtask 8.05 - Substations

(a) Objective

To provide conceptual designs and cost estimates for the major terminal subtstations at each end of the system, together with typical designs for substations at the intermediate load points.

(b) Approach

From the Electrical Systems Studies (Subtask 8.02) parameters will be obtained, which will be employed in finalizing station single-line diagrams, equipment specifications and configurations, philosophy of operation and control of the substations. Early decisions will be made on whether to man the substations or depend on automatic operation with supervisory control of switching equipment.

The chosen arrangement will be reviewed to ensure that it complies with system, environmental and operational requirements. Major equipment characteristics will be determined and sketches will be produced to allow cost estimates to be prepared.

Details of the substations and switchyards will be determined and will include:

- single-line diagrams
- transformer capacity
- typical substation layouts and arrangements
- shunt reactors (when required)
- auxiliary station service

(c) Discussion

The layout of the substations will be coordinated with the transmission line entry. For aesthetic, climatic and land management reasons, gas-insulated substation layouts will be examined. Final selection of gas-filled or conventional type will be made once the location of the substations is determined.

(d) Schedule

Weeks 65 through 120

Subtask 8.06 - Dispatch Center and Communications

(a) Objective

To produce a conceptual design and cost estimate for a computerized control and dispatch center that will provide reliable and secure operation of the proposed Susitna development and the Anchorage-Fairbanks transmission link. Appropriate communications for the center will be included.

(b) Approach

The Susitna River Basin project will introduce considerable hydroelectric generating capacity into a predominantly thermal-electric generating system. It is proposed to interconnect the Fairbanks area with that of Anchorage, thus developing a larger power system than the two existing systems. To make effective use of facilities in the enlarged power pool, a dispatch center with reliable communication system will be required. The following studies will be undertaken during the feasibility stage:

- Review and previous studies related to system control and communications in the Railbelt area.
- Collect data on existing communications and system control practised by the Railbelt utilities.
- Meet with the Alaska Power Administration and the utilities to discuss future or committed plans with respect to control centers or communications systems.
- Propose a range of alternatives to achieve the goal of providing effective control of the power pool. The cost of these alternatives will be estimated and compared in a report.
- Examine various degrees of sophistication and schedules and prepare estimated costs for introduction.
- Consider the question of which agency will have overall operating responsibility.
- Select a system and prepare conceptual designs and cost estimates.

(c) Discussion

It is necessary to define overall responsibility at the beginning of this phase of the work in order to establish the criteria for choosing the most suitable scheme.

The dispatch center and a comprehensive communications system will provide the following functions:

- Real time monitoring of system conditions
- Enhancement of system security
- Economic dispatch of generating facilities, both thermal and hydro
- Monitoring of transmission loads
- Economic dispatch of intertie power
- Provision of supervisory control for selected unattended substations

In our opinion, considerable advantage can be derived if the Railbelt power interconnection is operated with a central dispatch center and the complementing communications channels.

Arrangements will be made to enlist the services of specialized consultants such as Energy and Control Consultants from California to assist Acres and to review this section of the preliminary report.

(d) Schedule

Weeks 65 through 120

Subtask 8.07 - Transmission Line Cost Estimates

(a) Objective

To arrive at a feasibility estimate type of cost of the transmission system.

(b) Approach

Utilizing Acres' experience in northern construction logistics, a capital cost estimate will be prepared for the construction of the lines. Special care will be taken to fully reflect the need to respect strict controls on construction activities, to control environmental impacts and carry out a mitigation program during and following the completion of construction.

(c) Discussion

Costs of the procurement of material and their shipment to site will be carefully evaluated by investigations and supplemented by enquiries of competent suppliers.

Acres' estimates of costs for construction will be refined by the involvement of experienced contractors who will be asked to provide input regarding construction logistics and schedule.

(d) Schedule

Weeks 20 through 120

A.5.10 - TASK 9: CONSTRUCTION COST ESTIMATES AND SCHEDULES

(i) Task Objectives

To develop comprehensive, contractor-type construction, cost estimates for each major element of the recommended Susitna Hydroelectric Project, detailed engineering and construction schedules and an associated analysis of potential contingency constraints and impacts.

(ii) Task Output

The primary outputs of Task 9 will be cost estimate summary reports and construction schedules appropriate for inclusion in Task 10, FERC Licensing documentation. The final versions of these documents will be submitted for review and approval by Alaska Power Authority on or about Week 126 of the Study. These documents will be suitable for continuous updating and/or modifications during the subsequent study period through commencement of construction and for use in preparation of engineers' estimates during the construction and equipment supply contract bidding phases of the project.

Preliminary cost estimates and schedules will be the subject of design transmittals issued on or about Week 60 of the Study for inclusion in the Development Selection Report under Task 6.

(iii) List of Subtasks

Subtask 9.01 - Assemble Cost and Schedule Data
Subtask 9.02 - Prepare Preliminary Cost Estimates
Subtask 9.03 - Prepare Cost Estimate Update
Subtask 9.04 - Develop Engineering/Construction Schedule
Subtask 9.05 - Perform Contingency Analysis

(iv) Subtask Scope Statements

The primary purpose of Task 9 is to provide the basis for more detailed planning, marketing and financing of the Susitna Project during the period following submission of the FERC License Application through commencement of construction. The development of these estimates and schedules prior to license application and the relationships between Task 9 and other task activities are illustrated in the Master Schedules, Plates A7.1 and A7.2. This portion of the study will be divided into two parts. The initial part of Task 9 activities will be used to establish the information systems and basic mechanisms necessary to develop the cost estimates and schedules for selection of the optimum Susitna development. The second part of Task 9 activities will be devoted to the incorporation of more up-to-date information and appropriate revisions of the estimates and schedules prior to submission of the FERC License Application. For ongoing cost estimating and scheduling purposes, a continuous exchange of information will be necessary with Task 2 - Surveys, Task 5 - Geotechnical Exploration, Task 6 - Design Development, Task 7 - Environmental Studies and Task 8 - Transmission activities.

For purposes of the current Plan of Study, development of Task 9 activities has been based on the assumption that the optimum Susitna development will comprise dams at Watana and Devil Canyon and associated structures. This development is essentially the same as that recommended by the Corps of Engineers in its 1979 Supplemental Feasibility Report.

Subtask 9.01 - Assemble Cost and Schedule Data

(a) Objective

To assemble Alaska-based and national cost and schedule data appropriate to construction of large hydroelectric projects.

(b) Approach

Input to the activities of Subtask 9.02 will commence with the following preliminaries:

- Identify required project labor, material, and equipment (construction and permanent) categories
- Assemble cost and scheduling data including Alaskan and national labor, materials and equipment (construction and permanent), taxes, insurance, finance charges, other indirect costs, and delivery items
- Identify and assemble facility operating costs

On the basis of parallel Task 6 design development studies, appropriate construction activities will be identified together with construction method plans and diagrams for temporary site installations.

(c) Discussion

Early studies related to alternatives and development of an optimum Susitna development were undertaken on the basis of conceptual engineering-type cost estimates. These estimates will essentially be developed from previously published reports and available data from the Corps of Engineers or other sources. Establishment of reliable costs and schedules for the recommended Susitna Development will use a much more basic approach.

A computerized data base will be established which will be made available for use and further development during all subsequent cost estimating and scheduling activities.

(d) Schedule

Weeks 70 through 75

Subtask 9.02 - Prepare Preliminary Cost Estimates

(a) Objective

To prepare preliminary, construction-type cost estimates for the Susitna Hydroelectric Project.

(b) Approach

Preliminary cost estimates will be prepared for

- Site access arrangements,
- Permanent camp facilities,
- Watana Dam and associated works,
- Devil Canyon Dam and associated works,
- Transmission facilities,
- Reservoirs and related facilities.

These estimates will be based on reviews of previously published reports of the Susitna development, appropriately modified and updated in the light of such reviews. Lists of construction pay items and quantity estimates will be prepared for appropriate construction activities.

Unit and/or lump sum prices will be developed and assembled for appropriate pay items, including all direct and indirect costs, and total facility investment and operating cost estimates.

(c) Discussion

The results of this activity will provide the input for ongoing Task 6 - Design Development activities. Although these data may be subject to modification during later stages of the study when further drilling and testing information becomes available, the groundwork laid at this time will form the basis of all further costing activities to be performed.

(d) Schedule

Weeks 73 through 78

Subtask 9.03 - Prepare Cost Estimate Update

(a) Objective

Prepare updated, comprehensive, construction-type, cost estimates for the Susitna Project for inclusion in FERC License Application.

(b) Approach

To preliminary cost estimates prepared under Subtask 9.02 will be updated and modified for incorporation in the FERC License Application documents.

Construction methods, scheduling and cost studies already performed under Task 6 studies will be further developed and expanded under this subtask. The accuracy of construction costs will be improved by application of updated information, including the following:

(1) Site costs for labor, materials, equipment and fuel

(2) Installation procedures to be adopted for each project component; construction methodology for the dams, spillways and power plants

(3) Detailed construction schedule and resource allocation for each project component and the total project

(4) Site development requirements for power, access, transport, construction materials, water, and support facilities

(5) Technical and economic analysis for concrete manufacture, borrowed fill, quarries and disposal of excavated materials

(6) Construction manpower schedules

(7) Mechanical and electrical equipment price variation due to escalation and market pressures

(8) Short and long-term interest rates and cost escalation assessments

(9) Detailed list of pay items and quantity take-offs

(10) Detailed construction cost estimates, including unit prices, directs, indirects, contingencies, interest during construction and administration, cash flow diagram

Project engineering designs and preliminary equipment specifications prepared under ongoing Task 6 activities will serve as the baseline for each cost estimate. A standard estimating format will be adopted and sound accounting practices will be followed to separate direct costs, indirect costs and capital expenses. All costs will be tabulated into natural divisions that lend themselves to the application of the FERC code of accounts for hydropower projects.

Detailed quantity take-offs will be prepared from the project engineering drawings to support permanent material cost estimates. Consumable materials will be estimated using known rules-of-thumb and accepted unit rates.

Updated labor estimates will be prepared in conjunction with the scheduling effort. Typical project labor agreements will serve as a basis for these revised estimating costs. Rates of productivity, as dictated by the schedule and tempered by the Alaskan climate and work force, will be established for each type of work.

More realistic plant and equipment costs will be estimated using actual experience gained from similar work performed in Alaskan environments.

Indirect costs will be estimated based upon a number of factors, including total construction time, numbers of craft labor, length of shifts, volume of subcontracted work, etc. Finally, a cost escalation factor will be applied to each cost estimate to account for increases in labor and material costs throughout the life of the project.

(c) Discussion

The estimated cost of construction will be a key factor in establishing feasibility and licensing as well as financing of the project. Estimating construction costs in Alaska presents some unique factors and situations that can only be dealt with through practical experience at the field level. The Acres/Moolin team provides senior individuals with a wealth of experience of large hydroelectric developments in cold climate regions and with specific Alaskan construction experience. Input and review of all cost estimates by these personnel will ensure the reliability of the estimates.

Some of the unique problems that must be accounted for include the following:

- A relatively inexperienced labor force,
- Unusual environmental/weather constraints,
- High level of government surveillance/interaction,
- Low equipment productivity during cold weather,
- High freight costs for materials/spare parts.

(d) Schedule

Weeks 110 through 126

Subtask 9.04 - Develop Engineering/Construction Schedule

(a) Objective

To develop integrated engineering, construction and equipment installation network logic diagrams and bar chart schedules, optimize resource allocations, and perform analyses to identify probable critical path for construction of the Susitna Hydroelectric Project.

(b) Approach

The engineering, construction and equipment installation network will be established and updated on the basis of parallel Task 6 design development studies. A consolidated construction schedule will also be prepared to identify major construction activities and their required start and finish dates in bar chart format. Determination of the critical path will be accomplished by means of an appropriate computerized mathematical model which will facilitate later updating requirements.

The critical path analysis will show duration, early start date, late start date, early and late finish dates, float and zero float critical path for all major activities.

Preliminary schedules will initially be prepared as input to the Task 6 Development Selection Report and subsequently developed and modified for inclusion in FERC licensing documents under Task 10.

As discussed in Section A6, it is proposed that prior to commencement of construction of the Susitna Project a Program Planning Guide will be prepared. This guide will identify for Alaska Power Authority management the specific planning requirements for the project. It will also provide, for the eventual project management group, those products essential to the planning and management of the development.

(c) Discussion

The basic groundwork for the key elements of the Project Planning Guide will be performed under this subtask. Senior level personnel from the Acres/Moolin team will initiate the development of the specific elements that will be required for planning and management of the project. Experience gained on other "giant" projects such as the Churchill Falls Development, and the preparation of similar planning guides (Moolin has recently completed the Project Planning Guide for the Alaska Gasline) will serve as a basis for the task.

It is apparent in the industry that sponsors of giant projects are beginning to recognize the importance of first developing a program planning guide for the management of these projects. We feel this type of planning can best be done by a relatively small number of senior level, highly qualified individuals. This small group of personnel, selected because of their first-hand experience in managing and planning other projects, is in the best position to understand and convey the problems associated with giant projects.

As the size of the project increases, especially in remote areas where a greater dependence upon outside support is required, so does the number and complexity of the interfaces between the various elements of the project. It will be the responsibility of the planning team to define completely the additional level of input required for successful advancement of the project.

(d) Schedule

Weeks 73 to 126

Subtask 9.05 - Perform Contingency Analysis

(a) Objective

To investigate potential contingencies/risks and to evaluate their effects upon cost estimates and schedules.

(b) Approach

A preliminary assessment will be made for each aspect of the cost estimate and construction schedule to examine potential risks involved in terms of cost escalation and/or schedule slippage. Sources of risk will be considered both individually and collectively, and their potential impacts determined. From the results of the risk analysis options, fall-back position and contingency plans will be developed.

The results of this study will provide input to risk analysis to be performed under Task 11.

(c) Discussion

There are a number of contingencies that can have adverse effects upon the project, each of which must be analyzed. They include the following:

- The selected thin arch or other design for the Devil Canyon Dam may not stand up to further seismic testing. This may require a change in design, thus requiring new cost and schedule estimates.

- Unforeseen foundatin problems (unstable bedrock, permafrost, etc.) discovered during the POS and/or initial construction phases may lead to a requirement for deeper excavation or extensive confined excavation procedures.

- Unexpected flooding conditions, due to the size of the watershed involved, can have a significant impact upon costs.

- Unusually restrictive environmental conditions imposed by governmental agencies can have significant impacts. Large projects in Alaska have a history of attracting an unusually high involvement by the agencies that cannot be ignored.

- Unforeseen inclement weather may reduce the already short Alaskan construction season and force scheduled events into unfavorable weather conditions. Also, poor weather may require the use of special heated enclosures to allow the work to progress.

- Unexpected river icing conditions may require changes in design and/or construction of unplanned structures to contend with winter ice forces and spring breakup conditions.

(d) Schedule

Weeks 115 through 126

A.5.11 - TASK 10: LICENSING

(i) Task Objectives

To provide for timely preparation and assembly of all documentation necessary for application for license to the Federal Energy Regulatory Commission (FERC).

(ii) Task Output

The output from this task will be a completed application for licensing the Susitna Hydroelectric Project. This completed package, including exhibits A through W (less P and Q, which are not required for licensing a major hydroelectric project) will be prepared for final review by external review panels and by APA on or before the end of the 128th week of the study period, with earlier preliminary design transmittals having been assembled and reviewed in-house and by APA upon substantial completion of significant individual exhibits.

(iii) List of Subtasks

Subtask 10.01 - Impact of New FERC Regulations

Subtask 10.02 - Establish Regulatory Requirements

Subtask 10.03 - Data Acquisition from Others

Subtask 10.04 - Coordinate Exhibit Preparation within Major Task Categories

Subtask 10.05 - Prepare Exhibits D and E

Subtask 10.06 - Prepare Exhibit R

Subtask 10.07 - Prepare Exhibit T

Subtask 10.08 - Prepare Application Form

Subtask 10.09 - Documentation Review and Deficiency Correction

Subtask 10.10 - External Review, Client Execution, and Filing

(iv) Subtask Scope Statements

Assuming that technical and economic feasibility are found and that environmental impacts and proposed mitigatory actions are acceptable, the major target toward which all other work is aimed is the successful completion of a license application to FERC. Indeed, this entire Plan of Study has been prepared in such a manner that only those tasks and subtasks considered to be the minimum necessary for acceptance by FERC of the license application are included in the first 30 months. To be sure, a significant amount of follow-on work must necessarily be accomplished prior to eventual construction, but the historically lengthy periods associated with federal processing of applications clearly suggest that the earliest possible submission is in the best interest of the Power Authority. This latter observation was confirmed, during preparation of this Plan of Study, by Mr. Ron Corso, FERC, whose comments on the matter are summarized in Annex A to Task 10. Mr. Corso assures us that it is entirely appropriate--even advisable--to file an application which meets minimum requirements for submission while at the same time detailing plans for initiation or continuation of studies whose results may be required before the license itself is actually awarded. It will be noted in Annex A that new regulations will probably change the letter designation of various exhibits and will combine many into single packages. For purposes of clarity in succeeding subtasks, we have chosen to refer to the production of exhibits in terms of the current official titles.

There is a complication associated with the preparation of this task package. The current applicable FERC regulations are now under revision, and there is little doubt that they will be in force prior to that time we have proposed for filing. The most likely form of the new rules, we are given to understand, will be essentially the same as is now required, but there will be some effort made to streamline and expedite processing as well as to simplify procedures. Aside from Subtask 10.01, all remaining subtasks have been prepared to conform to the regulations as they now stand. Subtask 10.01 itself provides for review, assessment, and if necessary, adjustments associated with new regulations as they become effective. Subtask 10.02 establishes a complete listing, together with actions and responsible project personnel for compliance with all regulatory requirements, including, if appropriate, any new regulations which become effective during the course of the study.

The basic application must be made in accordance with a prescribed format and must be accompanied by a series of exhibits, each of which must meet certain criteria as detailed in the regulations. Table A5.8, Task 10, summarizes exhibit content and shows those points at which the output from other Tasks contributes to preparation of or actually furnishes individual exhibits. The last column of that table summarizes certain work to be accomplished in Task 10. Note that the exhibits may be generally broken down into the following categories:

(1) Those exhibits which must be acquired from sources external to the Acres team, such as State laws. Subtask 10.03 provides for data acquisition from others.

(2) Those exhibits which will be outputs from other tasks, prepared by various members within the Acres team. Subtask 10.04 accounts for monitoring and coordinating this type of exhibit.

(3) Those exhibits and the application form itself which must be prepared based upon data produced in other tasks or developed from other sources. Subtasks 10.05 through 10.08 cover necessary activities.

(4) Review of documentation. Subtasks 10.09 and 10.10 account for the often arduous and frequently time-consuming process of essential review, both in-house and by external panels, as well as final execution and filing.

TABLE A5.8

FERC LICENSE APPLICATION EXHIBIT

xhibit	Description	Primary Contributions From Task Numbers	Complete Product Produced Under Task	Required Additional Effort Under Task 10
A	Charter or certificate and article of incorporation of applicant.	13	10	Acquire copies of state laws under which the application is made.
B	Certified copy of resolutions of stockholders and/or directors authorizing application.	13	10	Secure data from APA regarding minutes, resolutions of the authorizing application.
C	Copies of State laws pertaining to construction of the project.	13	10	Acquire copies of special hydro-electric, waterpower, or irrigation laws of the State of Alaska.
D	Evidence of applicant's compliance with requirements of State laws pertaining to use of lands and water for the project.	2, 11, 12, 13	10	Prepare statement of steps that have been taken and that remain to be taken.
E	Ownership, extent and nature of water rights applicant will use and evidence of applicant's plans for perfecting its rights to use the water for operation of the works.	2, 3, 6, 12, 13	10	Acquire certificate from Alaska Department of Natural Resources regarding water rights.
F	Statement of land ownership affected by project including purchase and construction easement.		2	Review statement for deficiencies, monitor preparation.
G	Evidence of financial capacity of applicant to undertake for preliminary work and project.		11	Monitor preparation of statement or explanation showing proposed method of financing.
H	Statement of proposed operation of project works during low, normal and flood flows.	3, 6, 7, 12	6	Prepare necessary statement based on various task outputs.

TABLE A5.8 (Cont'd)

FERC LICENSE APPLICATION EXHIBIT

xhibits	Description	Primary Contributions From Task Numbers	Complete Product Produced Under Task	Required Additional Effort Under Task 10
I	Estimate of dependable capacity and average annual energy output of the proposed project.	3, 6	6	Review for adequacy, monitor preparation.
J	General map showing project boundaries, features and general location.	2, 6, 8	6	Review for adequacy, monitor preparation.
K	Detailed map of project area clearly showing project boundaries, survey data, land ownership and location of project features.	2, 6, 8	6	Review for adequacy, monitor preparation.
L	General design drawings of all principal structures and appurtenant features and other works of the project.	2, 3, 4, 5, 6, 8	6	Review for adequacy, monitor preparation.
M	General descriptions of mechanical, electrical and transmission equipment and appurtenances.	6, 8	6, 8	Review for adequacy, monitor preparation.
N	Detailed estimate of cost of developing the project.	1, 2, 6, 8, 9, 11	9	Review for adequacy, monitor preparation.
O	Detailed engineering and construction schedules.		9	Review for adequacy, monitor preparation.
P & Q	Not required.		None	None
R	Proposed plan for full public utilization of project waters and adjacent lands for recreational purposes.	2, 6, 7, 12, 13	10	Prepare plan in consultation with State, native owners, local communities, others.

TABLE A5.8 (Cont'd)

FERC LICENSE APPLICATION EXHIBIT

Exhibits	Description	Primary Contributions From Task Numbers	Complete Product Produced Under Task	Required Additional Effort Under Task 10
S	Report on the effect of the project upon the fish and wildlife resources of the project area.	3, 6, 7, 12	6 - Drawings 7 - Text	Review fish passage and mitigation drawings under Task 6 for adequacy. Review report from Task 8.
T	Statement of reasons why development of the project by applicant rather than by the Federal Government would be in the best public interest.	1, 11, 12, 13	10	Prepare statement.
U	Statement showing the manner in which the power and energy produced by the project will be utilized.	1, 8, 11	11	Review statement for adequacy, monitor preparation.
V	Map, text, photographs and drawings to describe the architectural and landscaping treatment proposed for the project works.	2, 6	6	Review for adequacy, monitor preparation.
W	Environmental report.	1, 7, 12	7	Review for adequacy, monitor preparation.

Subtask 10.01 - Impact of New FERC Regulations

(a) Objective

To review draft and final versions of new FERC regulations to be issued in the near future; prepare revisions to subtask work statements as appropriate; and assess cost and schedule impacts for consideration by the Power Authority.

(b) Approach

Immediately upon publication of proposed new regulations, a careful review will be conducted to identify changes which apparently must be addressed. Comments will be prepared, if appropriate, to ensure that obvious ambiguities are resolved and to recommend changes, particularly insofar as they might favorably and reasonably facilitate compliance. A comprehensive list of actions will be drawn up and responsibilities for implementation within the Acres team will be assigned to appropriate project personnel by name. Subtask work statements will be revised as necessary. To the extent that changes-- increases or decreases--in estimated costs and schedules appear necessary, a report will be made to the Power Authority, along with recommendations as how best to proceed.

(c) Discussion

As a matter of policy, we continuously monitor activities of the FERC, since there is much to be learned from the experience of Acres and others in recent past and ongoing application processing. A necessary part of this monitoring effort is, of course, associated with development of regulatory changes and of new or innovative interpretations and decisions on existing ones. We know with certainty that new proposed regulations are imminent, having already received some initial advice from Mr. Ronald Corso, Deputy Chief, Division of Licensed Projects, FERC. We have been assured that no major substantive changes for major hydroelectric projects are likely, and therefore we have some confidence that the remaining subtasks in this major Task are valid. Even so, it is prudent to provide for comprehensive review of any change, since a variation of even one tenth of one percent on a multibillion dollar project can produce millions of dollars in new requirements. The matter of preparing action lists and designating responsible individuals is one we regard as essential to the management of all phases of this project. It is fully in keeping with our earlier announced intent to accomplish all those things which are necessary for successful filing, and to provide for initiation or continuance subsequent to filing, all those additional activities required for award of a license, and beyond that, for eventual project construction.

(d) Schedule

To be furnished upon publication of proposed draft regulations.

Subtask 10.02 - Establish Regulatory Requirements

(a) Objective

To identify all regulatory requirements to be satisfied as a condition for licensing and provide for compliance.

(b) Approach

All statutes, rules, regulations, and other requirements directly or indirectly affecting the process of investigating and subsequently constructing the proposed project will be reviewed and a design transmittal will be prepared setting forth the steps which will be required for compliance. Specific action responsibilities will be assigned to members of the Acres team. Some of the federal statutes having significant impact on the project--and therefore to be reviewed under this subtask--include:

- Federal Water Power Act of 1920
- National Environmental Policy Act (P.L. 91-190)
- Fish and Wildlife Coordination Act (P.L. 85-624)
- Endangered Species Act (P.L. 930205)
- Historical Preservation Act (P.L. 89-665)
- Federal Water Pollution Control Act Amendments of 1972 (P.L. 92-500)
- Anadromous Fish Act
- Wilderness Act (P.L. 88-577)
- Wild and Scenic Rivers Act (P.L. 90-542)
- Coastal Zone Management Act (P.L. 93-612)
- Federal Land Policy and Management Act of 1976 (P.L. 94-579)
- Fuel Use Act of 1978
- Alaska Native Claims Settlement Act of 1971 (85 Stat. 706)

Rules, regulations, and procedures for permits are imposed as well under the laws of the State of Alaska. Some of the Departments and Agencies having direct responsibilities or significant interests within the State include:

- Department of Fish and Game
- Department of Economic Development
- Department of Commerce
- Department of Natural Resources

- Department of Environmental Conservation
- Department of Community and Regional Affairs
- Department of Labor
- Alaska Growth Policy Council
- Alaska Historical Commission
- Capital Site Planning Commission
- Land Use Planning Commission of Alaska
- Department of Public Safety
- Department of Transportation and Public Facilities

In addition, requirements imposed by municipalities, boroughs or Native organizations (who will eventually acquire title to land in and around the project area) will be identified and analyzed. Plans will be drawn up for compliance.

Assistance will be requested from the Alaska Department of Law in identifying and interpreting applicable State and local regulatory requirements. In the event that the Department of Law cannot assist, an Alaskan law firm will be engaged for consultation on these matters.*

(c) Discussion

As may be noted from the incomplete listing of federal laws and state and local interests above, there will be a complex web of permits and procedures to be satisfied. It is all the more important, then, to devote time and attention early in the study effort to ensure compliance. Indeed, some of the various permitting procedures provide opportunities for public notice and comment and, on occasion, for public meetings or hearings. Time requirements tend to be lengthy in such cases, and the process cannot begin until application is made. Much of the effort involved in completion of this subtask will contribute to the work involved in other subtasks. Subtask 10.05, for example, provides for preparation of Exhibit D, wherein evidence of compliance with State laws must be provided. It follows that identification of appropriate laws and description procedures for compliance are important first steps as well as convenient check lists for the provision of evidence of compliance.

(d) Schedule

Weeks 3 through 12 and intermittently thereafter throughout the study period.

*Legal consultation on applicable federal laws will be provided by Mr. Charles McCarthy, Esq., a Director of Acres and a long-time practitioner and expert before the former Federal Power Commission and the Current Federal Energy Regulatory Commission.

Subtask 10.03 - Data Acquisition from Others

(a) Objective

To coordinate the preparation and collection of data to be provided by various parties external to the Acres team and to assemble those exhibits for which no other input is required from the Acres team.

(b) Approach

Exhibits A, B, and C generally require that certain copies and certifications be provided. In each case, these documents are available from, or must be produced by, others. We will request the necessary items and review them for adequacy insofar as FERC requirements are concerned. In the event that deficiencies are noted, further efforts will be undertaken to assure they are corrected. Once the necessary documentation is received and found to be adequate, completed exhibits will be assembled and made available for preliminary review. Subsequent reviews will occur under subtasks 10.10 and 10.11. For purposes of task analysis, we assume that the actual license applicant will be the State of Alaska. Certain specific items and sources are noted below:

(1) For Exhibit A, copies of the laws under authority of which the application is made.

(2) For Exhibit B, copies of all minutes, resolutions of directors of the Power Authority, as well as any pertinent legislative proceedings and executive decisions substantiating authority to file the license application.

(3) For Exhibit C, copies of special hydroelectric, water power, or irrigation laws of the State. Note that this information will already have been assembled under Subtask 10.02, so that the only additional requirement under this Subtask is to review for completeness and assemble as an exhibit.

(c) Discussion

Although the level of effort associated with this Subtask is minimal, it is included to ensure that every item required under FERC regulations is accounted for.

(d) Schedule

Weeks 12 through 16

Subtask 10.04 - Coordinate Exhibit Preparation within Major Task Categories

(a) Objective

To ensure that outputs from various tasks are consistent with FERC requirements pertaining to applicable exhibits.

(b) Approach

FERC regulations will be reviewed in detail to identify specific products, along with their specifications, to be developed as outputs from other tasks within this Plan of Study. Criteria will be prepared and distributed to appropriate responsible individuals. Progress will be monitored throughout the course of the work and design transmittals will be reviewed in each case to ensure consistency with current--and to the extent that changes occur, future--FERC regulations. Complete exhibit packages will be prepared for Exhibits F through O, S and U through W. As noted in Table A5.8, each of these products is a required output from another task.

(c) Discussion

This subtask provides for positive controls to ensure that the work produced in other tasks will, in fact, be available for use without further modification (except, perhaps, for certain introductory materials and tables of contents) as exhibits in the application package. Certain specific criteria for dimensions, degree of detail, drawing content, and the like must be identified at the start to avoid costly abortive efforts and redundant work.

(d) Schedule

Throughout project period.

Subtask 10.05 - Prepare Exhibits D and E

(a) Objective

To acquire and evalute data incident to preparation and prepare exhibits D and E.

(b) Approach

Exhibits D and E are sufficiently closely related that concurrent work on both is justified.

Exhibit D calls for evidence of compliance with requirements of the laws of the State of Alaska with respect to bed and banks and to the appropriation, diversion, and use of water for power purposes and with respect to the right to engage in the business of developing, transmitting, and distributing power, and in any other business, necessary to effect the purposes of the license applied for, including a certificate of convenience and necessity, if required. This evidence shall be accompanied by a statement of the steps that have been taken and the steps that remain to be taken to acquire franchise or other rights from the State, boroughs, and municipalities before the project can be completed and put into operation.

Exhibit E requires a description of the nature, extent, and ownership of water rights in the development of the project, together with satisfactory evidence that the applicant has proceeded as far as practicable in perfecting its rights to use sufficient water for proper operation of the project works. A certificate from the proper State agency setting forth the extent and validity of the applicant's water rights shall be appended if practicable. In case the approval or permission of one or more State agencies is required by State law as a condition precedent to the applicant's right to take or use the water for the operation of the project works, duly certified evidence of such approval or permission, or a showing of cause why such evidence cannot be reasonably submitted shall also be filed. When a State certificate is involved, one certified copy and the required additional uncertified copies shall be submitted.

Subtask 10.02 seeks to identify applicatory laws and regulations as well as to plan a program for compliance. In this subtask, we will monitor the compliance program to ensure that it is being fulfilled. A report will be prepared setting forth the steps taken to the point of application as well as a description of further programs leading to eventual total compliance. Although application for license filed by the State implies that State law has itself been complied with, we will nonetheless take suitable measures to make known our compliance efforts. Thus will Exhibit D be prepared.

We will seek the assistance of the Alaska Department of Natural Resources in providing a definitive certificate of the extent and validity of the State's water rights. In the event that water-use conflicts are discerned (current authorities to reserve water for various uses are complicated or vague where they exist at all), they will be documented and evaluated. A report detailing the results of our own research on the water rights issue together with appropriate certification by the Department of Natural Resources will become Exhibit E.

We will provide draft copies of proposed Exhibits D and E to various State agencies under whose auspices regulatory and legal requirements are monitored or enforced. The earliest coordination of these items will contribute significantly to our ability to ensure understanding and compliance.

(c) Discussion

It is important to note that the issues of compliance with state law, and particularly of water rights, will be addressed in various public meetings, since it is in those forums that public perceptions of potential conflict are most likely to surface. In addition, workshops to be conducted under the public participation program (Task 12) are designed to seek involvement of interested and affected State agencies while the work goes on, rather than present them with a "fait accompli" at the end of the 30-month study effort.

(d) Schedule

Weeks 12 through 24 and 100 through 116.

Subtask 10.06 - Prepare Exhibit R

(a) Objective

To acquire and evaluate data incident to preparation and prepare Exhibit R - Recreation.

(b) Approach

We will seek to determine the interests and desires of the public insofar as recreation is concerned through the public participation program. The particular views of owners and residents who may be affected will be sought. Certainly, for example, Native organizations whose lands lie within or adjacent to project boundaries and residents within the river basin--particularly downstream--are especially important.

We will consult with the Department of Interior, the Power Authority and interested State Agencies on a continuing basis, and particularly during the eight scheduled workshops described in Task 12, Public Participation.

Three alternative concepts will be drawn up, one of which considers strictly controlled access and purposeful avoidance of man-made recreational features. These concepts will be available for review by the end of the 11th month so that they can be presented at the second public meeting to be held early in 1981. Environmental impacts will be evaluated as a portion of the work to be accomplished under Task 7 - Environmental Studies.

That alternative which appears to best satisfy the public interest, after a careful evaluation of all factors, will be presented for consideration at a workshop in May 1981. Modifications will be made as appropriate and a revised recommended concept will be presented at a workshop in September '81. A final conceptual recreational plan will then be developed in the detail required by FERC regulation for preparation of Exhibit R.

(c) Discussion

It will be noted that environmental studies conducted during Task 7 provide for the development of a rigorous final recreation plan during the post-license application phase. The conceptual plan prepared under this subtask will provide a basis for proceeding with that work. Should significant changes to the original concept be indicated, supplementary reports will be provided to FERC as the final plan emerges.

It is extremely unlikely that total consensus will be achieved on any single recreational concept. Indeed, it is probable that the spectrum of desires will range from no recreational development and strictly controlled access to a Disneyland North. It follows that the evaluation and selection process for a single recommended plan should be understandable and should, insofar as is possible, best balance environmental concerns, desired developments, and economic factors. In any case, we do not intend to assign a specific value to recreation in order to boost what might otherwise be an economically unjustifiable project into a seemingly attractive marginal development. Indeed, where private financing is sought, it will be achieved or denied on the basis of power benefits alone.

Consultation with various federal agencies will also be required in view of current federal interests in all project lands and expected continued federal interest in portions of the project area, including certain access routes and transmission routes.

(d) Schedule

Throughout project period.

Subtask 10.07 - Prepare Exhibit T

(a) Objective

To acquire and evaluate data incident to preparation and prepare Exhibit T--Statement of Reasons for Non-Federal Development.

(b) Approach

The reasons why development of the project by the State of Alaska rather than by the Federal Government is in the public interest will, of course, have been debated at length within the State prior to the decision to select a consultant to undertake the proposed work. We will review the minutes and transcripts of those meetings and sessions which led to that decision with a view toward expressing the reasoning in a formal report. Any additional light which may be shed on the matter as a result of public participation will be included as well. We will also seek the views of the Chief of Engineers, U.S. Army Corps of Engineers, since federal development would be accomplished by the Corps of Engineers if the State chooses not to use a consultant to accomplish the work.

After a selected development plan is developed, cost estimates and schedules are prepared, financial planning and risk analysis are essentially completed, and environmental impacts assessed, we will attempt to discern differences--both positive and negative--which deserve to be addressed in Exhibit T. A final report to serve as Exhibit T will be prepared upon completion of the last public meeting in April 1982.

(c) Schedule

Weeks 1 through 12, 122 through 125, with intermittent activities at other times.

Subtask 10.08 - Prepare Application Form

(a) Objective

To prepare application in prescribed format.

(b) Approach

The prescribed format for license application requires brief summaries of data which are contained in detail in the exhibits. We will prepare this document in draft form upon substantial completion of the various exhibits. An initial legal review will be accomplished at this time.

(c) Discussion

Although this task becomes relatively simple once all exhibits have been prepared, it is nonetheless extremely important, since the summary application form will be far more widely read than the detailed documentation which accompanies it.

(d) Schedule

Week 126

Subtask 10.09 - Documentation Review and Deficiency Correction

(a) Objective

To provide for final in-house review of draft license application.

(b) Approach

Whereas continuous reviews will have been conducted throughout the study period as individual subtasks are completed and various design transmittals and draft exhibits are offered for comment, we propose to conduct an exhaustive in-house review of the recommended final license application. A full two weeks will be set aside for this purpose and our designated in-house review panel will individually review and collectively meet to consider the proposed final draft application. Deficiencies will be corrected wherever they are found to occur. After the first week of the two-week review period, copies will be made available for final review by the expert external boards established for the purpose. That effort is covered under Subtask 10.10.

(c) Schedule

Weeks 127 and 128.

Subtask 10.10 - External Review

(a) Objective

To provide for final review by external boards and for final production of application ready for filing.

(b) Approach

External board members will be provided final draft copies of the proposed application three weeks before targeted completion date. Reviews will be conducted individually for approximately one week, and the boards will convene during a second week to permit discussion of concerns, if any. Members of the Acres team will be made available as necessary upon request to answer questions. To the extent that correctable deficiencies are discovered at any time during the review period, immediate action will be taken to alleviate the problem. For that purpose, a representative from the Acres team will be made available to the board for liaison and review throughout the two-week review period.

The final week of the study period will be devoted to final correction, production, and delivery of the application for execution and filing by the State.

(c) Discussion

The proposed careful review will serve several purposes. First, it is clearly important on a project of such magnitude to avail oneself of the best available opinion as to the adequacy of the work. Secondly, the collective efforts of eminent review groups may serve to reduce the challenges or interventions which may be made during the license processing period. Certainly, members of the external board may also be called as expert witnesses during later periods. Thirdly, the vital confidence of potential investors will surely be bolstered by the thoughtful deliberations of such an august body.

(d) Schedule

Weeks 128 through 130

A.5.12 - TASK 11: MARKETING AND FINANCING

(i) Task Objectives

To establish the feasibility of financing the project and to develop an approach which provides optimum financing cost to Alaska power Authority and the best overall benefit to the State of Alaska. An essential element of this task will be to build confidence in the project.

(ii) Task Output

The principal output of this task will be the draft support documentation for bond offering. While nine primary documents and approximately sixteen additional support documents are involved, some will be prepared with relative ease because the data contained therein will necessarily have been produced for other purposes. Notable outputs unique to the marketing and financing issue include a series of risk analyses and procedures for risk control and minimization, as well as a taxation report addressing the important question of eligibility for tax-exempt bond issuance.

Documents will be produced under three main categories:

(a)	Project Overview, including	Review of Design and Construction Concepts and Methodology
		Review of Cost Estimates and Schedules
		Economic Limits of Project
		Preliminary Assessment of the Financing Plan and Bond Offering Documentation
		Review of Environmental Constraints
		Development of the Organization and Expertise Sources
		Major Risks and Responses
(b)	Internal Reports for Management/ Financial Consideration (Provisional Listing)	Financing Requirements of all Parties and the Completion Guarantee
		Assessment of Capital Costs and Schedules
		Assessment of Critical Engineering Tasks and Associated Risk Analysis
		Project Contingencies, Risk Analysis and Planning

(b)	Internal Reports for Management/ Financial Consideration (Provisional Listing) (Cont.)	Environmental Agencies Requirements Native Peoples Requirements Probable Economic Limits to Project Inflation and Escalation Assessment Overrun Possibilities Risk Management Organization and Risk Minimization Policy Security of Project Capital Structure Economic Impact Preview Evaluation of Alternative Markets Available for Susitna Output Evaluation of Alternate Options for Meeting Railbelt Power Needs Review of Construction Contract Performance History in Alaska re Cost and Schedule General Economic Review
(c)	Draft Bond Documentation (Provisional Listing)	A. <u>Primary Volumes</u> Power Contracts Engineering Report Statutory Agreements, Legal Approvals and Land Claims Summary of Corporate Documents Technical Abstract and Engineer's Certificate Construction Cost Estimate Summary Construction Schedule and Project Expenditure Program Insurance Financing Summary

(c) Draft Bond

B. Support Volumes

Overall Project Organization

Engineering Reports (Construction)

- Access and Site Preservation
- Environmental Standards, Monitoring and Control
- Quality Assurance and Testing Programs
- Support Facilities and Logistics

Engineering Reports (Operations)

- Operating and Replacement Expenditures
- Chargeable Corporate Expenditures

Labor Agreements

Plan for Alaska Manpower and Procurement Content

Risk Management and Minimization

- Risk Analysis and Control
- Risk Minimization

Taxation Report

Legal Report

Review of Giant Projects

- Financing
- Construction and Engineering

Alternative Energy Sources

(iii) List of Subtasks

Subtask 11.01 - Project Overview Preparation and Update
Subtask 11.02 - Internal Report Preparation
Subtask 11.03 - Alternative Power Source Risk Analysis
Subtask 11.04 - Susitna Base Plan Initial Risk Analysis
Subtask 11.05 - Susitna Base Plan Extension and Revision
Subtask 11.06 - Susitna Financing Risk Analysis
Subtask 11.07 - Resolution of Tax Exempt Bond Issue
Subtask 11.08 - Identify Parties in Interest
Subtask 11.09 - Revenue Assurance Procedures
Subtask 11.10 - Liaison with APA Bond Underwriting Managers
Subtask 11.11 - Draft Documentation for Bond Offering Support

(iv) Subtask Scope Statements

It is recognized that Susitna is most likely to proceed on the basis of a Project Financing. Essential to this will be an accurate determination of revenues and properly established energy sales agreements. Furthermore, all project risks must be identified, their potential impact assessed, and appropriate contingency plans and provisions made.

In the approach recommended, a close working arrangement will be established from the outset of the study between technical, economic and financial advisory groups. The interaction between these interests will be developed through a series of specific tasks which provide the Authority with successively more comprehensive outlines and definition of a financing plan.

As the study proceeds, the specific requirements for supporting material essential for financing will be identified and its preparation undertaken in close collaboration with the selected bond underwriters. The completeness and excellence of bond offering support documentation is judged to be of crucial importance to a successful project. The work involves numerous, complex and interlinked tasks; and only comprehensive pre-planning can achieve the desired result.

In order to present the project in proper perspective to the many parties involved--Federal, State and local agencies, regulatory authorities, power purchasers, potential lenders, institutions, political groups and public--a comprehensive overview will be prepared. This will initially be in general terms, but will endeavor to cover all the interrelated elements of the project. As work proceeds, successive editions of the overview report become more explicit and complete.

It will be recognized that the knowledge and enthusiasm of many who have the power of veto or constraint over the Susitna project will be less than that of Alaska Power Authority and those most closely involved. Studies and explanations which may seem unnecessary to the sponsoring group may well be needed to convince third parties and engender their enthusiasm.

It is furthermore vitally important to disperse the knowledge among those employed in the project that all potential problems have been thoroughly examined and solved. This will generate the necessary degree of infectious enthusiasm which is an essential ingredient for even a determined team to succeed.

The work of the interdisciplinary group incorporating technical, economic, financial, and other skills would, furthermore, demonstrate clearly for management consideration the clear economic limits to the Susitna project (e.g., its maximum acceptable cost) and the time period in which its accomplishment must be regarded as a certainty before other measures to meet Alaska's power needs would have to be adopted. While examination of the negative limits of the project could be regarded as an expression of pessimism or even, in the ultimate, capable of cancelling the project, we consider such analysis vital. It should serve to establish the general robustness of the project and to demonstrate beyond doubt to the various governments, investors, lenders, completion guarantors and others the viability of any recommended scheme for development.

As the various elements of the project study reach the appropriate level of completion, it is planned to apply a rigorous analysis of risk and to recommend contingency provisions. The approaches to be used would involve modern techniques of analysis and probability assessment and deal with cost, schedule, technical and other controlling elements of the project.

The approach to be adopted would derive full benefit from previous financing efforts for major capital projects requiring capital funding of $1 billion or more. Experience has demonstrated the need for close and effective interaction between the owner and the various elements of his advisory team.

(v) Logic Diagram

A logic diagram is shown in Plate T11.1 to illustrate the manner in which various documents are prepared, interrelated, and assembled.

(vi) Investment Banker Inputs

Associated with us in Task 11 will be the investment banking firm of Salomon Brothers which is described in their memorandum at Section C of this Plan of Study. Salomon Brothers will apply its professional skills, experience, and judgment as a major investment banker to assist us in every aspect of Task 11 at a total level of effort equal to that provided by Acres. Costs throughout the various subtasks include both Acres and Salomon Brothers work.

Subtask 11.01 - Project Overview Preparation and Update

(a) Objective

To provide a key project document which reviews all major aspects of the project and its objectives, determining in principle whether these can be successfully met; provide through successive updating a continuing reassessment of the project's overall viability and financibility as various milestones are reached; and allow multidisciplinary inputs from many sources to be properly coordinated into a cohesive and well-balanced definition of the project.

(b) Approach

This Subtask will be performed by a small team who will receive inputs from many multidisciplinary sectors involved in the study. Initially the Project Overview will concentrate on a descriptive outline of the project objectives, the site for development and the project facilities. Capital costs and schedules will be at the outset preliminary only, but nonetheless considered adequate to determine initial overall viability. The Project Overview will identify the sensitivity to various risks and outline methods of mitigating these and possibly removing some from further consideration. The initial project overview preparation will occur after the go-no-go decision point at the end of the study.

The project overview and its subsequent revisions in updated form at intervals of 6 to 8 months throughout the study period will be presented from the "owner's viewpoint" and will consider all important aspects which affect acceptance, financibility and the undertaking of construction of the hydroelectric facilities.

The team will be directed by experienced senior staff familiar with the approach essential to projects of such magnitude and the complex financing arrangements that these involve.

In achieving its goal of preparation of a comprehensive, clearly understandable, concise and accurate overview of the project, the Project Overview Task Force will call on specific inputs from many sources, including:

- Technical
- Environmental
- Economic
- Marketing
- Financial
- Insurance
- Transportation
- Labor
- Tax
- Legal
- Political

Typical elements of the Project Overview are listed in Subparagraph (ii)(a) of Task Output above.

The final issue of the Project Overview during the study phase will provide a valuable summary document to bridge into subsequent licensing and preliminary design phases of the work. Eventually its content will have significant value for the Bond Offering Support Document and a variety of other applications, including preparation of project brochures as part of the public participation program.

(c) Discussion

The concept of the continuously updated "Project Overview" is of relatively recent origin and has developed from the special needs of large complex projects. It is necessary to address the complexity with a well planned compilation of material which places all the technical, commercial, economic, financial, contractual, environmental and other aspects in proper perspective and demonstrates that all vital problems are being sensibly addressed. The overview is planned to provide a consistent thread of documentation through the whole study process and, if construction should proceed, to provide a datum baseline for judging actual performance of the many elements in relation to the plans.

As the documents will have to serve many varied and non-technical interests, the language must be appropriately chosen and carefully edited for clarity and ease of understanding. Extensive use will be made of graphics, drawings, maps and pictorial illustrations. Production and binding will reflect the level of economy appropriate to draft and eventually final documentation.

(d) Schedule

Weeks 53 through 130.

Subtask 11.02 - Internal Report Preparation

(a) Objective

To prepare topical reports, for management consideration, on those aspects of the projects which have a strong bearing on financibility of the project; present material derived from the overall study in form suitable for easy assimilation by non-engineering participants in the overall task; and present the risks to which the project is exposed in the proper perspective.

(b) Approach

The team provided to assess the overall financibility of the project will be responsible for drawing together from many sources data, viewpoints, reports, assessments, impact statements, documents and a variety of other supporting material. In carrying out this task, the multidisciplinary specialists who will be supporting the team will assemble and edit topical internal reports for consideration by managerial staff of the Authority, their financial advisors/underwriting managers and others guiding the project through its study phase to implementation or abandonment. The internal reports may ultimately form a substantial proportion of documents to be subsequently produced in direct support of the financing or for a variety of other purposes. Every effort will be made to foresee all future possible uses of the material, and its presentation will be appropriately arranged.

One element of the internal reports which will receive special consideration is risk assessment, which will be applied to several aspects of the project such as technical, financial overrun, schedule delay, operating reliability, etc. Means of mitigating project risks will be dealt with in a comprehensive fashion as will be the contribution from insurance sources in dealing with residual exposures. The important detailed risk analysis itself is covered under subtasks 11.04 through 11.06. Related internal reports prepared as a a part of this subtask will present the results of those detailed professional studies in a manner which can be easily understood by decision makers whose ultimate agreement is essential to eventual construction.

Subparagraph (ii)(b) of the Task Output sets out a provisional listing of typical documents which may be required. The final listing would be planned at an early stage of the study in conjunction with the Authority and their advisors. Control sheets outlining responsibilities for specific input, index of contacts, and required schedule will be prepared in this planning stage.

The internal reports provide, on a selective basis, much of the material for the various editions of the Project Overview and the production of both series will be closely coordinated.

A consistent and cohesive series of reports will be prepared which will clearly address all the vital issues affecting project release for construction.

(c) Discussion

While documents of the type envisaged are the inevitable product of a comprehensive study, the benefit of a specific source of consistent internal reports is that the Authority will receive objective, well balanced, professional arguments on key issues to allow properly informed decisions. It is important to note that this approach is responsive to the APA plan to remain a lean, efficient organization. In a bigger and more highly staffed organization undertaking a major project of the scale of Susitna, the internal reports would be produced, no doubt, by individual specialist departments for the owners' project team responsible for final decision.

The proposed approach permits APA to avoid overstaffing for relatively short study or project management periods. An opportunity is offered for the special project task force to perform these functions under the control and direction of the Executive Director and the Board.

The team would be closely linked to the overall project study organization and perform functions which will be an essential part of the study task. It will serve, however, the owners' control group directly in providing the basis for assessment and decision on many issues having an impact on the project.

This subtask will continue during the post-application phase of the work.

(d) Schedule

Weeks 52 through 130.

Subtask 11.03 - Alternative Power Source Risk Analysis

(a) Objective

To examine uncertainty with an emphasis on relative differences dependent upon electricity source patterns; identify key uncertainty differences and key interdependencies; and if necessary, quantify uncertainty differences and their interdependencies; establish the validity of key assumptions; and assess viable levels of risk in terms of the State of Alaska's electric power generation mix.

(b) Approach

Acres will coordinate the assessment. Input will be obtained from personnel responsible for each study component, APA source documents and their authors, related reports, and related general literature. Established cross-impact analysis techniques will be recast in the general risk analysis framework developed by Acres to establish potential variation ranges conditional upon the values of other key variables. The key difference is the treatment of time as a continuous process rather than a series of events. To consider these relationships, we will identify the reasons for potential variations, concentrating on broadly defined reasons which have different effects upon each of several source mixes. For example, alternative growth rates developed under Task 1, Power Studies, will be related to two or three different rates of fuel cost escalation. Simple functional relationships will be established to illustrate key interdependencies. A number of power generation patterns with and without Susitna will be evaluated in terms of a sensitivity analysis using these conditional relationships between extremes.

If the case for or against Susitna is not clear, on expected cost grounds, these simple relationships will be refined, associated uncertainty will be quantified, and the validity of key assumptions will be established to the extent possible within budget extensions not considered in this proposal. Expected future electric power cost risk relationships for each electric power generation pattern considered will then be related to the need for the APA to avoid risky situations and mitigate the effects of undesirable situations.

(c) Discussion

General agreement on the extent of such dependencies will not be easily obtained. However, it is a key issue which should not be ignored. Most people will be sympathetic to the existence of some dependence, and minimal dependency assumptions may be all that is necessary to establish a clear case. A simple but realistic initial approach is a low cost minimum risk approach. Extension must be assessed in terms of initial results.

Providing conditional estimates will be a useful aspect of assessing base estimates, and associated costs for other participants are incorporated in their provisions, with the exception of WCC. For related reasons, no attempt to cost APA input has been made. Expenses account for the need to seek a wide spectrum of expert opinion.

(d) Schedule

Weeks 20 through 50	Development of initial conditional relationships and sensitivity analysis based evaluation of alternatives
After week 30	Extension and refinement as necessary, overlapping Subtask 12.04 if necessary.

Subtask 11.04 - Susitna Base Plan Initial Risk Analysis

(a) Objective

To identify all relevant risks in terms of specific problems associated with specific major components of the project and key aspects of the alternative power source risk assessment developed in subtask 12.03; identify all relevant preventative and responsive measures for these risks; identify which risks are minor given effective responses, and which need further attention; make a preliminary quantitative assessment of some key construction time risks, and their relationships with other key project cost risks, flagging risks which are important but best treated as conditions with respect to the current quantitative analysis; stimulate information flow between planning groups with respect to likely departures from the base plan; and stimulate documentation of problems and solutions to those problems underlying the base plan.

(b) Approach

Acres will coordinate the assessment. Input will be obtained from project personnel responsible for each component. Procedures developed by Acres will be used to assess construction time risk as follows:

Risk lists will be produced, labelling and describing all the relevant risks all those involved can identify.

Response lists will be produced, labelling and describing all relevant responses associated with each risk.

Secondary risk and response lists will be produced, considering risks associated with responses.

Rough quantitative assessment of risk/response sequences will allow some risks to be identified as minor, and not worth further analysis at present.

Still using risk/response lists, responses will be partially structured. Responses common to more than one risk will be identified. Responses will be preference ordered. Where possible, decision rules defining when responses would be used will be identified.

Special diagrams will be constructed to summarize the above analysis in a simple form.

Key base plan assumptions and key assumptions concerning responses to potential problems will be identified.

Probabilities necessary to assess key assumptions will be estimated. Most will be very specific conditional probabilities: for example, what is the probability of X working days for a particular activity in a particular month?

The implications of key assumptions will be examined, first in the context of specific risks for specific activities, gradually at a broader and broader level. For example, we will assess the chance of achieving the planned work on a specific activity in a specific season in relation to one or two key risks first, then look at other risks and other seasons. We will not relate different activities until we are satisfied with assumptions critical to the activity itself.

A variety of output forms will be used, depending on the questions being asked of the analysis. Most will be comparative probability distribution representations; for example, the probability of finishing activity Y by month X given a start in May, June, July, etc.

Construction time risk will be summarized, and converted to construction cost risk.

Other sources of construction cost risk will be considered in a similar manner, and linked to produce overall construction cost probability representations for confidence limit assessment purposes. Appropriate confidence limit assessment will be based on a comparison of quantified risks and nonquantified risks which must be treated as conditions.

Construction cost risk analysis will take place in a fixed time frame structure, unlike the PERT based analysis usually employed. That is, we will consider uncertainty in terms of "how much work can we achieve in a given time", instead of "how long will it take to achieve a given amount of work". This approach makes it much easier to assess probabilities, always a difficult task. It facilitates the consideration of weather windows and other seasonal dependencies. It also facilitates integrating construction cost risk with inflation and escalation studies at this point.

Other sources of project risk will be considered qualitatively in a similar manner, structuring risks and responses via listing procedures and simple summary diagrams.

Computation procedures are based on numerical integration techniques in a semi-Markov process framework. Another key advantage of the fixed time frame is the efficiency and precision of this approach relative to the more usual simulation or moment-integration analytical procedures.

All aspects of the Acres approach to risk analysis have been widely used in the context of fault-tree and event-tree analysis, reliability analysis, generalized PERT, Markov process and decision-tree analysis. However, the way we have integrated these aspects into a procedure tested in a variety of application areas is unique. Areas of application of the integrated procedure include hydro projects, thermal power projects, arctic gas pipelines, offshore North Sea oil pipelines and platforms and underground energy storage projects.

(c) Discussion

The effort expended on risk analysis can be tailored to an available budget. However, it must be expended in a systematic manner, and experience suggests that at this stage in a project's life a relatively simple quantitative analysis will suffice provided risks and associated preventative and responsive measures are carefully identified. If they are not, quantification of risks is rather meaningless, because it is not clear what has and has not been included.

(d) Schedule

Weeks 53 through 75	Develop initial risk analysis as base plan is developed, including quantitative analysis to test key base plan assumptions.
After week 75	Prepare risk analysis documentation for license application submission.

Subtask 11.05 - Susitna Base Plan Extension and Revision

(a) Objective

To revise the base plan initial risk assessment periodically as the base plan develops; explore key risk areas identified earlier; assist with base plan development as and when necessary; and respond to FERC requests for further analysis.

(b) Approach

Within the basic framework established in Subtask 12.04, further specific extensions and revisions.

(c) Discussion

Experience suggests risk analysis can be extremely useful at this stage in a project's development, but it is difficult to predict what sort of issues will benefit from further analysis until preliminary risk analysis results are available.

Costing is necessarily vague at this stage, but we believe the figure quoted should allow updating as necessary, response to a reasonable number of risk areas uncovered earlier and assessment of key changes proposed for the base plan.

This effort will continue during the post-application phase of the work.

(d) Schedule

As and when necessary.

Subtask 11.06 - Susitna Financing Risk Analysis

(a) Objective

To build on earlier risk analysis consideration of financial issues not yet developed, including assessment of contract and insurance arrangements, and an appropriate level of direct and indirect "insurance".

(b) Approach

Within the basic framework established in Subtask 11.05, specific extensions and revisions, in terms of both quantitative and qualitative analysis.

(c) Discussion

Earlier listing and structuring of risks and responses is of great value at this stage. Each proposed contract can be assessed against appropriate checklists of potential problems, and contract arrangements or insurances which cover a number of different sources of risk can be developed into an effective overall risk management pattern.

This subtask will be performed in its entirety subsequent to submittal of license application.

(d) Schedule

From license application to bonding.

Subtask 11.07 - Resolution of Tax Exempt Bond Issue

(a) Objective

To explore all legal means to secure tax-exempt financing for the Susitna Project and identify and describe those measures which must be taken in each case to secure that end.

Rank in order preferred approaches in the event more than one legal means is identified. Prepare a report summarizing reasons tax exempt financing is found to be impossible in the event no legal means is identified.

(b) Approach

A memorandum on financing considerations prepared by Salomon Brothers is included in Section C to this Plan of Study. As noted therein, a number of possible alternatives under the IRS Code can be explored. The special rules provided under Section 103 of Treasury Regulations for applying trade or business test and security interest test to bonds issued to finance an electric generating facility owned and operated by an exempt person (in this case, the State of Alaska or a public power authority) will be considered in a series of sequential steps summarized as follows:

(1) Classify the anticipated purchasers of power from the Susitna project into exempt and nonexempt persons. For example, municipalities such as Anchorage and Fairbanks will be exempt persons, whereas private electrical co-ops will be nonexempt.

(2) Determine whether any one nonexempt person will contract to take, or take or pay for, more than 25 percent of the project output of the Susitna project. If there is such a person, then the trade or business test is met.

(3) If there is no such person, identify the nonexempt persons who will each pay annual guaranteed minimum payments exceeding 3 percent of the average debt service on the Susitna bonds. The trade or business test is satisfied if the aggregate amount of power which these persons contract to take, or take or pay for, exceeds 25 percent of the project output of the Susitna project.

(4) If the trade or business test is met, total the payments that will be both pledged or used to pay debt service on the Susitna bonds and made pursuant to the contracts referred to in either paragraph 2 or 3 above. The security interest test is met if this aggregate amount exceeds 25 percent of the total debt service on the Susitna bonds.

If it appears that the Susitna bonds may be industrial development bonds because of the commitments by nonexempt persons to purchase power, consideration may be given to altering the makeup of the group of purchasers to avoid the trade or business test or security interest test. Further details are provided in the

Salomon Brothers memorandum. Assuming that one or more approaches are found to be possible, each will be evaluated in terms of the associated difficulties and probabilities of successful defense against challenge by or on behalf of regulatory authorities. All reasonable approaches will be rank ordered and the apparent best will be developed into a series of explicit measures to be taken by the State (including recommendations for legislation to be passed), the Alaska Power Authority, and others.

In the event that tax exempt financing is found to be impossible, a report will be prepared detailing the reasons that no reasonable approach could be found.

(c) Discussion

The question of tax-exemption on interest to be paid on bonds issued to finance the project is of extreme importance, for the overall cost of the project power and the type of financing plan to be developed hinge upon its resolution. So important, in fact, is this issue that even a negative report should not necessarily be regarded as a final and irrevocable ruling on the matter. Indeed, given the importance which the federal government has now attached to domestic energy production (especially from renewable resources) it is not inconceivable that federal regulatory or statutory changes can be achieved.

In the event, however, that negative findings on the tax exempt question are produced and cannot be reversed, the financibility of the project will not then necessarily become doubtful. The best alternative to tax exempt bonds will be recommended by an experienced professional investment banking firm whose successful historical participation in large project financing is well documented.

Legislation now pending could serve to resolve this issue in favor of tax-exemption for bonds associated with hydroelectric development. In the event that this legislation passes, the level of effort will be reduced to that amount necessary to ensure compliance with new laws.

(d) Schedule

Weeks 30 through 52. Intermittent updates thereafter.

Subtask 11.08 - Identify Parties in Interest

(a) Objective

To identify potential candidates to share some of the direct and indirect project risks and describe their possible involvements.

(b) Approach

A survey of all organizations and entities with any possible direct or indirect risk sharing involvement will be accomplished. These parties might include, for example, municipal electric systems, rural electric cooperatives, investor owned utilities, the Alaska Power Administration, and others. A profile will be drawn up for each and an assessment will be made as to how much of the total risk each may be expected to share under appropriate alternative scenarios and as to how such sharing can reasonably be accomplished.

(c) Discussion

There are a number of basic project financing risks which must be addressed. The analysis, assessment, and, where appropriate, quantification of these risks will be accomplished under Subtasks 11.04 through 11.06. Financing risks include:

-- Cost overruns prior to completion
-- Late completion and non-completion
-- Partial or total post-completion outages
-- Customer failure to provide anticipated cash flows
-- Regulatory risks, particularly insofar as new regulations affect the operation (and, therefore, of course, the profitability and/or consumer costs).
-- Technological risks, particularly insofar as the extent to which new or relatively unproven technology may increase financing difficulties.

Given these risks and reasonably detailed profiles of potential risk sharing parties, it is possible to consider a number of alternative participation scenarios. As successive iterations of the risk analysis efforts occur, the possible involvements of parties-in-interest are correspondingly clarified. An essential first step in this process, however, is the task of identifying and profiling potential candidates. Thus, this subtask provides an explicit recognition of that need.

(d) Schedule

Weeks 10 through 30

Subtask 11.09 - Revenue Assurance Procedures

(a) Objective

To explore alternative means to provide adequate revenue assurance to protect investors against the risk of default; develop a strategy for success.

(b) Approach

For large energy projects, the necessary revenue assurance may be derived from a demonstration of demand for the project output and adequate customer and regulatory support of the price for the power. Demonstration of demand can be satisfied by power sales contracts between APA and the immediate customers (e.g., municipalities, cooperatives, military bases, industrial plants, etc.). We intend to consider a number of alternative types of commitments and match them against immediate customers identified earlier in the group of parties-in-interest (see Subtask 11.08). Certain specific commitment types are described in the Salomon memorandum in the Appendix. These include take-or-pay obligations, take-and-pay obligations, minimum payment obligations, and step-up provisions.

Since price regulation and other regulatory constraints would necessarily affect the project, it is important to include discussions with all governmental and regulatory agencies in this exploration of revenue assurance.

In addition to power sales contracts, guarantees by the State or Federal government or others would provide further assurances. Guarantee possibilities will be identified and a preliminary assessment will be made of the probability of acquiring them.

A number of funds will be required (including, for example, "Reserve and Contingency Fund" or "Operating Fund") to ensure protection against unexpected shortfalls. Each such requirement will be identified along with its source.

As a final step in the development of revenue assure procedures, the apparent best strategy for successfully achieving the desired degree of revenue assurance will be described in a report to be prepared as a part of this subtask.

(c) Discussion

The basic credit risk against which investors attempt to protect themselves is the risk of default. The risk of default lies in the borrower's inability to meet interest and principal payments on his debt obligations in a timely fashion. Adequate revenue assurance protects the investor against this risk.

It will not be sufficient to conduct a one-time study of the revenue assurance issue and then assume the results will continue to remain valid throughout the course of the financing effort. Rather, a relatively continuous updating process is essential. In this regard, the provision of investment banker's services by a firm experienced in providing financial services for large projects is particularly important. This subtask will continue during the post-application phase of the work. The level of effort shown in cost summary tables includes only pre-application costs.

(d) Schedule

Weeks 100 through 120. Subsequent schedule to be determined.

Subtask 11.10 - Liaison with APA Bond Underwriting Managers

(a) Objective

To provide a continuing input as appropriate from study tasks of information and data which may have an impact on financing; provide engineering advice to the financing management group; and report to the Project Manager on any issues where financing considerations have an impact on the evolution of the project.

(b) Approach

Financing of a major project such as Susitna will call for a level of effort and ingenuity well beyond that normally involved in public works undertakings. Experience (particularly from the $1 billion Churchill Falls Project) has established the benefit in a particularly close relationship between technically oriented senior staff closely associated with the engineering related development of the project and the financial, legal, insurance, economic and other professional advisors assembled by the owner. The leader of the task force carrying the responsibilities under Subtasks 11.01 and 11.02 will be eminently suited and placed to provide this liaison function as an essential part of his other duties.

(c) Discussion

In major projects, there must be continual emphasis on multidisciplinary approaches to most of the important issues that have to be resolved. When capital investment is more modest and where many precedent cases are available for guiding decisions, the degree of liaison and interlinking of interests contemplated here might be viewed as extravagant. However, it may be suggested that the exigencies of even less ambitious capital works exposed to excessive cost escalation and the many risks imposed by current public and political attitudes call for closeknit coordination of all project interests throughout the undertaking from concept to completion.

The target is completion in the most efficient and cost-effective way possible and the strictest level of adherence to schedule and budget throughout the project. The aim can be most effectively taken by close cooperation between all interests from the outset.

(d) Schedule

Continuous through the full period of study.

Subtask 11.11 - Draft Documentation for Bond Offering Support

(a) Objective

To review with the Authority's Bond Underwriting Manager the requirements for support documents; prepare and issue outline index and content specifications and allocated responsibility for input; prepare, edit and produce successive draft documents in parallel with other findings, reports, etc, being produced in the later phases of the overall study, and prepare "Engineers Opinions" to support certification of the project.

(b) Approach

Throughout the financing support task, attention will be continually focused on the ultimate objective of a successful bond issue. Very large projects requiring financing at levels of $1 billion or more call for a particularly high standard of support documentation to build a sufficient level of confidence in the investment potential. Managers of major financing institutions are becoming increasingly sophisticated in their approach, particularly to major projects, and owners and underwriting managers must respond to their more exacting requirements.

We see the vital importance of preparing inputs to the bond offering support documents as the study proceeds. It is be planned that draft documents will be available by the conclusion of the study and will be available for further refinement as the project proceeds through licensing to its release date.

The specific approach to be adopted would parallel the successful precedent of Churchill Falls Hydroelectric Power Development which led in 1968 to the marketing of $550 million in First Mortgage bonds. While in this case work was heavily concentrated in a 3-month period in 1967 and continued at a lesser level for 15 months, the support materials for Susitna should be methodically assembled throughout the study period and prepared in draft form well in anticipation of any offering. A provisional listing of Bond Offering Documentation is set out in subparagraph (ii) of Task 11 above, and a summary of the objectives of each of the proposed documents is shown on Table A5.9.

(c) Discussion

It will be apparent from the provisional listing of documents that a wide range of interrelated topics must be addressed. This calls for input from a multidisiplinary group of specialists and sensitive coordination of all material into a cohesive, balanced and interrelated series of documents. These serve to demonstrate that all important questions have, in fact, been properly addressed and that the project has a high level of overall security as a result.

In view of the legal significance of these documents, the process of editing, approval and publication will require close working arrangement with the Authority's counsel, the underwriting managers,

TABLE A5.9

ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC POWER PROJECT

PROVISIONAL LIST OF BOND OFFERING SUPPORT DOCUMENTS

A - PRIMARY DOCUMENTS	OBJECTIVES
1. Power Contracts	To outline the terms and conditions of sale of the power and energy output from the Susitna Project.
2. Engineering Report	To provide a comprehensive statement, in simple language, regarding the physical nature of the site, the basis of development, the deterination of energy output, and a description of all facilities.
3. Statutory Agreements, Legal Approvals/Land Claims	To provide a comprehensive assembly of all relevant agreements as far as possible in their original layout and form.
4. Summary of Corporate Documents	To provide a comprehensive assembly of documents relating to the Alaska Power Authority and any other participants in the project.
5. Technical Abstract and Engineer's Certificate	To summarize the engineering report, construction cost estimates, schedule, operating and replacement expenditure estimates, and other documents leading to firm conclusions supported by an Engineer's Certificate of Opinion relating to operation, cost and schedule.
6. Construction Cost Estimate	To set out the basis of the construction cost estimate, including contingency provisions and to provide the necessary detail to establish an adequate level of completeness and confidence.

7. Construction Schedule and Project Expenditure Program — To provide a concise, but detailed, description of the construction schedule and project expenditure program of all facilities and critical path networks of all supporting activities in the oerall construction plan.

8. Insurance — To set out a concise statement of risks during construction and operation with an evaluation of the maximum foreseeable loss.

9. Financing Summary — To provide a summary of equity, debt and completion guarantee standby financing requirements with a schedule of drawdowns to meet construction plans.

B - SUPPORT DOCUMENTS	OBJECTIVES
1. Overall Project Organization	To provide a summary of relationships of all companies involved in the project with details of origins, responsibilities and corporate structures, supplemented with organization charts showing lines of reporting and authority.
2. Engineering Reports (Construction)	
2.1 - Access and Site Preservation	To provide a detailed description of the arrangements made for access and heavy transportation to the project site with a full statement of measures taken for site preservation and avoidance of delay arising from environmental concern.
2.2 - Environmental Standards, Monitoring and Control	To provide a comprehensive summary of all applicable requirements, responses and reports concerning environmental aspects of the project construction and operation.
2.3 - Quality Assurance and Testing Programs	To set out quality assurance directives established by the Authority and detailed evidence to demonstrate the methods by which these will be achieved.

2.4 - Support Facilities	To provide a comprehensive description of all construction and operational support facilities with demonstration of the adequacy of these to meet project requirements, including contingencies.
3. Engineering Report (Operations)	
3.1 - Operating and Replacement Expenditures	To provide details of the basis of estimate for manning and operating of the power project, and for the continuing maintenance plans.
3.2 - Chargeable Corporate Expenditures	To set out the estimates of corporate expenditures incurred by the authority which can be legitimately charged to operations.
4. Labor Agreements	To review the labor situation on both the national and state level, together with the legislative framework under which special labor agreements may be formed. To provide precedent data on experience with master project labor agreements. To include a statement of intent for such agreements to apply to the project, and to demonstrate the impact of these on project risk exposure.
5. Plan for Alaskan Manpower and Procurement Content	To present sufficient evidence to demonstrate that the desired portion of Alaskan content will be incorporated in the overall project.
6. Risk Management	
6.1 - Risk Analysis and Control	This section will descripe in detail the optimal responses to a risk minimization study, the organization of a formal risk mamagement team, its policies and methods of operation. It will also describe review policies and reporting systems designed to ensure continuous updating of both risk identification and response.

6.2 - Risk Minimization	To identify all risks to which the project may be subjected and plan responses to them which demonstrably reduce those risks collectively and individually to a minimum. The residual risk figure thus determined is an important factor in demonstrating the reliability and confidence level of the project.
7. <u>Taxation Report</u>	To deal with the impact of all aspects of federal, state and local taxation pertinent to the project.
8. <u>Legal Report</u>	To deal with all aspects of legislation and legal requirements under which the project will be constructed.
9. <u>Review of Giant Projects</u>	
9.1 - Financing	To identify and describe other relevant project financing to demonstrate the adequacy and logic of the project approach.
9.2 - Construction and Engineering	To summarize the experience accumulated from major North American capital projects in relation to achievement of engineering cost estimates and schedules.
10. <u>Alternative Energy Sources</u>	To provide a comprehensive review of alternative energy generation modes applicable to Alaska, with estimates of delivered energy cost and long-term reliability of supply.

legislative interests in the State of Alaska, and the owners' management team. The effort requires a painstaking level of processing of very large amounts of data and material and justifies its assignment to our selected team which has appropriate prior exposure to this function.

The list of bond offering support documentation as displayed in Table A5.9 reveals that there are great similarities to documentation required as exhibits to the FERC license application (see Task 10). Thus, in many cases, we will use the same documentation both as an exhibit and as bond offering support documentation. In others, it will be necessary to reformat exhibit data to meet financing needs. To the extent possible, however, bond offering support documentation will be delayed until after license exhibits are prepared.

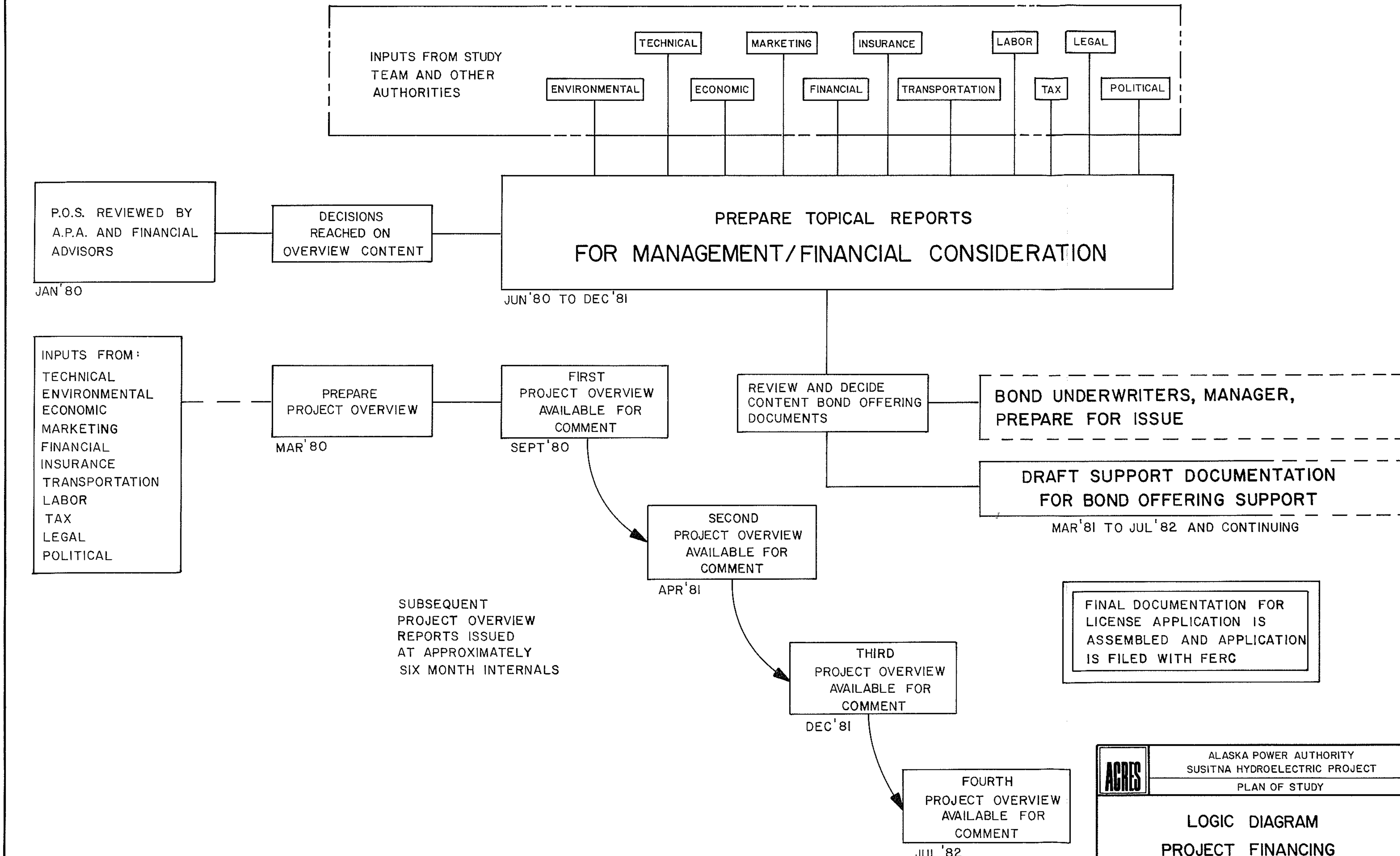
This subtask was contained in the September 11 version of the POS along with a schedule commencing in the sixth month of the feasibility study. As a result of discussions with the Alaska Power Authority, the proposed work will be deferred until after license application has been accomplished. A description of the required effort is retained in this version of the POS in order to ensure a complete description of the financing task.

(d) Schedule

Commence after license application and to be presented in a form for continuing effort into subsequent phases of the project.

Addendum to Plate T11.1

All references to year should be increased by one (e.g., Mar. '80 should be Mar.'81, etc.)



ACRES

ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT
PLAN OF STUDY

LOGIC DIAGRAM
PROJECT FINANCING

ACRES AMERICAN INCORPORATED	PROJECT: P 5477.00	PLATE TII.1

5-361/5-362

A.5.13 - TASK 12: PUBLIC PARTICIPATION PROGRAM

(i) Task Objectives

To keep the public fully informed of plans, progress, and findings associated with conduct of the detailed feasibility study, and to provide a means whereby the public (including individuals, public and private organizations, and various government agencies) can influence the course of the work.

(ii) Task Output

Outputs of the public participation program will generally include:

- Records of the proceedings of public meetings, together with written comments and proposed action lists derived from public inputs
- Monthly progress reports
- Records of the workshop meetings (to be made available upon request at the cost of reproduction and mailing)
- Records of deliberations of external environmental and engineering boards (to be made available upon request at the cost of reproduction and mailing)
- Written responses to individual letters of inquiry addressed to the project information office
- Action lists, together with notes as to status of pending actions
- News releases
- Audio and visual recordings
- Displays to be set up with periodic update.

(iii) List of Subtasks

12.01 Operate Information Office
12.02 Conduct Public Meetings
12.03 Conduct Workshops
12.04 Prepare, Publish, and Distribute Information Materials
12.05 Prepare and Maintain Action List

(iv) Subtask Scope Statements

The logic diagram at Plate T12.1 provides a broad overview of the manner in which the public participation program will be conducted.

In general, this program has been constructed to provide a series of iterations which are structured for feedback. Plate T12.2 illustrates the process. On a continuing basis throughout the course of the work, information regarding progress, preliminary findings, and plan revisions will be published; comments will be sought; action lists incorporating issues and concerns will be prepared; the plan of study will be updated; and a new information publication will be triggered.

External engineering and environmental boards will provide an independent review as well as a recourse in the event that the consultant's proposed actions or actual efforts are perceived as unresponsive to expressed concerns. Detailed descriptions of individual subtasks are contained in succeeding paragraphs.

Management of the Public Participation Program will be the responsibility of the Alaska Power Authority.

Subtask 12.01 - Operate Information Office

(a) Objective

To provide a central point for public access to project information; provide a coordinating agency for processing information requests, comments, and objections; and provide positive control for meeting scheduled information milestones.

(b) Approach

As soon as work commences on the feasibility study, an information office will be opened and a public participation project officer will be designated. The effort will demand the full time services of the information officer throughout the period during which the study is conducted as well as require administrative support and the part time assistance of others as the work progresses. By providing this vital link between the public and the study team, we expect to ensure that all inquiries are answered, that no comments are ignored, and that an aggressive information program is carried out.

It will be the duty of the information officer to design the format of other information activities (public meetings, workshops, newspaper tabloids, etc.) as well as make the necessary administrative arrangements.

The public participation project officer and assistants will be employees of the Alaska Power Authority.

(c) Discussion

Experience has shown that the typical professional engineer is reluctant to subject his preliminary findings to public scrutiny (and possibly criticism) until he has gathered all of the data he believes is necessary and has checked and double checked his results. The existence of an information office and the designation of an information officer will provide a means for the public to be kept abreast of what is transpiring as well as what is planned. Daily contact with various project personnel will allow the information officer to discharge his duties properly as well as free the engineers and the environmental scientists to concentrate on the skills at which they are most adept.

It is highly probable that periods of frenetic activity will occur as the information program is carried out. On such occasions, we anticipate seeking the assistance of additional locally hired staff to augment the normal information staff.

Coordination on a regular basis with agencies charged by statute or by executive order with direct involvement, or with organizations such as bulk recipients and distributors of electric power, will generally be accomplished directly at the appropriate action level without intervention or involvement of the information office. Even so, the information officer will be expected to assume the role of expediter in any case where it comes to his attention that required coordination is not being accomplished.

(d) Schedule

Entire study period.

Subtask 12.02 - Conduct Public Meetings

(a) Objective

To provide widely publicized opportunities, scheduled in advance in convenient locations, for presenting information to the public, soliciting their comments and concerns, addressing their questions, and involving them in the work; establish an official record of these public participation milestones as the basis for subsequent identification of specific actions to be incorporated into follow-on work; and offer the benefit of public reactions to the views of independent external environmental and engineering boards who will review the recommendations of the project managers at crucial milestones.

(b) Approach

Public meetings will be scheduled for the three following decision points:

(1) Near the start of the work so that the public may be informed of the plan of study and afforded an opportunity to comment on it.

(2) After one year's work is completed, at which time sufficient data will be available to permit recommendations as to whether to proceed. At this point, the public will have available for consideration a river basin plan, a comprehensive alternatives study, a progress report on all study work completed to date, and an updated plan for work to be undertaken in succeeding years.

(3) After preliminary findings are developed and initial drafts of all exhibits to be submitted with license application to the Federal Energy Regulatory Commission are prepared.

At each of the above milestones, three separate public meetings will be held in a two-week period--one each at Anchorage, Fairbanks, and Talkeetna. In addition, at least one meeting will be held in the Palmer/Wasilla area. Information to be addressed at each of the meetings will be made available at conveniently accessible points (e.g., public and school libraries) or at cost to those who wish to acquire personal copies. In each case, brochures summarizing progress, future plans, and problem areas will be prepared and distributed free of charge.

A written comment period of 30 days will be encouraged so that the action list can be updated in the most timely manner possible. This 30 day period does not in any way limit public comment throughout the course of the work. Indeed, the information office will receive and acknowledge written and oral inputs throughout the entire study period, and will coordinate the preparation of entries on action lists. The value of the relatively brief period for response to the public meeting lies in making entries on the action list as early in the planning process as possible. Some entries may have cost and scheduling implications and these are accommodated most easily during the early stages of planning.

(c) Discussion

The value and complexity of the proposed project as well as its location necessarily demand thorough--and almost inevitably, voluminous--reports, calculations, data tabulations, and the like. While such information will be made available for public scrutiny each time a reasonably separable package has been prepared, it is unlikely that the average concerned citizen will have the time or the education and experience to read and digest all of it. The public meeting affords an opportunity for every citizen to learn of what is planned and what has transpired, as well as to offer comment, advice, and/or criticism in a public forum. To be sure, public meetings are generally too large (and too diverse in interests represented) to make them efficient vehicles for generating compromises and courses of action which best meet study objectives while simultaneously addressing key issues raised by conflicting interests. We anticipate satisfying the latter need in part by scheduling and conducting workshops.

The meeting will be conducted by a team consisting of Power Authority staff, Acres staff, and appropriate subcontractors on the Acres team.

Public meetings are designed to be just what their name implies--an opportunity for the public to become aware of and involved in the work. They are primarily held to satisfy the needs of individuals, though no attempt will be made to stifle the inputs of organizations or agencies. While public inputs during the meeting and subsequent written comment periods are likely to include significant numbers of expressions of concurrence or of opposition, the results will not be regarded as a vote. Even so, summary records of the range of reactions will be maintained as a part of the record for later consideration during FERC hearings and interventions (if the latter occur).

(d) Schedule

Weeks 10 to 12; 52 to 54; 120 to 122

Subtask 12.03 - Conduct Agency Coordination and Public Participation Workshops

(a) Objectives

To provide scheduled opportunities for discussion, coordination, achieving appropriate and acceptable compromises, and in general addressing the needs of organizations and agencies having particularly strong interests in the course of the work; provide the vehicle for inputs and advice from particularly knowledgeable representatives of special interest groups, as well as an opportunity for dialogue not readily available at public meetings; and provide the public a chance to observe the face-to-face encounters and the discussions occurring at workshop sessions.

(b) Approach

Eight workshops are planned, six of which are scheduled in advance and two of which are reserved to address issues of opportunity. Each such session may last three days or more and will be divided into a series of subsessions so that time can be set aside for addressing the special interests of the following groups:

- Utilities in the Southcentral Railbelt
- State and federal agencies charged with regulation and preservation associated with the project
- Native villages whose lands or livelihood will be impacted
- Certain environmental organizations
- Others with whom coordination is needed

Because the capability to achieve compromises deteriorates as the number of participants increases beyond a dozen or so, ACRES proposes to recommend a manageable number of organizations to APA based upon an attempt to identify interests most clearly and substantively impacted by the project. (In this regard, for example, we would choose a recognized environmental organization operating in Alaska and concerned specifically about project impacts as they directly affect the Alaskan environment and the Alaskan quality of life over a national environmental organization whose objectives may be oriented toward "national" interests and whose representatives have not lived in and may seldom visit the State).

Each workshop session will probably last three days. The first two days would be for discussion and coordination with utilities, state and federal agencies, and native villages. This format will be designed by ACRES. Observation is possible and is encouraged by the public. Even so, oral comments and suggestions from individual observers in attendance will not be solicited during any session. Forms will be available, however, for attendees to express their views.

At least the last day of a workshop will be for discussion, and for achieving appropriate and acceptable compromises with environmental organizations. The design of this day will be by the public participation staff of the Power Authority. Again, public observation is possible and is encouraged.

Subsequent to each workshop, minutes of the meetings will be prepared and published, and action lists will be updated to account for agreements reached during the session as well as to reflect important inputs from various observers.

(c) Discussion

Whereas public meetings (Subtask 12.02) were described as responsive to the participation needs of individuals, the workshop sessions are designed to satisfy group or agency participation needs. The difficulty comes, of course, in selection of proper participating groups. We will make recommendations in this regard, but the choice is properly one for the State of Alaska. Thus we will rely on APA as the arbiter in the event that any interested organization seeks recourse from proposed exclusion.

There is some slight danger that exposing workshop sessions to public view may inhibit participants and keep them from "letting their hair down." In balance, though, we regard the public's right to know as the more important consideration and our costs are derived on the assumption that reasonably large facilities will be required and that a substantial number of interested persons will observe and will express views on the forms to be provided.

By regularly scheduling most of the workshops, we hope to ensure that surprises are avoided and that both the team and sub-session participants are kept fully aware of each other's progress. Given the sheer magnitude of the work, though, it is entirely possible that unforeseen events of great consequence for the proposed project will occur. Two workshops are included in the estimated costs to account for our perception that certain important new issues will need to be addressed when they arise rather than at a future scheduled meeting.

(d) Schedule

Weeks 18, 32, 47, 58, 72, 89, 106.

Two additional weeks to be scheduled during the course of the study.

Subtask 12.04 - Prepare, Publish, and Distribute Information Materials

(a) Objective

To ensure project information is made available on a regular and convenient basis; make explicit provisions for commitment of resources in support of a strong and aggressive public participation program; and support the assemblage of a proper historical record of the sequence of events leading to license application, and, if results so indicate, to eventual design, construction, and operation of a hydroelectric plant(s).

(b) Approach

This subtask will be undertaken to "translate" into readable language the various technical and scientific reports produced throughout the study. Graphics and photographs will be used to enhance readability. Specific efforts include the preparation, publication, and appropriate distribution of the following:

(1) A description of the major "players" involved in the Susitna decision. The players are both individuals and groups, formal decision makers and informal. In order to effect decisions, the public needs to understand who is making the decisions and when.

This effort will include interviews with the major players, and write-ups accompanied by photographs.

(2) Plan of Study.

The full plan of study is several inches thick and describes all studies to be managed by Acres over the next two-and-a-half years.

Specifically, the translation of this into an oral presentation will be used at the first round of public meetings. It will also be used with numerous informal meetings with special interest groups.

(3) Demand and Load Forecasts.

The preliminary report is due March 1980 from ISER, with the final report in June. The Public Information Office will draft a lay version of the information in order that the public understands the basis of all future work on alternatives.

(4) Alternatives Study.

The major items to be defined precisely for public understanding are the following:

- the alternatives
- impacts of the alternatives on the environment
- costs associated with alternatives
- social consequences of alternatives.

(5) Progress Report.

Studies are being conducted by Acres, by numerous subcontractors of Acres, by several legislative committees, and by numerous subcontracts of the legislative committee.

A useful progress report of the entire Susitna issue should include reference to all studies.

The coordination and tracking of the legislative studies is not the direct responsibility of the Power Authority.

Even so, the inclusion of these studies, and a description of how they relate to the ACRES studies, should be a part of the progress report in January 1981.

This document will accompany the alternatives study as one of two major pieces available to the public prior to the January 1981 public meeting.

The public information office will manage the translation of the above documents. Actual preparation of the technical reports and of oral presentations by Acres will be undertaken by the appropriate team member responsible for technical details. In the case of special graphics, subcontracts with Alaskan business will be sought.

Outputs of the public participation program will generally include:

- Records of the proceedings of public meetings, together with subsequent written comments and proposed action lists derived from public inputs,

- Monthly progress reports,

- Records of the workshop meetings (to be made available upon request at the cost of reproduction and mailing),

- Records of deliberations of external environmental and engineering boards (to be made available upon request at the cost of reproduction and mailing),

- Written responses to individual letters of inquiry addressed to the project information office,

- Action lists, together with notes as to status of pending actions,

- News releases,

- Audio and visual recordings,

- Displays to be set up with periodic update.

The costs of such an extensive effort are not inconsequential. Thus, certain distribution categories will be established as follows:

- Extensive distribution, free to the public, of summary data such as information brochures and pamplets,
- Wide distribution of bulky or voluminous materials (such as basin plan, alternative study) to strategically located information centers (e.g., libraries) (Requests for individual copies will be fulfilled at cost),
- Pinpoint target distribution of materials for publication by others (newspaper, magazines, etc.) at no cost to the recipient,
- Satisfaction of information requests at cost for various intermediate reports and data collections not normally routinely distributed.

We anticipate awarding one or more subcontracts (for printing and binding information materials) on a competitive basis to Alaskan firms (unless no capacity is available in Alaska at the time a subcontract is advertised or unless cost savings of 25 percent or more can be otherwise achieved).

(c) Discussion

A key element in the entire information publication process is timeliness. Thus, it will be important to ensure pertinent materials are available sufficiently far in advance of various meetings and workshops to permit review prior to the event.

Our plans to put the entire public participation program in the hands of a single manager and to deal exclusively with locally available subcontractors for logistical support of the program will contribute to our successful satisfaction of the timely distribution problem.

To maximize readability to the general public, graphics and photographs will be used as much as possible to help convey complex ideas and technical concepts.

To maximize coverage without incurring unreasonable costs, we intend to encourage the use of austere standards. An exception to this might be the decision to distribute information through the printing of a newspaper tabloid rather than a more limited distribution through photocopying and mailing. In regards to austere standards, for example, covers (where necessary) will be paper; colors will not be used except where necessary for clarity of a particular map or figure; volumes will be stapled rather than spiral bound or glued, and a variety of similar restrictions will be enforced.

(d) Schedule

Throughout project period.

Subtask 12.05 - Prepare and Maintain Action List

(a) Objective

To provide a positive system for ensuring all issues are addressed; permit up-to-date status reports on progress and procedures for addressing issues; and ensure that all necessary actions arising from the public participation program are assigned by name to team members.

(b) Approach

Subsequent to the first public meeting, all comments will be reviewed and a list will be drawn up in the form of individual actions sought by the public. The action list will be prepared and maintained by the APA public participation staff. The project manager will review the list and will mark certain actions as inappropriate for further pursuit, together with a brief note explaining why the requested action was recommended for rejection.

The action list will then be completed to include, for each approved action, a control number to facilitate tracking, the name of the team member responsible for carrying it out, cost and schedule implications (if any), and a target date for completion. Once the list is completed, it will be reviewed by APA, who will accept the recommendations of the project manager or revise the list as appropriate. Additional columns on action list registers will be available to indicate status, to permit recording remarks, and to indicate the number of times the particular action is requested by various members of the public.

The action list will be updated manually on a regular basis after each succeeding workshop or public meeting, or more often if significant numbers of substantive comments are received in the information office.

(c) Discussion

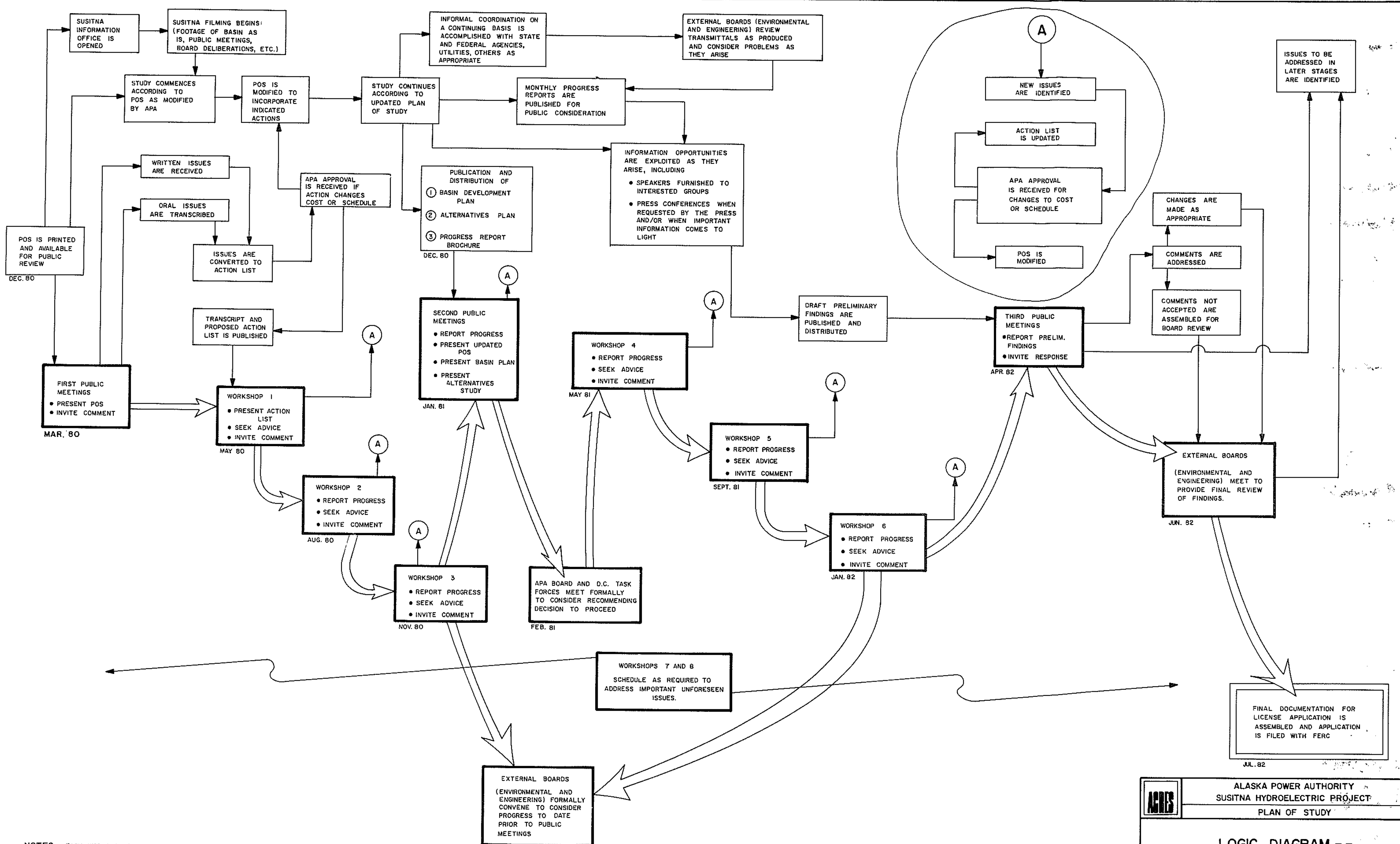
Assuming our study plan is a good one (and we are convinced that it is), it is logical to assume that most requested actions will already have been provided for.

In such cases, of course, neither cost nor schedule impacts will accrue and the "remarks" column of the action list will note that the necessary work is already planned. Even so, a public participation effort is specifically designed to ensure that individual concerns are considered--and it follows that some new ideas, real concerns or innovative approaches will be earmarked for consideration.

We suggest that the proposed action list system is a positive means for demonstrating to the public that their views are being carefully considered and that public participation is not being regarded as a necessary evil to which lip service must be paid.

(d) Schedule

Throughout project period.



NOTES: EACH WORKSHOP SHALL INCLUDE TIMES SET ASIDE FOR FORMAL SEPARATE DISCUSSIONS WITH (1) UTILITIES, (2) INTERESTED STATE AND FEDERAL AGENCIES, (3) NATIVE VILLAGES WHOSE LANDS OR LIVELIHOOD WILL BE IMPACTED BY THE PROPOSED PROJECT, AND (4) INTERESTED ORGANIZATIONS. WORKSHOPS MAY BE OBSERVED BY THE PUBLIC.

ACRES

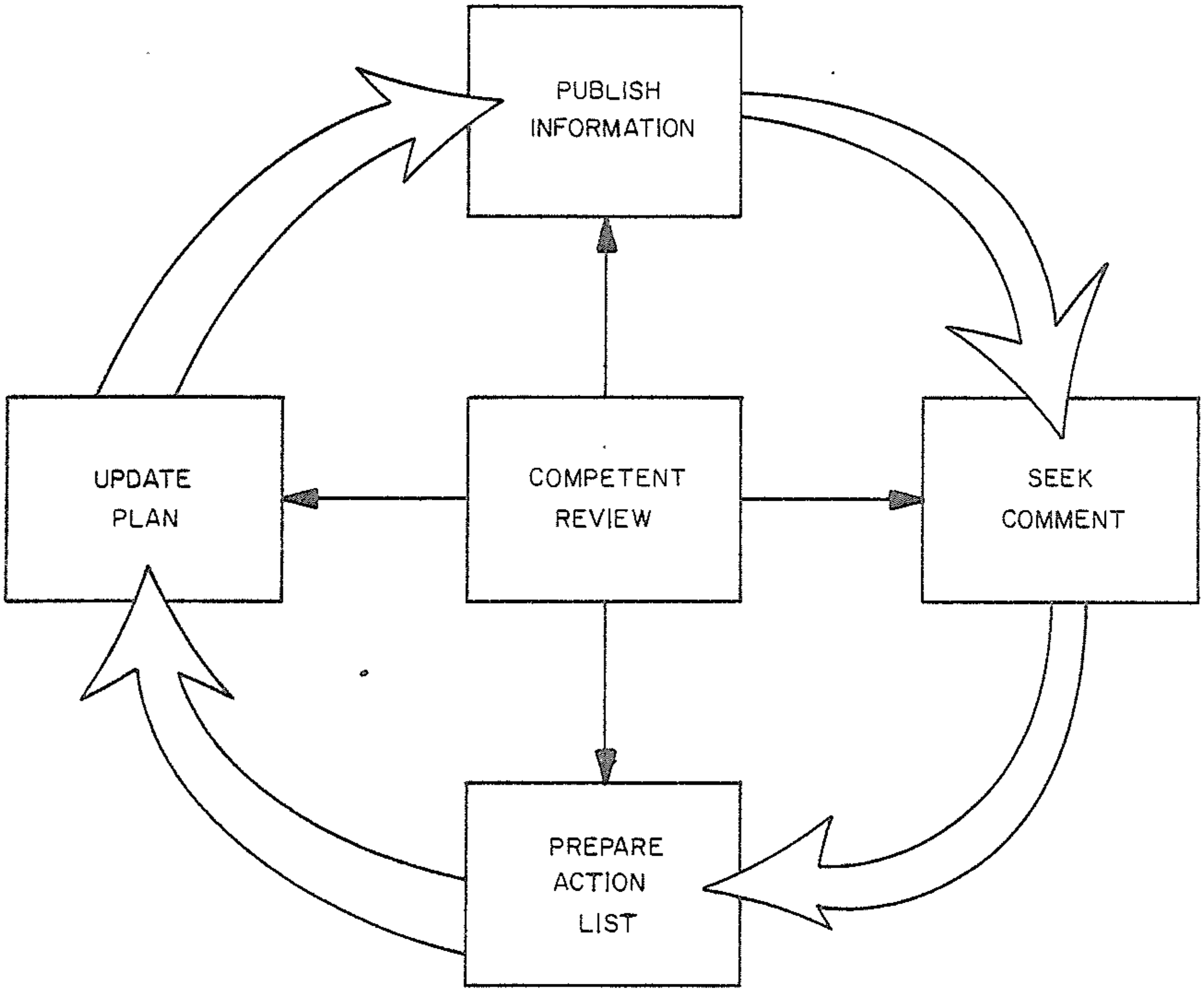
ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT
PLAN OF STUDY

LOGIC DIAGRAM -- PUBLIC PARTICIPATION PLAN

ACRES AMERICAN INCORPORATED

DATE
DEPARTMENT
PROJECT P 5477.00

PLATE: T12.1



ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT
PLAN OF STUDY

FEEDBACK PROVISIONS--
PUBLIC PARTICIPATION PLAN

ACRES AMERICAN INCORPORATED

PROJECT: P 5477.00

PLATE T12.2

A.5.14 - TASK 13: ADMINISTRATION

(i) Task Objectives

To develop for the Acres team plans, policies and procedures that will set forth the basic scheme for accomplishing the POS.

(ii) Task Output

The following documents, reports, manuals, etc. will be produced as a result of this task:

- Division of Responsibilities Manual
- Financial Control Procedures
- Project Master Schedule
  - -- Updates produced as required
- Schedule Control System
  - -- Periodic reporting to management
- Cost Control Manual
  - -- Periodic reporting to management
- Manpower Loading Schedule
  - -- Updated as appropriate
- Accounting Policies and Procedures Manual
  - -- Payroll reports
  - -- Accounts payable reports
  - -- Job cost reports
- Documentation Control System Manual

(iii) List of Subtasks

Corporate
13.01 - Prepare Division of Responsibility Manual
13.02 - Develop Financial Control Procedures

Project Control System
13.03 - Prepare Project Master Schedule
13.04 - Develop Schedule Control System
13.05 - Develop Cost Control System
13.06 - Prepare Manpower Loading Schedule
13.07 - Develop Accounting Policies and Procedures

Documentation
13.08 - Prepare Documentation Control System

Other Activities
13.09 - Pre-project Planning
13.10 - Coordination with Other Agencies
13.11 - ADF&G Support

(iv) Subtask Scope Statements

Administrative procedures will be identified and developed to form the elements of the project control system that will provide management visibility and control of the planning, data gathering, design, engineering, and finally, license application, portions of this POS. Preparation of documentation control procedures will assure that the information so valuable to completion of the POS moves smoothly and reliably. Certain adminstrative support effort and pre-contract award work must also be accounted for.

Subtask 13.01 - Prepare Division of Responsibilities Manual

(a) Objective

To establish the basic "How we will work" rules for the duration of the POS.

(b) Approach

Acres/Moolin corporate level personnel will prepare and review all input to this manual including:

- Project responsibility matrix
- Organization charts
- Approval authorities
- Specific duties and responsibilities of individuals/organizations
- Description of control systems and how they will be used
- Correspondence procedures

We will draw upon a depth of expertise within both organizations that has been gained on other similar projects to produce a valuable working tool.

(c) Discussion

Obviously, it is extremely important to establish early in the project, the basic documents that will be used to chart the course of the project and provide a basis for future strategy and policy decisions. The remoteness and sensitivity of the prime work location require that these policies and procedures be clearly understood by all field personnel in order that the work effort be advanced in a timely and cost effective manner.

(d) Schedule

Weeks 0 through 2

Subtask 13.02 - Develop Financial Control Procedures

(a) Objective

To develop and document the procedures used to pay the project costs and to establish budgetary control procedures.

(b) Approach

Acres/Moolin will work directly with the appropriate APA personnel in order that an agreed upon plan for handling these procedures be prepared early in the project. The following subjects will be addressed:

- Funding of engineer
  - Cash advances
  - Zero balance bank accounts
- Paying project costs
  - By advances or zero balance accounts
  - Directly by APA after verification
- Budget control
  - Original estimates
  - Basis for making budget revisions
  - Budget change procedures

(c) Discussion

It is important to recognize that the difficult site conditions may well lead to severe constraints on the field data gathering operations. The possibility of expanded/revised investigative requirements that may be imposed, either by design or other outside influences (APA, Federal, environmental), should also be understood. It is important that clear procedures be in force to handle such eventualities.

(d) Schedule

Weeks 0 through 4

Subtask 13.03 - Prepare/Update Project Master Schedule

(a) Objective

To establish and monitor the POS schedule showing the relative schedules of all functional areas/organizations.

(b) Approach

Each company within the Acres team will be responsible for the identification and scheduling of all the necessary tasks/subtasks to complete the project in accordance with the overall objectives. Each of these individual schedules will then be consolidated into a tentative Project Master Schedule, the basis of which is presented in this POS as Plate A7.1 and A7.2. The schedule will be presented in two separate forms:

- Bar chart format
  - -- Showing relation to progress for each individual subtask
  - -- Indicating dates of critical milestones/decisions
- Time based logic diagram showing
  - -- Decision milestones
  - -- Report submissions
  - -- License applications
  - -- Key meetings
  - -- Special presentations

As final reviews by APA and others dictate changes to the master schedule, it will be updated to reflect these changes. Also, the Project Master Schedule will be updated throughout the life of the project to reflect the completion of the various stages of the project and the possible changes required by early completion dates, slippages and other situations/constraints.

A computerized scheduling system will be employed for schedule control purposes. This system will be that presented in Part C3 of the POS or similar.

(c) Discussion

Adequate identification of the complete scope of work and a thorough understanding of potential constraints are the key elements to establishing a realistic schedule. For the purposes of this POS, it is assumed that the majority of the work effort will be directed towards eventual construction of Watana and Devil Canyon dams. This seems a likely probability; however, unforeseen events may expand the scope of work at either of these two sites or even require additional work at alternate sites. Although these occurrences cannot be predicted with any accuracy, and thus not scheduled, there are a number of "fall-back" positions that will be developed to ensure a timely completion of the work. Many of these problems can be handled by early identification of additional/alternate personnel and equipment, larger or alternate camp facilities, expansion of "off-season" operations, where possible, etc.

(d) Schedule

Weeks 0 through 4 (Initial review)
Continuous update as required

Subtask 13.04 - Develop Schedule Control System

(a) Objective

Identify the necessary parameters, establish information gathering systems and reporting methods to eliminate or minimize schedule slippages.

(b) Approach

Acres and Moolin personnel will work jointly to accomplish the following tasks leading up to a working schedule control system:

- Each discrete activity will be entered into a weighted percent complete reporting system.
- A baseline schedule for each category of work showing percent complete versus time will be prepared.
- Data gathering procedures and reporting formats and levels will be identified.
- Programs will be developed to accomplish the following:
  - Pinpoint and analyze all schedule slippage areas
  - Determine potential impact of slippages
  - Recommend corrective actions
  - Forecast anticipated completion dates
  - Perform regular reviews with management

(c) Discussion

Schedule control requires an accurate and timely reporting of data and the timely and committed review of data by those personnel responsible for control. The Acres/Moolin team has a great deal of experience in this regard, both in the planning of other large hydroelectric projects and in remote arctic environments. The ability to identify schedule problems at an early stage has been demonstrated on projects of equal or greater complexity.

As in the actual schedule preparation phase, the constraints must be identified early, by working directly with government agencies and others, to control schedules successfully. These agencies and others must be willing to participate, accept and commit themselves to this effort. In addition, the cost and benefits of constraints must be developed to allow senior APA and government officials to make rational go/no-go decisions.

(d) Schedule

Weeks 2 through 125

Subtask 13.05 - Develop Cost Control System

(a) Objective

To develop the necessary management tools and control systems for monitoring, reporting and control of project costs.

(b) Approach

The cost control system will be developed using the expertise of both Acres and Moolin personnel. Proven methods used on similar projects will be employed to ensure that a workable, unencumbered system is established. The following steps will be necessary:

Establish cost control centers. The work effort will be broken down into various elements, each of which will be controlled by a single manager/supervisor. This manager/supervisor will ultimately be responsible for all costs incurred in his area of responsibility.

Establish a project Code of Accounts. This will be the lowest level of detail utilized by the cost and schedule control system. The Code of Accounts will allow easy identification and isolation of each basic work element.

Prepare a cost estimate, based upon the cost estimates for each individual task/subtask, for each cost center.

Establish data gathering systems and reporting formats and levels. Both manhours and dollars expended will be reported for the control period and the total to date. Completion costs will be forecast and projected overruns/underruns will be tabulated.

A program will be developed to:
- Identify and analyze all cost overrun areas
- Recommend corrective actions to eliminate or minimize cost overruns
- Forecast total costs and potential scope of overruns
- Regularly review with management all cost reports, analyses and recommendations

(c) Discussion

The cost center concept is a valid one and has been used successfully on other similar projects. The success of the program depends to a great extent upon the participation, acceptance and commitment of those managers/supervisors identified as having cost center responsibilities. It requires a careful selection of personnel to ensure that costs are controlled. Many qualified personnel exist within the Acres/Moolin team who are familiar with this concept.

The main center will be established at Acres head office in Buffalo where established in-house project cost-control systems have been in operation for many years. A secondary center will be established in the proposed Acres' Anchorage office and appropriately linked with the Buffalo center.

(d) Schedule

Weeks 0 through 125

Subtask 13.06 - Prepare Manpower Loading Schedule

(a) Objective

To establish a manpower requirements schedule for the duration of the POS.

(b) Approach

This schedule will be established to coordinate employment, support services and equipment needs. As the manpower requirements for each discrete element of work are identified, they will be consolidated, based upon the Project Master Schedule, to produce a tabulation of manpower requirements versus time and location. In addition, the equipment needs to support the level of manpower required will be tabulated in a similar manner.

(c) Discussion

The Manpower Loading Schedule is a straightforward tabulation and will be used primarily to determine the size and location of camps. However, camp size must include space not only for the engineers field personnel, but also for management, government and transient personnel.

(d) Schedule

Weeks 3 through 4

Subtask 13.07 - Develop Accounting Policies & Procedures

(a) Objective

To develop and implement the necessary accounting policies and procedures to satisfy project requirements and support administrative control systems.

(b) Approach

Acres and Moolin personnel will work together to identify the project accounting requirements that will satisfy the needs of APA and other agencies involved, project control, procurement and tax aspects of the project. The input/output requirements will be identified and appropriate systems will be developed to provide the required output. Tentatively, all activities occurring in Alaska, both in the field and local project offices, will be processed by Acres' Anchorage office personnel with the backup assistance of the offices of Frank Moolin & Associates in Fairbanks and Acres' Buffalo facilities. Activities occurring in the corporate/design offices of Acres American will be handled by computer capability from the Buffalo, New York offices. Written accounting procedures will be prepared and issued as soon as possible after contract award to cover the following areas:

- General accounting
- Accounts payable
- Billings
- Invoicing
- Internal control
- Auditing
- Banking
- Expense accounts

(c) Discussion

Since much of the accounting input originates from remote field locations, it is imperative that timely and accurate transmittal of data be maintained. It will be the responsibility of the individual field supervisors and the field project manager to review all input prior to transmittal to the processing facility. It is important that the field personnel be aware of the input requirements and that they be committed to following through with this effort. Both Acres and Moolin personnel have worked under similar circumstances before and are familiar with these types of problems and how to cope with them.

(d) Schedule

Weeks 0 through 4 (Continuous update as required)

Subtask 13.08 - Prepare Documentation Control System

(a) Objective

To establish the methods to be used throughout the project for transmittal, storage, retrieval and display of all pertinent documentation.

(b) Approach

FERC license application and APA requirements will be used as guidelines to determine the documentation requirements. In addition, the requirements of local, state and federal agencies will be included. Finally, "in-house" document flow in support of design, cost and schedule activities must be considered and accounted for. Filing systems, records retrieval and a record storage system will be established, along with orderly methods for flow/transmittal of both internal and external documentation and correspondence. Included will be a tracking system to monitor the flow of documentation between field and office locations.

(c) Discussion

Prior to preparation of FERC license application and the various individual POS reports (power alternatives, development selections, environmental, hydrological, etc), it is extremely important that a system be implemented as early as possible to control and account for the large volume of documentation that will be gathered. Particular care and attention must be used when transferring documentation from remote field locations to the central offices where it will be reduced and stored.

(d) Schedule

Weeks 8 through 9

Subtask 13.09 - Pre-Project Planning

(a) Objective

To execute changes in the plan of study and carry out other activities at the request of the Authority in the pre-project time; i.e. prior to the actual project start date.

(b) Approach

At the request of APA incorporate revisions to the POS stemming from agency input, public input, meetings with public interest groups, study of certain options relating to more economical camp and logistics support, preparation of estimates to reflect ISER involvement and revisions to the financing and public participation programs.

(c) Discussion

This subtask covers work undertaken on behalf of the Authority subsequent to October 1, 1979 and prior to contract execution and covers such items as trips and coordination associated with ADF&G, DNR and APA.

(d) Schedule

Prior to contract execution.

Subtask 13.10 - Coordination with Other Agencies

(a) Objective

To provide a forum for state and federal agencies participation in the Susitna Hydroelectric Project Plan of Study.

(b) Approach

State agencies will have a role in the Susitna studies to the degree that they desire such a role and to the degree that the agencies' functions and responsibilities create an interest in the studies. Due to the importance of the issues involved and the magnitude of the potential project, widespread and extensive agency participation is anticipated.

There are three primary areas for agency involvement in the studies. First, there is participation in developing the plan of study. The plan of study is an evolving document that will only be final when the last study is complete. Preparation of the plan of study began in July 1979 with a review of the Corps of Engineers plan of study, a review of Devil Canyon Task Force and state agency comments made in response to previous Susitna studies, consultation with a panel of interested citizens, and review of biological studies recommended by ADF&G. In September, the plan of study was widely circulated, compared to competing proposals, presented publicly, and critiqued by individuals, organizations and agencies. ADF&G was then provided up to $20,000 to cover expenses incurred in the refinement of the biological study program. Meetings were also held with DNR, DEPD, ADF&G, DPDP and interested organizations and individuals during October, November, and December, 1979 for the purpose of refining the plan. The plan will be continually modified to insure that appropriate data is collected and analyzed to permit informed decisions regarding project feasibility and design and to meet the licensing requirements of the Federal Energy Regulatory Commission.

The second area for agency involvement is actual performance of certain studies. Where a state agency has the appropriate expertise and capability to respond in a timely manner, and where economies can be realized, such agencies will be requested to conduct certain studies. For example, ADF&G is under contract to conduct certain biological studies and ICER is under contract to develop projections of the possible future energy consumption trends for the Railbelt Region. The results of such work will be provided to Acres American Incorporated who remains responsible for controlling quality, meeting schedule, and assimilating the various activities.

The final area for agency participation is in the review of progress reports and planning and design documents that will flow from the study program.

While there are three general areas for agency participation, there are actually four ways to participate. First, an agency can involve itself as part of the established public participation program. The program is centered around three sets of public meetings, eight sets of workshops and an affirmative system to follow up a comments. Each workshop will include time set aside for formal separate discussion with state agencies. The public meetings are presently scheduled for February 1980, January 1981, and April 1982. The workshops are tentatively scheduled for May, August, November 1980, May, September 1981, and January 1982. Two others will be scheduled to address unforeseen issues as they develop.

An agency, if interested, can also participate as a member of the interagency biological studies steering committee. This group will be the focal point of federal and state coordination of the fishery and wildlife study programs.

As mentioned previously, state agencies may be actually involved in and responsible for the conduct of certain studies.

Finally, in addition to the various means of participation outlined so far, each agency is welcome and encouraged to deal directly with the Power Authority on any matter and at any time. An agency comment or request will be actively and rapidly followed up.

(c) Discussion

Following is a more detailed description of suggested agency involvement in the three areas of participation.

(1) Plan of Study

The importance of agency involvement in the preparation and refinement of the plan of study cannot be overemphasized. Each agency has an interest in insuring that those questions considered important to establishing the feasibility of the project and to proper design will be addressed during the planning and design process. It should be kept in mind, however, that the plan of study now under consideration addresses only the first 2 1/2 years of a licensing process that is expected to take approximately 5 years.

ADF&G, DOTPF, DEC, DNR, DPDP, DCRA and DCED will all receive copies of this plan of study, as will DEPD. The first series of public meetings, the primary subject of which will be the plan of study, will be held in February 1980. As noted earlier, separate discussion with state agencies will be formal part of each of the eight (8) workshops. The result of each public meeting and workshop will be a modification of the plan of study as new issues are identified. The content of the plan of study will also be the focus of the interagency biological studies steering committee, comprised of USF&WS, NMFS, DNR, ADF&G, DEC and USGS.

(2) Agency Study Participation

As presently envisioned ADF&G will conduct certain of the fish and wildlife studies through a reimburseable services agreement with the Power Authority. At a later stage of the study, DNR may similarly participate in the realm of instream flow studies. Special effort will be made to foster active participation by DEPD, especially in the broader energy planning issues. Space will be made available to DEPD and ADF&G in the Acres project office to encourage maximum interchange with planners on a daily basis during the study program.

Agency expertise and capability in other areas of study should be made known to the Power Authority if an active role in the studies is desired.

(3) Agency Review of Study Output

Progress reports and study documents will be provided to DPDP, ADF&G, DNR, DEC, DCRA, DOTPF, and DECD and also to DEPD. Comments can be made directly to the Power Authority or through the established series of workshops. The Devil Canyon Task Force will be asked to meet formally in February 1981 to consider whether the studies should proceed further, be redirected, or be terminated.

State agency coordination is important throughout the feasibility study and licensing process. The program suggested herein can be modified to accommodate a larger or smaller role as desired by each agency.

(d) Schedule

Throughout project period.

Subtask 13.11 - ADF&G Support

(a) Objective

To provide both administrative support and office facilities for ADF&G personnel engaged exclusively on the Susitna project.

(b) Approach

The ADF&G personnel to be engaged on the project exclusively as determined by ADF&G will be housed in Acres' project office. At this location they will be provided with administrative and office support which will be common to all project office activities.

(c) Discussion

The project office expenses related to this subtask will include additional office space lease costs, furnishings, office equipment, communications equipment, office supplies and the like, including storage facilities for equipment. The actual costs associated with this subtask are included under Task 7, Subtask 7.10.

(d) Schedule

Weeks 26 through 130.

SECTION A6 - POST LICENSE APPLICATION SUBMISSION ACTIVITIES

SECTION A6 - POST-LICENSE APPLICATION SUBMISSION ACTIVITIES

A6.1 - Introduction

The study activities detailed in other sections of this plan of study have been provided in accordance with the original APA Request for Proposals dated June 25, 1979, and subsequent modifications as noted throughout this POS. APA has also requested a description and preliminary cost estimate for activities which will follow submission of the license application up to a point when the license is received and construction work commences.

The approach recommended by is based on a preliminary assessment of the probable sequence of construction of project components which in turn is based on the Corps of Engineers' 1979 Report construction schedule. The first construction contract will consequently be for the Watana diversion facilities. Assuming no unforeseen serious interventions occur during the licensing process, the FERC license (which would allow construction to commence) should be awarded by early 1985. Engineering work to that point should therefore concentrate on design activities and preparation of bid and contract documents leading to award of a diversion construction contract immediately after receipt of the FERC license. Construction of the pioneer access road to Watana should also be completed by 1985.

A more conservative approach would involve accomplishment of only those activities necessary for award of the FERC license, deferring advanced design and access road work until later. Throughout the remaining portions of this section, work packages associated with expediting project completion are referred to as "Fast Track" and the conservative approach is designated as "License Only".

In this section of the proposal, summaries of activities to accomplish alternative post-license objectives are presented under the same general task headings discussed in Sections A1 through A5.

No significant activity is anticipated under the following tasks:

Task 1: Power Studies
Task 8: Transmission

The following tasks will continue, but at a lower level of activity than during the first phase:

Task 2: Surveys and Site Facilities
Task 4: Seismic Studies
Task 10: Licensing
Task 12: Public Participation

The remaining tasks will continue at a similar or increased level of activity including:

Task 3: Hydrology
Task 5: Geotechnical Exploration

Task 6: Design Development
Task 7: Environmental Studies
Task 9: Cost Estimates and Schedules
Task 11: Marketing and Finance
Task 13: Administration

The following discussion describes the anticipated activities that will be undertaken during the period through commencement of construction of the Watana project or through receipt of license.

The schedule associated with this work is shown on the Summary Schedule (Plate A2.1) and on the Master Schedules (Plates A7.1 and A7.2).

A6.2 - Surveys and Site Facilities

(a) Fast Track

The permanent base camp at Watana will be used as the base from which continued field studies in hydrology, geotechnical exploration, seismicity and the environmental areas will be conducted. Detailed surveying of the Watana site in support of Watana dam design activities will also be continued. A description of the camp is contained in Section A.8 - Logistical Plan. Equipment, most of which will be used in conjunction with the field activities and thus located at the base camp, will continue to be used after having been purchased during the first phase of the work.

During this phase, the airstrip at the Watana site would be upgraded to support the level of activity required to complete the preliminary engineering of the Watana facilities. In the event that no airstrip has yet been built, the need for it will be thoroughly evaluated. At the same time, a pioneer access road would be constructed utilizing portable or prefabricated bridges.

Additional activities conducted during this phase include photogrammetric mapping, hydrographic surveys, slope stability and erosion studies along the road access route.

(b) License Only

The permanent base camp at Watana will support continuing field studies in hydrology (particularly in-stream flow studies), seismicity and environmental areas. No further design support work will be conducted. To the extent that the External Review Board requires additional work to support initial findings (e.g., in the seismic area), it will, of course, be supported under Task 2.

A6.3 - Hydrology

(a) Fast Track

Following submission of the FERC license application, work will continue on obtaining hydrologic, hydraulic, ice and climate data. This information will provide the input to further studies necessary to complete the detailed project design and prepare contract documents and specifications. The data will also be used to provide detailed information in response to queries arising out of the FERC license application and to provide partial basis for the final EIS.

A brief discussion of the additional work to be done is given below.

(i) Field Data Index and Distribution System

Work in this activity will continue as discussed under Task 3.

(ii) Field Data Collection and Processing

Work in this activity will continue as discussed under Task 3. It may be possible to reduce the number of climatic stations during the later years as sufficient design information is obtained, particularly along the transmission line route.

(iii) Water Resources Studies

Utilizing the 2 to 3 years of additional data obtained from the existing and the new stream gauges, the streamflow extension studies will be revised. The same methodology as that proposed for this activity under Task 3 will be used. The streamflow data obtained from the sites will be used to improve the extrapolation of long-term streamflow data to these sites.

The "Low-Flow Frequency Duration Analysis", "Reservoir Filling and Operation Studies", and "Statistical Analysis of Pre- and Post-Project Streamflow" analyses will be reviewed and, if necessary, repeated utilizing the improved basic streamflow data and refined Watana project layouts and construction schedules. The same basic methodology as that described under Task 3 activities will be employed. The "Evaporation Studies" will be updated using the additional climatic data collected.

(iv) Flood Studies

The "Regional Flood Peak and Volume Frequency Analysis" will be reviewed in the light of additional data. It is not anticipated that additional analysis will be called for.

The "Probable Maximum Flood Determination" will be redone using a more comprehensive methodology than originally employed by the Corps of Engineers during Phase 1. A detailed storm maximization study will be undertaken to determine the probable maximum precipitation. More extensive meteorological studies will be performed to improve the estimates of maximum temperature sequence and snow depths.

Consideration will be given to recalibrating the SSARR river basin model. However, should the studies in Subtask 3.05 indicate that deficiencies in the model's performance are due to inadequacies or lack of detail in the model algorithms, a more sophisticated catchment model such as the National Weather Services Flood Forecasting System (incorporating either the Stanford or Sacramento Models) or HSP (Hydrologic Simulation Package marketed by Hydrocomp Inc., California) will be substituted. These better models offer an improved representation of the infiltration process and the subsurface water balance which could be important in improving calibration results.

The "Reservoir Flood Routing" excercises will be repeated using the revised flood data and Watana project layouts.

(v) Hydraulic and Ice Studies

It is anticipated that the FERC will stipulate a significant amount of engineering to be undertaken prior to commencement of construction of the major project facilities. It may be possible to defer some of these activities until after commencement of diversion construction. However, the anticipated requirements are presented herein and included in estimated costs.

Unless substantial changes to the hydrology, the basic project layouts or system operating policies are made, it will not be necessary to rerun the backwater calculations (HEC-2) and the ice-cover process model dynamic flow model downstream or upstream from the Watana site. Additional refinement of the diversion design will, however, be necessary. This will require additional runs using HEC-2 and the ice-cover process model.

In addition to the above analyses, it will be necessary to undertake further computer model studies as well as hydraulic model studies. These include:

(1) Computer Model Studies

One-dimensional dynamic flow model	- Applied to Susitna reach downstream from damsite for simulating dam break conditions.
Two- or three-dimensional dymanic flow model (numeric) or alternatively an analytical solution technique.	- Applied to the proposed reservoir to simulate landslide induced surges

Computer Model Studies Continued:

One-, two- and three-dimensional water quality models	- Applied to the reservoir and downstream channel reaches to simulate water quality changes.
Reservoir sediment deposition model	- Applied to reservoir predict location of sediment deposition (only if required and considered to be reliable).

(2) Hydraulic Model Studies

Diversion facilities (including an ice cover)	- To refine design of diversion facilities (design for ice conditions and erosion protection)
Spillways	- To refine design of spillway and plunge pool facilities, determine stage-discharge relationships and minimize air entrainment in plunge pools.

Glacial studies may also have to be undertaken. If significant future changes in the glacial regime are anticipated, a more intensive field program would be required to monitor these changes. If necessary, project design and/or operation would have to be modified to suit the predicted changes.

(vi) Sediment Yield and River Morphology

The sediment yield and river morphology analysis undertaken under Task 3 action will be reviewed and, if necessary, modified by incorporating additional data.

(vii) Access Road Studies

Additional hydraulic calculations will be undertaken to determine the dimensions of all bridges and culverts.

(b) License Only

Certain data collection activities will be continued in order to improve the current limited hydrological and meteorological data base.

In this category, for example, is included operation and a minimum level of maintenance of stream gauges and several climate stations. Instream flow studies described in Section A5 under Subtask 3.10 will continue to ensure complete satisfaction of needs expressed by DNR, ADFG, and the USFWS.

A6.4 - Seismicity Studies

(a) Fast Track

The long-term seismic network designed under the pre-license application phase will be installed and monitored and the data assembled and processed.

A6.5 - Geotechnical Exploration

(a) Fast Track

Detailed drilling and in situ permeability testing wil be conducted at the Watana site to improve delineation of the stratigraphy and to identify rock properties both for dam foundations and underground powerhouses. This will include borehole photography and conventional downhole permeability testing.

At the dam sites, pump tests will be conducted to determine accurately the permeability of materials in the dam foundations. A more detailed drilling program will be undertaken in the borrow areas to delineate approximately three times the borrow materials required to provide alternatives and contingencies. Sieve analysis, Atterburg limits and moisture profiles as well as hardness tests for aggregates will be performed to identify materials. Static and dynamic triaxial tests with pore pressure measurements will be run on reconstituted samples to represent in-place materials in the dam. In addition, constant mean normal stress triaxial tests and resonant column tests will be performed to determine dynamic and static elastic parameters.

Drilling programs in the borrow areas will be supplemented by seismic surveys to delineate stratigraphy and provide a more complete picture.

Laboratory testing will be undertaken to evaluate dynamic soil properties under simulated earthquake loading conditions.

(b) License Only

No further work under Task 5 will be undertaken except as necessary to support FERC requests. Monitoring of the short term seismic network will continue through the licensing period.

A6.6 - Design Development

(a) Fast Track

The objective of project design development activities following submission of the FERC license application is essentially to continue design activities to the extent necessary for project construction to commence as soon as possible after award of license. For the purposes of this POS, it has been assumed that one site, probably Watana, will be developed first. Thus activities during this period of approximately 2-1/2 years will be devoted to design of the Watana Project and the preparation of bid documents and completion of the bidding process for the diversion system. Responses to FERC requests for additional design data prior to award of license will also be provided.

The design development concept during this period will be geared to the methods of construction and the contract packaging proposed as a result of feasibility studies prior to license application. It is most likely that contracts will be packaged in accordance with construction schedule requirements over a period of some years. Thus, to minimize the financial risks, preconstruction design development costs will be appropriately spread over a period of more than 2-1/2 years, depending on the recommended phasing of award of construction and equipment supply contracts. The work to be undertaken will include the following:

- Update of Design Criteria Manual
- Engineering support for construction of access roads
- Engineering studies, stability analyses, permafrost thaw analysis and designs for excavation, rock support, foundation treatment, grouting, drainage, embankment material sources and placement, steel and concrete structures and mechanical and electrical equipment design and selection for:

  . Dams
  . Spillways
  . Intakes
  . Penstocks
  . Surge tanks (if required)
  . Tailraces
  . Diversion facilities
  . Power facilities
  . Switchyards
  . Mechanical/electrical equipment
  . Reservoirs and site facilities

During this phase, studies for major dams and structures will include determination of design aspects such as the following:

- geotechnical criteria with respect to other disciplines such as hydraulic, civil, etc.

- design parameters from the assessment of the field and laboratory investigation data

- appropriate analytical techniques to meet the design criteria for each technical aspect of the design.

(i) Dam Design

The major design effort will be the dam and the diversion system. The main design aspects to be considered include:

- foundation and abutment conditions
- construction materials
- seismic effects
- dam sections
- cofferdams
- diversion tunnels
- permafrost studies
- construction sequence and methods.

The details that will be considered for the above aspects are as follows:

(1) Foundation and Abutment Conditions

Depending on the extent of riverbed alluvium, excavation requirements will be determined for the type of cutoff (total or partial) and impervious blanket and other foundation treatments. Excavation requirements will include removal of loose alluvium and talus materials on the abutments.

Dewatering requirements during excavation will be determined using field permeability values and field pump test data and selection of primary and secondary wells.

The following studies also will be made:

- Seepage analyses for conditions during diversion and excavation of the main dam

- Seepage through bedrock foundation and abutments with consideration of permafrost zones thawed prior to impoundment and thaw due to reservoir impoundments

- Grouting requirements in the foundation bedrock and abutments and grouting methodology in cold weather including thaw analysis

- Abutment shaping and bedrock stripping and treatment of permafrost

- Pressure relief in overburden and bedrock.

(2) Construction Materials

Further testing and evaluation of construction materials will continue with respect to impervious and rock fills, to study static and dynamic shear strength behavior and crushing potential of rock fills under high confining dam loadings. Studies related to placing constraints due to to cold weather, exploitation and hauling methods along with test fills will be performed. Excess moisture contents in the impervious fills and methods of handling will be determined.

Availability and adequacy of filter and drainage materials will be confirmed. This aspect is particularly important as unusually large zone thicknesses of such material will be required for the earth/rockfill dam, as a defense against seismic effects.

(3) Seismic Effects

The seismic design in this phase will consider in detail the following aspects:

- Review in detail of the earthquake design spectrum, the preliminary design and findings from prelicensing studies.

- Evaluation of the cyclic mobility and the liquefaction potential of the foundation and embankment materials and consideration of the various alternative methods of minimizing the damage associated with these problems.

- Evaluation of the potential for generation and dissipation of pore water pressures in the embankment and foundation materials and the possible loss of strength that may accrue as a result of these pore pressures during and following an earthquake. Dynamic analysis techniques will be used for the evaluation and prediction of field performance.

- Employment of finite element techniques to study the dynamic response and the time history of stresses and deformations. Nonlinear material properties and the interaction between the dam and the reservoir will be given adequate consideration.

- Selection of criteria for soil placement and improvement by considering the stability and deformations during earthquake loadings.

- Provision of an adequate system of filter and transition zones to ensure progressive erosion through continuous cracks resulting from earthquake shaking can be minimized.

- Provision of wide cores with self-healing and erosion resistant properties in the event cracking develops during an earthquake.

- Consideration of seismic effects in regard to proper arrangement of core, transition zones, filters and shells.

Based on the evaluation of engineering conditions of the rock, design criteria will be established for rock excavation, rock reinforcement and rock support systems. Grouting requirements to treat the mass rock against seepage and uplift and the pressure relief requirements will be determined.

(ii) Powerhouse Design

Rock mechanics design studies will be undertaken to prepare a semi-detailed design of the powerhouse caverns and to firm up the location and alignment based on data obtained during exploration activites.

(iii) Other Design Activites

Spillway and intake structure will be founded on rock. The study will involve detailed design treatment to provide rock support and pressure relief systems to ensure stability of the structures. Rock slope stability of the spillway foundation and side slopes will be assessed in terms of the potential presence of weak zones of rock such as shear zones and joint sets, for various loading conditions with and without seismic effects.

Intake tunnel structures will involve evaluation of the structural geology, such as faults, shear zones and joint sets in order to establish the competency of the mass rock to support the gate structures. The design will involve determination of consolidation grouting, rock reinforcement, concrete lining, etc. The design of intake structures will largely be governed by geologic and hydraulic considerations.

Studies and designs of structures will be taken to the point of producing drawings in sufficient detail for bid purposes.

(iv) Bid Documents for Watana Diversion System

Bid documents for the Watana diversion system will be prepared and issued on behalf of APA for bidding. These documents will include specifications and drawings adequate for bidding purposes. Bids will be evaluated and a recommendation made to APA for an award of the contract to allow construction to commence on receipt of the FERC license and other necessary permits.

(b) License Only

No further work under Task 6 will be undertaken except as necessary to support FERC requests.

A6.7 - Environmental Studies

Subsequent to submission of the FERC license application, some studies planned and initiated prior to license application submission must be completed. The extended time period required for completion of some of the environmental subtasks is due to one or more of the following reasons:

- The required input to a specific environmental subtask must wait completion of other tasks such as surveys, hydrological studies, geotechnical exploration or design development.

- The length of life cycle that should be observed for the environmental element being studied is greater than the 30 months pre-license application period, particularly for anadromous fish and big game.

- The activity to be completed is a slowly developing study that requires longer time periods in order to obtain input from all relevant groups such as socioeconomic analysis.

- Mitigation efforts, such as archeological excavations, are dependent upon time of discovery.

- Input from FERC is desirable before the study is completed.

- Some activities do not start until a license application is submitted, i.e., response to interrogatory or preparation of testimony.

As a result the environmental study team anticipates work to continue on at least the following subtasks into the post-license application phase of the overall project:

- monitoring of field activities
- completion of the socioeconomic analyses
- final registration, documentation and field invesigation of archeological or historical resources
- completion of the land use analysis
- completion of the recreation plan development
- assessment of the finalized transmission corridor
- completion of the fish, wildlife and plant ecological baseline studies and impact analysis

Additional studies to be completed by the environmental study team in support of FERC license would include:

- construction impact analysis
- operational impact analysis
- preparation of expert testimony and response to interrogatories
- Finally, completion and/or revision and amendment of FERC license application exhibits.

Anticipated work effort on the above listed follow-on studies is discussed in the following paragraphs. Unlike previous Tasks 3, 5, and 6, this task will still be concerned with both the Watana and Devil Canyon sites.

(a) Land Use Analysis

During this phase the information that was generated in the pre-license application phase will be refined with the focus on the lands that have been determined to be directly impacted by the project. This refinement will aim towards the elimination of data voids, additional investigation of important leads, and the development of a more detailed description of the impacted areas. Additional interviews and field reconnaissance will be conducted.

The primary emphasis of this phase will be the prediction and evaluation of the impacts on current and future land use that would result from the development of the project. The critical concerns that were identified in Phase I will be re-evaluated on the ground and in consultation with the relevant project specialists, and additional study that has been determined to be necessary will be conducted. At that point, the team will segregate graphically and summarize the actual changes expected to be caused by the development and operation of the project. The detailed specialists' reports will be the primary source documents on the specific impacts. The impacts associated with these changes, as reported by the specialists, will also be summarized and identified with specific locales (zones of change) within the project area. The magnitude, duration, and significance of the impacts will be evaluated and discussed. The impacts will be evaluated for both the construction and operation phases of the project. A discussion of measures that could be used to mitigate the adverse effects will be provided.

These results will be evaluated internally through TES staff and externally through the landowners, management agencies, and government officials. Revisions will be made with minimal additional field work and presented in the supplementary environmental report.

(b) Recreation Plan Development

The goal of the recreation planning process is to develop a master area plan based on the perceptions of the public, the limitations of the resources, the planning guidelines of the managing agencies, and compatibility with the proposed operation of the project and other public uses of the land.

Phase I (pre-license application) of the planning process will result in an analysis of the available literature, preliminary projections of recreational use, and a preliminary assessment of the resource potential for recreation. The preliminary information generated in Phase I will be refined in Phase II (post-license application) in response to detailed plans for the construction and operation of the project and data generated by other disciplines (e.g. socioeconomic, fish and wildlife).

The project lands will be initially evaluated in Phase I to determine the areas that have the greatest potential for recreational development. During Phase II the potential areas, visitor attractions and related management concerns will be located on a base map and evaluated in more detail during brief field reconnaissances. Standardized criteria will be utilized to eliminate personal bias in the field site evaluation process. After the field suitability studies are completed, those sites that are identified as having the greatest potential for specific opportunities will be further evaluated in the field to determine their feasibility in terms of providing specific experiences, site durability, safety hazards and related impacts.

It is important to relate the development as well as possible to the requirements of the managing agency. The management staff of the agency will be interviewed to determine their basic management goals, their legal mandate to operate such an area, experience in such operations, probable funding, and specific site/facility requirements in order for them to be acceptable to the agency.

Prior to the formation of the concept plans, the information that has been gathered and generated during the planning process (including information from other project specialists) will be evaluated and conclusions synthesized to establish the program goals and objectives. The objectives will be developed based on:

- User perceptions in terms of desired recreational opportunities, levels of development, and visitor services.

- Unique scenic and natural landscape features and how these might be incorporated into the plan.

- Suitability of the resource to provide specific kinds of recreation and the durability to sustain that use.

- Compatibility with hydroelectric project operations. Certain activities, developments or their location may not be compatible and must be reviewed with the design engineers.

- Compatibility with other land use. Existing and future land uses will be described, and the compatibility of the proposed recreation development with these land uses will be evaluated.

- Potential management problems. Potential problems and their location will be brainstormed and placed on a base map. Problems such as natural hazards can be avoided in the site selection process; other problems may be overcome by proper site designs; still others can be mitigated through informational programs.

- Probable managing agency. The plan should fit within the scope of the agency.

Once the program objectives (activities, experience levels, and necessary site and facility development) are established, the evaluative criteria for each objective will be established. Then three distinctly different concept plans will be developed that at least minimally meet those objectives. These concept plans will be critiqued in relation to the evaluative criteria.

A trade-off table will summarize how each of the concept plans were rated for each objective. After this a panel of experts (agency and consultants) will be asked to critique this evaluation. Adjustments will then be made and the final plan will be selected that best meets the objectives and their criteria.

The final Master Area Plan will include maps showing the location of the project lands and waters that will be developed for recreational uses, initially and in the future. It will identify the location, type, and number of the various recreational facilities planned, initially and in the future. The predictions of recreational use of the facilities will be discussed. The management responsibilities for the various facilities will be described and a schedule of recreational development and cost estimates will also be included.

This Master Area Plan is designed in accordance with the requirements of Exhibit R of a FERC license application, under existing guidelines. Modifications, if needed, can be made to conform with the upcoming revision of FERC requirements. The development of the plan is scheduled to begin in Phase I and to be completed in Phase II, after detailed hydroelectric design specifications and operational information are available.

(c) Socioeconomic Analysis

After the initial license application submission, emphasis will be placed upon analyzing and assessing significant impacts at local, regional, and state levels. Examples of such impacts are (1) the possible influence of low electricity rates on the growth of manufacturing and processing industries in the region surrounding the project, and (2) the pressure to develop in new areas as a result of improved access.

Each of these potential impacts could significantly affect population and employment levels, business activity, land-use patterns, and other socioeconomic conditions. The impact analysis and assessment will therefore address immediate project impacts as well as the implications of such impacts for important socioeconomic conditions.

Additionally, the study will focus on the effects of the project on important commercial, recreational and subsistence fish and wildlife resources. It is known that some of these resources are of substantial value to user groups and that changes in the availability of these resources could have far-ranging effects.

The design of the study will also allow for in-depth analysis and assessment of other important impacts not yet firmly identified. This flexibility and adaptability will insure that effort is allocated only to the evaluation of relevant impacts.

(d) Cultural Resources

This effort represents the conclusion of all archeological field investigations and laboratory analyses. Also to be included is an investigation of the cultural resources along the primary transmission line corridor. Accomplishing this task will involve the following:

(1) identification and documentation of the cultural resources, by site, of the entire study area,
(2) formulation and explication of recommendations for mitigating construction impacts on each identified site, and
(3) development of a detailed report covering not only cultural resources but also those physical parameters affecting culture.

Both state and federal regulations mandate that all cultural resources of the project area be identified and inventoried; that effects of the project on each resource site be determined; and that any impacts be mitigated before any such sites are irreparably damaged. Procedures for identifying and discussing cultural resources of the primary one-half mile wide corridor will be the same as for the studies previously mentioned.

The final cultural resources report will include the location, description and mitigation recommendations for each site reported. The report will also detail the anticipated budget for any archeological excavation that is deemed appropriate prior to initiation of construction. The report will also include sections on culture-influencing factors such as vegetation, fauna, geology, history, prehistory and native populations. All topical discussion will be focused upon assessing the cultural resources of the entire study area.

(e) Transmission Corridor Assessment

Having established the one-half mile wide primary corridor prior to license application submission, these studies will be undertaken to further refine the corridor to a defined right-of-way no wider than that which will satisfy the minimum width requirements of the National Electric Safety Code. To accomplish this, the following will be necessary:

(1) provide environmental data to design engineers,
(2) apply previously established impact mitigation procedures to the selected right-of-way,
(3) develop the least impact right-of-way, and
(4) recommend specific construction impact mitigation procedures.

Following the development of a preliminary right-of-way, previously established construction impact mitigation procedures will be evaluated to insure that all anticipated impacts have been properly addressed. Among the impact topics to be reviewed are: clearing and slash disposal methodologies; stream crossing and erosion control practices; and access road, structure laydown and wire-stringing zone construction methods. If unanticipated impacts are identified, mitigation procedures addressing those impacts will be developed. Restoration plans will be addressed for areas of unavoidable impact.

(f) Fish Ecology Studies

The salmon fishery studies to be undertaken during the post-license application period will provide for continuing data collection to insure that a complete birth-to-reproduction cycle has been examined. Other baseline studies dealing with habitat and resident fish, may also continue into the post-license application period. In addition, detailed impact analysis and development of mitigation and monitoring program plans will be performed after license application submission.

The baseline studies to be completed after license application submission, as proposed by ADF&G, are as follows:

- Stock assessment of adult anadromous fish of the Susitna River will continue through a complete birth-to-reproduction cycle.
- Habitat studies of the Susitna River are scheduled to continue into this period.

These stock assessments and habitat studies to be performed by ADF&G after license application submission, as described in their proposal, include the following items:

- Investigation of the contribution of Susitna salmon stock to the Cook Inlet fishery. Continuation of this investigation into the post-license application period will depend on the outcome of the scale and electrophoretic feasibility study.

- Studies of the distribution of adult and juvenile salmon in the lower river.

- An attempt to identify new spawning stocks. Because of the inaccessibility of many areas and the turbidity of water, the possibility exists that unknown spawning stocks may exist. During the course of the entire program they will be sought.

- Definition of seasonal habitat requirements for incubation, rearing, spawning and passage of anadromous and resident fish populations.

- Definition of seasonal relationships between flow regimens and essential physical and biological habitat characteristics.

This project, like all hydroelectric projects in which major storages are involved, has three time periods that must be considered after the baseline studies have been done. These periods are the construction period, the filling period, and the plant operation period. The baseline studies, conducted before and after license application, will provide information needed to develop criteria for long-term protection and, perhaps, enhancement of the fishery. Therefore, in addition to the continuing baseline studies to be conducted by ADF&G as described above, TES will do the following during the post-license application period:

- Detailed impact analysis will be performed
- A mitigation plan will be developed
- Long-term studies will be developed to monitor the aquatic environment during construction, filling and operation of the hydroelectric project.

The detailed impact analysis to be prepared by TES will occur when the fishery studies conducted by ADF&G have generated the necessary information. The impact analysis will contain specific predictions about the effect of the hydroelectric project on the fishery resources of the Susitna River, including descriptions of the expected changes in the fishery resources of the proposed impoundment area as well as the area downstream of Devil Canyon.

Assuming that activites during one or more of the periods (construction, filling or operation) will have a negative effect on the fishery resources, it will be necessary to consider mitigative measures. As part of the post-license application activities, a mitigation plan will be proposed that will be designed to reduce the impact during these three periods. Hydrological data, and fishery data through the complete salmon study, will be necessary before enough is known about likely impacts so that a mitigation plan can be developed. At least preliminary information must be available before an estimate can be made of the effort required for the plan development. Therefore, it is recommended that when more information is available, TES, through Acres, submit to APA a proposal and associated cost estimate to develop a mitigation plan during the post-license application period.

If the Susitna Hydroelectric Project is authorized, a monitoring program of project impacts on the aquatic ecosystem may be required for the construction, filling, and operation periods. A plan of study and associated cost estimate for such a monitoring program will be developed during the post-license application program.

(g) Wildlife Ecology

In general, the wildlife ecology studies undertaken after the license application submission will be a more intensive, in-depth evaluation of the work that was started in the pre-license application phase.

As stated earlier for big game, it is impossible to gain the necessary understanding of habitat utilization and movement patterns within a 2-year period. Therefore, the post-license application phase will form the second half of the data collection effort. It is likely that by the beginning of this phase some preliminary conclusions can be drawn. The pre-license application phase effort will also serve to identify areas of concern and data voids. During Phase II, continued monitoring of big game populations will take place. Quantitative evaluation of moose habitat, both in the Upper Susitna Basin and the downstream areas, will also be conducted during this period. This will include an estimate of available browse, browse productivity, and browse utilization by wintering moose populations. Prior to the initiation of Phase II, a proposal will be submitted to prepare a mitigation plan during this phase.

Following the identification of key furbearer species and areas of abundance and preferred habitat an intensive survey of the furbearers will be conducted. A 3-year study effort started late in the pre-license application phase and continued following the submittal of the license application will be undertaken to gather data on population density, family units, home ranges, denning sites, diets, and seasonal use of habitats. In addition, the relationship of furbearers with other species will be evaluated. The type of information to be collected in this phase is necessary if appropriate mitigation measures are to be undertaken.

During this phase, a continuation of the intensive avian census will take place. Non-game mammal trapping will be a continuation of the program started in the preceeding phase and will result in covering the minimum 4-year time period needed to identify the cyclic properties of this group.

Intensive study sites in upland and wetland habitats will provide data on bird and non-game mammal species composition and density in each of the most extensive habitats of the region. This will provide an indication of habitat uniqueness and productivity. Also, these intensive sites should provide data that can be extrapolated to similar habitats throughout the upper basin and should provide a basis for predicting faunal changes based on habitat changes caused by construction alternatives.

If the results of the pre-license application phase identify the presence of significant concentrations of waterfowl, an intensive waterfowl study will be conducted during this phase. This study will determine, for each of the major wetland habitat types of the region, the type and degree of utilization by waterfowl and other water birds.

Data gathered during this phase is essential to developing a comprehensive understanding of the interrelationships that exist within communities. A refined, detailed impact evaluation will be prepared during Phase II. Data collected during Phase II will be vital in the preparation of the final impact evaluation and also in recommending appropriate mitigation measures. Information obtained during this phase will also be needed in order to respond to interrogatories that will be received during the license application review period.

(h) Plant Ecology

The primary objectives of this phase of the plant ecology study are to collect and analyze quantitative vegetation data for the various vegetation/habitat types to be affected by the proposed Susitna River Project, and to refine impact assessments utilizing collected data.

Quantitative data will be collected from the major types present in the impoundment areas and the riparian communities downstream. This information will not only be required to describe the vegetation community, but it will also be necessary for the development and implementation of a successful wildlife mitigation program. Specific quantitative sampling methods will be utilized to determine available browse, productivity, and browse quality in key moose habitats. Additional information will be derived from available literature. These data will be required to make an accurate prediction of the impact on moose populations.

Representative aquatic plant communities will be studied in the project area. Notes will be made on frequency, abundance, and vigor of plants.

Impacts of the proposed project, especially in the downstream floodplain to Talkeetna, will be discussed in the reports. Supportive literature concerning similar habitats and impacts on woody riparian communities will be utilized.

(i) Construction and Operation Impact Analysis

A detailed impact assessment for the construction phase and operational phase of the project will be completed. For the construction phase, impacts to be considered would include:

- Visual quality impact due to access roads, site facility, borrow pit operation, disposal of debris
- Air and water quality affected by land clearing process, and construction activity within stream beds
- Primary resource utilization including fuel, materials, land and manpower
- Financial resource commitment
- Safety.

For the operational phase in addition to the specific impacts discussed earlier in this section and Section A.5.8 of the plan of study, the following will be considered:

- Visual consequence of irreversibly changing the existing boreal forest area to a reservoir area
- Resource commitment or conservation in terms of energy and land use
- Long-term water quality impact
- Safety and accidental fire potential due to recreational use of area.

It is anticipated that the environmental impacts of the Susitna Project will be documented in two annual supplementary environmental reports for submission to FERC. These reports will include detailed impact analysis for each environmental discipline (socioeconomics, wildlife ecology, etc.) as well as a summary of the significant impacts of constructing and operating the Susitna Project.

(j) Completion of the Environmental Process

During the licensing processing, supplemental studies in many disciplines will be required for thorough impact analysis. The technical aspects of these studies are summarized under the subtask descriptions for these disciplines. It is proposed that annual supplementary environmental reports be prepared for submission to the FERC during the licensing process.

Principal Investigators in each discipline will prepare annual reports on the activities, results, and conclusions of the supplementary investigations. These reports will be compiled into comprehensive supplementary environmental reports. Every effort will be made to keep these reports in tune with the information needs of FERC and other regulatory agencies.

As necessitated by the environmental approval process or the Alaska Power Authority, written testimony relating to the Susitna Project environmental report will be prepared by the appropriate experts. This testimony will be for the purpose of highlighting project organization, activities and findings in conformance with FERC licensing requirements. Discussions among all discipline-specific groups will be held prior to preparation of testimony. This will allow the group to deal with the most pressing issues and devote equal attention to all problem areas. Oral testimony at public hearings will also be provided as required.

Upon receipt of interrogatories, and a request by the APA to respond to such interrogatories, they will be assigned to the appropriate Environmental Discipline Group Leader who will, in cooperation with the Principal Investigators, prepare an appropriate response.

Upon receipt of an interrogatory, the Environmental Discipline Group Leader will make a determination as to the type of response that would be appropriate. The response alternatives are as follows:

- Alternative 1

  The data exist and can be used to prepare an adequate response to the interrogatory.

- Alternative 2

  The data needed to reply to the interrogatory exist but will be available at some time in the future in a scheduled report. If the need for a detailed response is not critical, the response will indicate when and in what form the appropriate information will be available.

- Alternative 3

  The necessary data have not yet been collected and/or analyzed. In this case, the response will indicate when a detailed reply can be prepared.

- Alternative 4

  The data needed to reply to the interrogatory do not exist and are not planned to be collected in the future. Therefore, a detailed response is impossible and will be so explained.

All responses to interrogatories will be sent to the APA for approval and submission to the party that prepared the interrogatory.

Finally any reports, addenda, or supplements required to obtain final approval of an EIS for the Susitna Project will be prepared and submitted to APA.

The level of effort required for these and other post-license application activities can be estimated only on a preliminary basis at this time, but will be refined when more information is available on what will be needed for a FERC license decision and EIS approval.

A6.8 - Cost Estimates and Schedules

Activities under this task will continue in support of the ongoing Task 6 design development effort. In particular, Engineer's estimates and schedules will be required for access road and diversion scheme construction contracts.

For purposes of effective overall project management during subsequent phases, a Program Planning Guide will also be prepared. This will provide a complete guide to identify for APA management the specific planning requirements and, for the eventual project management contractor, those products essential to the planning and management of the Susitna hydropower project.

The products of the planning guide will include the following:

- A project master schedule that shows in graphical form the major milestone dates for planning products, events and decisions.

- A consolidated construction schedule that identifies the major construction activities and shows their required start and finish dates in bar-chart format.

- Fifteen specific work packages that explain in detail the planning required for each of the following areas:

  Corporate
  Engineering
  Permits and land
  Construction support

- Support services
- Project control
- Labor relations
- Contracts
- Quality assurance and quality control
- Camps
- Communications
- Procurement and logistics
- Permanent materials
- Construction equipment
- Construction

Each package will explain in detail its respective area and will include:

- An explanation of the objective of the work plan,
- A detailed scope of work outlining the planning products and activities to be developed within its area,
- Situations and factors to be considered in developing the planning products,
- An estimate of the manpower required to produce the planning products,
- A detailed critical path network showing the precedence relationship and logical ties of the planning activities within the package and its logical relationship to other work packages.

- A critical path analysis that shows duration, early start date, late start date, early finish date, float and critical path for all major activities,

- An estimate of manpower required for the planning effort,

- An estimate of manpower required for the pre-construction effort.

(b) License Only

No further work under Task 9 will be undertaken except as necessary to support FERC requests.

A6.9 - Licensing

Acres will provide all the assistance requested by APA to secure approval of the FERC license for the Susitna Project. This assistance is necessary for both the "Fast Track" and "License Only" alternatives.

After the license application has been prepared and submitted to FERC, as discussed in Section A.5.11, work will continue on preparation of supplemental material to support the initial application. The principal areas of activity include all work necessary to present bid documents for the Watana Dam and completion of all environmental studies impact assessments.

At this time, an accurate estimate of the work effort to prepare testimony, respond to interrogations or attend meetings is not available. Even so, our own experience to date has demonstrated such needs will arise. The level of effort shown below includes anticipated requirements to secure legal consultation and expert testimony in response to interventions.

A6.10 - Marketing and Financing

(a) Fast Track

The primary shift in activity in the area of marketing and financing is the availability of Salomon Brothers as direct consultants to APA to assist APA in matters of project financing and Bond Underwriting.

Acres will continue to be the focal point of all other activities in the marketing and financing areas, particularly in the areas of risk analysis, base plan extension and revenue assurance studies. All other activities discussed in Section A.5.12 will be continued on an as-needed basis to meet the needs of APA.

(b) License Only

Financing activities will be reduced to the minimum necessary to support FERC information needs and to update project overview documents as new information is developed in other tasks.

A6.11 - Public Participation

Activities in this area will be the same for both "Fast Track" and "License Only" alternatives. To keep the public fully informed of the progress being made relative to preliminary design and completion of the environmental assessment, the public participation program as described in Section A5.13 will be continued into the second phase. The goal during this phase will be to continue to seek feedback from all groups, agencies or individuals identified as interested parties during the first phase. Information materials will be prepared periodically and the information office will remain active to provide a continuous point of contact for the public. However, the anticipated level of activity during this phase should be lower than prior to submission of the FERC license application.

A6.12 - Administration

Project administration will continue through award of the FERC license at essentially the same level as described in Section A.5.14 for pre-license submission.

SECTION A7 - PROJECT SCHEDULES

SECTION A7 - PROJECT SCHEDULES

A.7.1 - Introduction

A master schedule is presented on the following pages as the basis for graphic portrayal of the timing of various subtasks which must be conducted concurrently or sequentially in achieving the overall project objectives. It will be noted that successful implementation of this plan demands a very early resource commitment, particularly in terms of acquisition and installation of important site support facilities. By the end of the first year of work, a decision point will be reached that will allow the State of Alaska to consider recommendations to proceed as planned, or as modified by efforts to that point--or to terminate if negative findings so indicate.

The second year of the project will include an acceleration of design activity as preliminary field investigations feed results to design teams. Design transmittals will be regularly prepared and reviewed and refinements will continue so that, during the final months of the two-and-a-half year period, all FERC exhibits can be completed.

Reviews throughout the progress of the work will be conducted internally and externally by proposed review boards, appropriate state and federal agencies, utilities, environmental interests, and other interested parties. During the 30th month, a review of the fully assembled proposed draft license application will be conducted so that it can be executed and filed by the State of Alaska at the end of the period.

Schedules are contained on:

Plate A7.1: Master Schedule-Sheet 1
Plate A7.2: Master Schedule-Sheet 2

TASK NO.	DESCRIPTION
1.00	POWER STUDIES
1.01	REVIEW ISER WORK PLAN
1.02	FORCASTING PEAK LOAD DEMAND
1.03	IDENTIFICATION OF ALTERNATIVES
1.04	SELECTION OF VIABLE EXPAN. SEQUENCES
1.05 & 1.06	EXPAN. SEQ IMPACT ASSMT. & PWR. STY. RPT.
2.00	SURVEYS & SITE FACILITIES
2.01 & 2.02	PROVISION LAND USE PERMITS, FIELD CAMP.
2.03	RESUPPLY & EMERGENCY SERVICE
2.04	LAND STATUS RESEARCH
2.05	LAND ACQUISITION ANALYSIS
2.06	RIGHT OF ENTRY
2.07	SITE SPECIFIC SURVEYS
2.08	AERIAL PHOTO. & MAPPING
2.09	CONTROL NETWORK SURVEYS
2.10	ACCESS ROADS
2.11	MAP & PHOTO. SEARCH
2.12	FIELD RECONN. OF RESERVOIR AREAS
2.13	MARKETABILITY & DISPOSAL STUDY
2.14	COST EST. FOR RESERVOIR CLEARING
2.15	SLOPE STABILITY & EROSION STUDY
2.16	HYDROGRAPHIC SURVEYS
3.00	HYDROLOGY
3.01	REVIEW OF AVAILABLE MATERIAL
3.02 & 3.03	FIELD DATA INDEX COLL. DIST. SYST.
3.04 & 3.05	WATER RESOURCE & FLOOD STUDY
3.06 & 3.07	HYD. & ICE, SEDIMENT YIELD, RIVER MORPH.
3.08	CLIMATIC STUDIES TRANSMISSION LINE
3.09	ACCESS ROAD STUDIES
3.10	LOWER SUSITNA STUDIES
4.00	SEISMIC STUDIES
4.01	REVIEW OF AVAILABLE DATA
4.02 & 4.09	SHORT & LONG TERM SEISMIC MONITORING
4.03 & 4.10	RESERVOIR INDUCED SEISMICITY
4.04	REMOTE SENSING IMAGE ANALYSIS
4.05	SEISMIC GEOLOGY RECONNAISSANCE
4.06 & 4.12	EVALUATION & REPORTING
4.07 & 4.13	GROUND MOTION STUDIES
4.08	PRELIM. ANALYSIS OF DAM STABILITY
4.11	SEISMIC GEOLOGY FIELD STUDIES
4.14	DAM STABILITY CONSULTING SERVICES
4.15	SOIL SUSCEPT. TO SEISMIC FAILURE
5.00	GEOTECH. EXPLORATION
5.01	DATA COLLECTION & REVIEW
5.02	PHOTO INTERPRETATION
5.03 & 5.04	EXPLORATORY PROGRAM - 1980
5.05 & 5.06	EXPLORATORY PROGRAM - 1981
5.07 & 5.08	EXPLOR. PROG. DESIGN & DATA COMP.
6.00	DESIGN DEVELOPMENT
6.01 & 6.02	REVIEW PREV. STUD. & INVEST. TUNNEL ALT.
6.03	EVALUATE ALT. SUSITNA DEVELOP.
6.04	DEVIL CANYON ARCH DAM EVALUATION
6.05,13,19,28,31	REPORTS
6.06	WATANA/DEVIL CANYON STAGED DEVELOP. ALT.
6.07 & 6.08	PRELIM. WATANA/DEVIL CANYON DAM ALT.
6.09 & 6.10	ESTAB. WATANA/DEVIL CAN. DESIGN CRITERIA
6.11	PRELIM. DESIGN WATANA DAM
6.12	PRELIM. DESIGN DEVIL CANYON DAM
6.14	SPILLWAY DESIGN CRITERIA
6.15	WATANA SPILLWAY ALT.
6.16	DEVIL CANYON SPILLWAY ALT.
6.17 & 6.18	PRELIM. DESIGN WATANA/DEVIL CANYON SPILL.
6.20	ACCESS & CAMP FACILITIES
6.21 & 6.22	WATANA/DEVIL CAN. DIVERSION SCHEMES
6.23 & 6.24	OPTIMIZE W./D.C. POWER DEVELOPMENT
6.25	OPTIMIZE DAM HEIGHTS
6.26 & 6.27	PRELIM. DESIGN WAT./D.C. POWER DEVELOP.
6.29 & 6.30	WATANA/DEVIL CAN. GEN. ARRG'T.

ACTIVITIES PRIOR TO LICENSE APPLICATION: 1980 (J F M A M J J A S O N D), 1981 (J F M A M J J A S O N D), 1982 (J F M A M J)

ACTIVITIES PRIOR TO AWARD OF CONSTRUCTION LICENSE: 1982 (J A S O N D), 1983 (J/F/M A/M/J J/A/S O/N/D), 1984 (J/F/M A/M/J J/A/S O/N/D), 1985 (J/F/M A/M/J J/A/S O/N/D)

SUSITNA BASIN GO/NO-GO

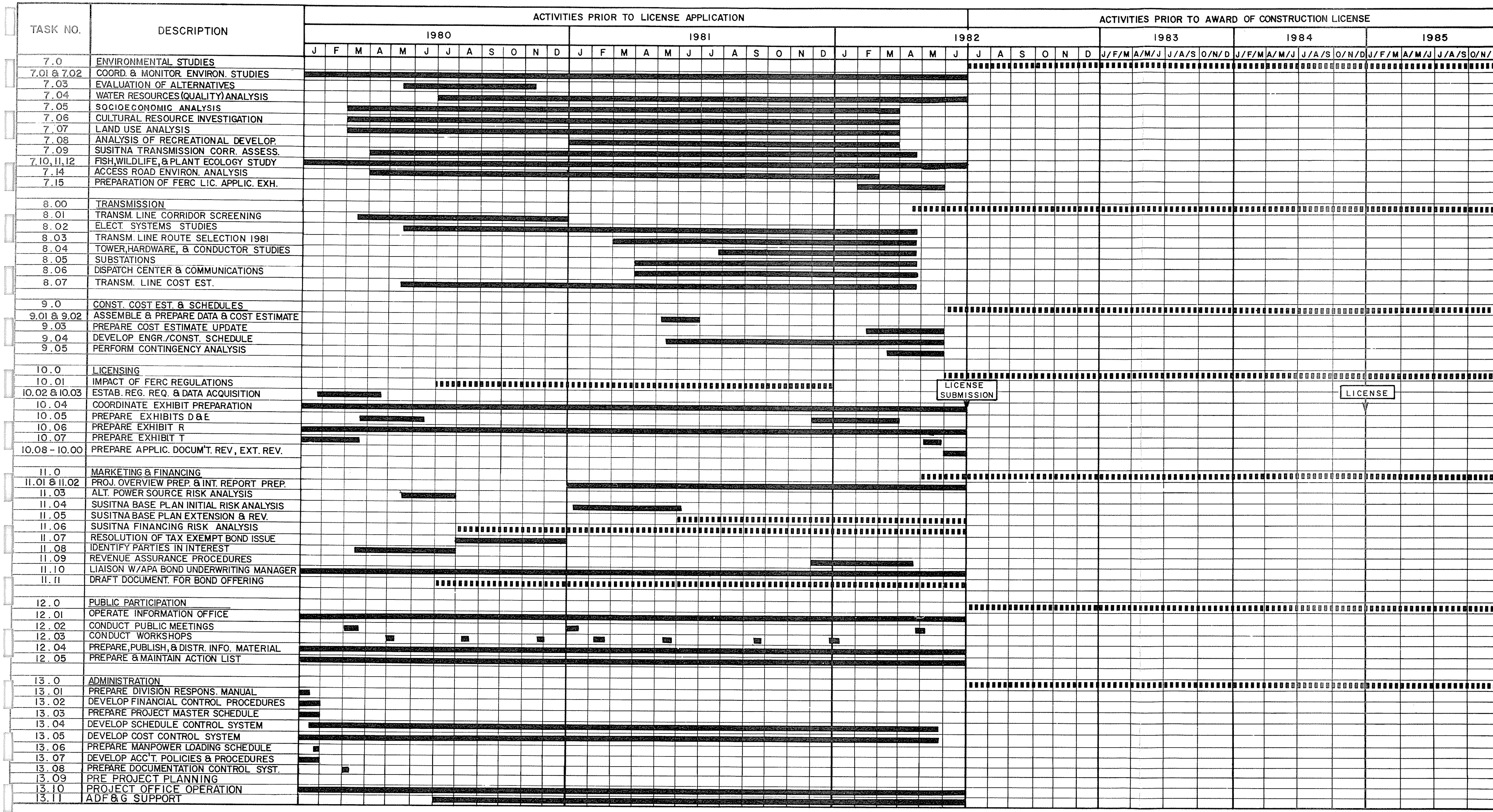
DEVELOPMENT SELECTION

FEASIBILITY & LICENSE SUBMISSION

ACRES

SUSITNA HYDROELECTRIC PROJECT
PLAN OF STUDY
PLATE A7.1 : MASTER SCHEDULE - SHEET 1

* REVISED



SUSITNA HYDROELECTRIC PROJECT

PLAN OF STUDY

PLATE A7.2: MASTER SCHEDULE - SHEET 2

* REVISED

SECTION A8 - LOGISTICAL PLAN

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(a) Statement of Problems

The sheer magnitude of the proposed project is itself virtually a guarantor of problems scaled to match. This plan seeks to anticipate and address major problems in advance--and thus to reduce the force of their impacts. Problems to be considered include:

(1) Land Use Restrictions and Permit Requirements. The unique nature of the proposed project area is such that land use restrictions and permit requirements will be imposed by multitudinous agencies. This subject is developed in further detail in subparagraph (b) below.

(2) Access. Perhaps the single greatest physical constraint on rapid successful completion of necessary site investigations is the difficulty of access. The project area is far from existing roads and no airfield is available to serve Watana dam site. The bulk of the project supplies (including fuel needs) must be brought overland during the winter months, demanding careful, detailed, expert advanced planning for a full year's operation. Even helicopter access is difficult (in addition to being expensive) since weather conditions including fog, winds, freezing rains, icing conditions, and snow frequently restrict or prevent helicopter use.

(3) Seasonal and Cyclical Constraints. The nature of the required work is such that a number of peak manning loads will occur, particularly during short summer seasons. The relative brevity of important data collection periods and the extensive time lapse before like collection activity can occur make it imperative that the proper investigators be at the correct location with the necessary equipment on time. (In this regard, for example, abortive data collection efforts during a particular spawning season may not be recouped for five years.)

(4) Weather. The effect of adverse weather on helicopter operations has already been noted above. Beyond the access question, though, is the extent to which weather conditions impact project operations. Consider aerial photography requirements, for example. The period after snow melt and prior to leaf cover is important, but weather conditions may severely limit its already short duration. Project planning must allow for weather delays as well as for gainful production on alternative tasks during inclement weather.

(5) Coordination of Subcontractor Activities. Acres has assembled a strong team representing high qualifications in a number of project areas as well as a substantial Alaskan presence. The strength of such a team can only be brought to bear fully and well if a proper system for management and coordination of diverse

activities is employed. This is especially true in view of the widespread geographical dispersion of various design offices.

(b) Summary of Land Use Restrictions and Permit Requirements

(1) Interested Agencies. A number of organizations and agencies have direct interests in the project area. These include:

- Bureau of Land Management under whose control some project lands now fall.

- Native villages which have already made selections, generally along the Susitna River, bordering federal power reserves which had been established prior to Alaska's assumption of Statehood. It should be noted that the power reserve does not include all of the land which would be required for the Watana reservoir as proposed in the Corps of Engineers' pre-authorization study (resulting, of course, from the Corps' selection of a higher dam at Watana than had earlier been proposed in studies by the Bureau of Reclamation). Native villages ultimately acquire surface rights to virtually all of the lands bordering proposed reservoirs as well as certain downstream and general vicinity parcels.

- Cook Inlet Region Incorporated, which will acquire all subsurface rights to the Native Village lands and which may temporarily receive and hold lands in trust until they are ultimately conveyed to individual villages in accordance with prior selections.

- Alaska Department of Natural Resources, which administers water rights. The State is the owner of all lands lying under the Susitna River and its tributaries.

- The Alaska Department of Fish and Game, whose responsibilities for protection and management of wildlife resources are essentially independent of ownership.

- The U.S. Army Corps of Engineers who are charged by Congress with administering permit programs for navigable waters and for wetlands.

- Other federal agencies whose involvement is assured because a federal license is required. (Thus, it is not necessarily true that the passage of land ownership to Native Corporations will eliminate most federal permit requirements or interventions. In this regard, for example, federally legislated archeological checks and clearances are expected to be required even though land ownership may have been transferred from the federal domain.) Particular agencies involved in coordination and/or permitting include the Fish and Wildlife Service, National Marine Fisheries Service, and the Environmental Protection Agency.

- Other State agencies whose concerns include water and air quality--and others which will control certain lands in the Susitna Basin which may ultimately be acquired by the State in exchange for lands selected elsewhere by Natives.

- The MATSU Borough whose coastal zone management plan must be accounted for and whose other direct interests must be identified and satisfied.

(2) Constraints. The net effects of dealing with diverse permitting agencies and resolving uncertainties in land ownership or water rights will be multifold. Surely they demand careful and detailed advanced planning, backed by experience in Alaska, for it matters little that 15 necessary permits have been acquired when one forgotten one holds up any work on a project. They also demand carefully coordinated application and implementation procedures, for care must be taken to ensure that funds are not twice expended to comply with a single provision common to two permits.

We intend to produce a high quality, technically correct, economically sound, environmentally acceptable report--including FERC license application if alternatives analysis and other studies support it--on time and without introducing permanent damages in the project area. It is this latter damage avoidance objective on which most permits are based. It follows that permittee and permittor should, in every case, be able to resolve apparent difficulties and proceed with the necessary activities.

(c) Proposed Methods for Dealing With Problems

The very fact that land use is severely restricted suggests that the closest possible relationship should be established with the land owners. Because we anticipate seeing ownership pass to the Cook Inlet Region, Inc., (CIRI), and thence ultimately to various selecting Native Villages, we propose to engage CIRI (in association with its engineer, Holmes and Narver (H&N)) to undertake a major share of the logistics activities in support of the project. Our own management system will be such that a responsible senior Acres official with decision-making authority will establish a project office in Anchorage, from which all in-state activities will be coordinated. The Project Manager will divide his time between in-state field data collection and out-of-state activities to include sophisticated design efforts in the home offices, seismic analysis at WCC offices in California, coordination with federal agencies (including FERC) as appropriate, and similar tasks. In later stages of detailed design, he will also need to review hydraulic model tests in Niagara Falls, ice studies at the Cold Regions Laboratory in New Hampshire (provided government projects do not preempt), and confer with potential manufacturers and suppliers.

Certain specific points may be made regarding the proposed logistical operation:

(1) CIRI/H&N will provide the layout and design of a semipermanent camp near Watana.

(2) CIRI/H&N will furnish all camp equipment, furniture, materials and supplies including fuel and pad for the camp.

(3) CIRI/H&N will furnish transportation of all building materials for the camp at Watana.

(4) CIRI/H&N will operate and maintain the Watana camp and furnish all food and camp operating supplies.

(5) CIRI/H&N will obtain the permits required for the camp.

(6) CIRI/H&N will operate the camp on the following schedule:

- Watana: Year round, February 1980-June 1982

(7) The Watana Camp will house a maximum of 40 persons (including O&M staff).

(8) CIRI/H&N will furnish electrical power, water and sewage systems. A small, biological sewage treatment plant will be installed to handle the camp sewage wastes. Incineration and/or approved burial methods will be used to dispose of other camp wastes. All operations will be conducted in accordance with DOI stipulations and DEC permits and regulations.

Local surface water sources will be investigated and economic studies performed to determine the suitability of supplying the camp water needs. If local surface water proves unsuitable, then installation of a well will be required.

(9) CIRI/H&N will furnish communications equipment:

- Ground to aircraft: appropriate navigational aids and communication facilities will be installed in support of air operations.

- Camp to work site: A base station shortwave radio will be installed at each camp location, and mobile radios will be carried by each work crew in the field. In addition, mobile radios will be installed in helicopters to allow communication with the camp and ground crews.

- Camp to outside: It is expected that the communication needs of the POS will require the installation of telephone lines to the camp facilities. Typically, these requirements have been grossly underestimated. We will work closely with local communication subcontractors to establish the level of hardware required to support the project.

(10) The Watana Camp, as furnished by CIRI/H&N, will consist of the following facilities::

- Dormitories of 40 persons (2 persons/room), toilet, showers, and personal laundry facilities (washer/dryer).

- Kitchen/diner with food storage

- Offices: 4 each (200 sq. ft.,total 800 sq. ft.) with furniture, but without office machines, i.e., typewriters, adding machines or photocopiers, etc.

- Recreation hall with: pool table, ping pong table, TV/Video tape player, movies.

  CIRI/H&N will supply movies and video tapes.

- Fuel storage: fuel storage dumps will be installed to provide adequate storage of diesel and jet (helicopter) fuels. Bladder tanks installed in approved, lined and diked areas will service the needs of the camp and aircraft:

  Jet fuel - 2 each, 25,000 gallon bladder tanks
  Gasoline - 1 each, 10,000 gallon bladder tanks
  Diesel fuel - 4 each, 25,000 gallon bladder tanks
  Propane - 2 each, 500 gallon tanks

- Laundry facilities for sheets, towels and kitchen linen

- Warehouse/shop, not including shop equipment

- Generators and generator shelter

- Water system with storage

- Sewage/incinerator system

- Dormitories, kitchen/diner, and recreation facilities to be connected via Arctic walkways.

(11) If camp facilities are required at Devil Canyon, a local lodge will be used.

(12) Food services will include well-balanced meals (three times per day - typically):

Hot breakfast: 6 a.m. to 7 a.m.
Cold sack lunch
Hot dinner: 6 p.m. to 7 p.m.
Pastries, fruit and coffee for snacks

(13) The following items are to be supplied as noted:

- All fuel required for camp operations (CIRI).

Note: diesel fuel required for power plant, water pumping and incineration of sewage/garbage.

- Office equipment and supplies (Acres)

- Air transportation (including emergency) for personnel

  All personnel will move to and from the field camp by helicopters originating at the Talkeetna airfield or in Anchorage. Overland transportation will be provided to Talkeetna from other locations. Transportation from the field camp to specific work sites will be provided by helicopter support. Where possible, field personnel will travel to work sites on foot.

- Helicopter transportation of food and consumable supplies from Anchorage as required (Subcontract with helicopter service company)

(14) The timely mobilization of the Susitna Camp in February 1980 is contingent upon having lead time to procure (90 - 120 days) camp buildings, generators, sewage treatment plant, pillow tanks, etc.

(15) CIRI/H&N will apply for and secure all permits necessary for any aspect of camp establishment and operation.

(16) CIRI/H&N will provide the single coordinating point for satisfaction of Alaskan Native Corporation land use stipulations.

(17) Acres American Incorporated will establish a project office in Anchorage and will designate a resident manager with decision authority as Chief Engineer for Alaska Operations (CEAO). The project office will accommodate representatives of other team members as well.

(18) All plans of operations as required by Bureau of Land Management will be prepared under the direction of the Acres CEAO. Specific responsibilities for preparation of plans within the proposed project team include:

- Overland transportation - CIRI/H&N
- Foundation and materials explorations - R&M
- Seismicity studies - WCC
- Fuel transportation and storage - CIRI/H&N
- Fire prevention and suppression - CIRI/H&N
- Wetlands survey - TES
- Biological studies - TES
- Waste disposal - CIRI/H&N
- Air operations - FMA
- Surface resource rehabilitation - R&M
- Personnel housing and transportation - CIRI/H&N

(19) The CEAO will prepare a detailed affirmative action plan for APA approval in which precise measures are set out to ensure maximum opportunities are made available to minorities, females, and handicapped persons. (We have already sought the assistance of CIRI/H&N to serve in the role of labor broker to ensure that, when available, necessary skills are drawn from the Native population in villages which have selected project lands.)

(20) If it can be shown to be cost effective, a tie line connecting the corporate headquarters of Acres American with the CEAO's office will be established to permit frequent uninhibited contact. In addition, Telex facilities in the Alaska project office will be installed so that time zone difficulties will not preclude receipt of messages transmitted at times when one or another of the various Acres' offices on the net is unmanned.

(21) A trained value engineering officer, drawn from within the Acres' staff, will review major operational plans and project designs throughout the course of the work.

(22) To the extent that necessary goods and services are available in Alaska, they will generally be procured in Alaska (unless significant economic advantages to APA can otherwise be secured).

(23) If use of a local lodge is found to be impracticable or uneconomical, a tent camp may be provided near Devil Canyon.

(24) To permit the earliest possible start of field activities, initial minimal winter camp facilities will be established in the same location as used by the Corps of Engineers in their recent drilling program. No expansion beyond the bounds of that area will be possible until snow cover disappears and appropriate archeological clearances are obtained.

(25) During winter months after 1980, an accessible frozen lake may be cleared to allow access to the study site by fixed-wing aircraft. The first year of project effort will be supported by helicopters. The need for later construction of an airfield will be evaluated by November 1980.

(26) Fire is the most persistent danger to a camp and its occupants in Alaska. The most common cause of camp fires are uncontrolled incinerators and leaking seals on individual oil fired furnace units. Because of the risk involved, positive actions will be taken including:

- Installation and periodic inspection of smoke alarms
- Periodic inspection of furnaces
- Installation of fire fighting equipment
- Establishment of a fire brigade.

(27) Safety/OSHA/Fire Prevention - Periodic inspections of all site facilities will be performed by trained personnel to evaluate and make recommendations regarding safety, compliance with OSHA standards and fire prevention programs. A safety officer will be designated. This person will organize camp fire brigades and report on the effectiveness of the effort. He/she will report directly to the project manager of field activities and will have the authority to stop work that is being performed in an unsafe manner.

(28) Medical - At a minimum, each field camp will have complete first aid facilities and personnel identified with advanced first aid

training. Qualified personnel will review the first aid program and make recommendations as appropriate. Medevac facilities and procedures will be available in the event injured personnel need to be transported to other facilities.

(29) Office Services - Office services (typing, reproduction, etc.) appropriate to each field location will be provided as needed. Complete facilities will be available through Moolin and R&M offices in both Anchorage and Fairbanks, as well as the project office to be established in Anchorage by Acres.

(30) Purchasing - A purchasing office within the project office, staffed by an experienced procurement person(s), will be established to support the needs of the POS. In addition, a purchasing/warehouse person will be located in the field camp to coordinate the procurement needs, operate the camp warehouse and administer a spare parts program.

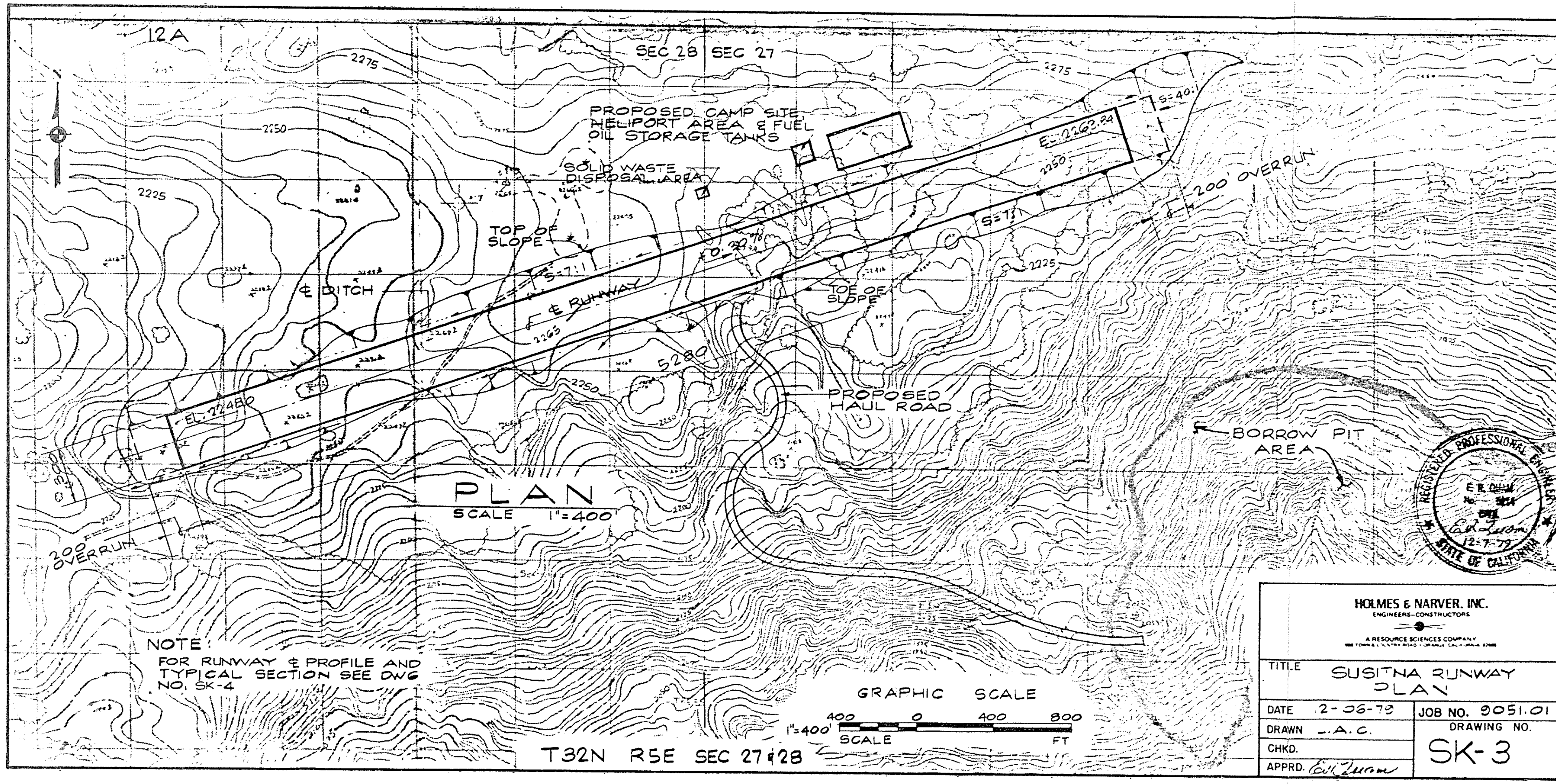
(31) Shipping/Marshalling - Procurement personnel will coordinate the movement of all project materials from vendors to the camp location(s). Most materials will travel overland to a marshalling yard to be established in Talkeetna where materials will then be shipped to the field site. Perishable items and "hot" items will be shipped direct from Anchorage to the field locations. Materials that cannot be shipped by helicopter will be transported overland during winter in accordance with DOI stipulations.

(32) Warehousing - An appropriate warehouse will be established at the field construction camp to store/control the material needs of the POS. Minimal indoor storage will be provided, with the bulk of the material being stored outdoors.

(33) Equipment Support/Spare Parts - Based upon previous experience with equipment use in Alaska, particularly during winter/arctic conditions, the establishment of a spare parts program is a necessity to ensure equipment availability and cost effective completion of the POS. Such a program will be developed, with the help of the local equipment vendors, and administered through the procurement/warehouse person.

(34) Winter access - The camp facilities and enough fuel for the first year of operation will be transported overland by Rolligons and/or cat trains in February 1980. Fuel and other heavy items will be brought in by the same technique in succeeding winters. To accomplish these movements, a snow clearing operation will be undertaken on the Denali Highway and a staging area will be established just off the highway. Overland transportation will involve a series of trips from staging area to camp site.

(35) Location - The camp location is shown in Plate A8.1. Although an airfield is shown on that diagram, it will not be constructed during the first year of operation. Should subsequent evaluation after the first year demonstrate its need and its environmental acceptability, it will be constructed in the location shown.



ACRES	ALASKA POWER AUTHORITY SUSITNA HYDROELECTRIC PROJECT PLAN OF STUDY

CAMP LOCATION
POSSIBLE RUNWAY LOCATION

	PROJECT	PLATE
ACRES AMERICAN INCORPORATED	P5700.12	A8.1

(36) Camp Facilities - A schematic diagram of proposed camp facilities is provided at Plate A8.2.

It is important to note that camp facilities will be designed to accommodate a peak load. This approach will permit some flexibility in meeting the difficulties associated with short data collection seasons and possible unfavorable weather conditions. In addition, our plan to establish a large camp at Watana greatly reduces the daily helicopter transportation system used by the Corps of Engineers during their most recent field investigations. The question of needed flexibility is further addressed by observing that the necessary equipment for field investigations and, in particular, for geotechnical investigations is integral to the proposed project team. Because R&M Consultants, Inc., is unique in its possession of a major investigatory equipment inventory, we anticipate being able to respond rapidly when requirements arise--and, at the same time, to avoid the costly downtime which would accrue for equipment brought into Alaska specifically for the project purpose.

In short, R&M's equipment will be available for project purposes as necessary; but its use on other tasks when not required for the Susitna project will reduce the total cost to the Alaska Power Authority.

(d) Schedule Requirements

A brief outline logic diagram is displayed at Plate T2.1 (following Task 2). As may be noted thereon, we intend to have a permanent camp in operation prior to the end of February 1980. This requires herculean effort and high early mobilization costs. Once the camp has been established, the subsequent loading will, of course, be a function of requirements of the various field investigation teams.

We anticipate at the outset that submittal of license application will not mark the end of field data needs. On the contrary, certain environmental field studies will be scheduled as far as 2-1/2 years beyond the planned FERC application. In addition, the history of major hydroelectric licensing effort is replete with post-application federal demands for additional field data. It follows that the permanent camp should remain in place at the termination of the first phase of the work to support scheduled and directed activities.

(e) Public Participation Philosophy

Details of the proposed public participation program are contained within the detailed task descriptions at Task 12 of the Plan of Study. Within the context of logistical planning, however, it is important to highlight several points:

(1) Needs and Desires of Area Residents. Whereas it is obvious that, if a major project is constructed, permanent impacts will be felt by area residents, it is also true that even the conduct of a deliberate and extensive study can cause disruption of lifestyle

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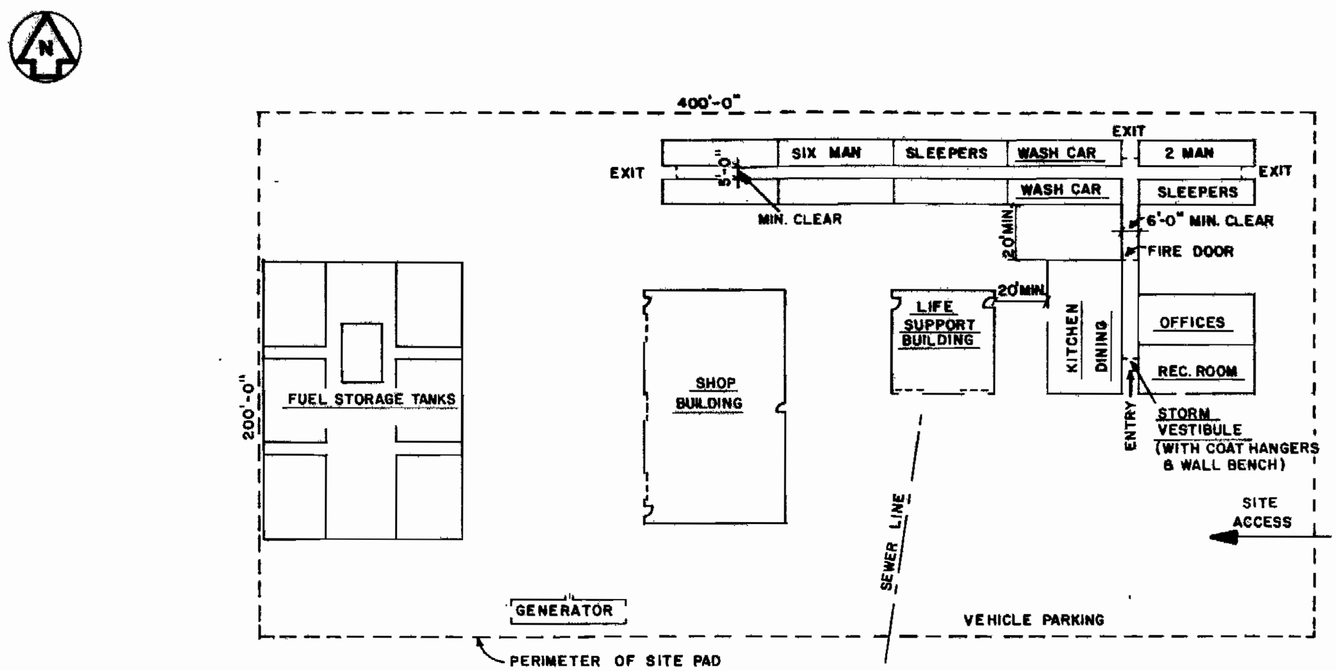

NOTE:

CAMP FACILITIES (BASED ON A DRAWING BY HOLMES & NARVER, INC.)

ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT
PLAN OF STUDY

CAMP FACILITIES

ACRES AMERICAN INCORPORATED	PROJECT	PLATE
	P5700.12	A8.2

for that group. The public participation plan includes provisions for public meetings in Talkeetna (where local impacts are possible) as well as a number of workshops, the locations of which have been purposely not pinned down in order to permit us to be responsive to sensitive problems when - and especially where - they arise. We have also chosen to include a full time public information officer whose duties demand sensitivity to needs and desires of all who will be affected either by the study or by the proposed project if studies indicate it should be built.

(2) The Action List. The unique action list system will be administered by APA and will provide a means to ensure that every required action, whether initiated by the request of a private individual or any representative of public or private organizations, is a matter of record. The proposed system provides for frequent update and the ability to check action status at any time. It follows that, for the first time to our knowledge, a means will be available to ensure that every action requested will have explicit attention and a by-name action officer - or will have an explicit statement of rejection available for review by external review panels, APA, or others. In short, the desires of area residents will be sought, recorded, acted upon, and the action status will be available in real time all the time!

(3) Getting Out the Information. With a project as large and complex as the one proposed, it is almost inevitable that a steady flow of highly technical data and reports will be generated. Whereas such information will generally be available to the public at the cost of reproduction, it will not have been prepared for the layman. In cooperation with the Acres technical staff, the APA public participation staff will prepare special brochures, to be distributed free of charge, wherein project status is encapsulated in a readable form. Pertinent reports of all kinds will be available sufficiently far in advance of public meetings to permit thoughtful study prior to presenting public testimony.

(4) Keeping Objectivity. No matter how well intentioned the project manager and his staff may be, they may well succumb to their own enthusiasm. We propose to avail ourselves of the objectivity which can be brought to bear by external engineering and environmental boards whose reviews from time to time will not only provide the public a measure of confidence that the course of the work is correct and proper, but also will serve to offer some recourse in the event that the project manager's recommendation and APA's decision to reject a citizen's proposed action is not accepted.

In short, the public participation program as proposed herein is responsive to the needs and desires of local residents - and to the public in general - because it provides explicit actions which can be tracked, because it includes an affirmative and vigorous public information program, and because it provides objective review groups whose eminence will be unquestionable and whose deliberations will provide an unprecedented quality and reliabilty check.