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RECONNAISSANCE REPORT FOR HYDROPOWER REDEVELOPMENT AT SAULT STE--ETC(U)
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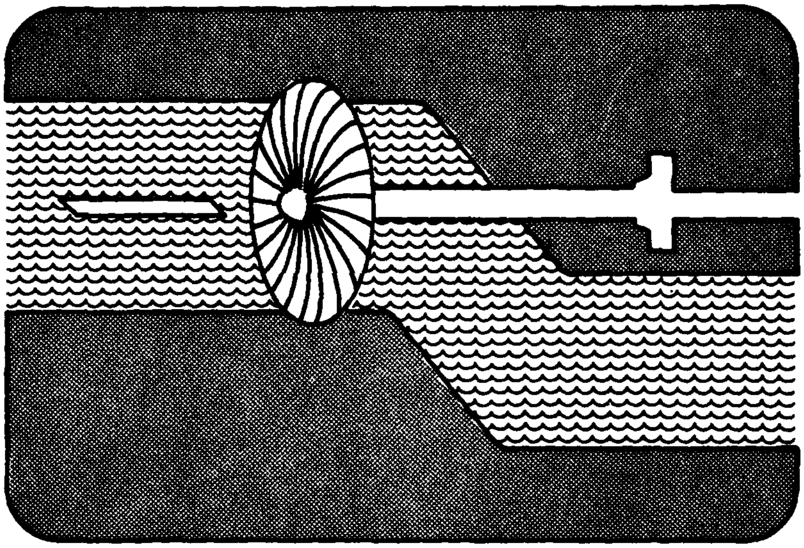
Reconnaissance Report For Hydropower Redevelopment At Sault Ste. Marie, Michigan



January 1981

U.S. Army Engineer District, Detroit
Corps of Engineers
Detroit, Michigan

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Hydropower
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This report document reconnaissance stage investigations completed by the Corps of Engineers on the feasibility of hydropower facilities redevelopment at Sault Ste. Marie, Michigan. While continued growth in demand for energy in the Michigan Upper Peninsula is anticipated, existing hydropower capacity has been unable to keep pace with current demand. In addition, a new Canadian hydropower plant is scheduled to go on line in 1982. At that time, water which the United States has traditionally used will be reduced. This

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered) reduction in available water will result in lower energy production, and in a further widening of the gap between hydroelectric supply capacity and demand.

The authorization for the study is provided under Section 102 of the River and Harbor Act of 1966. The prupose of the study is to determine the overall economic, engineering, environmental, and social feasibility of hydropower facilities redevelopment in United States waters at Sault Ste. Marie, Michigan, and to determine the extent of any recommended Federal participation.

After preliminary screening, four of the alternatives were developed to a greater level of detail. Evaluation of these alternatives indicated that whereas under one without project condition, all the alternatives would be economically feasible, under another without project condition, none of the alternatives would be feasible.

RECONNAISSANCE REPORT

FOR

HYDROPOWER REDEVELOPMENT

AT

SAULT STE. MARIE, MICHIGAN

JANUARY 1981

Department of the Army

Detroit District, Corps of Engineers

JANUARY 1981

RECONNAISSANCE REPORT

FOR

HYDROPOWER REDEVELOPMENT

AT

SAULT STE. MARIE, MICHIGAN

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RECONNAISSANCE REPORT
FOR
HYDROPOWER REDEVELOPMENT
AT
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THE STUDY AND REPORT

On a National level, the necessity for developing hydropower to meet the ever-increasing demand for power has been recognized by the Congress and the President. On a local level, the energy demand in the Upper Peninsula of the State of Michigan is expected to grow. Hydropower facilities on the St. Marys River supply power to the eastern portion of the Upper Peninsula; but this available hydropower has not been sufficient to meet the demands of the service area. In addition to the hydropower facilities, there are small diesel generating stations that also supply power to the service area.

The Great Lakes Power Corporation (GLPC) power plant is located on the Canadian side of the St. Marys River. GLPC is now building a new plant just downstream of the existing plant. By treaty of January 11, 1909, the boundary waters of the St. Marys River are divided equally between the United States and Canada. Traditionally, the U.S. has been able to use more than its 50% share of the waters available for power because the existing GLPC plant in Canada does not have the capability of utilizing Canada's full share of the waters. When the new GLPC plant is commissioned in 1982, Canada would be able to use its 50% share of the waters during periods of average and below average flows. Consequently, the water available for power on the U.S. side would be significantly reduced. This reduction in available water would result in lower energy production, and the gap between energy demand and hydroelectric energy supply would become wider if the existing power facilities are not redeveloped.

In order to meet the present and anticipated future demands of the eastern portion of the Upper Peninsula, it is necessary to consider redevelopment of the existing U.S. power plants on the St. Marys River at Sault Ste. Marie, Michigan, to fully utilize the hydroelectric potential.

This study includes: an analysis of the current state of the existing hydropower plants at Sault Ste. Marie, Michigan; identification of problems and their impacts on the plants; establishment of planning objectives; and formulation and evaluation of alternatives for redevelopment of hydropower facilities. The results of the study to date are compiled and presented in this reconnaissance report. The report consists of a main report and eight appendixes. The appendixes provide the background and detailed analysis of the data in support of the main report.

PURPOSE AND AUTHORITY

The purpose of the study is to determine the economic, engineering, environmental, social, and institutional feasibility of possible redevelopment of the existing hydropower facilities in U.S. waters at Sault Ste. Marie, Michigan. In addition, the study will determine the extent of any recommended Federal participation, if a plan is selected and recommended for Congressional authorization. During the study, possible plans of improvement to satisfy the energy needs of the area will be examined. Each plan will be evaluated to determine its engineering, economic, environmental, social, and institutional feasibility to satisfy present and future demands considering the overall public interest.

The authorization for the hydropower study is provided under Section 102 of the River and Harbor Act of 1966 (Public Law 89-789, approved 7 No ·mber 1966), which states:

> The Secretary of the Army is hereby authorized and directed to cause surveys to be made at the following named localities and subject to all applicable

provisions of Section 110 of the River and Harbor Act of 1950:

Great Lakes, particularly Lake Ontario and Lake Erie, in connection with water supply, pollution abatement, navigation, flood control, hydroelectric power, and related water resources development and control.

SCOPE OF THE STUDY

Reconnaissance Study

By definition, a reconnaissance study is a small scale feasibility investigation in which the issues expected to be important in the subsequent stages of the feasibility study are identified. The reconnaissance study appraises critical issues, and presents a first-cut analysis to identify if the potential exists for an economically and environmentally justified project.

The reconnaissance study was conducted on the basis of available information, and additional data on hydraulics and hydrology, power generation, cost estimates, and power values developed during the study. The information included engineering (hydraulic, hydrologic, foundations, structural, operations and maintenance, power demand), economic, environmental, institutional, and social data and suggestions from the public. Preliminary cost estimates were developed based on feasibility study manuals, manufacturers' catalogs, and engineering judgment. Power values provided by the Federal Energy Regulatory Commission (FERC) were utilized in deriving preliminary benefits. Environmental considerations might result in development of the Edison Sault Electric Company (ESELCO) power canal for fish spawning, with a control structure at the head of the canal, if the canal is not required for hydropower. Costs for such developments which might result from environmental considerations have not been included. Preliminary benefit/cost ratios were developed to reflect the potential of a possible hydropower redevelopment project and a set of conclusions and recommendations have also been included in the study.

Study Area

The study area encompasses the lands, waters, and all facilities on the United States side of the St. Marys River, the navigation locks, the U.S. Government power plant, the ESELCO power plant, and the U.S. Government and the ESELCO power canals at Sault Ste. Marie, Michigan. The study area also encompasses the compensating works, divided by the International boundary, the waters on the Canadian side of the river, and the Canadian Great Lakes Power Corporation hydropower facility. The St. Marys River, extending from Whitefish Bay at the east end of Lake Superior to Lake Huron, falls about 22 feet over a distance of approximately 70 miles. About a 20-foot fall occurs in the 2/3-mile long St. Marys River Rapids, located between the twin cities of Sault Ste. Marie, Michigan, and Sault Ste. Marie, Ontario, Canada. The study area and the location of the power plants are displayed on Figure 1.

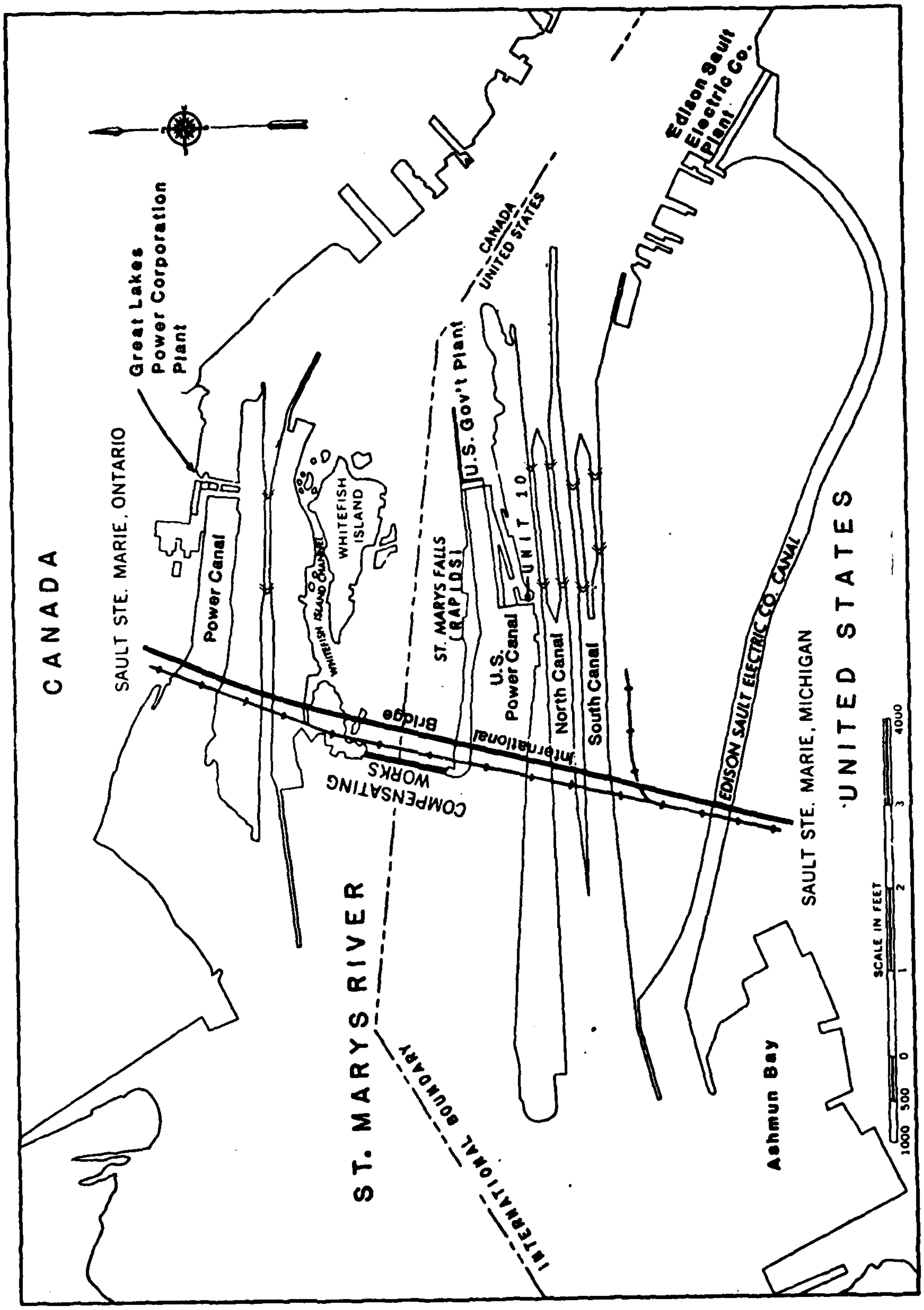
STUDY PARTICIPANTS AND COORDINATION

Coordination was established during the reconnaissance stage and would be maintained throughout the study with the appropriate Federal, State and local interests listed below, and any other entity having interest, jurisdiction or responsibility associated with the hydropower study.

FERC provided power values. ESELCO provided available information on its existing power facilities. In addition, during the course of the reconnaissance study, it became evident that coordination was required with the Advisory Council on Historic Preservation and the State of Michigan Historic Preservation Office.

a. <u>International and Federal Agencies</u>

International Joint Commission
International Lake Superior Board of Control



STUDY AREA AND LOCATION OF THE POWER PLANTS

FIGURE 1

Environmental Protection Agency

Federal Energy Regulatory Commission

Department of Energy

U.S. Department of State

U.S. Department of the Interior

- U.S. Fish and Wildlife Service
- Heritage Conservation and Recreation Service

U.S. Department of Transportation

- U.S. Coast Guard

Rural Electrification Administration

b. State Agencies

Department of Commerce

- Economic Development Administration

Office of the Governor (including the State Clearinghouse)

Michigan Department of State - History Division

Michigan Department of Natural Resources

Michigan Department of State Highways and Transportation

State of Michigan - Office of Economic Development

Michigan Public Service Commission

Energy Administration

c. Regional

Great Lakes Commission

Great Lakes Basin Commission

d. Local Interests

Chippewa County, Michigan

City of Sault Ste. Marie, Michigan

Northeast Michigan Regional Planning and Development Commission

Newberry Water and Light Board

e. U.S. and State Legislators - Michigan

U.S. Senator Donald W. Riegle, Jr.

U.S. Senator Carl Levin

U.S. Representative Robert W. Davis, 11th Congressional District

State Senator Mitch Irwin, 37th District

State Representative Charles H. Varnum, 107th District

State Representative D. J. Jacobetti, 108th District

State Representative Jack L. Gingrass, 109th District

State Representative Donald M. Koivisto, 110th District

PRIOR AND ONGOING STUDIES AND REPORTS

Other studies and reports providing information or dealing with authorization for development or modification affecting the St. Marys River in the vicinity of the proposed work, and summaries of recent and/or ongoing reports that are pertinent to this study are presented in this section.

a. The River & Harbor Act of 2 March 1945, Public Law 14, 79th Congress, Chapter 19 approved construction of a new hydroelectric power plant at Sault Ste. Marie, Michigan, on the St. Marys River in accordance with the plan recommended in House Document No. 339, 77th Congress, 1st session.

b. Lake Superior Outflow 1860-1968, a report by the Coordinating Committee on Great Lakes Basic Hydraulic and Hydrologic Data dated June 1970. This report documents the Lake Superior outflow studies for the period 1860-1968.

c. Feasibility Study of Remedial Works in the St. Marys Rapids at Sault Ste. Marie. A report to the International Joint Commission by the International Lake Superior Board of Control, dated September 1974. Water passing through the compensating works at Sault Ste. Marie is controlled by 16 gates at the head of the St. Marys River Rapids. Depending on the number of gates which are opened, the water flowing through the compensating works can vary greatly, from 3,000 cfs (1/2 gate open) to 60,000 cfs (16 gates open). These extremes of water discharge have an impact on the fisheries resources. The study investigated the feasibility of remedial works or other measures to ensure that crucial areas of the Rapids are not without water under low flow conditions.

d. Final Environmental Statement on Operations, Maintenance and Minor Improvements of the Federal Facilities at Sault Ste. Marie, Michigan, July 1977 prepared by the U.S. Army Corps of Engineers, Detroit District. The environmental impacts of the proposed Federal actions were evaluated. The proposed Federal actions include operations and maintenance of the navigation locks, power generation facilities, appurtenent structures, compensating works, administration buildings, canal park lands, and minor improvements and additions to the existing public facilities.

e. Great Lakes-St. Lawrence Seaway Navigation Season Extension Study. Several reports were prepared and completed under this study by the U.S. Army Corps of Engineers authorized by Section 107(a) and Section 107(b) of the 1970 River and Harbor Act. They include four Demonstration Program Annual Reports, 1972-1975; a Demonstration Program Report Summary, 1976; and a Special Status Report, July 1974. Also included are: the Final Demonstration Program Report, completed September 1979, which documented the results of the Demonstration Program which was conducted under a cooperative effort among several Federal agencies and non-Federal public and private interests and was conducted to determine the practicability of extending the navigation season on the Great Lakes - St. Lawrence Seaway system up to year-round; The Interim Feasibility Study, (House Document 96-181), forwarded to the Congress on 3 August 1979 by the Secretary of the Army, which recommends Federal participation in an extended navigation season on the upper four Great Lakes and their connecting channels to 31 January, plus or minus two weeks, using existing and operational measures; and The Final Survey Report which was completed in August 1979 and forwarded to the Board of Engineers for Rivers & Harbors for Washington level review in January 1980, which recommends 12-month navigation on the upper three Great Lakes and their connecting channels, up to 12-month navigation on the St. Clair River-Lake St. Clair-Detroit River system and Lake Erie, and up to 10-month navigation on Lake Ontario and the International Section of the St. Lawrence River.

f. Edison Sault Electric Company - Impact of New Great Lakes Power Plant on Hydro Availability, Stone & Webster, February 1978. This study, conducted for the Edison Sault Electric Company, addresses the effect of the new Canadian hydropower plant on existing power facilities in Michigan's Upper Peninsula.

g. Great Lakes Basin Framework Study (1975) prepared by the Great Lakes Basin Commission. There are 24 appendices to the framework study, each of which describes studies of a specific area associated with economic, social, environmental and physical fields related to the Great Lakes Basin. Appendix 10 of the report relates to power in the Great Lakes Region and presents the existing and projected electric power and corresponding water needs of the Great Lakes Basin.

h. International Great Lakes Level Board (IGLLB). The IGLLB was established by the IJC on December 2, 1964, to initiate and direct the studies required to answer the October 1964 reference (cited below) from the Governments of Canada and the United States. The reference asked the IJC, in part:

> "...to determine whether measures within the Great Lakes Basin can be taken in the public interest to regulate further the levels of the Great Lakes or any of them and their connecting waters so as to reduce the extremes of stage which have been experienced, and...for the purpose of bringing about a more beneficial range of stage for, and improvement in: (a) domestic water supply and sanitation; (b) navigation; (c) water for power and industry; (d) flood control; (e) agriculture; (f) fish and wildlife; (g) recreation; and, (h) other beneficial public purposes."

The study was conducted under the auspices of the International Joint Commission (IJC). There are 7 appendices to the report, each of which describes studies of a specific area associated with the Great Lakes. They are: Hydrology and Hydraulics; Lake Regulation; Shore Property; Fish, Wildlife and Recreation; Commercial Navigation; Power; and Regulatory Works.

i. Hydroelectric Power Evaluation: An August 1979 report by the Department of Energy-Federal Energy Regulatory Commission that provides a guide for evaluation of hydroelectric power aspects of water resource development with principal emphasis on determining the value or benefits of a project's electric power production and capacity.

j. The Future Electric Energy Requirements of Michigan's Upper Peninsula 1975-2000. A Final Report dated March 1976, conducted by the Stanford Research Institute for Edison Sault Electric Company, Lake Superior District Power Company, Upper Peninsula Power Company, and Wisconsin Michigan Power Company, addresses and forecasts the long-term (1975-2000) electric energy demand of Michigan's Upper Peninsula.

k. Great Lakes Connecting Channels & Harbors Survey Study. This study is being conducted by the U.S. Army Corps of Engineers, Detroit District. It includes a study of the waterways of the upper four Great Lakes which provide for deep-draft navigation between the lakes and associated deep-draft harbors in the region. The St. Marys River, including the lock facilities at Sault Ste. Marie, the Straits of Mackinac, the St. Clair River, Lake St. Clair, and the Detroit River constitute the connecting channels.

l. Hydroelectric Power Potential at Corps of Engineers Projects. This report was prepared by the U.S. Army Corps of Engineers Institute for Water Resources, July 1975. The Institute for Water Resources study of hydropower potential at Corps of Engineers projects was undertaken in response to the emerging problems of energy supplies and costs in the United States.

m. St. Marys River Redevelopment Project, Effects of Proposed Project on Lake Levels - (June 1978). A report by the Great Lakes Power Corporation submitted to the IJC at a public hearing held 6 September 1978 at Sault Ste. Marie, Ontario, describes studies undertaken and their results in light of construction of the proposed Canadian Great Lakes Power Corporation's hydroelectric plant redevelopment in the St. Marys River, at Sault Ste. Marie, Ontario.

n. National Hydropower Study. This is an ongoing study being conducted by the Corps of Engineers. The purpose of the study, as stated in the 1976 Act authorizing the study, is "to study the most efficient methods of utilizing the hydroelectric power resources at water resource development projects under the jurisdiction of the Secretary of the Army, and to prepare a plan based upon the findings of such study."

o. Feasibility Studies for Small Scale Hydropower Additions, July 1979, prepared by the U.S. Army Corps of Engineers. This guide manual provides technical data and procedural guidance for the systematic appraisal of the viability of potential small hydropower additions.

THE REPORT AND STUDY PROCESS

This report consists of a main report and eight appendixes. The main report describes the principal elements, including the scope of study, problems, objectives, formulation and evaluation of alternatives, conclusions and recommendations. The following appendixes contain a more detailed treatment of the subject matter.

Appendix A - Technical Studies
Appendix B - Hydrologic and Hydraulic Studies
Appendix C - Economics of the Alternatives
Appendix D - Environmental
Appendix E - Sociological Studies
Appendix F - Public Involvement and Pertinent Correspondence
Appendix G - Study Cost Estimate/Network of Activities
Appendix H - Abbreviations and Glossary

The study process involves three stages:

Stage 1 - Reconnaissance

Stage 2 - Development of Intermediate Plans

Stage 3 - Development of Detailed Plans

The principal tasks of the Stage 1I reconnaissance study are problem identification, formulation and preliminary examination and screening of the alternatives for hydropower redevelopment; development of those alternatives which appear to be potential candidates for a feasible plan; and evaluation of the alternatives to determine whether additional study is warranted.

A set of four planning tasks is performed in each stage. They are: problem identification; formulation of alternatives; impact assessment; and evaluation. Reconnaissance studies focus on problem identification and screening of potential alternatives to address these problems. Stage 2 studies will emphasize more detailed formulation studies culminating in development of selected alternative plans. Stage 3 studies will give greater emphasis to the impact assessment and evaluation of the alternative plans identified in Stage 2 studies.

A final report will be published at the conclusion of the study. This report will document the study and will present the recommendations of the District Engineer. Technical information developed in the study will be published in appendixes to the report.

PROBLEM IDENTIFICATION

On a national level, the necessity for developing hydropower to meet the ever-increasing demand for power has been recognized by the Congress and the President. In response to this need and directive, the Corps of Engineers is conducting a National Hydropower Study, authorized by the Congress in 1976, and scheduled for completion in 1981.

On a local level, the energy demand in the Upper Peninsula of the State of Michigan is expected to grow at an annual rate of 4.9% over the period 1974-1990[1]. All the hydropower generated at Sault Ste. Marie, Michigan, is distributed by the Edison Sault Electric Company (ESELCO) which services the eastern portion of the Upper Peninsula (see Figure 2). The ESELCO plant has been in existence for about 80 years and is presently functioning at about 70% efficiency. The available hydropower has not been sufficient to meet the demands of the ESELCO service area. On the Canadian side of the St. Marys River, the Great Lakes Power Corporation is building a new hydropower plant with a higher capacity than its present plant. When the new Canadian hydropower plant goes into operation in 1982 on the Canadian side of the St. Marys River at Sault Ste. Marie, Ontario, the water available for hydropower on the U.S. side of the St. Marys River would be reduced, resulting in a loss of energy on the U.S. side. If the power facilities on the U.S. side of the St. Marys River are not redeveloped, the loss of energy would be permanent and the gap between the energy demand and hydropower generation will widen.

NATIONAL OBJECTIVES

The national objectives for the study are as defined in the Water Resources Council's Principles and Standards for planning water and related land resources. They are:

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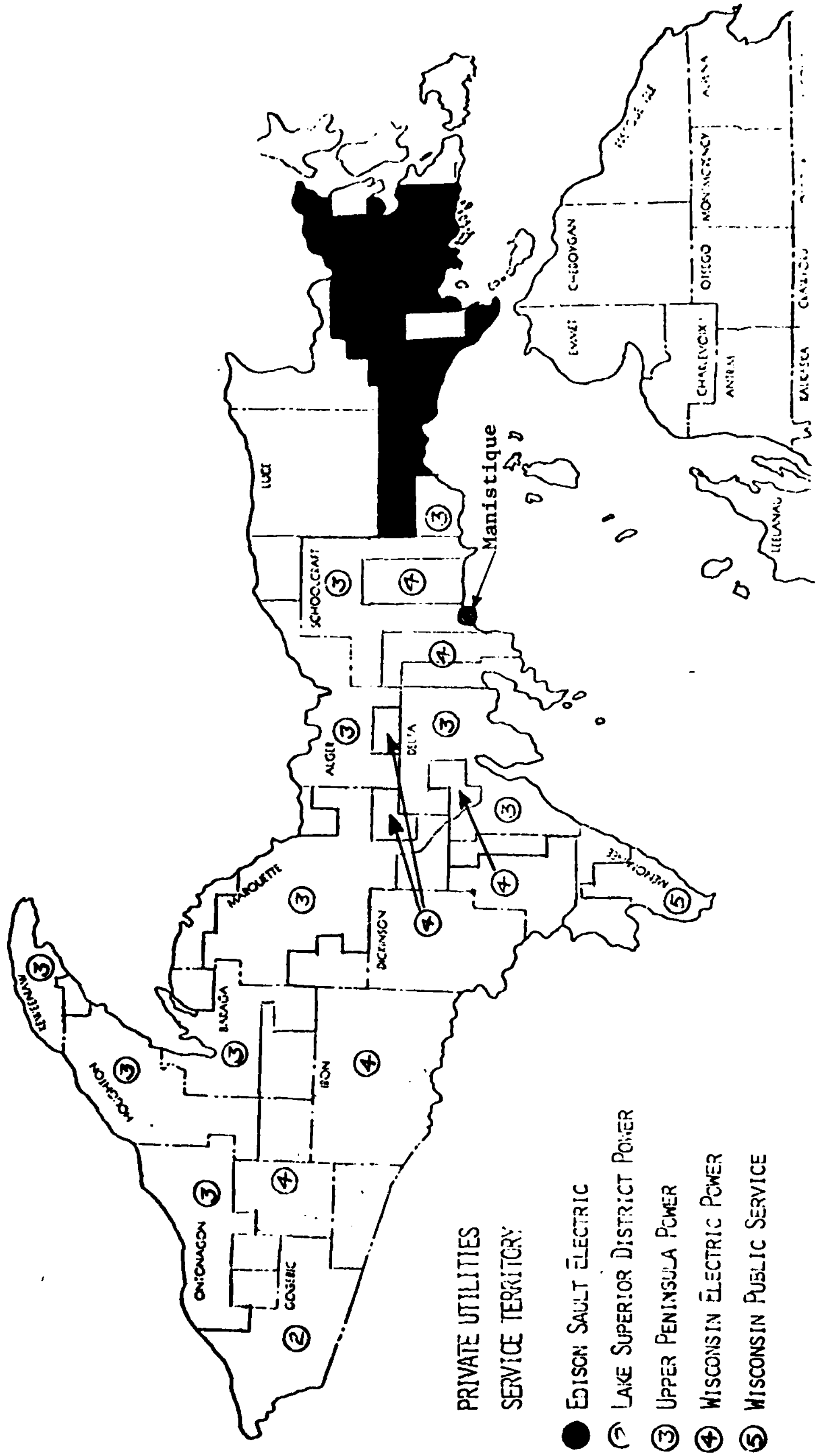
[1]The Future Electric Energy Requirements of Michigan's Upper Peninsula 1975-2000, 1976, Stanford Research Institute



PRIVATE UTILITIES
SERVICE TERRITORY
Edison Sault Electric
Lake Superior District Power
Upper Peninsula Power
Wisconsin Electric Power
Wisconsin Public Service
Manistique
LUCE
SCHOOLCRAFT
ALGER
DELTA
MARQUETTE
DICKINSON
MENOMINEE
BARAGA
HOUGHTON
KEWEENAW
IRON
ONTONAGON
GOGEBIC
EMMET
CHEBOYGAN
CHARLEVOIX
ANTRIM
OTSEGO
MONTMORENCY
LEELANAU

FIGURE 2

a. To enhance National Economic Development by increasing the value of the Nation's output of goods and services and improving national economic efficiency; and

b. To enhance the quality of the environment by the management, conservation, preservation, creation, restoration, or improvement of the quality of certain natural and cultural resources and ecological systems.

The alternatives formulated are evaluated in the context of achievement of these national objectives.

PUBLIC CONCERNS

A public workshop on the study was conducted at Sault Ste. Marie, Michigan, an 21 August 1980. The principal concerns expressed in the workshop are described below.

(1) The Edison Sault Electric Company (ESELCO) plant, power canal, and headgate structure are in the process of being nominated to the National Register of Historic Places. The nomination, on its acceptance, might emerge as a serious constraint on any possible plans to redevelop the ESELCO facility.

(2) The U.S. Government navigation locks facility blocks the shoreline view of the Rapids area. Access to the Rapids and the U.S. Government plant, and development of a public park in the Rapids area in conjunction with a similar project on the Canadian side of the rapids, was suggested.

(3) Several employees of ESELCO expressed their concern that the possible discontinuance of operating the ESELCO facility would directly impact on their employment. As a result of the discussion at the meeting, an alternative has been added for consideration whereby modifications would only be made to the U.S. Government facility and not the ESELCO facility. This study will determine if such an alternative is feasible.

Additional comments and questions expressed at the workshop were directed toward: (a) the future of the Edison Sault Electric Company (ESELCO) facility if hydropower redevelopment is determined to be feasible and justified; (b) the effect of the Canadian powerplant on generation of power on the United States side whereby Canada will be able, in 1982, to utilize their full 50% share of water, as specified under international treaty (which has not been traditionally the case); (c) how much power would be generated, who would pay for the project and who would benefit from the redevelopment project; (d) consideration of additional sources of energy production such as wind generation and wood burning plants; (e) engineering modifications to the hydropower facilities such as on the enlargement of power canals at the ESELCO and the U.S. Government facilities and the feasibility of the enlargement; (f) the number of gates required to be open at the Compensating Works according to Plan 1977 supplemental orders; (g) the amount of flow allowed through the Chicago Diversion; and (h) a concern about possible slippage of the foundation of the U.S. Government Plant.

In a meeting convened by the U.S. Fish and Wildlife Service on 6 August 1980, for the purpose of gathering information on this hydropower study, mitigative and enhancement measures on the St. Marys River were considered. Their concerns centered on the rapids area and the fluctuation of flows during the year, the lack of water during certain periods of the year, the availability of baseline data, and the need to enhance the fisheries in the rapids area. A representative of the Ministry of Natural Resources of Canada favored the implementation of one of the structural measures recommended in the September 1974 Feasibility Study of Remedial Works in the St. Marys Rapids at Sault Ste. Marie, as a means of offsetting some of the concerns expressed by the U.S. Fish and Wildlife Service, and expressed his Ministry's belief that any increase in the existing flows in the Rapids would not be considered favorably by Canada. The representative of Parks Canada expressed concern that the diversion of additional water to the Government power plant might create a strong current on the Canadian side, causing problems with the use of the Canadian navigation lock.

A letter from the Michigan Municipal Electric Association, dated 4 September 1980, expressed concern for the treatment of municipally and cooperatively owned electric utilities in accordance with the well established preference customer doctrine. The Association takes the position that any expansion or other improvement of the hydroelectric facilities should incorporate a full and complete recognition of the needs of preference customers in the region.

A letter dated 17 September 1980 from the U.S. Fish and Wildlife Service states their concerns. A copy of this letter may be found in Appendix D, "Environmental," Section II.

EXISTING CONDITION

The St. Marys River is the outlet of Lake Superior which connects the southeast end of Lake Superior with the north end of Lake Huron. The St. Marys River is about 67 miles long and is bordered on one side by Canada, and by the Upper Peninsula of the State of Michigan on the other. The St. Marys River drops about 22 feet over its length. Most of the fall occurs in the 2/3 mile-long St. Marys River Rapids at Sault Ste. Marie, Michigan/Ontario.

Both the United States and Canada have built locks on the St. Marys River at Sault Ste. Marie, Michigan/Ontario. These locks are chambers designed to move ships and recreation vessels due to a rapid change in water levels in the area.

Because the St. Marys River is in international territory, the use of the waters is governed by international agreement under the Treaty of 1909. Namely, precedence is given to water uses in the following order: (1) domestic; (2) navigation; and (3) power and recreation. The flow in the river has been completely controlled since 1921 with construction of the compensating works located at Sault Ste. Marie. The facilities through which the water flows are the navigation locks, hydropower plants, and the compensating works. Release of the water through these controls is prescribed by the International Lake Superior Board of Control, established under the International Joint Commission (IJC), in accordance with a Plan of Regulation (Plan 1977) designed to satisfy criteria specified by the IJC. Plan 1977 was used in the study to develop the historic flows on which the monthly availability of water for power is based. In general, the outflow from Lake Superior is distributed at Sault Ste. Marie in accordance with the provisions of the "Order of Approval" of the IJC of 26 May 1914, as amended by the "Supplementary Orders" dated 3 October 1979,

An example of the monthly distribution of water for a typical prescribed Plan 1977 outflow of 88,000 cfs is shown in Table 1.

TABLE 1

PRESENT DISTRIBUTION OF WATER

Navigation locks (U.S. & Canada)		910 cfs
Compensating Works		28,630 cfs*
U.S. Government Power Plant		12,480 cfs
Edison Sault Power Plant		28,280 cfs
Great Lakes Power Corporation Plant (Canada)		17,740 cfs
TOTAL	=	88,040 cfs

*Includes minimum requirement for environmental considerations in the Rapids area (i.e., equivalent to 1/2 gate opening in compensating works or approximately 3,000 cfs) plus water in excess of requirements for locks and power facilities.

Although the United States and Canada are entitled to an equal share of the St. Marys River water, the power plants on the United States side of the river have been using more than the 50% share of the water because Canada has not been able to use its 50% share. From the 1979 monthly average flow of 88,040 cfs, the combined total usage by the two power plants on U.S. side was 40,760 cfs (70%) in comparison with an average discharge of 17,740 cfs (30%) through the Canadian (GLPC) plant. With the completion in 1982 of the new Great Lakes Power Plant, Canada will be able to use their full 50% of the flow available for power generation up to a maximum of 35,000 cfs. This will mean a substantial decrease in the flow available for U.S. power production. This decrease in water availability to the United States is an important reason for the need to improve the efficiency of water use of half of the water available in the St. Marys River and the present U.S. power facilities.

If hydropower redevelopment is not undertaken, the projected water distribution once the Canadian plant goes into operation is given in the following table.

TABLE 2

PROJECTED DISTRIBUTION OF WATER - NO ACTION PLAN

Navigation locks (Based on 1995 projection)	960 cfs
Compensating works (1/2 gate open near maximum Lake Superior level)	3,100 cfs
U.S. Government plant	12,700 cfs
ESELCO plant	23,240 cfs
Great Lakes Power Corporation plant	35,000 cfs
Present and projected average (1900-1978) Lake Superior outflow	75,000 cfs

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There are two power plants at Sault Ste. Marie, Michigan on the United States side of the St. Marys River: the U.S. Government Plant and the ESELCO Plant. On the Canadian side, there is one plant: the Great Lakes Power Corporation Plant.

The U.S. Government Plant

The plant consists of two powerhouses with a total installed capacity of 18.4 megawatts (MW), using an average flow of 12,700 cfs. The main powerhouse located at the foot of the Rapids has three generating units each of 4.8 MW capacity installed in 1951-52 and one generating unit of 2.0 MW capacity installed in 1954. The Unit 10 powerhouse with a single unit of 2.0 MW capacity installed in 1932 is located at the head of the Rapids. The power generated at the Government Plant that is excess to the Government's needs, is sold to ESELCO by contract.

Description of the U.S. Government Plant

The original installation of the U.S. power plant consisted of four 71-inch, 525 horsepower (HP), vertical Leffel Sampson turbines with direct connected 450 kilowatt (kW) General Electric generators, and was built by ESELCO in 1906-7. In 1916, subsequent to the acquisition of the plant by the U.S. Government, a 60-inch, 929 HP, vertical Allis-Chalmers turbine, direct connected to a 781 kilovolt-ampere General Electric generator, was installed. In 1917, under the provisions of the River and Harbor Act of March 4, 1915, the tailrace was enlarged and deepened; and in 1925, by authority of the Secretary of War, the forebay was deepened. These two improvements resulted in an increase in head of 3 feet (from 14 to 17) and an increase in power capacity from 2,575 to 3,170 HP. In 1932, a new section of the plant was built to the north of the old portion, and a 114-in, 3,000 HP, vertical, adjustable blade, Allis-Chalmers turbine, direct connected to a 2,500 kilovolt-ampere General Electric generator, designated as Unit 10, was added. Pursuant to the March 2, 1945 Congressional authorization the original plant (except Unit 10) was removed and a new powerhouse was constructed downstream of Unit 10.

The turbines and generators in the U.S. Government main plant are in good condition and have most of the features of present powerhouse design generators. The Unit 10 generator is an older type design.

History of the Acquisition of the U.S. Government Plant by the United States

The hydroelectric power plant, originally owned by the Edison Sault Electric Company, was acquired by the United States under the provisions of Section 11 of the River and Harbor Act of March 3, 1909 (35 Stat. 920).

Further Development of U.S. Government Plant

Public Law (P.L.) 14, March 2, 1945 authorized the construction of the first step of a two-step development plan on the hydroelectric power plant at Sault Ste. Marie, Michigan, as recommended in House Document No. 339, 77th Congress, and stipulated that "no further development in addition to said first step shall be undertaken until hereafter authorized by law." The first step provided for the installation of approximately 14 MW in a new plant located adjacent to the U.S. navigation locks at an estimated cost of $3,500,000. The second step provided for the enlargement of the new plant or for the acquisition and reconstruction of the power plant formerly owned by Michigan Northern Power Company (now owned by ESELCO) to provide for an ultimate total installation of approximately 45 MW, at an estimated cost of $6,500,000."

The Edison Sault Electric Company (ESELCO) Plant

This plant, located below the Rapids and on the mainland shore of Sault Ste. Marie, Michigan, is serviced by a 2-1/2 mile long diversion canal. It has 78 power units with a total installed capacity of 41.3 MW and uses an average flow of 30,000 cfs. There are two units each of 375 kW capacity installed in 1901, two units each of 500 kW capacity installed in 1916, nineteen 60-cycle units each of 480 kW installed in 1916, and fifty-five 60-cycle units each of 585 kW installed during 1963-64. Since the plant is old, the efficiency of the plant is rather low, and is estimated to be about 70%.

The plant, canal, and headgates are in the process of being nominated by the Michigan History Division of the Michigan Department of State to the National Register of Historic Places.[2]

[2]The National Register of Historic Places was created by the U.S. Congress, Public Law 89-665, commonly referred to as the National Historic Preservation Act.

There are presently two contracts in existence between the Edison Sault Electric Company and the United States Government which deal with the water and power in excess of the needs at the U.S. Government facilities at Sault Ste. Marie, Michigan. One contract is an agreement to purchase from the U.S. Government part of the water available to the United States. This lease, which expires in the year 2000, was made with the stipulation that from the water available, the U.S. Government will first fulfill its water requirements for navigation, flow in the Rapids, and satisfy its need for water at the U.S. Power Plant; then water in excess of these requirements would be allocated to Edison Sault up to a maximum of 33,000 cfs.

The second contract is an agreement for sale of power generated at the U.S. Government Power Plant to Edison Sault Electric Company. This contract, which expires in June 2000, states that power in excess of that required for operation of the plant and that necessary for its operation of the St. Marys Falls Canal and its appurtenant works will be provided to the Edison Sault Electric Company for distribution.

ESELCO is the distributor for all hydropower generated at both the U.S. Government plant (in excess of Government needs) and ESELCO plant. The ESELCO service area includes the counties of Chippewa, Luce, Mackinac, and Schoolcraft in the eastern portion of the Upper Peninsula of Michigan.

Hydropower generation at the U.S. Government plant is allocated on a priority basis, under contract with ESELCO. In 1979, Government agencies, Cloverland Electric Cooperative, and ESELCO were allocated 2.455 MW, 4.221 MW, and 11.927 MW, respectively, power from the U.S. Government plant. The allocation is dependent on prior years demand.

ESELCO's purchases and sales of power over the 1975-1979 period are displayed in Table 3.

TABLE 3

EDISON SAULT NET GENERATION AND PURCHASES, 1975-1979
(Megawatt Hours)

Net Generation	1975	1976	1977	1978	1979
Hydro 1/	399,059	405,362	404,763	401,041	392,948
Diesel	848	1,962	1,536	1,683	2,779
Purchases from Other Utilities	55,156	68,419	92,041	96,283	114,208
Total	455,063	475,743	498,340	499,007	509,935
Losses and Unaccounted for	26,927	28,577	28,849	31,561	36,194
Company Use	1,407	1,503	1,547	1,605	1,047
Electricity Sold	426,729	445,663	467,944	465,841	472,694

1/ Includes the output of 18 megawatt U.S. Government Hydro Plant total output which is purchased by the Company net of government requirements for Sault Lock complex operation.

Hydropower has constituted a substantial part, about 77% to 87%, of the total net generation over the last 5 years. If no redevelopment of hydropower is undertaken, the hydropower generation is expected to drop to about 385,000 MWh.

Any change in hydropower generation levels of both the U.S. Government and ESELCO plants would have a direct impact, such as rate changes, on ESELCO customers. Changes in average annual use and revenue for ESELCO customers are shown in Table 4. Rates for residential and commercial customers have increased 21.2% and 16.6%, respectively, over the period 1975-1979. Although the Michigan Public Service Commission sets rates, the rate increase in the past could be construed as a trend.

TABLE 4

EDISON SAULT ELECTRIC COMPANY
CHANGES IN AVERAGE COSTS TO CUSTOMERS

Average Annual Use & Revenue Per Residential Customer	1975	1976	1977	1978	1979	% Increase 1975-1979
Kilowatt Hours	7,942	8,281	8,161	8,187	8,268	4.1
Revenue	$ 194	$ 222	$ 225	$ 236	$ 246	26.8
Revenue per Kilowatt Hour	2.45¢	2.69¢	2.76¢	2.88¢	2.97¢	21.2
Per Commercial Customer						
Kilowatt Hours	29,405	32,237	34,147	36,396	37,846	28.7
Revenue	$ 921	$1,095	$1,182	$1,304	$1,380	49.8
Revenue per Kilowatt Hour	3.13¢	3.40¢	3.46¢	3.58¢	3.65¢	16.6

Great Lakes Power Corporation Plant

This plant is located on the Canadian side of the International border. The present installed capacity is 21.5 MW with a discharge rate of approximately 18,000 cfs. A new plant with an installed capacity of about 52 MW and a discharge rate of 35,000 cfs is under construction immediately downstream from the existing plant. The new facility is expected to be on-line in 1982. Once in operation, the new plant is not expected to cause any change in the Lake Superior levels.

Table 5 provides a summary of the improvements on the St. Marys River authorized by the Congress, including those improvements at Sault Ste. Marie, Michigan (i.e., navigation lock facilities, powerplant facilities).

TABLE 5

AUTHORIZING LEGISLATION FOR WORK ON THE ST. MARYS RIVER

Acts	Work Authorized	Documents
July 11, 1870	Weitzel Lock (Replaced in 1943 by MacArthur Lock), Widen and Deepen Existing State Canal.	Report by Maj. O.M. Poe, Corps of Engineers, Not Published.
August 5, 1886	Poe Lock.	H. Ex. Doc 72, 49th Cong., 2d Sess.
July 13, 1892	Dredging Through Shoals Above Falls and Shoals Below Falls Between Lower End of Canal and Upper Entrance Channel into Lake Nicolet (Formerly Hay Lake).	H. Ex. Doc. 207, 51st Cong., 2d Sess. and Annual Report 1891, p. 2810.
June 13, 1902	Enlarging the Old Channel.	H. Doc. 138, 56th Cong., 2d Sess., and 215, 58th Cong., 3d Sess.
June 13, 1902	Lake Nicolet and Neebish Channels Work in that Section of River Below Locks.	H. Doc. 128, 56th Cong., 2d Sess.
March 3, 1907	Davis Lock Second Canal, and Emergency Dam.	H. Doc. 333, 59th Cong., 2d Sess. (Plan 3).
March 3, 1909	Lease of Waterpower at Falls. Lease Entered Into with Michigan Northern Power Co. Provided for Construction of Remedial and Compensating Works.	
July 25, 1912	Fourth Lock (Renamed "Sabin" Lock in 1943).	H. Doc. 65, 62d Cong., 1st Sess.
March 4, 1915	Deepen Tailrace of Power Plant	

TABLE 5 (Continued)

Sep. 22, 1922	Widen Upper Approach to Canals Through Vidal Shoals, Extend Anchorage and Maneuver Area Below Locks.	District Engineer Report, Oct. 29, 1920.
Jan. 21, 1927	Remove Round Island, Middle Ground, Extension of Northwest Canal Pier; and Widen Channels Middle Neebish Route.	H. Doc. 270, 69th Cong., 1st Sess.
July 3, 1930	Deepen Channels Throughout Downbound Route.	H. Doc. 253, 70th Cong., 1st Sess.
June 26, 1934	Operation and Care of Canal and Locks Provided for from War Department Appropriations for Rivers and Harbors.	
August 30, 1935	Widen Brush Point Turn and Channel from Brush Point to Point Louise.	River and Harbor Committee Doc. 53, 74th Cong., 1st Sess.
March 7, 1942	Construct New (MacArthur) Lock on Site of Former Weitzel Lock, Deepen Approach Channels to 27 Feet, and Reconstruct Approach Piers.	H. Doc. 218, 77th Cong., 1st Sess.
June 15, 1943	Named "MacArthur" Lock and Changed Name of "Fourth" Lock to "Sabin" Lock.	
March 2, 1945	Remove Bridge Island and Construct New Hydroelectric Power Plant.	H. Doc. 679, 78th Cong., 2d Sess. and H. Doc. 339, 77th Cong., 1st Sess.

TABLE 5 (Continued)

July 24, 1946	Replace Poe Lock at St. Marys Falls Canal with a New Structure 800 Feet Long, 100 Feet Wide and 32 Feet Deep, with Necessary Construction of Nose and Center Piers, and Widen and Deepen Channel Across Point Iroquois Shoals and in Lake Nicolet to Provide Wider Anchorage and Maneuver Areas in St. Marys River.	H. Doc. 335, 80th Cong., 1st Sess.
March 21, 1956	Deepen to Provide a Project Safe Draft to 25.5 Feet Over Full Width to Downbound and 2-Way Channels (Including Anchorage Areas) and Over Westerly 300-Foot Width of Upbound Middle Neebish Channel, When Levels of Lake Superior and Huron are at Their Respective Low-Water Datum.	S. Doc. 71, 84th Cong., 1st Sess.
July 9, 1956	Repeal Authorization of Bridge as a Part of Project, Authorize Alteration With Cost to be Apportioned by Sec. 6, Truman Hobbs Act, June 21, 1940.	None

Environmental

General Description

The St. Marys River is approximately 67 miles long and flows in a southeasterly direction between the State of Michigan and the Province of Ontario, Canada, from the eastern end of Lake Superior into the northern end of Lake Huron.

From Lake Superior to Lake Huron the surface level drops 22 feet. Only a 1/4-foot drop is encountered from Whitefish Bay to the head of the St. Marys Rapids, a distance of 14 miles. Most of the fall, about 20 feet, occurs between the head of the U.S. Navigation Canal and the foot of the Rapids, a distance of about 1-1/2 miles. Below the Rapids, the river falls about 2 feet as it divides into two channels around Sugar Island and flows to Lake Huron.

In the past, the sandstone ledge at the head of the St. Marys Rapids provided a natural barrier which controlled Lake Superior water levels. Following construction of the compensating works, Soo Locks, and the hydropower facilities, complete control of the flow has been achieved. During normal operation, when power and navigation flow requirements are met, the gates of the compensating works are set to regulate the remaining Lake Superior outflow through the rapids.

Since 1900, the discharge of the St. Marys River has averaged about 75,000 cubic feet per second (cfs), ranging from a maximum of 127,000 cfs in August 1943 to a minimum of 41,000 cfs in September 1955. However, it should be noted that under the present regulation plan the minimum flow is controlled at 55,000 cfs. Since 1921, when complete control of the river was achieved, flow through the Rapids area has averaged 17,000 cfs.

Water Quality

In general, the water in the study area reflects its source (Lake Superior), a cold, soft-water oligotrophic lake. The alkalinity is about 45 mg/l as $CaCo_3$ with a PH of about 7.8, oxygen is near saturation with extremely low concentrations of all forms of phosphorus and nitrogen. Similarly, the fauna of the study area reflect an oligotrophic environment, being of pollution intolerant types with isolated exceptions such as downstream of Algoma Steel Corp., Sault Ste. Marie, Ontario.

Benthic Communities

As part of the Stage 1 planning aid letter (see Appendix D, "Environmental," Section II), the U.S. Fish and Wildlife Service has provided a species list of benthic organisms which occur in and around the St. Marys Rapids area. Benthos included are:

Trichoptera of the genus Hydropsyche
Trichoptera of the genus Cheumatopsyche
Trichoptera of the species Psychomyia
Trichoptera of the genus Athripsodes
Diptera of the family Chironomidae
Diptera of the family Simulidae
Diptera of the family Tipulidae
Ephemeroptera of the family Heptagenudae
Isopods of the genus Asellus
Amphipods of the family Gammaridae
Annelida of the class Oligochaeta

Other rare forms are the triclads, hydra, stoneflies, leeches, fingernail clams, snails, and crayfish. The algae of the area is dominated by pollution intolerant diatoms and greens.

In addition, a survey of the benthic biota in the dewatered area of the Canadian rapids was undertaken on November 6 and 7, 1973, under the leadership of the U.S. Bureau of Sport Fisheries and Wildlife, Ann Arbor, Michigan, assisted by personnel from the Sea Lamprey Control Centre, Canada Department of the Environment, and from Sault College, Sault Ste. Marie, Ontario. The results of this survey were published as part of a report to the International Joint Commission by the International Lake Superior Board of Control entitled, "Feasibility of the Remedial Works in the St. Marys Rapids at Sault Ste. Marie," September 1974.

The report states that caddis fly nymphs were the most abundant order of insects. The numbers obtained were large, varying from 120 to approximately 11,600 per square meter. The average abundance of caddis fly nymphs at all stations for which there were counts was approximately 4,500 individuals per square meter.

Among the other invertebrates, it is significant that the Heptigenian mayflies, indicators of pure water, were present; whereas the Tubificid worms, indicators of gross pollution, were absent. Stonefly (Plecoptera) nymphs were not collected although they have been observed in the general area during the summer.

Fisheries

The St. Marys Rapids is a unique area and is known for its excellent fishery. As early as 1830, visitors congregated to watch Indians in bark canoes netting and spearing lake whitefish (Coregonus clupeaformis). In 1883, Ontario introduced rainbow trout (Salmo gairdneri) into Lake Superior. Sustained by frequent stocking by Michigan and Ontario, together with natural reproduction in the Rapids area, this species has become an important component of the Rapids fishery (Feasibility Study of Remedial Works in the St. Marys Rapids at Sault Ste. Marie, September, 1974, p. 2-18). Walleye (Stizostedion vitreum) has been another important species in the Rapids area from early settlement times.

The rocky substrate of the Rapids provides a productive substrate for benthic organisms, shelter for forage fish and spawning habitat for rainbow trout and other species. However, over the years, the historic whitefish and walleye fishery in the Rapids has declined. Although the same is true for the introduced rainbow trout fishery, it still provides quality fishing.

The habitat types found in this drainage include hardwood and coniferous forests, pastures, croplands, inland marshes and permanent and temporary wetlands contiguous to the St. Marys River.

Over 60 species of mammals may be found in the basin, some of which provide a very important resource to man as game animals or as recreational opportunities. These include whitetail deer, black bear, snowshow hare, bobcat, gray squirrel, raccoon, red fox, coyote, skunk, beaver, river otter, weasel, mink and muskrat. Of the numerous bird species found in the St. Marys River basin, woodcock, ruffed grouse and numerous species of ducks and geese also provide harvestable resources. Over 25 species of reptiles and 20 species of amphibians occur in the area.

The shoreline, islands, wetlands and shallow waters provide feeding, resting and nesting habitat for many waterfowl, shore and wading birds, colonial nesters, and songbirds. Waterfowl commonly seen in the basin include whistling swan, Canada goose, snow and blue geese, mallard, pintail, black duck, gadwall, American pigeon, northern shoveler, blue-winged and green-winged teals, wood duck, redhead, canvasback, ring-necked duck, lesser and greater scaup, common goldeneye, bufflehead oldsquaw, ruddy duck, and common, red-breasted and hooded mergansers. Common loons migrate and summer along the river. Herring gull, ring-billed gull, common tern, Caspian tern, black tern, black-crowned night heron, snowy egert, and great blue heron are found along the river.

Important migration areas along the river have been listed for birds of prey, shore birds and migrating passerines. Many waterfowl including scaup, common goldeneye, bufflehead and common and red-breasted merganser winter in open water areas of the harbor and around the power plants. A study conducted during the winter of 1978-1979 showed the St. Marys Rapids and the Edison Sault Hydroelectric Plant outfall areas to be critical food and resting habitats for wintering waterfowl.

The other fish known to occur in the study area include:

Lake Sturgeon	*Acipenser fulvescens*
Brook Trout	*Salvelinus fontinalis*
Splake	Brook trout x lake trout
Coho Salmon	*Oncorhynchus kisutch*
Chinook Salmon	*Oncorhynchus tshawytscha*
Pink Salmon	*Oncorhynchus gorbuscha*
Round Whitefish	*Prosopium cylindraceum*
Cisco	*Coregonus spp.*
Northern Pike	*Esox lucius*
White Sucker	*Catostomus commersoni*
Longnose Sucker	*Catostomus Catostomus*
Carp	*Cyprinus carpio*
Burbot	*Lota lota*
Rock Bass	*Ambloplites rupestris*
Yellow Perch	*Perca flavercens*
Alewife	*Alosa pseudoharengus*
Rainbow Smelt	*Osmerus mordax*
Lake Emerald Shiner	*Notropis antherinoides*
Spottail Shiner	*Notropis hudsonius*
Johnny Darter	*Etheostoma nigrum*

Logperch	Percina caprodes
Slimy Sculpin	Cottus cognatus
Mottled Sculpin	Cottus bairdi
Longnose Dace	Rhinichthys cataractae
Brook Stickleback	Eucalina Inconstans
Ninespine Stickleback	Fungitius

Wildlife

The St. Marys River drainage basin is composed of a wide diversity of habitat types which support a wide spectrum of the plant and wildlife species known to inhabit the Great Lakes Region.

Threatened/Endangered Species

Federally endangered species which may visit or pass through the St. Marys River area include American and Arctic peregrine falcons, the gray wolf, and the bald eagle. Bald eagles have been observed around the harbor areas and along the river during winter.

THE WITHOUT PROJECT CONDITION

The "without project" condition is defined as the situation which will prevail over the planning period in the absence of implementation of a plan to redevelop hydroelectric power in the St. Marys River area.

Although the United States and Canada are entitled to an equal share of the St. Marys River water, the power plants on the United States side of the river have traditionally been using more than the 50% share of the water. The reason for this is that Canada has not been able to use its 50% share. As an example, in 1979, out of an average monthly Lake Superior outflow of 88,040 cfs, the combined monthly average flow used by the two power plants on U.S. side was 40,760 cfs in comparison with 17,740 cfs through the Canadian Great Lakes Power Corporation (GLPC) plant. Based on the long-term average monthly flow of 75,000 cfs, after deducting 960 cfs for the navigation locks and 3,100 cfs for the compensating works (1/2 gate open), 70,940 cfs would be available for monthly power generation. The new GLPC power plant is expected to use a maximum of 35,000 cfs. The balance of 35,940 cfs would be available for hydropower in the U.S. Government and ESELCO plants. As a result, the projected reduction from the 1979 level would be about 5,000 cfs. A comprehensive analysis of the flow is given in Appendix B, "Hydrologic and Hydraulic Studies." The average annual energy of both the U.S. Government and ESELCO plants in 1979 was about 398,000 megawatt-hours (MWh). Under the no action plan, the projected average annual energy would be about 385,000 MWh; which is less than the 1979 energy production. The loss of energy is due to a reduction in the available water from its present level.

Under an existing contract, ESELCO receives water surplus to the U.S. Government plant requirements. According to Stone and Webster's report (cited as one of the prior reports), hydropower production at the ESELCO plant would be reduced by about 40,000 MWh once the GLPC plant is in service. (This estimate is greater than that developed by the St. Paul District.) ESELCO will have to make up for this loss of hydropower by increasing its purchased energy from other sources such as Consumers Power Company. This, in turn, would result in increased costs to ESELCO and its customers.

Environmental

A profile of the existing conditions of the study area will be expanded to portray future conditions without any project action. Currently, one of two possible conditions could exist. These are: (a) ESELCO could continue to operate when water is available, sufficient for hydropower, or (b) ESELCO would be provided with a minimum flow to clear the power canal and any excess water being discharged over the compensating works. The projection of the future environmental conditions will be made during Stage 2 and 3 in order to provide a complete basis for comparison of the effects of alternative plans.

PROBLEMS, NEEDS AND OPPORTUNITIES

Power Demand

An important aspect for consideration is the ever-increasing demand for energy. The East Central Area Reliability (ECAR) Council's April 1980 report (discussed in Appendix C, "Economics of the Alternatives") projects for ESELCO an increase in net energy required for its system. A more accurate estimate of the power demand would be available after the completion of a marketing study by the U.S. Department of Energy scheduled for FY 81. The hydropower redevelopment alternatives considered in his reconnaissance report would contribute to meeting future power needs (demand) in the eastern portion of the Upper Peninsula of Michigan.

Problems

The total hydropower generation from both the U.S. Government and ESELCO plants has been far less than the demand of the area customers. A factor contributing partly to this problem is the physical condition of the ESELCO plant, which is about 80 years old. The efficiency of the plant is about 70% at this time. A new element which would reduce the power production in the future is the expected decrease in the available water for hydropower in the power plants on the United States side of the St. Marys River. Traditionally, the United States has been able to use more than its 50% share of the waters available for power because the existing GLPC plant in Canada did not have the capability of utilizing Canada's full share of the waters. When the new GLPC plant is commissioned in 1982, Canada will be able to use its 50% share of the waters during periods of average and below average flows. Consequently, the water available for power on the United States side could be significantly reduced, resulting in less power generation.

Environmental interests have expressed concern about the widely fluctuating flows in the St. Marys Rapids being a threat to fish productivity.

Opportunities

While it is impossible to produce enough hydropower to meet the energy demand in the eastern portion of the Upper Peninsula, methods to increase power generation to its maximum potential are available. As for water, the reduction in the flow available to the United States for hydropower will occur whether the facilities are redeveloped or not. The only way to increase hydropower production is to build a new facility or modify the existing power plants to maximize power output utilizing the available flow.

As an alternative to hydropower, other sources of energy such as fossil fuel, nuclear, solar, wind, and geothermal could be developed. However, the Federal Energy Regulatory Commission (FERC) has determined that the most likely alternative to hydropower is a coal-fueled steam electric plant. The investigation of these alternative sources is not within the scope of this reconnaissance study.

Environmental considerations are the basis for maintaining, as a minimum, one-half gate opening of the compensating works. The <u>Feasibility Study of Remedial Works in the St. Marys Rapids at Sault Ste. Marie</u>, a report to the IJC by the International Lake Superior Board of Control, September 1974, (see "Prior and Ongoing Studies and Reports") considered the effects of the existing regulation of flow through the Rapids on the biological productivity, with special reference to the fishery. That study concluded that three structural alternatives are feasible both economically and environmentally. Any increase in the flow through the Rapids will result in a corresponding reduction in water for hydropower and, in turn, a reduction in power generation.

Hydropower is a most viable alternative in terms of producing electricity with a renewable resource - water. National directives encourage the development of hydropower in compliance with national goals for energy independence, use of renewable resources, and resource conservation.

One of the opportunities in this study is that redevelopment of hydropower can take place at existing facilities and therefore limit the environmental disturbance that would accrue as a result of the new power plant development. In addition to limiting environmental disturbance by utilizing existing sites, hydropower is a very efficient, non-pollutant, energy-conserving means of producing electricity. Hydropower is less expensive than fossil fuel generating plants and does not pose the concern for human safety as does nuclear power development.

PLANNING CONSTRAINTS

There are constraints that impact on this study. The constraints involve water levels and the distribution of water as follows:

Lake Superior water levels and outflows are regulated in accordance with the provisions of the "Order of Approval" of the International Joint Commission of 26 and 27 May 1914, as amended by the "Supplementary Orders" dated 27 September 1978 and 3 October 1979.

In addition to the above constraints of water level and supply availability, there are physical constraints. In general, plant capability is determined by design characteristics, physical condition, operational limitations, adequacy of prime mover, temperature, and head and tailwater elevations. In this respect, the ESELCO plant presents physical constraints because of its age (about 80 years old) and the condition of the structures.

PLANNING OBJECTIVES

The planning objectives being considered at this time for the study are as follows:

a. Contribute to hydropower production for domestic, commercial, and industrial purposes in the Upper Peninsula of the State of Michigan for an economic life of one hundred years.

b. Enhance or preserve fish and wildlife resources for ecological and diversity purposes in the St. Marys River at Sault Ste. Marie, Michigan, for an economic life of one hundred years.

c. Enhance or preserve water quality for domestic consumption and water recreation purposes in the St. Marys River for an economic life of one hundred years.

d. Contribute to the preservation of cultural resources of the St. Marys River in the project area for public education and historic appreciation purposes during a project life of one hundred years.

FORMULATION OF ALTERNATIVE PLANS

PLAN FORMULATION RATIONALE

In the reconnaissance stage emphasis was placed on the identification of significant problems and issues and identifying corresponding national and planning objectives for the study.

Formulation was directed towards identifying potential management measures to address the problems, issues and objectives. Both structural and non-structural measures have been identified. These management measures were then combined to form alternative plans. The resultant plans were then screened, on a preliminary basis, to determine whether or not a plan displayed any potential for fulfilling the national and planning objectives of the study. For those plans which did not display a potential, a rationale is provided for not considering the alternative further at the reconnaissance stage under the Section, "Evaluation of Alternatives." For those alternatives which did display a potential, a preliminary benefit-cost analysis was conducted, potentially significant impacts are presented, and a discussion of considerations (economic, environmental, hydrologic and hydraulic, institutional, social and technical) is provided.

Plan formulation has been accomplished using the guidelines set forth in Section V of the Water Resources Council's (WRC) Principles and Standards. The criteria governing the formulation of the alternatives are discussed below.

Environmental Criteria

a. Available sources of expertise will be utilized to identify forms of fish and wildlife populations and resources which might be endangered, damaged, or destroyed by plan implementation.

b. The use of natural resources to implement a selected plan will be minimized.

c. Adverse social impacts (increased noise levels, disruption to natural beauty, and possible detriments to health) should be minimized.

d. Activities attracted to the project area after plan implementation should be in consonance with activities of the surrounding area and be environmentally and socially acceptable.

e. Measures which conserve, protect, preserve, or enhance environmental quality in the project area will be incorporated in the selected plan.

f. The adverse impacts on fish and wildlife resources should be minimized.

Technical Criteria

a. The water available for hydropower should be utilized efficiently to achieve maximum energy production;

b. Improvements to the power plants should result in a physical life of 100 years, corresponding to an economic life of 100 years for the project;

c. Improvements should be sound, practicable, engineeringly feasible, and environmentally acceptable;

d. Technical solutions with the least adverse environmental impacts should be used;

e. If necessary, corrective and/or mitigative measures should be made part of the engineering solutions; and

f. Flow available for hydropower is to be determined in accordance with the 1914 Order of Approval of the IJC as amended by the Supplementary Orders of 1979.

Economic Criteria

a. Project dollar benefits should exceed project dollar costs;

b. Separable units of improvement should provide dollar benefits at least equal to its dollar cost;

c. The scope of the development should be such as to provide, or at least identify, the maximum net benefits;

d. Annual costs including operation and maintenance should be based upon a 100-year period of economic life and an interest rate of 7-1/8% based on August 1980 price levels;

e. There should be no more economically or environmentally acceptable means of accomplishing the same purpose or purposes that would be precluded from development if the plan were undertaken; and,

f. Projected project disbenefits, and environmental and social costs must be included, and if possible, quantified.

Social Criteria

a. Avoid unnecessary and/or unreasonable risk of loss of life and hazard to health and safety;

b. Measures to enhance social, cultural, educational, and historical values should be incorporated in the alternatives;

c. Disruption of man-made or natural resources, aesthetic values, community cohesion, and public facilities and services should be avoided;

d. Human environmental benefits and costs should be considered equal in status to monetary units;

e. Possible employment effects and changes to tax and property values should be identified; and,

f. Public acceptance of proposed modifications and ability and willingness to meet local requirements should be evaluated.

Institutional Criteria

a. Institutional requirements imposed by alternative plans must be an integral part of the project plan formulation process;

b. Coordination should be carried out with existing Federal, State, and local institutions that are operating in or have an interest in the study area;

c. Areas of responsibility of Federal, State, and local institutions should be defined;

d. Improvements proposed should be institutionally implementable; and

e. Existing contractual obligations between the U.S. Government and Edison Sault Electric Company for purchase of power and water are to be considered in the plan formulation process.

MANAGEMENT MEASURES

Management measures are used to describe appropriate institutional and structural and non-structural alternatives that address the problems and planning objectives of the study.

Management measures in a single purpose study such as hydropower are, by the inherent nature of the subject, limited in scope. The overriding factor in the undertaking of this study is to seek out measures which would develop the full power potential of the St. Marys River waters.

Structural and non-structural measures were considered. The structural measures involve modifying or rebuilding one or both of the power plants on the United States side of the St. Marys River, or continuing to operate as under existing conditions. The non-structural alternatives are essentially energy conservation measures, and have general applicability in hydropower projects. These measures are discussed in greater detail in the Section, "Development of Alternatives Plans."

Institutional measures would involve coordination with the International Joint Commission (IJC) and the International Lake Superior Board of Control (ILSBC), through the U.S. Department of State, ESELCO, the Federal Energy Regulatory Commission (FERC), the U.S. Department of Energy (DOE), the U.S. Fish & Wildlife Service (USF&WS), the Advisory Council on Historic Preservation, State of Michigan (including the State Histori: Preservation Office), and local interests. Should redevelopment of the U.S. Government facilities be proposed, the institutional means of marketing or selling the power to private interests would be considered.

POSSIBLE SOLUTIONS

Several alternatives, developed from the management measures, have been considered as possible solutions. Two of the alternatives which appear to have a potential for a feasible plan have been developed to a level of detail which would permit a preliminary determination to be made on their feasibility. They are Alternative 1 and Alternative 2. Alternative 2 is shown in three variations as Alternative 2(a), Alternative 2(b), and Alternative 2(c). In Appendix A to this report, Alternatives 2(a), 2(b), and 2(c) are numbered as Alternative 2, 3, and 4, respectively.

To achieve the objective of redeveloping the hydropower potential of St. Marys River, the following alternatives have been formulated:

<u>Alternative 1</u> - Modify the Edison Sault Electric Company (ESELCO) plant, and continue operation of the existing U.S. Government plant.

<u>Alternative 2(a)</u> - Expand the U.S. Government plant and discontinue operation of the ESELCO plant. Unit 10 of the U.S. Government plant would be dismantled and the main U.S. Government plant would be extended southward.

Alternative 2(b) - Construct a new U.S. Government plant and discontinue operation of the ESELCO plant. The existing U.S. Government plant would be abandoned.

Alternative 2(c) - Install new equipment in the U.S. Government plant and discontinue operation of the ESELCO plant.

Alternative 3 - Rebuild both the U.S. Government and the ESELCO plants. Unit 10 of the U.S. Government plant would be removed.

Alternative 4 - Modify the existing ESELCO plant, and discontinue operation of the U.S. Government plant.

Alternative 5 - Continue operation of the ESELCO plant and expand the U.S. Government plant. Unit 10 of the U.S. Government plant would be removed.

Alternative 6 - Alternative sources of energy. In the absence of hydropower, energy needed in the ESELCO service area will have to be supplied by other utility companies such as Consumers Power Company. Conventional or non-conventional energy sources will have to be developed.

Alternative 7 - Non-structural measures. These measures might include reducing demand, energy conservation, efficiency standards, and educational programs.

Alternative 8 - No action, the most probable future if hydropower redevelopment does not occur.

In addition, consideration will be given to including a low-head hydropower plant at the compensating works with all of the above redevelopment alternatives. The compensating works are presently used in the regulation of the water levels and flows of Lake Superior. Because of the potentially significant environmental impacts upon the Rapids area downstream of the compensating works and because this would be an additional source of possible power to the main plants, this is not being analyzed during the reconnaissance stage.

Fish and Wildlife enhancement opportunities in the St. Marys River area, will also be considered in each of the above redevelopment alternatives during subsequent stages.

PLANS OF OTHERS

The U.S. Fish and Wildlife Service (USF&WS) considers the fluctuating flows in the St. Marys River Rapids as an impact on the fisheries. Under the current regulation plan, a minimum of one-half gate opening of the compensating works is maintained. Any increase in the minimum flow through the Rapids would result in a corresponding reduction in the water available for power. The impact of this consideration would be analyzed in greater detail in Stage 2.

One of the participants, in the 21 August 1980 public workshop conducted by the Corps, recommended that consideration be given to an alternative in which the ESELCO plant would continue to operate and the U.S. Government plant would be expanded. Out of several possible options under this alternative, three have been considered and are addressed in this report.

DEVELOPMENT OF ALTERNATIVE PLANS

The following discussion provides a description of the alternative plans as outlined under "Possible Solutions." Alternatives 1, 2(a), 2(b), and 2(c) were chosen for preliminary analysis to determine if a potential exists for a possible hydropower redevelopment project at Sault Ste. Marie, Michigan. Detailed descriptions of these alternatives including costs are presented in Appendix A, "Technical Studies." Rationale for not analyzing the remaining alternatives to the same degree is presented under the subsequent Section, "Evaluation of Alternatives." In the development of the alternatives at the reconnaissance stage, emphasis was placed on the planning objective of hydropower redevelopment. Specific management measures were not evaluated as requested by fish and wildlife interests in the reconnaissance stage. Under plans developed for the International Joint Commission (IJC) to satisfy their Orders of Approval, water is set aside for environmental interests before water is made available to power (i.e., 1/2 gate opening of the compensating works to provide water in St. Marys River Rapids area for environmental and fish and wildlife interests). In the reconnaissance stage this requirement is used, in addition to that required for navigation, in determining the amount of water available to power. Taking additional water for fish and wildlife interests would be contrary to the Orders of Approval; however, its impact would be evaluated during Stage 2 and 3, once the potential for a project has been identified during the reconnaissance stage. It is important to note that to implement any such deviation of water distribution would require IJC approval.

Alternative 1

Under this alternative, the existing U.S. Government power plant would continue to function without change, and the ESELCO plant would be modified.

Two options for modification of the ESELCO plant were considered. Option I, at a lower investment cost of $40,305,000, consists of replacing 35 of the existing 78 units by 35 new 1.1 MW fixed-blade tube turbine-generator units in the middle half of the plant, with a total installed capacity of 38.5 MW, and an average annual energy of 434,000 MWh. Option II, at a higher investment cost of $43,703,000, consists of 32 new 1.1. MW fixed-blade adjustable turbines to drive pairs of existing generators in tandem.

Part of the existing relatively new auxiliary equipment such as power cables, switchgear, etc., would be retained. However, new equipment such as buswork, switchgear, etc., would be added. Approval of any modifications would be required from the State, and possibly the Federal, Historic Preservation agencies since the ESELCO plant has been nominated for inclusion into the National Registry of Historic Places.

Flow - The average discharge through the U.S. Government plant, including Unit 10, will continue at the present level of 12,700 cfs. The average flow predicted to be available at the ESELCO plant is approximately

24,300 cfs after completion of GLPC redevelopment. The flow used by the present ESELCO plant operating at full capacity is usually between 29,000 and 30,000 cfs, and rarely exceeds 33,000 cfs. The head at Sault Ste. Marie is nearly independent of the flow. For this reason, the median head was used in estimations for the reconnaissance study.

Edison Sault Power Canal - Over half of the length of the canal is wood-lined and fully contained within the soft overburden materials. Seepage along parts of the headrace has caused stability problems in the past. Problems of this type would, of course, be aggravated if the water level in the canal were to be lowered at a rate that does not allow sufficient time for the surrounding soils to drain. Erosion control in reaches where the canal is in overburden was accomplished by installing a wood liner. Since the canal has not been dewatered in over fifty years, dewatering and a thorough inspection of the canal would be necessary to determine remedial work required. If it is determined upon dewatering that the existing wood-lined part of the canal would not be adequate for the life of the project, it would be rebuilt with a suitable lining to withstand velocities approaching 8 feet per second.

Foundation - The condition of the powerhouse pile foundation has not been investigated. In the early stages of the plant's existence, remedial measures were undertaken to prevent deflection and erosion under the foundation. The overburden at the ESELCO plant consisting of loose silty sand and soft clay is weak and susceptible to settlement and erosion.

Adequacy of the foundation is a critical element in the engineering feasibility of major rehabilitation under consideration. Detailed foundation investigations would be included in Stage 2.

Alternative 2(a)

The ESELCO plant would discontinue operations, Unit 10 of the U.S.Government plant would be dismantled, and the main U.S. Government plant would be expanded to utilize the entire flow available for hydropower. The expansion would be about 45,000 square feet south of the existing plant. The turbine-generator units and other equipment of the existing main U.S. Government plant are in good condition and would continue to be used.

The center dike and crib dam would be removed to a location 400 feet upstream of the powerhouse. In order to increase flow efficiency and to protect the north wall of the Sabin lock, a 12-inch thick concrete pavement would be placed on the side slopes from the present location of Unit 10 of the U.S. Government plant to the proposed plant expansion site.

A permanent cut-off would be made from the north wall of the Sabin lock, just downstream from Unit 10 of the U.S. Government plant, to the concrete paved right bank of the headrace, and along this bank to the plant extension.

Three options for expansion of the U.S. Government plant were considered. In Option I, at the lowest investment cost of $57,661,000, three new 12.5 MW vertical propeller turbine-generator units with incremental installed capacity of 37.5 MW would be installed in the plant expansion. In Option II, at an investment cost of $66,325,000, the plant expansion would house 8 new 5 MW tube turbine-generator units. In Option III, at an investment of $70,860,000, three new 12.5 MW bulb units would be installed in the plant expansion. The total installed capacity of the expanded facility would be 53.9 MW (including 16.4 MW of the existing main U.S. Government plant), with an average annual energy of 432,000 MWh.

Flow - For Alternatives 2(a), 2(b) and 2(c), the total average flow through the U.S. Government plant would be about 34,700 cfs, compared to 11,200 cfs for the existing main U.S. Government plant. The design discharge, however, has been selected at 37,000 cfs.

U.S. Government Power Canal - Canal modification would be extensive, covering about 3,900 feet of headrace and about 300 feet of tailrace. Excavation upstream of Unit 10 of the U.S. Government plant would be primarily in bedrock requiring controlled blasting near bridge piers and existing walls. Excavation for the headrace downstream of Unit 10 of the U.S. Government plant would be primarily in overburden.

ESELCO Power Canal - Since the ESELCO power canal would not be required for power generation, possible alternate uses for the canal would be considered in Stage 2.

Alternative 2(b)

The ESELCO plant would discontinue operations, Unit 10 of the U.S. Government plant would be removed, and a new U.S. Government plant would be built south of the existing main U.S. Government plant. The existing plant would continue to operate only until the new plant goes into operation.

As in Alternative 2(a), in order to increase flow efficiency and to protect the north wall of the Sabin Lock, a 12-inch thick concrete pavement would be placed on the side slopes from the present location of Unit 10 of the U.S. Government plant to the proposed new plant site.

Three options were considered. In Option I, at the lowest investment cost of $74,844,000, five new 10.5 MW vertical propeller turbine-generators, with a total installed capacity of 52.5 MW, and an average annual energy of 432,000 MWh, would be installed. In Option II, at an investment cost of $77,061,000, ten new 5.25 MW tube turbines would be installed. In Option III, at an investment cost of $89,434,000, three new 18 MW bulb turbine units would be installed.

Flow - As in Alternative 2(a), the entire flow available for power would be uilized by the new plant, with an average flow of 34,700 cfs and a design discharge of 37,000 cfs.

U.S. Government Power Canal - A new headrace would be excavated upstream of the proposed new plant involving extensive modification of about 6,000 feet. The existing tailrace also would need modification as in Alternative 2(a).

Alternative 2(c)

The ESELCO plant would discontinue operations, Unit 10 of the U.S. Government plant would be removed, and the existing main U.S. Government plant would be modified to house new equipment.

The existing powerhouse is not designed to accommodate larger units and would need to be extended southward, as in Alternative 2(a), which would involve extensive modification. The powerhouse operations would be suspended during renovation. As in Alternative 2(a), a cut-off dike would be placed downstream of Unit 10 of the U.S. Government plant.

The three options considered are the same as in Alternative 2(b), but the investment costs are higher.

The investment costs of Option I with five new 10.5 MW vertical propeller turbine-generators, Option II with ten new 5.25 MW tube turbines, and Option III with three new 18 MW bulb turbine units, are $83,610,000, $86,722,000, and $100,029,000, respectively. As in Alternative 2(b), the average annual energy in 432,000 MWh.

Flow - The average flow and design flow are the same as in Alternative 2(b).

U.S. Government Power Canal - A different canal alignment required between Unit 10 of the U.S. Government plant and the modified U.S. Government plant would entail removal of the center dike.

Alternative 3

In this alternative, Unit 10 of the U.S. Government plant would be removed, and both the existing main U.S. Government plant and the ESELCO plant would be replaced by new facilities.

Engineering features for Alternative 3 have not been developed in the reconnaissance stage. A new U.S. Government plant would have a greater installed capacity than the existing capacity. The U.S. Government power canal would have to be enlarged to allow for a higher discharge. The ESELCO power canal would not need to be enlarged because the expected flow would be less than the existing canal capacity; however, improvements would be required on the canal to reduce losses.

If the ESELCO plant, together with its upstream power canal, is nominated to the National Register of Historic Places, a new plant site would be required. A preliminary evaluation, as stated in the Section, "Assessment and Evaluation of Management Measures," does not sustain a need to develop this alternative in greater detail.

Alternative 4

This alternative would involve a major redevelopment of the existing ESELCO facility which is now approximately 75 years old, and discontinuing the operation of the existing U.S. Government plant which is approximately 29 years old.

Discontinuance of the U.S. Government plant would necessitate utilization of all the water available for power by the ESELCO plant. The existing ESELCO power canal flow, at full plant capacity, is in the range of 29,000 cfs to 30,000 cfs. Assuming that the design flow in the ESELCO power canal would be about 37,000 cfs (the same as that for a new U.S. Government plant in Alternative 2(b)), the ESELCO power canal would need to be enlarged, resulting in an extensive and costly modification.

The ESELCO power canal flows through the City of Sault Ste. Marie. New bridges over the canal may be required. One of the bridges, at Spruce Street, is officially eligible for nomination to the National Register of Historic Places and attempts by the City of Sault Ste. Marie to modify this structure under existing conditions have been unsuccessful. The Edison Sault plant, its power canal and headgates, have been nominated by the State of Michigan for inclusion into the National Register. Installation of new equipment may necessitate a relatively high degree of modification of the plant itself, and approval of any modification is required from the State, and possibly the Federal Historic Preservation agencies.

Structural soundness of the ESELCO powerhouse foundation is a critical factor in determining whether the existing plant is amenable to modifications. Here also, the power generation is not expected to be higher than that of a new U.S. Government plant in Alternative 2(b). In fact, the head loss in the diversion canal would result in less power generation.

Alternative 5

This alternative involves removing Unit 10 of the U.S. Government plant and expanding the U.S. Government plant to increase the installed capacity. The ESELCO plant would continue its operations, with no plant modifications.

A determination on the extent of expansion in the U.S. Government plant will depend on the minimum flow required by ESELCO to continue functioning. Increased installed capacity of the U.S. Government plant would require a bigger power canal depending on the design flow and extension of the existing powerhouse.

Preliminary analysis was made on two options. Under Option I, the main U.S. Government plant would be expanded to increase the installed capacity from its present 16.4 MW to 21.4 MW. Average flow for the U.S. Government plant and the ESELCO plant would be approximately 14,700 cfs and 22,300 cfs, respectively. Average annual energy for both plants would be approximately 392,000 MWh. The investment cost would be approximately $14,044,000. The benefit/cost ratio would be approximately 0.23.

Under Option II, the main U.S. Government plant would be expanded to increase the installed capacity from its present 16.4 MW to 26.4 MW. Average flow for the U.S. Government plant and the ESELCO plant would be approximately 18,200 cfs, and 18,800 cfs, respectively. Average annual energy for both plants would be approximately 402,000 MWh. The investment cost would be approximately $20,244,000. The benefit/cost ratio would be approximately 0.38. The preliminary economic analysis indicates that further development of this alternative would not be necessary.

Alternative 6

Possible alternative sources of energy are briefly discussed below. Fossil fuel (coal, oil, gas) is burned to produce steam which, in turn, drives turbine-generators to generate electricity. Fossil fuel plants require a start-up time to go from the shut down stage to the producing stage.

Control fission reaction nuclear powered plants generate heat which is used in producing steam which, in turn, generates electricity. Nuclear plants are fairly large and are viewed by some people as posing a concern for human safety.

Geothermal power is the use of natural sources of heat such as hot springs.

Solar energy is one of the most promising sources of energy. The National Aeronautics and Space Administration has made a study on solar power satellites; however, technology is still under development.

Energy using wind forces has been developed to a limited extent. The capacity of windmill stations is generally small. During the 21 August 1980 workshop, a suggestion was made to consider development of wind energy at the U.S. Coast Guard radar site near Sault Ste. Marie, Michigan. The suggestion would be forwarded to the U.S. Department of Energy for consideration.

In the absence of hydropower to meet base-load demands for electricity in the ESELCO service area, additional quantities of electricity would most likely need to be purchased from outside the area, unless fossil fuel or nuclear energy is developed within the service area. Based on an assumption that ESELCO would not be in service, FERC has suggested that a coal-fueled steam electric plant would be the most likely alternative. This would mean a greater reliance on fossil fuel and nuclear plants which service customers for much larger utilities such as Consumers Power Company. Based upon present knowledge, non-conventional energy sources, including solar, wind, and geothermal, are unlikely to be developed in any magnitude which could substitute as an alternative base-load energy source for the eastern portion of the Upper Peninsula of Michigan, in the foreseeable future. Therefore, no further consideration would be given to these alternative sources of energy. Also, development of these alternative sources of power are not within the scope of this study.

Alternative 7

Non-structural alternatives are measures to reduce demand, to reduce losses in the distribution system, and to conserve energy. The level of demand could be reduced or the load pattern could be altered by price restructuring. Conservation measures would include utility-sponsored loans for insulation, appliance efficiency standards, educational programs, and increased transmission efficiency. Inter-regional or inter-utility company transfers of energy will also be considered.

The alternatives would be further developed in Stage 2 to determine the extent by which they would contribute to reduction in energy demand.

Alternative 8

This alternative involves a projection of basic existing demographic, economic, social and environmental factors to attempt to describe the most probable future if hydropower redevelopment of Sault Ste. Marie, Michigan does not occur.

Two future without project conditions are considered for this study. One future without project condition is that the U.S. Government plant will continue operation at its present capacity and Edison Sault will continue to operate with reduced flows (Scenario 1). This scenario presumes that the existing 80-year old Edision Sault plant could be operated indefinitely into the future at its current level of efficiency, with no capital improvements required. The other future without project condition is that Edison Sault will discontinue operation by year 2000 and that the U.S. Government plant will continue operations (Scenario 2). By year 2000 the Edison Sault plant will be approximately 100 years old, and ESELCO's existing water and power contracts with the U.S. Government will expire.

Estimated population figures for the counties of Chippewa, Luce, Mackinac and Schoolcraft for the period 1970-1977 has shown about a 10% growth in contrast to a 5.6% decline for the previous decade (1960-1970).

If the 1970-1977 trend is any indication, it would seem reasonable to assume a future annual growth of about 1.38%.

The demand for electricity in the Upper Peninsula of Michigan is expected to have an annual growth rate of 4.9% over the period 1974-1990; but there would be less hydroelectric energy available than at the present time as a result of the reduced flow for hydropower. Consequently, there would be an increase in the purchase of non-hydroelectric power by ESELCO from other power sources such as the Consumers Power Company located in the Lower Peninsula. The cost of purchasing power from other utility companies would result in rate increases and the additional costs would filter down to the consumers in the Edison Sault service area. As shown in Appendix E, "Sociological Studies," the four-county service area has a greater proportion of unemployed than the entire State of Michigan.

Relevant engineering data under this alternative is given in Table 6.

TABLE 6
ENGINEERING DATA ON "NO ACTION" ALTERNATIVE

	ESELCO	U.S. Government Plant		Total	
	Plant	Unit 10	Main	Scenario 1	Scenario 2
Effective Net Head (Ft.)	18.0	19.5	19.5	-	-
Design Flow for Existing Capacity (cfs)	33,800	1,400	11,550	46,750	12,950
Average Flow (cfs)	24,300	1,500	11,200	37,000	12,700
Installed Capacity (MW)	41.3	2.0	16.4	59.7	18.4
Annual Plant Factor	0.63	1.07	0.97	-	-
Average Annual Energy (MWh)	227,000	19,000	139,000	385,000	158,000

Other Considerations to the Alternatives

In addition, consideration will be given to including a low-head hydropower plant at the compensating works with all of the redevelopment alternatives described above. The compensating works are presently used in the regulation of the water levels and flows of Lake Superior. Because of the potentially significant environmental impacts upon the Rapids area downstream of the compensating works, this is not being analyzed during the reconnaissance stage. It is considered to be basically a source of additional power to that generated by the primary power plants. However, further consideration will be given during Stage 2 of this study.

Fish and wildlife enhancement opportunities will also be considered in each of the above redevelopment alternatives.

ASSESSMENT AND EVALUATION OF MANAGEMENT MEASURES

Evaluation is the analysis of impacts of the alternatives, including subjective judgment on relative contributions of the alternatives to the Planning and National objectives. Beneficial effects are weighed against adverse effects to establish overall desirability of an alternative. An appraisal would show the level of desirability of the alternatives. Since Alternatives 1, 2(a), 2(b) and 2(c) have been developed to a greater degree of detail than the others, the evaluation is less subjective and more detailed.

The primary objective is to contribute to maximum hydropower generation for an economic life of 100 years. The power generation for Alternatives 1, 2(a), 2(b) and 2(c) are in the range of 432,000-434,000 MWh. For Alternatives 3, 4, and 5, the power generation is expected to be in a range slightly lower than 432,000-434,000 MWh. The issue then would be whether an alternative is economically viable. The preliminary economic benefits have been established for two scenarios of the "without project condition." In Scenario 1, both the existing U.S. Government and the ESELCO plants would continue operations for the economic life of 100 years. In Scenario 2, while the U.S. Government plant would continue operations for the economic life of 100 years, it is assumed the ESELCO plant would cease operations in the year 2000.

An analysis of the significant effects of the alternatives under consideration is the basis to determine the feasibility of the alternatives.

IMPACT ASSESSMENT

Assessment is the identification, description, and, if possible, measurement of the impacts of the alternatives. Sources of impacts are the factors of an alternative which produce changes in the components of the "without project condition." The magnitude of the impact is determined by objective comparison of the "with project condition" and the "without project condition." Wherever possible, the impacts are quantified.

The following discussion under economic, environmental, institutional, hydrologic and hydraulic, social, and technical considerations identifies those factors to be considered in an impact evaluation. A summary table which displays pertinent data and potential significant impacts of the four alternatives considered is provided at the end of this section.

Economic Considerations

Water Resources Council's Principles and Standards

The Water Resources Council's Principles and Standards (P&S) provide planning requirements for hydropower studies. The P&S require that Federal water planning studies analyze National Economic Development (NED) and Environmental Quality (EQ) as equal objectives. NED is evaluated by the increase in the value of the Nation's output of goods and services and by the improvement of national economic efficiency; EQ is to be achieved by the management, conservation, preservation, creation, restoration, or improvement of the quality of certain natural and cultural resources and ecological systems.

The NED objective of economic efficiency would be achieved by the installation of any one of Alternatives 1, 2(a), 2(b) and 2(c) considered for preliminary analysis in this study. In comparison with the viable and implementable alternative considered (i.e., a thermal plant), installation of any of the hydropower plant alternatives best meets the needs of the EQ objective. Thermal plants use non-renewable resources and are more likely to cause detrimental impacts on the environment.

The economic justification of the proposed alternatives for hydropower results from comparing estimated average annual costs to estimated average annual benefits over the period of analysis.

Economic Principles

Benefits and costs were estimated following procedures set forth in the Principles and Standards. Costs include all costs of goods and services in completing any of the hydropower alternatives. Power benefits are derived from a comparison of the costs of producing this power by the most likely alternative means. See Appendix C, "Economics of the Alternatives," for the complete economic analysis.

Total Project Costs

Total cost estimate summaries for each alternative are displayed in Table 7. Costs are based on preliminary design and are at August 1980 price levels. A contingency factor of 15% is included. An indirect cost factor of 25% has been used for investigations, management, engineering and administrative costs needed to implement the project. For a more detailed breakdown of cost see Appendix A, "Technical Studies."

TABLE 7

COST SUMMARY

ALTERNATIVE 1	$40,305,000
	35-1.1 MW units (tube turbines) 38.5 MW installed $1,047/kW
ALTERNATIVE 2(a)	$57,661,000
	3-12.5 MW units (propeller turbines) 37.5 MW installed $1,538/kW
ALTERNATIVE 2(b)	$74,844,000
	5-10.5 MW units (propeller turbines) 52.5 MW installed $1,426/kW
ALTERNATIVE 2(c)	$83,610,000
	5-10.5 MW units (propeller turbines) 52.5 MW installed $1,593/kW

Annual Costs

Annual cost estimates are based on a 100-year period of analysis (1995-2095), with an interest rate of 7-1/8%. The year 1995 was assumed as the base year at which time a completed project could be operational. Annual costs include interest and amortization on investment costs, and operation and maintenance costs. It is estimated that construction of any alternative would be two years or less; therefore, interest during construction is not included in these preliminary cost estimates. Average annual costs for each alternative are presented in Table 8.

TABLE 8
AVERAGE ANNUAL COSTS

	Alternative 1	Alternative 2(a)	Alternative 2(b)	Alternative 2(c)
Interest (.07125)	$2,872,000	$4,108,000	$5,333,000	$5,957,000
Amortization (.00007)	3,000	4,000	5,000	6,000
Oper & Maintenance	1,209,000	1,690,000	2,206,000	2,095,000
Total Annual Cost	$4,084,000	$5,802,000	$7,544,000	$8,058,000

Benefits

Power benefits are estimated as the cost of providing equivalent power by the most likely alternative means. For this study the alternative has been determined to be a coal-fueled steam electric plant, located in the Lower Peninsula of Michigan. The Federal Energy Regulatory Commission (FERC) developed power values for hydropower through cost comparison with the coal plant alternative, based on July 1980 price levels. The FERC power values are based on preliminary engineering and hydraulic data on the hydropower alternatives developed by the St. Paul and Detroit Districts. Hydraulic and power generation data have since been refined, after the preliminary data were provided to FERC. For this reason, the benefit calculations should be considered only as estimates at this point.

Without Project Conditions; Benefit/Cost Comparisons

Two future without project conditions are considered for this study. One without project condition is that the U.S. Government plant will continue operation at its present capacity and the Edison Sault plant will continue to operate with reduced flows (Scenario 1). The other without project condition is that the ESELCO hydro facility will discontinue operation by year 2000 and that the U.S. Government plant will continue to operate (Scenario 2).

A summary of average annual benefits and average annual costs for each alternative under Scenario 1 is displayed in Table 9. In this instance, the only benefits attributable to these alternatives would be the incremental addition to dependable capacity (kW), and the incremental average annual energy (MWh) that would result from the modification or replacement of the Edison Sault plant. This scenario presumes that the existing 80-year old Edison Sault plant could be operated indefinitely into the future at its current level of efficiency, utilizing reduced flows, with no capital improvements required.

Appendix C, "Economics of the Alternatives," contains details on the development of the numbers in Table 9.

TABLE 9
AVERAGE ANNUAL BENEFITS AND COSTS
SCENARIO 1

Alternative	Dependable Capacity Value	Average Annual Energy	Total Incremental Benefits	Annual Costs	Benefit/Cost Ratio
1	$543,500	$1,440,600	$1,984,100	$4,084,000	0.49
2(a)	$923,000	$1,367,700	$2,290,700	$5,802,000	0.39
2(b)	$925,130	$1,471,100	$2,396,230	$7,544,000	0.32
2(c)	$925,130	$1,471,100	$2,396,230	$8,058,000	0.30

A summary of average annual benefits and average annual costs for each alternative under Scenario 2 is displayed in Table 10. For alternatives under this scenario, it is assumed that total generation of power will be fully utilized upon project implementation. This assumption is based on existing and projected demand in the study area. Under Scenario 2, benefits are calculated on the amount of dependable hydropower capacity and generation added to the system, assuming that the U.S. Government plant would continue to operate but that the Edison Sault plant shuts down by year 2000.

Justification

A comparison of average annual benefits and costs for each alternative under the assumptions of without project conditions (Scenario 1) reveals that none of the alternatives would be economically feasible (Table 9). Conversely, under the assumptions of without project conditions (Scenario 2), all alternatives are economically feasible. The problem is in judging the future of the Edison Sault hydropower facility, and in estimating the time frame in which maximum use and an optimum investment in the hydropower resource on the St. Marys River can be made.

Scenario 1 is problematic in that it is unrealistic to expect that the existing Edison Sault hydropower facilities could continue to function over some future 100-year project life without some additional investment being made to maintain its operation. Even if attempts were made to nurse the present plant along, the lack of plant efficiency would mean less than full utilization of a valuable resource.

It is for these reasons that Scenario 2 appears to be a better estimate of future hydropower developments. As competing forms of energy escalate in cost, an investment in hydropower can reap dividends over a long term project life, making use of a renewable resource.

TABLE 10

SUMMARY ANNUALIZED NED BENEFITS FOR STRUCTURAL MEASURES AND
NED COSTS FOR STRUCTURAL MEASURES
APPLICABLE DISCOUNT RATE: 7-1/8%, AUGUST 1980 PRICE LEVELS
PERIOD OF ANALYSIS: 1995-2095

Plant Data	Alternative 1	Alternative 2(a)	Alternative 2(b)	Alternative 2(c)
Installed Capacity, kW	56,900	52,600	52,600	52,600
Dependable Capacity, kW (incremental)	22,500	27,400	27,400	27,400
Average Annual Energy MWh	276,000	293,000	293,000	293,000
Average Annual Plant Factor	0.86	0.94	0.94	0.94
Unit Power Values:				
Dependable Capacity (S/kW)	$129.40	$130.00	$130.30	$130.30
Average Annual Energy (mills/kWh)	29.4	29.1	31.3	31.3
Benefits				
Annual Hydropower Benefits ($1,000)				
Dependable Capacity	2,912	3,562	3,570	3,570
Average Annual Energy	8,114	8,526	9.171	9,171
Total Annual Benefits	$11,026	$12,088	$12,741	$12,741
Project Cost ($1,000)				
First Cost	40,305*	57,661	74,844	83,610
Annual Cost:				
Interest (.07125)	2,872	4,108	5,333	5,957
Amortization 100-yrs. (.00007)	3	4	5	6
Operation & Maintenance	1,209	1,690	2,206	2,095
Total Annual Cost	$ 4,084	$ 5,802	$ 7,544	$ 8,058
Benefit/Cost Ratio	2.7	2.1	1.7	1.6
Excess Benefits Over Costs	$ 6,942	$ 6,286	$ 5,197	$ 4,683

*Does not include cost of major rehabilitation of the ESELCO power canal and powerhouse structure which might be required.

Environmental Consideration

Alternatives 1, 2(a), 2(b) and 2(c) have been preliminarily reviewed for identification of potential problems. Under Alternative 1, no significant change from the existing condition is anticipated. However, the ESELCO plant and power canal have been nominated as an historic site. Also, the Spruce Street Bridge over the power canal has been officially designated eligible to be nominated as an historic site.

Under Alternative 2, the following potential long-term problems have been preliminarily identified.

Fisheries

Excavation and dredging could affect the fisheries and/or the fisheries resources. Excavation above the existing U.S. Government power plants would remove an existing shallow water shelf. There is no information available on the existing biological communities or if the area has been used as a fish spawning or nursery area.

Selection of turbines for the power plants could affect fish from the standpoint of fish passage. This may be positive or negative depending on the type of turbines selected. In turbine selection, the speed of rotation of the turbines must be considered. A larger unit has lower r.p.m., thereby lessening the possibility of fish kill.

Sport Fishing

The elimination or reduction in flow through the ESELCO power canal could affect recreational fishing (from bridges). This may be positive or negative and could change the type of fish present.

Wildlife

The elimination or reduction in flow through the ESELCO power canal would reduce the open water of the tailrace. This area has been used as a wintering feeding/resting area for waterfowl.

To date only one site has been identified as a possible disposal site for dredged/excavated material, namely the North Pier adjacent to the U.S. Government power plant canal. This site may affect resting or nesting areas of water associated birds. However, this is not considered a significant impact at this time.

Historic Sites

The ESELCO powerhouse and its headrace (power canal) and headgates have been nominated by the State of Michigan for inclusion into the National Register of Historic Places. The Spruce Street bridge over the p wer canal has been officially designated by the keeper of the register as eligible to be nominated to the National Register of Historic Places.

General Impact Matrices

The following interaction matrices have been provided by the U.S. Fish and Wildlife Service. The matrices address developmental activities, and physical and biological disturbances.

For additional information refer to Appendix D, "Environmental."

Alternative 1

General Physical - Chemical Impact Matrix

Water Resource Development Activities / Physical-Chemical Characteristics of Streams	Channel enlargement	Channel realignment	Clearing and snagging	Dikes and jetties	Bank stabilization	Floodplain clearing	Flood protection levees	Flood control impoundments	Hydroelectric impoundments	Locks and dams	Diversion dams	Transbasin augmentation
Depth and stage												
Surface area												
Channel configuration												
Velocity												
Temperature												
Suspended solids												
Bed material												
Dissolved substances												
Light transmissivity												
Flow variability											X	

Alternative 1

General Biota Impact Matrix

Selected Stream and Floodplain Biota \ Physical-Chemical Characteristics of Streams	Depth and stage	Surface area	Channel configuration	Velocity	Temperature	Suspended solids	Bed material	Dissolved substances	Light transmissivity	Flow variability
Plankton										X
Benthos										X
Fish										X
Amphibians and reptiles										
Waterfowl and wading birds										
Small mammals										
Emergent aquatic vegetation										
Riparian vegetation										
Community structure										X

Alternative 2a

General Physical - Chemical Impact Matrix

Physical-Chemical Characteristics of Streams \ Water Resource Development Activities	Channel enlargement	Channel realignment	Clearing and snagging	Dikes and jetties	Bank stabilization	Floodplain clearing	Flood protection levees	Flood control impoundments	Hydroelectric impoundments	Locks and dams	Diversion dams	Transbasin augmentation
Depth and stage	X											
Surface area		X										
Channel configuration	X											
Velocity												
Temperature												
Suspended solids												
Bed material												
Dissolved substances												
Light transmissivity												
Flow variability	X											

Alternative 2a

General Biota Impact Matrix

Selected Stream and Floodplain Biota \ Physical-Chemical Characteristics of Streams	Depth and stage	Surface area	Channel configuration	Velocity	Temperature	Suspended solids	Bed material	Dissolved substances	Light transmissivity	Flow variability
Plankton										
Benthos	X									X
Fish	X	X	X							X
Amphibians and reptiles										
Waterfowl and wading birds										
Small mammals										
Emergent aquatic vegetation										
Riparian vegetation			X							
Community structure	X									X

Alternative 2b

General Physical - Chemical Impact Matrix

Water Resource Development Activities / Physical-Chemical Characteristics of Streams	Channel enlargement	Channel realignment	Clearing and snagging	Dikes and jetties	Bank stabilization	Floodplain clearing	Flood protection levees	Flood control impoundments	Hydroelectric impoundments	Locks and dams	Diversion dams	Transbasin augmentation
Depth and stage	X											
Surface area		X										
Channel configuration	X											
Velocity												
Temperature												
Suspended solids												
Bed material												
Dissolved substances												
Light transmissivity												
Flow variability	X											

Alternative 2b

General Biota Impact Matrix

Selected Stream and Floodplain Biota \ Physical-Chemical Characteristics of Streams	Depth and stage	Surface area	Channel configuration	Velocity	Temperature	Suspended solids	Bed material	Dissolved substances	Light transmissivity	Flow variability
Plankton										
Benthos	X									X
Fish	X	X	X							X
Amphibians and reptiles										
Waterfowl and wading birds										
Small mammals										
Emergent aquatic vegetation										
Riparian vegetation		X								
Community structure	X									X

Alternative 2c

General Physical - Chemical Impact Matrix

Water Resource Development Activities / Physical-Chemical Characteristics cf Streams	Channel enlargement	Channel realignment	Clearing and snagging	Dikes and jetties	Bank stabilization	Floodplain clearing	Flood protection levees	Flood control impoundments	Hydroelectric impoundments	Locks and dams	Diversion dams	Transbasin augmentation
Depth and stage												
Surface area												
Channel configuration												
Velocity												
Temperature												
Suspended solids												
Bed material												
Dissolved substances												
Light transmissivity												
Flow variability											X	

Alternative 2c

General Biota Impact Matrix

Selected Stream and Floodplain Biota \ Physical-Chemical Characteristics of Streams	Depth and stage	Surface area	Channel configuration	Velocity	Temperature	Suspended solids	Bed material	Dissolved substances	Light transmissivity	Flow variability
Plankton										X
Benthos										X
Fish										X
Amphibians and reptiles										
Waterfowl and wading birds										
Small mammals										
Emergent aquatic vegetation										
Riparian vegetation										
Community structure										X

Institutional Considerations

International Constraints

The Boundary Water Treaty of 1909 states in part that any obstruction or diversion of boundary water on either side of the line that would affect the natural level or flow to the other country must have approval for such works. This project may fall under the purview of this treaty and hence approval for the project would have to be obtained from the International Joint Commission.

The International Joint Commission (IJC) was set up pursuant to the Boundary Waters Treaty of 1909. The Commission's responsibilities under the Treaty fall into two principal categories. One category is that of Applications and Orders of Approval. The other consists of References, that is, the undertaking of investigations and studies of specific problems or questions of differences referred to the IJC by the Governments of the United States and Canada.

The Commission consists of three Commissioners appointed by the Government of Canada, and three Commissioners appointed by the President of the United States with the advice and consent of the Senate. These six Commissioners do not act as separate national delegations under instructions from their respective governments (as is the case for most similar bodies in the rest of the world), but as a single, unified body which seeks common solutions in the joint interests of Canada and the United States.

If it is deemed necessary to obtain such approval, as required under Articles III or IV of the Treaty, an application for use of such water will have to be filed with the Government (State Department) who will, in turn, refer the matter to the Commission. This determination should be made early in the planning process since history has shown that it takes a minimum of two years to process such a request. In addition, added requirements by the Commission may affect the cost of the project.

One other factor which must be considered under the International aspects of this study and the usage of water for power is the impact on the regulation of Lake Superior. Regulation of Lake Superior has been in effect since 1914 under the IJC Order of Approval dated 26 and 27 May 1914. The Commission's Orders noted above provide that the compensating works, power canals, and navigation locks be operated so as to maintain the level of Lake Superior "as nearly as may be" between elevation 600.5 and 602.0 IGLD-1955 and in such a manner as not to interfere with navigation. To guard against unduly high stages of water in the lower St. Marys River, the Order required that the discharge from Lake Superior be restricted so that the elevation of the water surface below the locks is not greater than 582.9 feet. The Commission established the International Lake Superior Board of Control to supervise the operation of all control works, canals, headgates and bypasses, and to formulate rules for their operations.

The Commission further issued Supplementary Orders of Approval dated 27 September 1978 and 3 October 1979 to protect and provide for certain flows in St. Marys Rapids. These Orders will have to be considered in evaluating the various alternatives developed in this study.

Contractural Constraints

There are presently two contracts in existence between the Edison Sault Electric Company and the United States Government which impact on this study. One is contract #DA-20-064-ENG-88 which is an agreement to purchase from the U.S. Government part of the water available to the United States. On 19 May 1950 Edison Sault signed a contract to lease from the U.S. Government water in the St. Marys River for the purpose of development of water power through its power plant. This lease, which expires in the year 2000, was made with the stipulation that from the water available to the U.S., the U.S. Government will first fulfill requirements for navigation, flow in the Rapids, and satisfy its need for water at the U.S. Power Plant; water in excess of these requirements would be allocated to Edison Sault up to a maximum of 33,000 cfs.

Contract #DA-20-064-ENG-632 is an agreement for sale of power generated at the U.S. Government Power Plant to the Edison Sault Electric Company. This contract, which was signed in November 1951 (last modified in 1979) and expires in June 2000, states that power in excess of that required for operation of the U.S. Government plant and that necessary for its operation of the St. Marys Falls Canal and its appurtenant works will be provided to the Edison Sault Electric Company for distribution.

Both of the above contracts will be evaluated to determine how they affect the feasibility of the project and what impact, if any, the project would have on the Edison Sault Electric Company.

Other Constraints

In 1955, the International Lake Superior Board of Control agreed to provide a limited quantity of water to the St. Marys Rapids under normal regulatory operating procedures for the regulation of Lake Superior. This agreement, which was consummated with the State of Michigan (representing a number of agencies interested in the protection of the Rapids fishery) is still in effect today. Under this agreement a minimum setting of one-half gate open in the compensating works is required.

In addition to the above agreement, the IJC's 1978 Supplementary Orders requires certain consideration of rapids flow for construction of the new Canadian Great Lakes Power Corporation Limited facility. These constraints on water distribution will be evaluated to determine their impact on cost and on feasibility.

Hydrologic and Hydraulic Considerations

Regulation

The St. Marys River forms the outlet of Lake Superior. From Whitefish Bay, at the east end of Lake Superior, the river flows in a general southeast direction to Lake Huron, a distance of approximately 70 miles. From its headwater on Whitefish Bay to its outlet on Lake Huron, the river falls about 22 feet, most of which (20 feet) occurs in the 2/3 mile-long

St. Marys Rapids at Sault Ste. Marie, Michigan and Ontario. The outflow from Lake Superior has been under complete control since 1921. The facilities (Figure 1) employed in this control consist of navigation locks, hydroelectric power plants and the compensating works (a control dam located on the International boundary). Release of water through these works is prescribed monthly by the international Lake Superior Board of Control in accordance with a plan of regulation (Plan 1977) designed to satisfy criteria specified by the International Joint Commission.

Plan 1977 was also employed herein to develop the historic flows on which the monthly availability of water for power was based.

Flow Distribution

The "Order of Approval" of the International Joint Commission of May 26, 1914 as amended by the "Supplementary Orders" dated 3 October 1979, on the matter of flow distribution between the two countries provides that:

"20. The amount of water available in each country for power purposes, under the 1914 Order, as amended, shall be one-half of the total amount available for power purposes as determined by the approved regulation plan and the requirements regarding flow allocation of the said Order, as amended, without prejudice to any determination by Governments of the ownership and distribution of waters diverted into Lake Superior from Long Lac and Ogoki."

Condition 1(b) of the Supplementary Orders of Approval in the Matter of the Regulation of Lake Superior and the St. Marys River (Dockets 6 and 8), dated September 27, 1978, is deleted and the following substituted therefore:

"b) For settings of up to four gates open the compensating works shall be operated so that the flow over the St. Marys Rapids shall be that which would occur under the 1955 modification of the Rule of 1949 or the approved regulation plan, whichever is greater, in the absence of the additional capacity provided by the Great Lakes Power Redevelopment project;"

Based on the above, the amount of water available monthly for power production is computed as follows:

$$Q_{u.s.} = \frac{Q_o - Q_n - Q_{cw}}{2}$$

where:

$Q_{u.s.}$ = United States share of water

Q_o = Lake Superior mean monthly outflow in cfs as determined from Plan 1977

Q_n = Estimated 1995 navigation flow requirements in cfs

Q_{cw} = Flow through compensating works in cfs

The amount of water available for Canadian power production can be obtained by substituting Q_c for $Q_{u.s.}$. The above relationship indicates that 50% of the flow is available for the development of power in each country after the requirements for flow through the navigation canals and the compensating works have been satisfied. The average flow required for navigation is approximately 960 cfs, while the flow through the compensating works can range from 3,000 to 60,000 cfs. The projected Canadian power flow requirement, based on the new plant configuration, is 35,000 cfs, which is limited by headrace canal design. Hence, giving consideration to these facts it would appear that during periods when the flow available for Canadian power production exceeds their requirements, any excess flow will be made available to the U.S. power facilities, as prescribed by the IJC Orders of Approval, revised October 1979. If this water is not utilized on the United States side, it will be spilled through the compensating works.

Flow Restrictions

There are three flow restrictions which impact on the determination of water available for power production. One of these restrictions was discussed in the prior section. The second restriction was the matter of satisfaction of the IJC's criteria for the regulation of Lake Superior, embodied in Plan 1977. The third restriction, also embodied in Plan 1977, is to protect against ice jams in the St. Marys River. This condition generally prevails from early-December to mid-April. To preclude any problems, the maximum winter flow (December through April) from Lake Superior shall not be greater than 85,000 cfs. Hence, consideration must be given to this fact in development of flow available for power production.

Head Losses

For the purpose of this reconnaissance report, the head losses have been determined using the relationship presented in the report "Regulation of Great Lakes Water Levels," Appendix F, to the International Joint Commission by the International Great Lakes Levels Board, December 7, 1973. These methods are documented in this reconnaissance report's Appendix B, "Hydrologic and Hydraulic Studies."

Channel Design

For purposes of this report, those alternatives which consider a modified Edison Sault Electric Company powerplant as viable will require no change in the headrace or tailrace. This is due to the fact that, on the average, there will be less water available to that plant location in the future than under existing conditions.

In the case where all available water is utilized at the U.S. Government site, canal designs for this reconnaissance report are based on maintaining an average velocity of 3.5 fps. To provide the required area for that velocity, expansion of the present canal and removal of Unit 10 to accommodate the anticipated flow would be required.

Social Considerations

As demand for hydroelectric power increases, the capacity of the Edison Sault Electric Company (ESELCO) to generate this power is decreasing. If power is transmitted from other electric companies in the network, the demand could be met. This, however, would be more expensive and the costs would eventually filter down to the consumers in the form of rate increases (subject to the authority of the Public Service Commission). Rates could also be increased as a result of hydropower redevelopment.

An adequate supply of inexpensive electricity would be of social benefit to residents of the four counties in the service area (Chippewa, Luce, Mackinac, and a portion of Schoolcraft). These four counties consume more electricity than they produce. Producing an increased amount of hydroelectric power by increasing power generation efficiency at the St. Marys River site would contribute to meeting the electricity needs of the region. The river provides a renewable, safe, natural, and inexpensive source of hydropower.

For this project from a social standpoint, there are considerable non-quantifiable social benefits of utilizing natural water resources for the public's benefit. Therefore, even if benefits only nominally exceed the costs of the project, redevelopment of the hydropower plants should still be considered. As growth of the area continues, demand for electricity will continue to increase; if hydropower redevelopment is not pursued, there will be a greater reliance upon more expensive alternative sources of power such as from Consumers Power Company.

There is a greater proportion of unemployed, old, and young people in the four-county area than in the rest of the State; therefore, there are fewer people in the labor force. Rate increases would be especially difficult for those people. Also, rate increases would more adversely affect those customers living in cold weather climates, who generally consume larger amounts of electricity for heating.

The hydropower redevelopment project could provide jobs for local construction workers. There is a greater proportion of construction workers in the four county area than in the State of Michigan. For more detailed information concerning social considerations, please refer to Appendix E, "Sociological Studies."

Technical Considerations

The following technical aspects were considered in the reconnaissance study of Sault Ste. Marie, Michigan, hydropower redevelopment study.

Technical considerations during the reconnaissance study were done by thorough review of available data, documents, reports, plans and specifications, and meetings with the staff of Detroit District, St. Paul District, Soo Area Office, Great Lakes Power Corporation (Canada) and Edison Sault Power Company, and field trips to all sites. The findings of the investigation are incorporated in Appendix A, "Technical Studies."

All work was done in accordance with regulations, technical manuals, guidelines, plans, and references relevant to this study. The existing hydroelectric facilities located within the Soo Area complex were reviewed with special emphasis on upgrading of hydroelectric capability based on flows, soil data, headrace and tailrace configuration, erosion protection, removal of present Unit 10, suitability of existing design concept, foundation requirements, blasting, excavation, building structure, transmission structures, anchor ice restriction, slope stability, structure stability, cofferdam requirement, hydroelectric needs, generating efficiencies, control and monitoring equipment, power transmission, transformers, expected losses, heating and cooling requirements, intake gates, and operations and maintenance cost, etc. Costs were developed for hydraulic work, site work & building, mechanical and electrical work, and transmission.

Summary

The following Table is provided which displays a summary of principal features of the four Alternatives (1, 2(a), 2(b), 2(c)) and potential significant impacts.

TABL

COMPARATIVE SUMMARY OF ALTERNATIVES 1, 2

	Alternative 1		Alternative 2(a)	
ENGINEERING				
	Design Flow (cfs)		Design Flow (cfs)	
	U.S. Government plant	12,950	Existing Government plant	1
	ESELCO plant	29,400	Expansion of Gov't plant	2
	TOTAL	42,350	TOTAL	3
	Average flow (cfs)		Average flow (cfs)	
	U.S. Government plant	12,700	Existing Government plant	1
	ESELCO plant	24,000	Expansion of Gov't plant	2
	TOTAL	36,700	TOTAL	3
	Installed capacity (MW)		Installed capacity (MW)	
	U.S. Government plant	18.4	Existing Government plant	1
	ESELCO plant	38.5	Expansion of Gov't plant	3
	TOTAL	56.9	TOTAL	5
	Average annual energy (MWh)		Average annual energy (MWh)	
	U.S. Government plant	158,000	Existing Government plant	13
	ESELCO plant	276,000	Expansion of Gov't plant	29
	TOTAL	434,000	TOTAL	43
	General Features		General Features	
	Government main plant could continue operating the same units.		Government main plant would in power generation.	
	Unit 10 of the Government plant could continue operating.		Unit 10 of the Government plan would be removed.	
	The Government power canal would not need to be modified.		About 5700 ft. of Government p canals would be modified.	
	The ESELCO canal (2-1/4 miles) would probably be dewatered, inspected, and rehabilitated.		The ESELCO canal could be used water passage for peak power demands, and environmental enh ment of canal. There would be 386,000 cubic yards of rock ou total of about 1,220,000 cubic of excavation.	
	There would be very little excavation.			
	The foundation for ESELCO plant would probably need more concrete to support vibrations of new heavy turbines. Overall adequacy for modification is not yet determined.		The foundation of the Governm plant would need to be modifi Good sandstone bedrock is exp	

TABLE 11

LTERNATIVES 1, 2(a), 2(b), and 2(c) AND IMPACT ASSESSMENT

rnative 2(a)		Alternative 2(b)		Alternative 2(c)	
cfs)		Design Flow (cfs)		Design flow (cfs)	
vernment plant	11,550	New Government plant	37,000	Government plant	37,000
f Gov't plant	25,450				
	37,000				
(cfs)		Average flow (cfs)		Average flow (cfs)	
vernment plant	11,200	New Government plant	34,700	Government plant	34,700
f Gov't plant	23,500				
	34,700				
acity (MW)		Installed capacity (MW)		Installed capacity (MW)	
vernment plant	16.4	New Government plant	52.6	Government plant	52.6
f Gov't plant	36.2				
	52.6				
l energy (MWh)		Average annual energy (MWh)		Average annual energy (MWh)	
vernment plant	139,000	New Government plant	432,000	U.S. Government plant	432,000
f Gov't plant	293,000				
	432,000				
res		General Features		General Features	
in plant would increase ion.		New Government plant would increase power generation.		Modified Government plant would increase power generation.	
e Government plant ved.		Unit 10 of the Government plant would be removed.		Unit 10 of the Government plant would be removed.	
. of Government power be modified.		About 6100 ft. of Government power canals would be modified.		About 1600 ft. of Government power canals would be modified.	
al could be used for for peak power nvironmental enhance- There would be about yards of rock out of a 1,220,000 cubic yards		The ESELCO canal could be used for water passage for peak power demands, and environmental enhancement of canal. There would be about 439,000 cubic yards of rock out of a total of about 1,305,000 cubic yards of excavation.		The ESELCO canal could be used for water passage for peak power demands, and environmental enhancement of canal. There would be about 426,000 cubic yards of rock out of a total of about 680,000 cubic yards of excavation.	
of the Government ed to be modified. bedrock is expected.				The foundation for the Government plant would need to be modified. Good sandstone bedrock is expected.	

2

	Alternative 1	Alternative
ENGINEERING (Cont'd)	Potential problems	Potential problems
	The timber piles could be deteriorated. Further investigation of the facility may determine whether the power plant should be replaced. Head gate structure needs study pertaining to its maintenance and modification to act as power canal closure structure.	Ice sluicing provision power facilities, a de design for constructio measures to keep headw off the north wall of Lock are needed.

ECONOMIC

	Alternative 1	
Total Cost	$40,305,000	$
Average Annual Cost	$ 4,084,000	$
Capacity Value ($/KW/-year)	$ 129.40	$
Energy Value (mills/KWH)	29.4	

Scenario 1

Dependable Capacity (KW) (Incremental Increase)	4,200	
Average Annual Energy (MWH) (Incremental Increase)	49,000	
Dependable Capacity Value	$ 543,500	$
Average Annual Energy Value	$ 1,440,600	$
Total Annual Benefits	$ 1,984,100	
Benefit/Cost Ratio	.49	

Scenario 2

Dependable Capacity (KW) (Incremental Increase)	22,500	
Average Annual Energy (MWH) (Incremental Increase)	276,000	
Dependable Capacity Value	$ 2,912,000	
Average Annual Energy Value	$ 8,114,000	
Total Annual Benefits	$11,026,000	
Benefit/Cost Ratio	2.7	
Excess Benefits Over Costs	$ 6,942,000	

TABLE 11 (Cont'd)

Alternative 2(a)	Alternative 2(b)	Alternative 2(c)
roblems	Potential problems	Potential problems
ng provisions for the lities, a dewatering construction, and o keep headwater pressures rth wall of the Sabin eeded.	Ice sluicing provisions for the power facilities and economical location of new power house is needed.	Approximately $12,661,000 in revenues would be lost during demolition and construction due to loss of power generation.
$57,661,000	$74,844,000	$83,610,000
$ 5,802,000	$ 7,544,000	$ 8,058,000
$ 130.00	$ 130.30	$ 130.30
29.1	31.3	31.3
7,100	7,100	7,100
47,000	47,000	47,000
$ 923,000	$ 925,130	$ 925,130
$ 1,367,700	$ 1,471,100	$ 1,471,100
$ 2,290,700	$ 2,396,230	$ 2,396,230
.39	.32	.30
27,400	27,400	27,400
293,000	293,000	293,000
$ 3,562,000	$ 3,570,000	$ 3,570,000
$ 8,526,000	$ 9,171,000	$ 9,171,000
$12,088,000	$12,741,000	$12,741,000
2.1	1.7	1.6
$ 6,286,000	$ 5,197,000	$ 4,683,000

	Alternative 1	Alternative 2
ECONOMIC (Cont'd)		
Tax Revenue	No Change (Very small positive impact is possible in that electricity bills could be smaller over the long term with continued hydroelectric base, thereby contributing to profitability of commerce and industry.	Same as Alternative 1
Property Values	Should remain relatively constant.	Same as Alternative 1
Public Facilities	Sault Edison Facility would be improved. Other public facilities remain the same.	Corps plant would be im Decrease in public faci discontinued use of Sau unless preserved as a h Other public facilities same.
Public Services	Some interruption of services during rehabilitation of Sault Edison.	Hydroelectric services Edison would be lost du discontinued use, thoug hydroelectric generatio increased.
Employment	Increased employment during rehabilitation.	Increased employment du expansion of Corps pla decreased employment in term due to discontinue Sault Edison.
Business and Industrial Activity	Should remain relatively constant, though a modest positive impact could be realized if electricity cost increases can be moderated as a result of the hydropower project.	Same as Alternative 1
Displacement of Farms	There are no farms in the project area.	Same as Alternative 1

TABLE 11 (Cont'd)

Alternative 2(a)	Alternative 2(b)	Alternative 2(c)
lternative 1	Same as Alternative 1	Same as Alternative 1
lternative 1	Same as Alternative 1	Same as Alternative 1
nt would be improved. in public facility due to ued use of Sault Edison, eserved as a historic site. lic facilities remain the	Public hydroelectric facility improved due to construction of new plant. Other public facilities remain the same.	Same as Alternative 2(a)
tric services from Sault uld be lost due to ued use, though overall tric generation would be .	Interruption of hydroelectric services due to construction.	Same as Alternative 2(a)
employment during of Corps plant, but employment in the longer to discontinued use of son.	Same as Alternative 2(a)	Slight increase in employment during installation of new equipment, decreased employment due to discontinued use of Sault Edison.
lternative 1	Same as Alternative 1	Same as Alternative 1
lternative 1	Same as Alternative 1	Same as Alternative 1

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	Alternative 1	Alternati
ENVIRONMENTAL	No significant impact to fish and wildlife is anticipated when compared to existing condition. However, the State of Michigan has nominated the ESELCO powerhouse and power canal to the National Register of Historic Places.	Excavation/dredgin fisheries resource the shoal area ups existing governmen Disposal of excavat material could aff a. Aesthetics of t area. b. Nesting and res water associated bi The type of turbine impact fish in term through the power f Reduction in flow t power canal could i waterfowl which uti feeding and resting flow could also imp living within the p Coordination with a agencies may be req The ESELCO power fa been nominated as hi
Man-made Resources	Possible impacts would include alteration of ESELCO hydropower facilities, which have been nominated as national historic sites.	Excavation/dredging dike areas between existing government facilities. Unit 1 demolished.
Fishery Resources	No significant impacts to fishery resources are anticipated when compared to existing conditions.	Excavation/dredging fisheries resources the shoal area upst The types of turbin impact fish in term through the power f The reduced flow th power canal could i inhabit the canal.

TABLE 11 (Cont'd)

Alternative 2(a)	Alternative 2(b)	Alternative 2(c)
ıvation/dredging may effect ıeries resources and benthos in shoal area upstream of the ıting government plant (Unit 10).	Same as Alternative 2(a)	Same as Alternative 2(a)
ıosal of excavated and dredge ırial could affect:		
Aesthetics of the north pier		
Nesting and resting areas of r associated birds.		
type of turbine selected may t fish in terms of fish passage gh the power facilities.		
tion in flow through the ESELCO canal could impact wintering fowl which utilize the area for ng and resting. The reduced could also impact the fish g within the power canal.		
ination with appropriate es may be required.		
ELCO power facilities have ominated as historic sites.		
tion/dredging will impact the reas between the locks and the ng government power ties. Unit 10 will be hed.	Same as Alternative 2(a)	Same as Alternative 2(a)
tion/dredging may effect es resources and benthos in al area upstream of Unit 10.	Same as Alternative 2(a)	Same as Alternative 2(a)
es of turbine selected may fish in terms of fish passage the power facilities.		
uced flow through the ESELCO nal could impact fish ~~which~~ the canal.		

2

TABL

	Alternative 1	Alternative 2(a)
ENVIRONMENTAL (Cont'd)		
Wildlife Resources	No significant impacts to wildlife resources are anticipated when compared to existing conditions.	Excavation/dredging may eff wildlife resources by remov creating possible nesting a resting areas for water ass birds. Reduced flow through ESELCO canal could impact winterin waterfowl which utilize the feeding and nesting.
Archeological Resources	Any measure which would have any effect on the ESELCO power house, power canal or head gates or Spruce Street Bridge will require coordination with appropriate agencies.	Due to possible damages cau decreased flow through the power canal, coordination w appropriate agencies, conce canal and the Spruce Street is required.
Air Quality	Temporary impacts are expected due to construction activities causing elevated dust and exhaust fume levels.	Same as Alternative 1, but duration and magnitude.
Water Quality	Temporary impacts are anticipated due to changes in water flows and possible increased siltation during construction.	A change in current flow th power canals may impact the quality by changing siltati erosional stresses, etc. Al as Alternative 1.
Noise Pollution	A temporary increase in noise levels in and around the project area is expected during construction.	Same as Alternative 1, but duration and magnitude.
SOCIAL		
Displacement of People	No effect.	Same as Alternative 1
Aesthetic Value	No significant effect.	Same as Alternative 1
Community Cohesion	No significant effect.	Possibly detrimental if emp at Sault Edison is cut back substantially.
Public Health	No effect.	Same as Alternative 1
Desirable Community Growth	Community Growth should remain fairly constant.	Same as Alternative 1

TABLE 11 (Cont'd)

Alternative 2(a)	Alternative 2(b)	Alternative 2 (c)
tion/dredging may effect fe resources by removing or ng possible nesting and areas for water associated	Same as Alternative 2(a)	Same as Alternative 2(a)
flow through ESELCO power could impact wintering owl which utilize the area for and nesting.		
possible damages caused by ed flow through the ESELCO anal, coordination with the iate agencies, concerning the nd the Spruce Street Bridge, ired.	Same as Alternative 2(a)	Same as Alternative 2(a)
Alternative 1, but of greater n and magnitude.	Same as Alternative 1, but of greater duration and magnitude.	Same as Alternative 1, but of greater duration and magnitude.
in current flow through the nals may impact the water by changing siltation loads, l stresses, etc. Also same native 1.	Same as Alternative 2(a)	Same as Alternative 2(a)
Alternative 1, but of greater and magnitude.	Same as Alternative 1, but of greater duration and magnitude.	Same as Alternative 1, but of greater duration and magnitude.
Alternative 1	Same as Alternative 1	Same as Alternative 1
Alternative 1	Same as Alternative 1	Same as Alternative 1
detrimental if employment Edison is cut back ally.	Same as Alternative 2(a)	Same as Alternative 2(a)
lternative 1	Same as Alternative 1	Same as Alternative 1
lternative 1	Same as Alternative 1	Same as Alternative 1

2

INSTITUTIONAL

IJC approval would be required for a redevelopment project involving either Alternative

Available flow for hydropower is dependent on Lake Superior water levels and outflows re as amended by the "Supplementry Orders" of 3 October 1979.

There are two existing contracts between the Government and the ESELCO, one on lease of the power contract is subject to termination by the Government after 30 June 1985.

For Alternative 1, contracts between local utilities and the U.S. Government, for sale o

For Alternative 2(a), 2(b), and 2(c), agreements between local utilities and the U.S. Go considered.

For any project that would impact on the Edison Sault Electric Company plant, its power approval from the Advisory Council on Historic Preservation and State of Michigan Histor

TABLE 11 (Cont'd)

lternative 1, 2(a), 2(b), or 2(c).

outflows regulated in accordance with the provisions of the "Order of Approval" of the IJC of May 26, 1914,

n lease of water and the other on sale of power. Both the contracts expire in the year 2000. However,
1985.

for sale of power and water in excess to the U.S. Government needs, would be considered.

the U.S. Government for the marketing and sale of power generated at the U.S. Government plant would be

its power canal and headgates, and the Spruce Street Bridge which crosses the power canal, would require
igan Historic Preservation Offices.

EVALUATION OF ALTERNATIVES

Evaluation is the process of determining the relative contribution of each alternative to the planning and National objectives. Whereas impact identification is normally objective, evaluation is subjective in character. The principal task in the reconnaissance stage has been problem identification; therefore, the process of impact identification in the reconnaissance stage has been subjective to a certain degree due to lack of specific data. The reconnaissance study effort was directed towards identifying if the potential exists for engineering and economic feasibility of the alternatives with consideration given to potential significant social, environmental and institutional impacts.

Equally important are the contributions to the environmental objectives and environmental acceptability of the engineeringly and economically feasible alternatives. An environmental analysis of the alternatives is described in the Section, "Environmental Considerations." No potential environmental problems are anticipated in Alternative 1. In Alternatives 2(a), 2(b) and 2(c), the impacts on fisheries and sport fishing have not been identified due to lack of sufficient information. The Government power canal expansion involves considerable excavation. The area on the Northwest Pier upstream of the International Bridge is being considered as a possible disposal site for the excavated material. Other disposal sites would be investigated in stages 2 and 3 of the study.

As a basis for evaluation, "without project" conditions are compared to "with project" conditions.

Scenario 1 of "Without Project Condition"

It is relevant to draw attention to the existing conditions. The ESELCO plant is about 80 years old. Not enough data are available to determine the condition of the foundation of the powerhouse, the stability of the structure, or the condition of the power canal.

This scenario presumes that the existing 80-year old Edison Sault plant could be operated indefinitely into the future at its current level of efficiency, with no capital improvements required. However, in light of these undetermined factors, it seems unlikely that the plant will continue to function over a 100-year economic life, until the year 2095, without substantial improvements to the structure.

Preliminary benefit/cost (B/C) ratios for Alternatives 1, 2(a), 2(b), and 2(c) using this scenario, are 0.49, 0.39, 0.32, and 0.30, respectively. None of the alternatives would be economically feasible under the assumptions of Scenario 1.

Scenario 2 of the "Without Project Condition"

Under this scenario, it is assumed the ESELCO plant would discontinue operation by the year 2000. Preliminary B/C ratios for Alternatives 1, 2(a), 2(b), and 2(c) are 2.7, 2.1, 1.7, and 1.6, respectively. The highest B/C ratio of Alternative 1 is to be viewed in light of undetermined factors of the existing ESELCO plant, as stated in the discussion under Scenario 1. Further examination of the beneficial and adverse features of the alternatives are discussed below.

Alternative 1

This alternative would modify the ESELCO power plant and continue operation of the existing U.S. Government plant.

<u>Beneficial Factors</u>

a. The preliminary B/C ratio is 2.7.

b. The useful life of new generation units at the ESELCO Plant is expected to extend over the 100-year economic life of the project.

c. No major ESELCO power canal modification would be required.

d. The quantity of excavated material is expected to be small and disposal is not expected to be a significant problem.

e. Employment opportunities at the ESELCO plant would continue.

Adverse Effects

a. The powerhouse is about 80 years old and is operating at low overall efficiency. The foundation condition has not been investigated and is unknown. While the superstructure does not seem to indicate significant defects, further confirmation of its stability would be required. If detailed investigations indicate that the existing facility is not adequate for the new installation, a new power plant would be required.

b. If the ESELCO plant is nominated to the National Register of Historic Places, it may wholly or partially prevent accomplishment of the required modifications to the ESELCO Plant.

c. The ESELCO power canal would need dewatering. This would result in an energy loss during periods of dewatering. Instability of the walls of the power canal is a concern during any dewatering.

d. The condition of the ESELCO power canal and the headgate structure is not known; therefore, the extent of work needed on them is uncertain. The factors concerning the age of the plant and the possibility of the foundation requiring major rehabilitation merits a high degree of consideration. Further detailed study in Stage 2 would provide a more precise base for evaluation.

Alternative 2(a)

This alternative would extend the U.S. Government plant and discontinue operation of the ESELCO plant.

Beneficial Factors

a. The preliminary B/C ratio is 2.1. It is less than that of Alternative 1.

b. A new extension to the main U.S. Government plant would replace the older Unit 10 of the U.S. Government plant.

c. Effective net power head at the U.S. Government plant is 19.5 feet, which is 1.5 feet greater than that at the ESELCO plant.

d. All the flow available for hydropower will be utilized in one facility, instead of in two plants as in Alternative 1. Accordingly, logistics of management, maintenance, and operations would be simpler in one plant than in two plants.

e. Employment opportunities at the U.S. Government plant could increase.

Adverse Factors

a. Extensive U.S. Government power canal modification would result in large quantities of excavation. Suitable disposal sites for the excavated material would be required.

b. Environmental impacts have not been identified. However, a canal modification could affect fisheries, waterfowl, and aesthetics.

c. Employment opportunities at the ESELCO plant would end.

d. Removing water from the ESELCO power canal could cause instability of the power canal walls.

In general, the beneficial factors outweigh the adverse effects. Further studies would be required for a more accurate assessment and evaluation of Alternative 2(a).

Alternative 2(b)

Alternative 2(b) provides for construction of a new U.S. Government plant and discontinuing operation of the ESELCO plant, and existing Government plant including Unit #10.

Beneficial Factors

a. The preliminary B/C ratio is 1.7. It is less than that in Alternatives 1 and 2(a).

b. An entirely new facility would replace the existing U.S. Government plant including Unit 10. The physical life of a new plant and the corresponding benefits would last over a 100-year economic life of the project.

c. Effective net power head at the U.S. Government plant is 19.5 feet, which is 1.5 feet greater than that at the ESELCO Plant.

d. All the flow available for hydropower would be utilized in one facility instead of two plants as in Alternative 1. Accordingly, logistics of management, maintenance, and operations would be simpler in one plant than in two plants.

Adverse Effects

a. The main U.S. Government plant is about 29 years old. Both the main U.S. Government plant and Unit 10 of the U.S. Government plant are in good condition. By eliminating the plant, all benefits from the remaining period of the plant's economic life would be lost.

b. A new powerhouse on the southside of the existing main U.S. Government plant would raise the water level on the north side of the Sabin Lock by about 20 feet. The lock wall is not designed for the 20-foot head.

Also, all the adverse effects of Alternative 2(a) are applicable for Alternative 2(b).

The construction of a new facility has to be balanced against loss of benefits for the remainder of the existing plant's economic life. Further study on potential new sites for a new plant would be required. As in Alternative 2(a), in a general way, the beneficial factors outweigh the adverse effects for Alternative 2(b).

Alternative 2(c)

In this alternative new equipment would be installed in the U.S. Government plant and operation of the ESELCO plant would be discontinued.

Beneficial Effects

a. The preliminary B/C ratio is 1.6. It is less than that of Alternative 1, 2(a), and 2(b).

b. New equipment in a modified U.S. Government plant would replace Unit 10 of the U.S. Government plant and the turbine-generators and other equipment in the main U.S. Government plant. Thus, the new equipment would last over the 100-year economic life of the project.

c. In addition to the above, beneficial factors c. and d. of Alternative 2(b) are equally relevant to Alternative 2(c).

Adverse Effects

a. The main U.S. Government powerhouse would require extensive modification.

b. Although the quantity of excavation in the U.S. Government power canal would be considerably less than in Alternative 2(b), suitable disposal sites would still be required.

c. The U.S Government plant would be closed during construction. This would result in a significant loss of much needed energy during construction.

In addition to the above, all the adverse effects of Alternative 2(a), and adverse effect a. of Alternative 2(b), are equally valid for this alternative. Extensive modification of the U.S. Government plant to house new equipment is certainly less desirable than a new plant of Alternative 2(b). The preliminary B/C ratio of 1.6 is less than the preliminary B/C ratio of 1.7 of Alternative 2(b). However, further development and analysis would be required to confirm these B/C ratios.

Alternative 3

Alternative 3 provides for rebuilding both the U.S. Government and the ESELCO plants; Unit 10 of the U.S. Government plant would be removed.

Beneficial Factors

a. New U.S. Government and ESELCO plants with a few large modern units would function well and last over the 100-year economic life of the project.

b. If a new ESELCO plant is built on its present site, very little real estate would be required.

c. Existing ESELCO headrace would be used with little modification to reduce head loss.

d. Very little ESELCO tailrace modification would be required.

e. The existing U.S. Government plant would remain in operation during much of the construction period.

f. Continued use of the ESELCO power canal for power would ensure environmentally acceptable flow.

g. Employment opportunities at the ESELCO plant would continue to exist.

Adverse Factors

a. The ESELCO plant is old but still in operation. Unit 10 of the U.S. Government plant is old but functioning well. The main U.S. Government plant is about 29 years old and is in good condition. Elimination of these plants would result in loss of benefits for the remainder of the physical or economic life of these plants.

b. Cofferdams would be required during ESELCO plant construction. Subsoil conditions would probably require deep cofferdams.

c. Two separate power plants would necessitate two separate operation and maintenance systems.

d. If the ESELCO plant is nominated to the National Register of Historic Places, a new environmentally acceptable plant site would be required. A new site would increase real estate costs.

A comparison with Alternative 2(c) would reinforce the arguments against this alternative. Investment as well as operations and maintenance costs of two new plants would be higher than those of a single new plant of Alternative 2(c). Two new plants would not produce more energy and benefits than one new plant because the available flow remains the same; however, efficiencies would be greater with one plant utilizing the same flow. Higher costs, approximately equal benefits as compared to Alternative 2(c) and no other substantial benefits, would justify elimination of Alternative 3.

Alternative 4

Alternative 4 would modify the existing ESELCO plant and discontinue operation of the existing U.S. Government plant.

Beneficial Factors

a. Utilization of all the available flow for hydropower at one plant results in improved efficiency.

b. Power generation at the U.S. Government plant would continue during the ESELCO plant modification.

c. Tailrace modification at the ESELCO plant would be significantly less than that required at the U.S. Government plant's tailrace, if all the available flow discharges through the U.S. Government plant.

d. Employment opportunities at the ESELCO plant would increase.

Adverse Factors

a. Major modifications would be required in the ESELCO plant. Existing foundation conditions would not permit installation of large generating units. The same considerations which led to a selection of 35 new 1.1 MW units in Alternative 1 would result in a selection of a large number of small units.

b. Extensive modification of the ESELCO headrace to permit the entire available flow would be required.

c. Additional real estate along the power canal would be required.

d. All the bridges across the ESELCO power canal would be modified or replaced by new structures. One bridge, at Spruce Street, has been officially determined, by the keeper of the National Registry, to be a structure eligible for nomination to the National Register of Historic Places.

e. The available net head at ESELCO would be about 1.5 feet less than at the U.S. Government plant.

f. Nomination of the ESELCO plant and its headrace and power canal to the National Register of Historic Places would limit the extent of permissible plant modification.

g. Employment opportunities at the U.S. Government plant would be lost.

h. The benefits for the U.S. Government plant during the rest of its economic life would be lost.

A comparison with Alternative 1 would reinforce the arguments against this alternative. The cost of modifying the ESELCO plant would be higher than that of Alternative 1. In Alternative 1 the plant was modified for a reduced installed capacity of 38.5 MW at an initial cost of $40,305,000. Based on the same average cost per MW, the investment cost of a 52.6 MW installation (the same as in the modified U.S. Government plant) would be about $55,066,000, excluding additional costs of power canal and bridge modifications. The power generation and, in turn, the benefits would not exceed those of Alternative 1. Higher investment cost and approximately equal benefits as compared to Alternative 1, and the argument against elimination of a relatively new and sound U.S. Government plant would justify elimination of Alternative 4.

Alternative 5

Alternative 5 would expand the U.S. Government plant and continue operations of the ESELCO plant.

Beneficial Factors

a. No major ESELCO power canal modifications would be required.

b. Normal operations at reduced flow will continue at the ESELCO plant.

c. Employment opportunities at the ESELCO plant would continue at a lower level.

d. The ESELCO power canal flow would be at an environmentally acceptable level.

e. The economic benefits for the expanded part of the U.S. Government plant would last for the 100-year economic life of the project.

Adverse Factors

a. Any expansion of the U.S. Government plant would result in canal modification (excavation) and new dikes.

b. Average annual energy was estimated for two options; one with a 5 MW extension and the other with a 10 MW extension to the main U.S. Government plant, and eliminating Unit 10 of the U.S. Government plant. The projected average annual energy is 392,000 MWh for Option I and 402,000 MWh for Option II. Both are less than the values for Alternatives 1, 2(a), 2(b), and 2(c).

Preliminary cost estimates were made for both options. Scenario 1 of the "Without Project Condition" assumes the ESELCO plant would continue to function over the 100-year economic life. Under Scenario 1, the approximate B/C ratios are 0.23 for Option I, and 0.38 for Option II. Neither option is economically feasible.

An analysis of Alternatives 1, 2(a), 2(b), and 2(c) under Scenario 1 also resulted in B/C ratios less than 1. It appears that any alternative based on continued benefits from the ESELCO plant without any modifications over the 100-year economic life of the project would be economically infeasible. There are no apparent substantial benefits, except continued limited employment opportunities at the ESELCO plant. The employment opportunities at the ESELCO plant would certainly be greater under Alternatives 1, 3 and 4.

Accordingly, no further development of Alternative 5 would be required.

Alternative 6

Alternative 6 is to use alternative sources of energy. The development of alternative sources of energy is not within the scope of this study, and also it is highly unlikely that over the short term any of the renewable energy sources could substitute in generating electricity for base loads.

Alternative 7

Alternative 7 is to use non-structural measures. Non-structural measures have not been developed in the reconnaissance stage. They would be developed and evaluated in subsequent stages of the study.

Alternative 8

Alternative 8 is no action.

Beneficial Factors

The only apparent beneficial factor is that there would be no change in the existing environment.

Adverse Effects

The demand for energy is expected to increase. The gap between energy demand and supply will widen. Under Scenario 1, average annual energy production is expected to drop from about 398,000 MWh in 1979, to approximately 385,000 MWh in 1982 when the new Canadian plant goes into operation. Under Scenario 2, when ESELCO discontinues its operations, the average annual energy will further drop to approximately 158,000 MWh. In either case, the dependence on sources of electricity other than hydropower would increase; consequently, consumer rates would rise. Large rate increases could impede economic growth in the ESELCO service area. The no action plan would result in less than full development of the hydropower potential of the U.S. share of the waters.

CONTRIBUTIONS TO NATIONAL AND PLANNING OBJECTIVES

National Objectives

Alternatives 1, 2(a), 2(b), and 2(c) contribute to the NED objective by increasing hydropower production and its value. The B/C ratios for these alternatives are greater than 1. These alternatives have potential to contribute to the EQ objective in several ways. Making maximum effective use of available hydropower means a compensating decrease in needs for coal fired, oil fired, or nuclear power with the recognized adverse effects of these means of energy generation. Should it be feasible, modification of flows in the power canal could be used for fishery enhancement and improved sport fishing in the area under the alternatives which consider discontinuing the operation of the Edison Sault Electric Company facility.

Planning Objectives

Alternatives 1, 2(a), 2(b), and 2(c) contribute to Planning Objective 1 by increasing hydropower production during the 100-year period. The projected average annual energy production is 434,000 MWh in Alternative 1 and 432,000 MWh in Alternatives 2(a), 2(b), and 2(c). The preliminary B/C ratios under Scenario 2 are 2.7, 2.1, 1.7, and 1.6 for Alternatives 1, 2(a), 2(b), and 2(c), respectively.

Contribution to Planning Objective 2 is achieved by preservation of fish and wildlife resources in Alternative 1. No significant impact is anticipated. Contributions of the other alternatives have not been identified in this stage.

Contribution to Planning Objective 3 is achieved through control of pollution and return of water into the St. Marys River in order to preserve water quality.

STUDY MANAGEMENT

The study is under the general supervision of the Planning Branch, Engineering Division, Detroit District Corps of Engineers.

Coordination will be maintained throughout the study with the appropriate Federal, State and local interests as listed in the "Study Participants and Coordination" Section to this report, and any other entity having interest, jurisdiction, or responsibility associated with the hydropower study.

INTERDISCIPLINARY STUDY APPROACH

Under the Interdisciplinary Study Approach many different aspects of the project are investigated. Specialists in each field examine the impacts the project may cause. Economics, environmental, institutional, hydrologic and hydraulic, social, and technical parameters are analyzed. Various members of this interdisciplinary "team" work together to produce the report in which equal consideration is given to all aspects of the project.

Coordination with non-Corps interests is required to address policy and technical concerns.

Coordination to obviate policy concerns or to resolve any that may develop is to be conducted at the appropriate Federal, State, or local Government level.

FURTHER STUDIES REQUIRED

Additional studies will be required in Stage 2 and 3. These include:

a. Civil and Geotechnical

(1) Study feasibility to use larger design flows in U.S. Government Plant headrace to install larger capacity turbo-generating units

and capture additional energy; compare additional investment cost with additional capacity and energy benefits.

(2) Soil borings and testing of underground strata at the power plant sites and power canals. At the ESELCO plant, a detailed boring and testing program will be required at the plant and along the canal to define foundation conditions for stability, seepage and settlement evaluation.

(3) Provide a detailed condition inspection for ESELCO power canal.

(4) Recent topography surveys will be required.

(5) Provide detailed design for dewatering.

(6) A study should be accomplished to determine the ease of removal for the rock, to determine the cost of removal, and to determine the most economical canal cross section.

(7) A detailed layout of the powerhouse should be prepared to provide adequate areas for storage, work and controls.

(8) A detailed foundation investigation should be accomplished in the future to provide detailed foundation information.

(9) A detailed condition survey should be completed for the headgate structure on the ESELCO power canal. This survey will determine future work needed to either maintain the structure or modify it to act as a closure in the power canal.

(10) A detailed hydraulic design is needed to provide a minimum flow for environmental considerations when the ESELCO power plant stops generating power. This design is needed to satisfy environmental concerns for the power canal.

(11) Future considerations for safety and provisions for the public should be investigated further during the design stage.

(12) The affect of the future lock should be taken into account when sufficient data is available to analyze its impact to the canal alignment and cross section.

(13) Study the possibility of a combination of both Alternatives 1 and 2(a), which would use the ESELCO plant for peaking, with operation performed remotely from the U.S. Government plant.

(14) Consider the use of the Edison Sault plant for diverting excess water in lieu of the compensating works to the extent of 30,000 cfs conveniently in winter and summer.

(15) Selection of economically and environmentally acceptable disposal sites for excavated material.

(16) Spillway adequacy of the U.S. Government plant.

(17) Seepage investigation of Northwest Pier just upstream of Unit 10 of the U.S. Government plant.

(18) Erosion control measures.

(19) Structural analysis of the ESELCO superstructure.

(20) Site selection for a new U.S. Government plant.

(21) Frazil ice control on the U.S. Government plant headrace.

(22) Effect of increase in the head of the U.S. Government plant headrace on the north side of the Sabin Lock.

b. Electromechanical

(1) Determine economic life of existing electrical system at the ESELCO plant.

(2) Prepare outline plan to update substation at the ESELCO plant.

(3) Evaluate condition of D.C. generators used for exitation in the ESELCO plant. Determine if they can be reused in the rehabilitated plant.

(4) Provide study to determine if a single tube turbine and generator (as proposed) or one turbine driving two existing generators at the ESELCO plant is more economical and feasible.

(5) Study on repairs of both the U.S. Government and ESELCO plants.

c. Environmental

Investigation of the use of the sandstone shelf upstream of Unit 10 of the U.S. Government plant by the fish and benthic organisms in the area, in the assessment of the U.S. Government power canal modifications under Alternatives 2(a) and 2(b).

Environmental consideration under Stage 2 (the development of intermediate plans) would identify essential components of the intermediate plans effect on the environment and provide a preliminary assessment sufficient to identify major environmental changes from the "without project condition." The initial environmental document during Stage 3 (development of detailed plans) will be the preparation of the Draft Environmental Impact Statement (DEIS). This DEIS would emphasize the detailed environmental assessment and evaluation of a small number of possible alternatives. The DEIS would also be of a comparable level of detail with engineering and economic data to assist in conducting a trade-off analysis and in selecting the best plan for implementation. The initial impact assessment will occur during Stage 2 and will utilize existing available environmental information for evaluation of alternatives. This initial assessment may be utilized to eliminate some alternatives but, more importantly, it would indicate whether additional information will be required for the detailed assessment during Stage 3.

The initial assessment would include environmental baseline studies. These Stage 2 baseline studies would primarily entail a literature search for all pertinent data including biological; air, water and sediment quality; social, cultural and archaeological. Acquisition and analysis of this data will provide the necessary background data upon which subsequent evaluation of each alternative's impacts against the "without project condition," as well as those impacts of other alternatives, can be determined.

The process of environmental analysis will continue from the initial studies and assessment to be performed in Stage 2 into the more specific studies, based on the accumulation of additional data, and subsequent evaluation to be performed in Stage 3.

The process of environmental analysis will include investigation in the following six areas during Stage 3.

(1) Land Use - Changes in land use, that could result either directly or indirectly from implementation of any one of the study alternatives, will be analyzed from both a short-term and long-term perspective.

(2) Social Effects - An inventory will be made of outstanding, unique, or significant aesthetic, cultural and archaeological features that could be affected by any alternative considered. Efforts will be made to maintain or enhance these areas where feasible. Proposals will strive to insure compatibility with natural surroundings or projected land uses of the location. The interrelationship of social effect considerations, such

as community cohesion, demography, and aesthetics, with environmental factors will be analyzed to insure that implementation of study proposals will maintain the quality of the environment as well as satisfy functional requirements.

(3) Air Quality - An evaluation will be made of the probable impact of study proposals in air use and air quality. Consideration will be given to direct effects of implementing any study proposals and indirect effects to related increases in air use, such as industrial development. Consideration will be given to natural air pollution, such as fog, as well as that generated by man.

(4) Sediment Quality and Excavated and Dredged Material Disposal - Appropriate studies addressing sediment quality and dredge material disposal, including sampling and laboratory analysis, would be made to identify and prevent adverse environmental effects of material excavation and disposal. Consideration would be given to the possibilities for environmental enhancement through optimum use of material for desired alterations of the natural ecological systems.

(5) Water Uses and Water Quality - A study will be made of projected water uses and water quality without the effects of study proposals. Many environmental factors directly influence water use and the resultant quality of the water. Land use, zoning restrictions, population projections, and pollution abatement practices must all be considered jointly in determining the specific effect any study proposals might have on water use and water quality, as related to Federal and State standards.

(6) Fish and Wildlife Resources - In-depth studies will be required to determine the overall effect of study proposals on fish, wildlife and their habitats. These studies would explore the need for protection of unique habitat areas. The need for mitigation of habitat losses, if any, attributable to study proposals and/or studies for maximization of

environmental values for engineering activities will be identified. Opportunities for development of fish and wildlife activities not now present, but which can be introduced as a result of environmental alteration, would be considered. A study would be conducted to identify the living organisms existing in this study reach as well as that portion of the St. Marys River downstream of this study reach that would be affected directly and/or indirectly by any alternative other than the "no action" alternative.

Areas of importance to fish and wildlife resources are indicated by an X in the chart below:

Area	Impacts: Aquatic	Impacts: Terrestrial
Plant Location	X	X
Intake location	X	
Discharge location	X	
Engineering Systems	X	X
Seepage prevention	X	
Intake system	X	
Discharge system	X	
Sanitary waste system	X	
Fish Protection/Passage	X	
Construction Activities	X	X
Access structures	X	X

Social Well-Being

Social well-being is defined in terms of the general well-being of individuals and the variability of communities in which they reside. The assessment and evaluation of impacts on social well-being are hindered by the inability to quantitatively assess the values of many, if not most, human experiences and needs. Physical changes, such as displacement of individuals or groups of individuals, are obvious; but many of the emotional, intangible impacts that result from change are not so obvious. A prime sociological concern is to preserve existing intra- and inter-community relationships that are essential to community viability and integrity. Indicators to be used to measure change in social well-being are:

a. The conveniences of communities and individuals, such as employment opportunities;

b. Disruption of life styles, such as relocation of individuals, land use changes, and nuisance effects; and

c. General security of life and health. Assessment of effects on social well-being requires full use of information generated in the assessment of ecological, hygienic, aesthetic, and economic effects. Economic effects are related to social well-being in many areas including the loss of desirable fish and wildlife communities which are important to recreational resources and have economic value.

An analysis of the effects on social well-being of the various alternatives deals with the consideration of hygienic, aesthetic, and ecological effects. The analysis will also include, in Stage 3, consideration of factors such as displacement of people, archaeological and historical factors, transportation, leisure and cultural opportunities, community cohesion and changes, and the values and attitudes of affected people. Such factors as land use, economic development, regional growth, and employment opportunities are socially related concerns which are usually considered under economic effects.

Financial benefits through increased employment opportunities pertain to economics. What members of a community think and feel about the prospects of gaining new jobs or losing present ones is a special concern. In this particular project, the impacts on employment may vary, depending on the future status of operations at the Edison Sault plant. If the efficiency of the existing ESELCO plant can be maintained at relatively low cost for an extended period of time, then no major changes in employment patterns would be expected. If, on the other hand, it is determined that redevelopment of the government facility in some form is the best alternative for efficienty utilizing the water available for hydropower, some reduction in employment at ESELCO might be expected. In this case, it is conceivable that more people might be required to monitor, operate, and maintain a new, larger government hydropower facility.

In either circumstance, any alternative which involves construction would temporarily increase employment opportunities during the construction period.

In judging the social impacts of reduced or enhanced employment opportunities, it is important to take into account the existing employment situation at the Edison Sault Electric Company. Over the period 1975 to 1979, the number of full-time employees at the company declined from 131 to 118. This is not necessarily indicative of a long term trend. But given a without project condition, it is at least a possibility that employment at ESELCO will decline if nothing happens to change the existing generation of hydropower on the U.S. side of the St. Marys River.

System of Accounts

The effects of all plans of improvements on the components of the Social Well-Being (SWB) as well as Environmental Quality (EQ) objectives will be investigated, assessed, and displayed.

The results of evaluating alternative plans must be consistent with the requirements of the Water Resources Council's (WRC) Principles and Standards (P&S) and related policies.

The Systems of Accounts (SA) is a display requirement of the Principles and Standards and is integral to the iterative planning process. The SA will be filled out with increasing refinement and detail as the study progresses from Stage 2 to Stage 3. The planning process generates information, some of which will be displayed as the content of an interim SA at the end of each iteration. The interim SA will be used to help determine what must be done on the next iteration to improve planning.

The SA can display only a limited amount of information derived during the planning process. Therefore, an interdisciplinary planning team will utilize considerable latitude in the format and level of detail of the SA. Most of its content will result from the evaluation of significant impacts. Thus, only significant beneficial and adverse contributions will be displayed. In addition, the SA will describe each alternative carried through the final planning stage; display the planning objectives; present each plan's performance against the specified evaluation criteria; and indicate the timing, geographical incidence, uncertainty, exclusivity, and actuality associated with the evaluation of significant impacts.

Environmental Trade-offs/Remedial/Mitigative Measures

Where adverse effects are significant, project modifications will be considered. For each significant adverse effect the possibility of (a) eliminating the effect; and (b) mitigating the effect by minimizing or reducing it to an acceptable level of intensity; or (c) by compensating for it by including a counterbalancing positive effect, will be investigated in Stage 3. The cost of such measures, as well as any costs of reduced project performance, will provide a further basis for comparing alternatives and for deciding how or whether to modify them or to accept the adverse effects.

Coordination

Effective assessment procedures require a variety of information sources as well as continous feedback. Therefore, informal exchanges with Federal, International, State, and private groups and with individuals will be sought at the beginning of any investigation and maintained throughout the planning process. Pursuant to the Corps mandate to preserve and/or enhance water quality, and to record and preserve historical/cultural/archaeological resources, more formal discussions will occur in the course of initial formulation in Stage 2 through late-stage public meetings in Stage 3. These discussions will coordinate an interdisciplinary planning effort with those agencies having a vested responsibility for preserving/maintaining some segment of our Nation's valuable natural resources.

Finally, pursuant to the Corps' mandate for preserving our Nation's historical/cultural/archaeological resources, pertinent correspondence requesting the Department of the Interior for investigations of historical, archaeological and paleontological resources will be initiated in Stage 2. Further, contact will be made in Stage 2 with the State Archaeologist and the State Historic Preservation Officer regarding the effect of the proposed action upon the aforementioned heritage resources within the possible project area. In addition to necessary coordination with these State officials prior to preparation of the Final Draft Environmental Statement, a Draft Environmental Statement (DES) will be provided them and the Advisory Council on Historic Preservation for review and comment.

The environmental statements will include a discussion of the steps taken to comply with Sections 1(3) and 2(b) of Executive Order 11593, Protection and Enhancement of the Cultural Environment, 13 May 1971. The Environmental Impact Statement (EIS) will also include information indicating that the National Register of Historic Places has been consulted and that no National Register properties will be affected by the project, or a listing of the properties to be affected, an analysis of the nature of the effects, a discussion of the ways in which the effects were taken into account, and an account of steps taken to assure compliance with Section 106 of the National Historic Preservation Act of 1966 (P.L. 89-665; 80 Stat. 915; 16 N.S.C. 470f) in accordance with procedures of the Advisory Council on Historic Preservation as they appear in the Federal Register of 25 January 1974 and subsequent issues.

Thus, consultation with a wide range of interests (not limited to the specific agencies previously mentioned) will test the adequacy of identification of effects while at the same time validating their (effects) designation as beneficial or adverse. In addition, continued coordination will provide the needed commentary on measures considered for project modification. Coordination with the State Historical Preservation officer and State Archaeologist will be maintained and documentation of the coordination will be included in the Draft EIS.

Finally, because public participation is viewed as an integral part of the planning and administrative process of all Corps of Engineers civil works activities, public participation will be planned and incorporated into the conduct of this study. Public participation is a continuous two-way communication process which involves keeping the public fully informed on the status and progress of studies and findings of plan formulation and evaluation activities; actively soliciting from all appropriate concerned agencies, groups and individuals their opinions and perceptions of objectives and needs; and determining public preferences regarding resources use and alternative development or management strategies plus any other information and assistance relevant to plan formulation and evaluation.

A Draft Environmental Statement will accompany a Draft Feasibility Report as part of the initial output of Stage 3 of this study. The final output of Stage 3 will be a Final Feasibility Report and Final Environmental Statement.

PUBLIC INVOLVEMENT

The "Public" is defined as any affected or interested non-Corps of Engineers entity. This includes other Federal, State, regional, and local governmental entities and officials, including public and private organizations, and individuals.

It is the policy of the Chief of Engineers that planning be conducted in the atmosphere of public understanding, trust, and mutual cooperation. The intent of this policy is to insure that planning studies are responsive to public needs and preferences. Study activities to accomplish this intent include the following.

-- Public workshops and meetings during the course of the study to discuss study progress, findings and future work activities, and to solicit public input.

-- Use of printed materials and public communications media to facilitate public expression of needs, alternatives, and related impacts.

-- Coordination of study activities with related activities of other agencies to insure compatibility of plans developed by the study with other plans affecting the study area.

-- Use of study area organizations to establish and maintain direct participation of the public.

A more detailed summary is provided in Appendix F, "Public Involvement and Pertinent Correspondence."

A public workshop was held in August 1980 at Sault Ste. Marie, Michigan. The purpose of the workshop was to present the study objectives and preliminary alternatives under consideration in the reconnaissance study. Also, the public was encouraged to express their views, questions, and concerns concerning hydropower redevelopment. Some of the issues brought out at this workshop have been summarized under "Public Concerns." As the study progresses, additional workshops and meetings will be held. The next workshop is tentatively scheduled for the summer of 1981. Throughout the study, coordination will be maintained with all interested public, and appropriate Federal, State and local interests. In the "Study Participants and Coordination" portion of this report, a list is given showing those agencies, legislators, and local interests to be kept informed of the study progress.

STAGE 2 METHODOLOGY

The intermediate stage emphasizes identifying and analyzing the range of alternative ways for addressing the planning objectives. Considerable emphasis must be placed on more specifically defining these objectives. Based on a more definitive analysis of the objectives, alternatives will be outlined and refined without concentrating on detailed engineering or design considerations. Data should be sufficient to set forth and analyze alternative concepts of resource management. The expected impacts of these alternative plans are to be assessed and evaluated, concentrating on their significant consequences. A high level of detail is not appropriate at this stage. The alternative developed should provide choices as to the different viable resource management options for more detailed studies in Stage 3.

Stage 2 studies will be conducted in Fiscal Year 1981. Stage 2 formulation studies will evaluate the alternatives identified for further study in this report. Non-structural alternatives will be screened to identify those with potential. Following the initial screening, more detailed study of those non-structural alternatives with the greatest potential will be conducted. The most likely structural alternative will be identified and evaluated by FERC. Design concepts for each major structural element of each alternative will then be evaluated to identify the least costly, environmentally acceptable design concept. After selection of the best design concept for each major structural element, Stage 2 designs and cost estimates for different project capacities will be prepared for use in optimization studies to maximize project benefits.

Impact assessment studies will address the potential project impact on fish and wildlife, water quality, environmental and cultural resources, social well-being in the vicinity of the site, economic feasibility of the alternatives, and institutional/international considerations.

Evaluation studies will determine and compare the NED and EQ contributions of the structural and non-structural alternatives. At the conclusion of Stage 2 evaluation studies, alternative plans will be formulated for analysis during Stage 3 studies.

Milestone Schedule

The milestone schedule for the study is as follows:

Milestone	Title
MS 1 - 1 Mar 1980	- Study Initiation
MS 2 - 31 Oct 1980	- Approval of Reconnaissance Report by Division Engineer
MS 3 - 30 Apr 1981	- Submission of Stage 2 Documentation to Division
MS 4 - 31 May 1981	- Stage 2 Checkpoint Conference
MS 5 - 30 Jun 1981	- Completion of Action on Memorandum for Record
MS 6 - 31 Dec 1981	- Submission of Draft Survey Report to Division
MS 7 - 31 Jan 1982	- Stage 3 Checkpoint Conference
MS 8 - 28 Feb 1982	- Completion of Action on Conference Memorandum for Record
MS 9 - 31 Mar 1982	- Coordination of Draft Survey Report and Draft Environmental Impact Statement
MS 10 - 31 Aug 1982	- Submission of Final Survey Report and Revised Draft Environmental Impact Statement to Division
MS 11 - 30 Sep 1982	- Release of Division Engineer Public Notice and Submission of Report to the Board of Engineers for Rivers and Harbors (U.S. Army Corps of Engineers) to initiate Washington level review.

Funding Requirements

The total study cost is estimated at $955,000. The breakdown of funds by fiscal year for the study is summarized below:

	FY 80	FY 81	FY 82
Stage 1	$240,000	$ 5,000	$ -
Stage 2	-	287,000	-
Stage 3	-	123,000	300,000
Total	$240,000	$415,000	$300,000

A detailed study cost estimate (PB-6) and network of activities is included under Appendix G, "Study Cost Estimate/Network of Activities."

Responsibility for Accomplishing Tasks

Management of the study will be the responsibility of the Planning Branch of the Engineering Division, Detroit District. The Branch is responsible for the fiscal work and financial management of the study and coordinates joint efforts with representatives of appropriate Federal, State, and local agencies.

Various elements of the Detroit District are assigned responsibility for providing technical support to the Planning Branch during the course of the study. Tasks are completed according to the milestone schedule as previously given.

TENTATIVE STAGE 3 METHODOLOGY

During this final stage, emphasis is on modifying, assessing and evaluating the intermediate alternatives carried into Stage 3 from Stage 2 to produce detailed, implementable plans. Design, assessment, and evaluation in this stage requires data that is specific and well-defined. The alternative plans produced at its completion must be at a comparable level of detail so that an effective choice can be made.

Stage 3 of the planning process provides the basis for selecting one of the detailed plans and, if appropriate, recommending it for Congressional authorization. Generally, only one plan should be selected regardless of whether or not it is within the existing general authority of the Corps. If the selected plan falls under the Corps authority, then it can be recommended by the District Engineer for implementation. If the selected plan is not within existing Corps authority, the reporting document would describe how it could be implemented.

CONCLUSIONS

The significant tasks accomplished in this study are:

-- Problem identification

-- Statement of objectives

-- Formulation of alternatives

-- Development of alternatives

-- Evaluation of alternatives to determine if potential feasible alternatives exist.

After the alternatives were formulated, a preliminary subjective evaluation indicated that Alternatives 1, 2(a), 2(b), and 2(c) displayed a greater potential feasibility than the other alternatives and, therefore, were chosen for further development. Also during this evaluation of alternatives, areas which needed further investigation were identified. The alternatives were presented at a public workshop. The issues raised during the workshop have been addressed and a new alternative has been added. Consideration of providing additional water in the Rapids would need further study. The subject of existing contracts between the U.S. Government and ESELCO was brought up in the public workshop. This subject has been addressed in this report.

Specific conclusions are:

-- Evaluation of all alternatives show that Alternatives 1, 2(a), 2(b), and 2(c) display potential economic feasibility.

-- Environmental impacts have to be identified in future studies to effect environmental evaluation.

-- Based on existing data collected to date, there is no apparent engineering, environmental, social, economic, or institutional constraint that would preclude the study from proceeding into subsequent stages.

STUDY DIRECTIONS

Studies required in the subsequent stages have been identified under the Section, "Study Management," and are displayed on a network of activities in Appendix G. Environmental studies as recommended by the U.S. Fish & Wildlife Service have also been considered. These studies would provide refined data on the selected alternatives.

The Federal Energy Regulatory Commission (FERC) would be provided revised data on installed and dependable capacities and annual energy output to compute refined power values. Based on these refined power values, economic evaluation would result in more accurate B/C ratios.

The U.S. Department of Energy would complete a marketing study for a determination of financial feasibility of a recommended plan.

LOCAL COOPERATION

Under Alternatives 2(a), 2(b), and 2(c), the ESELCO power canal would not be required for power generation. The disposition of the power canal needs to be addressed in subsequent stages, and would require the cooperation of ESELCO and the City of Sault Ste. Marie.

POLICY AND OTHER ISSUES

The redevelopment alternatives could fall under the purview of the IJC; therefore, IJC approval may be required prior to implementation of a selective alternative. Any decision to implement any of Alternatives 2(a), 2(b), or 2(c) prior to the year 2000 should consider obligations arising out of the existing contracts between the U.S. Government and ESELCO. Because the Edison Sault Electric Company Plant and its power canal and headgates are presently being nominated for inclusion into the National Register of Historic Places, coordination of the project is required with the State of Michigan Historic Preservation Office and the Advisory Council on Historic Preservation. Also, the Spruce Street bridge crossing the canal has been determined to be eligible for nomination to the National Registry of Historic Places.

RECOMMENDATIONS

Further study is recommended.

ROBERT V. VERMILLION
Colonel, Corps of Engineers
District Engineer

APPENDIX A

TECHNICAL STUDIES

Department of the Army

Detroit District, Corps of Engineers

APPENDIX A

FOR

RECONNAISSANCE REPORT

SAULT STE. MARIE POWER PLANT REDEVELPMENT (HYDROPOWER)

AT

SAULT STE. MARIE, MICHIGAN

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SAULT STE. MARIE POWER PLANT REDEVELOPMENT

INTRODUCTION

This Appendix, prepared by St. Paul District Corps of Engineers at the request of Detroit District Corps of Engineers, was made to provide a technical study of given alternatives to effectively utilize the hydroelectric potential of St. Mary's River. Water available to the U.S. for power generation purposes has not been used efficiently by today's standards. The amount of power generated by the U.S. Government Powerhouse (Corps Plant), U.S. Unit 10, and Edison Sault Electric Company Powerhouse (Edison Sault Plant) serving the Sault Ste. Marie area is no longer sufficient to meet the demands.

ABSTRACT

Alternative 1

Alternative 1 consists of rehabilitating the Edison Sault Plant for more effective use of the available potential and continued use of the Corps Plant and U.S. Unit 10. The installation of 35 new 1.1 megawatt tube turbines and generators in the existing Edison Sault Plant has been selected as a viable solution. The estimated investment cost is $40,305,000. Advantages of this alternative include relatively low initial cost, minimal loss of power during construction, and the flexibility of multiple units. Disadvantages include age of plant, canal, and headgate structure (built in the early 1900's), possible foundation problems, and greater headloss in the existing canal. Future considerations should include a detailed condition inspection of the structures, canal, and foundation. Remaining units after modification in Edison Sault Plant will be bulkheaded.

Alternative 2 (Alternative 2(a), Main Report)

Alternative 2 consists of expanding the Corps Plant by approximately 45,000 square feet and discontinuing use of the Edison Sault Plant. The installation of three 12.5 megawatt vertical propeller turbines in the addition has been selected as a viable solution. The estimated investment cost is $57,661,000. Advantages of this alternative include power generation capability during construction, equipment similar to that installed in the

existing Corps Plant, and centralized operation of power generation. Disadvantages include large quantities of rock removal for headrace and powerhouse construction, and a mixture of new and older equipment. Future considerations should include the study of varying design flows in the headrace.

Alternative 3 (Alternative 2(b), Main Report)

Alternative 3 consists of constructing a new powerplant south of the existing Corps Plant, and discontinuing use of the Corps Plant and Edison Sault Plant. The installation of five 10.5 megawatt vertical propeller turbines or ten 5.25 megawatt tube turbines have been selected as viable solutions with estimated investment costs of $74,844,000 and $77,061,000 respectively. Advantages of this alternative include power generation capability during construction and realization of new equipment and building. Disadvantages include relatively higher rock excavation costs.

Alternative 4 (Alternative 2(c), Main Report)

Alternative 4 involves installation of new equipment in the existing Corps Plant and discontinuing use of the Edison Sault Plant. Equipment identical to Alternative 3 was evaluated. The estimated investment cost is $83,610,000 for vertical propeller turbines and $86,722,000 for tube turbines. Advantages and disadvantages are similar to Alternative 3, except that considerable energy and revenue would be lost during demolition and construction.

Conclusions

The existing Corps Plant building is in good condition and should be functional for the economic life of this project. The existing four vertical propeller units are in excellent condition and are as efficient as most modern plants. The Corps Plant should not be abandoned or demolished and rebuilt as required in Alternatives 3 and 4. It is recommended that Alternatives 1 and 2 be selected for economic analysis in the reconnaissance report and, pending advantageous benefit/cost relationships, be carried to Stage 2 Planning.

PROJECT DEVELOPMENT

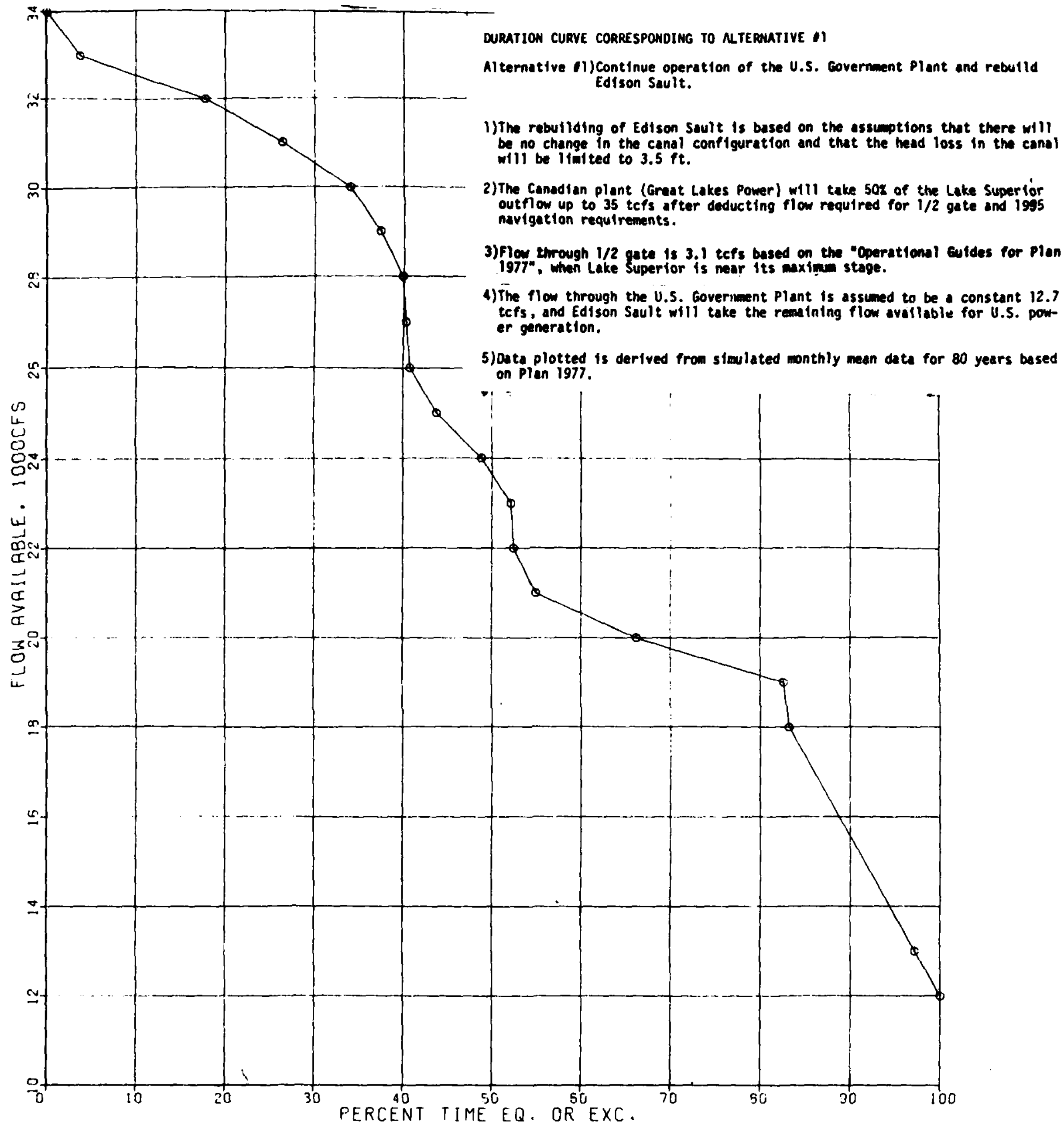
Hydrologic and Hydraulic Analysis

Hydroelectric power production is dependent on the flows available to pass through the power plant. The flows for power generation are represented in the form of flow-duration curves.

Alternative 1 - Rebuild Edison Sault

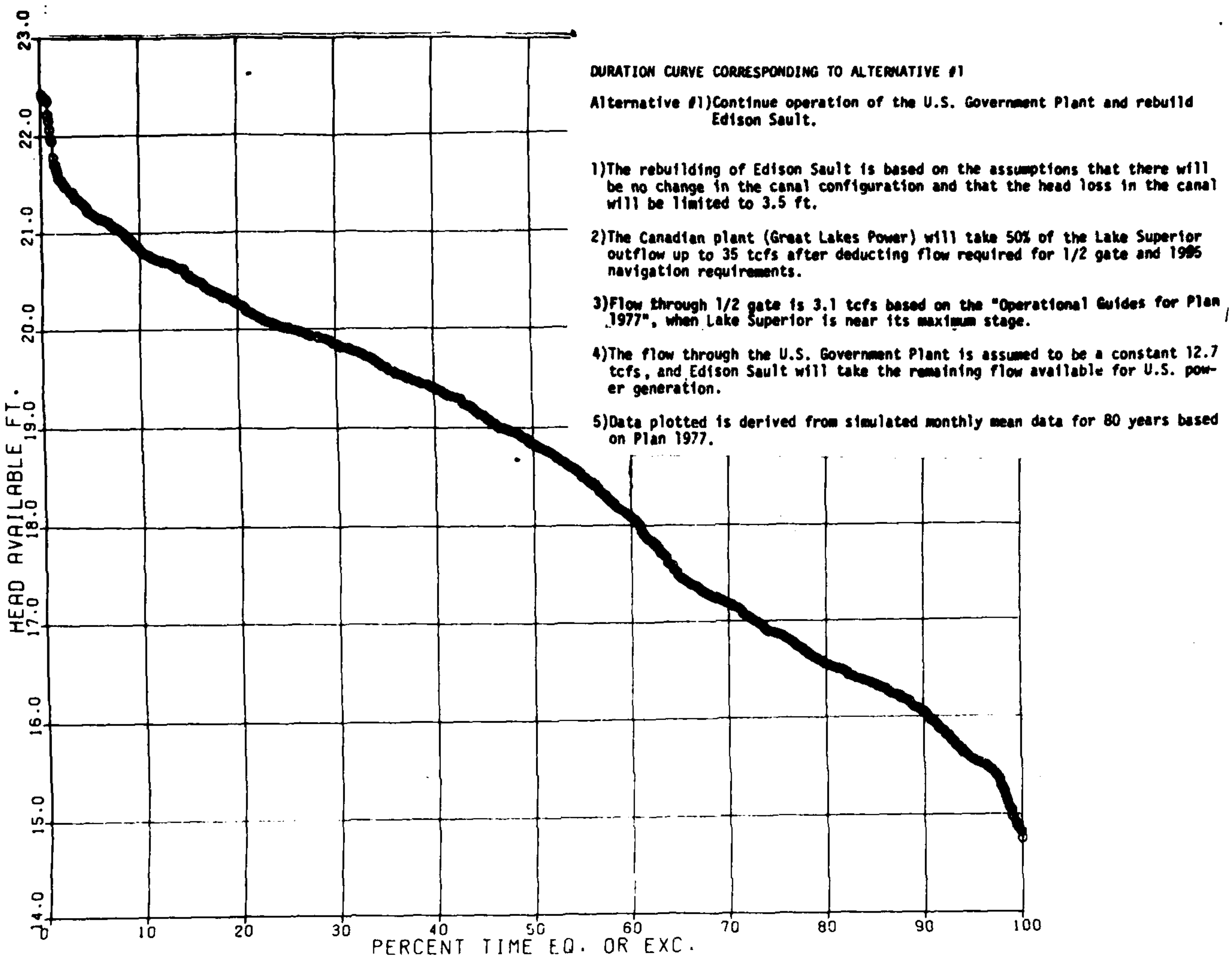
The flow-duration curve simulated for Alternative 1 is shown in Figure A-1. This is the only alternative which considers the flow available at the Edison Sault plant. When the new Canadian (Great Lakes Power) plant is in operation, reductions of flow will occur at the Edison Sault plant more often than at present. The assumptions made regarding the flow-duration curve are listed on the figure. Average annual flow predicted to be available at this site is approximately 24,300 cfs. The flow used by the present Edison Sault plant operating at full capacity is usually between 29,000 and 30,000 cfs, with a maximum of 33,000 cfs. Existing bays of this plant cannot easily accommodate tube turbines larger than 8.5 feet in diameter. A suitable size is the 8.2-foot turbine which can produce 1,500 hp at 18 ft. head. The flow required for this power and head is 840 cfs per unit. To minimize canal erosion problems, it was decided to choose a design discharge to accommodate as many 1,500 hp units as possible without exceeding 30,000 cfs. Thus: 840 cfs times 35 units equals 29,400 cfs.

The variation in head at Edison Sault is shown in Figure A-2. Figures A-3 and A-4 show the headrace and tailrace elevation duration curves for this alternative. Because of the uncommon situation between two very large lakes, the head at Sault Ste. Marie is nearly independent of the flow. For this reason, the median head was used in estimations for the reconnaissance study. If a proper relationship is found to exist between head and another parameter such as flow or time, this would be of some help in refining the energy values in Stage II.



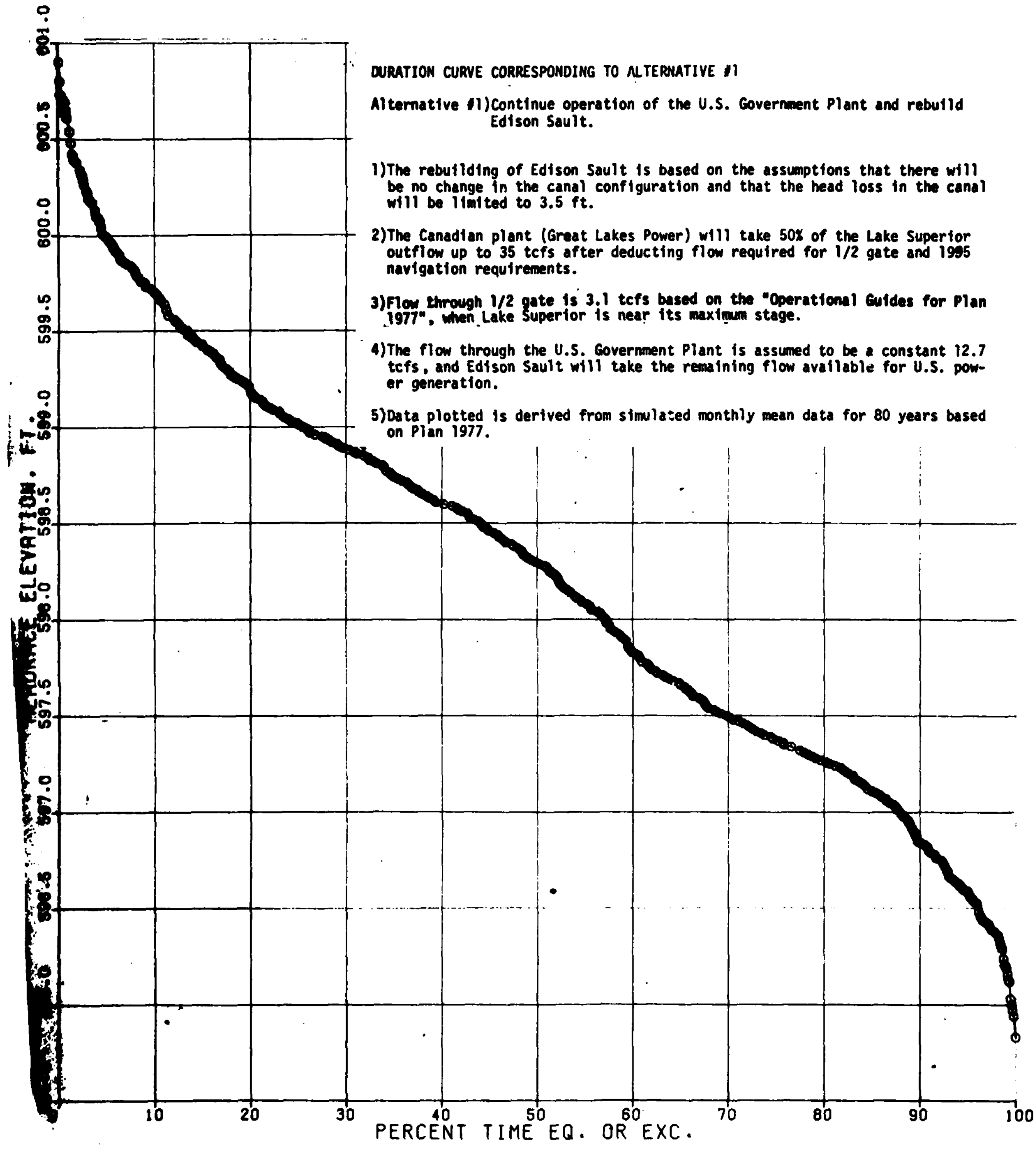
FLOW AVAILABLE FOR POWER AT EDISON SAULT

FIGURE A-1



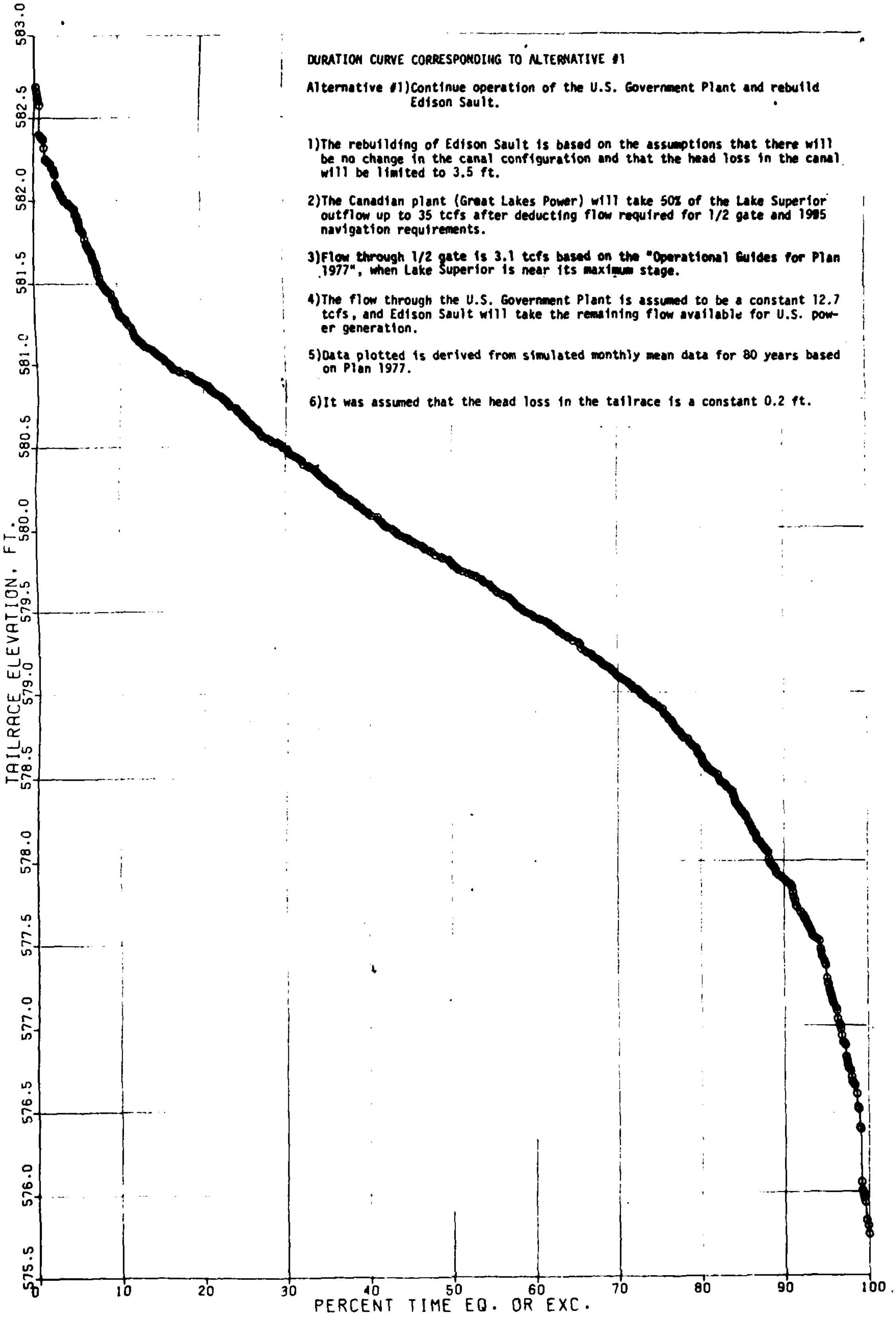
HEAD AT EDISON SAULT

FIGURE A-2



HEADRACE ELEVATION AT EDISON SAULT

FIGURE A-3



TAILRACE ELEVATION AT EDISON SAULT

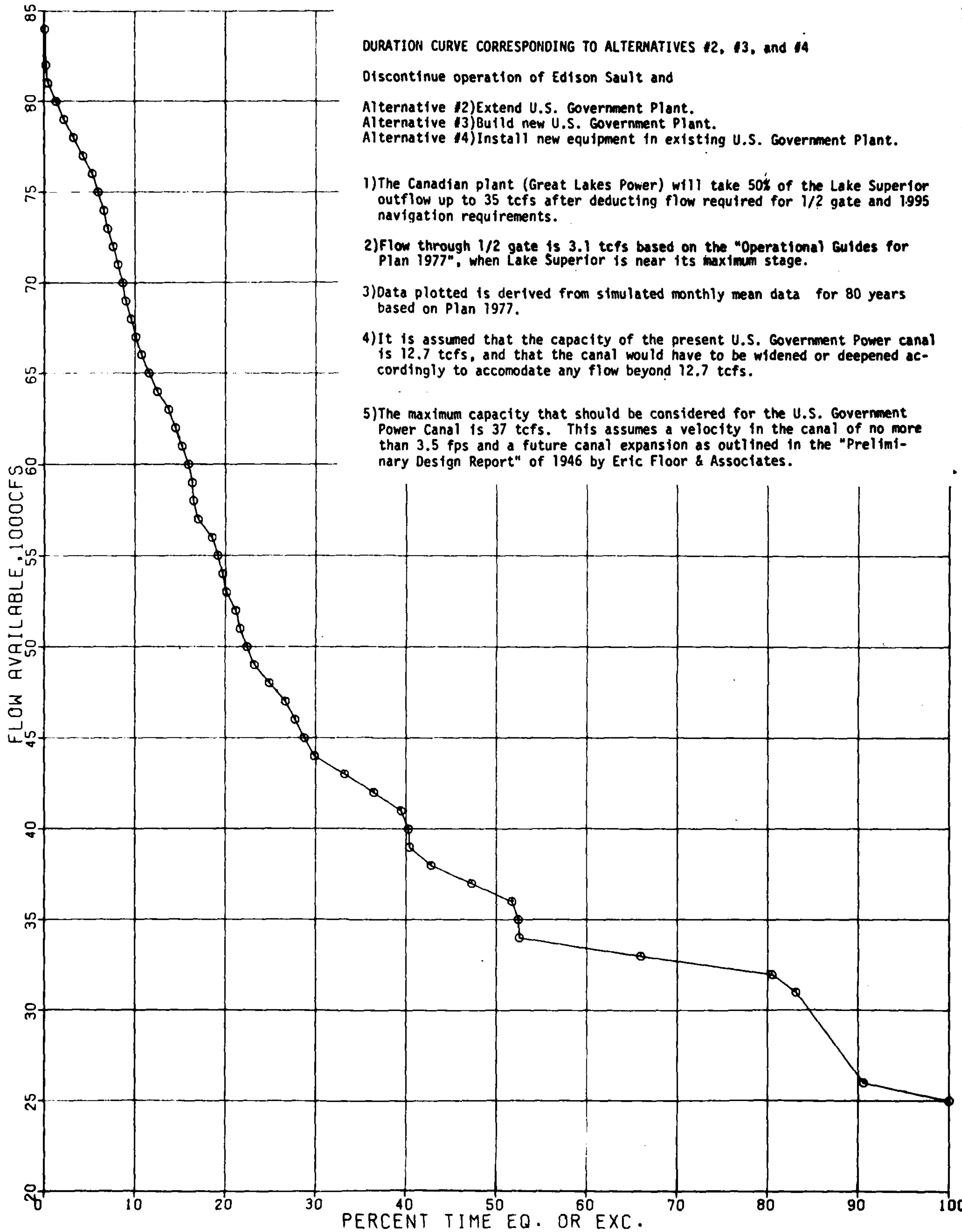
FIGURE

Replacement of present machines with modern equipment would result in up to 28% increase in output. Economic use of the Edison Sault facility requires that changes in the canal and power plant structure be minimized. The power canal would retain its present configuration, with allowances to be made for repair as necessary for continued efficient operation. Consideration should be given to modifying the forebay to reduce the expansion losses. It appears that up to 0.75 foot of the present head loss is due to sudden widening of the channel into the forebay. The plant superintendent stated that a 1/2-foot head difference is normal between the center and the ends of the plant, which is indicative of the high loss of head in this area. A smoother hydraulic transition through the forebay into the turbine intakes could reduce these losses by maintaining the high velocites through the forebay.

Alternatives 2, 3 and 4 - Expand Corps Plant

Figure A-5 shows the flow-duration curve corresponding to alternatives 2, 3 and 4 involving the Corps plant. The curve is derived from simulated monthly mean data for 80 years based on the "Draft Operational Guides for Plan 1977." It gives the U.S. share of flow available after environmental and navigation requirements have been met. Flow through the locks is estimated as 1,500 cfs. Minimum flow through the compensating gates required by Plan 1977 is one-half gate opening or 3,100 cfs when Lake Superior is near its maximum stage. The Canadian plant (Great Lakes Power) will take 50% of the Lake Superior outflow up to 35,000 cfs, after deducting flow required for environmental and navigation requirements. Average annual flow at this site (by area under flow duration curve) is approximately 41,900 cfs. This flow is exceeded 36% of the time.

The present capacity of the Corps plant and Unit 10 power canal is 12,700 cfs with 11,200 cfs flowing directly to the Corps plant and the remainder flowing to Unit 10. To generate additional energy at this site, the canal would have to be widened and/or deepened to convey the additional flow. A plan for future canal expansion was outlined in the "Preliminary Design Report" of 1946 by Eric Floor and Associates. The



FLOW AVAILABLE FOR POWER AT US GOVT. PLANT

FIGURE A-5

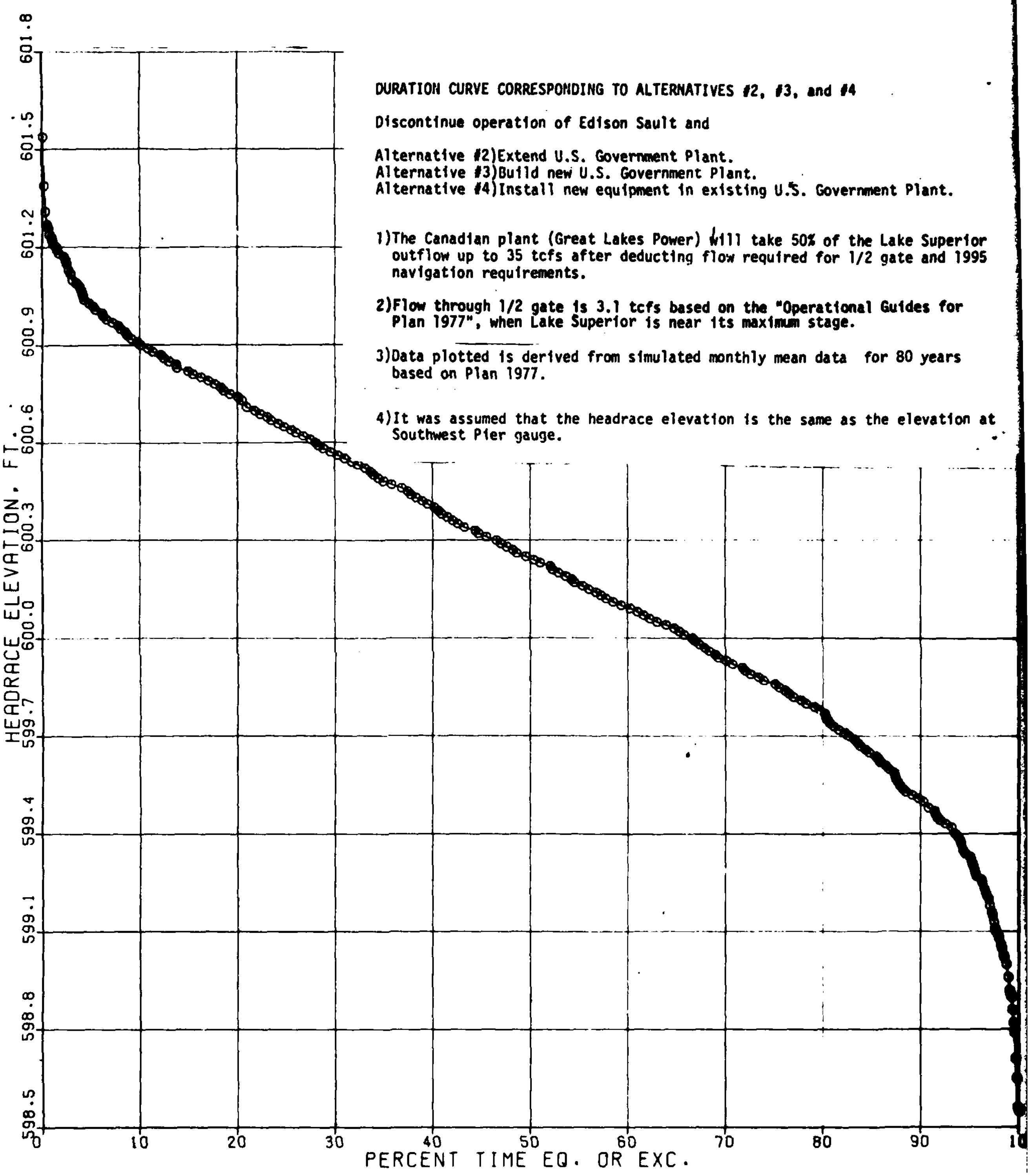
maximum capacity of the canal is 37,000 cfs at a velocity of 3.5 fps. This capacity was, therefore, selected as the design discharge for Alternatives 2, 3 and 4.

Although a channel velocity of 3.5 fps was used in this study for headrace excavation costs, a velocity of 2.5 fps would reduce the production of frazil ice. The presence of frazil or anchor ice can block turbine intakes, restrict the headrace cross section, increase flow resistance, and consequently increase head loss. At the Corps plant, the ice has affected the flows to a point where plant shutdown occurs for a period of one-half to three-fourths day several times per year. In these cases, power is delivered to the Edison system at high rates from other suppliers when contractural demands are exceeded. In Stage II, consideration should be given to excavation of a deeper channel such that 2.5 fps would be the average velocity in the headrace. The additional cost of excavation should be compared with operational revenue losses due to icing.

Figures A-6, A-7 and A-8 show the headrace elevation, tailrace elevations, and head duration curve, respectively, for Alternatives 2, 3 and 4. The headrace elevation is the elevation recorded at the Southwest Pier gauge. The tailrace elevation is the elevation at the U.S. Slip gauge downstream of the Corps plant with an adjustment of 0.6 foot for head losses in the power canal and tailraces. The head duration curve represents the difference between the tailrace and headrace elevations and depicts the gross head for power generation at the Corps plant. The data plotted is derived from simulated monthly mean data for 80 years based on Plan 1977.

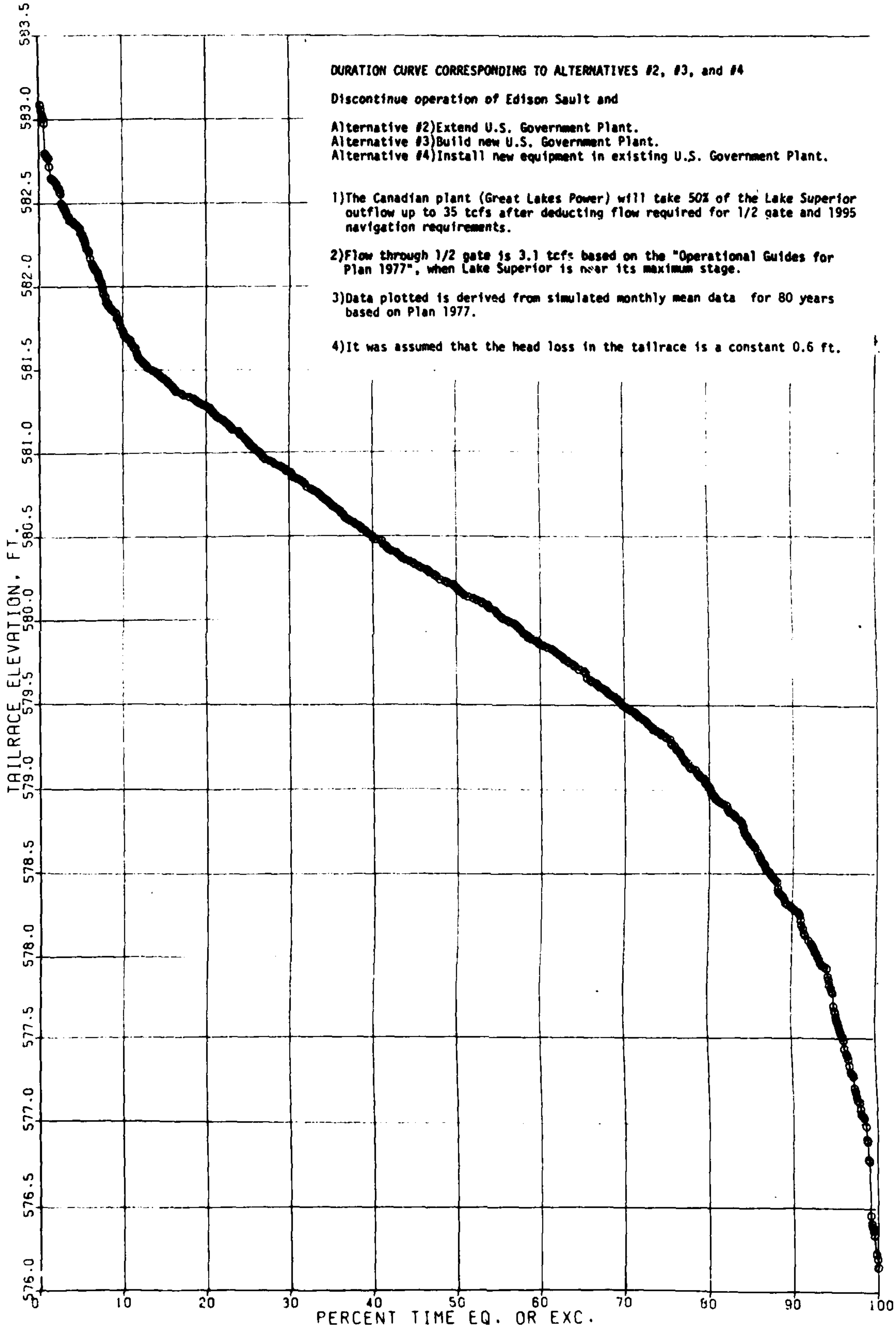
Spillway Considerations

Lake Superior has an area of 31,700 square miles, which is nearly 40% of the total drainage basin above Sault Ste. Marie. This mammoth reservoir is ideal for hydropower purposes since flows may be adjusted widely while the head remains essentially constant.



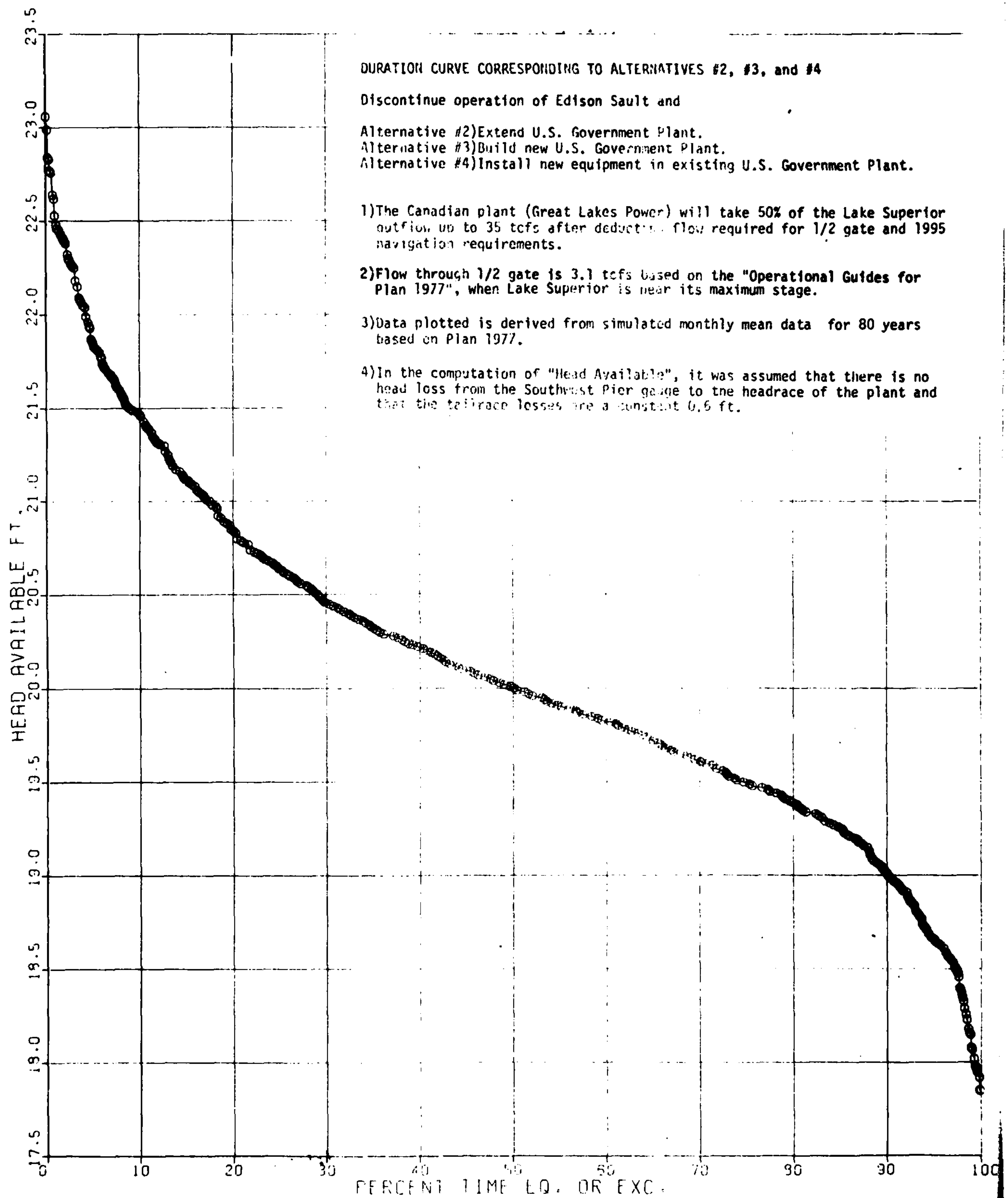
HEADRACE ELEVATION AT US GOVT. PLANT

FIGURE A-



TAILRACE ELEVATION AT US GOVT. PLANT

FIGURE A-7



HEAD AT US GOVT. PLANT

FIGURE A-8

The storage volume of Lake Superior between elevations 600.0 and 601.0 is equivalent to the average annual flow at Sault Ste. Marie (75,000 cfs) for 136 days. Presented in another way: if the present Corps plant were to be shut down completely for 2 weeks, this would cause a rise of only 0.20 inches in Lake Superior.

Because of the high ratio of storage to annual flow, spillway capacities moderately larger than the average flow are adequate. The present Compensating Works perform this function at Sault Ste. Marie. As power generation capacities increase, the proportion of spillway capacity used will decrease.

For Alternatives 2 and 3, an ice sluice should be provided as part of the powerhouse complex to provide for the sluicing of any ice which may enter the headrace area.

Although the present Compensating Works are adequate from a hydrologic view, investigation should be made to insure that designs under consideration satisfy the requirements of law and international agreements.

Power Potential

Four alternatives were studied, each comprised of several options among turbine types. Under each option, several sizes of turbine were investigated to find the lowest total cost for that option. The turbines and generators were selected to be of the same capacity and manufacturer to reduce the required spare parts inventory.

Table A-1 lists for each alternative the basic design data and selected parameters which include design flows, plant capacities, dependable capacity, average flow through turbines, average annual energy generation, and annual plant factors.

TABLE A-1
BASIC DATA AND SELECTED PARAMETERS

	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Basic Data				
Average flow at Sault Ste. Marie (80 years) = 75,000 cfs				
Average total flow for U.S. power generation = 41,900 cfs				
Assume overall plant efficiency = 0.86				
Median gross head (50% point of NCE head duration curve)(ft.)	18.8	20.0	20.0	20.0
Estimated hydraulic losses (trash racks, intakes, draft tube) (ft.)	0.8	0.5	0.5	0.5
Effective net power head	18.0	19.5	19.5	19.5
Assume no outage due to plant submergence				
Length of transmission line (13.8 kv)(miles)	0	2.0	2.0	2.0
Upper limit of turbine operation = 105% of rated capacity				
Lower limit of turbine operation = 40% of rated capacity				
Selected Parameters				
Design flow for *existing capacity of channel (cfs)	12,950	11,550		
Design flow for incremental capacity of channel (cfs)	29,400	25,450		
Design flow for total installation (cfs)	42,350	37,000	37,000	37,000
*Existing installed capacity (kW)	18,400	16,400		
Incremental design capacity (kW)	38,500	36,200		
Total design capacity (kW)	56,900	52,600	52,600	52,600
Net dependable capacity at *existing installation (kW)	16,300	14,300		
Net dependable capacity for incremental installation (kW)	22,500	27,400		
Net dependable capacity for total installation (kW)	38,800	41,700	41,700	41,700
Average flow at *existing installation (cfs)	12,700	11,200		
Average flow for incremental installation (cfs)	24,000	23,500		
Average flow for total installation (cfs)	36,700	34,700	34,700	34,700
*Existing average annual energy (MWh)	158,000	139,000		
Incremental average annual energy (MWh)	276,000	293,000		
Total average annual energy (MWh)	434,000	432,000	432,000	432,000
*Existing annual plant factor	0.98	0.97		
Incremental annual plant factor	0.82	0.92		
Overall annual plant factor	0.86	0.94	0.94	0.94

*The adjective "existing" here refers only to that portion of present facilities to be retained in the total design alternative.

Plant capacities are computed from the following power equation:

$$\text{Power (kW)} = \frac{(Q_{design})\ (H)\ (e)}{11.8}$$

where: Q = design flow (cfs)

H = effective net power head (ft.) = gross head at plant minus losses charged to trash rack, intake and draft tube

e = overall plant efficiency (assumed 0.86 for all alternatives)

Average annual energy generation is calculated from the following energy equation:

$$\text{Annual energy (kWh)} = \frac{(Q_{avg})\ (H)\ (e)\ (8760)}{11.8}$$

where: Q = average flow (cfs) (from area under flow duration curve, between minimum and maximum turbine operating limits)

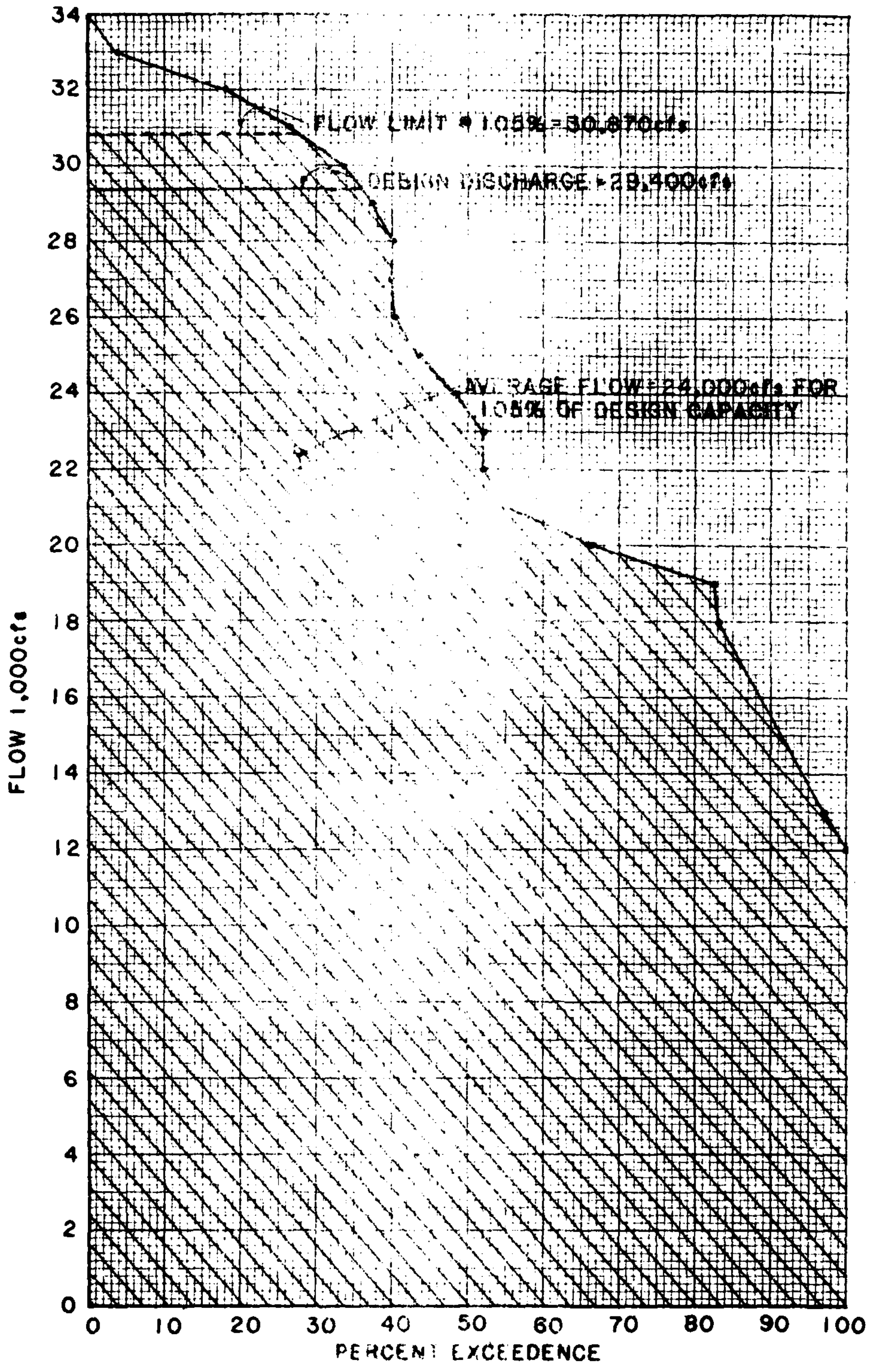
8760 = number of hours in 1 year

Alternative 1

The effective net power head used for Alternative 1 is the median head, minus hydraulic losses of 0.8 foot charged to the trash rack, intake, and draft tube. From the head duration curve shown in Figure A-2, the gross head is 18.8 feet. This value includes calculated canal losses. The effective net power head (difference between the gross head and the intake, trash rack, and draft tube losses) used in the capacity and energy calculations is 18.0 feet.

The flow available to the Edison Sault site is limited by the capacity of the power canal. The other constraint is the allotment of flow to the facility by International and Federal agreements.

Figure A-9 shows the selected design parameters on the flow duration curve. The design flow for Alternative 1 is 29,400 cfs, which is exceeded



FLOW - DURATION CURVE

SHOWING FLOWS AVAILABLE AT EDISON SAULT PLANT AFTER ALLOWING FOR OPERATIONS OF CORPS PLANT

FIGURE A-9

36% of the time. The available power is $P = \frac{(29,400)(18.0)(.086)}{11.8} = 38,500$ kW. When added to the present combined Corps and Unit 10 plant capacity of 18,400 kW, the total capacity of this alternative is 56,900 kW.

Table A-1 shows the dependable capacity for Alternative 1. Dependable capacity is defined (IACWR, 1965) as the "load carrying ability of a station or system under adverse conditions for the time interval and period specified when related to the characteristics of the load to be supplied." Dependable capacity for this project is calculated from the discharge on the flow duration curve associated with a percent of time exceeded, called the Streamflow Reliability Percentage (SRP). For this project, a value of 85% for SRP was assumed, which is equivalent to a 15% forced outage percentage in fossil-fueled generating plants. According to FERC, a fossil-fueled generating plant is the most likely alternative to this project. Thus, using the corresponding SRP discharge in the power equation, the dependable capacity for Alternative 1 is estimated to be $\frac{(17,500)(18.0)(0.86)}{11.8} = 22,900$ kW. Net dependable capacity is exclusive of capacity required for station use. For this alternative 400 kW is estimated for station use. Therefore, the net dependable capacity is 22,900 kW - 400 kW = 22,500 kW. The sum of the present Corps plant net dependable capacity (16,300 kW) and the computed 22,500 kW is 38,800 kW total net dependable capacity.

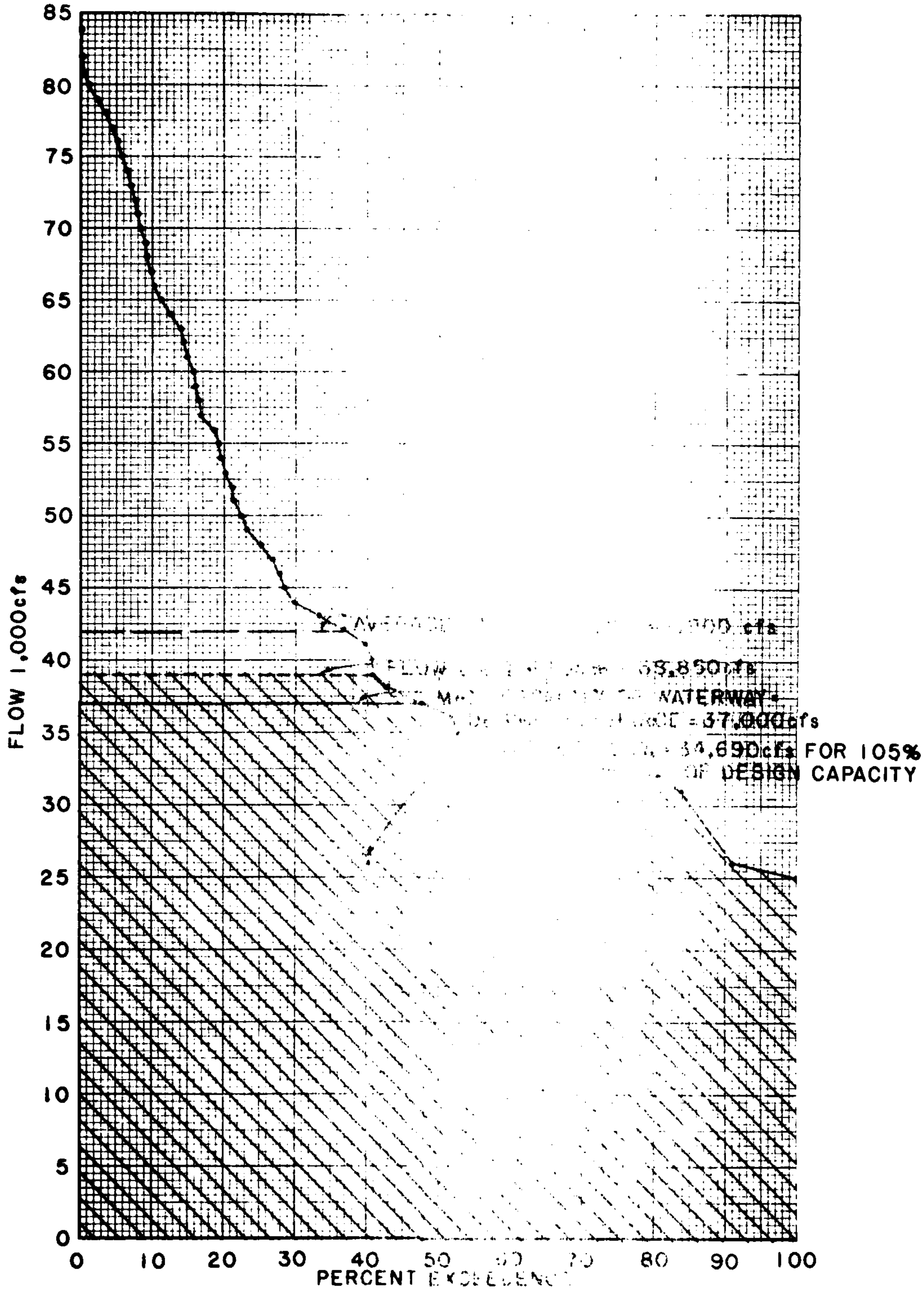
Average annual energy generation is calculated by using the energy equation. The average discharge through the turbines is estimated by integrating the area under the flow duration curve with 105% of the design discharge as the upper turbine operating limit. This upper limit represents an overload capacity that can be credited in operation of the project with Kaplan, vertical propeller, tube or bulb turbines. The lower operating limit for each turbine is 40% of the design flow. In all of these designs, the flow at 40% of one turbine is less than the lowest observed flow. Figure A-9 shows the flow duration curve with design flow and average flow for 105% of design capacity for Alternative 1. The calculated incremental energy generated is, therefore, 276,000 MWh. The existing average annual energy generated is estimated at 158,000 MWh, generated by the Corps plant and Unit 10 at 19.5 feet of head.

Alternatives 2, 3 and 4

The effective net power head used for Alternatives 2, 3 and 4 is the head that prevails at least 50% of the time, minus hydraulic losses that are charged to the trash rack, intake and draft tube. From the head duration curve shown in Figure A-8 the gross head is approximately 20.0 feet. One-half foot is estimated for hydraulic losses. Therefore, the effective net power head used in the capacity and energy calculations is 19.5 feet.

The design flow for Alternatives 2, 3 and 4 is 37,000 cfs, which is exceeded 47% of the time. Figure A-10 shows the selected design parameters on the flow duration curve. Because the maximum channel capacity was limited to 37,000 cfs, various combinations of design flows and multiple unit turbines were not studied to optimize power potential. It may be feasible to use larger design flows and thus install larger capacity turbo-generating units and capture additional energy; however, a corresponding increase in channel capacity would have to be made. The additional investment cost must be compared with the additional capacity and energy benefits. This aspect could be studied in more detail in the Stage II study.

The power at this site, using the power equation with total design flow of 37,000 cfs and effective net power head of 19.5 feet, is 52,600 kW. For Alternative 2, (extend the Corps plant) the existing design flow is 11,550 cfs with installed capacity of 16,400 kW. The available design flow for expansion is, therefore, 37,000 cfs - 11,550 cfs = 25,450 cfs. The corresponding capacity that would be added to the plant is, therefore, 36,200 kW. Total design capacity was calculated by adding the computed 36,200 kW incremented capacity value to the existing installed capacity value of 16,400 kW to get 52,600 kW. Unit 10 was not considered as part of the existing facilities because it would be removed to allow for the expansion of the Corps plant.



FLOW - DURATION

SHOWING TOTAL FLOW AVAILABLE TO U.S. FOR POWER GENERATION.

FIGURE A-10

Using the discharge corresponding to 85% for SRP, the dependable capacity for Alternatives 2, 3 and 4 is estimated to be $\frac{(29,500(19.5)(0.86)}{11.8}$ = 41,900 kW. For the total installation, 200 kW is estimated for station use. The total net dependable capacity for Alternatives 2, 3 and 4 is, therefore, 41,900 - 200 = 41,700 kW. The 1979 power system statement for the Corps plant (including Unit 10) gives its net dependable capacity as 16,300 kW. For Alternative 2, the net dependable capacity for the existing installation was computed as 14,300 kW, which is equal to the net dependable capacity of the plant minus 2,000 kW for Unit 10. The net dependable capacity for the incremental installation is estimated to be 41,700 - 14,300 = 27,400 kW.

Figure A-10 shows the flow duration curve with total average flow, design flow and average flow for 105% of design capacity used for Alternatives 2, 3 and 4 at the Corps plant. Total average annual energy generation for these alternatives is, therefore, 432,000 MWh. The incremental energy generated for Alternative 2 with extension of the Corps plant is 293,000 MWh. This assumes that the Corps plant has an average flow of 11,200 cfs that generates 139,000 MWh per year with an effective net power head of 19.5 feet.

Physical Plant Options for Alternatives

Introduction

At Sault Ste. Marie, at least three different configurations of reaction turbine could be used for power generation. Among these are: vertical propeller, bulb, tube and Straflo units. All of these have runners of axial-flow design, which is the best type for low head situations. These units are further discussed in the mechanical section.

The approach taken in this appendix was to study a variety of configurations to indicate the lowest cost option for each alternative. The flows chosen for design capacities were conservative; that is, turbines designed for these flows would pass the average U.S. allotment of water

(35,000 cfs) at a high plant factor. This should tend to maximize the benefit-cost ratio. If these alternatives are shown to be very profitable in Stage I, then other design flows could be considered in Stage II to maximize either benefit cost ratio or annual net benefit.

Estimates for mechanical equipment should be requested from manufacturers during Stage II. If the project is feasible, then final selection of turbine/generator and other mechanical equipment should be made by totalling firm bid prices from manufacturers in Stage III prior to the final design of the powerhouse.

Alternative 1

Of the myriad possibilities for improving the Edison Sault Plant, most of the economically feasible possibilities include the installation of tube turbines. The range of possibilities for this option is from "extensive modification of the existing structure" to that of "continued maintenance of the present equipment."

Present performance of the existing plant is quite good and maintenance costs are low, especially when one considers the age of the equipment. Most of the generators were rewound circa 1963, which should extend their life past the year 2000. Present turbine units are obsolete in design, and their efficiency is about 70%. Maintenance costs are relatively low and with good maintenance the equipment is expected to last indefinitely. The main disadvantages seem to be only two: 1) Inefficiency due to obsolete design; and 2) Ice-related problems during winter operations. New propeller turbines, with better efficiences and larger water passages would reduce both of these problems.

One of the most critical issues involved is the condition of the canal, foundation and structure at Edison Sault. The strength of this alternative depends upon the condition of these items. Although the powerhouse structure appears to be in very good condition, thorough tests would have to be made to determine the actual condition of the foundation. There could be no advantage to this alternative if foundation conditions were anything less than satisfactory. The options shown below assume that the structure is sound, the foundations are solid, and that the canal would require no extensive rework.

Option I Renovate 35 bays of the existing plant with new standardized tube turbines and generators. The 2250 mm propeller unit would have three fixed blades, and would drive a direct-connected 1100 kilowatt generator. The generators would be synchronous 3-phase type with self contained exciters. These turbine-generator units would be similar in design to the units at the Cornell, Wisconsin, N.S.P. plant. The proposed units could be installed while most of the plant is still operating, thus reducing the cost of generation lost during construction. The total capacity for this option is 38.5 MW. The chief advantages of this option are its inherent simplicity and reliability, due to fixed blade operation and self contained exciters.

Option II Install 32 tube turbines to drive pairs of existing generators in tandem. Generators closest to the turbines would have their shafts modified to transmit the additional torque. Turbine units would be 2500 mm four-blade adjustable units with speed increasers to match the existing 180 rpm generators. An additional 1250 kW D.C. unit is provided for additional reliability of excitation current. An alternative to this unit is a solid state A.C.-D.C. converter. The cost per kW for this option is close to that for Option I, and the output is 35.2 MW.

Alternative 2

This alternative involves expansion of the existing Corps plant, abandonment of the Edison Sault plant, as a base load plant, and demolition of Unit 10. An additional headrace would be constructed parallel to the existing headrace at the Corps plant. Three options were studied using vertical propeller, tube, and bulb turbines. All options are fixed blade with adjustable wicket gates for quick response shutdown and load regulation. The units are heavy, slow-speed turbine/generators with massive substructure necessary for the large water passages. Each turbine would be directly coupled to a synchronous, 3-phase 60 Hz generator at 13.8 kV output voltage.

Although the Edison Sault plant would be abandoned as a base load plant, it could be used for peaking by generating with flows in excess of the design flow for the expanded Corps plant. In accordance with the results of the study thus far, the equipment at the Edison Sault plant appears to be in fair and usable condition for many years of generation, provided some improvement to the facility be made. Furthermore, it appears that operation of each unit could be performed remotely from the Corps plant through supervisory or solid wire control in which case the plant could be unattended. This plan would be based on the supposition that the cost for acquiring the Edison Sault plant would be reasonable and that the substructure for the plant is in good condition. The advantage for such a plan would be that all water available for generation would be utilized to its maximum as it is intended in the directives. Secondly, the Edison plant could be considered for diverting excess water in place of the Compensating Works to the extent of 30,000 cfs conveniently winter and summer.

Option I consists of three 12.5 MW vertical propeller units with incremental installed capacity of 37.5 MW. Runner diameter is 23.5 feet. Compared to Options II and III, the vertical propeller would require considerable excavation work for draft tube construction. The powerhouse would be similar to the existing powerhouse.

Option II consists of eight 5 MW tube turbines with a runner diameter of 15 feet. The incremental installed capacity is 40 MW. Some companies manufacture standardized units; however, the largest standard runner diameter made is 9.5 feet. The five MW units approach the largest capacity tube unit that can be used for this application. In general, for a given total capacity, the smaller the number of units, the lower the cost. Relative to the existing structure, the tube powerhouse would maintain a low profile as an aesthetic consideration. It would be about 50 feet longer in the downstream dimension than the existing powerhouse. The units would be fixed blade, adjustable wicket gates with upstream tainter gates for flow control and quick response shut down of the plant.

Option III Three 12.5 MW bulb turbines are proposed for Option III. These units would be similiar to those units now under construction for Great Lakes Power Corporation, Limited in Sault Ste. Marie, Ontario, except for their smaller runner diameter of 19.4 feet. Incremental installed capacity is 37.5 MW. Due to the compact design, powerhouse floor space and height is minimized.

Alternative 3

This alternative involves construction of a new plant south of and adjacent to the Corps plant. The existing Corps plant, and the Edison Sault plant would be abandoned as base load plants. As stated under Alternative 2, the Edison Sault plant may be used for peaking or bypassing excess flows. Unit 10 and a portion of its spillway would be demolished.

To minimize power revenues that would be lost during construction of the new plant, the existing plant (except Unit 10) would continue to operate until the new plant is in service. A new headrace would be built to augment flows from the existing headrace. Four options were considered for this alternative using vertical propeller, tube, Kaplan, and bulb turbines. All units would have fixed blades and adjustable wicket gates except for the Kaplan units. Each turbine would be directly coupled to a synchronous, 3-phase generator at 60 Hz and 13.8 kV.

Option I is five 10.5 MW vertical propellers with a 21.5 feet runner diameter. Total plant capacity is 52.5 MW.

Option II is ten 5.25 MW tube turbines with runner diameters of approximately 15.3 feet. Total plant capacity is also 52.5 MW. The 5.25 MW units approach the largest sized tube units that could be used at this head.

Option III is the same as Option I except Kaplan units are used. The five 10.5 MW vertical Kaplan units have adjustable blade settings that are coordinated with the wicket gate position for optimum flow control and efficiency. The total plant capacity is 52.5 MW. The turbine runner would be 21.5 feet in diameter. The additional cost of approximately 2.25 million dollars for the wicket gates and adjustable blades is not cost-effective for a site with multiple turbines, constant flow, and small variation in head.

Option IV is identical to the plant now under construction for Great Lakes Power Corporation, Limited in Sault Ste. Marie, Ontario. It includes three 18 MW bulb turbines with a runner diameter of 23.3 feet. Total plant capacity is 54 MW. The bulb units would provide a compact powerhouse construction. Deep setting of turbines provides efficient design and a powerhouse with a low external profile.

Alternative 4

Alternative 4 involves installation of new equipment in the existing Corps plant, extending the plant, if necessary, and discontinued operation of the Edison Sault plant except for proposed peaking operations or spillway augmentation. Unit 10 would be dismantled. The existing four vertical propeller units are as efficient as units of present day design. The spacing of the existing units is very conservative, precluding the option of installing larger vertical units without serious loss in efficiency. Other units of the horizontal type could be installed, such as bulb, tube, or Straflo turbines. Retrofitting the existing plant to accommodate these units would require considerable modification and demolition. This alternative would, therefore, be very similiar to Alternative 3. Only the upstream wall, gates, trash racks, and part of the foundation could be used in a new "horizontal" scheme. Any of the horizontal, axial flow options would require extension of the powerhouse downstream. The bulb units, although compact, would require deeper excavations and new foundations.

The options studied for this alternative are the same as those in Alternative 3. The only dissimilarity is the location of the powerhouse and the corresponding difference in excavation costs. Along with the foregoing considerations, it should be noted that approximately $12,661,000 in revenues would be lost during demolition and construction under this alternative.

GEOTECHNICAL

Introduction

The Geotechnical Section was prepared from a study of information available from investigations for existing or proposed structures in the area. No new information was generated for the study. This section is intended to provide a summary interpretation of the important elements of consideration for use in a reconnaissance level study and to provide a base from which more detailed studies can be initiated. The section addresses general materials' characteristics, or properties, and specific items of consideration. Although this format is redundant, it should help readers find specific topics of interest without reading the entire section.

Plate A-4 is presented to show the surface elevations, top of bedrock and profiles through channels and structures considered for the Corps Plant alternatives. Plate A-5 shows representative boring logs in the area.

Physiography

St. Marys River Valley has a northeast trend from Lake Superior to approximately 3 miles east of St. Marys Rapids. At that point the valley direction changes to a southeast alignment; the river separates into two channels at Sugar Island, and the north channel follows a narrow valley having a dissected escarpment of the Laurentian Upland as a northeast boundary and Sugar Island and other islands as a southwest boundary.

From Lake Superior to Sugar Island, St. Marys River Valley is bounded on the north by the escarpment of a dissected penaplane, the Gros Cap Batholith, with elevations of 400-600 feet above the valley floor. The south boundary is defined by morainal highlands and terraces of glacial lake sediments. The most prominent relief feature is Mission Hill which is a moraine 440 feet above and less than a 1-mile distance from the head of St. Marys River. Valley width ranges between 3 miles near St. Marys Rapids and 9 miles at Waiska Bay near the river head. Except at the rapids, the St. Marys River occupies most of the valley and has a maximum width of five miles at Point Iroquois Shoals-Waiska Bay. The river has a general appearance of several interconnected bays.

The existing Corps Plant is located at the south margin of St. Marys Rapids which are about one-quarter mile wide and three-quarters of a mile long. The fall of water ranges from 18 to 24 feet with the varying stages of water. Prior to construction of a dam and compensating works, the rapids provided a natural dam for controlling the water level of Lake Superior. Presently, the St. Marys River area is rising in elevation at a rate somewhat less than 0.75 feet per century as indicated by precise surveys dating from 1877. Presumably the land was depressed as the continental ice sheets advanced into the region, and when the ice disappeared the land tended to rise back to its previous altitude.

General Geology

Few areas in the United States have received the intensive, detailed geologic investigations that the Lake Superior region received during the past 80 years by geologists seeking iron and copper ores. The sandstone at St. Marys Rapids, however, is not a mineralized formation and, therefore, received only a brief description in passing. Most of the early publications describing the "Lake Superior Sandstone" were concerned with the question of rock age and stratigraphic position. Specifically, was the rock more closely related to the copper-bearing rocks of Keweenawan age or the Paleozoic rocks of the Michigan Basin? The age could not be determined with fossils because fossils have not been found. However, Jacobsville sediments rest unconformably upon Middle Keweenawan basalt and are overlain by upper Cambrian sandstone. Thus, due to stratigraphic position, Jacobsville sandstone is considered lower or middle Cambrian. For this report, the rock name Jacobsville sandstone will be used because it has been in common usage for more than 60 years.

The Jacobsville Formation has been divided into 4 principal rock-stratigraphic units or facies which are identified by grain size and bedding pattern and named the conglomerate, lenticular, massive and red siltstone by Hamblin (1958). They interfinger or grade laterally from one type to another due to changes in depositional environment. Rock previously exposed in excavations and recovered by borings in the study area closely resembles outcrops of the red siltstone facies at Agate Falls, Ontonagon County, and the lenticular sandstone facies in the Munising Area.

The regional dip of the sandstone is reported in the literature to be about 40 feet per mile to the south toward the center of the Michigan Basin, a bowl-shaped bedrock depression centered in the State of Michigan. Reports of detailed investigations in the project area, however, state the local dip to be to the west at about 3 feet per 100 feet.

The scope of this study does not allow more than a cursory evaluation of earthquake hazard for the project area. Seismic risk maps show the project to be in zone one, or an area in which only minor earthquake damage may be expected. Detailed seismic risk analyses are normally conducted for only extremely sensitive structures such as nuclear power plants in zone one.

Site Geology and Soils

Overburden

As a result of extensive construction for the existing locks and power plant structures, the overburden in the area north of the Sabin Lock to the southern edge of St. Marys Rapids is mostly fill material consisting of clay, sand, gravel and very large sandstone boulders. Also in the fill material are timbers, steel, fragments of limestone masonry and concrete used for earlier construction. The natural overburden material, found mostly along the Sabin Lock wall, consists of sand, gravel and igneous boulders.

The overburden material in the area of the Edison Sault Power Canal, south of the lock structures, varies with the change in elevation of the top of bedrock. At the head gates near the upstream end of the canal, where the top of bedrock is highest, the overburden consists of sand and sandstone spoil from the construction of the canal. As the top of bedrock decreases in elevation going downstream, the overburden thickens to include soft sediments. At the lower end of the canal, where the top of bedrock is more than 50 feet lower, the overburden consists of loose silty sand and substantial amounts of soft clay.

Bedrock

Bedrock in the project area is the Jacobsville Formation. A composite description of that portion of the formation relavent to this study is summarized in the following paragraphs from investigations and reports for existing or proposed structures in the immediate vicinity.

The dominant rock type is a thin-bedded, fine-grained quartzose sandstone. The sandstone ranges from clean to variably silty and shaly with the fines both disseminated throughout the mass and concentrated in thin seams of shale, sandy shale or shaly sandstone. The sandstone is cemented with silica, sericite illite and iron oxide and ranges from moderately hard to very hard. Shale seams range from soft to hard.

Clay-filled bedding planes are common features on boring logs. The criteria used to differentiate them from very thin shale seams are not clear; therefore, the extent of secondary filling of open bedding planes is not well established. These features should, however, be most prevalent near the bedrock surface and diminish with depth.

The formation is predominantly red in color with minor variations from white to mottled pink and purple; scattered white and gray reduction spots are abundant.

The bedding is irregular and characterized by ripple marks, cross bedding and fluvial troughs. Latteral and vertical changes in lithology complicate correlation of boring logs. Although individual beds can be correlated in excavations and between closely spaced borings, projection of beds for design purposes is not advisable.

The rate at which the rock weathers when exposed depends on its texture. Clean, hard sandstone is very resistant to weathering but shale seams weather, or disintigrate, rapidly on exposure. Other rock types weather at rates between these two extremes, generally dependent on hardness and shale content.

Structurally, the formation is uncomplicated. The variations in sedimentary composition and bedding, however, make the determination of local strike and dip difficult. The formation has an overall dip to the west of about 3 feet in 100 feet but local variations are recognized in existing reports and should be anticipated in any new work. Jointing is reported to be present as bedding-plane and high-angle joints. The Foundation Report for the New Poe Lock identifies a system of nearly vertical joints with strikes of N70E and N30E. Also, shear joints, or those along which movement has occurred, were recognized. The high angle joints extend for considerable distances along their strikes but have vertical magnitudes generally less than 12 feet. Joints are reportedly easy to recognize due to white or gray reduction bands next to the joint planes. The frequency of fracturing and jointing is greatest near the bedrock surface and diminishes with depth. The term bedding plane joint is used in some reports to describe partings in the rock along planes of deposition. Some of the features are reported to be filled with clay that was deposited in openings formed by post-glacial rebound.

A review of boring logs for other investigations shows that the bedrock was cored best with double tube core barrels using bottom-discharge diamond bits. Core recovery was close to 100%; however, drilling rates were slow. Recorded times generally exceeded 1 hour for a 5 foot core run with 4- or 6-inch core barrels. Drilling times in excess of 2 hours per 5-foot run were common. Drilling water losses were recorded in some borings but were not significant items and were frequently attributed to a poor casing seal at the bedrock-overburden contact.

Ground Water

No comprehensive ground-water analysis is warranted for this study. The assumption that ground water will be encountered in the project area at the same level as the nearby river is adequate. Also, no indication of artesian conditions nor more than normal ground water problems are indicated by the available references or experience in the vicinity.

Construction Materials

No comprehensive investigation for construction materials was made for this study. Available data indicate reliable coarse concrete aggregate and material for stone protection can be shipped in by boat from quarrys located at Drummond Island and Rogers City, Michigan. Fine concrete aggregate is available in gravel pits within a radius of 5 miles from the project.

Geotechnical Considerations - Alternative 1

Engineering Properties

Overburden material identified from available borings in the area of the Edison Sault Power Canal varies with the change in elevation of the top of bedrock. At the head gates near the upstream end of the canal where the top of bedrock is highest, the overburden consists of sand and sandstone spoil from the construction of the canal. As the top of bedrock decreases in elevation going downstream, the overburden thickens to include soft sediments. At the lower end of the canal where the top of bedrock is more than 50 feet lower, the overburden consists of loose silty sand and substantial amounts of soft clay. While no tests have been made on the overburden material, consideration of design and resulting remedial work done at the power plant indicates the types of foundation problems that might be encountered. The original power plant, completed in 1902-1903, was built on timber piles because of the thick layer of soft clay above the bedrock. When water was released into the canal the center of the building deflected several inches toward the St. Marys River. The operating head had to be reduced to fourteen feet to prevent further damage. In 1903, water seeped through the forebay and eroded a cavern 100 feet wide, 120 feet long and 10 feet deep under the power plant foundation. For the next 12 years, various repair plans failed to stop leakage from the forebay. In 1916 and 1917 forty 5½-foot-diameter cast iron buttresses filled with concrete were placed to bedrock at the downstream side of the building. Ten years later a steel sheetpile cutoff was driven to bedrock across the entire upstream side of the power plant. Since that time, no shut down of the plant has been required because of foundation related problems.

These problems show that the overburden is very weak and susceptible to stability, settlement and erosion problems if not treated properly. Any plan for updating the machinery inside the powerhouse would have to include a thorough analysis of the condition of the foundation, a complete structural stability analysis, and an evaluation of whether the present structure would last for the life of the new plant. A detailed boring and testing program would have to be conducted to obtain parameters needed for a complete analysis.

Also included in any plan to upgrade the power plant would be an investigation of the existing Power Canal. Over half of the 2¼-mile-long canal is wood lined and fully contained within the surrounding soft overburden materials. Although visual inspection seems to indicate that, overall, the wood-lined portion of the canal is in good condition, rock has been dumped in some areas where holes in the wood-lining have been detected. Also, annual maintenance to keep the canal operational includes repair of slope failures, continual replacement of top board on the wood-lined portion of the canal, and replacement of concrete and grouted sandstone walls that have been under-cut. Since the canal has not been dewatered in over fifty years, dewatering and a thorough inspection of the canal will be necessary to determine remedial work required for this alternative. If it is determined upon dewatering that the existing wood-lined canal would not be adequate for the life of the project, it would be extremely costly to rebuild the canal with a suitable lining to withstand velocities approaching 8 feet per second.

Bedrock was not encountered in borings near the power plant that extended 50 to 60 feet below the ground surface. However, it is assumed that the bedrock is of the same type and quality as discussed for alternatives 2, 3 and 4.

Excavation

Modification of the Edison Sault Plant or Power Canal would require no significant excavation unless a new head gate is required near the upstream end of the canal. Installation of a new head gate would require a limited amount of rock excavation to found the structure.

Seepage and Erosion Control

Seepage and erosion control must be evaluated for temporary conditions existing during construction and for the permanent conditions existing after construction.

For Alternative 1, seepage and erosion control are considered important only in the headrace and tailrace areas. Some stability problems that may be partly due to seepage along the headrace have been reported and repaired as part of a normal maintenance program. Problems of this type would, of course, be aggravated if the water level in the canal were to be lowered at a rate that does not allow sufficient time for the surrounding soils to drain. Erosion control in reaches where the canal is in overburden was accomplished by installing a wood liner. This measure has apparently been effective and has required a low frequency of maintenance. Any program involving rehabilitation of the generating plant for long-term use should include remedial measures required to assure proper functioning of the canal for the life of the plant. Also, maintenance and future use of the canal are vital considerations in any plan to abandon the plant.

Cofferdams and Dewatering

Rehabilitation work at the Edison Sault Plant would require cofferdams for canal inspection and for the installation of new machinery. For the canal inspection, it may be necessary to build a series of cofferdams so that separate reaches of the canal could be dewatered independently. This approach would be highly dependent on the amount of canal repair needed and the required time to map the areas in need of repair. The important factor in providing separate reaches of dewatering in the canal would be to preclude damage to the existing wood channel lining by minimizing the exposure time of the wood planking to the air. In all cases, dewatering would have to be at such a rate that would allow slow drainage of the overburden. The inspection of the canal could shut down the operation of the power plant for an extended period of time.

To place new machinery in the power plant, an effort would be made to keep most of the plant operational by cofferdaming only two turbines at a time. The need to remove the wooden planking in the forebay to obtain a cofferdam seal would have to be investigated in Stage 2 planning.

Geotechnical Considerations - Alternatives 2, 3 & 4

Engineering Properties

Overburden in the area of the Corps Plant is mostly coarse fill with a high percentage of sandstone boulders and is expected to be very permeable. While no soil tests have been made on the overburden, it is not recommended that the overburden be used as fill in cofferdam construction or as a founding material for any structure.

Bedrock of the Jacobsville Formation was tested to determine strength parameters for previous investigations. As would be expected, a wide range of parameters were obtained because of the variations in types of rock represented. The parameters determined are listed in Table A-2 by rock type and source of information. The only major problem element in the Jacobsville Formation is the shale seams which provide planes with low resistance to shearing and weathering. In selecting parameters for use, one should consider that the shale seams are present and continuous in any foundation or excavation. Borings in the vicinity of the new power plant location show, that in the range of bottom elevations for the different alternatives, there are several small shale seams present. However, most of the sandstone in this range is good quality and stability should not be a problem as long as care is taken so that structures are not founded directly on a shale seam or shaly sandstone. Borings will be required at the power plant site to determine actual foundation conditions, especially the locations of shale seams.

Bearing capacity of unweathered Jacobsville sandstone is judged as adequate for any proposed structure. The rock is reported in reference No. 2 to have a bearing capacity of over 100 MN/m^2 (10 tsf).

Weathering of shaly phases of the formation may present problems in foundations that are open for extended periods of time or subjected to severe freeze-thaw conditions. Rapid deterioration occurs at shale seams

TABLE A-2

BEDROCK STRENGTH PARAMETERS

Type of Test	Material Type	Sample	Reference Number	Strength Parameters Cohesion (psi)	Strength Parameters ϕ (degrees)	Young's Modulus (psi)
Direct Shear	Clay Seams in Sandstone	1.	a.	5	37	
		2.	b.	5	31	
		3.	c.	0	30	
		4.	d.	0	17	
	Shaly Bedding Planes	1.	a.	57	63	
		2.	b.	5	62	
	Argillaceous Sandstone	1.	a.	317	62	
	Sandstone	1.	b.	57	63	
Triaxial Compression	Argillaceous Sandstone	1.	a.	1200	40	
		2.	b.	1250	48.5	
	Sandstone	1.	b.	2000	40	
		2.	b.	3250	53	
	Hard Sandstone	1.	a.	1500	50	
Unconfined Compression	Argillaceous Sandstone	1.	a.			1.2×10^6
		2.	b.			1.0×10^6
	Sandstone	1.	b.			2.8×10^6
		2.	b.			1.1×10^6

a. Results of Laboratory Rock Core Tests - New Sabin Lock Project - March 1975 - Corps of Engineers, Ohio River - Division Laboratories

b. Results of Laboratory Rock Core Tests - Sault Ste. Marie - April 1976 - Corps of Engineers, Ohio River Division Laboratories

c. Design Transmittal - Powerhouse Foundations - St. Mary's Redevelopment Project - February 1979 - Acres Consulting Services Limited, Niagra Falls, Canada

d. Used by Corps of Engineers in Design of New Poe Lock As stated in the Foundation Report for New Poe Lock - Detroit District and shaly sandstone beds. Foundation protection should, therefore, be considered in future detailed studies.

Water is conducted through the rock by secondary intersticies such as joints, fractures or open bedding planes. Reference No. 2 suggests a permeability range of 5×10^{-4} to 1×10^{-3} cm/sec for the sandstone. Experience from previous and current construction activities, however, suggests lower values are more appropriate. No major short- or long-term seepage problems due to high rock permeabilities are anticipated. This evaluation must, of course, be verified by comprehensive investigation during more definitive design studies.

Excavation Considerations

Extensive channel and structural excavation would be required for any Corps Plant alternative. See Plate A-4 for probable channel and structure excavation sites. Upstream of Unit 10, headrace excavation to elevations between 574.5 and 579.5 (USLS) would be primarily in bedrock of the Jacobsville Formation. The upper few feet of the bedrock may be rippable if the excavation is conducted in the dry; however, blasting would be required for most of the excavation. Excavation without dewatering would require all rock to be blasted and would be much more difficult than performing the same work in an unwatered condition. The cost of excavation without unwatering is estimated to be much greater than that for excavation in the dry, not including cofferdams and unwatering equipment. In either case, excavation near bridge piers and existing walls must be controlled to avoid damage to existing structures and all blasting must be supervised and monitored.

Channel excavation for the headrace downstream from Unit 10 would be primarily in overburden which contains a high percentage of igneous and sandstone boulders. Extraneous debris such as steel and concrete should also be expected. This lower headrace channel would be excavated in the dry if Unit 10 is left in place until excavation is completed. Overburden excavation should be anticipated to require an effort greater than that normally specified for common excavation.

Seepage and Erosion Control

Seepage and erosion control must be evaluated for temporary conditions existing during construction and for the permanent conditions existing after construction.

For the Corps Plant alternatives, seepage through the coarse overburden must be considered a problem in any excavation below the present water table. Seepage from this material during headrace channel excavation might possibly be tolerated, but positive cutoffs, such as sheetpile cells or impervious earthen embankments, must be planned for structural excavations. Permanent seepage control must be constructed in areas where high gradients would exist and allow undesirable hydrostatic pressures to be transmitted to structures. A new power plant next to the existing one would create a headwater pool against the Sabin Lock wall, requiring a concrete paved slope and perforated drain to be placed along the headrace to keep hydrostatic levels against the wall at tailwater elevation. A permanent cutoff from the proposed concrete paving along the headrace to the upstream end of the lock chamber wall would also be necessary to prevent upper pool water levels from entering behind the wall.

Based on information from boring logs, the Foundation Report for the New Poe Lock and current experience at the Canadian Power Plant site, temporary seepage in excavations through the bedrock is expected to be tolerable and present no major problem. As with the overburden, the only areas where long-term seepage control may be necessary are where high head differentials exist with short seepage paths. Treatment in such areas could be by grouting, removal and replacement with concrete or a system of drains.

Erosion control during construction will be limited to riprap or anchored reinforced poly protection of earth cofferdams subject to erosion by currents or waves. Permanent erosion control will be limited to the same general areas that are protected under the existing conditions and any new areas where overburden materials are subjected to currents and wave action. Hydraulic efficiency requires that concrete paving be placed on both sides of the headrace from the new powerhouse to Unit 10. The right bank of the tailrace would have to have stone protection adequate to withstand discharge velocities from the new power plant.

Cofferdams and Dewatering

The overburden in the area of any new power plant construction north of the Sabin Lock is mostly fill material comprised of sand, gravel and boulders from prior excavations and is expected to be very permeable. A cutoff through this material to the top of bedrock will be required to dewater any excavation in this area. Since the overburden is comprised of many large boulders, it would first have to be removed and backfilled with suitable material before driving sheetpile or installing a slurry trench. The most extreme type of cofferdam needed would be steel sheetpile cells driven through the backfill or constructed in templates and placed on bedrock around the entire excavation. A more likely cofferdam plan, however, would be to use a combination of cells in open water, the existing powerhouse to the north, and a sheetpile cutoff or slurry trench in the overburden adjacent to the Sabin Lock wall.

Available reports, boring logs and site inspection of the excavation for the new Canadian Power Plant indicate that short term seepage through the bedrock during construction should be tolerable and easily controlled.

Headrace excavation for the new power plant could either be done in the wet or in the dry. Excavation in the dry would necessitate the construction of 3000 feet of cofferdam in 6-7 feet of water. However, rock excavation in the wet is much more expensive than in the dry and is technically more difficult. Environmental concerns, such as fish kill and turbidity caused by blasting, must be considered if excavation is conducted in open water. These difficulties make the alternative of excavating in the dry much more desirable than excavating in the wet, despite the cofferdam and unwatering costs. A plan for excavation in the dry was used for estimating costs.

The most economical cofferdam would be an earth-dike fill placed on bedrock and extending from Unit 10, past the International Railroad Bridge and back to the Northwest Pier. This would include the excavation of some overburden material to bedrock in the area upstream of Unit 10. For an earth fill, some type of bank protection would be necessary on the riverward side of the cofferdam to prevent erosion. Due to the slow velocities in the existing headrace channel (2.5 feet per second), reinforced poly anchored at the top and toe of the embankment, could be used. In reaches where wave action is high, riprap and bedding would be necessary. Both bank protection options for the earth dike should be studied and compared to the cost of a sheetpile cofferdam.

The guidewall on the south side of the Northwest Pier was placed on timber cribbing, making seepage a potential problem where the Northwest Pier narrows to less than 100 feet just upstream of Unit 10. Headwater pool on the guidewall is at about elevation 602 (USLS Datum; Subtract 1.6 feet to obtain IGLD Datum) while the top of bedrock is at elevation 590± (USLS), putting 12 feet of head at the base of the pervious overburden. The sluice gates in this area could also cause leakage if not properly sealed. Dewatering problems will have to be addressed in Stage 2 planning.

Impacts on Existing Structures

If a new powerhouse is built south of the existing Corps Plant, the water level on the north side of the Sabin Lock wall would be raised approximately 20 feet (assuming that the new plant would be located at the site of the main plant). This would put a 20-foot head on the north side when the lock is at tailwater level. The wall was not designed to have a higher water level on the north side than on the lock side. Therefore, a drainage system will be included along the concrete paving and paralleling the lock wall to keep the water near tailwater level.

When excavating a new headrace upstream of Unit 10, care must be taken near the piers of the International Highway and Railroad Bridges. The highway bridge was designed and built so that the piers would be founded below any future headrace excavation in the area. However, care must still be taken when blasting near the piers. The railroad bridge was built before any headrace construction in the area so it is likely that the bottom elevation of the headrace would be below the base of the piers. When the initial headrace was built, the channel was centered between two piers of the Railroad Bridge to avoid excavation problems. The Canadians are now planning to rehabilitate the bridge by placing new piers between existing ones. This work should be coordinated with headrace excavation to minimize problems. It would be better if the headrace is excavated before the new piers are constructed.

By selecting any one of alternatives 2, 3 or 4, the energy output of the Edison Sault Power Plant would be discontinued and the flow in the canal would be either kept to a minimum or stopped altogether. If minimal flow was continued, it would have to be regulated at the downstream end of the canal so that the present water levels could be kept the same to avoid deterioration of the wood-lined portion of the canal. Stoppage of flow would require that the canal be backfilled. Therefore, by discontinuing operation of the Edison Sault Power Plant, substantial costs would be incurred to the project for maintaining or closing the canal.

Under alternatives 2, 3 and 4, Unit 10 would be demolished. For alternatives 2 or 3, it would be removed to allow a new headrace. For alternative 4, Unit 10 would be removed and replaced with an earthen levee or concrete wall.

Disposal of Excavated Materials

Excavated material would be disposed of on the Northwest Pier.

Recommended Geotechnical Investigations

The evaluations presented in this study were derived from a review of existing data developed for other purposes in the general area. Site specific information must be obtained for more detailed evaluations, especially for items with high cost sensitivity such as rock excavation and cofferdams.

Alternative 1

A detailed boring and testing program will be required at the Edison Sault Plant and along the canal to define foundation conditions for stability, seepage and settlement evaluation.

Sources of material for cofferdam construction must be located, and the adequacy of potential sources of concrete aggregate verified during feasibility studies. Sufficient surveys would also be required to obtain updated topography drawings of the area to allow reliable estimates of excavation quantities and layout of project features. Additional investigations would, of course, be required for studies beyond the planning level to refine and maintain geotechnical evaluation commensurate with the level of study.

Alternatives 2 and 3

Since a considerable quantity of rock excavation will be required for the headrace in these alternatives, a more detailed understanding of the excavation characteristics of the rock must be developed during Stage 2 planning. This would require a minimum of four borings. A more definite understanding of overburden characteristics and the quality of the bedrock at the proposed new power plant sites would also be needed and would require at least two borings. Required testing would be dependent on material, especially weak shale seams, encountered in borings. Material sources and survey requirements would be the same as described in alternative 1.

Alternative 4

This alternative would involve borings in the headrace channel if it had to be enlarged to carry a larger amount of water. Material sources and survey requirements would be the same as described in alternative 1.

ELECTRICAL

Facility Integrity - Corps Plant

Generators

Generator Units 1, 2, and 3 in the Corps Plant are synchronous type-rated 5333 kVA, 4800 kW, 13.8 kV, 3-phase 60 cycle, 80 RPM. These generator units were put in operation in 1952. Generator Unit 3A in the Corps Plant is a synchronous type-rated 2500 kVA, 2000 kW, 4.16 kW, 4.16 kV 3-phase, 60-cycle, 128.6 RPM. Generator Unit 3A was put in operation in 1954. Generator Unit 10 is located in the old powerhouse upstream from the Corps Plant. It is a synchronous type-rated 2500 kVA, 2000 kW, 4 kV 3-phase 60-cycle 128.5 RPM. Generator Unit 10 has been in operation since 1932. The Corps Plant units and Unit 10 are vertical shaft-type generators.

The generators in the Corps Plant are in excellent condition and have most of the features of the present design generators. These generators have temperature detectors for the stator and bearings, cooling water low-flow detectors, bearing oil level detectors and speed detectors. Frequency and load control is provided through a hydraulic governor with permanent magnet generator as speed sensor and load controller. This equipment is a modern type and is similar to and would be compatible with equipment planned for Alternatives 2, 3, and 4. Insulation resistance tests of the field and armature windings are made during each maintenance period. Site personnel indicated that the insulation-resistance values have been within the acceptable level for each generator.

The Unit 10 generator is an older type design than those in the Corps Plant. It has open commutators and exposed brushes. It lacks many of the modern sensing features required for monitoring temperatures and lubricating oils. The governor has been modified from a belt-driven type to a generator-powered induction motor which drives the flyball mechanism. In 1958, a new Class B stator winding was installed on Unit 10 to replace a defective Class A winding. Site personnel indicated that the insulation resistance of the windings for Unit 10 has been acceptable since the winding was changed.

Unit 10 is still useful as a generator but will be discontinued for use in Alternates 2, 3, and 4, but will be used in plan Alternate 1 until its useful life is expended. The turbine cannot be used in any alternate plan other than No. 1. The generator can be reinstalled over a new turbine in Alternates 1, 2, and 3 schemes; however, it cannot be justified for reinstallation due to high investment cost per kVA for such a small capacity unit, and for the balance of life remaining in the generator. Unit 10 is close to the 50-year expected life of the unit. The governor is obsolete in design and would require replacement.

Electrical Equipment

The major components to be considered in the evaluation of the electrical equipment are generator switchgear, station service switchgear, transformers, controls, battery system, and wiring. This equipment is approximately 30 years old in the Corps Plant. It has been maintained in good working order. Spare parts are available at the site for alternator field rheostat, governors, field coils for alternators, exciters, stators windings, etc.

Table A-3 lists the major maintenance projects for the Corps Plant and the years they were done. Major electrical items on this list are installation of 4th power feeder (Item 8), replacement of station batteries (Item 9), replacement of 2500 kVA transformer (Item 12), and installation of controls for one-man operation (Item 14). All control circuit wire has insulation rated for 1000 volts. Cable for 15 kV operation is a lead-covered type for most locations. These types of cable have a very long service life even under severe moisture and temperature conditions. Power cables of 15 kV rating have shown no deterioration to date. The type of conditions that are extremely unfavorable to the operation of high voltage switchgear are high humidity, and type of contamination or dust, and wide or rapid changes in temperature. The Corps Plant powerhouse is kept very clean and is relatively free from contamination and dust. The switchgear is energized almost 100% of the time which causes normal heating to drive most of the moisture from the insulation. Stationary-type batteries designed for long-term use have a life expectancy from 15 to 25 years depending on their design. The station batteries would have to be replaced at least one more time in a 50-year life.

Obsolescence will require replacement of some electrical items in the future while repairing or maintaining. All switchboards and switchgear are in satisfactory condition and will provide continual service except for minor items requiring repair or replacement. To date, all lighting panel bus and breakers have been replaced due to obsolescence. Lighting fixtures are the next to be replaced with high intensity discharge units to increase lighting level, save energy consumption, and general updating on most floors. Alternates 2, 3, and 4 will incorporate such improvements.

The Unit 10 electrical equipment is approximately 48 years old. It is in good operating condition because of good maintenance, but more maintenance will be required in future years to keep it at its present level. Replacement parts will be difficult to buy because of unavailability of this age equipment, although parts may be rebuilt.

Facility Integrity - Edison Sault Electric

Generators

The Edison Sault Plant has a total of 78 generators installed. They are horizontal shaft-type units. Four of these are direct current (D.C.) generators which supply the exitation for the A.C. generators. Two of the D.C. generators are rated 375 kW, 250 volts, and two are rated at 500 kW, 220 volts. The existing generators were installed in 1916. The D.C. generators are connected to a common bus which runs the full length of the plant. Forty-one A.C. generators were first installed in 1901-1902. In 1915-1916, additional units were installed completing a total of 78 units in operation.

Fifty-five generators were 25-cycle units. The power plant was owned by Carbide Power Company up to 1963; at which time, it was purchased by Edison Sault Electric Company. At this time, the 25-cycle A.C. generators were rewound for 60-cycle operation. The A.C. generators have various ratings, 55 of them have ratings of 650 kVA at 4400 volts 180 RPM, 19 have ratings 600 kVA at 4000 volts 180 RPM. The actual combined rating of the 60 cycle units is approximately 41,300 kW. The speed is controlled by a belt-driven hydraulic governor which varies the turbine's wicket-gate opening. Governors are of obsolete design which provide starting, stopping, and gate setting capability only. The generator bearings have temperature indicators for high temperature alarms and sensors for low-governor oil level. These sensors were installed sometime after the original installation. It appears that no winding temperature indicators are installed. The generators appear to be in good condition and could be in service for many years with routine maintenance. They lack many of the sensing and control features of modern design generators. This might require more operators than a modern plant of the same capacity.

Electrical Equipment

Most of the plants electrical system is the original installation except for the plant substation equipment (transformers and switchgear) for the outgoing transmission lines. The outgoing transmission equipment was installed after the Edison Sault Electric Company purchased the plant in 1963. The wiring and breakers for the generating system are part of the original installation. Most of higher voltage cables are lead-covered, oil-impregnated paper insulated. The electrical system is well maintained and, for its age, is giving good service at the present time. But the age would indicate that higher maintenance costs will be incurred in future years. Much of the equipment is obsolete. Expected life of such equipment would be judged to be at least 20 years with routine maintenance.

Alternative 1 - Rebuild Edison Sault Plant, Continue Corps Plant

When installing new turbines in the Edison Sault Plant, new electrical equipment should be installed under both options considered. The age of the electric system would preclude the reuse of the existing system. It would not last for the design life of the turbines, reference Existing Conditions, Electric Equipment in this appendix. New equipment would include a complete new buswork, switchgear, control board, relay board, new conduits and conductors, station service, station battery, D.C. switchboard, etc. Existing power cables, switchgear, high voltage transformers, metering equipment in the substation would be retained since the equipment is relatively (1963-

1964) new and has much of its original life retained.

Consideration should be given to reusing the existing generators. One proposal is to drive two existing generators from one new turbine. A more detailed study in Stage 2 would address the advantages and disadvantages of reusing the existing generators, and it would address the economical factors to be considered. There is enough floor space to accommodate the placement of two generators driven by one new turbine. Most of the generators are in good condition. See Existing Conditions, Edison Sault Plant Generators, in this report. If this alternative is studied in Stage 2, the condition of the D.C. generators used for exitation will have to be evaluated to determine if they can be reused in the rehabilitated plant.

New station service power and lighting would be required in the plant, because it would not be adequate for the new equipment that would be installed. High intensity discharge-type lighting should be installed to improve the lighting system.

Alternative 2 - Extend Corps Plant - Discontinue Edison Sault Plant

Three options are being considered under this alternative. They are 3 - 12.5 MW vertical propeller turbines, 8 - 5 MW tube turbines and 3 - 12.5 MW bulb turbines. The following discussions for this alternative is based primarily on 3 - 12.5 MW vertical propeller turbines, but most of the consideration would also apply to the two other options. Almost all of the electrical equipment in the existing plant would be used as it now exists. The existing 13.8 kV bus could be tied to the new 13.8 kV bus. New additional feeders would be run to the Edison Sault Substation. The existing feeder cables are tested each year and show no deterioration to date and would be used as is except for possible rerouting and splicing. They would be tested along with new cables if they are spliced or rerouted. A new Electrical Service tunnel would extend from the powerhouse to Electrical Manhole No. 5 (See Plate No. A3).

The station service for the new portion of the plant should provide power for motor loads from the new 13.8 kV ring bus and to the new and existing 480 volt bus, as well as from the existing 13.8 kV and 4.1 kV buses. The present control room size may be adequate for a 3-unit 12.5 MW addition but would be inadequate for a 8-unit 5 MW addition. Also, additional controls would be required if the Edison Sault Plant, for the extent of its useful life, is under remote or supervisory operation from the Corps plant.

Electrical power from the Corps Plant will be delivered in accordance with the present contract at 13.8 kV through multiple cables terminating at switchgear in the Magazine Street Substation of the Edison Sault Electric Company. Ownership of cables will be at the U.S. Government property line on the north side of Portage Avenue near the west end of the MacArthur Lock. The Edison Sault Electric Company will provide the continuation from a new manhole at the Government property line on the north side of Portage Avenue to necessary switchgear at the substation. Arrangements for such work will be by mutual agreement during the planning stages.

Alternative 3 - Build New Corps Plant - Discontinue Edison Sault Plant

The new plant is to be built while the existing plant stays in operation. Therefore, none of the existing electrical equipment could be used in the new plant. Unit 10 would be put out of service when excavation of the new head-race begins. The power feeders would be routed to the Edison Sault Electric Company's substation, as recommended in Alternative 2.

Three options are being considered under this alternative. They are 5 - 10.5 MW vertical propeller turbines, 10 - 5.25 MW tube turbines and 3 - 18 MW bulb turbines. Electrical equipment required would be generator switch-gear, station service switchgear, transformers, control, battery system and wiring. Necessary auxiliary equipment needed would be ventilating system, oil and water system, cables and cable support system, auxiliary switchboards, complete control and relay boards, and power cable to Manhole 5.

Alternative 4 - Install New Equipment in Corps Plant - Discontinue Edison Sault Plant

Electrical equipment required for this alternative would be similar to the equipment discussed in Alternative 3. It would be possible to reuse some of the equipment that now exists, such as motors and pumps. But most existing equipment probably would not match the new turbine generator equipment. If this alternative is chosen for study in Stage 2, an engineering analysis of the existing equipment would then be done to determine what equipment might be reusable. Additional feeder cables to the Edison Sault Electric substation would be required. Generating units considered under this alternative are the same as those for Alternative 3. The electrical equipment, controls, and auxiliary equipment would be the same as required for Alternative 3.

LIST OF MAJOR MAINTENANCE PROJECTS AT ST. MARY'S FALLS CORPS PLANT
1951 - 1980

1. Oct 1951 - Feb 1952 - 3 main units in operation.
2. 1953 - Unit #10 of old hydro remoted. Step-up 2500 kVA transformer installed, 15 kVA cable and new switchgear installed; new benchboard and relaying installed.
3. 1954 - Unit #3A installed and placed in operation.
4. 1957 - Replaced H&V 2&3HP with 2 20HP pumps for improved cooling of powerhouse.
   - Installed cooling coil in Unit #3A turbine floor to improve cooling of generator.
5. 1958 - New stator windings on Unit #10 to replace defective windings.
6. 1961 - Replaced draft tube dewatering pumps from 2 25HP 1000 g.p.m. pumps to 2 75HP 3000 g.p.m. pumps. The 1000 g.p.m. were inadequate in size.
7. 1965 - Installed 150T water chiller to improve powerhouse cooling. This included installation of 1 25HP chilled water circulating pump and piping as well as condenser piping and all controls.
8. 1971 - Installed 4th power feeder to substation which included new ducts on footbridge, new benchboard in control room and relaying.
9. 1971 - Replaced station batteries.
10. 1972 - Sluiceway stabilization of Unit No. 10.
11. 1974 - Reroofed new powerhouse.
12. 1974 - Replaced 2500 kVA dry type power transformer.
13. 1975 - Replaced 150T water chiller unit with one of improved design.
14. 1977 - 80 - Installing components and controls for one-man operation.

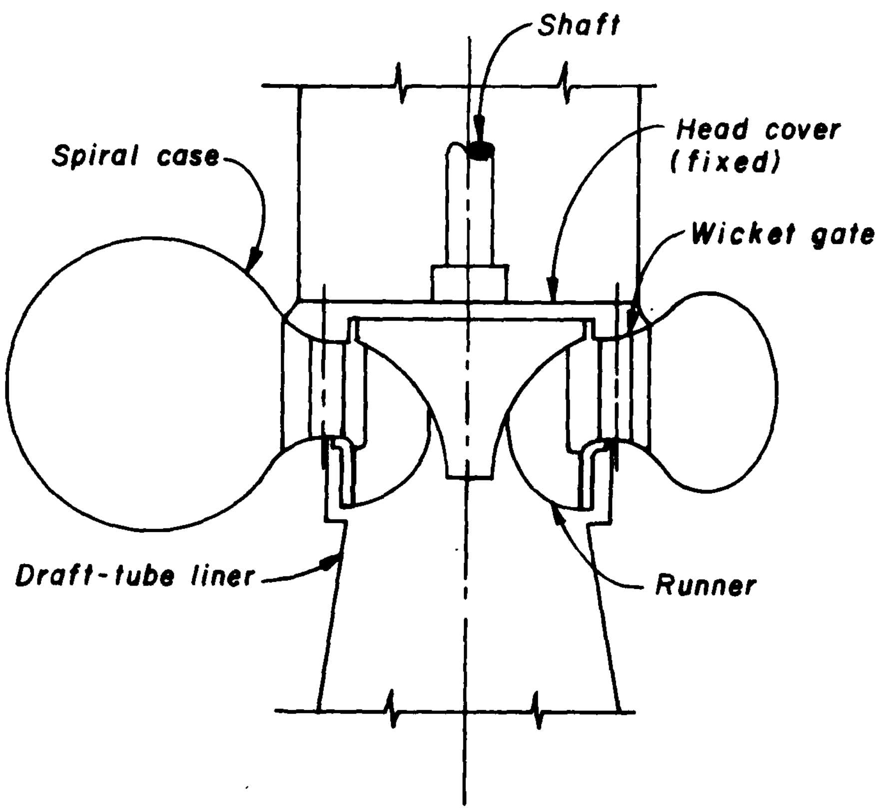
TABLE A-3

MECHANICAL

Reaction Type Turbines

Several reaction type turbine-generator units have been considered in this study. The reaction type is divided into propeller (axial flow) and Francis (mixed flow).

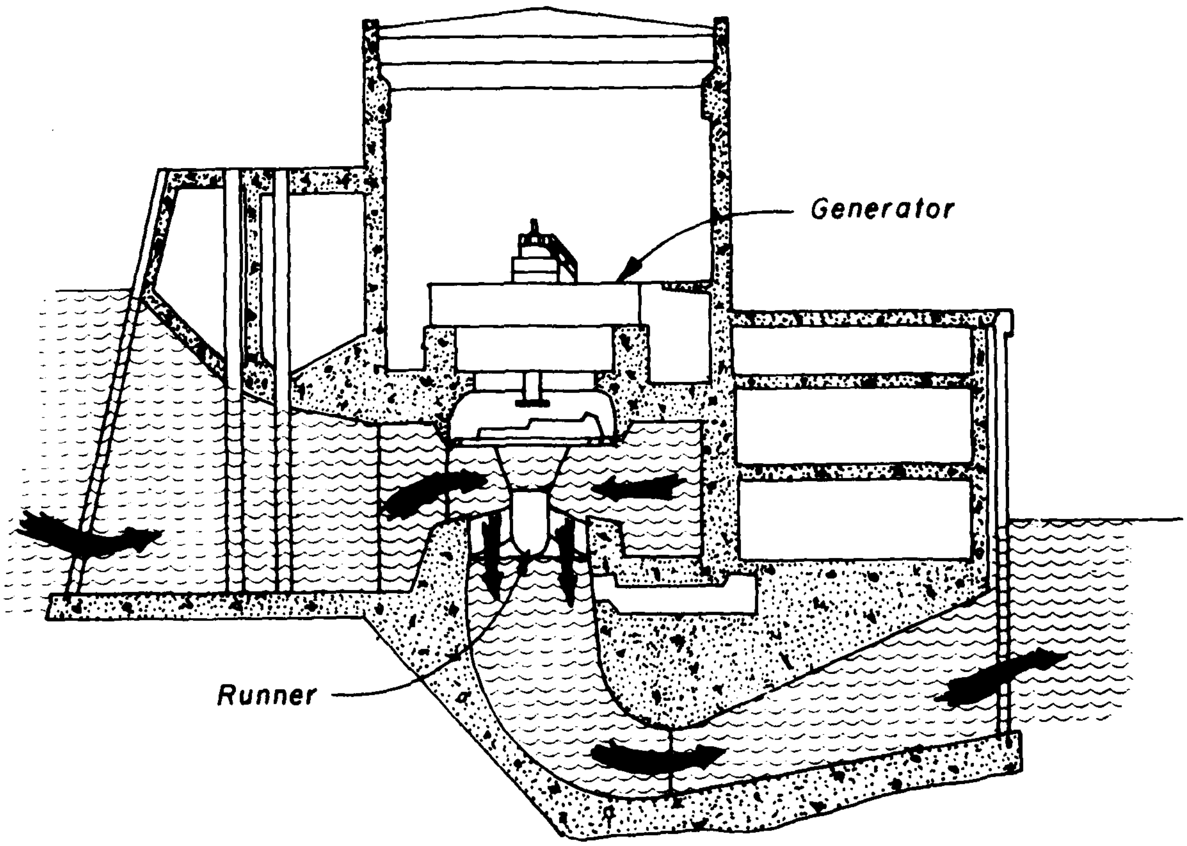
The Francis-type turbine operates at about one-half the speed of a propeller unit for the same given head and unit output. The water passages and runners are, therefore, larger and more expensive. The Francis turbine is intended for high head (200 feet) applications. The spiral case (water supply) and 90° draft tube elbow usually require more excavation and larger structures than comparable axial propeller types.



FRANCIS TURBINE

Figure A-11

The Kaplan turbine is a propeller turbine with adjustable blades. The turbine is usually a vertical unit with a spiral case (water supply) and a 90° draft tube elbow and will also require more excavation and a larger structure than comparable axial propeller types. The Kaplan turbine has a flat efficiency curve over a wider range of flows than the propeller type, however, a Kaplan unit requires more maintenance than a propeller type. The losses through the Kaplan unit are greater than an axial-type turbine unit. The Kaplan is suitable for heads between 10 and 120 feet.



ADJUSTABLE-BLADE KAPLAN TURBINE

Figure A-12

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RECONNAISSANCE REPORT FOR HYDROPOWER REDEVELOPMENT AT SAULT STE--ETC(U)
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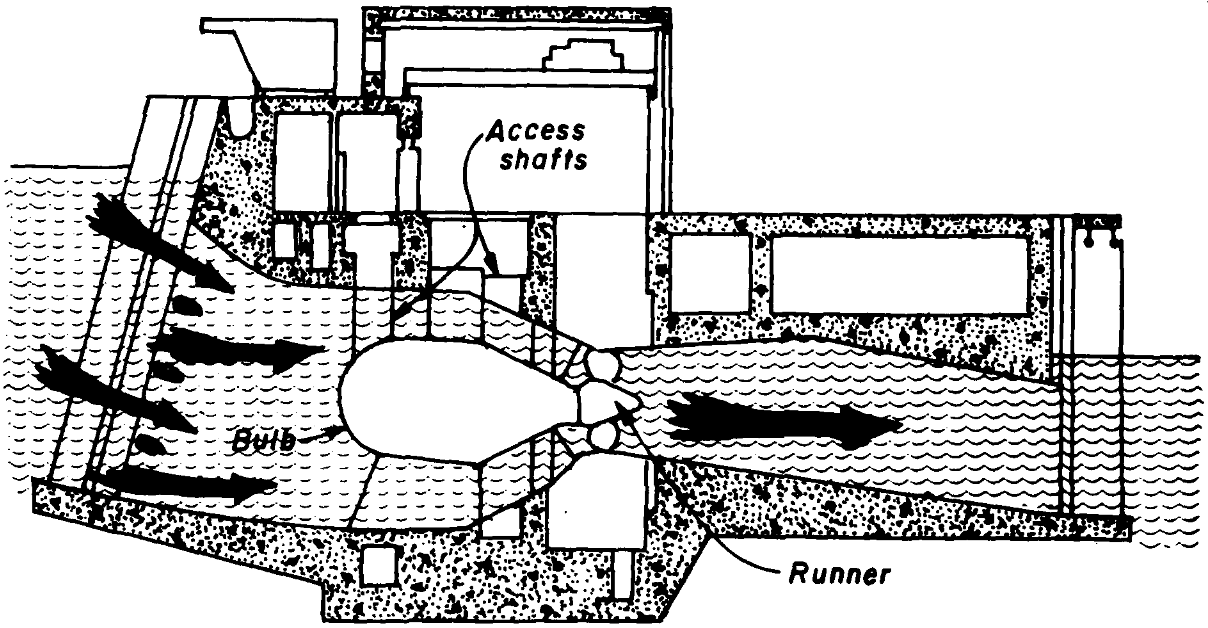
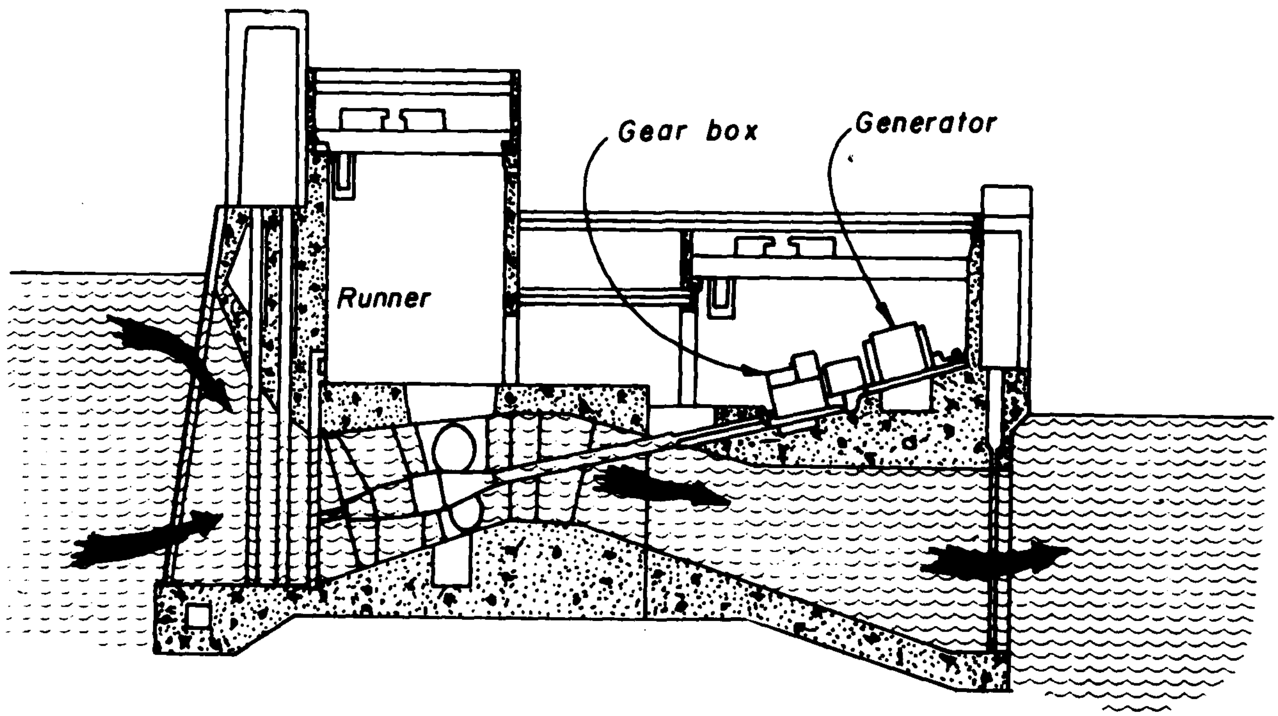
The bulb turbine, an axial propeller type, developed in 1933 has the advantages of lack of outside seals and alignment problems. Disadvantages are difficulty in providing generator cooling and access through the water passage to the generator. As seen in the sketch below, the entire generator-turbine assembly is within the water passage. The maximum economical runner size is 23-25 feet with maximum head in the 50-60-foot range. A minimum limiting practical runner size is 10-13 feet. Specific output, the power developed per unit diameter at a given unit head is higher than a Francis or Kaplan unit.



BULB TURBINE

Figure A-13

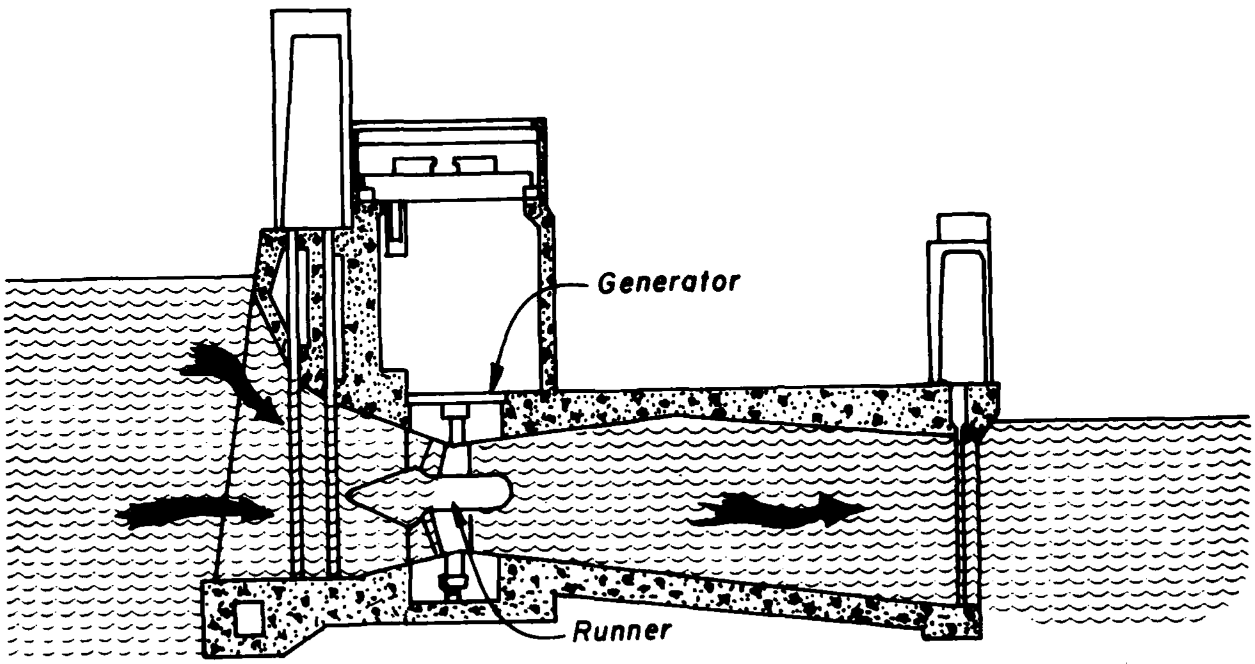
The tube turbine uses a standard generator located outside the water passage. A smaller size generator with higher speed may be used with a gear increaser. The use of the long drive shaft between the turbine and the generator, requires substantial bearing support and a wider powerhouse structure. The long drive shaft would result in alignment problems between the generator and turbine. The tube turbines are especially well suited for replacing old vertical units with new higher capacity units in the same space. This provides increased plant output with only small structural alterations. The tube turbine is most adaptable to standardization which would lower costs and provide shorter delivery by reducing site specific and engineering costs.



TUBE TURBINE

Figure A-14

The rim-generator is one of the earliest developed. It has the advantage of compactness, no drive shaft required, and that a large generator with large rotational inertia could be used. The major disadvantage is lack of successful operation due to problems with connections, seals and bearings between the runner and generator. The units have been limited to under 10 feet runner diameter and 2 MW size.



RIM-GENERATOR TURBINE

Figure A-15

Facility Integrity

The existing generating plants that were investigated are the U.S. power plant and Edison Sault Power Plant. The U.S. Power plant has three (3) 6975 HP, 21-foot head, vertical fixed blade propeller turbines operating at 80 RPM. The auxiliary unit (3A) is a Kaplan unit, 3000 HP, 20-foot head operating at 128.6 RPM, with hydraulic control of the blade angle. The turbines and accessory mechanical equipment are well maintained and should have a 20-30 year remaining life. A remote single turbine-generator unit, identified as Unit 10 is located upstream of the U.S. power plant. The Unit 10 has reached the end of its expected economic and useful life. It would be impossible to retain this unit under most plans studied.

The Edison Sault Power Plant has 78 units in tandem pairs of horizontal double axial turbines. The turbines are set in an open flume arrangment. The turbines are automatically controlled by a wicket gate actuated by a hydraulic governor. The turbines are rated at 600-750 HP at an 18-21 foot head. The turbine runners are in opposed position on each end of the unit with the discharge converging and exiting in the bottom of the flume. The condition of the turbines is fair, however, a significant amount of shaft and bearing maintenance is required. The turbine runners are also in a deteriorated condition and are being rebuilt on a regular basis by the maintenance crew. The normal useful life of these turbines has been expended. The other mechanical equipment appears to be in good condition and could be expected to exceed the remaining life of the turbines.

ALTERNATIVE STUDIES

Alternative 1

The replacement of existing generating equipment in the Edison Sault Power Plant with new turbine-generator units or possibly new turbines with existing generators tied in tandem to one turbine, constitute the first alternative studied. The open flume design would be modified structurally to encase and support the tube-type turbines. An intensive investigation into the structural-foundation conditions associated with this concept would be a necessary future consideration. The condition of all other mechanical equipment should be investigated along with the need for a new intake gantry crane which could service the new tube turbines and intake gates/bulkheads.

Alternative 2

The extension of the existing U.S. power plant is the second alternative studied. The most logical approach and the intention in the original U.S. plant design was the addition of vertical turbines. This does indeed prove to be the lowest first cost in installation. The vertical propeller turbines have a proven operating history. The installation of three 12.5 MW vertical propeller units would provide good utilization of flow; however, one unit should be a Kaplan unit for variation in output with available flow rates. The extension of the U.S. plant could permit maximum utilization of existing generating facilities (Edison Sault and Corps plants) during the construction period.

Alternative 3

The construction of an entirely new U.S. power plant is the third alternative studied. The difference between vertical propeller and tube turbines in installation costs is not significant enough to cause selection of either unit. In Stage 2 planning if this alternative were chosen, a more detailed analysis of tube unit versus vertical turbine should be considered. The major disadvantage with this alternative is the loss of some existing generating capability during periods of construction and the change from cost for an incremental capacity increase basis to cost on total capacity basis may cause an undesirable end cost/installed kW figure.

Alternative 4

The fourth alternative has been considered without substantial merit since it is basically the same as the third alternative. The use of the existing U.S. plant with new equipment installed is not a viable alternative. The majority of the structure would need to be removed for either larger vertical propeller or tube turbine installation. The salvage value of the remaining structure and equipment causes only a modest decrease in cost of alternative four over the new structure under alternative three. The lost existing generating capacity during the construction period would be a significant factor.

CIVIL/STRUCTURAL

Alternative 1

Facility Integrity

A cursory inspection of the Edison Sault Plant was performed on 26 July 1980. The superstructure condition is essentially the same as observed by Stone and Webster in the 1969 inspection report, reference 19:
"The exterior masonry walls of the powerhouse are in remarkably good condition, free of serious cracks or other signs of foundation settlement. Although the sandstone blocks show signs of weathering on the exterior face, the mortar joints are generally in excellent condition and no areas requiring pointing were observed. Several diagonal cracks were noted at the center and west end of the downstream will,but these have no structural significance at present."

In a Stone and Webster survey of the Powerhouse in 1962, reference 20, the following is a discussion of the foundation condition:
"Since the piles and the mat timbers are continuously submerged, there is no danger of deterioration of the wood. In 1916, sloping cast iron caissons were placed at alternate piers between the individual tailraces. Later, in 1926, a washout occurred along the west central side of the foundation mat. Before it had developed to serious proportions, the plant was shut down, the forebay and canal dewatered, and steel sheet piling driven adjacent to the upstream edge of the mat. This forms a continuous barrier along the mat and the east and west sides of the forebay".

"Review of drawings showing the alterations and the repair of the foundations in 1916 and 1926 indicated that the measures taken were sufficient to correct the deficiencies which had developed at those times. Careful visual examination of the tailrace face of the building and the buttressed platform showed no evidence of recent settlement cracks, thus, indicating that the foundations are in a stable condition. Three diagonal cracks were observed at the center and west end of the wall. These appeared to have been caused by settlement and probably occurred prior to the 1916 and 1926 repairs. Inspection of the interior face of the wall showed that the cracking was not of a serious nature and no longer of structural importance. Considering the length, age and foundations of the building, the exterior masonry wall was suprisingly free of cracks and other signs of settlement or deterioration due to age."

The condition of the timber pile foundation is unknown. The movement prior to 1916 could have sheared off some of the piling or could have caused deformation of the piling. The cursory inspection was not sufficiently detailed to determine the foundation's condition. Presently, the head gate structure does not require extensive modification to continue operation. Normal maintenance, painting and repair would be required to continue operation of the head gate structure.

Required Work

Alternative No. 1 consists of replacing 35 of the existing turbines and generators with tube turbines and generators. See Plate A-2. The replacement units would be in the middle half of the plant for improved hydraulic flow characteristics. Also, the walls of the canal would need to be rehabilitated to replace deteriorated timbers or repair rotating walls. It is anticipated that a floating cofferdam would be built which would close off two turbines at a time. This would be used to dewater the intake area for installation of the tube turbines. There would be sufficient working room between the floating cofferdam and the future headwall to facilitate forming and concrete placement. Additional concrete would be needed to stiffen the floor slab and draft tube and to dampen the induced vibrations. Each turbine would be supplied with a remotely-controlled wheel gate.

Future Considerations

Future considerations for this alternative are as follow:

a. A detailed condition inspection is needed for the head gate structure and the power canal. This inspection is necessary to determine future maintenance costs. Present routine maintenance procedure for the power canal has consisted of dumping rock in areas where the timber planking has come loose.

b. A detailed foundation condition investigation for the powerhouse is essential to determine the overall feasability of installing new turbines and generators in the existing building.

c. Due to the age of the building, a detailed investigation of the entire building and its ancillary works should be accomplished. This is necessary due to the extreme age difference between the Edison Sault Plant and the Corps Plant.

d. Due to the unusual existing hydraulic flow conditions at the powerhouse, a model study is recommended to determine the best location for turbine replacement.

e. A study should be undertaken to determine if a single tube turbine and generator (as proposed) or one turbine driving two existing generators is more economical and feasible.

f. Recent topography and borings will be needed for future studies.

Alternative 2

Facility Integrity

The main Hydroelectric Powerhouse is in good condition. Periodic Inspection Report (PIR) dated 1980, No. 2, reference 21, for the Main and Unit 10 Hydroelectric Powerhouse states: "No significant structural deficiencies were observed that would affect the safety of operation of either." Based on visual inspection and the PIR, it is felt that the Corps Plant will be functional for the economic life of the project.

Required Work

This alternative consists of a southerly extension of the existing Corps Plant to provide the desired generating capacity. Plate A-3 shows vertical propeller units with an arrangement very similar to the existing turbines and generators. The headrace channel was sized for a maximum flow velocity of 3.5 feet per second. To reduce the maximum velocity to 2.5 feet per second, the cost for additonal rock excavation would be $3,900,000. In order to convey the design flow into the existing powerhouse and the powerhouse extension, the center dike and crib dam would be removed to a location which is 400' upstream of the powerhouse. A twelve-inch thick concrete pavement would be placed on the side slopes from the present location of Unit 10 to the proposed powerhouse extension. This pavement would improve flow efficiency and also protect the north wall of the Sabin Lock. According to the "Preliminary Design for St. Mary's Falls Power Plant" by Eric Floor and Associates, the North wall of the Sabin Lock was not designed for the headrace water level and, thus, would not be stable.

An earth cofferdam would be built so that the rock excavation in the headrace above Unit 10 can be accomplished in the dry. This would reduce the unit price for rock excavation by about one-half. This earth cofferdam would also be used for removal of Unit 10. A cellular steel sheet pile cofferdam would be used during excavation for the powerhouse foundation and for construction of the powerhouse substructure. A permanent cut-off would be made from the north wall of the Sabin Lock, just downstream from Unit 10, to the concrete paved right bank of the headrace, and along this bank to the plant extension. During a majority of the construction period, power generation would be continued at the main Corps Plant. This will be beneficial since outside replacement power would not have to be purchased.

After extending the Corps Plant, flow thru the Edison Sault Power Canal would be reduced to the amount required to maintain water quality. To provide this flow, provisions would be made at the Edison Sault Plant to limit the discharge. The discharge must be limited at the Edison Sault Plant so that the canal level remains fairly constant at or near upper pool.

Future Considerations

Future considerations for this alternative are as follows:

a. A detailed design for dewatering of the features should be undertaken.

b. A study should be accomplished to determine the ease of removal for the rock, to determine the cost of removal, and to determine the

the most economical channel cross section based on channel velocity.

c. A detailed layout of the powerhouse should be prepared to provide adequate areas for storage, work and controls.

d. Current topography of the area is needed to accurately determine quantities.

e. A detailed foundation investigation should be accomplished in the future to provide detailed foundation information.

f. A detailed condition survey should be completed for the Headgate Structure on the Edison Sault Power Canal and the Edison Sault Plant. This survey will determine future work needed to either maintain the structures or modify them to act as closures for the power canal.

g. A detailed hydraulic design is needed to provide a minimum flow when the Edison Sault Powerhouse stops generating power. This design is needed to satisfy environmental concerns for the power canal.

h. Future considerations for safety and provisions for the public should be investigated further during the design stage.

i. The effect of and on the future lock should be taken into account when sufficient data is available to analyze the impact of the channel alignment and cross section.

j. Positioning of the powerhouse extension should be considered. The existing tailrace crane could be utilized if the downstream wall of the extension lines up with the downstream wall of the Corps plant.

Alternative 3

Facility Integrity

The discussion of the existing conditions for Alternative 2 may be applied to this alternative. See the discussion in Facility Integrity for Alternative 2.

Required Work

This alternative would abandon the existing Corps Plant and build an entirely new powerhouse south of the existing one. The discussion for Alternative 2 is applicable except that tube turbines are more economical. See Figures A-16 and A-17 for Plan and Section. The construction sequence is identical to that presented for Alternative 2. The new powerhouse would be located south of the existing Corps Plant to reduce rock excavation. It was felt that the present location provided the most economical location.

Future Considerations

The future considerations for Alternative 3 are identical with those presented for Alternative 2, with the addition that the most economical location should be determined for the new powerhouse.

Alternative 4

Facility Integrity

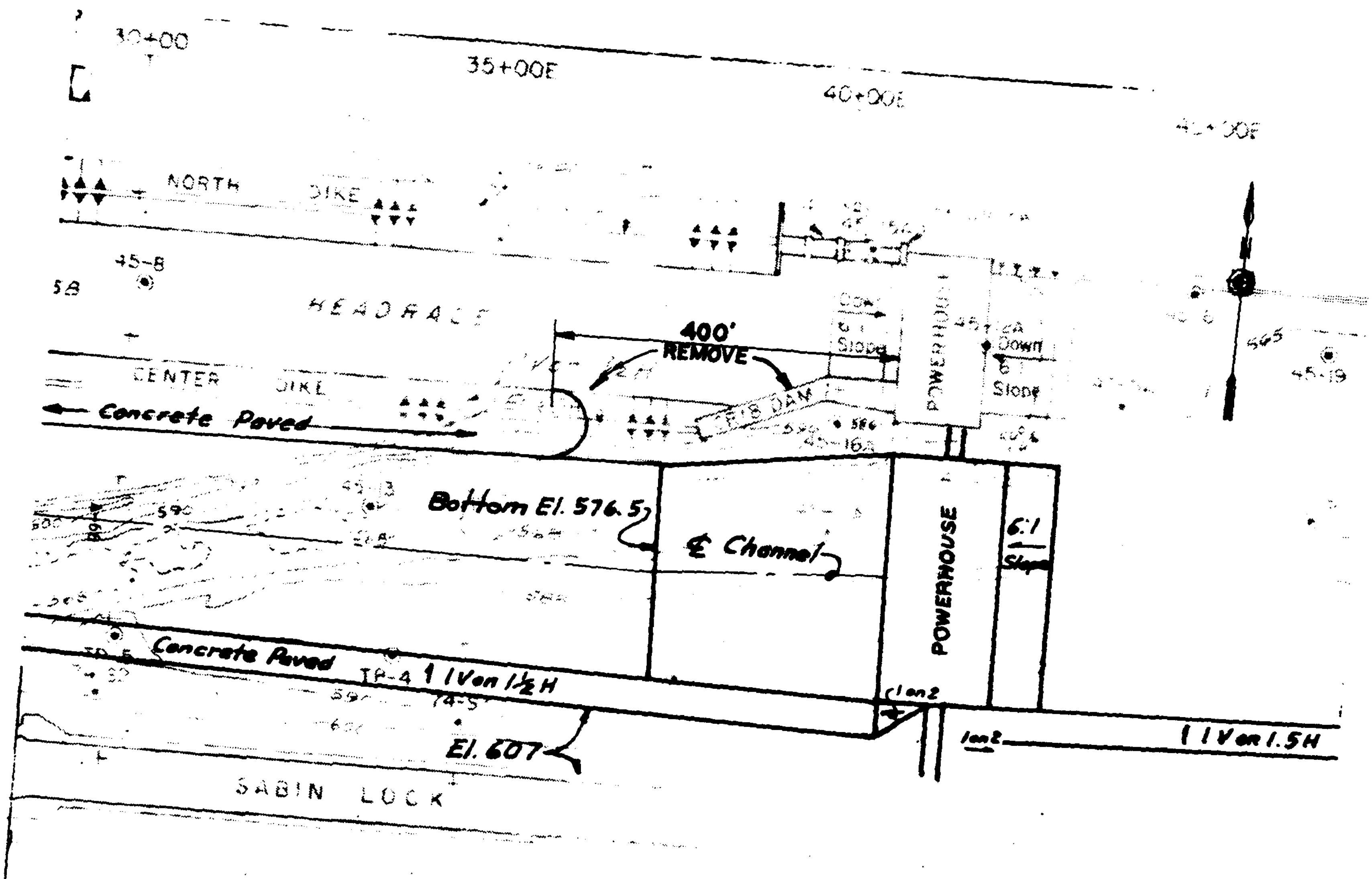
See the discussion of the existing conditions for Alternative 2, since they are applicable for this alternative.

Required Work

This alternative is almost the same as Alternative 3, except that in place of abandoning the Corps Plant, the powerhouse would be extensively modified. See Figure A-17 for final configuration. Only the upstream wall, gates, trashracks and part of the foundation would be retained for tube turbines proposed for this alternative. The powerhouse also must be extended southward (see Figure A-18). Power generation would not be continued during construction and, thus, the cost of purchasing replacement power must be included in the cost estimate. A different channel alignment between Unit 10 and the powerhouse would be required for this alternative in order to convey water into the powerhouse. This changed alignment requires removal of the entire Center Dike but would reduce the amount of fill between the channel and the Sabin Lock. (See Figure A-18.) Also, by placing the Cutoff Dike at the present location of Unit 10, the North wall of the Sabin Lock would not be subjected to water at the headrace level. The construction sequence discussed for Alternative 2 also applies to this alternative.

Future Considerations

The future considerations for Alternative 4 are identical to those presented for Alternative 2 and, thus, will not be restated.



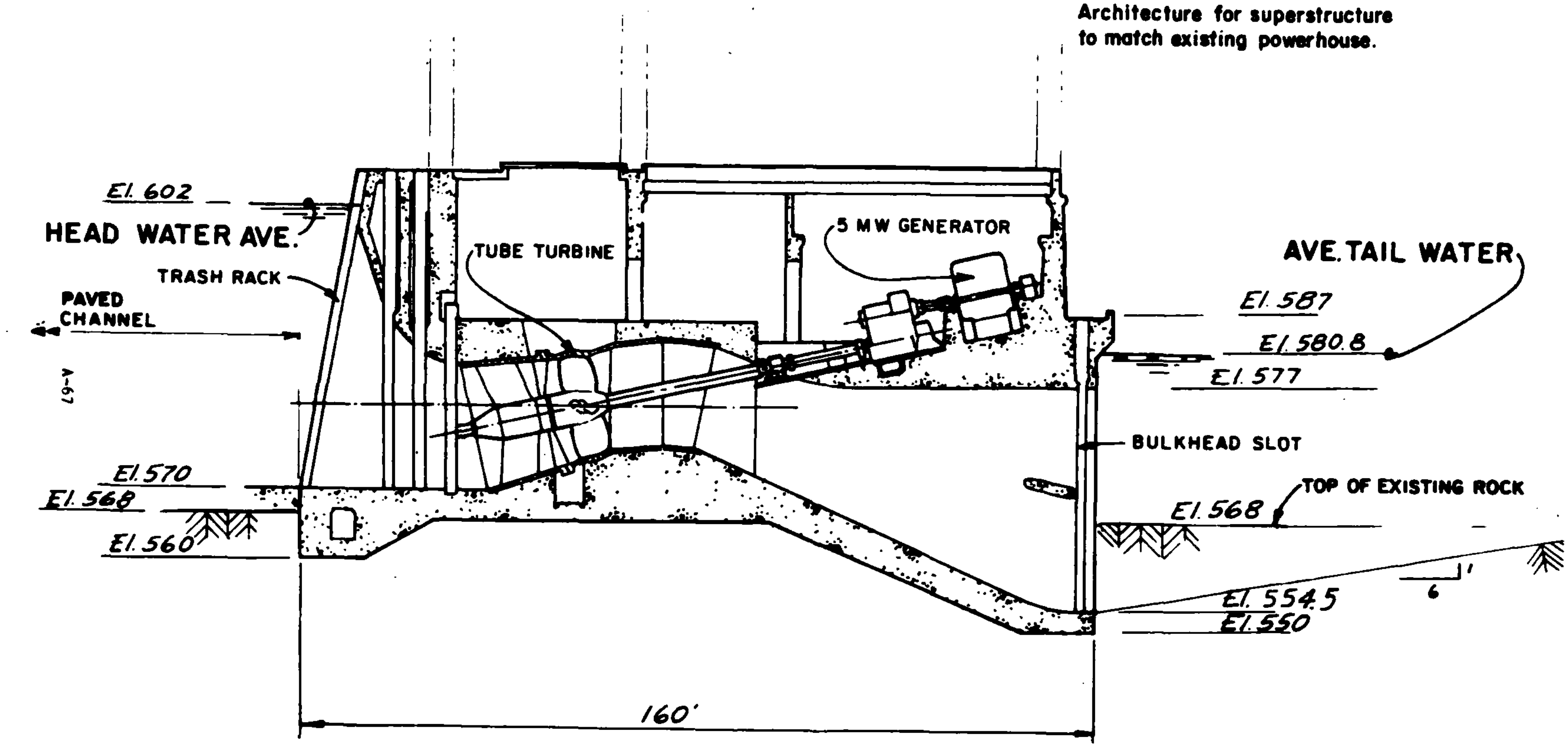
NOTE: CONTOURS ARE USLS DATUM: SUBTRACT 1.6' TO OBTAIN IGLD DATUM

30+00E

PLAN

ALTERNATE 3
PLAN

FIGURE A-16

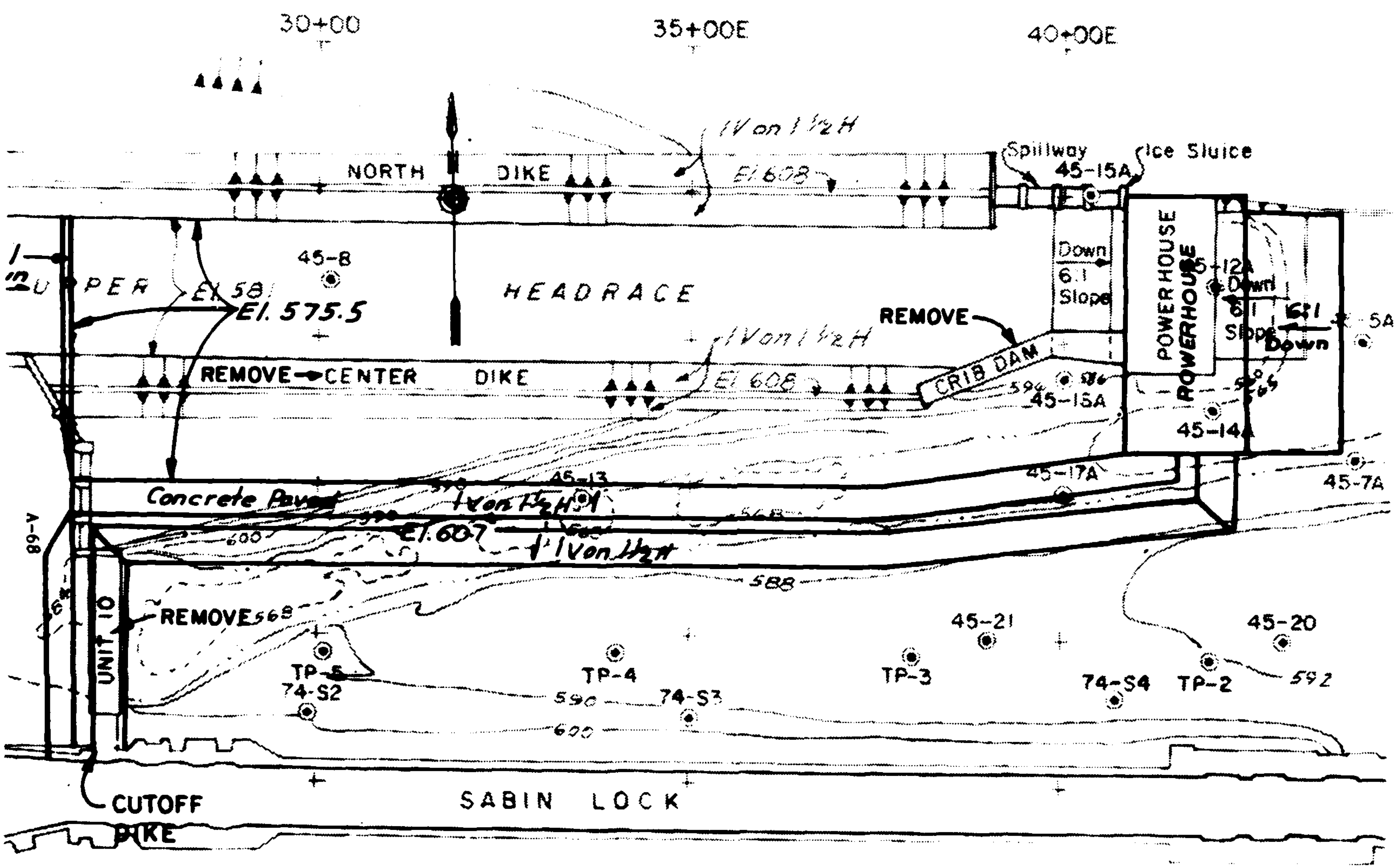


TYPICAL SECTION

N.T.S.

ALTERNATIVES 3 & 4
TYPICAL SECTION

FIGURE A-17



NOTE: CONTOURS ARE USLS DATUM. SUBTRACT 1.6' TO OBTAIN IGLD DATUM

30+00E

PLAN

35+00E

ALTERNATE 4
PLAN

FIGURE A-18

COST ESTIMATE

Charts and tables from reference 23 were utilized to provide a basis for estimating the major share of construction costs that are governed by capacity and head, e.q., turbines, generators, building, and supporting electrical/mechanical equipment. Other site specific costs were generated from calculated quantities and unit costs. A contingency factor of 15% has been used to allow for uncertainties and minor omissions. An indirect cost factor of 25% has been used for investigations, management, engineering and administrative costs needed to implement the project. The feasibility of options concerning the Edison Sault Plant is largely dependent on the work required to the Edison Sault Plant foundation, power canal, and headgate structure. The report assumes adequate foundation conditions and head gate structure integrity, and includes $1,078,000 for canal work (contingencies and indirect costs included).

COST SUMMARY TABLE

	OPTION I	OPTION II	
ALTERNATIVE 1	$40,305,000 35-1.1 MW units 38.5 MW installed $1,047/kW	$43,703,000 32-1.1 MW units 35.2 MW installed $1,242/kW	
	VERTICAL PROPELLER	TUBE TURBINES	BULB TURBINES
ALTERNATIVE 2	$57,661,000 3-12.5 MW units 37.5 MW installed $1,538/kW	$66,325,000 8-5 MW units 40 MW installed $1,658/kW	$70,860,000 3-12.5 MW units 37.5 MW installed $1,890/kW
ALTERNATIVE 3	$74,844,000 5-10.5 MW units 52.5 MW installed $1,426/kW	$77,061,000 10-5.25 MW units 52.5 MW installed $1,468/kW	$89,434,000 3-18 MW units 54 MW installed $1,656/kW
ALTERNATIVE 4	$83,610,000 5-10.5 MW units 52.5 MW installed $1,593/kW	$86,722,000 10-5.25 MW units 52.5 MW installed $1,652/kW	$100,029,000 3-18 MW units 54 MW installed $1,852/kW

Table A-4

OPERATION AND MAINTENANCE COSTS

The guide manual "Feasibility Studies for Small Scale Hydropower Additions" suggests a multiplier of 2 to 4 percent should be used to determine annual O & M costs (Vol. VI, page 6-4). It is recommended that a multiplier of 3 percent be used for this study, with an inflation factor of 6 1/2 percent to calculate annual costs for the life of the project. The first year operation and maintenance costs corresponding to Table A-4 of the report are therefore:

	Option I	Option II
Alternative 1	$1,209,000	$1,311,000

	Vertical Propeller	Tube Turbines	Bulb Turbines
Alternative 2	$1,690,000	$1,950,000	$2,086,000
Alternative 3	2,206,000	2,272,000	2,644,000
Alternative 4	2,095,000	2,189,000	2,588,000

Table A-5

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7.2

ALTERNATIVE 1 — OPTION I (38.5 MW)

REBUILD 35 BAYS OF EXISTING EDISON SOO PLANT WITH NEW TUBE TURBINES AND GENERATORS

FROM VOL V FIG 3-14 1.1 MW - - -	810,000
LESS 10% FOR FIXED BLADES - -	(81,000)
LESS 12% FOR DIRECT CONNECT GENERATOR	(97,200)
LESS 7% FOR NO BUTTERFLY INLET VALVE	(56,700)
LESS 5% FOR NO GOVERNOR, SPEED CONTROLS	(40,500)
1.1 MW UNIT (EACH) - -	534,600
35 UNITS - - -	18,711,000
INSTALLATION (25%) - - - - -	4,680,000
MISC POWERPLANT EQUIPMENT - - - VOL V FIG 6-5 (3X170,000) VOL V PAGE 6-8	510,000
STATION ELECTRICAL EQUIPMENT - - - VOL V, FIG 5-4 - 0.5 X 1,000,000 FROM GRAPH PLUS 20,000 + 58,000 (n-1)	2,500,000
35 WHEEL GATES (17.5' X 13.5') 35 GATES X $75/SF - - -	620,000

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ALTERNATIVE 1 - OPTION I

CONCRETE BULK HEADS: (FOR UNUSED UNITS)

16 CY @ $300/CY = $4,800/PENSTOCK

43 PENSTOCKS @ 4,800/PENSTOCK — — 206,400

CHANNEL REPAIR:
STABILIZE NORTH CANAL BANK
FROM HYDRO PLANT OPERATIONS & MAINTENANCE REPORT - SEPT 1978,
R.O. KING - CONSULTANT — — — — — 750,000

TOTAL ESTIMATE FROM GRAPHS = 21,721,000
REGIONAL CORRECTION FACTOR = 0.9
COST ESCALATED TO JULY 1980 = 10% LESS (-217,000)

SUBTOTAL: 27,760,000

MOBILIZATION, SITE PREP @ 1% — — — 278,000

28,038,000

CONTINGENCIES 15% — — — — — — 4,206,000

SUBTOTAL — — 32,244,000

INDIRECT COSTS 25% — — 8,061,000

TOTAL: $40,305,000

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ALTERNATIVE 1

OPTION II (35.2 MW)

REPLACE EXISTING TURBINE WITH STANDARD TUBE UNIT, ADJUSTABLE BLADE W/ SPEED INCREASER. USE EXISTING GENERATORS IN TANDEM

BASIC COST ALLIS-CHALMERS 810,000 IN NOV 1979 LESS 25% FOR GENERATION = 607,500 × 32 UNITS — — 19,440,000

MODIFY GENERATOR SHAFTS
$20,000/UNIT @ 32 UNITS — — — 640,000

INSTALLATION @ 25% — — — — 4,860,000

MISC. POWER PLANT EQUIPMENT — — — — 510,000
VOL V FIG 6-5
3 × 170,000 (SEE VOL V, PAGE 6-6)

STATION ELECTRICAL EQUIPMENT — — — 2,318,000
VOL V FIG 5-4
0.5 × 1,000,000 FROM GRAPH
PLUS 20,000 + 58,000(n-1)

33 WHEEL GATES
(17.5' × 13.5') @ $75/SF — — — — 585,000

CONCRETE BULKHEADS (FOR UNUSED UNITS)
16 CY @ $300/CY
45 PENSTOCKS @ 4,800/PENSTOCK — — 216,000

1 DC UNIT - 1250 KW — — — — — 810,000

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ALTERNATIVE 1 OPTION II

CHANNEL REPAIR:

STABILIZE NORTH CANAL BANK FROM HYDROPLANT OPERATIONS & MAINTENANCE REPORT - SEPT 1978, R.O. KING - CONSULTANT	250,000
TOTAL ESTIMATE FROM GRAPHS - 2,828,000 REGION 4 CORRECTION FACTOR 0.9 COST ESCALATION TO JULY 1980 = 10% LESS	(-28,000)
SUBTOTAL:	30,101,000
MOBILIZATION, SITE PREP, ETC. @ 1%	301,000
SUBTOTAL:	30,402,000
CONTINGENCIES 15%	4,560,000
	34,962,000
INDIRECT COSTS 25%	8,741,000
TOTAL:	$43,703,000

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7.3 ALTERNATIVE 2

TURBINE THROAT DIAMETER = 23.5'

VERTICAL PROPELLER - 3-12.5 MW UNITS

TURBINE, GENERATOR, EXCITER, GOVERNOR + INSTALLATION FIG 3-13, EXTENDED
DEDUCT 10% FOR FIXED BLADE PROPELLER 4,320,000/12.5 MW --- 12,960,000

POWERHOUSE (FIG. 4-5 EXTENDED, VOL VI) 1,420,000/12.5 MW -- 4,260,000

STATION ELEC EQUIPMENT (FIG 5-4, VOL V EXTENDED) ---- 1,100,000
0.5 (1,000,000) FROM FIG, PLUS 20,000 + 58,000 (n-1)

MISC. POWER PLANT EQUIP (FIG 6-5, VOL V EXTENDED) ---- 570,000
(190,000 x 3) SEE VOL 5 PAGE 6-6

SWITCHYARD CIVIL COSTS (FIG 4-12 VOL VI) (COST TO EDISON SOO ELEC CO.) ---- 0

UPSTREAM TAINTER GATES OR UP STREAM SLIDE GATES (TABLE 3-1, 3-2 VOL VI) 34,000/GATE -- 102,000

TRASH RACKS: 2,300 SF @ $30/SF ----- 69,000

DRAFT TUBE GATES: 34,000/GATE -- 102,000

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ALTERNATIVE 2 3·12.5 MW VERTICAL PROPELLER

ADDITIONAL STATION EQUIPMENT
COSTS FOR MULTIPLE UNITS
20,000+58,000(N-1) ---- 136,000
(FIG 5-4 VOL V)

SWITCHYARD EQUIPMENT COSTS
(FIG 6-3, VOL V EXTENDED) ------- 0
ASSUME 13.8 KV (COST BORN BY EDISON
SOO ELEC. CO.)

TRANSMISSION LINE COST
(TABLE 4-2, VOL I) INTERPOLATE ---- 220,000
USING 2 mi

(19,329,000)

COST INDEX JULY 1978 TO
JULY 1980 1.1

REGIONAL FACTOR 0.9

GRAPH SUBTOTAL: 19,136,000

SITE SPECIFIC ESTIMATES

REMOVE UNIT 10 & SLUICEWAY --- 1,700,000

HEADRACE EXCAVATION
ROCK 350,000 CY @ 20.00/CY -- 7,000,000
SOIL 250,000 CY @ 8.00/CY -- 2,000,000
FILL 250,000 CY @ 8.00/CY -- 2,000,000
CONC 870 CY @ 50.00/CY -- 44,000

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ALT 2 = 3-12.5 MW VERTICAL PROPELLER

TAIL RACE EXCAVATION

ROCK 22,400 CY @ 20.00/CY -- 448,000

SOIL 200,800 CY @ 8.00/CY -- 1,606,000

POWER HOUSE EXCAVATION

ROCK 54,200 CY @ 20.00/CY -- 1,084,000

SOIL 26,000 CY @ 8.00/CY -- 208,000

CUTOFF DIKE:

FILL 34,000 CY @ 2.00/CY --- 68,000

SHEET PILING 9690 SF @ 13.00/SF --- 126,000

DEWATERING

HEADRACE

FILL 76300 CY @ 10.00/CY -- 763,000

SOIL EXCAVATION 54,125 CY @ 8.00/CY -- 433,000

PUMPING -- --- -- 259,000

POWERHOUSE

PILING 60,200 LF @ 17.00/LF -- 1,204,000

CELL FILL 17,350 CY @ 10.00/CY 174,000

PUMPING -- --- -- 195,000

PERFORATED DRAIN PIPE: 1530 LF @ 10.00/LF -- 15,000

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ALT 2: 3-12.5 MW VERTICAL PROPELLER

REMOVE CRIB DAM 3400CY @ 40.00/CY --	136,000
CLOSE SABIN SLUICEWAY ----	210,000
SITE SPECIFIC SUBTOTAL:	19,673,000
TOTAL:	$38,809,000
MOBILIZATION, SITE PREP, ETC ≈ 1%	$388,000
SUBTOTAL =	39,197,000
ENERGY REVENUE LOST - UNIT 10, 2YR, (USE 22.7 MILLS KWH BASED ON FERC POWER VALUES 1980) ----	795,000
CAPACITY REVENUE LOST - UNIT 10, 2YR (USE $130/KW BASED ON FERC POWER VALUES - 1980) ----	520,000
CONTINGENCIES 15% ≅	5,880,000
SUBTOTAL:	45,077,000
INDIRECT COSTS 25% ≅	11,269,000
SUBTOTAL	$56,346,000
REVENUE LOST ----	1,315,000
TOTAL	$57,661,000

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TURBINE THROAT DIAMETER ≈ 17.4'

ALTERNATIVE 2

3 - 12.5 MW BULB TURBINES

TURBINE, GENERATOR, EXCITER, GOVERNOR + INSTALLATION
FIG 3-15 EXTENDED
DEDUCT 10% FOR FIXED BLADE PROPELLER
6,210,000/12.5 MWB --- 18,630,000

POWERHOUSE (FIG 4-3, EXTENDED, VOL VI)
2,620,000/12.5 MW BULB -- 7,560,000

STATION ELEC EQUIPMENT (FIG 5-4, VOL V EXTENDED) --- 1,100,000

MISC. POWER PLANT EQUIP (FIG 6-5, VOL V EXTENDED) ---- 570,000
190,000 X 3 (SEE VOL 5 PAGE 6-6)

SWITCHYARD CIVIL COSTS (FIG 4-12 VOL VI) (COST BORNE BY EDISON SOO ELEC CO.) -- 0

UPSTREAM TAINTER GATES OR UP STREAM SLIDE GATES (TABLE 3-1, 3-2 VOL VI) 75,000/GATE -- 225,000

TRASH RACKS:
3200 SF @ $30/SF ------ 96,000

DRAFT TUBE GATES: $75,000/GATE --- 225,000

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Computed by: DPR, CO, DR

Checked by:

Approved by:

Price Level:

ALTERNATIVE 2

ADDITIONAL STATION EQUIPMENT COSTS FOR MULTIPLE UNITS
20,000+58,000(N-1) — — — — 136,000
(FIG 5-4 VOL V)

SWITCHYARD EQUIPMENT COSTS
(FIG 6-3 VOL V EXTENDED)
ASSUME 13.8 KV (COST TO EDISON SOO ELEC CO.) — — 0

TRANSMISSION LINE COST
(TABLE 4-2, VOL I) INTERPOLATE — — — — 220,000
USING 2 MI

(28,762,000)

COST INDEX JULY 1978 TO JULY 1980 1.1

REGIONAL FACTOR 0.9

GRAPH SUBTOTAL: 28,474,000

SITE SPECIFIC ESTIMATES

REMOVE UNIT 10 & SLUICEWAY — — — 1,700,000

HEAD RACE EXCAVATION

ROCK 350,000 CY @ 20.00/CY — 7,000,000

SOIL 250,000 CY @ 8.00/CY — 2,000,000

FILL 324,900 CY @ 8.00/CY — 2,599,000

CONC 870 CY @ 50.00/CY — 44,000

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DRK 6A, DK			

ALT 2 - 3-12.5 MW BULB TURBINES

TAIL RACE EXCAVATION

ROCK	15,600 CY @ 20^{00}/CY --	312,000
SOIL	103,400 CY @ 8^{00}/CY --	827,000

POWERHOUSE EXCAVATION

ROCK	53,900 CY @ 20.^{00}/CY -	1,078,000
SOIL	14,400 CY @ 8^{00}/CY -	115,000

CUT OFF DIKE

FILL	43,400 CY @ 2^{00}/CY --	87,000
SHEET PILING	12350 SF @ 13^{00}/SF --	161,000

DEWATERING

HEAD RACE

FILL	76,300 CY @ 10^{00}/CY -	763,000
SOIL EXCAVATION	54,100 CY @ 8^{00}/CY -	433,000
PUMPING	-- -- -- --	259,000

POWER HOUSE

PILING	75,000 LF @ 17^{00}/LF --	1,275,000
CELL FILL	21,700 CY @ 10^{00}/CY -	217,000
PUMPING	-- -- -- --	195,000

PERFORATED DRAIN PIPE 1530 LF @ 10^{00}/LF - 15,000

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ALT 2 - 3-12.5 mw BULB TURBINES

REMOVE CRIB DAM: 3400CY @ 40.00/CY	136,000
CLOSE SABIN SLUICEWAY	210,000
SITE SPECIFIC SUBTOTAL	19,426,000
TOTAL	$47,900,000
MOBILIZATION, SITE PREP, ETC ≈ (1.0%)	479,000
SUBTOTAL	48,379,000
ENERGY REVENUE LOST - UNIT 10, 2YR, (USE 22.7 MILLS/Kwh BASED ON FERC POWER VALUES 1980)	795,000
CAPACITY REVENUE LOST - UNIT 10, 2YR, (USE $130/KW BASED ON FERC POWER VALUES 1980)	520,000
CONTINGENCIES 15%	7,257,000
SUBTOTAL	55,636,000
INDIRECT COSTS 25%	13,909,000
SUBTOTAL	69,545,000
REVENUE LOST	1,315,000
TOTAL	$70,860,000

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ALTERNATIVE 2

TUBE TURBINES — 8-5 MW TUBES

TURBINE, GENERATOR, EXCITER,
GOVERNOR + INSTALLATION
FIGURE 3-14, EXTENDED
DEDUCT 10% FOR FIXED BLADE
PROPELLER: 2,310,000/5MW — — — 18,480,000
ADD 10% FOR WICKET GATES
ADD 10% FOR CUSTOM DESIGN

POWERHOUSE (FIG 4-2,
EXTENDED, VOL VI) 580,000/5MW — — — 4,640,000

STATION ELEC EQUIPMENT
(FIG 5-4, VOL V EXTENDED) — — — — 1,150,000

MISC. POWER PLANT EQUIP
(FIG 6-5, VOL V EXTENDED) — — — — 585,000
195,000 x 3 (SEE VOL V PAGE 6-6)

SWITCHYARD CIVIL COSTS
(FIG 4-12 VOL VI) COST BORN BY EDISON — — — 0
SOO ELEC CO.

UPSTREAM TAINTER GATES OK
UP STREAM SLIDE GATES
(TABLE 3-1, 3-2 VOL VI) (TUBES HAVE OWN GATES) — 0

TRASH RACKS!
6000 SF @ $30/SF — — — — — 180,000

DRAFT TUBE GATES 29,000/GATE — — — 232,000

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ALTERNATIVE 2 - 8-5MW TUBE TURBINES

ADDITIONAL STATION EQUIPMENT COSTS FOR MULTIPLE UNITS
20,000+58,000(N-1) — — — — 426,000
(FIG E4 VOL II)

SWITCHYARD EQUIPMENT COSTS
(FIG 6-3 VOL I EXTENDED) (COST BORN BY — — 0
ASSUME 13.8 KV FUISON 500 ELEC CO.)

TRANSMISSION LINE COST
(TABLE 4-2, VOL I) INTERPOLATE — — — 340,000
USING 2 MI

(25,933,000)

COST INDEX JULY 1978 TO JULY 1980 1.1

REGIONAL FACTOR 0.9

GRAPH SUBTOTAL: 25,674,000

SITE SPECIFIC ESTIMATES

REMOVE UNIT 10 & SLUICEWAY — — — 1,700,000

HEAD RACE EXCAVATION
ROCK: 350,000 CY @ 20.00/CY — — 7,000,000
SOIL: 250,000 CY @ 8.00/CY — — 2,000,000
FILL: 249,200 CY @ 8.00/CY — — 1,994,000
CONC: 870 CY @ 50.00/CY — — 44,000

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ALT 2 – 8-5 MW TUBES (CONTINUED)

TAIL RACE EXCAVATION
ROCK 25,800 CY @ 20.00/CY – – 516,000
SOIL 248,200 CY @ 8.00/CY – – 1,986,000

POWER HOUSE EXCAVATION
ROCK 10,200 CY @ 20.00/CY – – 204,000
SOIL 28,200 CY @ 8.00/CY – – 226,000

CUTOFF DIKE:
FILL 29400 CY @ 2.00/CY – – 59,000
SHEET PILING 8360 SF @ 13.00/SF – – – 109,000

DEWATERING:
HEADRACE
FILL 76,300 CY @ 10.00/CY – 763,000
SOIL EXCAVATION 54,100 CY @ 8.00/CY – 433,000
PUMPING – – – – – 259,000

POWERHOUSE
PILING 63,000 LF @ 17.00/LF – 1,071,000
CELL FILL 18,200 LF @ 10.00/CY – 182,000
PUMPING – – – – – – 195,000

PERFORATED DRAIN PIPE 1530 LF @ 10.00/LF – 15,000

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ALT 2 — 8-5 MW TUBE TURBINES

REMOVE CRIB DAM 3,400 CY @ 40.00/CY --	136,000
CLOSE SABIN SLUICEWAY - - - - -	210,000
SITE SPECIFIC SUBTOTAL —	19,102,000
TOTAL	44,776,000
MOBILIZATION, SITE PREP ETC ≈ (1.0%) - - - - - -	448,000
SUBTOTAL - -	45,224,000
ENERGY REVENUE LOST - UNIT 10, 2YR, (USE 22.7 MILLS/KWH BASED ON FERC POWER VALUES 1980) - - - - -	795,000
CAPACITY REVENUE LOST - UNIT 10, 2YR, (USE $130/KW BASED ON FERC POWER VALUES 1980) - - - - -	520,000
CONTINGENCIES 15% - - -	6,784,000
SUBTOTAL:	52,008,000
INDIRECT COSTS 25% - - - -	13,002,000
SUB TOTAL	$65,010,000
REVENUE LOST - - - - -	1,315,000
TOTAL	$66,325,000

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7.4 ALTERNATIVE 3

TURBINE THROAT DIAMETER = 15.3'

TUBE TURBINES - 10-5.25 MW

TURBINE, GENERATOR, EXCITER, GOVERNOR + INSTALLATION. FIGURE 3-14, EXTENDED. DEDUCT 10% FOR FIXED BLADE PROPELLER 2,310,000/5.2 MW; ADD 10% FOR WICKET GATES; ADD 10% FOR CUSTOM DESIGN	23,100,000
POWERHOUSE (FIG 4-2, EXTENDED, VOL VI) 600,000/5.25 MW	6,000,000
STATION ELEC EQUIPMENT (FIG 5-4, VOL V EXTENDED)	1,350,000
MISC. POWER PLANT EQUIP (FIG 6-5, VOL V EXTENDED) 215,000 x 3 (SEE VOL V PAGE 6-6)	645,000
SWITCHYARD CIVIL COSTS (FIG 4-12 VOL VI) (COST TO EDISON SOO ELEC CO.)	0
UPSTREAM TAINTER GATES OR UPSTREAM SLIDE GATES (TABLE 3-1, 3-2 VOL VI) (GATES PROVIDED WITH STANDARD TUBE)	0
TRASH RACKS: 6000 SF @ $30/SF	180,000
DRAFT TUBE GATES: 10 @ 20,000	200,000

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ALTERNATIVE 3 - TUBE TURBINES - 10-5.25 MW

ADDITIONAL STATION EQUIPMENT - - - 542,000
COSTS FOR MULTIPLE UNITS
20,000 + 58,000(N-1)
(FIG 5-4 VOL V)

SWITCHYARD EQUIPMENT COSTS 0
(FIG 6-3 VOL I EXTENDED) (COST TO EDISON SOO
ASSUME 13.8 KV ELEC CO.)

TRANSMISSION LINE COST - - - - - 340,000
(TABLE 4-2, VOL I) INTERPOLATE
USING 2 MI

(32,357,000)

COST INDEX JULY 1978 TO 1.1
JULY 1980

REGIONAL FACTOR 0.9

SUBTOTAL: 32,033,000

SITE SPECIFIC ESTIMATES

REMOVE UNIT 10 & SLUICEWAY - - - 1,700,000

HEAD RACE EXCAVATION
ROCK 349,200 CY @ 20.00/CY - - 6,984,000
SOIL 256,600 CY @ 8.00/CY - - 2,053,000
FILL 123,000 CY @ 8.00/CY - - 984,000
CONC 870 CY @ 50.00/CY - - 44,000

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ALT 3 — TUBE TURBINES 10-5.25 MW

TAILRACE EXCAVATION

ROCK 65800 CY @ 20^{00}/CY -- 1,316,000

SOIL 307,400 CY @ 8^{00}/CY -- 2,459,000

POWERHOUSE EXCAVATION

ROCK 12800 CY @ 20^{00}/CY -- 256,000

SOIL 35100 CY @ 8^{00}/CY -- 281,000

CUT OFF DIKE

FILL 25400 CY @ 2^{00}/CY -- 51,000

SHEET PILING 7200 SF @ 13^{00}/SF -- 94,000

DEWATERING

HEADRACE

FILL 76300 CY @ 10^{00}/CY --- 763,000

SOIL EXCA 54125 CY @ 8^{00}/CY --- 433,000

PUMPING ------- 259,000

POWER HOUSE

PILING 78600 LF @ 17^{00}/LF --- 1,336,000

CELL FILL 22700 CY @ 10^{00}/CY -- 227,000

PUMPING ------- 286,000

PERFORATED DRAIN PIPE: 1530 LF @ 10^{00}/LF -- 15,000

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ALT 3 - TUBE TURBINES 10-5.25 MW

REMOVE CRIB DAM: 3400 CY @ 40.00/CY --	136,000
CLOSE SABIN LOCK SLUICEWAY ---	210,000
REMOVE PORTION OF CENTER DIKE:	
ROCK 11,600 CY @ 20.00/CY --	232,000
CONC 380 CY @ 50.00/CY --	19,000
SITE SPECIFIC SUBTOTAL =	20,138,000
SUBTOTAL -	52,171,000
MOBILIZATION, SITE PREP. ETC ≅ 1% -------	522,000
SUBTOTAL	52,693,000
ENERGY REVENUE LOST - , UNIT 10 FOR 2 YEARS (USE 22.7 MILLS/KWH BASED ON FERC POWER VALUES-1980) --	795,000
CAPACITY REVENUE LOST - , UNIT 10 FOR 2 YEARS (USE $13.0/KW BASED ON FERC POWER VALUES - 1980). ----	520,000
CONTINGENCIES 1[illegible]% ----	7,904,000
INDIRECT COSTS 25% ----	15,149,000
SUBTOTAL =	75,746,000
REVENUE LOST --------	1,315,000
TOTAL	$77,061,000

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ALTERNATIVE 3

TURBINE THROAT DIAMETER - 21.5'

VERTICAL PROPELLER - 5 - 10.5 MW

TURBINE, GENERATOR, EXCITER, GOVERNOR + INSTALLATION FIG 3-13, EXTENDED DEDUCT 10% FOR FIXED BLADE PROPELLER 4,050,000/10.5 MW	20,250,000
POWERHOUSE (FIG. 4-5 EXTENDED, VOL VI) 1,280,000/10.5 MW	6,400,000
STATION ELEC EQUIPMENT (FIG 5-4, VOL V EXTENDED)	1,350,000
MISC. POWER PLANT EQUIP (FIG 6-5, VOL V EXTENDED)	215,000
SWITCHYARD CIVIL COSTS (FIG 4-12 VOL VI) (COST TO EDISON SOO ELEC CO.)	0
UPSTREAM TAINTER GATES OR UP STREAM SLIDE GATES (TABLE 3-1, 3-2 VOL VI) 5 @ $27,000	135,000
TRASH RACKS 3800 SF @ $30/SF	114,000
DRAFT TUBE GATES: 5 @ $27,000	135,000

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ALTERNATIVE 3 VERTICAL PROPELLER 5-10.5 MW

ADDITIONAL STATION EQUIPMENT COSTS FOR MULTIPLE UNITS; --- - 252,000
20,000 + 58,000 (N-1)
(FIG 5-4 VOL V)

SWITCHYARD EQUIPMENT COSTS - - - - - - 0
(FIG 6-3, VOL V EXTENDED) (COST TO EDISON
ASSUME 13.8 KV SOO ELEC CO.)

TRANSMISSION LINE COST - - - - - 340,000
(TABLE 4-2, VOL I) INTERPOLATE
USING 2 mi

(29,191,000)

COST INDEX JULY 1978 TO
JULY 1980 - - - - - - 1.1

REGIONAL FACTOR - - 0.9

SUBTOTAL: 28,899,000

SITE SPECIFIC ESTIMATES

REMOVE UNIT 10 & SLUCEWAY - - - - 1,700,000

HEAD RACE EXCAVATION

ROCK	349,200 CY	@ 20^{00}/CY	6,984,000
SOIL	258,800 CY	@ 8^{00}/CY	2,070,000
FILL	111,700 CY	@ 8^{00}/CY	894,000
CONC	870 CY	@ 50^{00}/CY	44,000

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ALT3 — VERTICAL PROPELLER 5-10.5 MW

TAILRACE EXCAVATION

ROCK	83,600 CY @ 20.00/CY	1,672,000
SOIL	332,500 @ 8.00/CY	2,660,000

POWER HOUSE EXCAVATION

ROCK	57,200 CY @ 20.00/CY	1,114,000
SOIL	41,800 CY @ 8.00/CY	334,000

CUTOFF DIKE

FILL	22,700 CY @ 2.00/CY	45,000
SHEET PILING	6500 SF @ 13.00/SF	85,000

DEWATERING

HEAD RACE

FILL	76300 CY @ 10.00/CY	763,000
SOIL EXC.	54,125 CY @ 8.00/CY	433,000
PUMPING		259,000

POWERHOUSE

PILING	88,500 LF @ 17.00/LF	1,505,000
CELLFILL	25500 CY @ 10.00/CY	255,000
PUMPING		286,000

PERFORATED DRAIN PIPE 1530 LF @ 10.00/LF — 15,000

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ALT 3 - VERTICAL PROPELLER 5-10.5 MW

REMOVE CRIB DAM. 3400 CY @ 40.00/CY --	136,000
CLOSE SABIN LOCK SLUICEWAY - - -	210,000
REMOVE PORTION OF CENTER DIKE:	
ROCK 11,600 CY @ 20.00/CY -	232,000
CONC 380 CY @ 50.00/CY -	19,000
SITE SPECIFIC SUBTOTAL -	21,745,000
SUBTOTAL =	50,644,000
MOBILIZATION, SITE PREP. ETC ≈ 1% - - - - - -	506,000
SUBTOTAL -	51,150,000
ENERGY REVENUE LOST - UNIT 10 FOR 2 YEARS (USE 22.7 MILLS/KWH BASED ON FERC POWER VALUES - 1980) - -	795,000
CAPACITY REVENUE LOST - UNIT 10 FOR 2 YEARS (USE $130 /KW BASED ON FERC POWER VALUES - 1980) - - -	520,000
CONTINGENCIES 15% - - - - -	7,673,000
INDIRECT COSTS 25% - - - - -	14,706,000
SUBTOTAL	73,529,000
REVENUE LOST - - - - - -	1,315,000
TOTAL:	$74,844,000

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TURBINE THROAT DIAMETER = 23.3

ALTERNATIVE 3

BULB TURBINES 3-18 MW

TURBINE, GENERATOR, EXCITER, GOVERNOR + INSTALLATION, FIG 3-15 EXTENDED DEDUCT 10% FOR FIXED BLADE PROPELLER 8,460,000/18 MW --- 25,380,000

POWERHOUSE (FIG 4-3, EXTENDED, VOL V) 3,800,000/18 MW --- 11,400,000

STATION ELEC EQUIPMENT ---- 1,400,000
(FIG 5-4, VOL V EXTENDED)

MISC. POWER PLANT EQUIP ---- 660,000
(FIG 6-5, VOL V EXTENDED)
3 x 220,000 (SEE VOL V PAGE 6-6)

SWITCHYARD CIVIL COSTS
(FIG 4-12 VOL VI) (COST TO EDISON SOO ELEC CO.) --- 0

UPSTREAM TAINTER GATES OR
UP STREAM SLIDE GATES
(TABLE 3-1, 3-2 VOL VI) 3 @ 79,000 EA -- 237,000

TRASH RACKS:
4100 SF @ $30/SF ---- 123,000

DRAFT TUBE GATES: 3 @ 79,000 EA -- 237,000

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ALTERNATIVE 3 BULB TURBINES 3-18 MW

ADDITIONAL STATION EQUIPMENT
COSTS FOR MULTIPLE UNITS,
20,000+58,000(N-1) — — — — 136,000
(FIG 5-4 VOL V)

SWITCHYARD EQUIPMENT COSTS (COST BORN BY — 0
(FIG 6-3 VOL V EXTENDED) EDISON SOO ELEC CO.)
ASSUME 13.8 KV

TRANSMISSION LINE COST — — — — 352,000
(TABLE 4-2, VOL I) INTERPOLATE
USING 2 MI

(39,925,000)

COST INDEX JULY 1978 TO — — — 1.1
JULY 1980

REGIONAL FACTOR 0.9

SUBTOTAL: 39,526,000

SITE SPECIFIC ESTIMATES

REMOVE UNIT 10 & SLUICEWAY — — — 1,700,000

HEADRACE EXCAVATION

ROCK 349,200 CY @ 20.00/CY — — 6,984,000

SOIL 250,000 CY @ 8.00/CY — — 2,000,000

FILL 249,200 CY @ 8.00/CY — — 1,994,000

CONC 870 CY @ 50.00/CY — — 44,000

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ALT 3 BULB TURBINES 3-18 MW

TAIL RACE EXCAVATION
ROCK 25,800 CY @ 20.00/CY -- 516,000
SOIL 248,200 CY @ 8.00/CY -- 1,986,000

POWER HOUSE EXCAVATION
ROCK 102,700 CY @ 20.00/CY -- 2,054,000
SOIL 14,400 CY @ 8.00/CY -- 115,000

CUTOFF DIKE
FILL 29,400 CY @ 2.00/CY --- 59,000
SHEET PILING 8360 SF @ 13.00/SF --- 109,000

DEWATERING
HEADRACE
FILL 76300 CY @ 10.00/CY -- 763,000
SOIL EXC 54,125 CY @ 8.00/CY -- 433,000
PUMPING --------- 259,000

POWERHOUSE
PILING 63,000 LF @ 17.00/LF -- 1,071,000
CELL FILL 18,200 CY @ 10.00/CY - 182,000
PUMPING ------ 286,000

PERFORATED DRAINPIPE: 1530 LF @ 10.00/LF -- 15,000

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ALT 3 - BULB TURBINES 3-18 MW

REMOVE CRIB DAM: 3400 CY @ 40.00/CY -	136,000
CLOSE SABIN LOCK SLUICEWAY - - -	210,000
REMOVE PORTION OF CENTER DIKE ROCK 11,600 CY @ 20.00/CY - -	232,000
CONC 380 CY @ 50.00/CY - -	19,000
SITE SPECIFIC SUBTOTAL -	21,167,000
SUBTOTAL:	60,693,000
MOBILIZATION, SITE PREP, ETC ≅ 1% - - - - - - - -	607,000
SUBTOTAL	61,300,000
ENERGY REVENUE LOST - UNIT 10 FOR 2 YEARS (USE 22.7 MILLS/KWH BASED ON FERC POWER VALUES - 1980) - -	795,000
CAPACITY REVENUE LOST - UNIT 10, FOR 2 YEARS USE \$130/KW BASED ON FERC POWER VALUES - 1979) - -	520,000
CONTINGENCIES 15%	9,195,000
INDIRECT COSTS 25% - - - - - -	17,624,000
SUBTOTAL -	88,119,000
REVENUE LOST - - - - - - -	1,315,000
TOTAL	\$ 89,434,000

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7.5 ALTERNATIVE 4

VERTICAL PROPELLER: 5 - 10.5 MW

POWER HOUSE/TURBINE COSTS - SEE
ALTERNATIVE 3 (VERTICAL PROPELLER) -- 28,899,000

SITE SPECIFIC ESTIMATE

REHAB EXST POWER HOUSE:
ASSUME COMPLETE DEMOLITION - - - 3,300,000

REMOVE UNIT 10 & SLUICEWAY - - - - 1,700,000

HEADRACE EXCAVATION
ROCK 421,000 cy @ 20.00/cy - - - 8,420,000
FILL 147,500 cy @ 8.00/cy - - - 1,180,000
CONC 2200 cy @ 50.00/cy - - - 110,000

POWER HOUSE EXCAVATION
ROCK 50,000 CY @ 20.00/cy - - 1,000,000

CUTOFF DIKE:
FILL 12300 CY @ 2.00/cy - - 25,000
SHEET PILING 5600 SF @ 13.00/SF - - 73,000

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ALT A - VERTICAL PROPELLER

DEWATERING
HEADRACE

FILL 76300 CY @ 10^{00}/CY	763,000
EXCA. 54125 CY @ 8^{00}/CY	433,000
PUMPING	259,000

POWER HOUSE

PILING 81100 LF @ 17^{00}/LF	1,379,000
CELL FILL 23400 CY @ 10^{00}/CY	234,000
PUMPING	286,000

NEW DIKE

FILL 97300 CY @ 2^{00}/CY	195,000
CONC 2500 CY @ 100^{00}/CY	250,000

PERFORATED DRAIN PIPE 1530 LF @ 10^{00}/LF	15,000
REMOVE CRIB DAM: 3460 CY @ 40^{00}/CY	136,000
CLOSE SABIN SLUICEWAY	210,000
SITE SPECIFIC SUBTOTAL	19,968,000
SUBTOTAL	48,867,000

NCS FORM 34
1 NOV 1976

COMPUTATION SHEET

Name of Office	Project	Date	Page
COE L - ST. PAUL DIST	ST. MARYS HYDROPOWER	3/17/80	of

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DPR SC. DR			

ALT 4 - VERTICAL PROPELLER

MOBILIZATION, SITE PREP, ETC, ± 1% — 489,000

SUBTOTAL: $49,356,000

ENERGY REVENUE LOST - US PLANT & UNIT 10 FOR 2 YEARS (USE 24.4 MILLS PER KWH BASED ON FERC POWER VALUES - 1980) — 7,866,000

CAPACITY REVENUE LOST - U.S. PLANT & UNIT 10 FOR 2 YEARS USE $130.30/KW BASED ON FERC POWER VALUES - 1980) — 4,795,000

CONTINGENCIES 15% — 7,403,000

SUBTOTAL — 56,759,000

INDIRECT COSTS (25%) — 14,190,000

SUB TOTAL: $70,949,000

REVENUE LOST — 12,661,000

TOTAL $83,610,000

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ALTERNATIVE 4

BULB TURBINES 3- 18 MW

POWER HOUSE/TURBINE COSTS-SEE ALTERNATIVE 3 (BULB TURBINES) -- 39,526,000

SITE SPECIFIC ESTIMATES

REMAIN EXIST POWER HOUSE: ASSUME COMPLETE DEMOLITION --- 3,300,000

REMOVE UNIT 10 & SLUICE WAY --- 1,700,000

HEAD RACE EXCAVATION

ROCK 421,000 CY @ 20.00/CY -- 8,420,000

FILL 147,500 CY @ 8.00/CY -- 1,180,000

CONC 2,200 CY @ 50.00/CY -- 110,000

POWER HOUSE EXCAVATION

ROCK 95,500 CY @ 20.00/CY - 1,910,000

CUT OFF DIKE

FILL 17,000 CY @ 2.00/CY - - 34,000

SHEET PILING 7700 SF @ 13.00/SF - - 100,000

COMPUTATION SHEET

Date 30/7/80 | Page of

Name of Office: CORPS OF ENG ST PAUL DISTRICT | Project: ST. MARYS HYDRO POWER

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ALT 4 - BULB TURBINES

DEWATERING
HEAD RACE
FILL 76300 CY @ 10^{00}/CY --- 763,000
EXCA 54,125 CY @ 8^{00}/CY --- 433,000
PUMPING --------- 259,000

POWER HOUSE
PILING 67800 LF @ 17^{00}/LF --- 1,153,000
CELL FILL 19500 CY @ 10^{00}/CY --- 195,000
PUMPING --------- 286,000

NEW DIKE
FILL 97300 CY @ 2^{00}/CY --- 195,000
CONC 2500 CY @ 100^{00}/CY --- 250,000

PERFORATED DRAIN PIPE 1530 LF @ 10^{00}/LF = 15,000

REMOVE CRIB DAM, 3400 CY @ 40^{00}/CY = 136,000

CLOSE SABIN LOCK SLUICEWAY --- 210,000

SITE SPECIFIC SUBTOTAL = 20,649,000

SUBTOTAL = 60,175,000

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Name of Office	Project
[illegible] DIST	ST. MARYS HYDRO POWER

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[illegible]			

ALT 4 - BULB TURBINES

MOBILIZATION, SITE PREP, ETC ≅ 1%	602,000
SUBTOTAL	60,777,000
ENERGY REVENUE LOST - US PLANT & UNIT 10, FOR 2 YEARS (USE 24.4 MILLS PER KWH BASED ON FERC POWER VALUES - 1980)	7,866,000
CAPACITY REVENUE LOST - US PLANT & UNIT 10, FOR 2 YEARS (USE $130.30/KW BASED ON FERC POWER VALUES - 1980)	4,795,000
CONTINGENCIES (15%)	9,117,000
SUBTOTAL	69,894,000
INDIRECT COSTS (25%)	17,474,000
SUBTOTAL	$87,368,000
REVENUE LOST	12,661,000
TOTAL =	$100,029,000

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COMPUTATION SHEET

Date 30/7/80	Page of

Name of Office	Project
COE - ST. PAUL DISTRICT	ST. MARYS HYDROPOWER

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DRR. SC. Z.B.			

ALTERNATIVE 4

TUBE TURBINES - 10 - 5.25 MW

POWER HOUSE/TURBINE COSTS - SEE
ALTERNATIVE 3 (TUBE TURBINES) - - 32,033,000

SITE SPECIFIC ESTIMATES

REHAB POWER HOUSE:
ASSUME COMPLETE DEMOLITION - - - 3,300,000

REMOVE UNIT 10 & SLUICE WAY - - - - - 1,700,000

HEAD RACE EXCAVATION
ROCK 421,000 CY @ 20.00/CY - - - 8,420,000
FILL: 147,500 CY @ 8.00/CY - - - 1,180,000
CONC: 2,200 CY @ 50.00/CY - - - 110,000

POWER HOUSE EXCAVATION
ROCK 5200 CY @ 20.00/CY - - - 104,000

CUTOFF DIKE
FILL 13200 CY @ 2.00/CY - - - 26,000
SHEET PILING 6,000 SF @ 13.00/SF - - - 76,000

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COMPUTATION SHEET

Name of Office	Project	Date	Page
[illegible] PAUL DISTR[illegible]	ST. MARYS HYDROPOWER	30/7/80	of

Computed by	Checked by	Approved by	Price Level
DEC [illegible] DR			

ALT 4 – TUBE TURBINES

DEWATERING	
HEADRACE	
FILL 76,300 CY @ 10.00/CY ---	763,000
EXCA. 54,125 CY @ 8.00/CY ---	433,000
PUMPING ---	259,000
POWERHOUSE	
PILING 76,200 LF @ 17.00/LF --	1,295,000
CELL FILL 22,000 CY @ 10.00/CY --	220,000
PUMPING ---	286,000
NEW DIKE	
FILL 97300 CY @ 2.00/CY ---	195,000
CONC 2500 CY @ 100.00/CY ---	250,000
PERFORATED DRAIN PIPE: 1530 LF @ 10.00/LF –	15,000
REMOVE CRIB DAM: 3400 CY @ 40.00/CY --	136,000
CLOSE SABIN LOCK SLUICEWAY ---	210,000
SITE SPECIFIC SUBTOTAL –	18,978,000
SUBTOTAL:	$1,011,000

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Name of Office: ... DISTRICT	Project: ST. MARYS HYDROPOWER	Date: 30/7/80	Page of
Computed by: DRL, SC, DK.	Checked by	Approved by	Price Level

ALT 4 - TUBE TURBINES

MOBILIZATION, SITE PREP, ETC ≅ 1% — — — — — 510,000

SUBTOTAL = 51,521,000

ENERGY REVENUE LOST - US PLANT & UNIT 10 FOR 2 YEARS (USE 24.4 MILLS PER KWH, BASED ON FERC POWER VALUES - 1980) — — — — — — 7,866,000

CAPACITY REVENUE LOST - US PLANT & UNIT 10 FOR 2 YEARS (USE $30.39/KW BASED ON FERC POWER VALUES - 1980) — — — 4,795,000

CONTINGENCIES 15% — — — — 7,728,000

SUBTOTAL 59,249,000

INDIRECT COSTS 25% — — — — 14,812,000

SUB TOTAL — — — $74,061,000

REVENUE LOST — — — — — — 12,661,000

TOTAL — — $86,722,000

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COMPUTATION SHEET

NAME OF OFFICE: COE - ST. PAUL DISTRICT | COMPUTATION: ALTERNATIVE 2 | DATE: 7/7/80 | PAGE OF PAGES

SUBJECT: 7.6 ST. MARYS HYDRO POWER - QUANTITY SUMMARY

PRICE LEVEL

COMPUTED BY: S.C. | CHECKED BY | APPROVED BY

	UNIT	8-5 MW TUBES	3-12.5 MW VERTICAL PROPELLER	3-12.5 MW BULB TURBINES
HEADRACE EXCAVATION				
ROCK	CY	350,000	350,000	350,000
SOIL	CY	250,000	250,000	250,000
FILL BETWEEN CHANNEL & LOCK WALL	CY	249,200	250,600	324,900
CONCRETE	CY	870	870	870
POWERHOUSE EXCAVATION				
ROCK	CY	10,200	54,200	53,900
SOIL	CY	28,200	26,000	14,400
CUTOFF DIKE				
FILL	CY	29,400	34,000	43,400
SHEETPILING	SF	8,360	9,690	12,350
TAILRACE				
ROCK EXCAVATION	CY	25,800	22400	15600
SOIL "	CY	248,200	209,800	103400
DEWATERING				
HEADRACE (EARTH COFFERDAM)				
FILL	CY	76,260	76260	76260
SOIL EXC	CY	54125	54125	54125
POWERHOUSE (SHEET PILE CELLS)				
PILING (PSA 23)	LF	63000	60,200	75,000
CELL FILL	CY	18200	17,350	21,700
PERFORATED DRAIN PIPE	LF	1530	1530	1530

NCS Form 15 22 Dec 75

COMPUTATION SHEET

NAME OF OFFICE	COMPUTATION	DATE	PAGE OF PAGES
C of E - ST. PAUL DISTRICT	ALTERNATIVE 3	7/8/80	

SUBJECT: ST. MARYS HYDROPOWER — QUANTITY SUMMARY

PRICE LEVEL

COMPUTED BY: I.C | CHECKED BY: | APPROVED BY:

	UNIT	10-5MW TUBE	5-10MW VERT. PROP.	3-18MW BULB
HEADRACE EXCAVATION				
ROCK	CY	349,200	349,200	349,200
SOIL	CY	256,600	258,800	250,000
FILL (BTW CHANNEL & LOCKWALL)	CY	123,000	111,700	249,200
CONC	CY	870	870	870
POWERHOUSE EXCAVATION				
ROCK	CY	12800	45000	102700
SOIL	CY	35100	41800	14400
CUTOFF DIKE				
FILL	CY	25400	22700	29400
SHEET PILING	SF	7200	6500	8360
TAILRACE EXCAVATION				
SOIL	CY	307,400	332,500	298,200
ROCK	CY	65800	83600	25800
REMOVE PORTION OF CENTER DIKE				
ROCK	CY	11600	11600	11600
CONC (12")		380	380	380
DEWATERING				
HEADRACE				
COFFERDAM FILL	CY	76300	76300	76300
SOIL EXCAVATION	CY	54125	54125	54125
POWERHOUSE				
PILING (PS-23)	LF	78600	88500	63000
CELL FILL	CY	22700	25500	18200
PERFORATED DRAIN PIPE	LF	1530	1530	1530

NCS Form 15 22 Dec 75

COMPUTATION SHEET

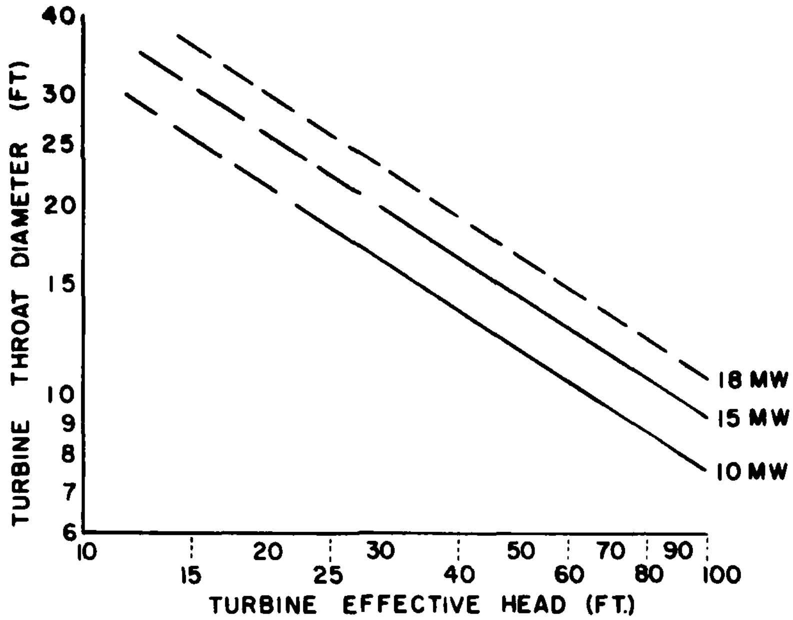
NAME OF OFFICE: C OF E - ST. PAUL DISTRICT | COMPUTATION: ALTERNATIVE 4 | DATE: 7/9/80 | PAGE OF PAGES

SUBJECT: ST MARYS HYDRO POWER - QUANTITY SUMMARY | PRICE LEVEL

COMPUTED BY: S.C | CHECKED BY | APPROVED BY

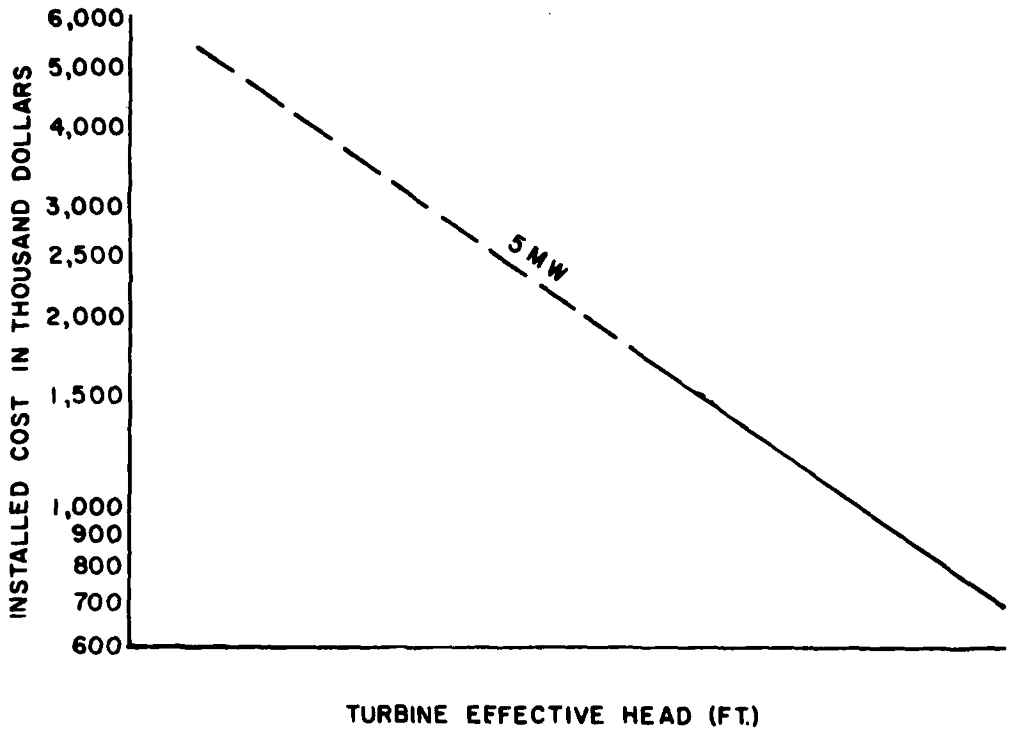
	UNIT	TUBE	VERT PROP	BULB
HEADRACE EXCAVATION				
ROCK	CY	421,000	421,000	421,000
SOIL	CY	147,500	147,500	147,500
CONC	CY	2200	2200	2200
NEW DIKE	CY	97300	97300	97300
NEW CONC	CY	2500	2500	2500
CUTOFF DIKE				
FILL	CY	13200	12300	17000
SHEET PILING	SF	6000	5600	7700
POWERHOUSE				
ROCK EXCAVATION	CY	5200	50,000	95500
DEWATERING				
HEADRACE				
SOIL EXC	CY	54125	54125	54125
COFFERDAM FILL	CY	76300	76300	76300
POWER HOUSE				
PILING (PSA23)	LF	76200	81100	67800
CELL FILL	CY	22000	23400	19500
PERFORATED DRAIN PIPE	LF	1530	1530	1530

NCS Form 15 22 Dec 75



PROPELLER TURBINE THROAT DIAMETER
(extended)

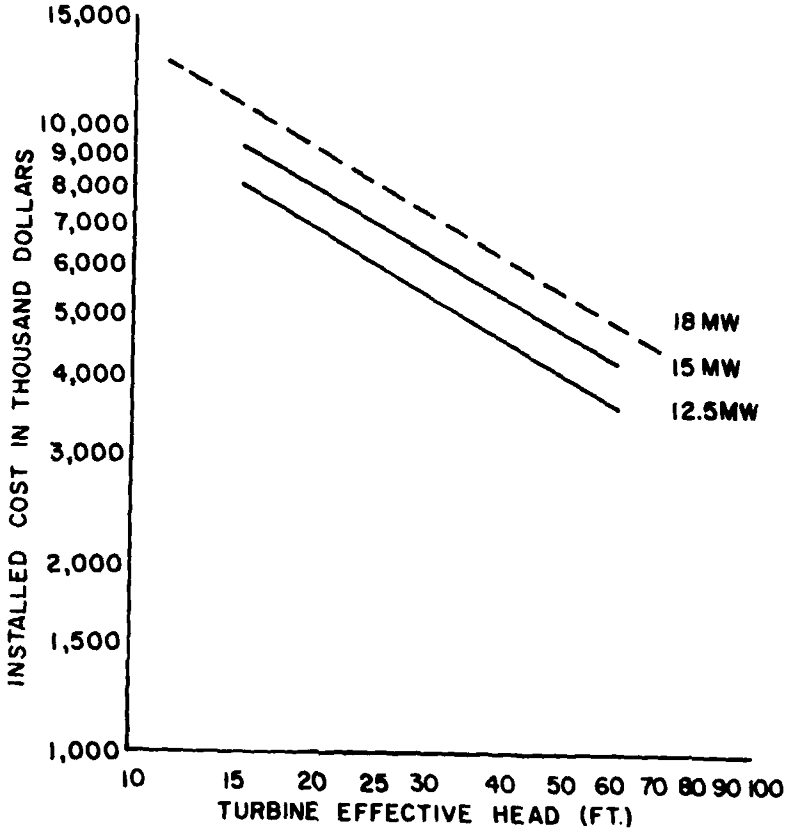
REF. FIG. 3-7 VOL. V HEC MANUAL



STANDARD TUBE TURBINE COSTS
(extended)

REF. FIG. 3-14 VOL. V HEC MANUAL

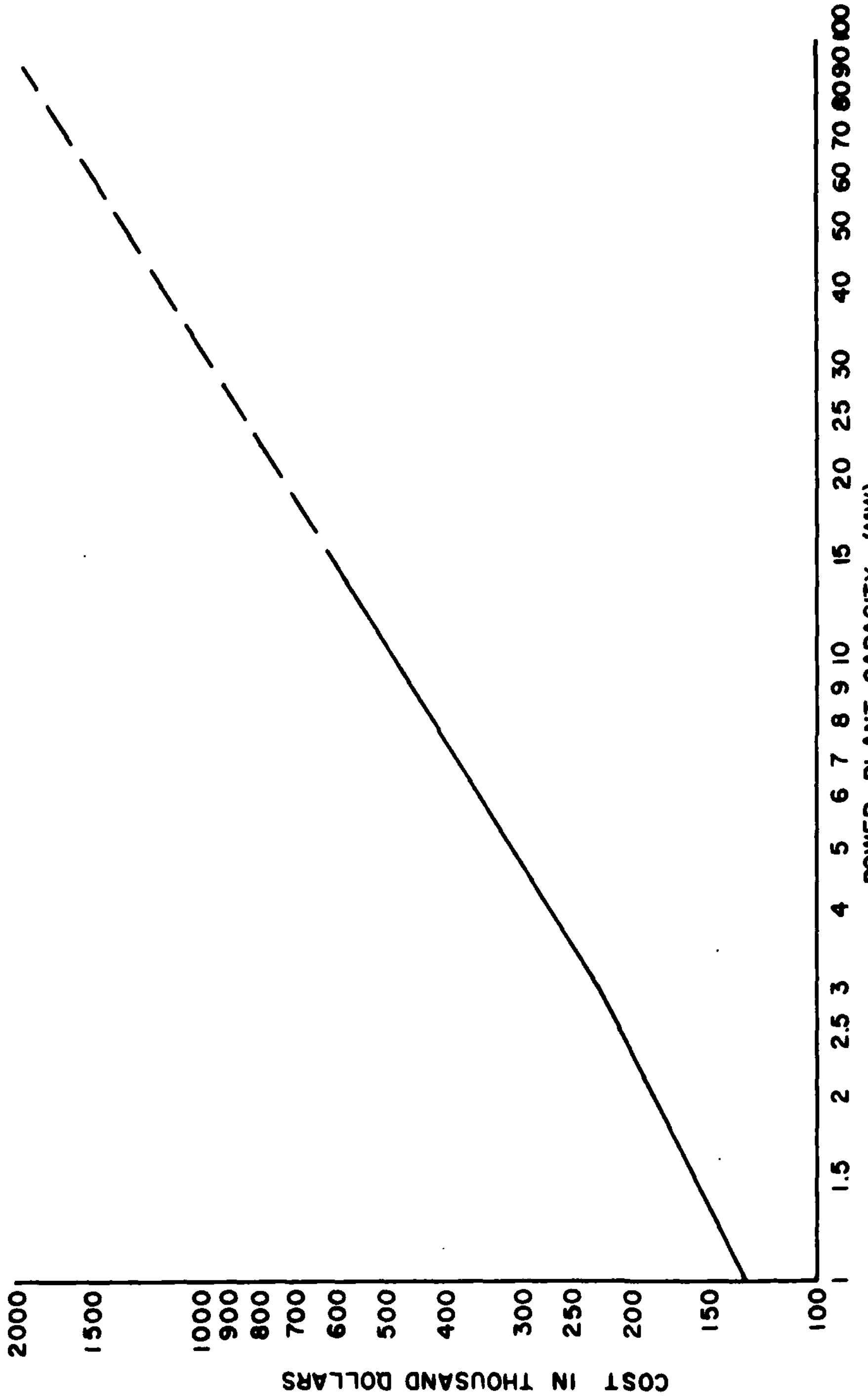
FIGURE A-20



BULB TURBINE COSTS
(extended)

REF. FIG. 3-15 VOL. V HEC MANUAL

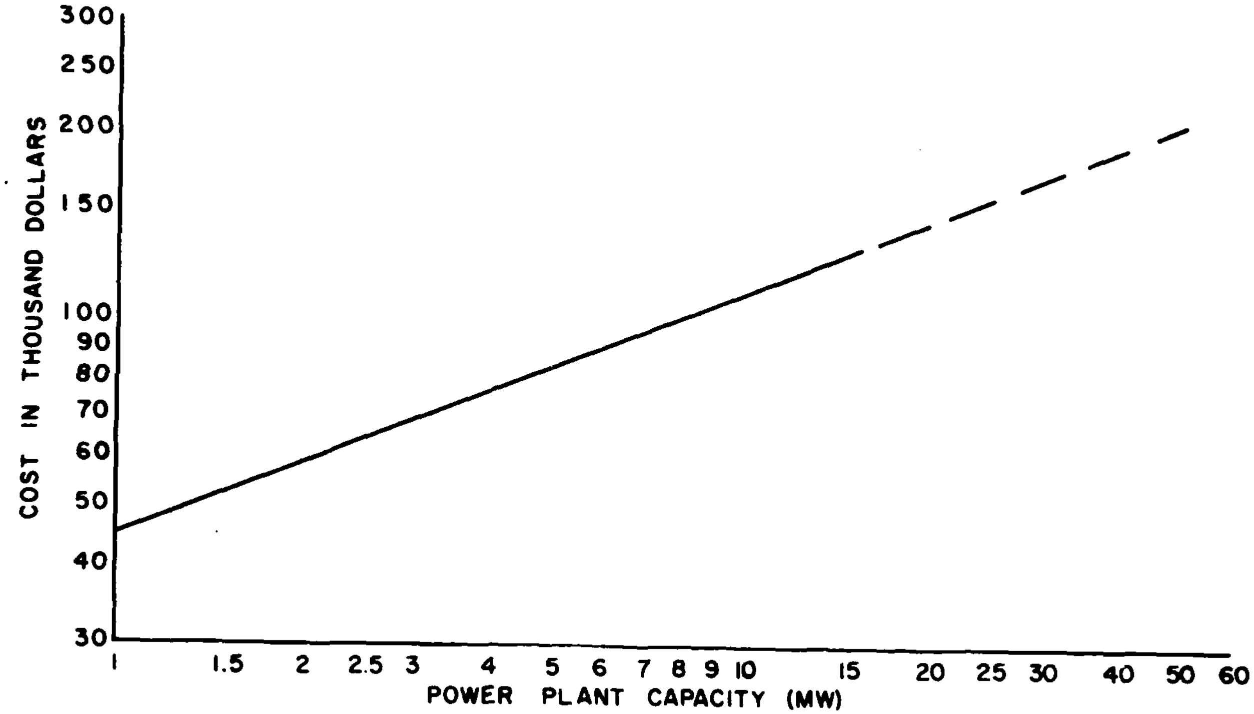
FIGURE A-21



STATION ELECTRICAL EQUIPMENT COSTS
(extended)

REF. FIG. 4-5 VOL V HEC MANUAL

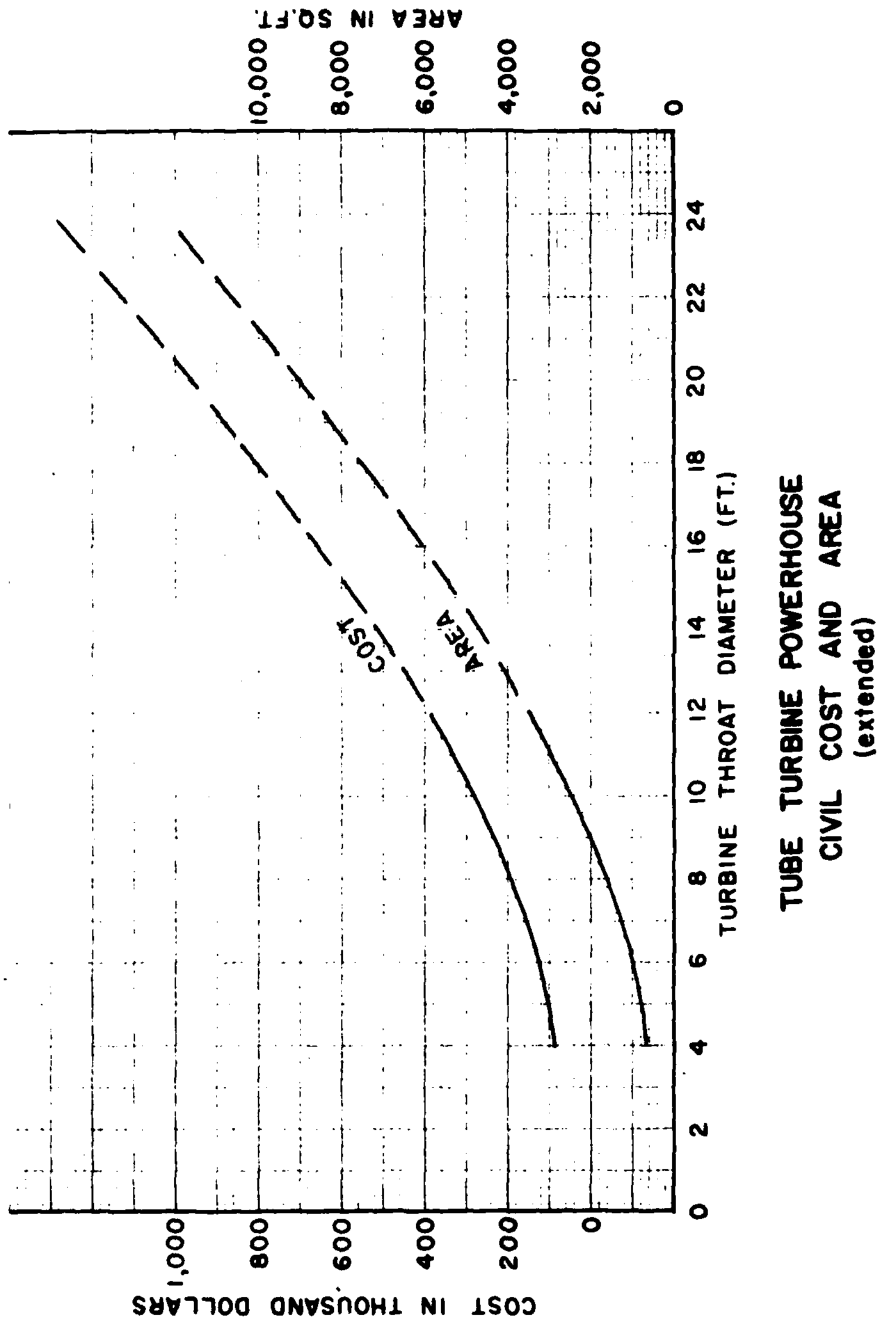
FIGURE A-22



MISCELLANEOUS POWER PLANT EQUIPMENT COSTS
(extended)

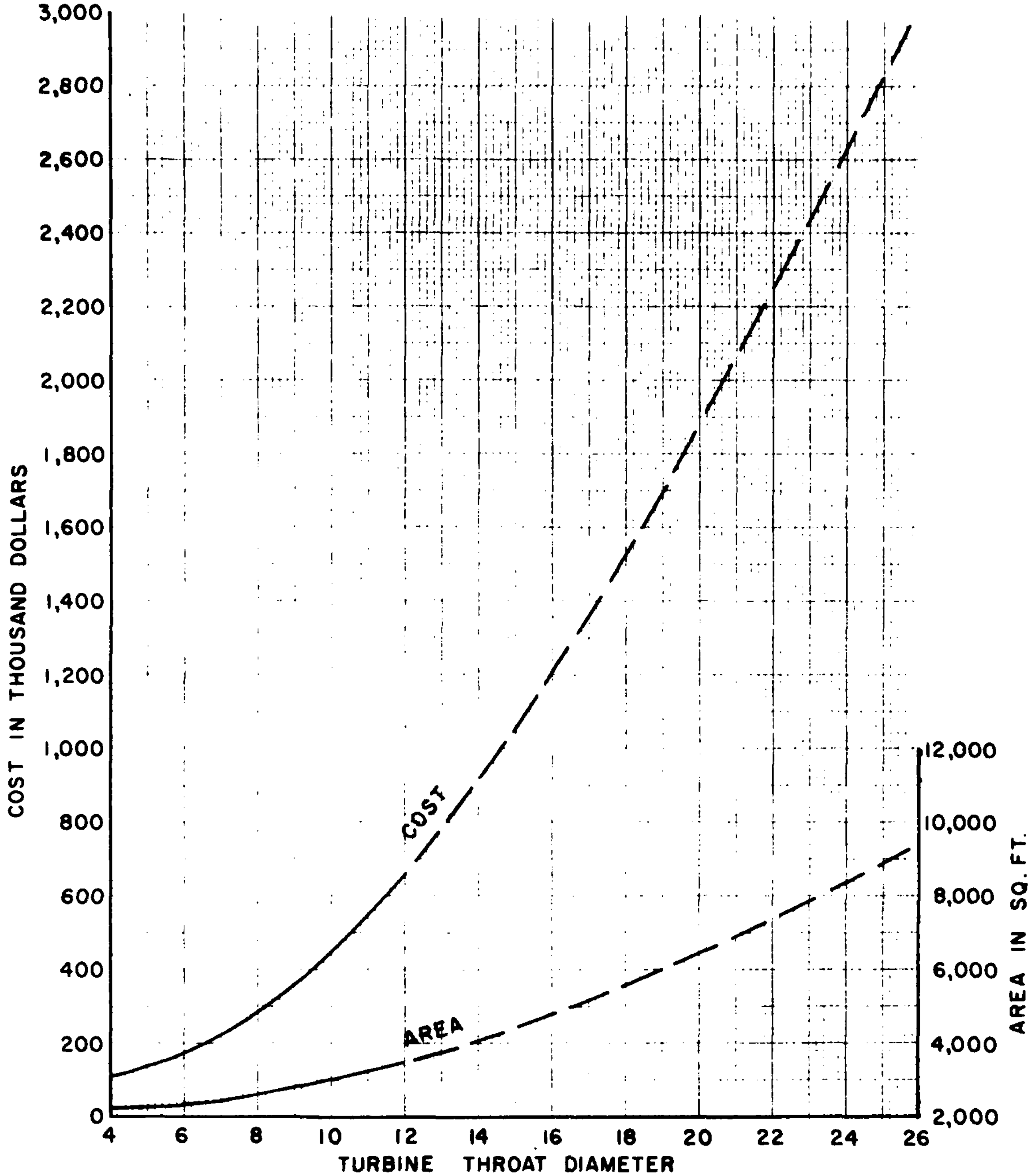
REF. FIG. 6-5 VOL. V HEC MANUAL

FIGURE A-23



REF. FIG 4-2 VOL VI HEC MANUAL

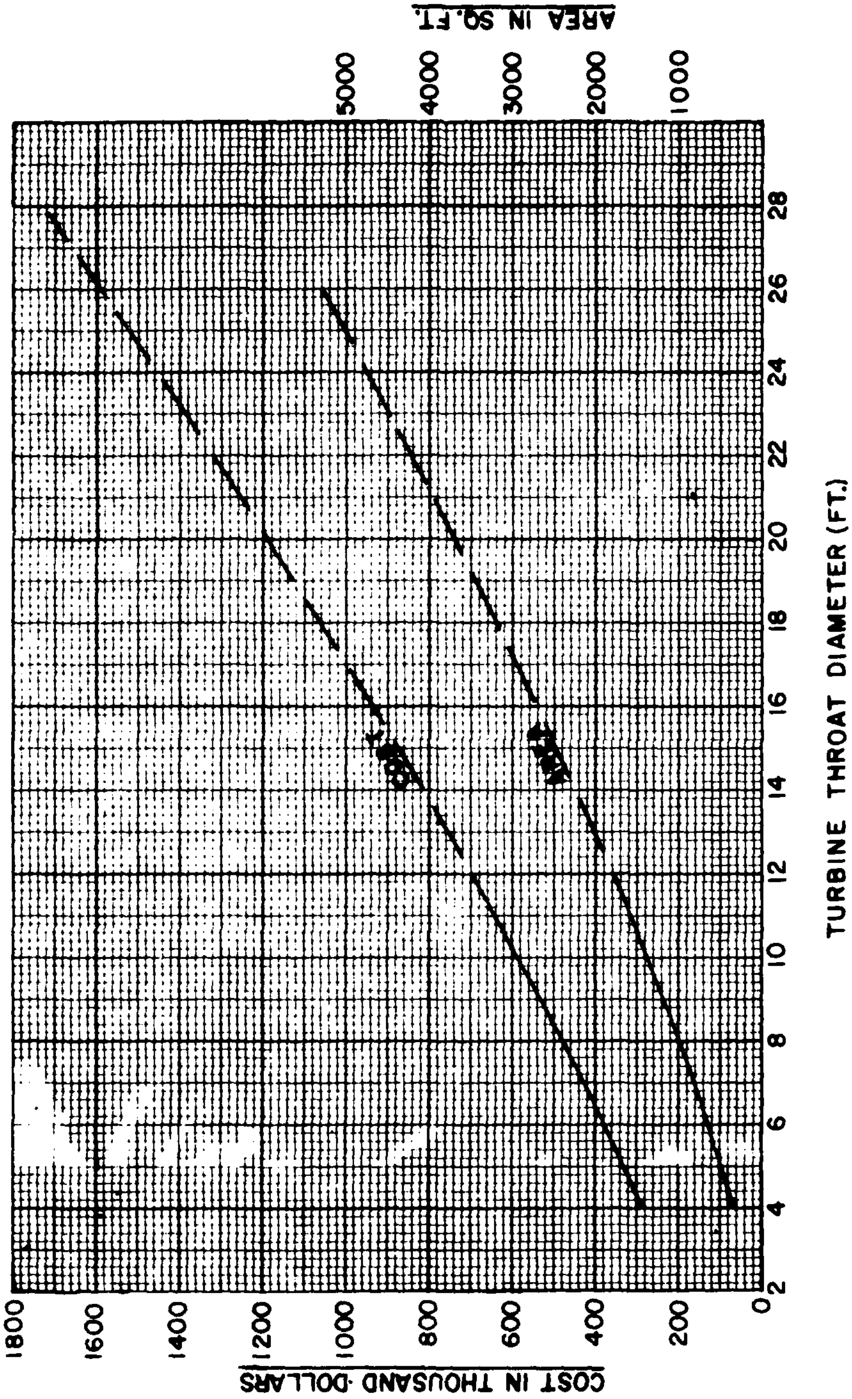
FIGURE A-24



BULB TURBINE AND RIM TURBINE POWERHOUSE CIVIL COST AREA
(extended)

REF FIG 4-3 VOL. VI HEC MANUAL

FIGURE A-25



PROPELLER TURBINE POWERHOUSE CIVIL COST AND AREA
(extended)

REF. FIG 5-4 VOL V HEC MANUAL

FIGURE A-26

SUMMARY FINDINGS

Alternative 1

Alternative 1 consists of rehabilitating the Edison Sault Electric Company Powerhouse, (see Plate A-2). Two options were considered, that of renovating 35 bays to install new standardized tube turbines and generators, and installing 32 tube turbines to drive pairs of existing generators in tandem. Investment costs were estimated at $40,305,000 and $43,703,000 respectively. Rehabilitation would result in up to 20% improvement in power output.

At a design flow of 29,400 cfs, total power of 38,500 kW could be generated. When added to the current U.S. plant capacity of 18,400 kW, the total capacity of this alternative is 56,900 kW. The total average annual energy is 434,000 MWh.

The Edison Sault Plant, completed in 1902-1903, was built on piles because of a thick layer of soft clay above bedrock. The plant experienced water seepage and erosion through the forebay and building movement in the years following construction. In 1916 and 1917 concrete buttresses were placed to bedrock at the rear of the building and ten years later a steel sheetpile cutoff was driven to bedrock across the front of the power plant. Since that time, no foundation related problems have been experienced. The existing Power Canal is 2¼ miles long and wood-lined. It appears the wood-lined portion of the canal is in good condition, but periodic repairs have been required. The canal has not been dewatered in over fifty years. The canal headgate structure appears to be in good condition, requiring only normal maintenance painting and minor repairs.

The existing Edison Sault Plant has a total of 78 turbines/generators. Most of the plants electrical system is the original installation, except for the plant substation equipment. New electrical equipment should be installed. New station service power and lighting would be required in the plant for the new equipment.

The renovated bays would be in the middle half of the power plant.

Additional concrete would be required to stiffen the floor slab and draft tube, and to dampen induced vibrations. Each turbine would be supplied with a remotely-controlled wheel gate.

The condition of the timber pile foundation is unknown. The movement prior to 1916 could have sheared off some of the piling or could have caused deformation of the piling. A detailed foundation condition investigation for the powerhouse is essential to determine the overall feasibility of installing new turbines and generators in the existing building. If the foundation is found inadequate in Stage 2 or 3 planning, the construction of an entirely new plant could be considered for this alternative. For the flow available, cursory investigations have been made for a new plant. Options considered were:

a) 12 Tube Turbines, 118" Diameter: 26.4 MW,
Investment Cost = $59,426,000

b) 15 Tube Turbines, 118" Diameter: 33 MW,
Investment Cost = $72,843,000

c) 18 Tube Turbines, 118" Diameter: 39.6 MW,
Investment Cost = $86,118,000

d) 8 Tube Turbines, 182" Diameter: 40 MW,
Investment Cost = $84,301,000

Alternative 2

Alternative 2 (see Plate A-2), consists of expanding the Corps Plant, and discontinuing use of Unit 10 and the Edison Sault Plant. An additional headrace, requiring large quantities of rock excavation, would be constructed parallel to the existing headrace. Options considered were three 12.5 MW vertical propeller units, eight 5 MW tube turbines, and three 12.5 MW bulb turbines. Investment cost estimates are $57,661,000, $66,325,000, and $70,860,000 respectively.

Average annual flow at the site is approximately 41,900 cfs. The present capacity of the U.S. power canal is 12,700 cfs. The proposed canal would have a maximum capacity of 37,000 cfs at a velocity of 3.5 fps. This capacity was selected as the design discharge for alternatives 2, 3, and 4. The effective net power head used in the capacity and energy calculations is 19.5 feet. The total capacity of this alternative is 52,600 kW. The total average annual energy is 432,000 MWh.

Extensive channel and structural excavation is required. Upstream of Unit 10, headrace excavation would be primarily in bedrock. Blasting would be required for most of the excavation to design depths. Excavation near bridge piers and existing walls must be controlled to avoid damage to existing structures.

The generators and turbines in the Corps Plant are in good condition. Almost all of the electrical equipment in the existing plant would be used as it now exists. The Corps Plant building also is in good condition.

Alternative 3

Alternative 3 (see figure A-16) consists of constructing a new powerplant south of the existing Corps Plant, and discontinuing use of the Corps Plant, Unit 10, and Edison Sault Plant. Options considered were five 10.5 MW vertical propeller turbines, ten 5.25 MW tube turbines, and three 18 MW bulb turbines. Investment cost estimates are $74,844,000, $77,061,000 and $89,434,000 respectively.

To minimize power revenues that would be lost during construction of the new plant, the existing Corps Plant would continue to operate until the new plant is in service. A new headrace would be built to augment flows from the existing headrace. The new plant is located south of the existing powerhouse to reduce rock excavation.

Hydraulic and geotechnical considerations are similar to Alternative 2.

Alternative 4

Alternative 4 consists of renovating and installing new equipment in the existing Corps Plant, and discontinuing use of Unit 10 and the Edison Sault Plant. Options considered were five 10.5 MW vertical propeller turbines, ten 5.25 MW tube turbines, and three 18 MW bulb turbines. Investment cost estimates are $83,610,000, $86,722,000, and $100,029,000 respectively.

This alternative is similar to Alternative 3, except that in place of abandoning the existing powerhouse, the powerhouse would be extensively modified. Only the upstream wall, gates, trashracks, and part of the foundation would be retained for tube turbines. The powerhouse also must be expanded southward, (see figure A-18). Power generation would not be continued during construction, resulting in lost energy and revenues.

FUTURE PLANNING CONSIDERATIONS

a. Study feasibility to use larger design flows in Corps Plant headrace to install larger capacity turbo-generating units and capture additional energy; compare additional investment cost with additional capacity and energy benifits.

b. Take a minimum of 4 borings in Corps Plant headrace area to study rock characteristics.

c. Take a minimum of 2 borings at proposed new power plant site.

d. At Edison Sault Plant, a detailed boring and testing program will be required at the plant and along the canal to define foundation conditions for stability, seepage and settlement evaluation.

e. Determine economic life of existing electrical system at Edison Sault Plant.

f. Prepare outline plan to update substation at Edison Sault Plant.

g. Evaluate condition of D.C. generators used for exitation in Edison Sault Plan. Determine if they can be reused in the rehabilitated plant.

h. Provide a detailed condition inspection for Edison Sault Plant headgate structure and power canal.

i. Due to the unusual existing hydraulic flow conditions at the Edison Sault Plant, a model study is recommended to determine the best location for turbine placement.

j. Provide study to determine if a single tube turbine and generator (as proposed) or one turbine driving two existing gererators at the Edison Sault Plant is more economical and feasible.

k. Recent topography surveys will be required.

l. Provide detailed design for dewatering.

m. A study should be accomplished to determine the ease of removal for the rock, to determine the cost of removal, and to determine the most economical channel cross section.

n. A detailed layout of the powerhouse should be prepared to provide adequate areas for storage, work and controls.

o. Current topography of the area is needed to accurately determine quantities.

p. A detailed foundation investigation should be accomplished in the future to provide detailed foundation information.

q. A detailed condition survey should be completed for the Headgate Structure on the Edison Sault Power Canal. This survey will determine future work needed to either maintain the structure or modify it to act as a closure in the power canal.

r. A detailed hydraulic design is needed to provide a minimum flow when the Edison Sault Powerhouse stops generating power. This design is needed to satisfy environmental concerns for the power canal.

s. Future considerations for safety and provisions for the public should be investigated further during the design stage.

t. The affect of the future lock should be taken into account when sufficient data is available to analyze its impact to the channel alignment and cross section.

u. Study the possibility of a combination of both alternatives 1 and 2, which would use the Edison Sault Plant for peaking, with operation performed remotely from the U.S. Plant.

v. Consider the use of the Edison Sault Plant for diverting excess water in place of the compensating Works to the extent of 30,000 cfs conveniently winter and summer. This would eliminate the need to electrify the compensating works.

REFERENCES

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   U.S. Army Engineer - Detroit District
   December 1974

2. Design Transmittal - Powerhouse Foundations
   St. Mary's Redevelopment Project - February 1979
   Acres Consulting Services Limited

3. Results of Laboratory Rock Core Tests
   Sault Ste. Marie - April 1976
   Corps of Engineers, Ohio River Division Laboratories

4. Borings in the Area of the Edison Sault Canal:

5. a. At Portage Avenue Bridge (1968)
   b. At Bingham Avenue Bridge (1980)
   c. At Meridian Avenue Bridge (1968)
   d. Along International Highway and Railroad Bridge Alignments (1959-1960)
   e. At Proposed Site of Great Lakes Copper Corporation southeast of Power House (1966)

6. Borings in the Area of the Locks and U.S. Power Plant:

   a. International Highway Bridge (1959)
   b. Poe Lock (1958-1959)
   c. 1907 Borings (Davis Lock)
   d. 1945 Borings (New U.S. Power Plant)
   e. 1974 Borings (Sabin Lock)
   f. 1979 Borings (Compensating Works)

7. 1979 Power System Statement
   Form 12-A

8. Drawings of New U.S. Power Plant

   a. Site Surveys (DC-171-9, 13)
   b. Probings of Upper Headrace (DC-171-8)
   c. Spoil Area Limits (DC-171-15)
   d. Evcavation Upper and Lower Headrace (DC-172-1, 3)
   e. Excavation and Dike Fill (DC-172-12)

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12. Plan and Cross Section Drawing of the Edison Sault Power Canal

13. Site Inspection - 23-27 June 1980

14. Personal Communication with Mr. Terrance Smith, NCD Geologist, Regarding Sources of Construction Material - 1980

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22. Federal Energy Requlatory Commission, Hydroelectric Power Evaluation, U.S. Dept. of Energy, 1979.

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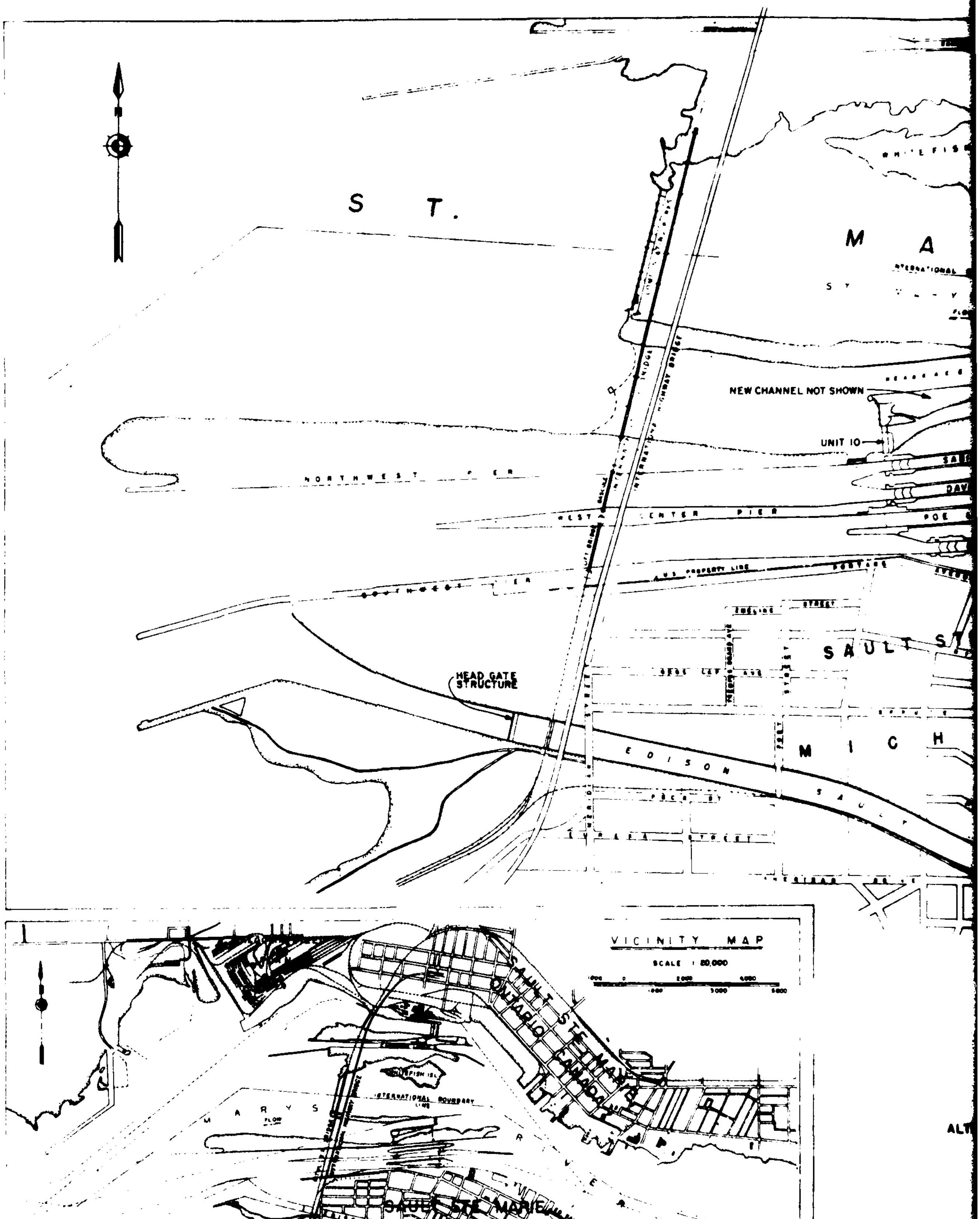
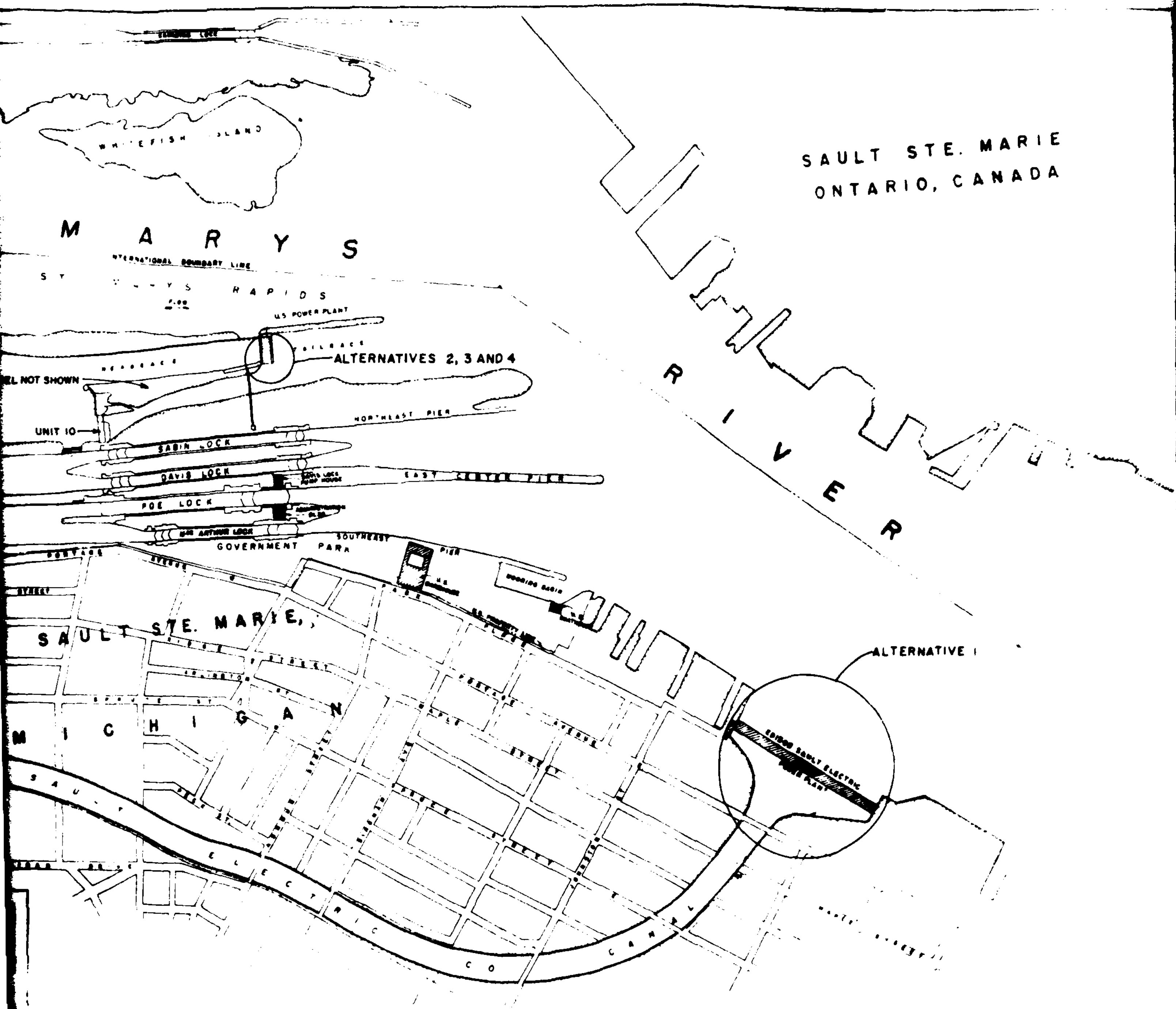

S T.
M A
NEW CHANNEL NOT SHOWN
UNIT 10
NORTHWEST PIER
WEST CENTER PIER
SOUTHWEST PIER
SAULT
HEAD GATE
STRUCTURE
EDISON
M I C H
VICINITY MAP
SAULT STE MARIE
ONTARIO
CANADA
SAULT STE MARIE
MICHIGAN



SITE MAP

SCALE 1"=400'

ALTERNATES.

1. REBUILD EDISON PLANT, CONTINUE CORPS PLANT
2. EXTEND CORPS PLANT, DISCONTINUE EDISON PLANT
3. BUILD NEW CORPS PLANT, DISCONTINUE EDISON PLAN
4. INSTALL NEW EQUIPMENT IN CORPS PLANT, DISCONTINUE EDISON PLANT

DEPARTMENT OF THE ARMY

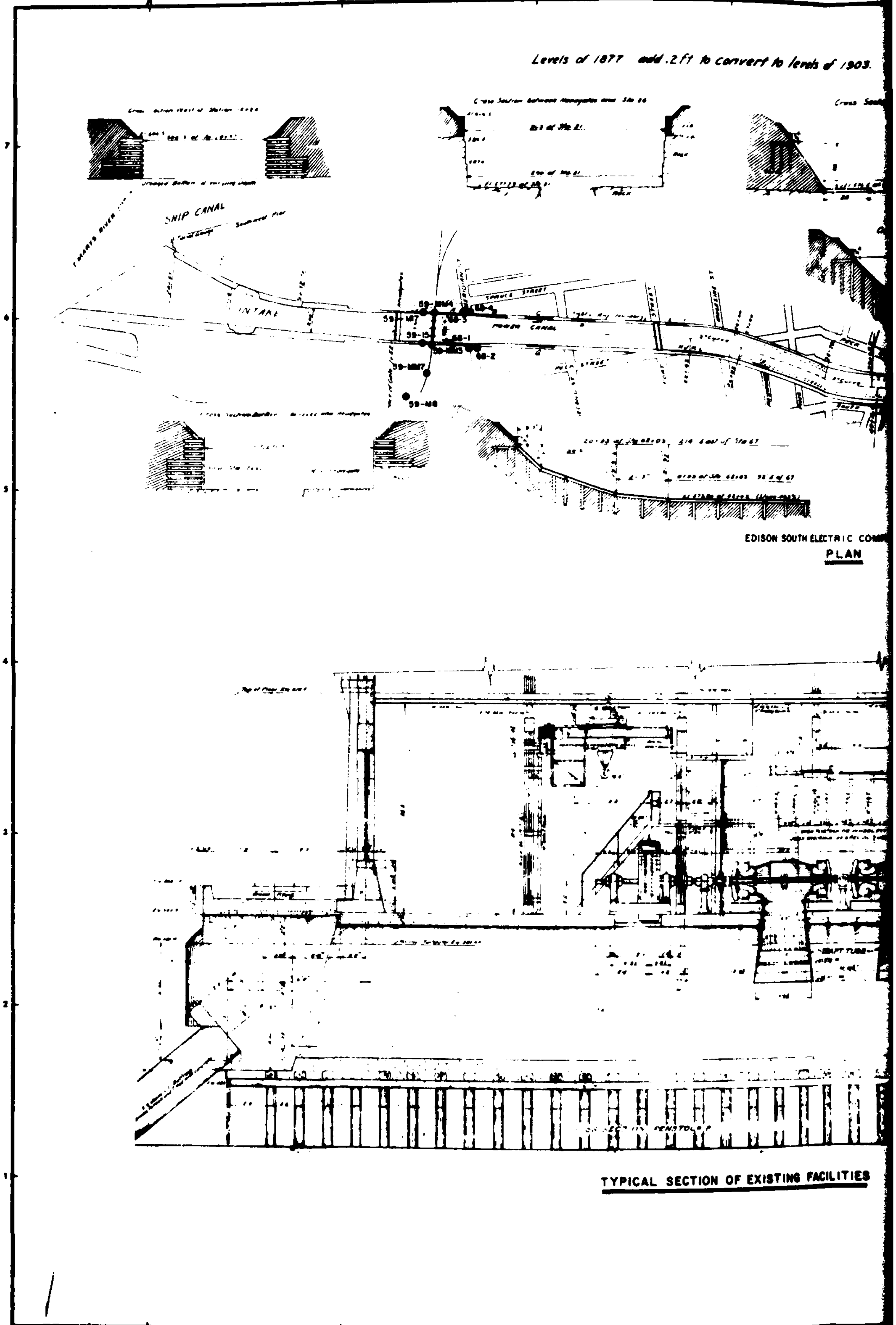
DEPARTMENT OF THE ARMY

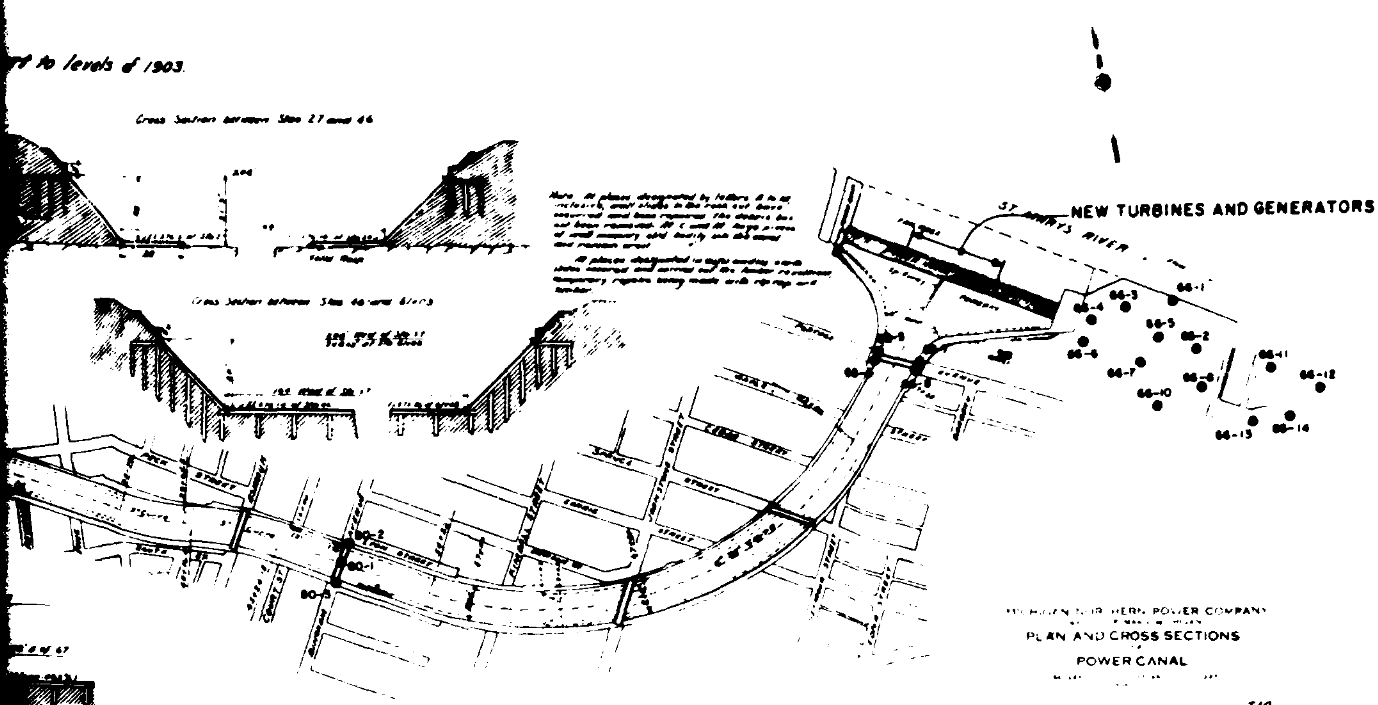
SAULT STE MARIE POWER PLANT
REDEVELOPMENT MICHIGAN
HYDROELECTRIC POWER
RECONNAISSANCE REPORT

GENERAL PLAN

APPROVED

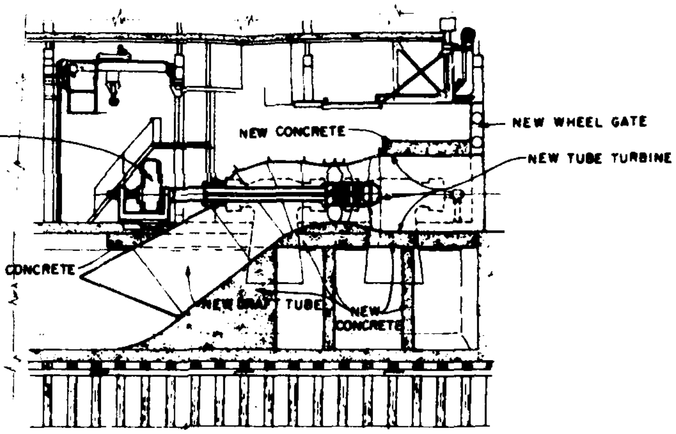
PLATE A-1


Levels of 1877 add .2 ft to convert to levels of 1903.
SHIP CANAL
INTAKE
POWER CANAL
SPRUCE STREET
59-M17
59-15
59-M8
EDISON SOUTH ELECTRIC COM
PLAN
TYPICAL SECTION OF EXISTING FACILITIES



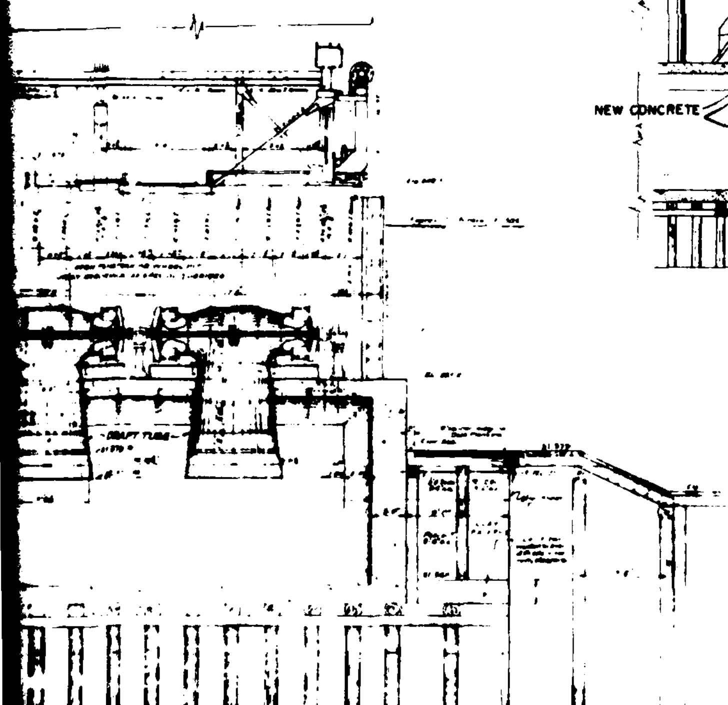
ON SOUTH ELECTRIC COMPANY POWER CANAL

PLAN



ALTERNATIVE I

SECTION



TING FACILITIES

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST PAUL DISTRICT, CORPS OF ENGINEERS
ST PAUL, MINNESOTA

DEPARTMENT OF THE ARMY
DETROIT DISTRICT, CORPS OF ENGINEERS
DETROIT, MICHIGAN

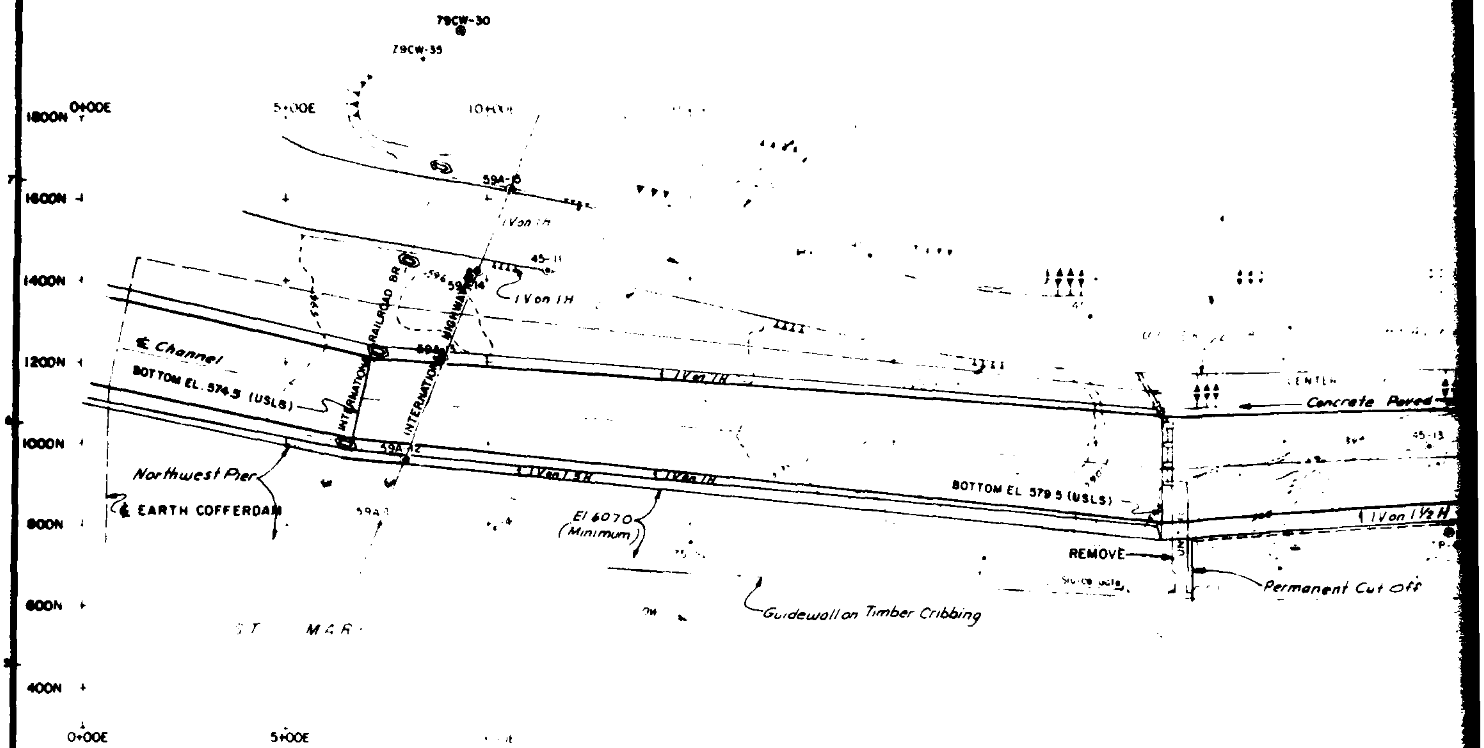
DESIGNED BY G.H., G.L.C
DRAWN BY JU
CHECKED BY G.L.C
SUBMITTED BY:
APPROVED:

SAULT STE. MARIE POWER PLANT
REDEVELOPMENT, MICHIGAN
HYDROELECTRIC POWER
RECONNAISSANCE REPORT
EDISON SAULT PLANT
PLAN & SECTIONS

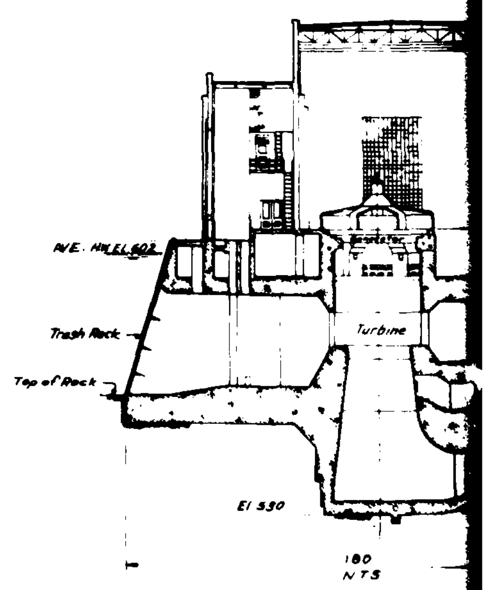
DATE

DRAWING NUMBER

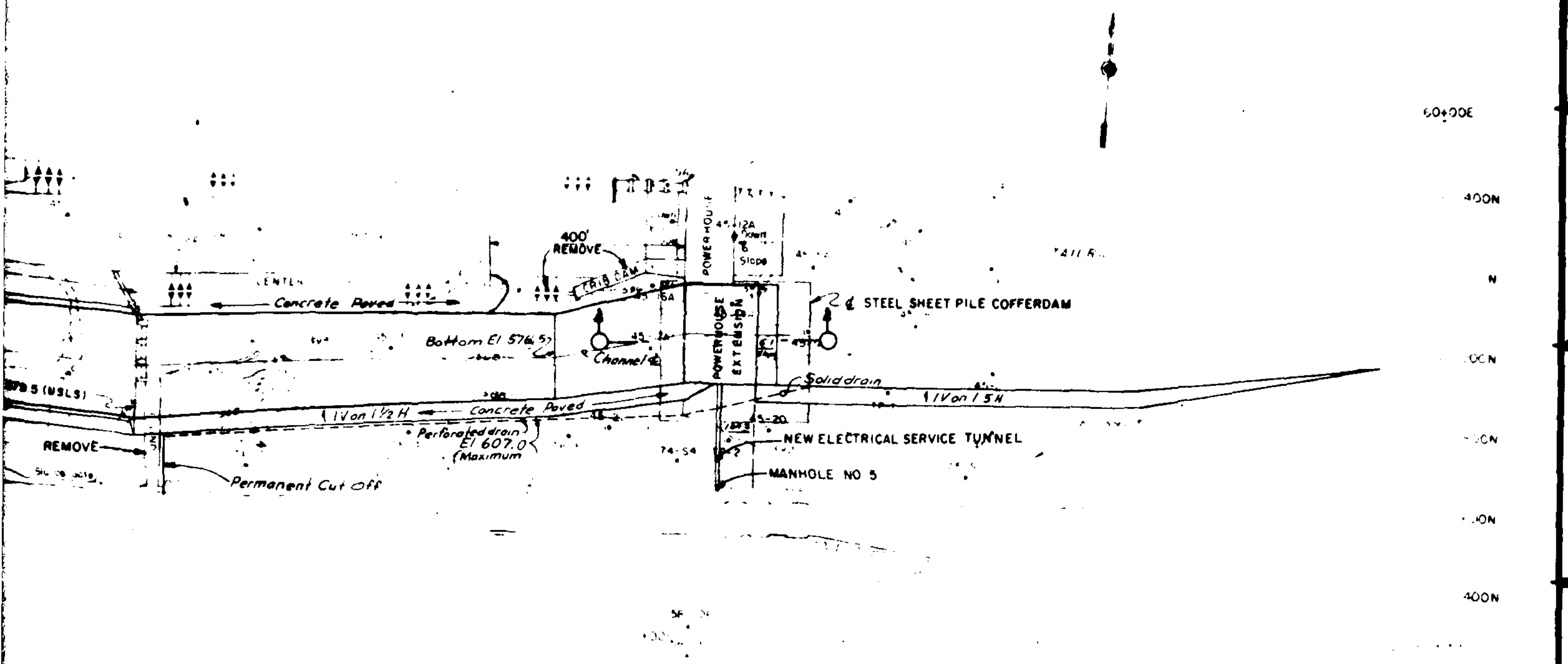
SHEET OF



ALTERNATE 2
PLAN

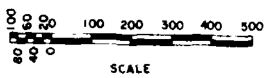


SECTION THRU POWERHOUSE EX

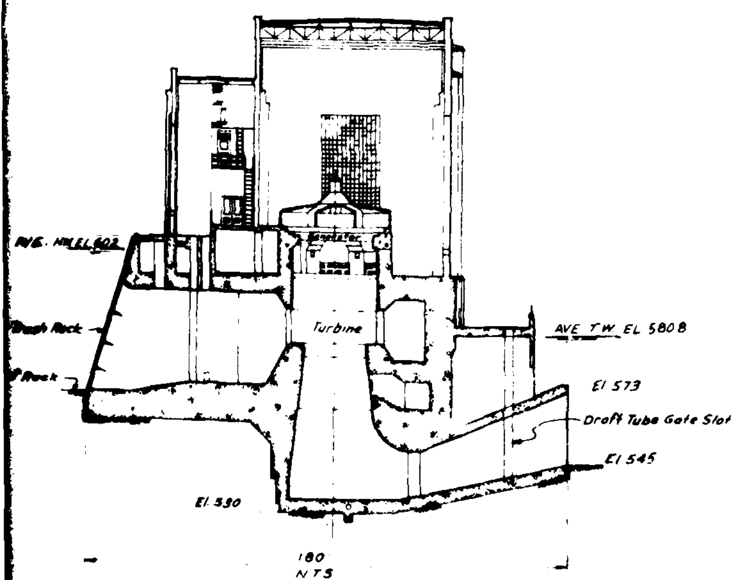


ALTERNATE 2
PLAN

NOTE CONTOURS ARE USLS DATUM; SUBTRACT 1.6' TO OBTAIN IGLD DATUM



SCALE



SECTION THRU POWERHOUSE EXTENSION

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST PAUL DISTRICT CORPS OF ENGINEERS
ST PAUL MINNESOTA

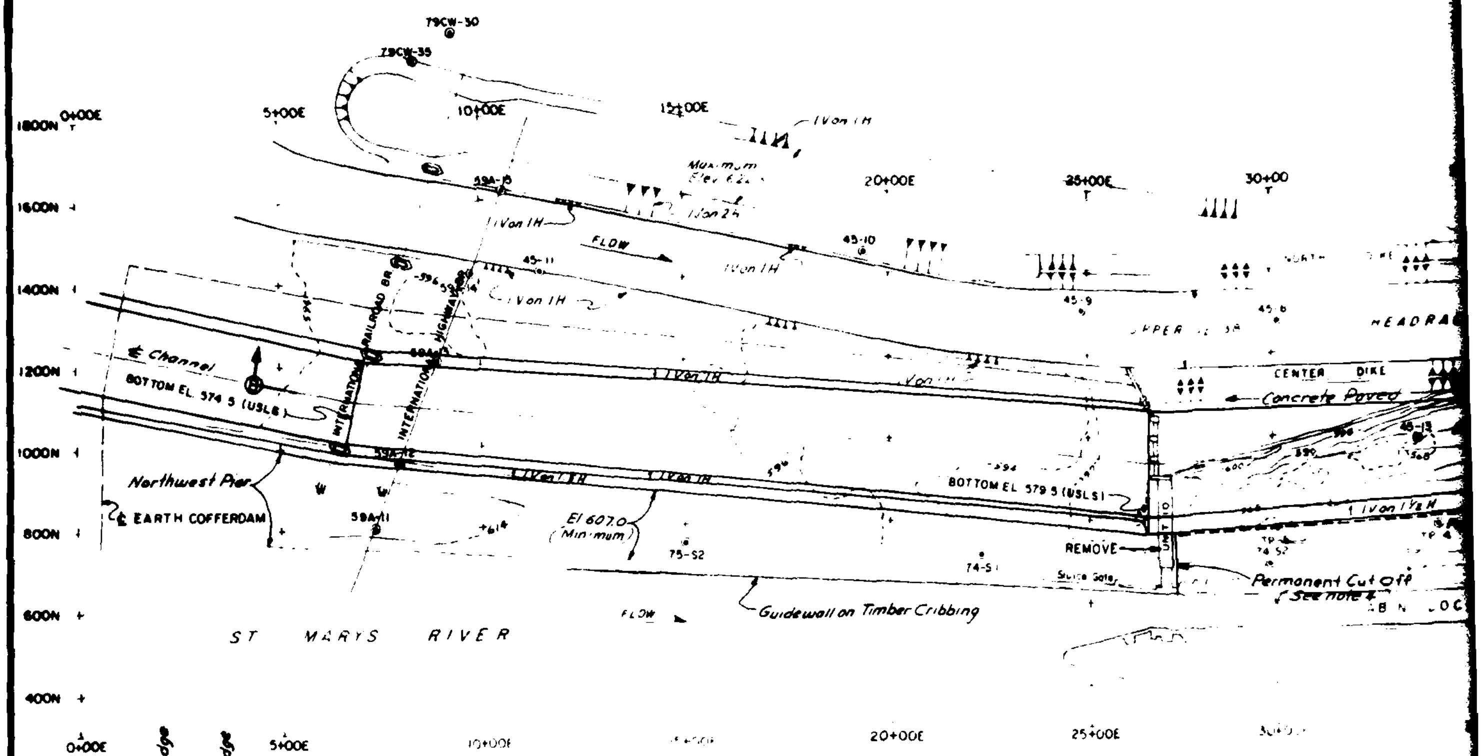
DEPARTMENT OF THE ARMY
DETROIT DISTRICT, CORPS OF ENGINEERS
DETROIT, MICHIGAN

DESIGNED BY: D.R., G.L.C
DRAWN BY: JU
CHECKED BY: GLC
SUBMITTED BY:
APPROVED:

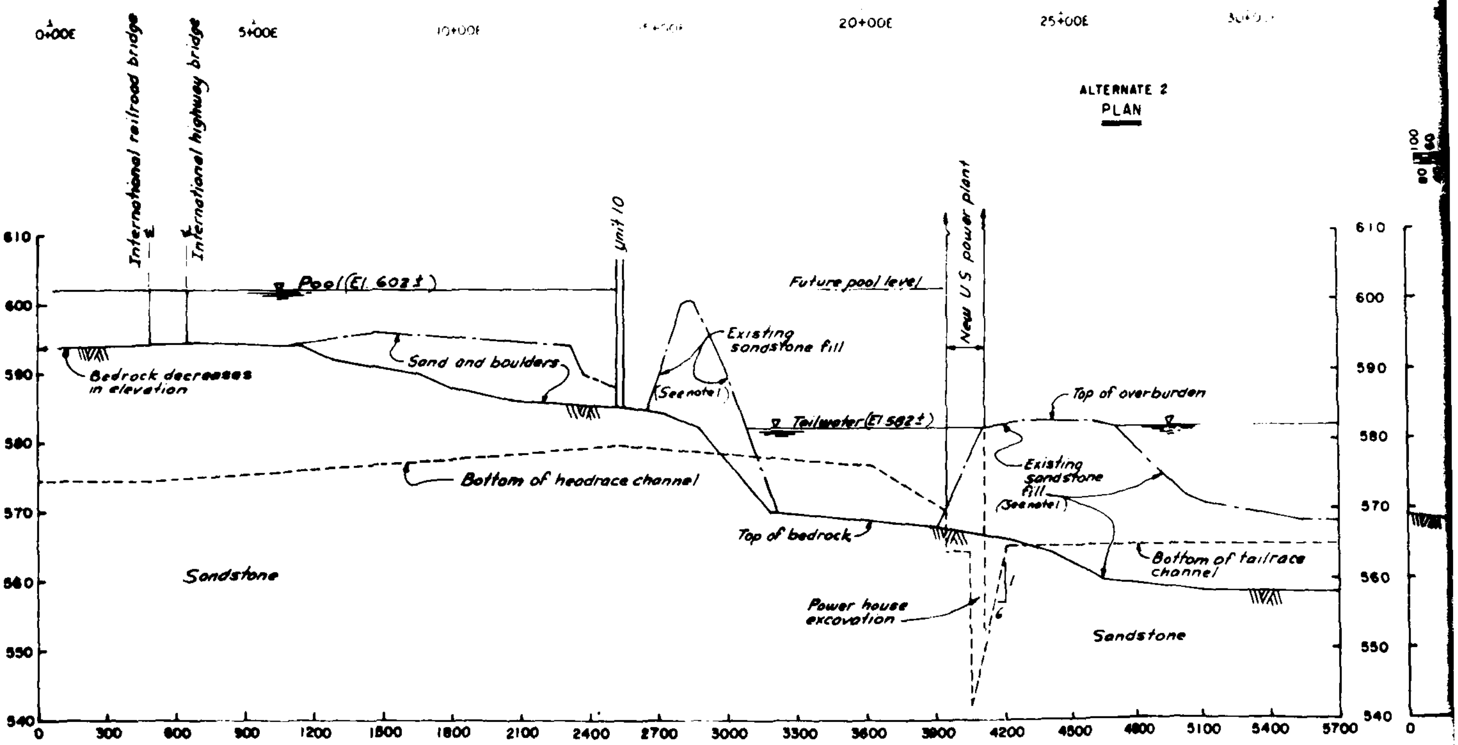
SAULT STE MARIE POWER PLANT
REDEVELOPMENT, MICHIGAN
HYDROELECTRIC POWER
RECONNAISSANCE REPORT
CORPS PLANT
PLAN & SECTION

DATE:
SCALE: AS SHOWN
DRAWING NUMBER
SHEET OF

PLATE A-3

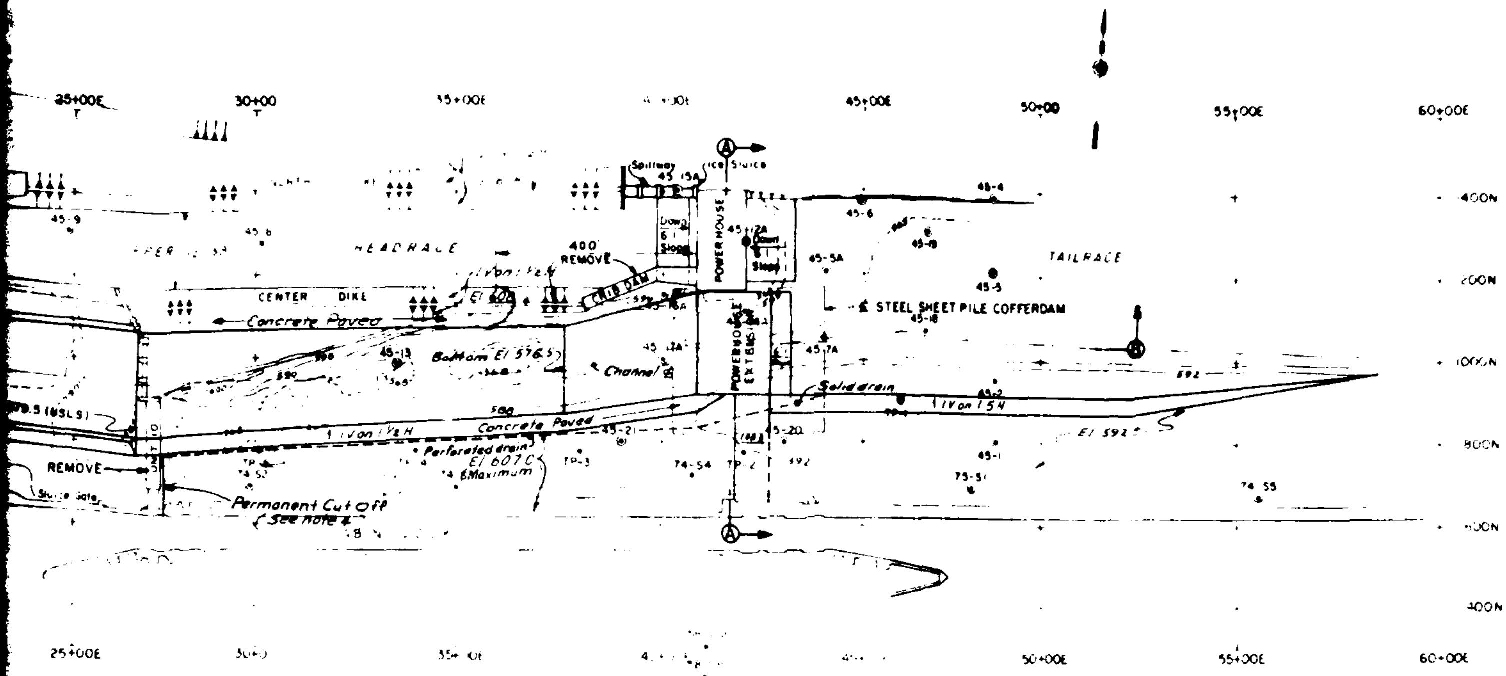


ALTERNATE 2
PLAN



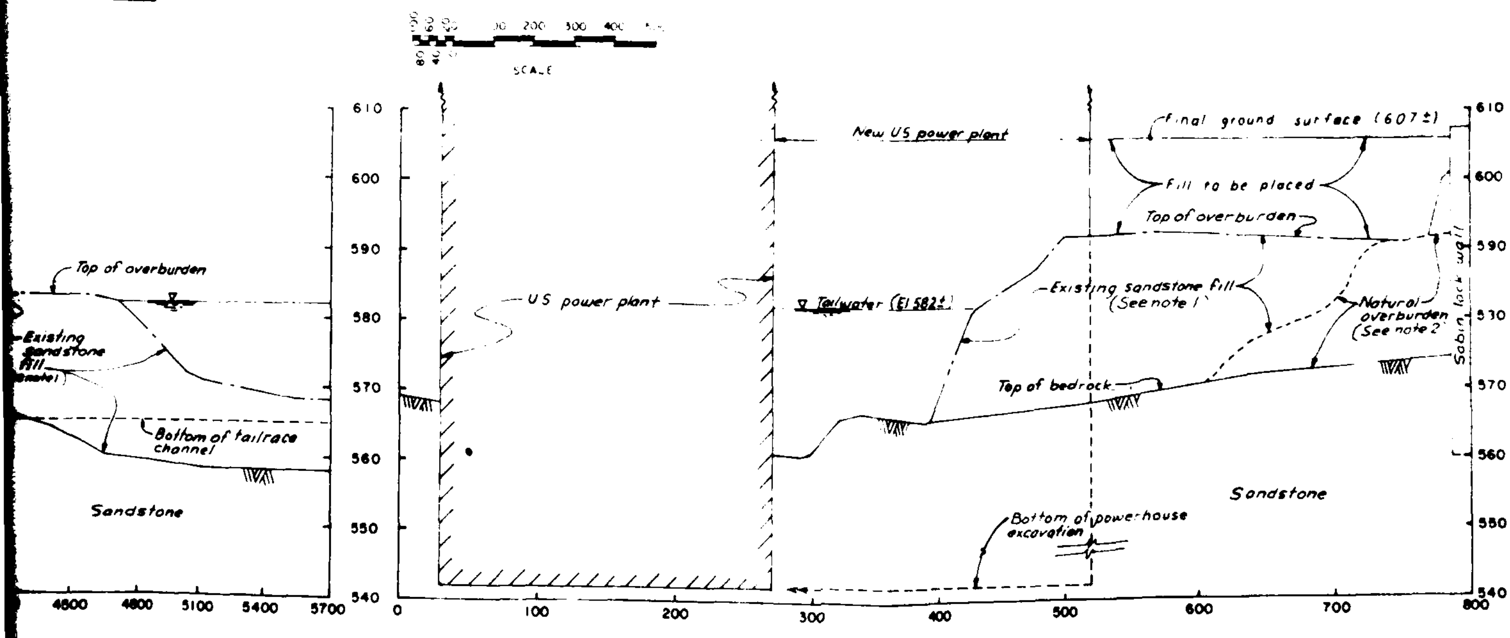
SECTION B-B
Scale 1" = 10' Vertical
1" = 300' Horizontal

NOTE: 1 Sandstone fill consists of sand, clay, gravel
2 Natural overburden consists of sand, gra
3 Elevations are U S L S datum, subtract
4 Because the overburden contains numero to bedrock and backfilled before the cut-



ALTERNATE 2
PLAN

NOTE CONTOURS ARE USLS DATUM; SUBTRACT 1.6' TO OBTAIN IGLD DATUM



SECTION A-A
Scale 1" = 10' Vertical
1" = 50' Horizontal

NOTE
1. Sandstone fill consists of sand, clay, gravel and sandstone boulders
2. Natural overburden consists of sand, gravel and some igneous boulders
3. Elevations are USLS datum, subtract 1.6' to obtain IGLD datum
4. Because the overburden contains numerous boulders, it would have to be excavated to bedrock and backfilled before the cut-off could be made

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

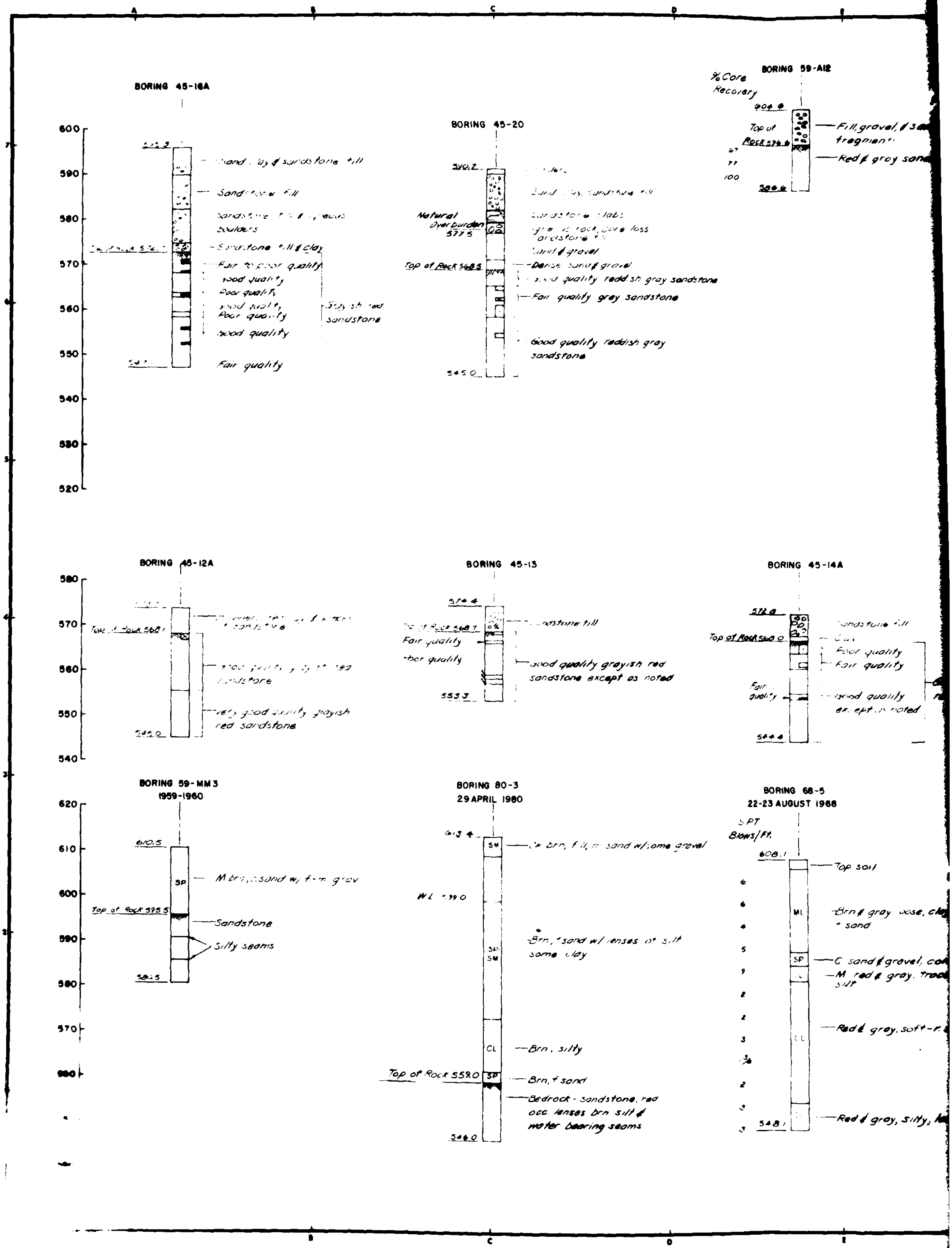
DEPARTMENT OF THE ARMY
DETROIT DISTRICT, CORPS OF ENGINEERS
DETROIT, MICHIGAN

DESIGNED BY D R
DRAWN BY JU
CHECKED BY D R
SUBMITTED BY
APPROVED

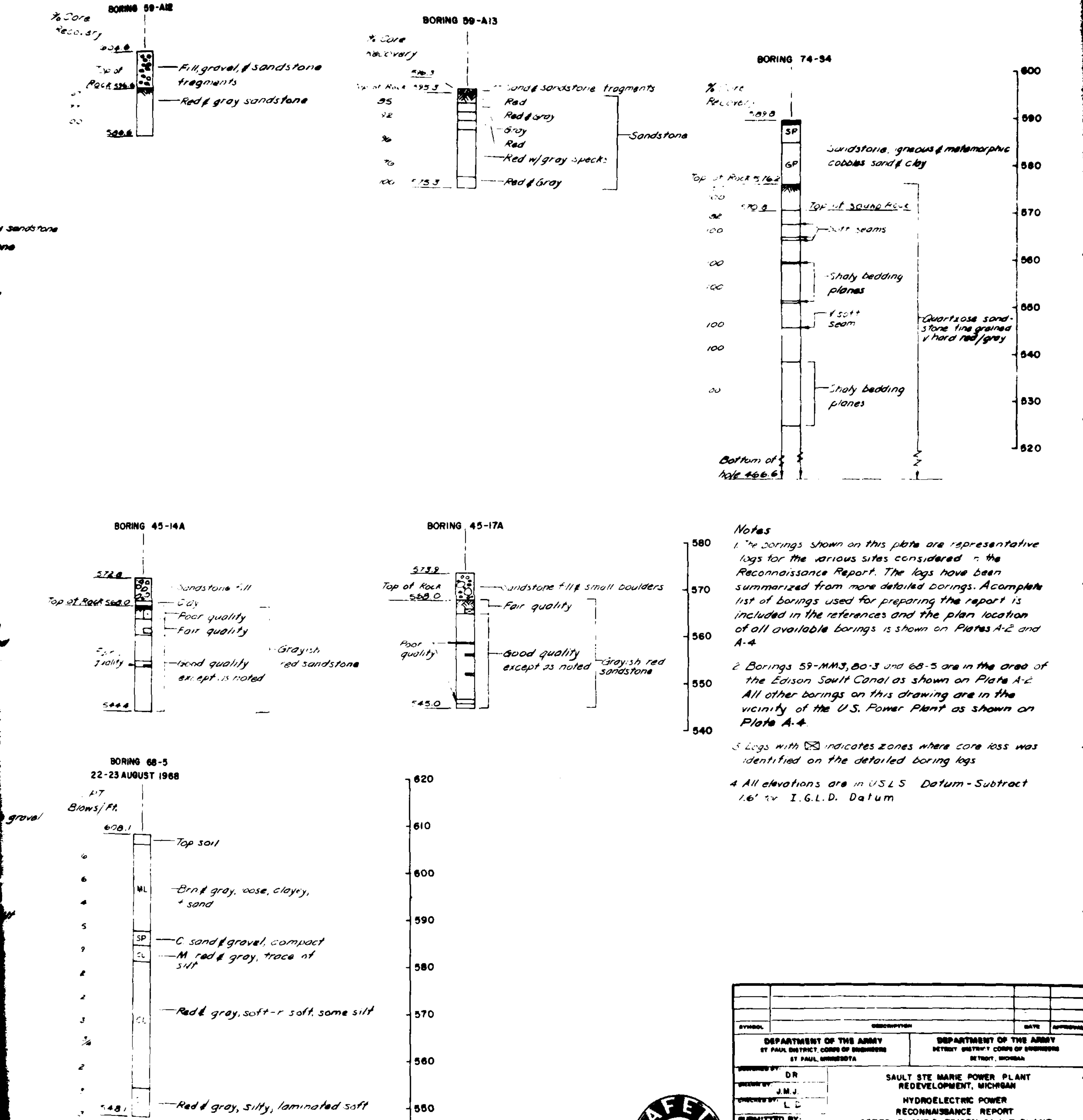
SAULT STE. MARIE POWER PLANT
REDEVELOPMENT, MICHIGAN
HYDROELECTRIC POWER
RECONNAISSANCE REPORT
CORPS PLANT
GEOLOGY & CHANNEL SECTIONS

DATE:
SCALE AS SHOWN
DRAWING NUMBER
SHEET OF

PLANT A-4



BORING 45-16A
Sand, clay & sandstone fill
Sandstone fill
Sandstone fill & clay
Fair to poor quality
Good quality
Poor quality
Good quality
Poor quality
Good quality
Fair quality
Grayish red sandstone
BORING 45-20
Natural Overburden 577.5
Top of Rock 568.5
Sandstone slabs
Sand & gravel
Dense sand & gravel
Good quality reddish gray sandstone
Fair quality grey sandstone
Good quality reddish gray sandstone
545.0
BORING 59-A12
% Core Recovery
Top of Rock 596.6
Fill, gravel, & sa
fragment
Red & gray sand
BORING 45-12A
Top of Rock 568.1
Very good quality grayish red sandstone
545.0
BORING 45-13
574.4
Top of Rock 568.7
Fair quality
Poor quality
Good quality grayish red sandstone except as noted
553.3
BORING 45-14A
572.0
Top of Rock 568.0
Poor quality
Fair quality
Fair quality
Good quality except as noted
544.4
BORING 59-MM3
1959-1960
610.5
SP
Top of Rock 595.5
Sandstone
Silty seams
580.5
BORING 80-3
29 APRIL 1980
SM
WL 599.0
SP-SM
Brn., f sand w/ lenses of silt some clay
CL
Brn., silty
Top of Rock 559.0
SP
Brn., f sand
Bedrock - sandstone, red occ. lenses brn silt & water bearing seams
546.0
BORING 68-5
22-23 AUGUST 1968
SPT Blows/Ft.
608.1
Top soil
ML
SP
C sand & gravel, co
Red & gray, soft
CL
548.1
Red & gray, silty,



Notes

1. The borings shown on this plate are representative logs for the various sites considered in the Reconnaissance Report. The logs have been summarized from more detailed borings. A complete list of borings used for preparing the report is included in the references and the plan location of all available borings is shown on Plates A-2 and A-4.
2. Borings 59-MM3, 80-3 and 68-5 are in the area of the Edison Sault Canal as shown on Plate A-2. All other borings on this drawing are in the vicinity of the U.S. Power Plant as shown on Plate A-4.
3. Logs with ⊠ indicates zones where core loss was identified on the detailed boring logs.
4. All elevations are in U.S.L.S. Datum - Subtract 1.6' to I.G.L.D. Datum

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ST. PAUL, MINNESOTA

DEPARTMENT OF THE ARMY
DETROIT DISTRICT, CORPS OF ENGINEERS
DETROIT, MICHIGAN

SAULT STE MARIE POWER PLANT REDEVELOPMENT, MICHIGAN

HYDROELECTRIC POWER RECONNAISSANCE REPORT

CORPS PLANT & EDISON SAULT PLANT
REPRESENTATIVE BORING LOGS

Designed by: DR
Drawn by: J.M.J.
Checked by: L.D.
SUBMITTED BY:
APPROVED:
DATE:

SAFETY PAYS

PLATE A-6

APPENDIX B

HYDROLOGIC AND HYDRAULIC STUDIES

Department of the Army

Detroit District, Corps of Engineers

APPENDIX B

HYDROLOGIC AND HYDRAULIC STUDIES

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APPENDIX B

HYDROLOGIC AND HYDRAULIC STUDIES

INTRODUCTION

This study, prepared by the Detroit District Corps of Engineers, Great Lakes Hydraulics and Hydrology Branch, evaluates the hydraulic and hydrologic factors which should be considered in determining the feasibility of U.S. hydroelectric power redevelopment in the St. Marys River at Sault Ste. Marie, Michigan.

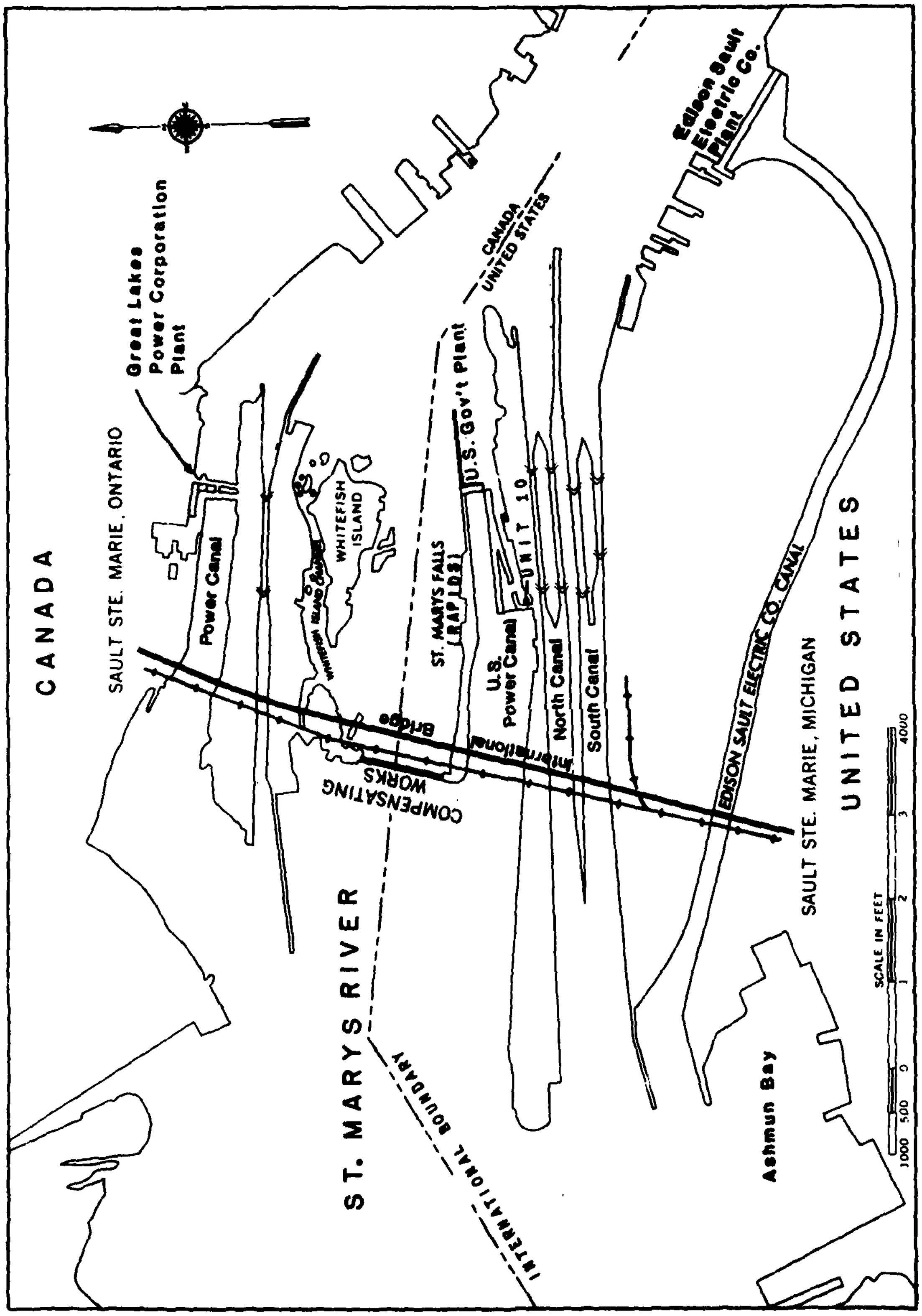
There are presently two hydroelectric power plants on the U.S. side of the St. Marys River (see Figure B-1). The Edison Sault Power Plant is located on the south side of the river and downstream of the Soo Locks. The U.S. Government Power Plant is located between the Soo Locks and the St. Marys Rapids and consists of the main plant and the Unit 10 Power Plant located just upstream of it.

In the conception of alternative plans for U.S. hydropower redevelopment, it is assumed that Canadian hydropower will use up to a maximum of 35,000 cfs. This is a direct result of the redevelopment of the Great Lakes Power Plant scheduled for completion in 1982. It should be noted that Appendix A, "Technical Studies," uses atypical canal options incorporating information taken from each of the canal options reported in this Appendix.

The four alternatives evaluated in this report are as follows:

Alternative 1 consists of rebuilding the Edison Sault Power Plant and continuing the operation of the U.S. Government Power Plant as it presently exists.

Alternative 2(a) consists of discontinuing the Edison Sault Power Plant and enlarging the main U.S. Government Power Plant. Under this alternative Edison Sault would be abandoned and Unit 10 upstream of the main U.S. Government Plant would be removed.



LOCATION OF STUDY AREA

FIGURE B-1

Alternative 2(b) consists of discontinuing the Edison Sault Power Plant and building a new U.S. Government Power Plant. Under this alternative Edison Sault and the main U.S. Government Plant would be abandoned and Unit 10 would be removed.

Alternative 2(c) consists of discontinuing the Edison Sault Power Plant and modernizing the main U.S. Government Plant by installing new equipment in the existing plant. Edison Sault would be abandoned and Unit 10 would be removed.

STUDY METHOD

The first step in the investigation involves compiling historic data and governing hydrologic conditions. This is necessary because the historic data are not hydrologically homogeneous and reflect different flow regimes. The historic levels and flows employed in this Appendix have been adjusted to reflect conditions which would have occurred during the period from 1900 to 1979 if the current regime had been in effect over the entire period. These levels and flows are termed the "basis-of-evaluation" and their development is as follows:

In order to permit hydrologic evaluation of various flow management alternatives on a uniform basis, an assumed set of constant conditions within the Great Lakes system was adopted and the monthly mean levels and outflows for each lake were adjusted accordingly. This was done by routing through the system the historical net basin supplies, assuming a regime defined by this set of fixed conditions. The varying effects of changes in channels, diversions and lake regulation were thus removed from the data. No adjustments were made in the data for the effects of regulation of tributaries or variations in winter ice retardation.

Assumptions

The historic levels and flows were adjusted to the following fixed conditions:

a. A constant diversion of 5,000 cfs into Lake Superior by way of the Long Lake and Ogoki diversions.

b. Lake Superior regulated in accordance with Plan 1977, which is the currently authorized plan being used by the International Lake Superior Board of Control for determining releases from Lake Superior.

c. A constant diversion of 3,200 cfs out of Lake Michigan at Chicago. This is the maximum allowable diversion at Chicago by decree of the U.S. Supreme Court, dated June 12, 1967.

d. 1962 outlet conditions for Lake Huron. This represents the present conditions, which have existed since the 1962 completion of the 27-foot navigation channel dredging.

e. A constant diversion, by way of the Welland Canal, of 7,000 cfs out of Lake Erie and into Lake Ontario. This is the approximate 1950-1976 diversion through the Welland Canal during that period.

f. 1953 outlet conditions for Lake Erie.

Computer Program

The simulated levels and outflows for Lake Superior and the levels for Lake Michigan-Huron developed by the International Great Lakes Diversions and Consumptive Uses Study Board's "basis of evaluation" were used to compute the flow and head available for power at the U.S. Government Power Plant and at the Edison Sault Power Plant for each of the four alternatives. A computer program which computes headrace and tailrace elevations at the respective power plants was developed for this purpose.

Head Available

The head available at each plant was determined as the difference in elevation between the two lakes (HLAKES), less the head loss from Lake Superior to the plant forebay, the head loss in the plant tailrace, and the head loss from the plant tailrace to Lake Huron. The relationships employed were as follows:

a. Head loss (HSWP), in feet, from Lake Superior to Southwest Pier (SWP) gauge, located near the entrance to the Edison Sault Electric Company Power Canal;

$$HSWP = 0.0037143\ Q \times 10^{-3} - 0.06572$$

Where: Q is the Lake Superior mean monthly outflow, in 1,000 cfs

b. Head loss (HHURON), in feet, from U.S. Slip gauge (USS), located near the tailrace for the Edison Sault plant, to Lake Huron

during the ice period:

$$HHURON = (Q/1.93)^{5}/(USS - 569.56)^{7.5} + .09$$

and during the open water period:

$$HHURON = (Q/1.605)^{2.5}/(USS - 567.29)^{3.75} + .09$$

Where: USS is the water surface elevation at U.S. Slip gauge, in feet.

c. Head loss in the Edison Sault plant tailrace is the difference between the power canal head loss and the SWP-USS loss. For purposes of the present evaluation, this head loss was assumed a constant 0.2 ft.

d. Head loss (HESPC), in feet, in the Edison Sault Power Canal is computed as follows: (Note: The maximum head loss is limited to 3.5 ft. by the power company to keep excessive velocities from damaging the canal walls.)

$$HESPC = 27{,}800\ QS^{2.6}/(SWP - 568.97)^{5.2}$$

Where: QS is the canal flow in 1,000 of cfs,
SWP is water surface elevation at Southwest Pier gauge, in feet.

e. Head loss at the U.S. Government plant consists of the river loss from Southwest Pier gauge to the regulating works, the loss in the head race to the plant forebay, the loss in the tailrace, and the river loss from the tailrace to U.S. Slip gauge. The variations in these small losses have insignificant effect on the evaluation of the various alternative plans. For purposes of the present evaluations, the river losses and headrace and tailrace losses were assumed constant at 0.6 foot.

f. The only head losses which are not considered at this time are the internal plant losses, which are computed in Appendix A.

The computation of head available is as follows:

Head Available at Edison Sault = HLAKES - HSWP - HHURON - HESPC - 0.2

Head Available at U.S. Government Plant = HLAKES - HSWP - HHURON - 0.6

Flow Available

The flow available for power production in Canada and the U.S. was computed from the following relationship:

$$QT = Q - QM - 3100$$

Where: QT is the total flow available for power generation, in cfs.

Q is the total outflow from Lake Superior, in cfs.

QM is the given value for flow through the navigation locks for the specific month, in cfs. (An average flow for each month is provided in the program).

3,100 is the flow, in cfs, through 1/2 gate open in the compensating works when Lake Superior is near its maximum elevation.

Whenever QT/2 for Canadian power production exceeds the maximum capacity of 35,000 cfs, the excess flow would be utilized by the U.S. power facilities.

Once the total flow available for U.S. power generation has been determined, it is split between the two power entities. For Alternative 1, the flow available at the Edison Sault plant is computed as the total U.S. flow available minus the U.S. Government Plant flow of 12,700 cfs. Since Alternatives 2(a), 2(b) and 2(c) require no flow through the Edison Sault plant, the total flow available for U.S. power generation goes directly to the U.S. Government facility.

Duration Curves

Duration curves were developed for flow available, head available, headrace elevations, and tailrace elevations to be used as design criteria. These duration curves were used in selecting design flows and heads for the proposed power plants.

FLOW DISTRIBUTION

Long-term Average Flows

In 1982, upon completion of the new Great Lakes Power Plant, Canada will begin using their full share of the available water for power generation. Since the United States has been using excess water not previously used by Canada, this will result in a substantial decrease in the flow available for U.S. power generation. The distribution of flow in the St. Marys River, based upon a present and projected average (1900 - 1979) Lake Superior outflow of 75,000 cfs, is as follows:

	Long-term Average Prior to Great Lakes Power Redevelopment	Long-term Average After Great Lakes Power Redevelopment
Navigation locks	960 cfs	960 cfs
Compensating works	13,340 cfs	3,100 cfs (1/2 gate)
U.S. Government Plant	12,700 cfs	12,700 cfs
Edison Sault Plant	30,000 cfs	23,240 cfs
Great Lakes Power	18,000 cfs	35,000 cfs
Total Lake Superior outflow	75,000 cfs	75,000 cfs

Flow available for Power after Great Lakes Power Redevelopment

Total flow available for power generation (QT)

QT = Q - QM - 3100 (from previous section, "Flow Available")

QT = 75,000 - 960 - 3100

QT = 70,940 cfs

Flow available for Canadian power generation

1/2 x 70,940	=	35,470 cfs
Maximum Canadian plant capacity	=	35,000 cfs
Excess water	=	470 cfs

Flow available for U.S. power generation

1/2 x 70,940	=	35,470 cfs
Excess water not used by Canada	=	470 cfs
Total flow available for U.S. power		35,940 cfs

Upon completion of the Great Lakes Power Plant the total flow available for U.S. power generation would decrease 16%, from 42,700 cfs to 35,940 cfs. Since the U.S. Government Power Plant has first priority on water received, the flow available to the Edison Sault Power Plant would decrease 22% from 30,000 cfs to 23,240 cfs. This shows the need to improve the efficiency of the present power facilities if the same U.S. power production is to be maintained.

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4 OF 6
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CANAL DESIGN

Alternative 1

Alternative 1 consists of rebuilding Edison Sault and continuing operation of the U.S. Government Power Plant. The U.S. Government Plant would continue to receive 12,700 cfs and Edison Sault would receive the remainder of the U.S. power flow allocation from Lake Superior. Based on the flow duration curve the median flow into the Edison Sault Plant would be approximately 24,000 cfs, which is 6,000 cfs less than its average long-term usage. From the head duration curve the median head available, neglecting internal plant losses, is 18.8 ft. The present velocity in the Edison Sault Power Canal is 7.8 fps and would remain the same. The head loss in the canal from Southwest Pier gauge to the plant is presently limited to a maximum of 3.5 ft. with a long-term average of approximately 2.2 ft. These losses would remain the same. It is assumed that the Edison Sault canal configuration and alignment would remain the same, although some canal repair work might be necessary.

Alternatives 2(a), 2(b), 2(c)

For these alternatives the total flow available for U.S. power generation would be diverted to the modified U.S. Government facilities. This would require that the Unit 10 Power Plant be removed and the Edison Sault Power Plant be discontinued. One possible consideration for the Edison Sault power canal once the plant is abandoned is to allow only minimal flow for environmental benefits, such as fish spawning.

Alternatives 2(a), 2(b) and 2(c), assume a 3.5 fps canal velocity at the U.S. Government site. Based on the duration curves the median U.S. flow would be 37,000 cfs and the median head, neglecting internal plant losses, would be 20 ft.

Determination of Canal Requirements

To determine possible canal configurations, it is necessary to compute the present canal capacity at the U.S. Government site.

Average Dimensions of the main U.S.
Government Plant Headrace - 195 ft. wide and 20 ft. deep

Cross-sectional Area = 195 ft. x 20 ft. = 3,900 ft^2

As previously stated, the median U.S. flow for Alternatives 2(a), 2(b), and 2(c) is 37,000 cfs. To maintain a design velocity of 3.5 fps, the required canal cross-sectional area would be:

$$A_{Required} = \frac{Q}{V} = \frac{37,000}{3.5} = 10,600 \text{ ft}^2$$

$$A_{Additional} = A_{required} - A_{present}$$

$$A_{Additional} = 10,600 \text{ ft}^2 - 3,900 \text{ ft}^2 = 6,700 \text{ ft}^2$$

The additional canal cross-sectional area needed is 6,700 ft^2

Velocity Rationale

If the design velocity is allowed to exceed 3.5 fps, a smaller canal cross-sectional area would be required resulting in lower excavation costs. Velocities higher than 3.5 fps would reduce the available head and may also cause an increase in frazil ice accumulation in the canal which could cause plant shutdowns. This condition already exists at velocities of 3.5 fps causing as many as three to four shutdowns during an average winter. This does not preclude the fact that velocities beyond 3.5 fps should not be totally discounted, but for this study they will not be considered further.

Unit 10 Headrace Requirements

For Alternatives 2(a), 2(b) and 2(c), the existing headrace of Unit 10 would have to be deepened as would the entire tailrace of the U.S. Government Plant. Based on the contour map furnished in the "Preliminary Design Report . . ." in May 1946, the headrace canal modifications would be as follows:

Sta. 0 + 00 E to 3 + 00 E --	Maintain existing canal bottom (Canal cross-sectional area meets the requirements of 6,700 ft^2).
Sta. 3 + 00 E to 25 + 00 E --	Excavate canal to a bottom elevation of 586 (IGLD 1955). The existing bottom elevation averages 594.4 (IGLD 1955).
Sta. 25 + 00 E to Existing Unit 10 --	Maintain existing canal bottom. (Canal cross-sectional area meets the requirements of 6,700 ft^2).

As shown above, 2,200 feet of the headrace canal would require excavation. If the present average width of the headrace is maintained at 460 ft. and the area required is 6,700 ft^2, the required depth would be,

$$\frac{6,700}{460} = 14.5 \text{ ft.}$$

The canal depth may be increased if it is determined to be more feasible to excavate deeper than to widen the canal. For example, as shown in Figure B-2, the proposed headrace could be designed as an extension of the main U.S. Government Plant headrace, with a depth of 20 feet and an average width of 335 feet.

Tailrace Requirements

The existing tailrace of the main U.S. Government Plant is 400-450 feet wide and approximately 10 feet deep, and will require further excavation to accommodate a discharge of 37,000 cfs. The canal could be enlarged to a width of about 700 ft. extending about 300 ft. downstream of the tailrace. The specific configuration of the tailrace is not critical, as long as the minimum cross-sectional area is 10,600 ft^2.

Alternative 2(a)

Alternative 2(a) would discontinue the Edison Sault Power Plant and extend the main U.S. Government Power Plant. There are four different canal configurations being considered at this time. Each option would require the removal of Unit 10.

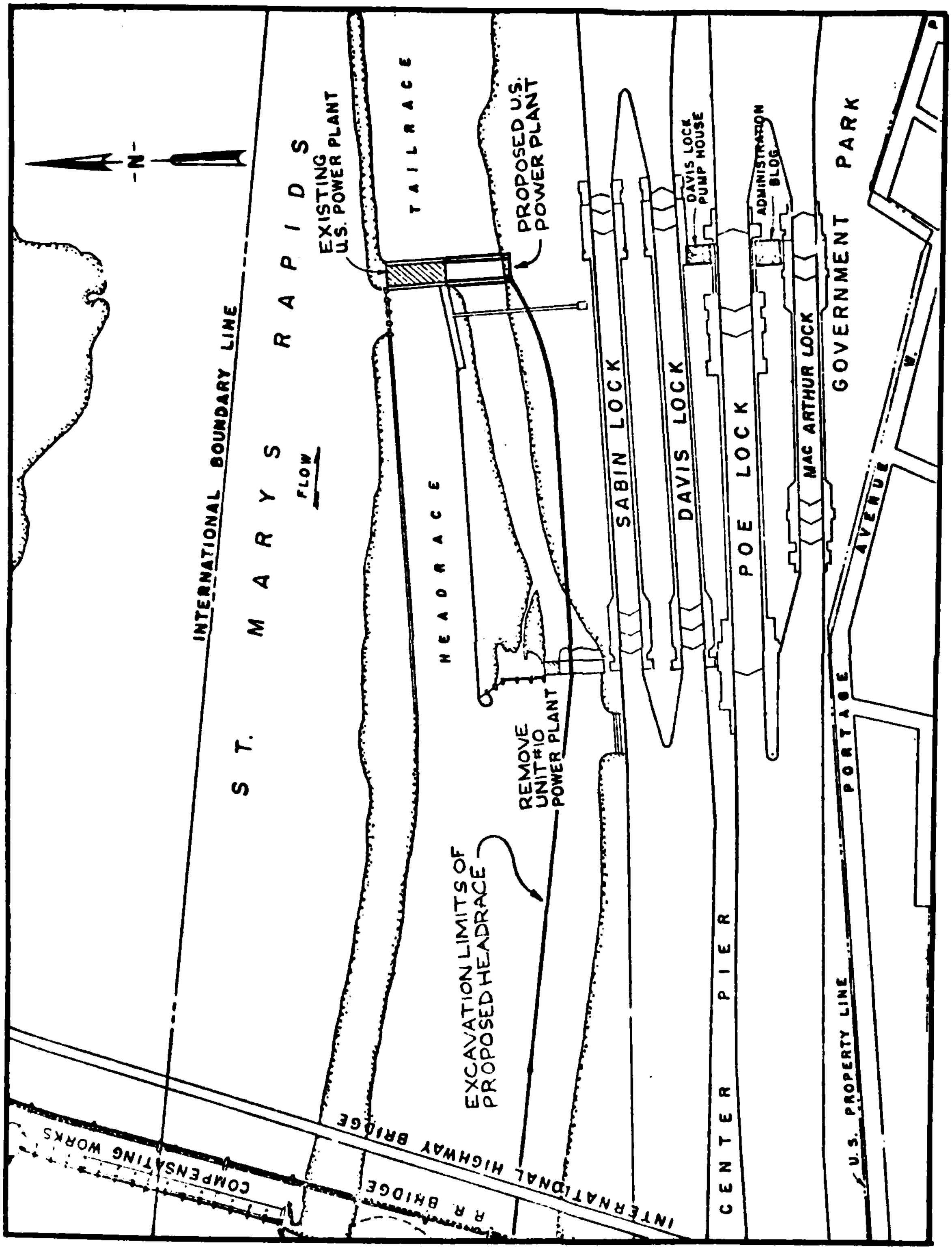
Option I (Figure B-2)

The headrace of Unit 10 and the tailrace of the main U.S. Government Plant would be excavated as previously described. The existing center dike north of the Unit 10 tailrace would be removed and the main U.S. Government Plant headrace would be extended to the south to an average width of 529 feet and a depth of 20 feet. Upon removal of the Unit 10 powerhouse, a dike would be constructed to divert flow into the proposed headrace. The portion of the Unit 10 tailrace beyond the area of the proposed headrace would be backfilled.

Option II (Figure B-3)

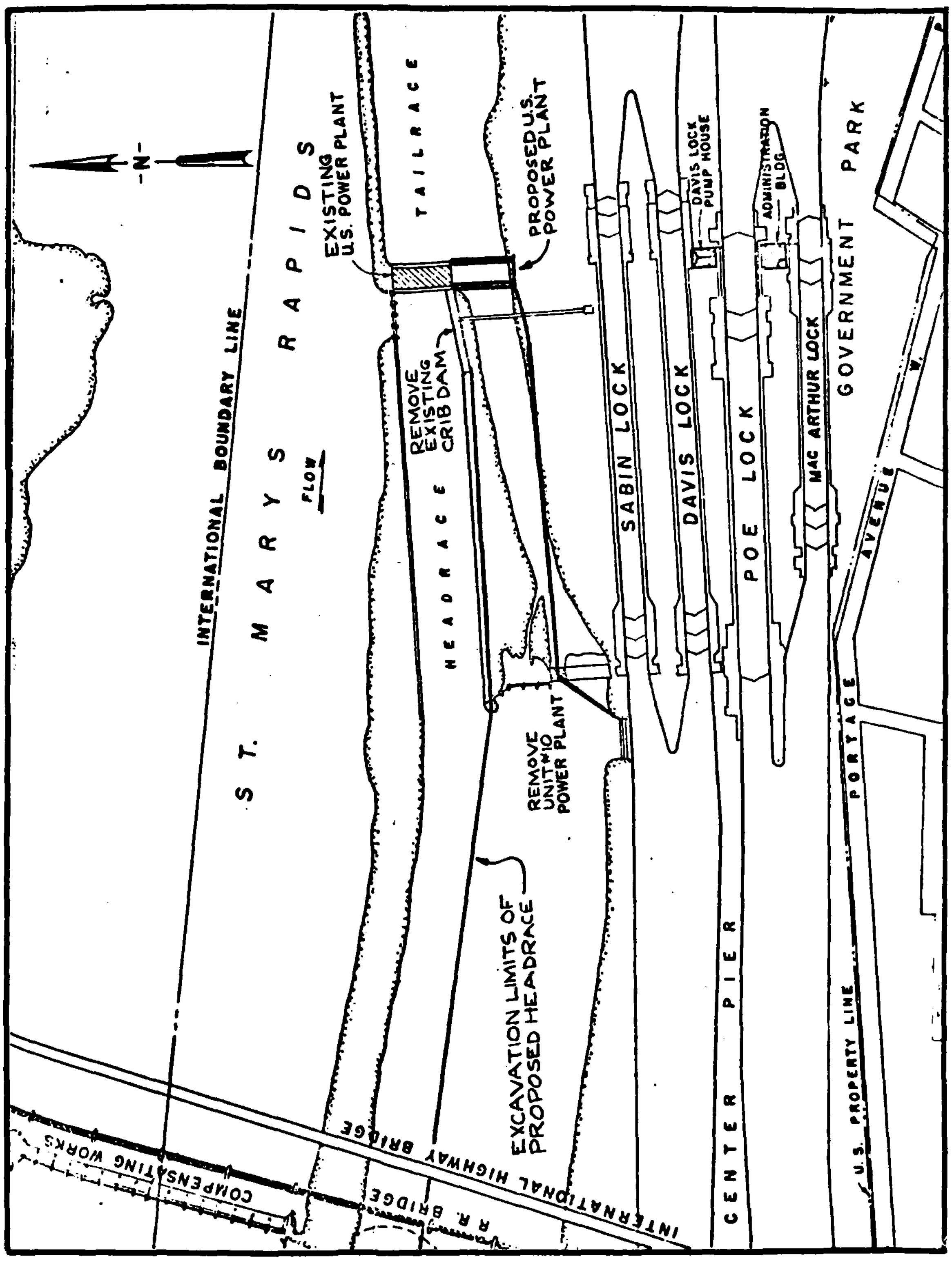
For the proposed lower headrace (present tailrace of Unit 10), a constant centerline station would be maintained and it would be excavated so that the north bank of the proposed canal would match the south bank of the existing center dike. This canal would average 239 feet wide and 28 feet deep to handle a flow of 23,350 cfs.

The existing lower headrace of the main U.S. Government Plant would remain as it is and handle 13,650 cfs.



CANAL OPTION I

FIGURE B-2



CANAL OPTION II

FIGURE B-3

Option III (Figure B-4)

The proposed headrace would retain the centerline of the existing Unit 10 tailrace and the canal would be excavated to accommodate 23,350 cfs. The width of the canal would average 223 feet and the depth would be 30 feet.

The existing lower headrace of the main U.S. Government Plant would remain as is and handle 13,650 cfs.

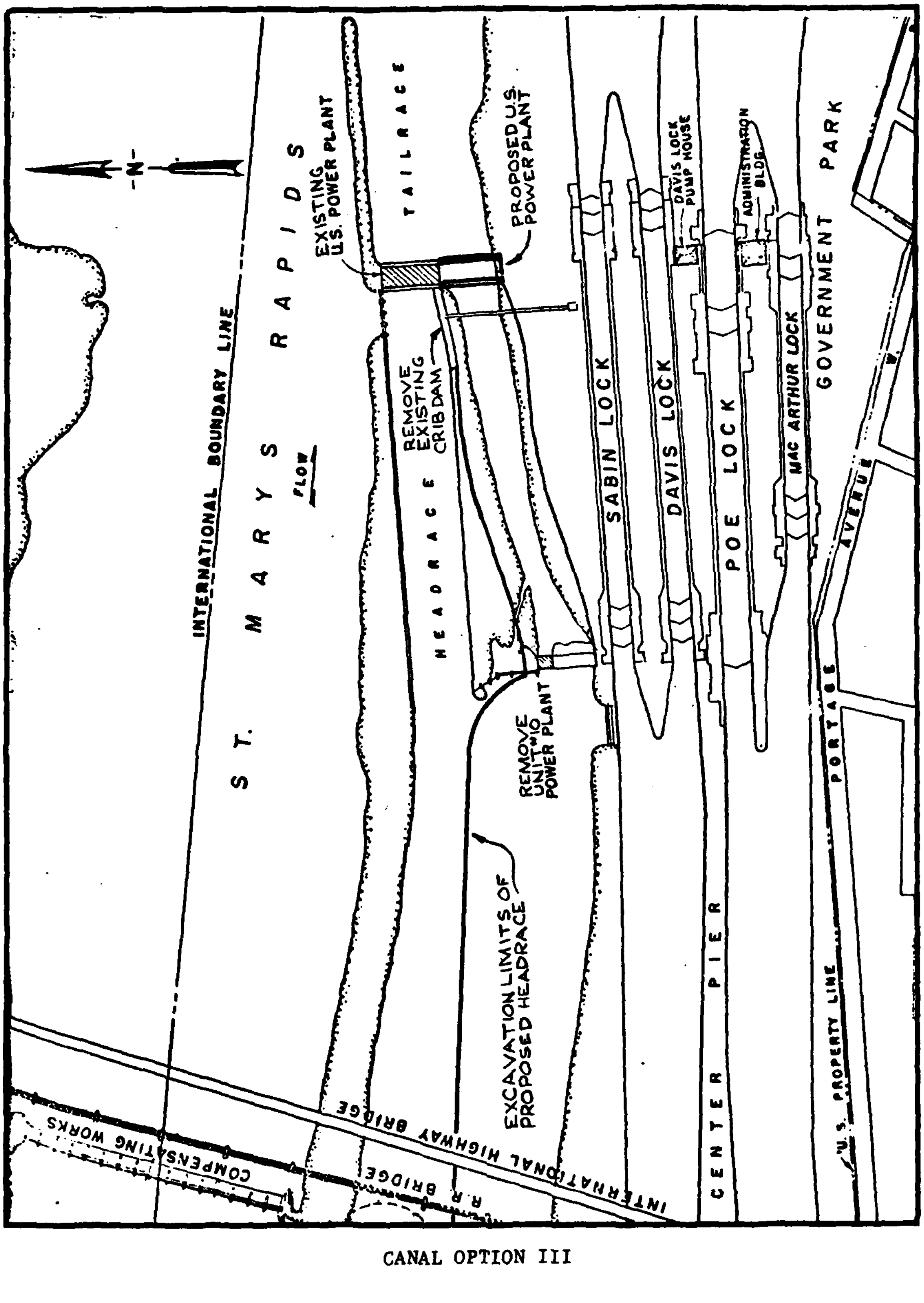
Option IV (Figure B-5)

Under this option, instead of extending the main U.S. Government Plant, the plant extension would actually be located on the site of Unit 10 after it is removed. The existing tailrace of Unit 10 would be widened and deepened to an average width of 445 feet and a depth of 15 feet, to handle a plant discharge of 23,350 cfs. The existing lower headrace of the main U.S. Government Plant would remain the same to handle a flow of 13,650 cfs.

Alternative 2(b)

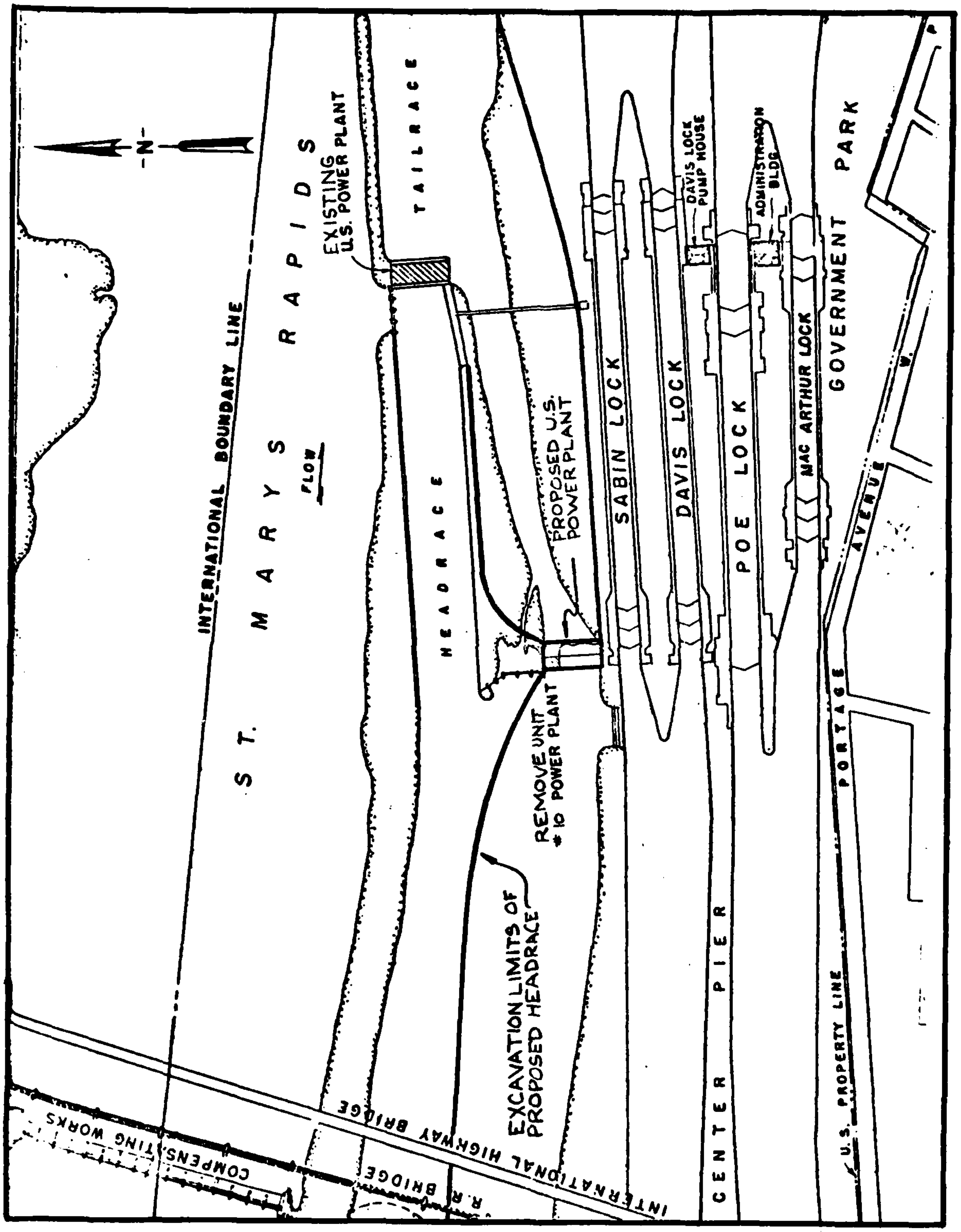
Alternative 2(b) consists of discontinuing the Edison Sault Power Plant and building a new U.S. Government Power Plant. The Unit 10 Plant and the main U.S. Government Plant would be replaced.

The new power plant could be located either on the site of the main U.S. Government Plant or on the site of Unit 10. If located on the site of the main U.S. Government plant it would require a canal configuration similar to either Option I, II, or III of Alternative 2(a). A new plant located on the Unit 10 site would require a canal configuration similar to that outlined in Option I of Alternative 2(a) except that the present lower headrace of the main U.S. Government Plant would be diked off just north of Unit 10 and the entire flow would be diverted into the new U.S. Government Plant.



CANAL OPTION III

FIGURE B-4



CANAL OPTION IV

FIGURE B-5

Alternative 2(c)

Alternative 2(c) requires discontinuing the Edison Sault Plant and installing new equipment in the U.S. Government Plant. The Unit 10 Plant would be removed. The canal configuration would be the same as in Option I of Alternative 2(a), except there would be no extension of the main U.S. Government Plant. Although the canal could accommodate 37,000 cfs, it is questionable whether or not a structure having the same physical size as the existing main U.S. Government Plant could handle 37,000 cfs.

FINDINGS

This Appendix discusses the hydraulics and canal modifications of the various alternatives available for redevelopment of hydropower generation on the U.S. side of the St. Marys River at Sault Ste. Marie, Michigan.

Hydraulic considerations of Alternatives 2(a), 2(b) and 2(c) indicate that they are about equal, with no one plan having a distinct advantage over the others. Since these alternatives involve only changes to the U.S. power facilities, further modifications to increase canal and/or plant capacities are feasible.

Alternative 1 concerns modifications to the Edison Sault Plant and no change to the U.S. Power Plant. Since it is not considered hydraulically or economically feasible to propose changes in the Edison Sault Power Canal, this particular alternative is limited in total capacity to accept water for power generation.

REFERENCES

1. "Regulation of Great Lakes Water Levels - Appendix B - Lake Regulation," Volume 1, Report to the IJC by the International Great Lakes Level Board, 7 December 1973.

2. "Regulation of Great Lakes Water Levels - Appendix F - Power," Report to the IJC by the International Great Lakes Levels Board, 7 December 1973.

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4. "Preliminary Design Report for St. Marys Falls Power Plant at St. Marys River, Michigan," by Erik Floor & Associates, May 1946.

5. "Definite Project Report on St. Marys River, Michigan, the Construction of a new Hydroelectric Power Plant," by the Detroit District Corps of Engineers, October 1948.

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10. "Further Regulation of the Great Lakes," International Joint Commission, 1976.

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13. Noble & Woodards Reports on Lake Superior Regulation, 1910-1980.

APPENDIX C

ECONOMICS OF THE ALTERNATIVES

Department of the Army
Detroit District, Corps of Engineers

APPENDIX C

ECONOMICS OF THE ALTERNATIVES

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ECONOMICS OF THE ALTERNATIVES

INTRODUCTION

The economic justification for the alternatives under study can be determined by comparing estimated average annual costs to estimated average annual benefits over the 100-year period of analysis selected for this study.

Benefits and costs were estimated following current Corps of Engineers standards. Costs include all costs of goods and services. Power benefits are derived based on the cost of producing this power by the most likely alternative means.

CONSTRUCTION COST

Total cost estimate summaries for each alternative are displayed in Table C-1. Costs are based on preliminary design and are at August 1980 price levels. A contingency factor of 15% is included. An indirect cost factor of 25% has been used for investigations, management, engineering and administrative costs needed to implement the project. For a more detailed breakdown of cost see Appendix A, "Technical Studies".

ANNUAL COSTS

Annual costs estimates are based on a 100-year period of analysis (1995-2095), with an interest rate of 7-1/8%. Annual costs include interest and amortization on investment cost, and operation and maintenance cost. It is estimated that construction, of any alternative, would be two years or less; therefore, interest during construction is not included in these preliminary cost estimates. Average annual costs for each alternative are presented in Table C-2.

TABLE C-1

COST SUMMARY

ALTERNATIVE 1	$40,305,000 35-1.1 MW units (tube turbines) 38.5 MW installed $1,047/kW
ALTERNATIVE 2(a)	$57,661,000 3-12.5 MW units (propeller turbines) 37.5 MW installed $1,538/kW
ALTERNATIVE 2(b)	$74,844,000 5-10.5 MW units (propeller turbines) 52.5 MW installed $1,426/kW
ALTERNATIVE 2(c)	$83,610,000 5-10.5 MW units (propeller turbines) 52.5 MW installed $1,593/kW

TABLE C-2

AVERAGE ANNUAL COSTS

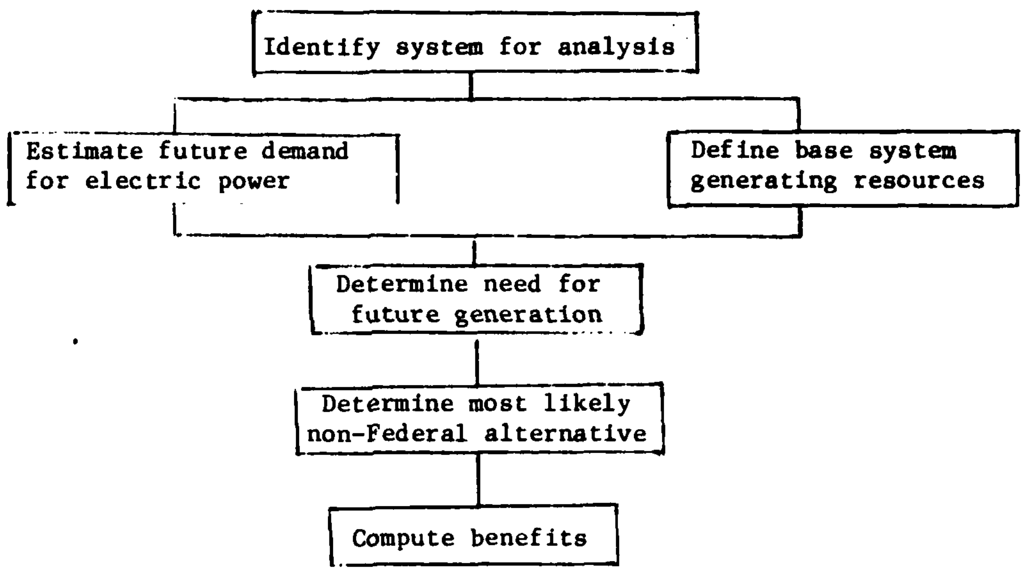
	Alternative 1	Alternative 2(a)	Alternative 2(b)	Alternative 2(c)
Interest (.07125)	$2,872,000	$4,108,000	$5,333,000	$5,957,000
Amortization (.00007)	3,000	4,000	5,000	6,000
Oper. & Maintenance	1,209,000	1,690,000	2,206,000	2,095,000
Total Annual Cost	$4,084,000	$5,802,000	$7,544,000	$8,058,000

ANNUAL BENEFITS

The procedures for identifying National Economic Development (NED) benefits in hydropower studies are set forth in rules and regulations prepared by the Water Resources Council and published in the Federal Register on 14 December 1979. The step-by-step evaluation procedure, set forth in Figure C-1, includes the following:

FIGURE C-1

ECONOMIC EVALUATION PROCEDURE



The conceptual basis for evaluating the benefit from energy produced by hydroelectric powerplants is society's willingness to pay for these outputs. In the absence of direct measures of marginal willingness to pay, the benefit is measured by the resource cost of the most likely alternative to be implemented in the absence of a hydroelectric power plant. The Federal Energy Regulatory Commission (FERC) conducts the analysis which compares hydropower and thermal plant alternatives as the means by which the value of hydropower is determined.

THE SYSTEM IDENTIFIED

The Edison Sault Electric Company is engaged in the generation of electricity, primarily through its hydropower plant, and it purchases and sells significant amounts of electricity in exchanges with neighboring utilities. The primary service area of the Edison Sault Company itself encompasses large areas of Chippewa and Mackinac Counties at the eastern end of the Upper Peninsula, and the city of Manistique in Schoolcraft County. Edison Sault also provides large quantities of electricity to the Cloverland Electric Cooperative, which services other customers in Chippewa, Mackinac, and Luce Counties, and smaller amounts to the Wisconsin Electric Company and the Upper Peninsula Power Company. Edison Sault buys sizable quantities of electricity from the Consumers Power Company, which is based in the Lower Peninsula.

In considering how the electrical energy needs of the eastern Upper Peninsula can best be met, and the role of hydropower in meeting these needs, the relationship of Edison Sault with these neighboring utilities must also be considered in determining supplies and demands for electricity.

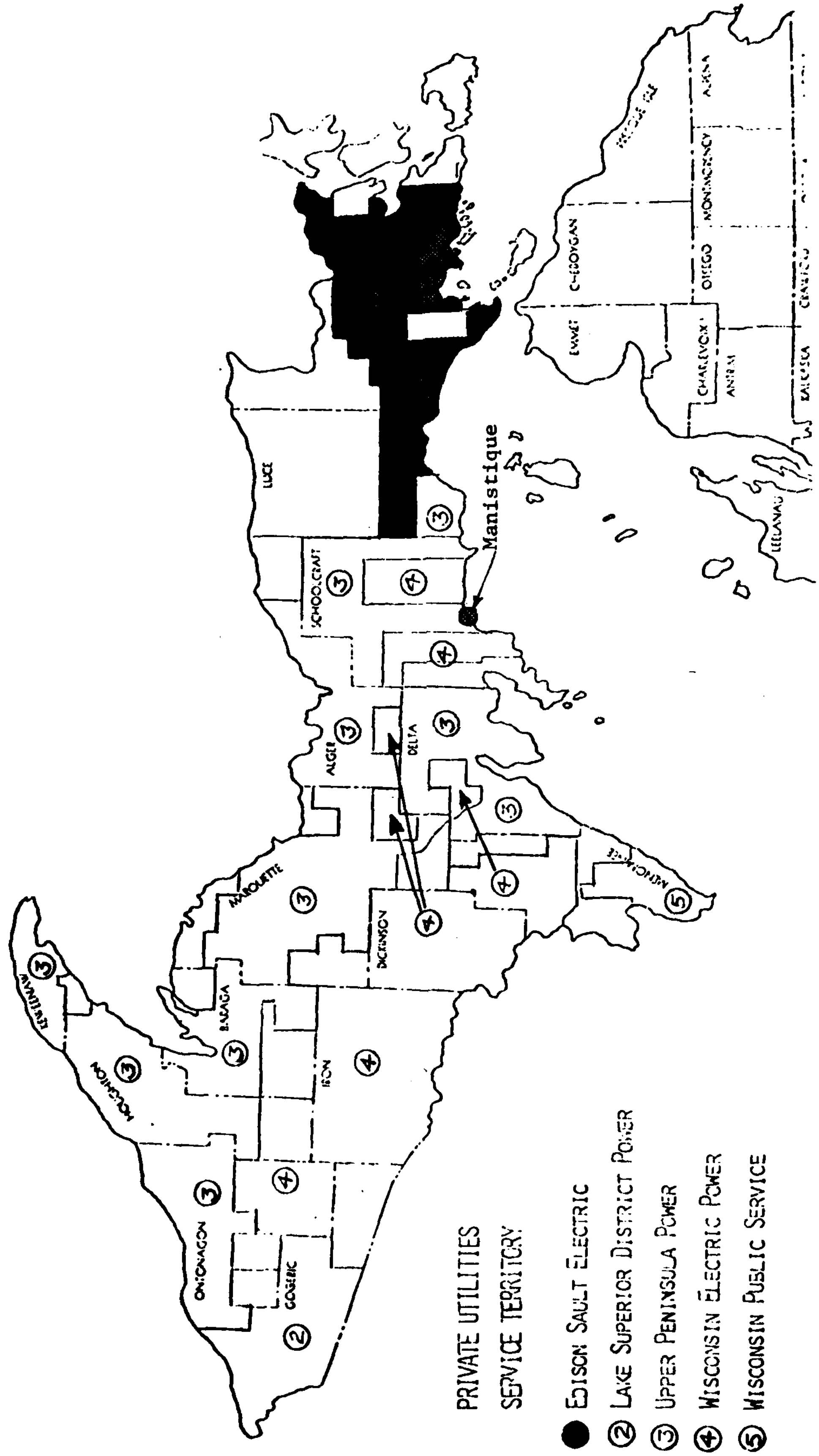
Electric power is obtained from a network system of utility companies. If customers' use of electricity exceeds the capacity of their regional utility company, energy will be transferred to the region automatically via cable. Companies supply electricity to users other than their own customers; likewise, customers consume electrical power other than that generated from their own utilities. Companies exchange electrical energy so that a utility can buy power from neighbor companies during peak hours and sell power to neighbors during off-hours. This all means that the odds of a blackout in any one locality are reduced; electrical demand must exceed supply in the entire network to bring about blackouts. An increase of power output in one utility company will contribute to the network as a whole.

In the case of this particular project, the Edison Sault Hydroelectric Company receives much of its power from Consumers' Power Company as well as the Corps' facility; in turn, it supplies Cloverland Cooperative with much of its extra power needs. The map in Figure C-2 represents the territory serviced by both the Edison Sault and U.S. Government facilities. Back-up electrical energy is provided primarily by Consumers' Power Company. Figure C-3 represents the Cloverland service area which, in turn, receives supplemental power from mainly the Edison Sault facility.

Hydroelectric power on the St. Marys River would appear to provide the safest and cheapest source of electricity for the local area. Insofar as the Edison Sault Hydroelectric Utility can minimize the amount of power which is purchased from other utilities, less energy will be needed from other parts of the regional network to meet the demands of this area. Data from Table C-3 presents both purchases from and sales to other electric utility companies.

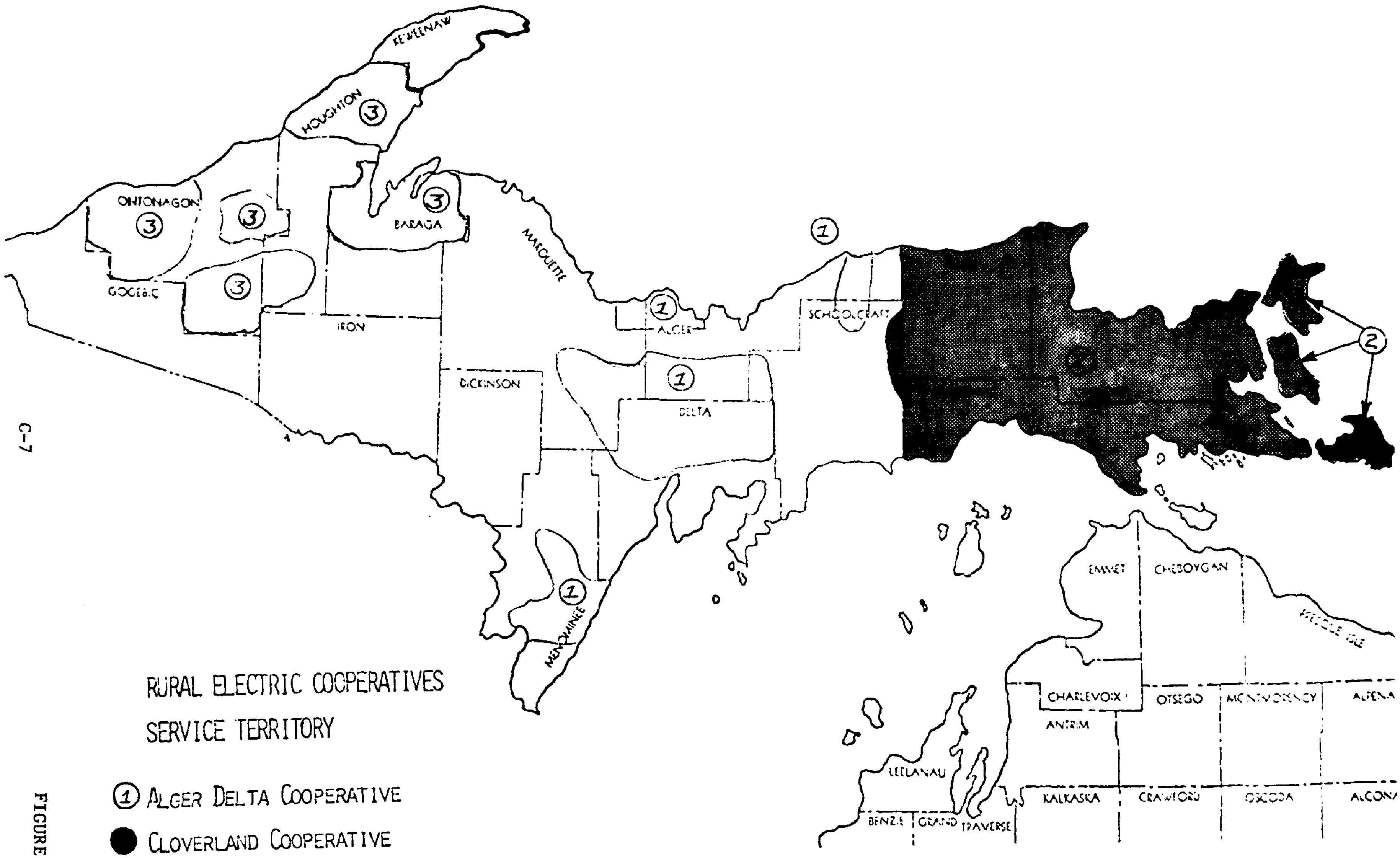
The rate at which purchases of additional electric power is increasing from year to year far exceeds that of sales to other utility companies; although, actually a greater amount of megawatts is sold to than bought from other utilities. From 1978 to 1979, the difference between rates of sales and purchases seems most dramatic. Purchases from other utilities continued to increase at an 18.6% rate; while, sales to other utilities actually fell. The need to buy more and more electricity from other companies is indicative of Edison Sault's inability to supply its customers with the power they demand from the hydroelectric resource in the region.

According to Stone & Webster Consultants, by 1985 either an additional 138-kV cable will be required from Consumers Power to Edison Sault Company or additional generation will be required in the Upper Peninsula. Loss of cable connections from Consumers' Power Company would result in blackouts.



PRIVATE UTILITIES
SERVICE TERRITORY
Edison Sault Electric
② Lake Superior District Power
③ Upper Peninsula Power
④ Wisconsin Electric Power
⑤ Wisconsin Public Service
Manistique
LUCE
SCHOOLCRAFT
ALGER
DELTA
MARQUETTE
DICKINSON
BARAGA
IRON
ONTONAGON
GOGEBIC
CHEBOYGAN
EMMET
OTSEGO
CHARLEVOIX
ANTRIM

FIGURE C-2



RURAL ELECTRIC COOPERATIVES
SERVICE TERRITORY

(1) ALGER DELTA COOPERATIVE
● CLOVERLAND COOPERATIVE
(3) ONTONAGON COOPERATIVE

FIGURE C-3

TABLE C-3

EDISON SAULT COMPANY
PURCHASES AND SALES TO OTHER UTILITY COMPANIES

	1975	1976	1977	1978	1979	% Increase 1975-1979
Purchases	55,176*	68,419	92,041	96,283	114,208	107
Sales	79,683	86,363	110,040	116,928	116,424	46

Source: Edison Sault Electric Company Annual Report, 1979.

* Figures represent megawatt hours

The Edison Sault Electric plant is more than seventy-five years old, and its continued operation over an extended period of time is questionable. It has a long inefficient headrace and 78 independent turbine-generator sets. These units have a lower mechanical efficiency. After June of 1982, Canadians will be able to use their full 50% share of St. Marys River waters, a portion of which has been utilized by Edison Sault to generate power. Efficiency problems will then be further complicated, and even more electricity will have to be purchased from Consumers Power Company. Power generation presently provided by Edison Sault is inadequate to meet the rising demand for electricity.

RESOURCES FOR GENERATION OF ELECTRICITY

Sources of information for identifying the generation resources and demands of the region include the Power System Statement (Form No. 12) furnished by Edison Sault to the Energy Information Administration of the Department of Energy; the Edison Sault Electric Company Annual Report for 1979; and the April 1980 report of the East Central Area Reliability (ECAR) Council on the Coordinated Bulk Power Supply Program. The Power System Statement (Form No. 12-A) for the Government hydro plant on the St. Marys River, prepared for the Energy Information Administration by the U.S. Army Engineer District, Detroit, provides details on that facility.

Edison Sault relied upon hydropower production for approximately 99% of the electricity generated by the company in 1979. Net generation from the company's hydro plant amounted to 246,883 megawatt hours (MWh), while net generation from the company's diesel plants at St. Ignace, Mackinac Island, and Manistique totaled 2,779 MWh.

The entire generation of the Government hydro plant, in excess of the facility's own requirement, is sold to the Edison Sault Company. In 1979, this amount was 146,065 MWh. This means that hydropower was responsible for 392,948 MWh of electricity generated for sale by the company, which is roughly 77% of the total amount of electricity generated and purchased by the company (509,935 MWh) for distribution in 1979.

Any change which impacts on the potential for hydropower generation, such as the reduction of flows to the U.S. side of the St. Marys River, will therefore affect a significant generating resource of the company itself. Other sources of electricity for the company in 1979 were purchases from Consumers Power Company of 105,379 MWh and from the Cloverland Electric Cooperative in the amount of 8,829 MWh.

Table C-4 summarizes the sources of electricity for the Edison Sault Electric Company over the period 1975-1979:

TABLE C-4

EDISON SAULT NET GENERATION AND PURCHASES, 1975-1979
(Thousands of Kilowatt Hours)

	1975	1976	1977	1978	1979
Hydro 1/	399,059	405,362	404,763	401,041	392,948
Diesel	848	1,962	1,536	1,683	2,779
Purchases from Other Utilities	55,156	68,419	92,041	96,283	114,208
Total	455,063	475,743	498,340	499,007	509,935
Losses and Unaccounted for	26,927	28,577	28,849	31,561	36,194
Company Use	1,407	1,503	1,547	1,605	1,047
Electricity Sold	426,729	445,663	467,944	465,841	472,694

1/ Includes the output of 18 megawatt U.S. Government Hydro Plant total output which is purchased by the Company net of government requirements for Sault Lock complex operation.

It can be seen that hydropower generation has been quite constant over this five year period, and that the increase in sales for the company can be attributed to the growth in purchases Edison Sault is making from other utilities. As the reduction in flows to the Edison Sault hydro plant in 1982 will drop its output from roughly 250,000 MWh annually to roughly

227,000 MWh, the difference will have to be made up through even larger purchases from Consumers Power Company in the future.

EXISTING DEMAND

The number of residential customers of Edison Sault has increased modestly between 1974 and 1979. Commercial establishment customers decreased, while the number of industries remained the same. These statements are supported by data in Table C-5. The Sault's industrial customers consume the greatest amount of electricity and their rate of use is increasing more than that of commercial establishments and residences. Data from Table C-6 would seem to indicate that the increase in electrical consumption by commercial establishments is quite substantial in view of a decrease in the number of these establishments. This increase in utilization of electricity could mean expanded operations.

The three industrials which the Sault services are: (1) U.S. Steel Limestone Quarry; (2) Great Lakes Pipeline; and (3) Manistique Paper and Pulp Mill. In addition, the Sault sells a small quantity of electricity to the Upper Peninsula Power Company which services Inland Steel Quarry, and sells a substantial amount to Cloverland Cooperative which services Dolomite Quarry and may service Land Products Company if they open a plant in Brevort in 1981. This new company will require extra energy from Cloverland which receives power from Edison Sault. In 1979, the three industrial customers used 113,721 megawatt hours. As indicated in Table C-7, electricity generated from the Edison Sault Facility diminished 2.9% from 1975 to 1979, while electricity used by customers increased 10.7% during that same time period.

Conservation measures, the close of Kincheloe Air Force Base and milder weather can dissipate the increasing gap between demand and capacity but come far from closing it. Commercial establishments and industries have increased their consumption of electric power over the four year period, although they did not increase in numbers. These businesses may

TABLE C-5

EDISON SAULT COMPANY
NUMBER AND KIND OF CUSTOMERS

Customers	1975	1976	1977	1978	1979	% Increase 1975-1979
Residential	12,466	12,764	12,826	12,870	12,896	3.4
Commercial	2,356	2,357	2,312	2,315	2,333	-0.9
Industrial	3	3	3	3	3	0.0
Other	12	12	12	12	12	0.0
Total	14,837	15,136	15,153	15,200	15,244	2.7

Source: Edison Sault Electric Company Annual Report, 1979.

TABLE C-6

EDISON SAULT COMPANY
MEGAWATTS SOLD TO CUSTOMERS

	1975	1976	1977	1978	1979	% Increase 1975-1979
Residential	99,009 MWh	105,694	104,677	105,362	106,625	7.7
Commercial	69,280	75,982	78,948	84,257	88,294	27.4
Industrial	86,517	85,071	104,991	106,628	113,721	31.4
Firm Sales to Other Utilities	79,683	86,363	110,040	116,928	116,424	46.1
Negotiated Government Accounts	67,313	68,470	55,581	41,748	40,447	-39.9
Street Lighting	2,135	2,194	2,183	2,228	2,323	8.8
Total Firm Customer Sales	403,937	423,774	456,420	457,151	467,834	15.8
Non-Firm Sales to Other Utilities						
(Including Excess Hydro Sales)	22,792	21,889	11,524	8,690	4,860	-78.7
Total Sales	426,729 MWh	445,663	467,944	465,841	472,694	10.7

Source: Edison Sault Electric Company Annual Report, 1979.

TABLE C-7

EDISON SAULT COMPANY
CAPACITY VS. DEMAND
(MWh)

Electricity	1975	1976	1977	1978	1979	% Increase 1975-1979
Generated from Sault	254,290	257,259	251,649	251,724	246,883	-2.9
Used by Sault Customers	426,729	445,663	467,944	465,841	472,694	10.7

Source: Edison Sault Electric Company Annual Report, 1979.

be conserving energy in terms of cost per unit of production or sale, but their use of electricity increased. Residential units did decrease their average use of electricity from 1976 to 1977 and consumed the same average amount in 1978, but the 1979 usage rates increased back to what they were in 1976. Dividing the figures of megawatts sold in Table C-6 to number of residents in Table C-5 for corresponding years, one finds that the average unit expended 7.9 megawatts in 1975, 8.3 in 1976 and 1979, and 8.2 in 1977 and 1978. Conservation measures have not thus far abated a rise in consumption; although they may have prevented use from increasing to an even higher level.

Over 20 new businesses and government agencies have occupied the former Kincheloe Air Force Base including the Kinross Correctional Facility, Barker Tool Company and Sun Industrial Systems. Winters of 1978 and 1979 were milder than those of 1976 and 1977. Electrical consumption by Sault customers actually decreased from 1977 to 1978 by .4% as calculated from figures in Table C-7. Of the last five years, 1977 to 1978 was the only one in which sales fell. Considering this trend, demand should be expected to continue to exceed capacity.

DEPENDABLE AND ASSURED CAPACITY

The dependable capacity of conventional hydro plants, as described in the Energy Information Administration's Form 12, Schedule 16, "relates to the capacity which under the most adverse flow conditions of record can be relied upon to carry system load, provide dependable reserve capacity, and meet firm power obligations, taking into account seasonal variations and other characteristics of the load to be supplied and of firm power obligations. Some systems may be able to utilize off-peak energy from other systems so as to increase the dependable capacity of the reporting system conventional hydro plants." Table C-8 summarizes data provided by Edison Sault on Form 12, Schedule 16 for 1979, identifying arrangements under a hypothetical Maximum Annual System Load:

TABLE C-8

NET DEPENDABLE CAPACITY AVAILABLE FOR THE YEAR ENDED DECEMBER 31, 1979

		Megawatts	Megawatts
1.a)	System fuel plants	9	
b)	System conventional hydro plant	30	
c)	Subtotal		39
2.	Capacity available from firm purchases:		
	U.S. Government Hydro Plant	17	
	Cloverland Electric Cooperative	9	
	Consumers Power Company	43	
	Total		69
3.	Firm obligations to other systems:		
	Cloverland Electric Cooperative	16	
	Wisconsin Electric Company	3	
	Upper Peninsula Power Company	5	
	Total		24
4.	Net dependable capacity plus net purchases (1c plus 2 minus 3)		84
5.	Reserve capacity required (exclusive of reserve for load growth)		
	a. Total reserve for system	30	
	b. Available through interchange or emergency agreement	25	
	c. Reserve capacity required to be supplied by own system (a minus b)		5
6.	Net assured system capacity (4 minus 5)		79

With a reduced flow allocated to the Edison Sault hydro facility in the future, the net dependable capacity of the plant will be reduced from 30 megawatts to approximately 18 megawatts. Presumably in anticipation of these operational changes, a request by Edison Sault to increase the contract capacity reservation from 43 MW to 50 MW was agreed to by Consumers Power Company on 15 April 1980.

OPERATIONS UNDER 1979 PEAK LOAD CONDITIONS

Form 12, Schedule 13 identifies the generation and tranfers of electricity taking place during the date and hour of system peak load in 1979. Table C-9 presents figures of the integrated demand on the system on 15 January 1979, at 6:15 P.M.

TABLE C-9

INTEGRATED DEMAND DURING PEAK LOAD, 1979

		Megawatts
A.	Combined net demand on system generating plants	34
B.	Power received from other systems	
	U.S. Government Hydro Plant	15
	Consumers Power Company	17
	Cloverland Electric Cooperative	15
C.	Demand on generating plants plus power received	81
D.	Power delivered to other systems	
	Cloverland Electric Cooperative	19
	Wisconsin Electric Company	3
	Upper Peninsula Power Company	2
	Total power delivered	24
E.	System peak load of the year (C minus D)	57

The Edison Sault 1979 Annual Report indicates that the maximum load of 81.6 MW was 1% above the peak load of the previous year (80.8 MW). Generally, however, the 1979-1980 winter peak loads were down approximately 3.5% from the 1978-1979 winter peak loads because of milder weather and conservation efforts on the part of consumers (including increased use of wood as an alternate fuel for home heating).

According to a report prepared by the Stone and Webster Management Consultants for Edison Sault in February 1978, a shift in operating procedures of the Edison Sault plant would be required for hydropower to be utilized to the same extent in meeting peak load demands in the future. This would mean a change in operating the hydro plant from a fully base loaded schedule (as is currently done) to a smaller base load plus peaking capacity schedule. This would necessitate larger off peak power purchases from Consumers Power.

Another possibility identified in the consultant's report for meeting peak load demands was the installation of additional diesel peaking capacity within the Edison Sault system. This option would appear to be a less desirable alternative, given the diesel fuel price hikes in 1979 and continued concern about ultimate availability of fuel supplies.

The consultant's report also attempted to project the additional costs that might be expected as Edison Sault relies increasingly on power purchases to meet its needs, especially once the operation of the new Canadian hydro plant begins. The report concludes that power cost increases should be expected, which is understandable given that the utility will be depending increasingly on non-hydropower based sources of electricity. The without-plan condition in this report, which would involve no physical changes in the hydro plants on the American side, would only accelerate this trend. Edison Sault power purchases from Consumers Power were $2,904,000 in 1979 and $2,539,000 in 1978. This was 29% of the total costs of the company in 1979 and 27% of the total costs of the company in 1978. This figure will likely increase in the future whether or not structural improvements are made to the hydropower facilities.

DISTRIBUTION OF SYSTEM LOAD

Form 12, Schedule 15 of the Energy Information Administration contains details on Edison Sault system loads on a seasonal basis, specifying hourly demands for the first weeks of April, August, and December, 1979. The daily totals for the three one-week periods during the year are summarized in Table C-10.

TABLE C-10

SYSTEM LOAD DATA FOR SPECIFIED WEEKS

	Sun	Mon	Tue	Wed	Thu	Fri	Sat
April	1	2	3	4	5	6	7
MWh	889	978	915	926	969	724*	993
August	5	6	7	8	9	10	11
MWh	881	1114	1044	1137	1099	1109	993
December	2	3	4	5	6	7	8
MWh	916	1054	984	956	1002	908	986

* A storm caused disruptions this day, accounting for this abnormally low number.

Though Table C-10 shows the summer figures in August to be highest, the peak demands for Edison Sault are normally experienced during winter cold spells.

In terms of energy transferred between firms (Form 12, Schedule 8), Edison Sault delivered 119,962 MWh to the Cloverland Electric Cooperative, 13,329 MWh to the Wisconsin Electric Company and 19,644 MWh to the Upper Peninsula Power Company in 1979. This means that Edison Sault was involved in the transfer of electricity greater than the amount actually sold to neighboring utilities.

ELECTRIC UTILITY RATES

Comparing rates with other Michigan Electric Utilities in Table C-11, Edison Sault has the lowest residential rates. Indiana and Michigan Electric Company, and Cloverland, offer lower commercial rates. Michigan Power, Wisconsin Public Service, and Edison Sault all offer the second lowest rates. Edison's rates for larger commercial establishments are second only to those of Indiana and Michigan, and Cloverland; however, Wisconsin, Cloverland, Fruit Belt, and Michigan offer better rates than Edison for smaller commercial concerns. Edison Sault's rates for large industries are second only to those of Indiana and Michigan; for smaller industries, Cloverland and Indiana and Michigan offer better rates. Consumers Power Company has rates considerably higher than Edison Sault. According to rates in Table C-11, customers can expect to pay anywhere from 1.47 and 1.99 times or nearly one and a half and twice the rates for consumers Power as compared with Edison Sault service.

Rates for residential and commercial customers have increased 21.2% and 16.6%, respectively, between 1975 and 1979 according to data presented in Table C-12.

Further cost increases should be expected as hydropower comes to serve a smaller proportion of the region's need for electricity, even given any of the structural improvements considered in this report. The structural improvements themselves would necessitate a large capital investment whose costs would need to be recovered.

The marketing of any excess electricity that Edison Sault may generate is covered in a 6 November 1975 service agreement between Consumers Power Company and Edison Sault. The agreement states that Consumers Power agrees to purchase and accept from the Customer (Edison Sault), and the

TABLE C-11

BILLS FOR MICHIGAN
ELECTRIC UTILITIES, 1979

Utilities	Residential			Commercial			Industrial	
Private Investors	250kWh	1,000kWh	2,000kWh	1,000kWh	24,000kWh	180,000kWh	432MWh	21,600MWh
Alpena Power	$11.68	$34.97	$ 65.89	$47.52	$1,065.60	$ 6,276	$13,775	$ 688,770
Consumers Power	14.66	52.69	108.73	73.44	1,716.00	9,505	19,218	960,904
Detroit Edison	14.56	52.30	107.94	61.10	1,396.63	9,904	17,302	856,510
Edison Sault	9.06	28.72	54.94	49.72	866.20	6,024	10,705	483,782
Indiana & Michigan	10.25	33.24	57.46	48.48	752.56	5,490	9,508	392,532
Lake Superior	13.33	43.41	83.52	87.59	962.23	7,623	17,086	802,455
Michigan Power	13.23	43.90	84.80	48.71	1,085.56	7,031	15,376	583,985
Upper Power Main	17.62	60.29	117.18	77.29	1,790.65	9,109	18,584	895,854
Upper Power Iron River	14.97	49.83	96.31	56.88	1,282.80	9,200	17,945	887,868
Wisconsin Electric	14.53	43.86	80.97	54.31	1,177.75	6,571	14,129	706,452
Wisc. Public Service	11.73	34.71	61.62	43.41	917.25	5,136	12,081	515,326
REA Cooperatives								
Alger Delta Co-op.	17.70	54.98	104.69	58.96	1,348.00	8,733	19,103	955,164
Cherryland Rural	18.63	54.78	102.98	70.80	1,527.60	9,306	20,095	1,003,343
Cloverland Elec.	12.86	35.44	63.88	47.64	939.00	4,783	10,019	499,189
Fruit Belt Elec.	14.98	44.90	84.80	48.90	1,090.50	7,407	16,218	807,419
O & A Electric	18.96	60.23	115.26	68.73	1,593.45	9,730	21,326	1,062,787
Oceana Elec.	17.65	56.05	105.65	66.45	1,367.25	9,426	20,718	1,035,434
Ontonagon Rural	20.92	67.18	128.85	69.98	1,615.03	10,758	23,082	1,154,077
Presque Isle Elec.	19.18	60.50	115.60	71.50	1,645.90	10,458	22,989	1,149,462
Southeastern Mi.	18.66	57.95	110.34	61.19	1,337.75	9,234	20,450	1,022,504
Thumb Elec.	18.97	59.37	113.24	64.32	1,434.00	9,932	21,644	1,082,206
Top O'Michigan	20.67	58.99	107.18	73.69	1,404.50	9,959	21,746	1,083,969
Tri-County	18.72	59.20	113.17	65.97	1,445.25	10,045	23,765	1,188,257
Western Mi.	19.39	62.55	120.10	67.05	1,551.45	10,412	23,082	1,152,702

Source: Michigan Public Service Commission, obtained through Michigan Energy Administration, 1979.

TABLE C-12

EDISON SAULT ELECTRIC COMPANY
CHANGES IN AVERAGE COSTS TO CUSTOMERS

Average Annual Use & Revenue Per Residential Customer	1975	1976	1977	1978	1979	% Increase 1975-1979
Kilowatt Hours	7,942	8,281	8,161	8,187	8,268	4.1
Revenue	$ 194	$ 222	$ 225	$ 236	$ 246	26.8
Revenue per Kilowatt Hour	2.45	2.69	2.76	2.88	2.97	21.2
Per Commercial Customer						
Kilowatt Hours	29,405	32,237	34,147	36,396	37,846	28.7
Revenue	$ 921	$1,095	$1,182	$1,304	$1,380	49.8
Revenue per Kilowatt Hour	3.13	3.40	3.46	3.58	3.65	16.6

Customer agrees to supply and sell to the Company (Consumers Power), all surplus electric energy which the Customer may, from time to time, have available in excess of the Customer's own requirements.

PROJECTIONS OF FUTURE DEMANDS FOR POWER

Form 12, Schedule 19 contains estimates on the part of Edison Sault concerning net energy available for loads, peak loads anticipated, and load factors for the period 1980 to 1983. This data is presented in Table C-13.

TABLE C-13

SUMMER AND WINTER PEAK MONTH
AND CALENDAR YEAR LOAD ESTIMATES, 1980-1983

Year	Month of Peak	Net Energy for Load (Megawatt-Hours)	Peak Load (Megawatts)	Load Factor (Percent)
(1)	(2)	(3)	(4)	(5)
Seasonal peak month data:				
1980				
Summer	Aug.	30,500	56	73.1
Winter 1980-81	Dec.	31,050	60	69.8
1981				
Summer	Aug.	31,300	58	73.2
Winter 1981-82	Dec.	33,700	61	73.9
1982				
Summer	Aug.	32,000	59	73.0
Winter 1982-83	Dec.	34,600	63	74.1
1983				
Summer	Aug.	32,800	60	73.0
Winter 1983-84	Dec.	35,500	64	74.1
Calendar year data:				
1980	Dec.	356,950	60	68.0
1981	Dec.	365,200	61	68.0
1982	Dec.	374,000	63	68.0
1983	Dec.	383,600	64	68.0

It can be seen, in studying the net energy availability and the peak load projections, that the demands placed on the Edison Sault system are expected to grow, if only at a modest pace. This growth will take place in the context of a reduced capability of hydropower generation to meet the demands of the service area.

The significance of the load factor can be briefly described. The load factor is defined as the ratio of average load supplied during a designated period to the maximum peakload occurring in the same period. The formula for deriving the load factor is as follows:

$$\text{Percent load factor} = \frac{\text{net energy for load} \times 100}{\text{Peak load} \times \text{hours in month (or year)}}$$

In Table C-13 above, using August 1980 as an example, the formula would be applied as:

$$\frac{30{,}500 \times 100}{56 \times 744 \text{ hrs}} = 73.1\%$$

The load factor is an indicator which shows what percentage of system needs could be supplied by average electric production if demand were continuously at a peak load level. A figure in the 60's or better is an indication (not a firm rule) that the system is generating or purchasing enough electricity to meet fluctuating demand. For Edison Sault in 1979, the load factor was 70.2, with monthly figures ranging from 80.7 down to 70.1.

A set of demand projections for the Edison Sault Company for the 10 year period 1979-1989 is contained in the ECAR 1 April 1980 report on the bulk power supply program. Table C-14 displays this information.

TABLE C-14

ESTIMATED DEMAND & ENERGY FOR 1980-1989 AND ACTUAL DATA FOR 1979

EDISON SAULT ELECTRIC COMPANY

1979 (Previous Years) LINE		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
01	Peak Hour Demand-MW	57	57	53	53	53	52	52	56	52	56	53	55
02	Net Energy-GWh	32	31	30	28	28	27	28	30	28	29	30	31
1980 (Reporting Year) LINE													
03	Peak Hour Demand-MW	59	58	55	53	52	54	53	56	55	55	57	60
04	Net Energy-GWh	35	30	30	30	30	30	30	30	30	30	30	30
1981 (Next Year) LINE													
05	Peak Hour Demand-MW	61	60	57	54	54	56	55	58	57	57	59	62
06	Net Energy-GWh	35	30	30	30	30	30	30	30	30	30	30	30

PREVIOUS YEAR AND 1ST 10 YEARS LINE		1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
07	Peak Hour Demand: Summer-MW	56	56	58	60	62	64	67	69	71	74	76
08	Peak Hour Demand: Winter-MW	56	60	62	64	66	69	71	74	76	79	81
09	Net Energy-GWh	352	360	370	380	400	410	420	440	450	470	490

Source: East Central Area Reliability (ECAR) Council April 1980 report on the Coordinated Bulk Power Supply Program, Volume 2, ESEC section, p. 8-ESEC-1

Peak hour demands during summer and winter for each year of the 1980's are projected, with annual increases in the two and one-half to three and one-half percent range, and projected increases in the net energy needed for the Sault Edison system (generation, plus energy received, minus energy delivered) are shown in gigawatts (thousands of megawatts).

It is interesting to note that the ECAR projections for 1983, in terms of peak hour demands in summer and winter and in terms of net energy for load, exceed those provided by the Edison Sault Company on Form 12, Schedule 19, for 1983. The ECAR report itself reflects downward revisions from earlier forecasts which had straight-lined growth in electricity consumption nationwide on the order of 7% annually, which was the pattern prior to the first set energy of price hikes in 1973.

NEED FOR FUTURE GENERATION

A second table from the same ECAR source projects the estimated resources, demand, and margin for the company over the 1980-1989 period. There are at least two points to be made about the data displayed in Table C-15. The first is that the net capability of the company shows no change over the 10 year period, which is not likely to be the case given the anticipated reduction in flows to the Edison Sault hydroplant. The second is that demands are expected to be met through increasingly higher levels of imports of electricity over the period, even if the generating capability of Edison Sault itself were to remain at present levels. Whatever the new source(s) of electricity developed or purchased to cover growth in demand, the costs will be substantially above present levels. In quantitative terms, this projection indicates that an additional 20-25 MW will need to be added to the total resources of Edison Sault over the next ten years to keep pace with demand. Development of one of the hydropower alternatives in this study would not contribute significantly in meeting this additional demand, but it would reduce to a small extent in the near term (and probably a larger extent in the long term, given the aged condition of the existing Edison Sault hydro facility) the

TABLE C-15

ESTIMATED RESOURCES, DEMAND & MARGIN FOR THE 1980-1989 YEAR PERIOD

EDISON SAULT ELECTRIC COMPANY

LINE		1980		1981		1982		1983		1984	
	RESOURCES IN MW	SUM	WIN	SUM	WIN	SUM	WIN	SUM	WIN	SUM	WIN
01	Net Capability	39	40	39	40	39	40	39	40	39	40
02	Scheduled Imports	45	48	48	50	51	53	53	56	56	60
03	Scheduled Exports	26	26	27	26	28	27	28	28	29	29
04	Total Resources	58	62	60	64	62	66	64	68	66	71
05	Inoperable Capability	0	0	0	0	0	0	0	0	0	0
06	Operable Resources	58	62	60	64	62	66	64	68	66	71
	DEMAND IN MW										
07	Peak Hour Demand	56	60	58	62	60	64	62	66	64	69
08	Interruptible Demand	0	0	0	0	0	0	0	0	0	0
09	Demand Requirements	56	60	58	62	60	64	62	66	64	69
	MARGIN IN MW										
10	Margin	2	2	2	2	2	2	2	2	2	2

LINE		1985		1986		1987		1988		1989	
	RESOURCES IN MW	SUM	WIN	SUM	WIN	SUM	WIN	SUM	WIN	SUM	WIN
01	Net Capability	39	40	39	40	39	40	39	40	39	40
02	Scheduled Imports	61	63	64	67	67	70	71	75	74	78
03	Scheduled Exports	31	30	32	31	33	32	34	34	35	35
04	Total Resources	69	73	71	76	73	78	76	81	78	83
05	Inoperable Capability	0	0	0	0	0	0	0	0	0	0
06	Operable Resources	69	73	71	76	73	78	76	81	78	83

TABLE C-15 (Cont.)

LINE		1985		1986		1987		1988		1989	
		SUM	WIN	SUM	WIN	SUM	WIN	SUM	WIN	SUM	WIN
	DEMAND IN MW										
07	Peak Hour Demand	67	71	69	74	71	76	74	79	76	81
08	Interruptible Demand	0	0	0	0	0	0	0	0	0	0
09	Demand Requirements	67	71	69	74	71	76	74	79	76	81
	MARGIN IN MW										
10	Margin	2	2	2	2	2	2	2	2	2	2

Source: East Central Area Reliability (ECAR) Council April 1980 report on the Coordinated Bulk Power Supply Program, Volume 2, ESEC section, p. 8-ESEC-4 increasing reliance of the company on purchases of electricity from other sources.

MOST LIKELY ALTERNATIVE

The most likely alternative to hydropower in this region, according to the Federal Energy Regulatory Commission (see FERC letter dated 26 August 1980, Appendix F), would be a coal-fueled steam electric plant. This plant, according to the assumption made in the FERC simulation model, would be a part of the Michigan Electric Coordinated System as it is projected to exist in 1990. (The Michigan Electric Coordinated System consists of the Consumers Power Company and the Detroit Edison Company, the two largest utilities in the Lower Peninsula.) The needs of Edison Sault customers could be met through the purchase from Consumers Power (assuming appropriate contractural arrangements) of electricity generated by one of these plants. Only a small portion of the total amount of electricity generated by a modest sized coal plant would need to be transmitted to Edison Sault to meet the demands of the service area. In developing a most likely alternative in this manner, economies of scale are maintained in analyzing the coal burning plant alternative. This is the alternative developed by FERC on which the power and energy values of the various hydropower plant options were developed.

POWER VALUES

Using a coal-fueled steam electric plant as the most likely alternative to the proposed hydroelectric project, the "at-site" power values were computed by FERC and are summaried in Table C-16. The FERC calculations are based on preliminary engineering and hydraulic data developed by St. Paul and Detroit Districts. As this data has been refined since the information was provided to FERC, the benefit calculations should at this point be considered only as estimates.

TABLE C-16

ENERGY AND CAPACITY VALUES

	ALTERNATIVE		
	1	2(a)	2(b) and 2(c)
Description of Alternative	18.4 MW Corps Plant + 30 MW Edison Sault Plant	16.4 MW Corps Plant + 40 MW Corps Plant	52.5 MW Corps Plant using all of U.S.A. water
GWh Annual Hydro Production	223.59	293.10	432.09
Mills/kWh Energy Value Adjustment	0	0	0
Mills/kWh Final Energy Value Based on current fuel cost of coal-steam alternative with production cost of 19.82 mills/kWh	22.93	22.70	24.42
Mills/kWh Final energy value based on lifetime levelized real cost fuel escalation. Annual rate of finance -			
7.125% (Esc. Coeff. = 1.281)	29.37	29.08	31.28
11.5% (Esc. Coeff. = 1.233)	28.27	27.99	30.11
% Hydro reliability capacity value adjustment	+28.9	+28.9	+28.9
$/kW-year capacity value. Annual rate of finance -			
7.125%	129.37	129.95	130.31
11.5%	265.27	266.26	266.87

These preliminary power values are based on August 1980 price levels and reflect the following general assumptions.

Power values are a measure of the benefits of power produced by a hydroelectric plant. As a surrogate of society's willingness to pay, power values are based on the resource costs of constructing and operating the most likely alternative to be implemented in the absence of the hydroelectric plant. This resource cost is given as the investment cost (capacity value) necessary to construct the most likely alternative and the production cost (energy value) which results from operation of the alternative.

The capacity component includes all fixed costs and is measured in dollars per year per kilowatt of dependable capacity. The energy component is fuel costs plus variable operation and maintenance costs and is measured in mills per kilowatt hour.

Power values are developed based on an analysis of the difference in "system" costs resulting from the system being operated with the most likely alternative and with the proposed hydropower additions.

WITHOUT PROJECT CONDITIONS

Two future without project conditions are considered for this study. One future without project condition is that the Government plant will continue operation at its present capacity and the Edison Sault plant will continue to operate with reduced flows (Scenario 1). This scenario presumes that the existing 80 year old Edison Sault plant could be operated indefinitely into the future at its current level of efficiency, with no capital improvements required.

The other future without project condition is that the Edison Sault hydro facility will discontinue operation by year 2000 and that the Government plant will continue operations (Scenario 2). In this instance, benefits are calculated on the amount of dependable hydropower capacity and generation added to the system, for each of the report alternatives, assuming that the Government plant continues to operate but the Edison Sault plant shuts down. Table C-17 displays basic information regarding future without project conditions.

WITHOUT PROJECT CONDITIONS, ALTERNATIVE 1, 2(a), 2(b), 2(c) (SCENARIO 1)

Alternative 1 considers the modification of the Edison Sault Electric Company plant and continued operation of the existing U.S. Government Plant. The benefits attributable to this alternative would be the dependable incremental capacity (kW), and the incremental average annual energy (MWh) that result from the modification or replacement of the Edison Sault plant.

The calculation of benefits and costs for Alternative 1 compared to future without project conditions (Scenario 1) are displayed in Table C-18.

Under Alternative 2(a) the operations of the existing Edison Sault Electric Company plant would be discontinued, Unit 10 of the U.S. Government plant would be dismantled, and the main Government plant would be extended southward. The extension would have new power generation units.

The calculation of benefits and costs for Alternative 2(a) compared to future without project conditions (Scenario 1) are displayed in Table C-19.

Alternative 2(b) consists of constructing a new U.S. Government plant and discontinuing operation of the Edison Sault Electric Company plant. This alternative is the same as Alternative 2(a) except for the following feature. Instead of extending the U.S. Government plant as in Alternative 2(a), the existing U.S. Government plant would be abandoned, and a new facility would be constructed.

TABLE C-17

WITHOUT PROJECT CONDITIONS
REDUCED FLOW

Basic Data	Edison Sault	Unit 10	Corps Plant
Assume Overall Plant Efficiency	0.70	0.86	0.86
Median Gross Head	18.8	20.0	20.0
Estimated Hydraulic Losses	0.8	0.5	0.5
Effective Net Power Head	18.0	19.5	19.5

Selected Parameters	Edison Sault	Unit 10	Corps Plant	Total System
Design Flow for Existing Capacity (cfs)	33,800	1,400	11,550	46,750
Existing Installed Capacity (kW)	41,300	2,000	16,400	59,700
Dependable Capacity (kW)	18,300	2,000	14,300	34,600
Average Flow (cfs)	24,300	1,500	11,200	37,000
Average Annual Energy (MWh)	227,000	19,000	139,000	385,000
Annual Plant Factor	0.63	1.07	0.97	0.74

TABLE C-18

ALTERNATIVE 1
BENEFITS AND COSTS

	Without Project Conditions Scenario 1	Alternative 1	Incremental Increase
Dependable Capacity (kW)	34,600	38,800	4,200
Average Annual Energy (MWh)	385,000	434,000	49,000
Annual Plant Factor	0.63	0.86 [1/]	0.82 [2/]
Dependable Capacity Value	$129.40 x 4,200		543,500
Average Annual Energy Value Mills/kWh	29.4 x 49,000		1,440,600
			$1,984,100
Project Cost: $40,305,000			
Annual Cost:			
Interest (.07125)			2,872,000
Amortization 100-yrs. (.00007)			3,000
Operation & Maintenance			1,209,000
Total Annual Cost			$4,084,000
Benefit/Cost Ratio			0.49

1/ Overall Plant Factor
2/ Incremental Plant Factor

TABLE C-19

ALTERNATIVE 2(a)
BENEFITS AND COSTS

	Without Project Conditions Scenario 1	Alternative 2(a)	Incremental Increase
Dependable Capacity (kW)	34,600	41,700	7,100
Average Annual Energy (MWh)	385,000	432,000	47,000
Annual Plant Factor	0.63	0.94[1/]	0.92[2/]
Dependable Capacity Value	$130.00 x 7,100		923,000
Average Annual Energy Value Mills/kWh	29.1 x 47,000		1,367,700
Total Incremental Benefit			$2,290,700
Project Cost: $57,661,000			
Annual Cost:			
Interest (.07125)			4,108,000
Amortization 100-yrs. (.00007)			4,000
Operation & Maintenance			1,690,000
Total Annual Cost			$5,802,000
Benefit/Cost Ratio			0.39

1/ Overall Plant Factor
2/ Incremental Plant Factor

The calculation of benefits and costs for Alternative 2(b) compared to future without project conditions (Scenario 1) are displayed in Table C-20.

Alternative 2(c) consists of installing new equipment in the U.S. Government plant and discontinuing operation of the Edison Sault Electric Company plant. This alternative also is the same as Alternative 2(a), except for the following feature. Instead of extending the U.S. Government plant as in Alternative 2(a), new equipment would be installed in the existing main powerhouse of the U.S. Government Plant. The proposed new equipment would necessitate considerable modification of the existing powerhouse.

The calculation of benefits and costs for Alternative 2(c) compared to future without project conditions (Scenario 1) are displayed in Table C-21.

WITHOUT PROJECT CONDITIONS, ALTERNATIVE 1, 2(a), 2(b), 2(c) (SCENARIO 2)

Each alternative under this scenario is the same as those discussed under Scenario 1. As stated earlier, the base year of the project is 1995. Under Scenario 2, the Edison Sault Electric Company could continue operation of its hydro plant until the year 2000. By year 2000 the Edison Sault plant will be approximately 100 years old, and in addition, the company's contract with the U.S. Government for purchasing part of the water available to the U.S. will have expired.

For each alternative under Scenario 2, it is assumed that total generation of power from a new facility will be fully utilized upon project implementation (1995). This is based on the fact that Edison Sault Electric Company cannot keep pace with demand for electrical power, which is the reason for importing electricity. Implementation of any of the alternatives, however, would reduce somewhat the increasing reliance of the company on purchases of electricity from other utilities.

TABLE C-20

ALTERNATIVE 2(b)
BENEFITS AND COSTS

	Without Project Conditions Scenario 1	Alternative 2(b)	Incremental Increase
Dependable Capacity (kW)	34,600	41,700	7,100
Average Annual Energy (MWh)	385,000	432,000	47,000
Annual Plant Factor	0.63	0.94	0.94
Dependable Capacity Value	$130.30 x 7,100		925,130
Average Annual Energy Value Mills/kWh	31.30 x 47,000		1,471,100
Total Incremental Benefit			$2,396,230
Project Cost: $74,844,000			
Annual Cost:			
Interest (.07125)			5,333,000
Amortization 100-yrs. (.00007)			5,000
Operation & Maintenance			2,206,000
Total Annual Cost			$7,544,000
Benefit/Cost Ratio			0.32

TABLE C-21

ALTERNATIVE 2(c)
BENEFITS AND COSTS

	Without Project Conditions Scenario 1	Alternative 2(c)	Incremental Increase
Dependable Capacity (kW)	34,600	41,700	7,100
Average Annual Energy (MWh)	385,000	432,000	47,000
Annual Plant Factor	0.63	0.94	0.94
Dependable Capacity Value	$130.30 x 7,100		925,130
Average Annual Energy Value Mills/kWh	31.30 x 47,000		1,471,100
Total Incremental Benefit			$2,396,230
Project Cost: $83,610,000			
Annual Cost:			
Interest (.07125)			5,957,000
Amortization 100-yrs. (.00007)			6,000
Operation & Maintenance			2,095,000
Total Annual Cost			$8,058,000
Benefit/Cost Ratio			0.30

The calculation of benefits and costs, benefit/cost ratios and other pertinent information for each alternative for the period 1995 to year 2095 are presented in Table C-22.

JUSTIFICATION

A comparison of average annual benefits and costs for each alternative under the assumptions of without conditions (Scenario 1) reveals that none of the alternatives would be economically feasible. Conversely, under the assumptions of without conditions (Scenario 2), all alternatives are economically feasible. The problem is in judging the future of the Edison Sault hydropower facilities, and in estimating the time frame in which maximum use and an optimum investment in the hydropower resource on the St. Marys River can be made.

Scenario 1 is problematic in that it is unrealistic to expect that the existing Edison Sault hydro facilities could continue to function over some future 100 year project life without some additional investment being made to maintain its operation. Even if attempts were made to nurse the present plant along, the lack of plant efficiency would mean less than a full utilization of a valuable resource.

It is for these reasons that Scenario 2 appears to be a better estimate of future hydropower developments. As competing forms of energy escalate in cost, an investment in hydropower can reap dividends over a long term project life, making use of a renewable resource.

NET PRESENT VALUE (NPV)

The net present value analysis incorporates all of the pertinent economic data into a consistent one-figure decision rule that allows alternatives to be screened and ranked. The general rule is to determine the present value, at the time of the first expenditure, of the future stream of net benefit flows. For this analysis, it is

TABLE C-22

SUMMARY ANNUALIZED NED BENEFITS FOR STRUCTURAL MEASURES AND NED COSTS FOR STRUCTURAL MEASURES
APPLICABLE DISCOUNT RATE: 7-1/8%, AUGUST 1980 PRICE LEVELS
PERIOD OF ANALYSIS: 1995-2095

Plant Data	Alternative 1	Alternative 2(a)	Alternative 2(b)	Alternative 2(c)
Installed Capacity, kW	56,900	52,600	52,600	52,600
Dependable Capacity, kW (incremental)	22,500	27,400	27,400	27,400
Average Annual Energy MWh	276,000	293,000	293,000	293,000
Average Annual Plant Factor	0.86	0.94	0.94	0.94
Unit Power Values:*				
Dependable Capacity ($/kW)	$129.40	$130.00	$130.30	$130.30
Average Annual Energy (mills/kWh)	29.4	29.1	31.3	31.3
Benefits				
Annual Hydropower Benefits ($1,000)				
Dependable Capacity	2,912	3,562	3,570	3,570
Average Annual Energy	8,114	8,526	9,171	9,171
Total Annual Benefits	$11,026	$12,088	$12,741	$12,741
Project Cost ($1,000)				
First Cost	40,305	57,661	74,844	83,610
Annual Cost:				
Interest (.07125)	2,872	4,108	5,333	5,957
Amortization 100-yrs. (.00007)	3	4	5	6
Operation & Maintenance	1,209	1,690	2,206	2,095
Total Annual Cost	$ 4,084	$ 5,802	$ 7,544	$ 8,058
Benefit/Cost Ratio	2.7	2.1	1.7	1.6
Excess Benefits Over Costs	$ 6,942	$ 6,286	$ 5,197	$ 4,683

* Preliminary values provided by FERC based on lifetime levelized real cost fuel escalation.

assumed that for each alternative, one-half of the capital costs will be spent in the first year, and one-half in the second year. The screening decision criteria is to reject the alternative if the NPV is less than or equal to zero.

In order to determine the impact of an annual inflation rate on the streams of benefits, the NPV of benefits using an inflation rate of 6-1/2% is compared to the NPV of benefits without an inflation rate escalation.

Tables C-23 through C-26 display NPV of benefits for each alternative without escalation. Tables C-27 through C-30 display NPV of benefits with escalation.

As can be seen from the Tables, the NPV of all alternatives are positive, with Alternative 1 having the largest NPV of benefits in both cases.

Table C-23
Net Present Value Without Escalation
Alternative 1

PROJECT: HYDROPOWER-ALT 1

PROJECT LIFE ------ 100 YRS.
PRICE ESCALATION -- 0%
INTEREST RATE ----- 7.125%

YEAR	CAPITAL COSTS	O&M COSTS	BENEFITS	NET ANN. BENEFITS	VALUE FACTOR	PRES VAL $1,000
1995	20,153	0	0	-20,153	1.0000	-20,153
1996	20,153	0	0	-20,153	0.9335	-18,812
1997	0	1,209	11,078	9,869	0.8714	8,600
1998	0	1,209	11,078	9,869	0.8134	8,028
1999	0	1,209	11,078	9,869	0.7593	7,494
2000	0	1,209	11,078	9,869	0.7088	6,996
2001	0	1,209	11,078	9,869	0.6617	6,530
2002	0	1,209	11,078	9,869	0.6177	6,096
2003	0	1,209	11,078	9,869	0.5766	5,690
2004	0	1,209	11,078	9,869	0.5382	5,312
2005	0	1,209	11,078	9,869	0.5024	4,959
2006	0	1,209	11,078	9,869	0.4690	4,629
2007	0	1,209	11,078	9,869	0.4378	4,321
2008	0	1,209	11,078	9,869	0.4087	4,034
2009	0	1,209	11,078	9,869	0.3815	3,765
2010	0	1,209	11,078	9,869	0.3562	3,515
2011	0	1,209	11,078	9,869	0.3325	3,281
2012	0	1,209	11,078	9,869	0.3104	3,063
2013	0	1,209	11,078	9,869	0.2897	2,859
2014	0	1,209	11,078	9,869	0.2704	2,669
2015	0	1,209	11,078	9,869	0.2525	2,491
2016	0	1,209	11,078	9,869	0.2357	2,326
2017	0	1,209	11,078	9,869	0.2200	2,171
2018	0	1,209	11,078	9,869	0.2054	2,027
2019	0	1,209	11,078	9,869	0.1917	1,892
2020	0	1,209	11,078	9,869	0.1789	1,766
2021	0	1,209	11,078	9,869	0.1670	1,649
2022	0	1,209	11,078	9,869	0.1559	1,539
2023	0	1,209	11,078	9,869	0.1456	1,437
2024	0	1,209	11,078	9,869	0.1359	1,341
2025	0	1,209	11,078	9,869	0.1268	1,252
2026	0	1,209	11,078	9,869	0.1184	1,169
2027	0	1,209	11,078	9,869	0.1105	1,091
2028	0	1,209	11,078	9,869	0.1032	1,018
2029	0	1,209	11,078	9,869	0.0963	951
2030	0	1,209	11,078	9,869	0.0899	887
2031	0	1,209	11,078	9,869	0.0839	828
2032	0	1,209	11,078	9,869	0.0784	773

Table C-23(Cont.)

2033	0	1,209	11,078	9,869	0.0731	722
2034	0	1,209	11,078	9,869	0.0683	674
2035	0	1,209	11,078	9,869	0.0637	629
2036	0	1,209	11,078	9,869	0.0595	587
2037	0	1,209	11,078	9,869	0.0555	548
2038	0	1,209	11,078	9,869	0.0518	512
2039	0	1,209	11,078	9,869	0.0484	478
2040	0	1,209	11,078	9,869	0.0452	446
2041	0	1,209	11,078	9,869	0.0422	416
2042	0	1,209	11,078	9,869	0.0394	389
2043	0	1,209	11,078	9,869	0.0367	363
2044	0	1,209	11,078	9,869	0.0343	339
2045	0	1,209	11,078	9,869	0.0320	316
2046	0	1,209	11,078	9,869	0.0299	295
2047	0	1,209	11,078	9,869	0.0279	275
2048	0	1,209	11,078	9,869	0.0260	257
2049	0	1,209	11,078	9,869	0.0243	240
2050	0	1,209	11,078	9,869	0.0227	224
2051	0	1,209	11,078	9,869	0.0212	209
2052	0	1,209	11,078	9,869	0.0198	195
2053	0	1,209	11,078	9,869	0.0185	182
2054	0	1,209	11,078	9,869	0.0172	170
2055	0	1,209	11,078	9,869	0.0161	159
2056	0	1,209	11,078	9,869	0.0150	148
2057	0	1,209	11,078	9,869	0.0140	138
2058	0	1,209	11,078	9,869	0.0131	129
2059	0	1,209	11,078	9,869	0.0122	121
2060	0	1,209	11,078	9,869	0.0114	113
2061	0	1,209	11,078	9,869	0.0106	105
2062	0	1,209	11,078	9,869	0.0099	98
2063	0	1,209	11,078	9,869	0.0093	92
2064	0	1,209	11,078	9,869	0.0087	85
2065	0	1,209	11,078	9,869	0.0081	80
2066	0	1,209	11,078	9,869	0.0075	74
2067	0	1,209	11,078	9,869	0.0070	70
2068	0	1,209	11,078	9,869	0.0066	65
2069	0	1,209	11,078	9,869	0.0061	61
2070	0	1,209	11,078	9,869	0.0057	57
2071	0	1,209	11,078	9,869	0.0053	53
2072	0	1,209	11,078	9,869	0.0050	49
2073	0	1,209	11,078	9,869	0.0047	46
2074	0	1,209	11,078	9,869	0.0044	43
2075	0	1,209	11,078	9,869	0.0041	40
2076	0	1,209	11,078	9,869	0.0038	37
2077	0	1,209	11,078	9,869	0.0035	35
2078	0	1,209	11,078	9,869	0.0033	33
2079	0	1,209	11,078	9,869	0.0031	30
2080	0	1,209	11,078	9,869	0.0029	28
2081	0	1,209	11,078	9,869	0.0027	27
2082	0	1,209	11,078	9,869	0.0025	25

Table C-23 (Cont.)

2083	0	1,209	11,078	9,869	0.0023	23
2084	0	1,209	11,078	9,869	0.0022	22
2085	0	1,209	11,078	9,869	0.0020	20
2086	0	1,209	11,078	9,869	0.0019	19
2087	0	1,209	11,078	9,869	0.0018	18
2088	0	1,209	11,078	9,869	0.0017	16
2089	0	1,209	11,078	9,869	0.0015	15
2090	0	1,209	11,078	9,869	0.0014	14
2091	0	1,209	11,078	9,869	0.0014	13
2092	0	1,209	11,078	9,869	0.0013	12
2093	0	1,209	11,078	9,869	0.0012	12
2094	0	1,209	11,078	9,869	0.0011	11
2095	0	1,209	11,078	9,869	0.0010	10

NET PRESENT VALUE OF PROJECT = $90,193

Table C-24
Net Present Value Without Escalation
Alternative 2(A)

PROJECT: HYDROPOWER-ALT 2(A)

PROJECT LIFE------ 100 YRS.
PRICE ESCALATION -- 0%
INTEREST RATE ----- 7.125%

YEAR	CAPITAL COSTS	O&M COSTS	BENEFITS	NET ANN. BENEFITS	VALUE FACTOR	PRES VAL $1,000
1995	28,830	0	0	-28,830	1.0000	-28,830
1996	28,830	0	0	-28,830	0.9335	-26,912
1997	0	1,730	11,841	10,111	0.8714	8,811
1998	0	1,730	11,841	10,111	0.8134	8,225
1999	0	1,730	11,841	10,111	0.7593	7,678
2000	0	1,730	11,841	10,111	0.7088	7,167
2001	0	1,730	11,841	10,111	0.6617	6,690
2002	0	1,730	11,841	10,111	0.6177	6,245
2003	0	1,730	11,841	10,111	0.5766	5,830
2004	0	1,730	11,841	10,111	0.5382	5,442
2005	0	1,730	11,841	10,111	0.5024	5,080
2006	0	1,730	11,841	10,111	0.4690	4,742
2007	0	1,730	11,841	10,111	0.4378	4,427
2008	0	1,730	11,841	10,111	0.4087	4,133
2009	0	1,730	11,841	10,111	0.3815	3,858
2010	0	1,730	11,841	10,111	0.3562	3,601
2011	0	1,730	11,841	10,111	0.3325	3,362
2012	0	1,730	11,841	10,111	0.3104	3,138
2013	0	1,730	11,841	10,111	0.2897	2,929
2014	0	1,730	11,841	10,111	0.2704	2,734
2015	0	1,730	11,841	10,111	0.2525	2,553
2016	0	1,730	11,841	10,111	0.2357	2,383
2017	0	1,730	11,841	10,111	0.2200	2,224
2018	0	1,730	11,841	10,111	0.2054	2,076
2019	0	1,730	11,841	10,111	0.1917	1,938
2020	0	1,730	11,841	10,111	0.1789	1,809
2021	0	1,730	11,841	10,111	0.1670	1,689
2022	0	1,730	11,841	10,111	0.1559	1,577
2023	0	1,730	11,841	10,111	0.1456	1,472
2024	0	1,730	11,841	10,111	0.1359	1,374
2025	0	1,730	11,841	10,111	0.1268	1,283
2026	0	1,730	11,841	10,111	0.1184	1,197
2027	0	1,730	11,841	10,111	0.1105	1,118
2028	0	1,730	11,841	10,111	0.1032	1,043
2029	0	1,730	11,841	10,111	0.0963	974
2030	0	1,730	11,841	10,111	0.0899	909
2031	0	1,730	11,841	10,111	0.0839	849

Table C-24(Cont.)

2032	0	1,730	11,841	10,111	0.0784	792
2033	0	1,730	11,841	10,111	0.0731	740
2034	0	1,730	11,841	10,111	0.0683	690
2035	0	1,730	11,841	10,111	0.0637	644
2036	0	1,730	11,841	10,111	0.0595	602
2037	0	1,730	11,841	10,111	0.0555	562
2038	0	1,730	11,841	10,111	0.0518	524
2039	0	1,730	11,841	10,111	0.0484	489
2040	0	1,730	11,841	10,111	0.0452	457
2041	0	1,730	11,841	10,111	0.0422	426
2042	0	1,730	11,841	10,111	0.0394	398
2043	0	1,730	11,841	10,111	0.0367	372
2044	0	1,730	11,841	10,111	0.0343	347
2045	0	1,730	11,841	10,111	0.0320	324
2046	0	1,730	11,841	10,111	0.0299	302
2047	0	1,730	11,841	10,111	0.0279	282
2048	0	1,730	11,841	10,111	0.0260	263
2049	0	1,730	11,841	10,111	0.0243	246
2050	0	1,730	11,841	10,111	0.0227	230
2051	0	1,730	11,841	10,111	0.0212	214
2052	0	1,730	11,841	10,111	0.0198	200
2053	0	1,730	11,841	10,111	0.0185	187
2054	0	1,730	11,841	10,111	0.0172	174
2055	0	1,730	11,841	10,111	0.0161	163
2056	0	1,730	11,841	10,111	0.0150	152
2057	0	1,730	11,841	10,111	0.0140	142
2058	0	1,730	11,841	10,111	0.0131	132
2059	0	1,730	11,841	10,111	0.0122	124
2060	0	1,730	11,841	10,111	0.0114	115
2061	0	1,730	11,841	10,111	0.0106	108
2062	0	1,730	11,841	10,111	0.0099	100
2063	0	1,730	11,841	10,111	0.0093	94
2064	0	1,730	11,841	10,111	0.0087	88
2065	0	1,730	11,841	10,111	0.0081	82
2066	0	1,730	11,841	10,111	0.0075	76
2067	0	1,730	11,841	10,111	0.0070	71
2068	0	1,730	11,841	10,111	0.0066	66
2069	0	1,730	11,841	10,111	0.0061	62
2070	0	1,730	11,841	10,111	0.0057	58
2071	0	1,730	11,841	10,111	0.0053	54
2072	0	1,730	11,841	10,111	0.0050	50
2073	0	1,730	11,841	10,111	0.0047	47
2074	0	1,730	11,841	10,111	0.0044	44
2075	0	1,730	11,841	10,111	0.0041	41
2076	0	1,730	11,841	10,111	0.0038	38
2077	0	1,730	11,841	10,111	0.0035	36
2078	0	1,730	11,841	10,111	0.0033	33
2079	0	1,730	11,841	10,111	0.0031	31
2080	0	1,730	11,841	10,111	0.0029	29
2081	0	1,730	11,841	10,111	0.0027	27
2082	0	1,730	11,841	10,111	0.0025	25

Table C-24(Cont.)

2083	0	1,730	11,841	10,111	0.0023	24
2084	0	1,730	11,841	10,111	0.0022	22
2085	0	1,730	11,841	10,111	0.0020	21
2086	0	1,730	11,841	10,111	0.0019	19
2087	0	1,730	11,841	10,111	0.0018	18
2088	0	1,730	11,841	10,111	0.0017	17
2089	0	1,730	11,841	10,111	0.0015	16
2090	0	1,730	11,841	10,111	0.0014	15
2091	0	1,730	11,841	10,111	0.0014	14
2092	0	1,730	11,841	10,111	0.0013	13
2093	0	1,730	11,841	10,111	0.0012	12
2094	0	1,730	11,841	10,111	0.0011	11
2095	0	1,730	11,841	10,111	0.0010	10

NET PRESENT VALUE OF PROJECT = $76,582

Table C-25
Net Present Value Without Escalation
Alternative 2(B)

PROJECT: HYDROPOWER-ALT 2(B)

PROJECT LIFE------ 100 YRS.
PRICE ESCALATION -- 0%
INTEREST RATE ----- 7.125%

YEAR	CAPITAL COSTS	O&M COSTS	BENEFITS	NET ANN. BENEFITS	VALUE FACTOR	PRES VAL $1,000
1995	37,422	0	0	-37,422	1.0000	-37,422
1996	37,422	0	0	-37,422	0.9335	-34,933
1997	0	2,244	12,494	10,250	0.8714	8,932
1998	0	2,244	12,494	10,250	0.8134	8,338
1999	0	2,244	12,494	10,250	0.7593	7,783
2000	0	2,244	12,494	10,250	0.7088	7,266
2001	0	2,244	12,494	10,250	0.6617	6,782
2002	0	2,244	12,494	10,250	0.6177	6,331
2003	0	2,244	12,494	10,250	0.5766	5,910
2004	0	2,244	12,494	10,250	0.5382	5,517
2005	0	2,244	12,494	10,250	0.5024	5,150
2006	0	2,244	12,494	10,250	0.4690	4,808
2007	0	2,244	12,494	10,250	0.4378	4,488
2008	0	2,244	12,494	10,250	0.4087	4,189
2009	0	2,244	12,494	10,250	0.3815	3,911
2010	0	2,244	12,494	10,250	0.3562	3,651
2011	0	2,244	12,494	10,250	0.3325	3,408
2012	0	2,244	12,494	10,250	0.3104	3,181
2013	0	2,244	12,494	10,250	0.2897	2,970
2014	0	2,244	12,494	10,250	0.2704	2,772
2015	0	2,244	12,494	10,250	0.2525	2,588
2016	0	2,244	12,494	10,250	0.2357	2,416
2017	0	2,244	12,494	10,250	0.2200	2,255
2018	0	2,244	12,494	10,250	0.2054	2,105
2019	0	2,244	12,494	10,250	0.1917	1,965
2020	0	2,244	12,494	10,250	0.1789	1,834
2021	0	2,244	12,494	10,250	0.1670	1,712
2022	0	2,244	12,494	10,250	0.1559	1,598
2023	0	2,244	12,494	10,250	0.1456	1,492
2024	0	2,244	12,494	10,250	0.1359	1,393
2025	0	2,244	12,494	10,250	0.1268	1,300
2026	0	2,244	12,494	10,250	0.1184	1,214
2027	0	2,244	12,494	10,250	0.1105	1,133
2028	0	2,244	12,494	10,250	0.1032	1,058
2029	0	2,244	12,494	10,250	0.0963	987
2030	0	2,244	12,494	10,250	0.0899	922
2031	0	2,244	12,494	10,250	0.0839	860

Table C-25 (Cont.)

2032	0	2,244	12,494	10,250	0.0784	803
2033	0	2,244	12,494	10,250	0.0731	750
2034	0	2,244	12,494	10,250	0.0683	700
2035	0	2,244	12,494	10,250	0.0637	653
2036	0	2,244	12,494	10,250	0.0595	610
2037	0	2,244	12,494	10,250	0.0555	569
2038	0	2,244	12,494	10,250	0.0518	531
2039	0	2,244	12,494	10,250	0.0484	496
2040	0	2,244	12,494	10,250	0.0452	463
2041	0	2,244	12,494	10,250	0.0422	432
2042	0	2,244	12,494	10,250	0.0394	404
2043	0	2,244	12,494	10,250	0.0367	377
2044	0	2,244	12,494	10,250	0.0343	352
2045	0	2,244	12,494	10,250	0.0320	328
2046	0	2,244	12,494	10,250	0.0299	306
2047	0	2,244	12,494	10,250	0.0279	286
2048	0	2,244	12,494	10,250	0.0260	267
2049	0	2,244	12,494	10,250	0.0243	249
2050	0	2,244	12,494	10,250	0.0227	233
2051	0	2,244	12,494	10,250	0.0212	217
2052	0	2,244	12,494	10,250	0.0198	203
2053	0	2,244	12,494	10,250	0.0185	189
2054	0	2,244	12,494	10,250	0.0172	177
2055	0	2,244	12,494	10,250	0.0161	165
2056	0	2,244	12,494	10,250	0.0150	154
2057	0	2,244	12,494	10,250	0.0140	144
2058	0	2,244	12,494	10,250	0.0131	134
2059	0	2,244	12,494	10,250	0.0122	125
2060	0	2,244	12,494	10,250	0.0114	117
2061	0	2,244	12,494	10,250	0.0106	109
2062	0	2,244	12,494	10,250	0.0099	102
2063	0	2,244	12,494	10,250	0.0093	95
2064	0	2,244	12,494	10,250	0.0087	89
2065	0	2,244	12,494	10,250	0.0081	83
2066	0	2,244	12,494	10,250	0.0075	77
2067	0	2,244	12,494	10,250	0.0070	72
2068	0	2,244	12,494	10,250	0.0066	67
2069	0	2,244	12,494	10,250	0.0061	63
2070	0	2,244	12,494	10,250	0.0057	59
2071	0	2,244	12,494	10,250	0.0053	55
2072	0	2,244	12,494	10,250	0.0050	51
2073	0	2,244	12,494	10,250	0.0047	48
2074	0	2,244	12,494	10,250	0.0044	45
2075	0	2,244	12,494	10,250	0.0041	42
2076	0	2,244	12,494	10,250	0.0038	39
2077	0	2,244	12,494	10,250	0.0035	36
2078	0	2,244	12,494	10,250	0.0033	34
2079	0	2,244	12,494	10,250	0.0031	32
2080	0	2,244	12,494	10,250	0.0029	30
2081	0	2,244	12,494	10,250	0.0027	28

Table C-25(Cont.)

2082	0	2,244	12,494	10,250	0.0025	26
2083	0	2,244	12,494	10,250	0.0023	24
2084	0	2,244	12,494	10,250	0.0022	22
2085	0	2,244	12,494	10,250	0.0020	21
2086	0	2,244	12,494	10,250	0.0019	20
2087	0	2,244	12,494	10,250	0.0018	18
2088	0	2,244	12,494	10,250	0.0017	17
2089	0	2,244	12,494	10,250	0.0015	16
2090	0	2,244	12,494	10,250	0.0014	15
2091	0	2,244	12,494	10,250	0.0014	14
2092	0	2,244	12,494	10,250	0.0013	13
2093	0	2,244	12,494	10,250	0.0012	12
2094	0	2,244	12,494	10,250	0.0011	11
2095	0	2,244	12,494	10,250	0.0010	11

NET PRESENT VALUE OF PROJECT = $61,789

Table C-26
Net Present Value Without Escalation
Alternative 2(C)

PROJECT: HYDROPOWER-ALT 2(C)

PROJECT LIFE------ 100 YRS.
PRICE ESCALATION -- 0%
INTEREST RATE ----- 7.125%

YEAR	CAPITAL COSTS	O&M COSTS	BENEFITS	NET ANN. BENEFITS	VALUE FACTOR	PRES VAL $1,000
1995	41.805	0	0	-41,805	1.0000	-41,805
1996	41.805	0	0	-41,805	0.9335	-39,025
1997	0	2,176	12,494	10,318	0.8714	8,991
1998	0	2,176	12,494	10,318	0.8134	8,393
1999	0	2,176	12,494	10,318	0.7593	7,835
2000	0	2,176	12,494	10,318	0.7088	7,314
2001	0	2,176	12,494	10,318	0.6617	6,827
2002	0	2,176	12,494	10,318	0.6177	6,373
2003	0	2,176	12,494	10,318	0.5766	5,949
2004	0	2,176	12,494	10,318	0.5382	5,554
2005	0	2,176	12,494	10,318	0.5024	5,184
2006	0	2,176	12,494	10,318	0.4690	4,839
2007	0	2,176	12,494	10,318	0.4378	4,518
2008	0	2,176	12,494	10,318	0.4087	4,217
2009	0	2,176	12,494	10,318	0.3815	3,937
2010	0	2,176	12,494	10,318	0.3562	3,675
2011	0	2,176	12,494	10,318	0.3325	3,430
2012	0	2,176	12,494	10,318	0.3104	3,202
2013	0	2,176	12,494	10,318	0.2897	2,989
2014	0	2,176	12,494	10,318	0.2704	2,790
2015	0	2,176	12,494	10,318	0.2525	2,605
2016	0	2,176	12,494	10,318	0.2357	2,432
2017	0	2,176	12,494	10,318	0.2200	2,270
2018	0	2,176	12,494	10,318	0.2054	2,119
2019	0	2,176	12,494	10,318	0.1917	1,978
2020	0	2,176	12,494	10,318	0.1789	1,846
2021	0	2,176	12,494	10,318	0.1670	1,724
2022	0	2,176	12,494	10,318	0.1559	1,609
2023	0	2,176	12,494	10,318	0.1456	1,502
2024	0	2,176	12,494	10,318	0.1359	1,402
2025	0	2,176	12,494	10,318	0.1268	1,309
2026	0	2,176	12,494	10,318	0.1184	1,222
2027	0	2,176	12,494	10,318	0.1105	1,140
2028	0	2,176	12,494	10,318	0.1032	1,065
2029	0	2,176	12,494	10,318	0.0963	994
2030	0	2,176	12,494	10,318	0.0899	928
2031	0	2,176	12,494	10,318	0.0839	866

Table C-26(Cont.)

2032	0	2,176	12,494	10,318	0.0784	808
2033	0	2,176	12,494	10,318	0.0731	755
2034	0	2,176	12,494	10,318	0.0683	704
2035	0	2,176	12,494	10,318	0.0637	658
2036	0	2,176	12,494	10,318	0.0595	614
2037	0	2,176	12,494	10,318	0.0555	573
2038	0	2,176	12,494	10,318	0.0518	535
2039	0	2,176	12,494	10,318	0.0484	499
2040	0	2,176	12,494	10,318	0.0452	466
2041	0	2,176	12,494	10,318	0.0422	435
2042	0	2,176	12,494	10,318	0.0394	406
2043	0	2,176	12,494	10,318	0.0367	379
2044	0	2,176	12,494	10,318	0.0343	354
2045	0	2,176	12,494	10,318	0.0320	330
2046	0	2,176	12,494	10,318	0.0299	308
2047	0	2,176	12,494	10,318	0.0279	288
2048	0	2,176	12,494	10,318	0.0260	269
2049	0	2,176	12,494	10,318	0.0243	251
2050	0	2,176	12,494	10,318	0.0227	234
2051	0	2,176	12,494	10,318	0.0212	219
2052	0	2,176	12,494	10,318	0.0198	204
2053	0	2,176	12,494	10,318	0.0185	191
2054	0	2,176	12,494	10,318	0.0172	178
2055	0	2,176	12,494	10,318	0.0161	166
2056	0	2,176	12,494	10,318	0.0150	155
2057	0	2,176	12,494	10,318	0.0140	145
2058	0	2,176	12,494	10,318	0.0131	135
2059	0	2,176	12,494	10,318	0.0122	126
2060	0	2,176	12,494	10,318	0.0114	118
2061	0	2,176	12,494	10,318	0.0106	110
2062	0	2,176	12,494	10,318	0.0099	103
2063	0	2,176	12,494	10,318	0.0093	96
2064	0	2,176	12,494	10,318	0.0087	89
2065	0	2,176	12,494	10,318	0.0081	83
2066	0	2,176	12,494	10,318	0.0075	78
2067	0	2,176	12,494	10,318	0.0070	73
2068	0	2,176	12,494	10,318	0.0066	68
2069	0	2,176	12,494	10,318	0.0061	63
2070	0	2,176	12,494	10,318	0.0057	59
2071	0	2,176	12,494	10,318	0.0053	55
2072	0	2,176	12,494	10,318	0.0050	52
2073	0	2,176	12,494	10,318	0.0047	48
2074	0	2,176	12,494	10,318	0.0044	45
2075	0	2,176	12,494	10,318	0.0041	42
2076	0	2,176	12,494	10,318	0.0038	39
2077	0	2,176	12,494	10,318	0.0035	37
2078	0	2,176	12,494	10,318	0.0033	34
2079	0	2,176	12,494	10,318	0.0031	32
2080	0	2,176	12,494	10,318	0.0029	30
2081	0	2,176	12,494	10,318	0.0027	28

Table C-26(Cont.)

2082	0	2,176	12,494	10,318	0.0025	26
2083	0	2,176	12,494	10,318	0.0023	24
2084	0	2,176	12,494	10,318	0.0022	23
2085	0	2,176	12,494	10,318	0.0020	21
2086	0	2,176	12,494	10,318	0.0019	20
2087	0	2,176	12,494	10,318	0.0018	18
2088	0	2,176	12,494	10,318	0.0017	17
2089	0	2,176	12,494	10,318	0.0015	16
2090	0	2,176	12,494	10,318	0.0014	15
2091	0	2,176	12,494	10,318	0.0014	14
2092	0	2,176	12,494	10,318	0.0013	13
2093	0	2,176	12,494	10,318	0.0012	12
2094	0	2,176	12,494	10,318	0.0011	11
2095	0	2,176	12,494	10,318	0.0010	11

NET PRESENT VALUE OF PROJECT = $54,204

Table C-27
Net Present Value With Escalation
Alternative 1

PROJECT: HYDROPOWER-ALT 1

PROJECT LIFE ------ 100 YRS.
PRICE ESCALATION -- 6.5%
INTEREST RATE ----- 7.125%

YEAR	CAPITAL COSTS	O&M COSTS	BENEFITS	NET ANN. BENEFITS	VALUE FACTOR	PRES VAL $1,000
1995	20,153	0	0	-20,153	1.0000	-20,153
1996	21,462	0	0	-21,462	0.9335	-20,035
1997	0	1,209	11,078	9,869	0.8714	8,600
1998	0	1,288	11,798	10,510	0.8134	8,550
1999	0	1,371	12,565	11,194	0.7593	8,500
2000	0	1,460	13,382	11,921	0.7088	8,450
2001	0	1,555	14,251	12,696	0.6617	8,401
2002	0	1,656	15,178	13,521	0.6177	8,352
2003	0	1,764	16,164	14,400	0.5766	8,303
2004	0	1,879	17,215	15,336	0.5382	8,255
2005	0	2,001	18,334	16,333	0.5024	8,207
2006	0	2,131	19,526	17,395	0.4690	8,159
2007	0	2,269	20,795	18,525	0.4378	8,111
2008	0	2,417	22,147	19,730	0.4087	8,064
2009	0	2,574	23,586	21,012	0.3815	8,017
2010	0	2,741	25,119	22,378	0.3562	7,970
2011	0	2,920	26,752	23,832	0.3325	7,923
2012	0	3,109	28,491	25,381	0.3104	7,877
2013	0	3,311	30,343	27,031	0.2897	7,831
2014	0	3,527	32,315	28,788	0.2704	7,786
2015	0	3,756	34,416	30,660	0.2525	7,740
2016	0	4,000	36,653	32,652	0.2357	7,695
2017	0	4,260	39,035	34,775	0.2200	7,650
2018	0	4,537	41,572	37,035	0.2054	7,605
2019	0	4,832	44,274	39,443	0.1917	7,561
2020	0	5,146	47,152	42,006	0.1789	7,517
2021	0	5,480	50,217	44,737	0.1670	7,473
2022	0	5,837	53,481	47,645	0.1559	7,430
2023	0	6,216	56,958	50,741	0.1456	7,386
2024	0	6,620	60,660	54,040	0.1359	7,343
2025	0	7,050	64,603	57,552	0.1268	7,300
2026	0	7,509	68,802	61,293	0.1184	7,258
2027	0	7,997	73,274	65,277	0.1105	7,215
2028	0	8,517	78,037	69,520	0.1032	7,173
2029	0	9,070	83,109	74,039	0.0963	7,131
2030	0	9,660	88,511	78,852	0.0899	7,090
2031	0	10,288	94,264	83,977	0.0839	7,048
2032	0	10,956	100,392	89,435	0.0784	7,007

Table C-27(Cont.)

2033	0	11,668	106,917	95,249	0.0731	6,966
2034	0	12,427	113,867	101,440	0.0683	6,926
2035	0	13,235	121,268	108,033	0.0637	6,885
2036	0	14,095	129,150	115,056	0.0595	6,845
2037	0	15,011	137,545	122,534	0.0555	6,805
2038	0	15,987	146,486	130,499	0.0518	6,766
2039	0	17,026	156,007	138,981	0.0484	6,726
2040	0	18,133	166,148	148,015	0.0452	6,687
2041	0	19,311	176,947	157,636	0.0422	6,648
2042	0	20,566	188,449	167,883	0.0394	6,609
2043	0	21,903	200,698	178,795	0.0367	6,570
2044	0	23,327	213,744	190,417	0.0343	6,532
2045	0	24,843	227,637	202,794	0.0320	6,494
2046	0	26,458	242,433	215,975	0.0299	6,456
2047	0	28,178	258,191	230,014	0.0279	6,418
2048	0	30,009	274,974	244,964	0.0260	6,381
2049	0	31,960	292,847	260,887	0.0243	6,344
2050	0	34,037	311,882	277,845	0.0227	6,307
2051	0	36,250	332,155	295,905	0.0212	6,270
2052	0	38,606	353,745	315,139	0.0198	6,233
2053	0	41,115	376,738	335,623	0.0185	6,197
2054	0	43,788	401,226	357,438	0.0172	6,161
2055	0	46,634	427,306	380,672	0.0161	6,125
2056	0	49,665	455,080	405,415	0.0150	6,089
2057	0	52,894	484,661	431,767	0.0140	6,054
2058	0	56,332	516,164	459,832	0.0131	6,018
2059	0	59,993	549,714	489,721	0.0122	5,983
2060	0	63,893	585,446	521,553	0.0114	5,948
2061	0	68,046	623,500	555,454	0.0106	5,914
2062	0	72,469	664,027	591,558	0.0099	5,879
2063	0	77,179	707,189	630,010	0.0093	5,845
2064	0	82,196	753,156	670,960	0.0087	5,811
2065	0	87,539	802,111	714,573	0.0081	5,777
2066	0	93,229	854,249	761,020	0.0075	5,743
2067	0	99,288	909,775	810,486	0.0070	5,710
2068	0	105,742	968,910	863,168	0.0066	5,676
2069	0	112,615	1,031,889	919,274	0.0061	5,643
2070	0	119,935	1,098,962	979,027	0.0057	5,610
2071	0	127,731	1,170,395	1,042,663	0.0053	5,578
2072	0	136,034	1,246,470	1,110,437	0.0050	5,545
2073	0	144,876	1,327,491	1,182,615	0.0047	5,513
2074	0	154,293	1,413,778	1,259,485	0.0044	5,480
2075	0	164,322	1,505,673	1,341,351	0.0041	5,448
2076	0	175,003	1,603,542	1,428,539	0.0038	5,417
2077	0	186,378	1,707,772	1,521,394	0.0035	5,385
2078	0	198,493	1,818,778	1,620,285	0.0033	5,354
2079	0	211,395	1,936,998	1,725,603	0.0031	5,322
2080	0	225,135	2,062,903	1,837,768	0.0029	5,291
2081	0	239,769	2,196,992	1,957,223	0.0027	5,261
2082	0	255,354	2,339,796	2,084,442	0.0025	5,230

Table C-27(Cont.)

2083	0	271,952	2,491,883	2,219,931	0.0023	5,199
2084	0	289,629	2,653,855	2,364,226	0.0022	5,169
2085	0	308,455	2,826,356	2,517,901	0.0020	5,139
2086	0	328,505	3,010,069	2,681,564	0.0019	5,109
2087	0	349,857	3,205,723	2,855,866	0.0018	5,079
2088	0	372,598	3,414,096	3,041,497	0.0017	5,049
2089	0	396,817	3,636,012	3,239,195	0.0015	5,020
2090	0	422,610	3,872,352	3,449,742	0.0014	4,991
2091	0	450,080	4,124,055	3,673,976	0.0014	4,962
2092	0	479,335	4,392,119	3,912,784	0.0013	4,933
2093	0	510,492	4,677,607	4,167,115	0.0012	4,904
2094	0	543,674	4,981,651	4,437,978	0.0011	4,875
2095	0	579,012	5,305,459	4,726,446	0.0010	4,847

NET PRESENT VALUE OF PROJECT = $607,942

Table C-28
Net Present Value With Escalation
Alternative 2(A)

PROJECT: HYDROPOWER-ALT 2(A)

PROJECT LIFE------ 100 YRS.
PRICE ESCALATION -- 6.5%
INTEREST RATE ----- 7.125%

YEAR	CAPITAL COSTS	O&M COSTS	BENEFITS	NET ANN. BENEFITS	VALUE FACTOR	PRES VAL $1,000
1995	28,830	0	0	-28,830	1.0000	-28,830
1996	30,704	0	0	-30,704	0.9335	-28,662
1997	0	1,730	11,841	10,111	0.8714	8,811
1998	0	1,842	12,611	10,768	0.8134	8,759
1999	0	1,962	13,430	11,468	0.7593	8,708
2000	0	2,090	14,303	12,214	0.7088	8,657
2001	0	2,226	15,233	13,007	0.6617	8,607
2002	0	2,370	16,223	13,853	0.6177	8,557
2003	0	2,524	17,278	14,753	0.5766	8,507
2004	0	2,688	18,401	15,712	0.5382	8,457
2005	0	2,863	19,597	16,734	0.5024	8,408
2006	0	3,049	20,871	17,821	0.4690	8,359
2007	0	3,247	22,227	18,980	0.4378	8,310
2008	0	3,459	23,672	20,213	0.4087	8,262
2009	0	3,683	25,211	21,527	0.3815	8,213
2010	0	3,923	26,849	22,927	0.3562	8,165
2011	0	4,178	28,595	24,417	0.3325	8,118
2012	0	4,449	30,453	26,004	0.3104	8,070
2013	0	4,738	32,433	27,694	0.2897	8,023
2014	0	5,046	34,541	29,494	0.2704	7,976
2015	0	5,375	36,786	31,411	0.2525	7,930
2016	0	5,724	39,177	33,453	0.2357	7,884
2017	0	6,096	41,723	35,628	0.2200	7,838
2018	0	6,492	44,436	37,943	0.2054	7,792
2019	0	6,914	47,324	40,410	0.1917	7,746
2020	0	7,364	50,400	43,036	0.1789	7,701
2021	0	7,842	53,676	45,834	0.1670	7,656
2022	0	8,352	57,165	48,813	0.1559	7,612
2023	0	8,895	60,880	51,986	0.1456	7,567
2024	0	9,473	64,838	55,365	0.1359	7,523
2025	0	10,089	69,052	58,963	0.1268	7,479
2026	0	10,744	73,541	62,796	0.1184	7,436
2027	0	11,443	78,321	66,878	0.1105	7,392
2028	0	12,187	83,412	71,225	0.1032	7,349
2029	0	12,979	88,833	75,855	0.0963	7,306
2030	0	13,822	94,607	80,785	0.0899	7,264

Table C-28(Cont.)

2031	0	14,721	100,757	86,036	0.0839	7,221
2032	0	15,678	107,306	91,628	0.0784	7,179
2033	0	16,697	114,281	97,584	0.0731	7,137
2034	0	17,782	121,709	103,927	0.0683	7,096
2035	0	18,938	129,620	110,683	0.0637	7,054
2036	0	20,169	138,046	117,877	0.0595	7,013
2037	0	21,480	147,019	125,539	0.0555	6,972
2038	0	22,876	156,575	133,699	0.0518	6,931
2039	0	24,363	166,752	142,389	0.0484	6,891
2040	0	25,947	177,591	151,645	0.0452	6,851
2041	0	27,633	189,135	161,502	0.0422	6,811
2042	0	29,429	201,428	171,999	0.0394	6,771
2043	0	31,342	214,521	183,179	0.0367	6,732
2044	0	33,379	228,465	195,086	0.0343	6,692
2045	0	35,549	243,315	207,766	0.0320	6,653
2046	0	37,860	259,131	221,271	0.0299	6,614
2047	0	40,321	275,974	235,654	0.0279	6,576
2048	0	42,941	293,913	250,971	0.0260	6,537
2049	0	45,733	313,017	267,284	0.0243	6,499
2050	0	48,705	333,363	284,658	0.0227	6,461
2051	0	51,871	355,032	303,161	0.0212	6,424
2052	0	55,243	378,109	322,866	0.0198	6,386
2053	0	58,833	402,686	343,852	0.0185	6,349
2054	0	62,658	428,860	366,203	0.0172	6,312
2055	0	66,730	456,736	390,006	0.0161	6,275
2056	0	71,068	486,424	415,356	0.0150	6,238
2057	0	75,687	518,042	442,355	0.0140	6,202
2058	0	80,607	551,715	471,108	0.0131	6,166
2059	0	85,846	587,576	501,730	0.0122	6,130
2060	0	91,426	625,768	534,342	0.0114	6,094
2061	0	97,369	666,443	569,074	0.0106	6,059
2062	0	103,698	709,762	606,064	0.0099	6,023
2063	0	110,438	755,897	645,458	0.0093	5,988
2064	0	117,617	805,030	687,413	0.0087	5,953
2065	0	125,262	857,357	732,095	0.0081	5,918
2066	0	133,404	913,085	779,681	0.0075	5,884
2067	0	142,075	972,436	830,360	0.0070	5,850
2068	0	151,310	1,035,644	884,334	0.0066	5,815
2069	0	161,145	1,102,961	941,816	0.0061	5,782
2070	0	171,620	1,174,653	[illegible]	0.0057	5,748
2071	0	182,775	1,251,006	1,068,231	0.0053	5,714
2072	0	194,656	1,332,321	1,137,666	0.0050	5,681
2073	0	207,308	1,418,922	1,211,614	0.0047	5,648
2074	0	220,783	1,511,152	1,290,369	0.0044	5,615
2075	0	235,134	1,609,377	1,374,243	0.0041	5,582
2076	0	250,418	1,713,986	1,463,569	0.0038	5,550
2077	0	266,695	1,825,396	1,558,701	0.0035	5,517
2078	0	284,030	1,944,046	1,660,016	0.0033	5,485
2079	0	302,492	2,070,409	1,767,917	0.0031	5,453
2080	0	322,154	2,204,986	1,882,832	0.0029	5,421

Table C-28 (Cont.)

2081	0	343,094	2,348,310	2,005,216	0.0027	5,390
2082	0	365,395	2,500,950	2,135,555	0.0025	5,358
2083	0	389,146	2,663,512	2,274,366	0.0023	5,327
2084	0	414,440	2,836,640	2,422,200	0.0022	5,296
2085	0	441,379	3,021,022	2,579,643	0.0020	5,265
2086	0	470,069	3,217,388	2,747,320	0.0019	5,234
2087	0	500,623	3,426,518	2,925,895	0.0018	5,204
2088	0	533,164	3,649,242	3,116,079	0.0017	5,173
2089	0	567,819	3,886,443	3,318,624	0.0015	5,143
2090	0	604,727	4,139,062	3,534,334	0.0014	5,113
2091	0	644,035	4,408,101	3,764,066	0.0014	5,083
2092	0	685,897	4,694,627	4,008,730	0.0013	5,054
2093	0	730,480	4,999,778	4,269,298	0.0012	5,024
2094	0	777,961	5,324,764	4,546,802	0.0011	4,995
2095	0	828,529	5,670,873	4,842,344	0.0010	4,966

NET PRESENT VALUE OF PROJECT = $606,530

Table C-29
Net Present Value With Escalation
Alternative 2(B)

PROJECT HYDROPOWER-ALT 2(B)

PROJECT LIFE------ 100 YRS.
PRICE ESCALATION -- 6.5%
INTEREST RATE ----- 7.125%

YEAR	CAPITAL COSTS	O&M COSTS	BENEFITS	NET ANN. BENEFITS	VALUE FACTOR	PRES VAL $1,000
1995	37,422	0	0	-37,422	1.0000	-37,422
1996	39,854	0	0	-39,854	0.9335	-37,204
1997	0	2,244	12,494	10,250	0.8714	8,932
1998	0	2,390	13,306	10,916	0.8134	8,880
1999	0	2,545	14,171	11,626	0.7593	8,828
2000	0	2,711	15,092	12,381	0.7088	8,776
2001	0	2,887	16,073	13,186	0.6617	8,725
2002	0	3,074	17,118	14,043	0.6177	8,674
2003	0	3,274	18,231	14,956	0.5766	8,624
2004	0	3,487	19,416	15,928	0.5382	8,573
2005	0	3,714	20,678	16,964	0.5024	8,523
2006	0	3,955	22,022	18,066	0.4690	8,474
2007	0	4,212	23,453	19,241	0.4378	8,424
2008	0	4,486	24,977	20,491	0.4087	8,375
2009	0	4,778	26,601	21,823	0.3815	8,326
2010	0	5,088	28,330	23,242	0.3562	8,278
2011	0	5,419	30,171	24,752	0.3325	8,229
2012	0	5,771	32,133	26,361	0.3104	8,181
2013	0	6,146	34,221	28,075	0.2897	8,134
2014	0	6,546	36,446	29,900	0.2704	8,086
2015	0	6,971	38,815	31,843	0.2525	8,039
2016	0	7,424	41,337	33,913	0.2357	7,992
2017	0	7,907	44,024	36,117	0.2200	7,945
2018	0	8,421	46,886	38,465	0.2054	7,899
2019	0	8,968	49,934	40,965	0.1917	7,853
2020	0	9,551	53,179	43,628	0.1789	7,807
2021	0	10,172	56,636	46,464	0.1670	7,762
2022	0	10,833	60,317	49,484	0.1559	7,716
2223	0	11,538	64,238	52,700	0.1456	7,671
2024	0	12,287	68,413	56,126	0.1359	7,627
2025	0	13,086	72,860	59,774	0.1268	7,582
2026	0	13,937	77,596	63,659	0.1184	7,538
2027	0	14,843	82,640	67,797	0.1105	7,494
2028	0	15,807	88,011	72,204	0.1032	7,450
2029	0	16,835	93,732	76,897	0.0963	7,407
2030	0	17,929	99,825	81,896	0.0899	7,363

Table C-29(Cont.)

2031	0	19,095	106,313	87,219	0.0839	7,320
2032	0	20,336	113,224	92,888	0.0784	7,278
2033	0	21,658	120,583	98,926	0.0731	7,235
2034	0	23,065	128,421	105,356	0.0683	7,193
2035	0	24,565	136,769	112,204	0.0637	7,151
2036	0	26,161	145,659	119,497	0.0595	7,109
2037	0	27,862	155,126	127,265	0.0555	7,068
2038	0	29,673	165,210	135,537	0.0518	7,027
2039	0	31,601	175,948	144,347	0.0484	6,986
2040	0	33,655	187,385	153,729	0.0452	6,945
2041	0	35,843	199,565	163,722	0.0422	6,904
2042	0	38,173	212,537	174,364	0.0394	6,864
2043	0	40,654	226,352	185,697	0.0367	6,824
2044	0	43,297	241,064	197,768	0.0343	6,784
2045	0	46,111	256,734	210,623	0.0320	6,745
2046	0	49,108	273,421	224,313	0.0299	6,705
2047	0	52,300	291,194	238,893	0.0279	6,666
2048	0	55,700	310,121	254,422	0.0260	6,627
2049	0	59,320	330,279	270,959	0.0243	6,589
2050	0	63,176	351,747	288,571	0.0227	6,550
2051	0	67,282	374,611	307,328	0.0212	6,512
2052	0	71,656	398,961	327,305	0.0198	6,474
2053	0	76,313	424,893	348,580	0.0185	6,436
2054	0	81,274	452,511	371,237	0.0172	6,399
2055	0	86,557	481,924	395,368	0.0161	6,361
2056	0	92,183	513,249	421,067	0.0150	6,324
2057	0	98,175	546,610	448,436	0.0140	6,287
2058	0	104,556	582,140	477,584	0.0131	6,251
2059	0	111,352	619,979	508,627	0.0122	6,214
2060	0	118,590	660,278	541,688	0.0114	6,178
2061	0	126,298	703,196	576,898	0.0106	6,142
2062	0	134,508	748,904	614,396	0.0099	6,106
2063	0	143,251	797,582	654,332	0.0093	6,070
2064	0	152,562	849,425	696,863	0.0087	6,035
2065	0	162,479	904,638	742,159	0.0081	6,000
2066	0	173,040	963,439	790,400	0.0075	5,965
2067	0	184,287	1,026,063	841,776	0.0070	5,930
2068	0	196,266	1,092,757	896,491	0.0066	5,895
2069	0	209,023	1,163,786	954,763	0.0061	5,861
2070	0	222,610	1,239,432	1,016,823	0.0057	5,827
2071	0	237,079	1,319,996	1,082,916	0.0053	5,793
2072	0	252,490	1,405,795	1,153,306	0.0050	5,759
2073	0	268,901	1,497,172	1,228,271	0.0047	5,725
2074	0	286,380	1,594,488	1,308,108	0.0044	5,692
2075	0	304,995	1,698,130	1,393,135	0.0041	5,659
2076	0	324,819	1,808,508	1,483,689	0.0038	5,626
2077	0	345,933	1,926,061	1,580,129	0.0035	5,593
2078	0	368,418	2,051,255	1,682,837	0.0033	5,560
2079	0	392,365	2,184,587	1,792,222	0.0031	5,528
2080	0	417,869	2,326,585	1,908,716	0.0029	5,496

Table C-29(Cont.)

2081	0	445,031	2,477,813	2,032,783	0.0027	5,464
2082	0	473,958	2,638,871	2,164,913	0.0025	5,432
2083	0	504,765	2,810,398	2,305,633	0.0023	5,400
2084	0	537,575	2,993,073	2,455,499	0.0022	5,369
2085	0	572,517	3,187,623	2,615,106	0.0020	5,337
2086	0	609,731	3,394,819	2,785,088	0.0019	5,306
2087	0	649,363	3,615,482	2,966,119	0.0018	5,275
2088	0	691,572	3,850,488	3,158,917	0.0017	5,244
2089	0	736,524	4,100,770	3,364,246	0.0015	5,214
2090	0	784,398	4,367,320	3,582,922	0.0014	5,183
2091	0	835,384	4,651,196	3,815,812	0.0014	5,153
2092	0	889,684	4,953,524	4,063,840	0.0013	5,123
2093	0	947,513	5,275,503	4,327,990	0.0012	5,093
2094	0	1,009,101	5,618,410	4,609,309	0.0011	5,063
2095	0	1,074,693	5,983,607	4,908,914	0.0010	5,034

NET PRESENT VALUE OF PROJECT = $598,525

Table C-30
Net Present Value With Escalation
Alternative 2(C)

PROJECT: HYDROPOWER-ALT 2(C)

PROJECT LIFE------ 100 YRS.
PRICE ESCALATION -- 6.5%
INTEREST RATE ----- 7.125%

YEAR	CAPITAL COSTS	O&M COSTS	BENEFITS	NET ANN. BENEFITS	VALUE FACTOR	PRES VAL $1,000
1995	41,805	0	0	-41,805	1.0000	-41,805
1996	44,522	0	0	-44,522	0.9335	-41,561
1997	0	2,176	12,494	10,318	0.8714	8,991
1998	0	2,317	13,306	10,989	0.8134	8,939
1999	0	2,468	14,171	11,703	0.7593	8,887
2000	0	2,628	15,092	12,464	0.7088	8,835
2001	0	2,799	16,073	13,274	0.6617	8,783
2002	0	2,981	17,118	14,137	0.6177	8,732
2003	0	3,175	18,231	15,055	0.5766	8,681
2004	0	3,381	19,416	16,034	0.5382	8,630
2005	0	3,601	20,678	17,076	0.5024	8,580
2006	0	3,835	22,022	18,186	0.4690	8,530
2007	0	4,085	23,453	19,368	0.4378	8,480
2008	0	4,350	24,977	20,627	0.4087	8,431
2009	0	4,633	26,601	21,968	0.3815	8,381
2010	0	4,934	28,330	23,396	0.3562	8,333
2011	0	5,255	30,171	24,917	0.3325	8,284
2012	0	5,596	32,133	26,536	0.3104	8,236
2013	0	5,960	34,221	28,261	0.2897	8,188
2014	0	6,347	36,446	30,098	0.2704	8,140
2015	0	6,760	38,815	32,054	0.2525	8,092
2016	0	7,199	41,337	34,138	0.2357	8,045
2017	0	7,667	44,024	36,357	0.2200	7,998
2018	0	8,166	46,886	38,720	0.2054	7,951
2019	0	8,697	49,934	41,237	0.1917	7,905
2020	0	9,262	53,179	43,917	0.1789	7,859
2021	0	9,864	56,636	46,772	0.1670	7,813
2022	0	10,505	60,317	49,812	0.1559	7,768
2023	0	11,188	64,238	53,050	0.1456	7,722
2024	0	11,915	68,413	56,498	0.1359	7,677
2025	0	12,690	72,860	60,171	0.1268	7,632
2026	0	13,514	77,596	64,082	0.1184	7,588
2027	0	14,393	82,640	68,247	0.1105	7,544
2028	0	15,328	88,011	72,683	0.1032	7,500
2029	0	16,325	93,732	77,407	0.0963	7,456
2030	0	17,386	99,825	82,439	0.0899	7,412
2031	0	18,516	106,313	87,798	0.0839	7,369

Table C-30 (Cont.)

2032	0	19,719	113,224	93,504	0.0784	7,326
2033	0	21,001	120,583	99,582	0.0731	7,283
2034	0	22,366	128,421	106,055	0.0683	7,241
2035	0	23,820	136,769	112,949	0.0637	7,199
2036	0	25,368	145,659	120,290	0.0595	7,157
2037	0	27,017	155,126	128,109	0.0555	7,115
2038	0	28,774	165,210	136,436	0.0518	7,073
2039	0	30,644	175,948	145,304	0.0484	7,032
2040	0	32,636	187,385	154,749	0.0452	6,991
2041	0	34,757	199,565	164,808	0.0422	6,950
2042	0	37,016	212,537	175,521	0.0394	6,910
2043	0	39,422	226,352	186,929	0.0367	6,869
2044	0	41,985	241,064	199,080	0.0343	6,829
2045	0	44,714	256,734	212,020	0.0320	6,789
2046	0	47,620	273,421	225,801	0.0299	6,750
2047	0	50,715	291,194	240,478	0.0279	6,710
2048	0	54,012	310,121	256,109	0.0260	6,671
2049	0	57,523	330,279	272,757	0.0243	6,632
2050	0	61,262	351,747	290,486	0.0227	6,594
2051	0	65,244	374,611	309,367	0.0212	6,555
2052	0	69,484	398,961	329,476	0.0198	6,517
2053	0	74,001	424,893	350,892	0.0185	6,479
2054	0	78,811	452,511	373,700	0.0172	6,441
2055	0	83,934	481,924	397,991	0.0161	6,404
2056	0	89,389	513,249	423,860	0.0150	6,366
2057	0	95,200	546,610	451,411	0.0140	6,329
2058	0	101,388	582,140	480,753	0.0131	6,292
2059	0	107,978	619,979	512,001	0.0122	6,255
2060	0	114,996	660,278	545,282	0.0114	6,219
2061	0	122,471	703,196	580,725	0.0106	6,183
2062	0	130,432	748,904	618,472	0.0099	6,147
2063	0	138,910	797,582	658,673	0.0093	6,111
2064	0	147,939	849,425	701,486	0.0087	6,075
2065	0	157,555	904,638	747,083	0.0081	6,040
2066	0	167,796	963,439	795,643	0.0075	6,004
2067	0	178,703	1,026,063	847,360	0.0070	5,969
2068	0	190,319	1,092,757	902,439	0.0066	5,935
2069	0	202,689	1,163,786	961,097	0.0061	5,900
2070	0	215,864	1,239,432	1,023,568	0.0057	5,865
2071	0	229,895	1,319,996	1,090,100	0.0053	5,831
2072	0	244,838	1,405,795	1,160,957	0.0050	5,797
2073	0	260,753	1,497,172	1,236,419	0.0047	5,763
2074	0	277,702	1,594,488	1,316,786	0.0044	5,730
2075	0	295,752	1,698,130	1,402,377	0.0041	5,696
2076	0	314,976	1,808,508	1,493,532	0.0038	5,663
2077	0	335,450	1,926,061	1,590,612	0.0035	5,630
2078	0	357,254	2,051,255	1,694,001	0.0033	5,597
2079	0	380,476	2,184,587	1,804,111	0.0031	5,565
2080	0	405,206	2,326,585	1,921,379	0.0029	5,532
2081	0	431,545	2,477,813	2,046,268	0.0027	5,500

Table C-30(Cont.)

2082	0	459,595	2,638,871	2,179,276	0.0025	5,468
2083	0	489,469	2,810,398	2,320,929	0.0023	5,436
2084	0	521,284	2,993,073	2,471,789	0.0022	5,404
2085	0	555,168	3,187,623	2,632,455	0.0020	5,373
2086	0	591,254	3,394,819	2,803,565	0.0019	5,341
2087	0	629,685	3,615,482	2,985,797	0.0018	5,310
2088	0	670,615	3,850,488	3,179,873	0.0017	5,279
2089	0	714,205	4,100,770	3,386,565	0.0015	5,248
2090	0	760,628	4,367,320	3,606,692	0.0014	5,218
2091	0	810,069	4,651,196	3,841,127	0.0014	5,187
2092	0	862,724	4,953,524	4,090,800	0.0013	5,157
2093	0	918,801	5,275,503	4,356,702	0.0012	5,127
2094	0	978,523	5,618,410	4,639,888	0.0011	5,097
2095	0	1,042,127	5,983,607	4,941,480	0.0010	5,067

NET PRESENT VALUE OF PROJECT = $594,250

APPENDIX D

ENVIRONMENTAL

Department of the Army
Detroit District, Corps of Engineers

APPENDIX D

ENVIRONMENTAL

TABLE OF CONTENTS

APPENDIX D

SECTION I

FIELD RECONNAISSANCE MEETING

AUGUST 15, 1980

UNITED STATES GOVERNMENT

memorandum

DATE: August 20, 1980

REPLY TO ATTN OF: T. J. Miller, Biologist

SUBJECT: Information Gathering Meeting for Sault Ste. Marie Hydropower Project - Minutes of August 6, 1980 Meeting

TO: Supervisor, ELFO-ES, East Lansing, MI

The meeting convened at approximately 9:30 a.m. at Lake Superior State College, Sault Ste. Marie. Represented were: Parks Canada, Ontario Ministry of Natural Resources, Great Lakes Power Corporation, Edison Sault Electric Company, Michigan State University, Michigan Department of Natural Resources, Lake Superior State College, Corps of Engineers, and the East Lansing Field Office. The attendance sheet is attached.

I asked the group if they would expose any methods or avenues for enhancing the St. Marys River environment or mitigating impacts to the St. Marys River environment in connection with the proposed hydropower redevelopment study. I asked Mr. Jackovich of the Corps of Engineers to explain each of the alternatives. Mr. Jackovich started by stressing that the objective of the hydropower redevelopment study was to make the most efficient use of the water in the St. Marys River available for power production. The water available for power production during times of average flow is 70,000 cfs (75,000 average flow, minus 5,000 which is used for lock operation, domestic use, and rapids maintenance). Mr. Jackovich then proceeded to outline the alternatives as follows:

Alternative 1 consists of maintaining the Corps' plant and inserting 35 tube turbines in the existing Sault Edison power plant, leaving the other 43 turbines as is. This alternative would use all the water available for power production and have the capability of using additional water during times of higher than average flows. The opportunity for enhancement of the natural resources in the St. Marys River with this alternative is minimal.

Alternative 2 consists of a new powerhouse with either three 12.5 MW turbines or eight 5 MW turbines built adjacent to the Corps of Engineer's present powerhouse. Mr. Jackovich commented that the three 12.5 MW units would be his personal preference.

The alternative using three 12.5 MW units would allow for a total base-loaded capacity during times of average flow of 53.5 MW. This is a substantial improvement in efficiency. When the flows exceed the average annual flow, the existing Sault Edison Plant could be used to generate additional electricity. In addition, the Sault Edison plant could be used to adjust the levels of Lake Superior in the interest of navigation. Mr. Jackovich indicated that the cost for Alternative 2 was more than that for Alternative 1, but much less than the costs for Alternatives 3 and 4.

In connection with Alternative 2 there would have to be excavation work for a power canal which would require removal of the Unit 10 powerhouse and 350,000 cubic yards of sandstone upstream of the powerhouse site and extending to the International Bridge. When the group was asked for suggestions on possible mitigative or enhancement measures, two items surfaced:

1. The sandstone to be excavated could be used to provide river shoreline protection needs stemming from winter navigation, or could possibly be used in the lower river to provide fish-attracting shoals.

2. One of the objectives of the redevelopment study is to at least maintain the present 48.0 MW of hydroelectric production in the face of a reduction in the amount of water available for use on the U.S. side of the St. Marys River. A present problem in the river is that the rapids area of the St. Marys River is suffering from a) lack of water at certain times, and b) a widely fluctuating water regime, as a result of variable lake levels. With Alternative 2 there could be a base flow higher than the present half-gate-open setting at the compensating works. The fluctuating environment could then be eliminated by adjusting lake levels using the Sault Edison facility at times when there is a higher than average discharge in the river.

To accomplish Item 2 above (a stabilized flow over the rapids area) two things would be necessary:

1. The <u>net increase</u> in generating capacity from building the new, more efficient, plant would have to be foregone and the water allowed to flow over the rapids.

2. A comprehensive monitoring program needs to be established across the Lake Superior basin in conjunction with a predictive model to allow extended planning time to optimize the use of water for power production and environmental quality.

Alternatives 3 and 4 involve approximately the same type and level of construction and operation as Alternative 2. The group felt that the enhancement and mitigative measures would be similar to those in Alternative 2.

Mr. John Bouchard (Parks Canada) brought up the point that the additional draw of water toward the proposed plant may create a strong current on the Canadian side, causing problems with the use of the Canadian ship lock. Mr. Jackovich acknowledged that this will have to be considered in the feasibility study.

At this point we broke for lunch. Parks Canada and Sault Edison representatives departed.

Upon resumption, the Canada Ministry of Natural Resources brought up two points for consideration by the Corps in Alternatives 2, 3, and 4. These considerations are: 1) The discharge of the proposed plant will be directed toward the Canadian shore where potential for erosion should be investigated, and 2) Sault Canada is going to construct a new waste treatment plant for its domestic sewage and one of the alternative sites for discharge is north and west of the compensating works. The possible effects of this on the alternatives and the rapids area may need to be considered.

A discussion of the rapids area ensued. The consensus was that the greatest threat to the fish productivity of the rapids area is the widely fluctuating flows (from 3,000 to 60,000 cfs). The half-gate-open low flow over the rapids was considered to be inadequate for successful spawning and nursery. Dr. Gleason of Lake Superior State College pointed out that historical records show the rapids area was an important fishing ground for native Americans and that this area provided the needed spawning for rainbow trout and whitefish up to 1972. In addition, the rapids provided a migratory route for fish to immigrate or emigrate between the Great Lakes, maintaining diversity in the fishes gene pools.

The suggestion was made that a study be developed to describe the existing conditions and potential production of the rapids area to support the recommendations of the 1974 Remedial Studies Report which has been accepted by the IJC (International Joint Commission). Another suggestion was that a case can be made using historical records, to support a flow recommendation for the rapids area. The problem with the historical information seems to be that it is qualitative in nature and can't be used to quantify the potential fishery production of the rapids.

Dr. Gleason suggested that in order to estimate the present rapids fishery and get an indication of the potential, a study spanning approximately a decade with a stable flow of about 7,000 cfs would be desirable. He said the flow may be able to be increased occasionally but not decreased.

The Ministry of Natural Resources of Canada suggested that one of the structural measures proposed in the 1974 Remedial Studies Report be implemented, thus the need to determine an acceptable flow in the rapids area, as it now exists, would not be necessary. The reason for this position was that the Ministry believed the political climate was such that obtaining any flow above that which is now provided would not be looked on favorably. Many within the group disagreed, citing that in the U.S. people are more amenable to environmental quality measures in construction projects. In addition, the point was noted that there is no guarantee that the structural remedial measures would provide suitable habitat for successful spawning and nursery for the area.

There was no concrete agreement that the study of the rapids area or the remedial measures should be recommended.

It was recommended that a survey should be implemented to determine if the area to be excavated above the U.S. power plant is a spawning area for fish .

The meeting terminated at 3:45 p.m.

T. J. Miller

T. J. Miller

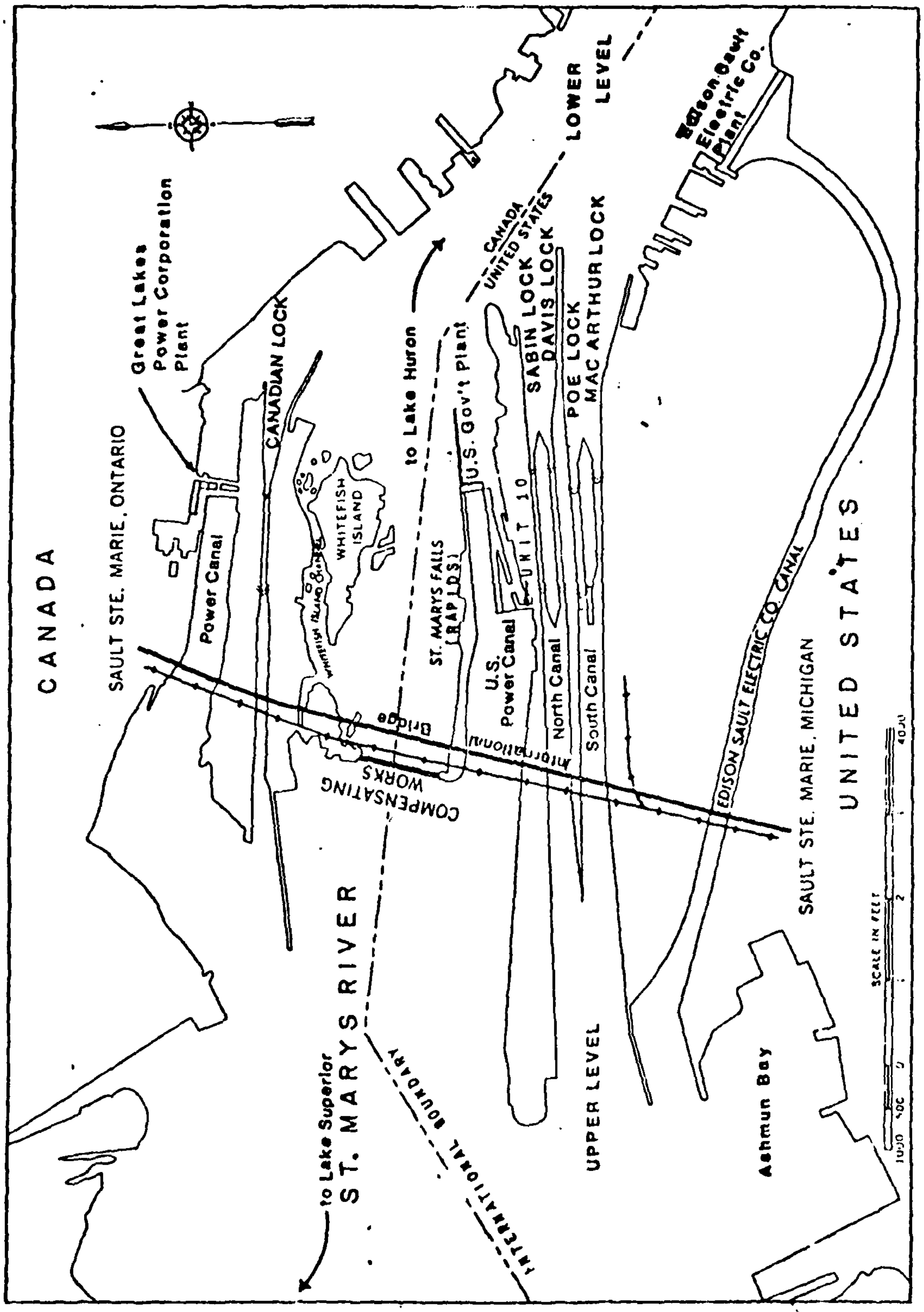
cc: Lloyd Fanter, U.S. Army District Engineer, Detroit, MI

SAULT STE. MARIE POWER PLANT

REDEVELOPMENT MEETING

August 6, 1980

NAME	AGENCY	PHONE
T. J. Miller	USFWS, East Lansing	517-337-6651
Wayne Crayton	USFWS, East Lansing	517-337-6654
Walt Duffy	Michigan State University Dunbar Station	906-635-1925
Mark Fornwall	U.S. Army Corps (Detroit)	313-226-6237
Wayne Mansfield	Edison Sault Electric	906-632-2221
Ron Harrison	Parks, Canada	705-253-1143
F. M. Jakovich	Corps of Engineers	906-632-3311
Win Chance	Edison Sault Electric	906-632-2221
John Schrouder	MDNR, Newberry	906-293-5132
Gale R. Gleason	LSSC	906-632-6841
Derry Armstrong	Ontario Natural Resources	705-949-1231
John Sellers	Ontario Natural Resources	705-949-1231
Bill Gregory	Edison Sault Electric	906-632-2221
John D. Bouchard	Parks, Canada Sault Ship Canal	705-253-1143
Max Tomlinson	Great Lakes Power Corp.	705-942-3814


CANADA
SAULT STE. MARIE, ONTARIO
Great Lakes Power Corporation Plant
CANADIAN LOCK
Power Canal
WHITEFISH ISLAND
to Lake Huron
ST. MARYS FALLS (RAPIDS)
U.S. Gov't Plant
UNIT 10
CANADA
UNITED STATES
SABIN LOCK
DAVIS LOCK
POE LOCK
MAC ARTHUR LOCK
LOWER LEVEL
Edison Sault Electric Co. Plant
U.S. Power Canal
North Canal
South Canal
International Bridge
COMPENSATING WORKS
EDISON SAULT ELECTRIC CO. CANAL
SAULT STE. MARIE, MICHIGAN
UNITED STATES
SCALE IN FEET
to Lake Superior
ST. MARYS RIVER
INTERNATIONAL BOUNDARY
UPPER LEVEL
Ashmun Bay

APPENDIX D

SECTION II

PLANNING AID LETTER

U.S. FISH AND WILDLIFE SERVICE

United States Department of the Interior

IN REPLY REFER TO:

FISH AND WILDLIFE SERVICE
EAST LANSING FIELD OFFICE (ES)
Room 301, Manly Miles Building
1405 S. Harrison Road
East Lansing, Michigan 48823

September 17, 1980

Colonel Robert V. Vermillion
U.S. Army Engineer District
Detroit
P.O. Box 1027
Detroit, MI 48231

Dear Colonel Vermillion:

This planning aid letter is provided in compliance with the obligations of the U.S. Fish and Wildlife Service to the Detroit District Corps of Engineers under Support Agreement No. NCE-IS-80-008-EK. This Support Agreement pertains to Fiscal Year 1980 transfer funds and the Scope of Work activities of the Fish and Wildlife Service's Division of Ecological Services in the Sault Ste. Marie Power Plant Redevelopment Feasibility Study, Sault Ste. Marie, Michigan.

These comments have been prepared under the authority of and in accordance with provisions of the Fish and Wildlife Coordination Act (48 Stat 401, as amended; 16 U.S.C., 661 et seq.) and in compliance with the intent of the National Environmental Policy Act of 1969.

In keeping with the objectives of the Support Agreement, we will address each objective in the order of its listing.

Objective A - Define on a preliminary basis which aquatic and/or terrestrial communities could be impacted by the proposed project activities.

Fishery

The following fishes are known to occur in the study area. The list has been compiled from sport fishing reports and/or surveys conducted by the scientific community.

Lake Whitefish	Coregonus clupeaformis
Rainbow Trout	Salmo gairdneri
Lake Sturgeon	Acipenser fulvescens
Brook Trout	Salvelinus fontinalis

Splake	Brook trout x lake trout
Coho Salmon	Oncorhynchus kisutch
Chinook Salmon	Oncorhynchus tshawytscha
Pink Salmon	Oncorhynchus gorbuscha
Round Whitefish	Prosopium cylindraceum
Cisco	Coregonus spp:
Northern Pike	Esox lucius
White Sucker	Catostomus commersoni
Longnose Sucker	Catostomus Catostomus
Carp	Cyprinus carpio
Burbot	Lota lota
Rock Bass	Ambloplites rupestris
Yellow Perch	Perca flavescens
Walleye	Stizostedion vitreum
Alewife	Alosa pseudoharengus
Rainbow Smelt	Osmerus mordax
Lake Emerald Shiner	Notropis antherinoides
Spottail Shiner	Notropis hudsonius
Johnny Darter	Etheostoma nigrum
Logperch	Percina caprodes
Slimy Sculpin	Cottus cognatus
Mottled Sculpin	Cottus bairdi
Longnose Dace	Rhinichthys cataractae
Brook Stickleback	Eucalia Inconstans
Ninespine Stickleback	Pungitius pungitius

Invertebrates which occur in the St. Marys Rapids area and which may occur in other locations in the study area include:

Trichoptera of the genus Hydropsyche
Trichoptera of the genus Cheumatopsyche
Trichoptera of the species Psychomyia
Trichoptera of the genus Athripsodes
Diptera of the family Chironomidae
Diptera of the family Simulidae
Diptera of the family Tipulidae
Ephemeroptera of the family Heptageniidae
Isopoda of the genus Asellus
Amphipoda of the family Gammaridae
Annelida of the class Oligochaeta

Other rare forms are the triclads, hydra, stoneflies, leeches, fingernail clams, snails, and crayfish.

The algae of the area is dominated by pollution intolerant diatoms and greens.

In general, the water in the study area reflects its source, (Lake Superior) a cold, soft-water oligotrophic lake. The alkalinity is about 45 mg/l as $CaCo_3$ with a PH of about 7.8; oxygen is near saturation, and the water has extremely low concentrations of all forms of phosphorus and nitrogen. Similarly the fauna of the study area reflects an oligotrophic environment being of pollution intolerant types with isolated exceptions such as downstream of Algoma Steel Corp., Sault Ste. Marie, Ontario.

Objective B - Describe how and why the communities in Objective A could be impacted by implementation of the various alternatives.

Due to the lack of information on engineering features connected with the additional alternatives presented during the public meeting at Sault Ste. Marie on August 21, 1980, these alternatives were not analyzed from an environmental standpoint.

Alternative 1: Continue operation of the existing Corps' plant, and rebuild Edison Sault to achieve maximum efficiency.

The activities connected with this alternative should not have any more of a negative impact on the ecosystem than that which is already occuring. The major negative impact occuring at present is the diversion of water from the Rapids area in the river. Minimal impact appears to be occuring from the killing of fish by passage through the turbines at the hydroelectric facilities.

Diversion of the water for hydro power, as well as regulation of Lake Superior levels for navigation, causes wide fluctuations in the volume of water flowing over the Rapids area. The Rapids area has been identified by the International Joint Commission (IJC) as the most important spawning area in the St. Marys River for steelhead and whitefish. In addition to the spawning attributes, the Rapids area supports a large population of fish food organisms which cannot withstand sudden dewatering. This diversion causes desication of invertebrates and limits the available spawning area for fishes.

This assessment is based on the understanding that no major excavation will be needed in connection with this alternative.

Alternative 2: Discontinue operation of Edison Sault, and extend the Corps powerhouse to utilize the full U.S. share of the water and develop maximum power. This involves widening of the existing U.S. power canal to provide for the increased discharge. Additionally, this requires consideration of the disposition of the Edison Sault diversion canal. The possibility of filling the canal which is currently being used for discharge of some storm water would be considered, together with the appropriate level of responsibility to implement and maintain (i.e., city, county, etc.).

It is our understanding that the placement of the addition to the Corps of Engineers' plant would require excavation of a shelf of Jacobsville Sandstone. Excavation would be from the site of the existing Corps' plant upstream to the International Bridge. Impacts from the excavation would be the displacement of a family of beaver which has established itself in the old Unit #10 tailrace area. The impacts of this excavation on the aquatic community of this shelf would be the physical removal of that community presently existing. However, there is no information available on the biological community, or spawning/nursery use of this area by fishes, thus the seriousness of removal cannot be assessed. It is our understanding that excavation work will take place in-the-dry. If this is the case water quality impacts from the excavation would not seem to be a concern. The disposal site for excavated materials will be of concern from an environmental standpoint. The site for placement of these materials has not yet been addressed.

As demonstrated by Bell, 1969, the types of turbines planned for use in addition to the Corps' hydro plant should have a slight positive impact from the standpoint of fish passage.

The disposition of the Edison Sault diversion canal will have a negative effect on local fishing taking place on the bridges over the canal and on the fishery in the tailrace of the Edison Plant.

Another impact from this alternative is that cited in the discussion for Alternative 1, i.e., the diversion of water away from the St. Marys Rapids in the study area with a continued supression of the biological production of the area.

Alternative 3: Discontinue operation of the Edison Sault, and build an entirely new power facility at the existing Corps' power plant site utilizing the full U.S. share of the water.

It is our understanding that this alternative would involve no more excavation in the sandstone shelf area than that in Alternative 2, and presumably the Edison Sault Power Canal would still be disposed of. Therefore, it is our opinion that the impacts from Alternative 3 would be similar to that from Alternative 2.

Alternative 4: Discontinue operation of the Edison Sault and install new power machinery at the existing Corps' power facility utilizing the full U.S. share of the water.

The discontinuance of power production at the Edison Sault Plant and disposition of the power canal would have the same effect as Alternative 2. The installation of new equipment in the existing Corps' facility presumably would eliminate the need to excavate the sandstone shelf upstream from the plant. The diversion of water from the Rapids area would have the same impact as that presently occuring.

(No Action) Alternative: This alternative involves a projection of basic existing demographic, economic, social, and environmental parameters to attempt to describe the most probable future if hydropower redevelopment of Sault Ste. Marie, Michigan does not occur.

From an environmental standpoint the impacts presently occuring, namely large flow variability over the Rapids, would continue as in the past.

Objective C - *Present U.S. Fish and Wildlife Service's preliminary* recommendations which emphasize fish and wildlife resource concerns in the project area.

With respect to the resource concerns in the project area we have basically three:

1. Adequate protection of the St. Marys Rapids area.

2. The impact on the surrounding biological community of removal of the sandstone shelf area upstream from old Unit #10.

3. The effects of the redevelopment alternatives on the sport fishery in the area.

A narrative of our concerns follows:

1. To afford adequate protection for the Rapids area of the river, a relatively stable flow is required of sufficient volume to water the important spawning, nursery, and invertebrate production

areas of the Rapids. Previous studies (Feasibility Study of Remedial Works in the St. Marys Rapids at Sault Ste. Marie, 1974) recommend a flow of 26,000 cfs as that flow which is optimum to provide for spawning, nursery areas, and invertebrate production.

To accomplish this objective, we recommend that the Corps investigate and develop a model with the capability to use basin-wide monitoring information on stream discharge, precipitation, and evaporation to provide sufficient planning time to optimize water use with respect to power interests and environmental maintenance. In addition, it would appear that with Alternatives 2, 3, and 4 it would be desirable to maintain the Edison Sault Plant as a peaking facility to avoid having to use the compensating works to dump water over the Rapids during times of high lake levels.

From a fishery standpoint it would be desirable to plan an alternative that would maintain the present power production capability and use the water over and above that, up to the 50 percent share of the U.S. water, to enhance the low flows of the St. Marys Rapids.

2. The impact on the surrounding biological community of removing the sandstone shelf is not known and cannot be determined without some on-site information gathering. Our recommendation is that biological production and use by fishes in the area be investigated in order that the impact of removal may be assessed.

3. The redevelopment of hydropower on the river may have substantial effects on the sport fishery. Disposition of the Edison Sault Power Canal would eliminate the sport fishery along it and in the tailrace of the Edison Sault Plant if the plant were closed. We recommend that if the power canal is to be disposed of that a flow large enough to sustain the fishery be preserved in the canal.

   The potential to enhance the sport fishery in the Sault Ste. Marie area also exists in connection with the hydroelectric redevelopment. The St. Marys Rapids area has long been recognized as a valuable fishery for rainbow trout and lake whitefish. If public access to this fishery could be provided with the help of walkways and fishing platforms near the International Bridge or the railroad bridge and on Corps'

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property along the Rapids, it would substantially enhance the recreational fishery in the area.

Objective D - Present U.S. Fish and Wildlife Service's recommendation for future studies under the Fish and Wildlife Coordination Act for FY 81 and FY 82.

A study we would like to recommend in connection with the Edison Sault Power Canal disposition, is the removal of the Edison Sault structure and conversion of the power canal to a spawning riffle for fish. This would involve placement of gravel in the canal and regulation of the water flow in the canal to optimize conditions for successful fish spawning.

A survey that needs to be completed in order to adequately assess the impact of the widening of the power canal in Alternatives 2 and 3 is an investigation of the use of the sandstone shelf upstream of old Unit #10 by the fishes in the area. This type of survey would necessarily include a spawning survey and benthic productivity survey. Information gathered in these surveys may point out the need for further study.

With respect to our previous recommendation to maintain the present electric generating capacity and forego any net increase due to more efficient use of the water, a study may need to be instituted to support, with quantitative information, the contention of increased natural fish reproduction from the rapids area with an increased base flow. A study of this type would require a relatively stable flow with a larger low flow volume than the present half gate-open setting at the compensating works. In addition, the biological lag time will have to be considered (the time between initiation of a higher stable flow and the response time of the organisms).

As pointed out earlier, more lead time is needed when predicting Lake Superior water levels in order to optimize water use in the river with respect to navigation, power interests, and the environment. Therefore, we recommend that the Corps of Engineers investigate ways to predict Lake Superior water levels more accurately and further in the future so as to avoid the dumping of large volumes of water over the rapids suddenly.

Objective E - Produce a Planning Aid Letter complete with a comparative environmental assessment and ranking of alternatives, a matrix display of projected impacts of various alternatives on fish and wildlife resources, and a set of recommended ecological planning objectives as a guide in future studies.

As the alternatives have been presented to us in the Statement of Work, Sault Ste. Marie Power Plant Redevelopment Feasibility Study, Stage I, the ranking of the alternatives from the most favorable to least favorable alternative on an environmental basis is as follows:

1. Alternative 1: No new excavation would be involved with this alternative but water would continue to be diverted from the Rapids area. This alternative would not provide the most efficient use of water for power production.

2. Alternative 4: It is our understanding that this alternative would not require new excavation either, although this alternative, as presented, would continue to divert water from the Rapids area at times of low lake levels. Disposition of the Edison Sault Power Canal may adversely affect the sport fishery of the area.

3. Alternative 2: This alternative involves much excavation with the associated impacts, and disposition of the Sault Edison Power Canal which may have a detrimental impact on the sport fishery associated with the Edison Sault Power Canal and tailrace. Diversion of water from the rapids area would continue.

4. Alternative 3: This alternative involves the most excavation and construction with the associated short and long-term impacts. The disposition of the Edison Sault Power Canal may adversely effect the sport fishery of the area. Diversion of water from the Rapids area would continue as in the past.

The alternatives may undergo changes which would alter the environmental ranking. The attached general matrices for each alternative identify some of the associated impacts.

Should you or your staff have questions or need clarification regarding our position, please contact our East Lansing Field Office at 517-337-6629.

Sincerely yours,

Ray C. Williams

Ray C. Williams
Acting Field Supervisor

Attachment

REFERENCES

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GENERAL PHYSICAL - CHEMICAL IMPACT MATRIX

Alternative 1

Physical-Chemical Characteristics of Streams \ Water Resource Development Activities	Channel enlargement	Channel realignment	Clearing and snagging	Dikes and jetties	Bank stabilization	Floodplain clearing	Flood protection levees	Flood control impoundments	Hydroelectric impoundments	Locks and dams	Diversion dams	Transbasin augmentation
Depth and stage												
Surface area												
Channel configuration												
Velocity												
Temperature												
Suspended solids												
Bed material												
Dissolved substances												
Light transmissivity												
Flow variability (Rapids)											X	

GENERAL BIOTA IMPACT MATRIX

Alternative 1

Selected Stream and Floodplain Biota \ Physical-Chemical Characteristics of Streams	Depth and stage	Surface area	Channel configuration	Velocity	Temperature	Suspended solids	Bed material	Dissolved substances	Light transmissivity	Flow variability (Rapids)
Plankton										X
Benthos										X
Fish										X
Amphibians and reptiles										
Waterfowl and wading birds										
Small mammals										
Emergent aquatic vegetation										
Riparian vegetation										
Community structure										X

GENERAL PHYSICAL - CHEMICAL IMPACT MATRIX

Alternative 2

Water Resource Development Activities / Physical-Chemical Characteristics of Streams	Channel enlargement	Channel realignment	Clearing and snagging	Dikes and jetties	Bank stabilization	Floodplain clearing	Flood protection levees	Flood control impoundments	Hydroelectric impoundments	Locks and dams	Diversion dams	Transbasin augmentation
Depth and stage	X											
Surface area		X										
Channel configuration	X											
Velocity												
Temperature												
Suspended solids												
Bed material												
Dissolved substances												
Light transmissivity												
Flow variability (Rapids)	X											

GENERAL BIOTA IMPACT MATRIX

Alternative 2

Selected Stream and Floodplain Biota / Physical-Chemical Characteristics of Streams	Depth and stage	Surface area	Channel configuration	Velocity	Temperature	Suspended solids	Bed material	Dissolved substances	Light transmissivity	Flow variability (Rapids)
Plankton										
Benthos	X									X
Fish	X	X	X							X
Amphibians and reptiles										
Waterfowl and wading birds										
Small mammals										
Emergent aquatic vegetation										
Riparian vegetation			X							
Community structure	X									X

GENERAL PHYSICAL - CHEMICAL IMPACT MATRIX

Alternative 3

Physical-Chemical Characteristics of Streams \ Water Resource Development Activities	Channel enlargement	Channel realignment	Clearing and snagging	Dikes and jetties	Bank stabilization	Floodplain clearing	Flood protection levees	Flood control impoundments	Hydroelectric impoundments	Locks and dams	Diversion dams	Transbasin augmentation
Depth and stage	X											
Surface area		X										
Channel configuration	X											
Velocity												
Temperature												
Suspended solids												
Bed material												
Dissolved substances												
Light transmissivity												
Flow variability (Rapids)	X											

GENERAL BIOTA IMPACT MATRIX

Alternative 3

Physical-Chemical Characteristics of Streams / Selected Stream and Floodplain Biota	Depth and stage	Surface area	Channel configuration	Velocity	Temperature	Suspended solids	Bed material	Dissolved substances	Light transmissivity	Flow variability (Rapids)
Plankton										
Benthos	X									X
Fish	X	X	X							X
Amphibians and reptiles										
Waterfowl and wading birds										
Small mammals										
Emergent aquatic vegetation										
Riparian vegetation		X								
Community structure	X									X

GENERAL PHYSICAL - CHEMICAL IMPACT MATRIX

Alternative 4

Water Resource Development Activities / Physical-Chemical Characteristics cf Streams	Channel enlargement	Channel realignment	Clearing and snagging	Dikes and jetties	Bank stabilization	Floodplain clearing	Flood protection levees	Flood control impoundments	Hydroelectric impoundments	Locks and dams	Diversion dams	Transbasin augmentation
Depth and stage												
Surface area												
Channel configuration												
Velocity												
Temperature												
Suspended solids												
Bed material												
Dissolved substances												
Light transmissivity												
Flow variability (Rapids)											X	

GENERAL BIOTA IMPACT MATRIX

Alternative 4

Physical-Chemical Characteristics of Streams / Selected Stream and Floodplain Biota	Depth and stage	Surface area	Channel configuration	Velocity	Temperature	Suspended solids	Bed material	Dissolved substances	Light transmissivity	Flow variability (Rapids)
Plankton										X
Benthos										X
Fish										X
Amphibians and reptiles										
Waterfowl and wading birds										
Small mammals										
Emergent aquatic vegetation										
Riparian vegetation										
Community structure										X

APPENDIX D

SECTION III

SIMULATED FLOW DATA
FOR THE ST. MARYS RAPIDS

APPENDIX D-III

SIMULATED FLOW DATA
FOR THE ST. MARYS RAPIDS

The purpose of the inclosed information is to illustrate the frequency of occurrence of flows greater than 37,000 cfs for each month from 1900 to 1979. The flows used are those which would have occurred during the period from 1900 to 1979 if the existing Regulation Plan 1977 had been in effect over that period.

Based on the alternatives being considered in the reconnaissance report for this study, a median flow of 37,000 cfs is expected to be available for U.S. power generation. This flow was arrived at by first deducting from the total Lake Superior outflow the flow required for the navigation locks and then the flow through the compensating works at the minimum setting of 1/2 gate (approximately 3,100 cfs). After meeting these requirements, the remainder of the Lake Superior outflow is split between the U.S. and Canada for power generation. There will always be a minimum of approximately 3,100 cfs flowing through the rapids, but for periods when the flow available for power generation exceeds 37,000 cfs, the possibility of diverting this excess flow into the rapids is being considered.

The tables entitled "Flows in Order of Severity" list the flows greater than 37,000 cfs and the order in which they occur, highest to lowest. The percent of time that the flows are equalled or exceeded is computed by dividing the order number by the total number of data, which in this case is 80. The percentages are then plotted against flows to develop the frequency of occurrence curves.

FLOWS IN ORDER OF SEVERITY

Order Number	Amount of Flow Over 37 TCFS	Order Number	Amount of Flow Over 37 TCFS
JANUARY		FEBRUARY	
1	10.35	1	9.70
2	9.64	2	9.20
3	7.54	3	7.05
4	7.50	4	6.87
5	6.39	5	6.06
6	6.28	6	5.69
7	6.16	7	5.64
8	5.97	8	5.59
9	5.86	9	5.55
10	3.95	10	3.53
11	1.36	11	1.22
12	1.24	12	0.95
13	0.91	13	0.73
14	0.90	14	0.51
15	0.75	15	0.26
16	0.61	16	0.21
17	0.56	17	0.20
18	0.36	18-80	0
19	0.06		
20	0.02		
21-80	0		

FLOWS IN ORDER OF SEVERITY

Order Number	Amount of Flow Over 37 TCFS	Order Number	Amount of Flow Over 37 TCFS
MARCH		APRIL	
1	9.32	1	9.56
2	9.16	2	9.37
3	6.66	3	6.49
4	6.61	4	5.90
5	5.63	5	5.30
6	5.60	6	5.27
7	5.45	7	5.16
8	5.36	8	4.85
9	5.23	9	4.67
10	3.51	10	3.24
11	1.03	11	0.37
12	0.79	12	0.35
13	0.72	13	0.34
14	0.51	14	0.08
15	0.26	15-80	0
16	0.18		
17-80	0		

FLOWS IN ORDER OF SEVERITY

Order Number	Amount of Flow Over 37 TCFS	Order Number	Amount of Flow Over 37 TCFS
	MAY		MAY
1	37.59	24	17.76
2	33.60	25	16.76
3	32.85	26	15.27
4	29.63	27	14.02
5	29.46	28	12.84
6	28.95	29	12.42
7	28.16	30	12.03
8	27.64	31	11.99
9	27.36	32	9.25
10	27.25	33	9.00
11	26.91	34	8.96
12	26.40	35	8.35
13	25.86	36	8.26
14	25.70	37	7.64
15	25.66	38	7.62
16	24.00	39	7.60
17	23.99	40	7.07
18	22.62	41	6.80
19	22.24	42	6.19
20	18.93	43	4.48
21	18.81	44	4.42
22	18.44	45	4.37
23	17.93	46	4.28

FLOWS IN ORDER OF SEVERITY

Order Number	Amount of Flow Over 37 TCFS	Order Number	Amount of Flow Over 37 TCFS
MAY		JUNE	
47	4.22	1	41.89
48	4.15	2	40.26
49	4.05	3	39.50
50	3.73	4	37.22
51	3.63	5	35.82
52	3.62	6	32.14
53	2.88	7	31.41
54	2.09	8	30.59
55-80	0	9	30.09
		10	28.74
		11	27.30
		12	26.96
		13	26.62
		14	26.18
		15	25.83
		16	25.18
		17	24.47
		18	23.85
		19	23.51
		20	23.51
		21	22.79

FLOWS IN ORDER OF SEVERITY

Order Number	Amount of Flow Over 37 TCFS	Order Number	Amount of Flow Over 37 TCFS
	JUNE		JUNE
22	19.94	44	4.70
23	19.62	45	4.64
24	19.00	46	4.62
25	15.51	47	4.62
26	14.73	48	4.44
27	14.60	49	4.22
28	13.99	50	4.15
29	13.39	51	4.00
30	13.24	52	3.64
31	13.14	53	3.43
32	12.23	54	3.24
33	10.61	55	3.22
34	10.41	56	2.81
35	10.09	57	0.01
36	9.90	58-80	0
37	9.89		
38	8.01		
39	7.38		
40	5.09		
41	4.93		
42	4.90		
43	4.75		

FLOWS IN ORDER OF SEVERITY

Order Number	Amount of Flow Over 37 TCFS	Order Number	Amount of Flow Over 37 TCFS
	JULY		JULY
1	43.24	22	24.62
2	42.60	23	22.48
3	42.30	24	19.12
4	40.83	25	19.03
5	40.81	26	19.02
6	40.62	27	18.82
7	40.27	28	18.71
8	35.44	29	18.39
9	35.14	30	15.30
10	33.72	31	15.28
11	33.12	32	14.12
12	29.59	33	13.89
13	29.43	34	12.72
14	28.51	35	11.83
15	28.43	36	11.57
16	26.97	37	11.24
17	26.03	38	11.06
18	25.58	39	10.85
19	25.28	40	10.74
20	25.23	41	10.49
21	25.09	42	10.34

FLOWS IN ORDER OF SEVERITY

Order Number	Amount of Flow Over 37 TCFS	Order Number	Amount of Flow Over 37 TCFS
JULY		AUGUST	
43	10.19	1	43.46
44	10.04	2	43.08
45	6.96	3	42.30
46	5.26	4	41.52
47	4.89	5	40.38
48	4.83	6	40.33
49	4.44	7	40.24
50	4.02	8	39.61
51	3.96	9	39.54
52-80	0	10	39.46
		11	39.39
		12	39.26
		13	38.74
		14	38.56
		15	37.70
		16	37.42
		17	32.36
		18	30.52
		19	27.56
		20	26.42
		21	26.20
		22	25.92

FLOWS IN ORDER OF SEVERITY

Order Number	Amount of Flow Over 37 TCFS	Order Number	Amount of Flow Over 37 TCFS
AUGUST		AUGUST	
23	24.63	44	5.25
24	23.48	45	5.16
25	22.34	46	5.15
26	22.10	47	4.86
27	20.40	48	4.47
28	19.31	49	4.13
29	18.54	50	3.75
30	12.15	51	3.57
31	11.47	52	3.08
32	10.94	53-80	0
33	10.76		
34	10.72		
35	10.44		
36	9.14		
37	8.51		
38	7.33		
39	5.90		
40	5.75		
41	5.59		
42	5.53		
43	5.50		

FLOWS IN ORDER OF SEVERITY

Order Number	Amount of Flow Over 37 TCFS	Order Number	Amount of Flow Over 37 TCFS
SEPTEMBER		SEPTEMBER	
1	44.90	22	23.43
2	43.53	23	20.40
3	43.20	24	19.13
4	42.63	25	19.00
5	42.40	26	18.09
6	41.94	27	16.65
7	41.63	28	16.33
8	40.80	29	15.78
9	40.47	30	15.05
10	40.12	31	15.03
11	39.18	32	15.00
12	38.25	33	12.97
13	37.40	34	11.39
14	36.52	35	11.38
15	33.11	36	11.28
16	32.29	37	10.54
17	28.23	38	10.10
18	27.21	39	8.75
19	26.48	40	8.46
20	25.73	41	5.62
21	24.91	42	5.47

FLOWS IN ORDER OF SEVERITY

Order Number	Amount of Flow Over 37 TCFS	Order Number	Amount of Flow Over 37 TCFS
SEPTEMBER		OCTOBER	
43	4.60	1	46.78
44	4.09	2	46.37
45	0.47	3	42.84
46	0.31	4	42.83
47	0.15	5	42.00
48-80	0	6	41.09
		7	41.04
		8	40.20
		9	38.66
		10	38.43
		11	35.39
		12	35.21
		13	35.01
		14	34.64
		15	33.78
		16	32.71
		17	31.42
		18	29.36
		19	27.57
		20	26.81
		21	20.70
		22	20.39

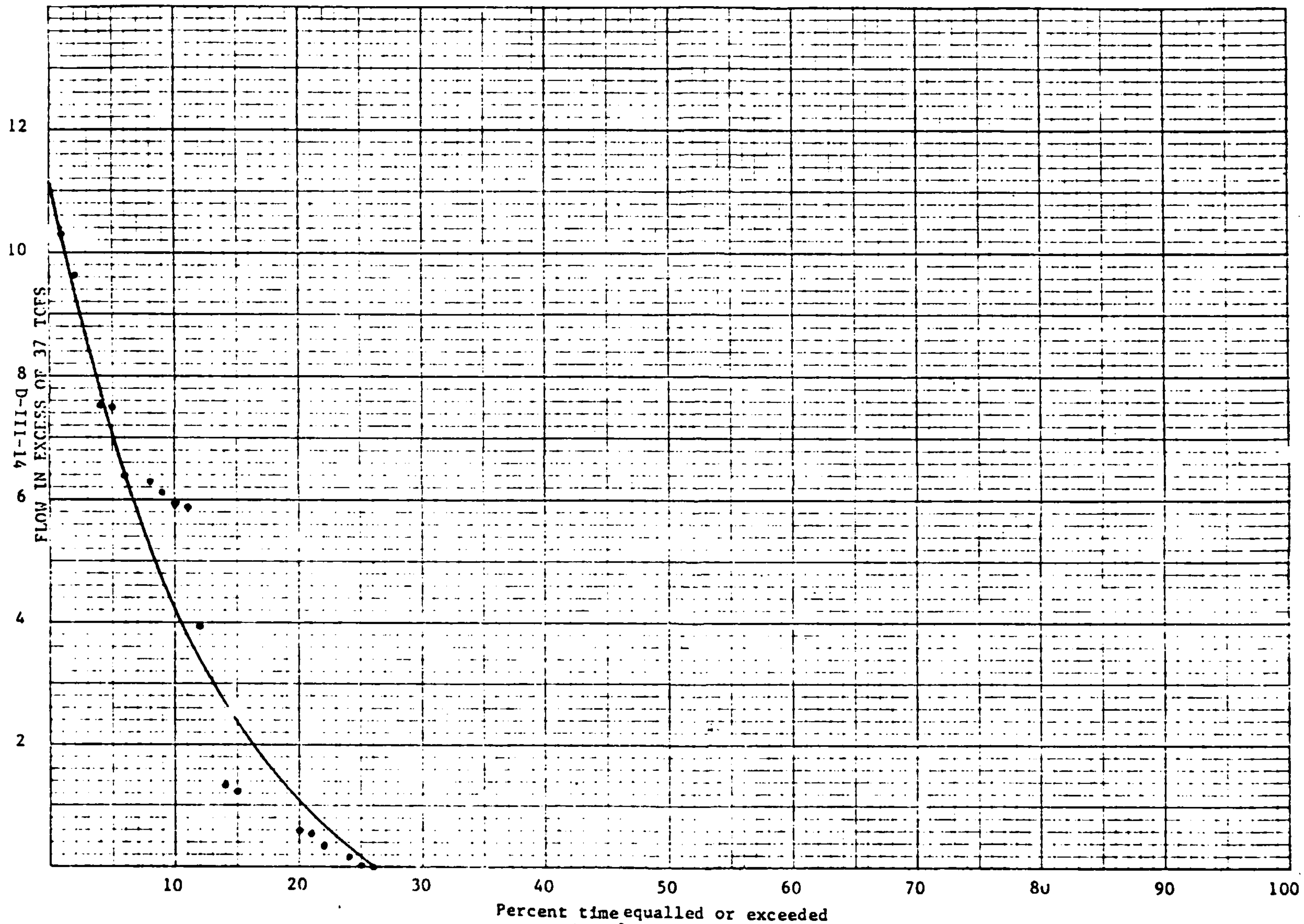
FLOWS IN ORDER OF SEVERITY

Order Number	Amount of Flow Over 37 TCFS	Order Number	Amount of Flow Over 37 TCFS
OCTOBER		NOVEMBER	
23	18.52	1	44.48
24	16.52	2	41.22
25	16.16	3	41.04
26	15.21	4	40.65
27	13.39	5	40.57
28	11.78	6	39.14
29	10.63	7	38.96
30	10.03	8	38.08
31	8.24	9	37.97
32	6.39	10	37.41
33	6.01	11	37.38
34	5.72	12	36.18
35	5.68	13	35.85
36	5.46	14	35.63
37	5.45	15	33.75
38	5.38	16	33.62
39	3.91	17	32.51
40	3.59	18	31.49
41	1.15	19	30.77
42-80	0	20	30.35
		21	30.12

FLOWS IN ORDER OF SEVERITY

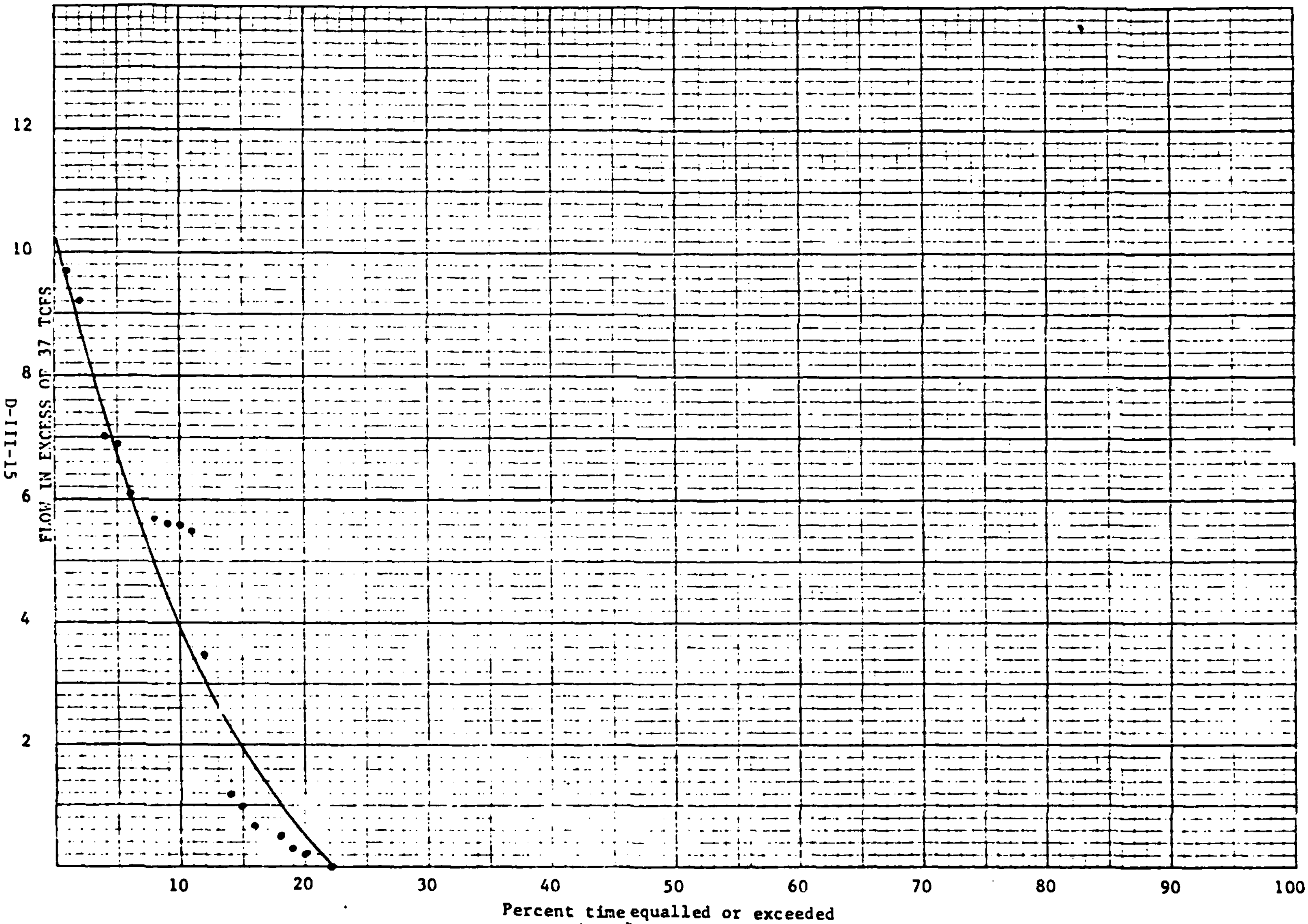
Order Number	Amount of Flow Over 37 TCFS	Order Number	Amount of Flow Over 37 TCFS
NOVEMBER		DECEMBER	
22	28.42	1	10.60
23	27.58	2	10.40
24	23.90	3	7.96
25	23.35	4	6.97
26	23.07	5	6.36
27	22.86	6	6.18
28	19.27	7	6.15
29	18.64	8	6.13
30	17.69	9	4.07
31	17.44	10	1.30
32	16.56	11	1.19
33	14.15	12	1.00
34	11.17	13	0.96
35	9.97	14	0.83
36	6.36	15	0.74
37	6.33	16	0.62
38	5.59	17	0.36
39	5.58	18	0.19
40	5.19	19	0.11
41-80	0	20	0.11
		21-80	0

Flow available for the Rapids area



JANUARY

Flow available for the Rapids area



FEBRUARY

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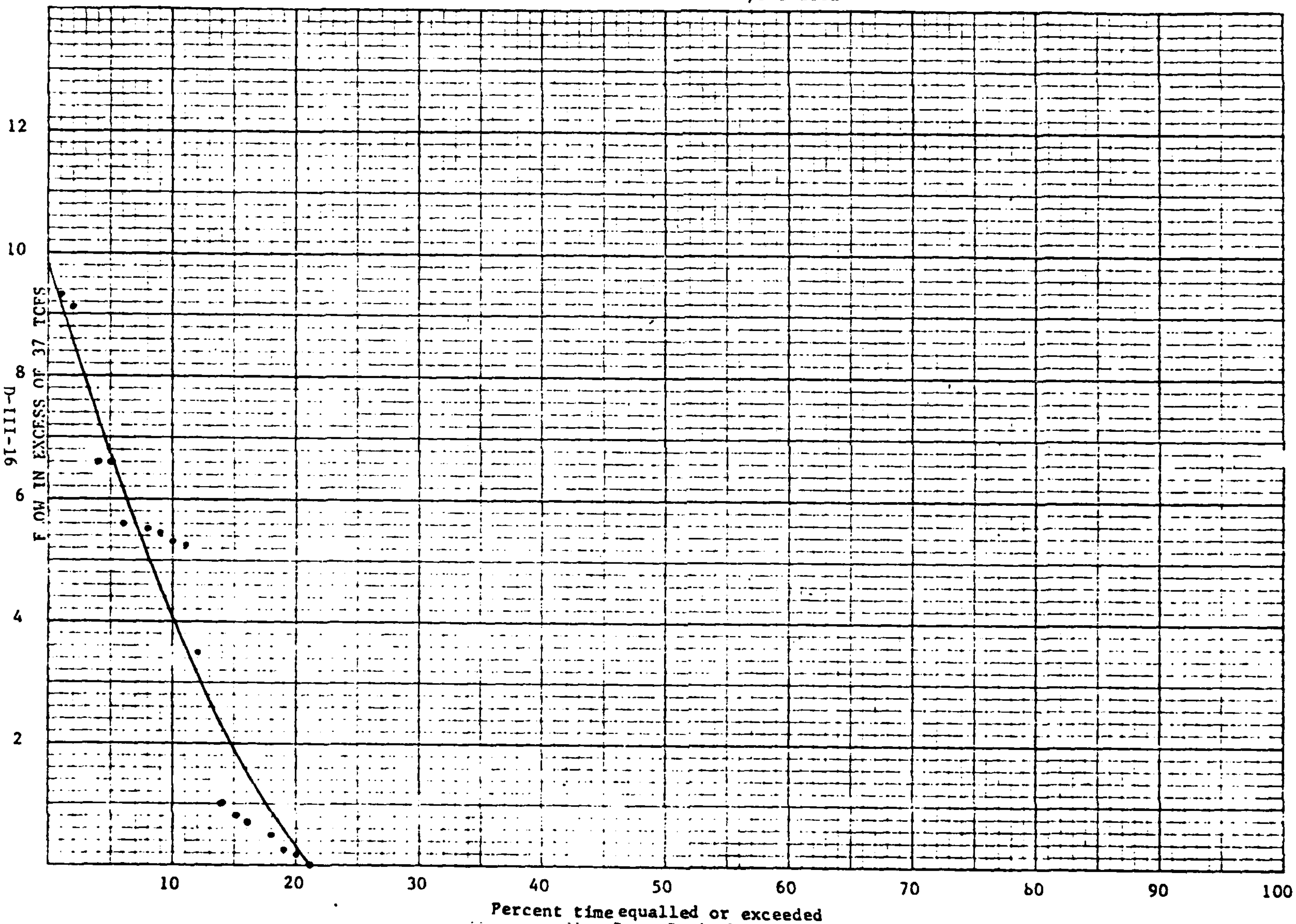
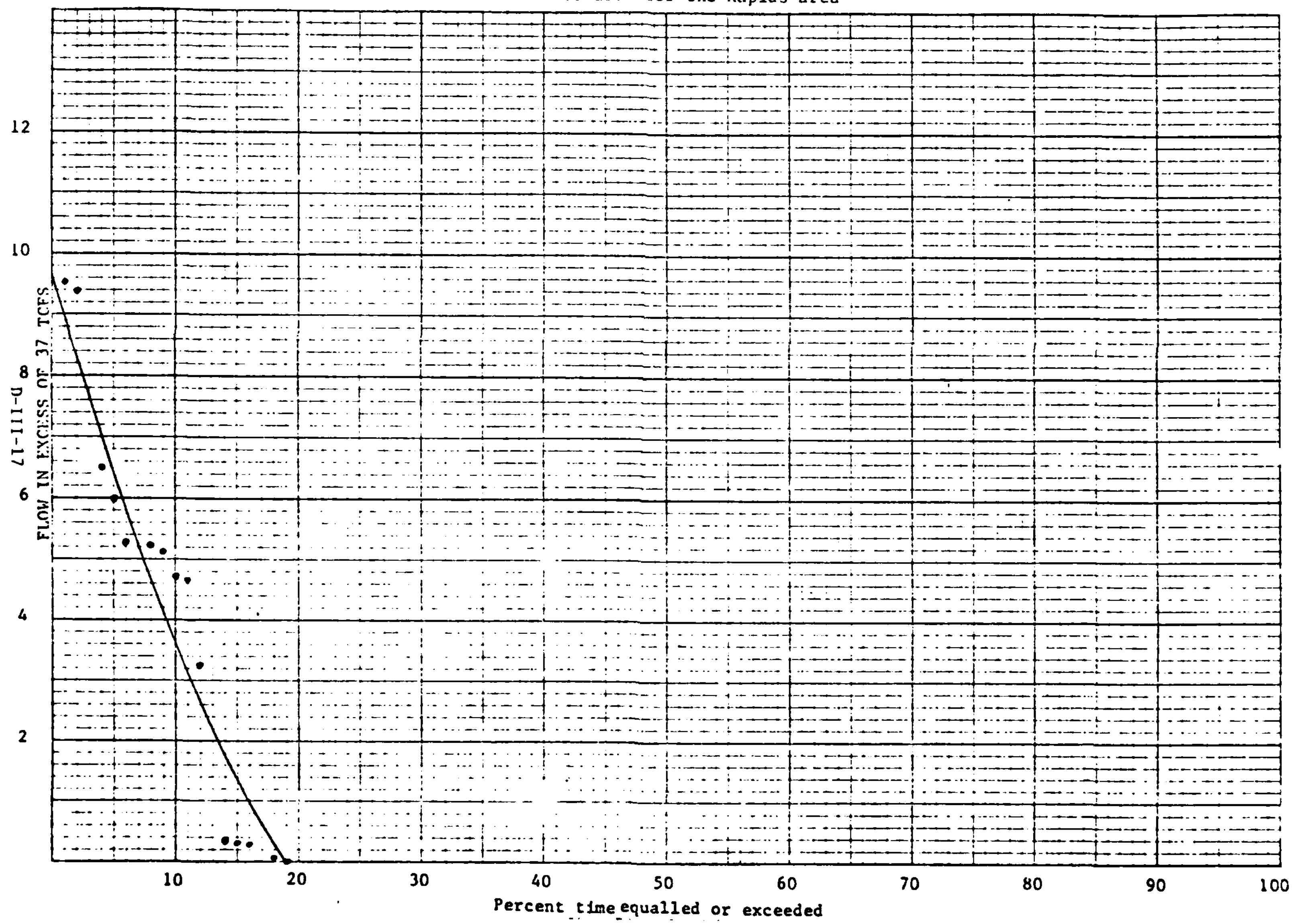


MARCH

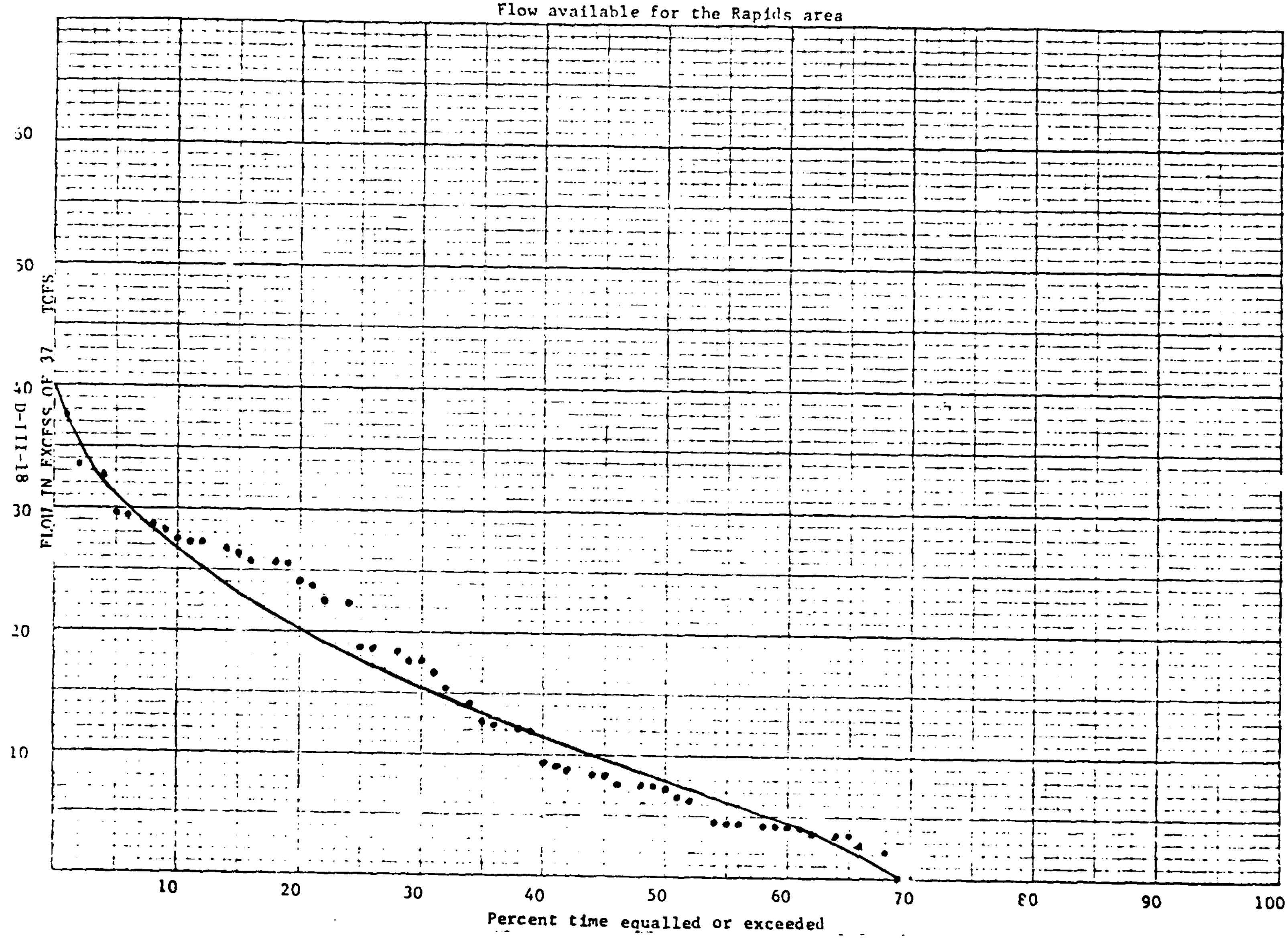
D-III-16

Flow available for the Rapids area

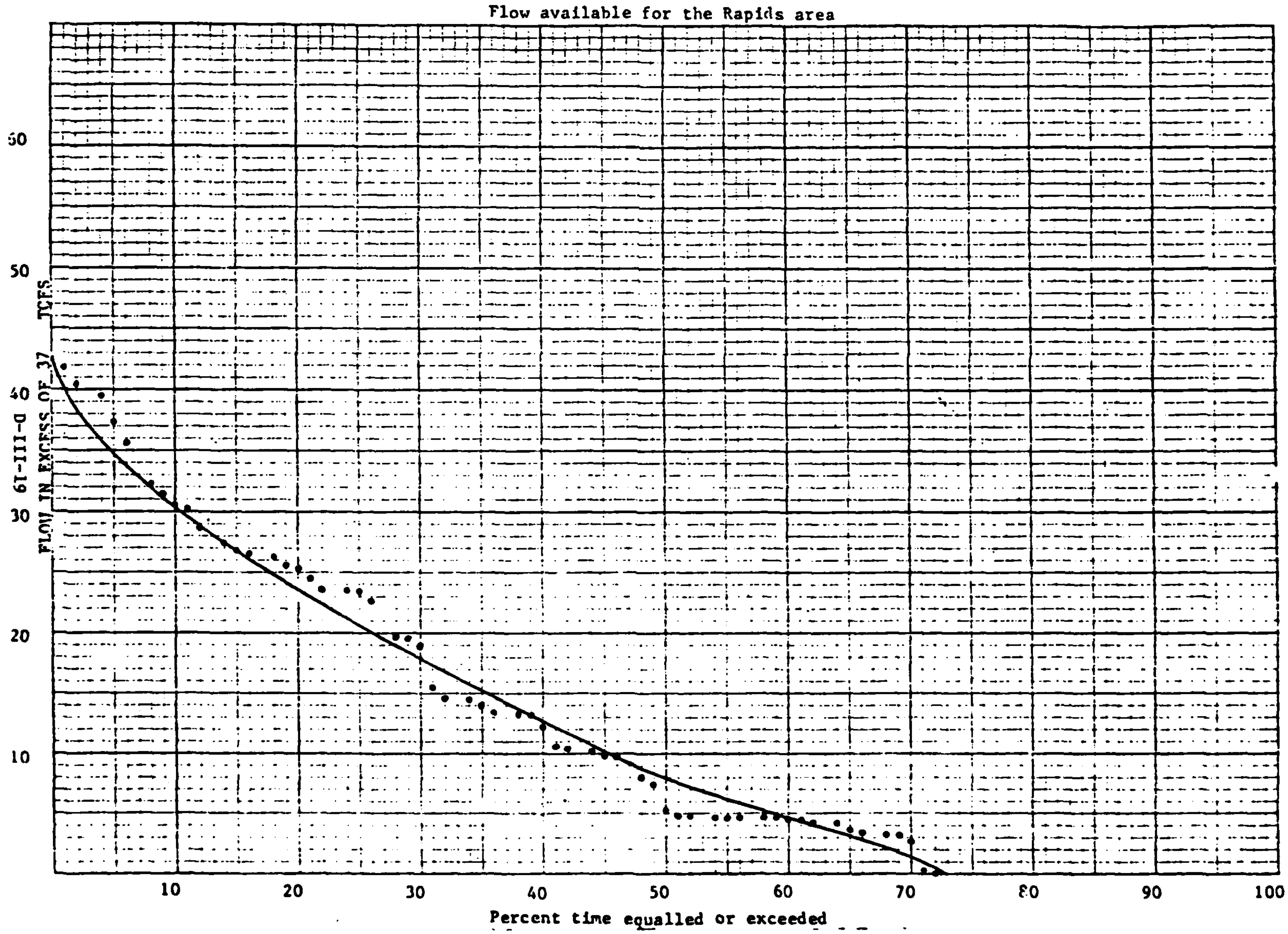


APRIL

Flow available for the Rapids area



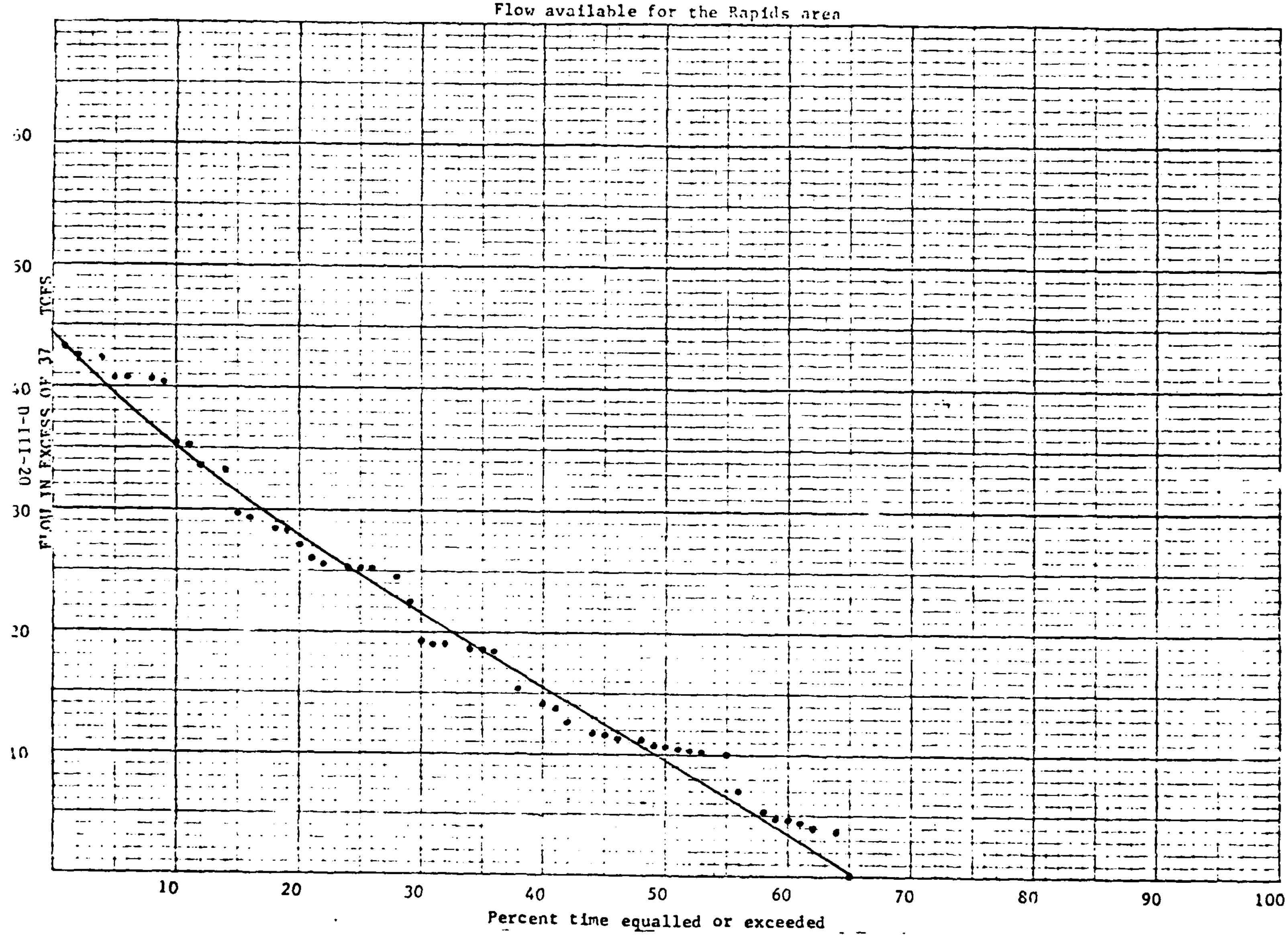
MAY



Flow available for the Rapids area
60
50
40
30
20
10
FLOW IN EXCESS OF 37 TCFS
D-III-19
10
20
30
40
50
60
70
80
90
100
Percent time equalled or exceeded

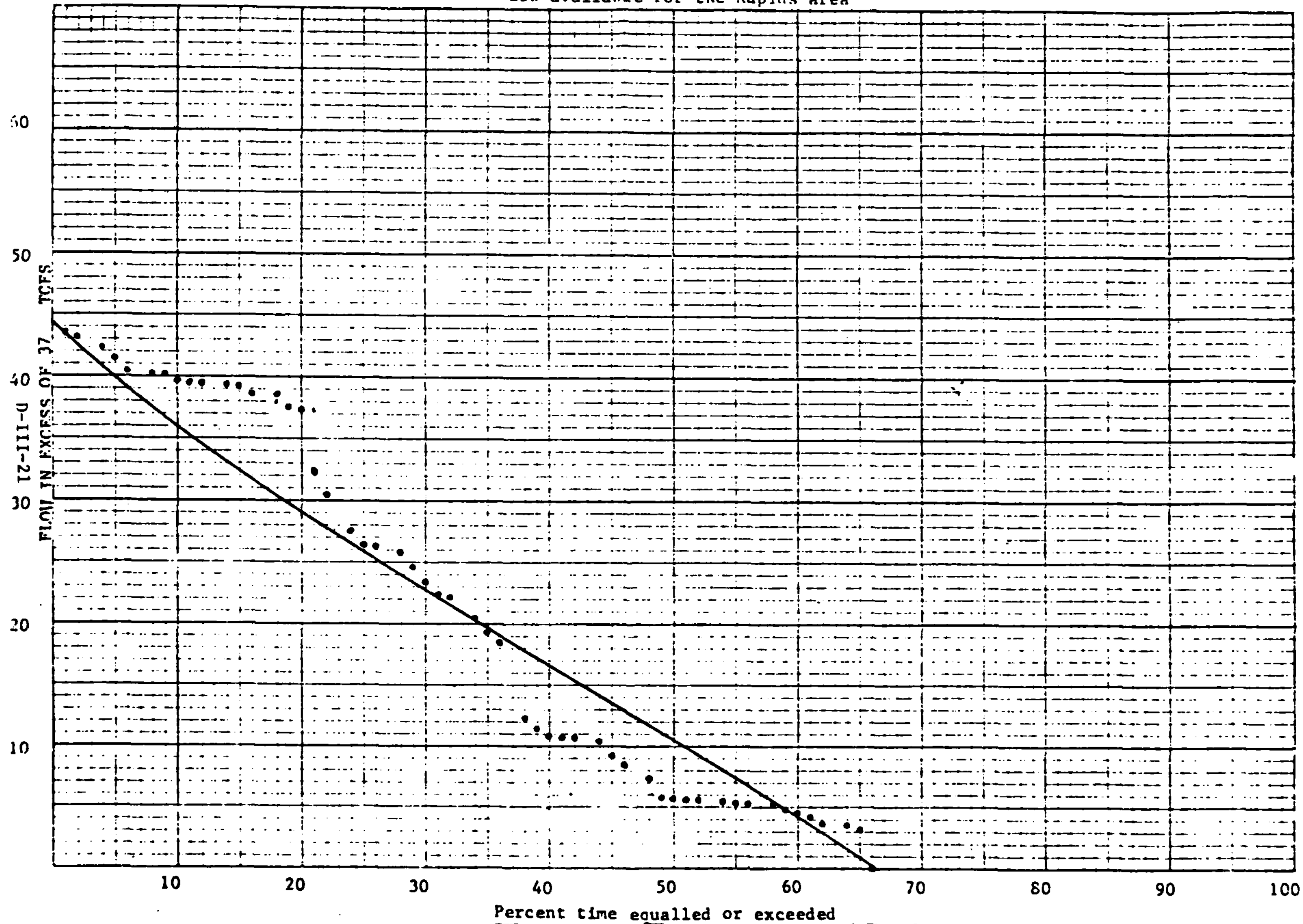
JUNE

Flow available for the Rapids area



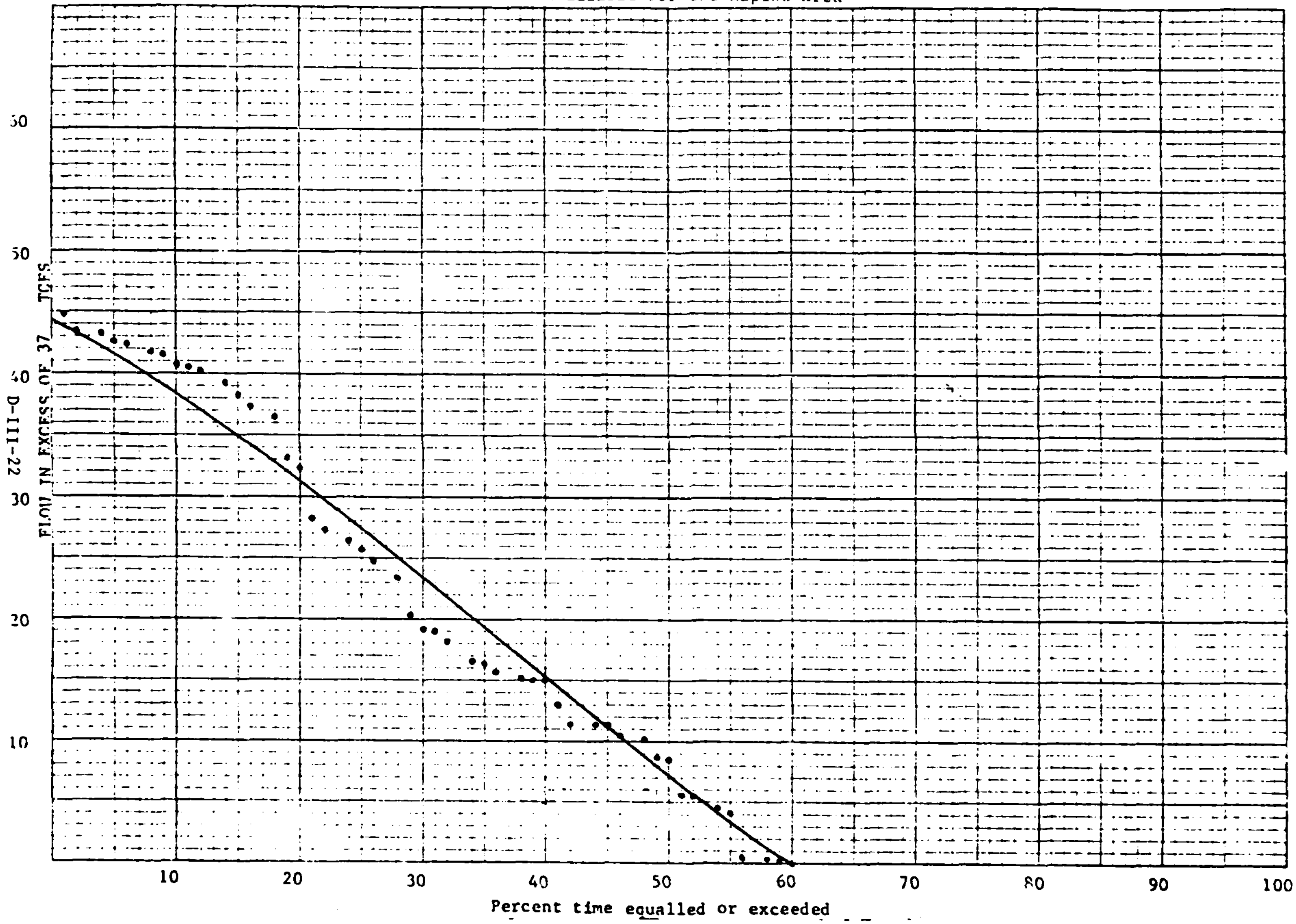
JULY

Flow available for the Rapids area



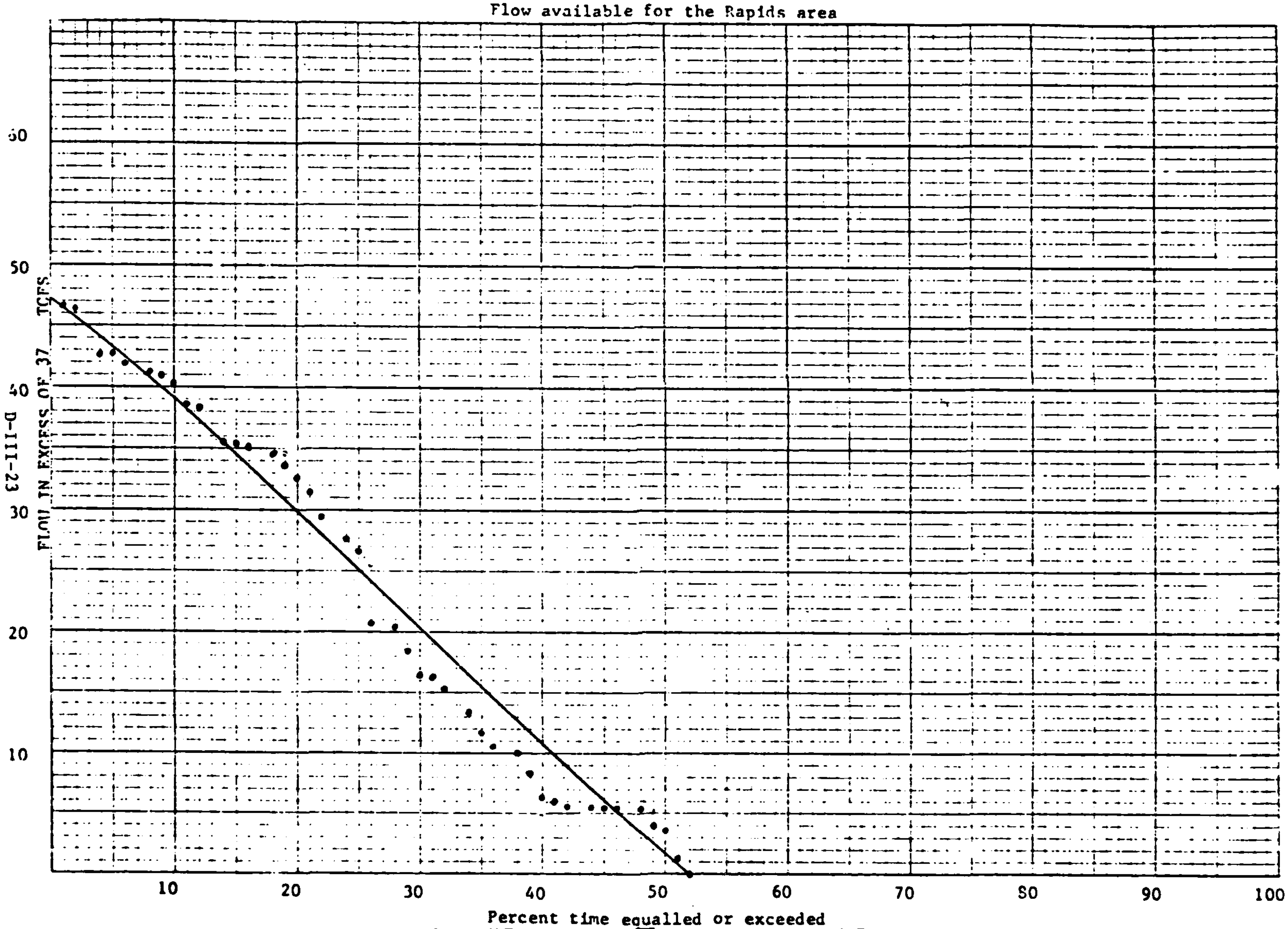
AUGUST

Flow available for the Rapids area



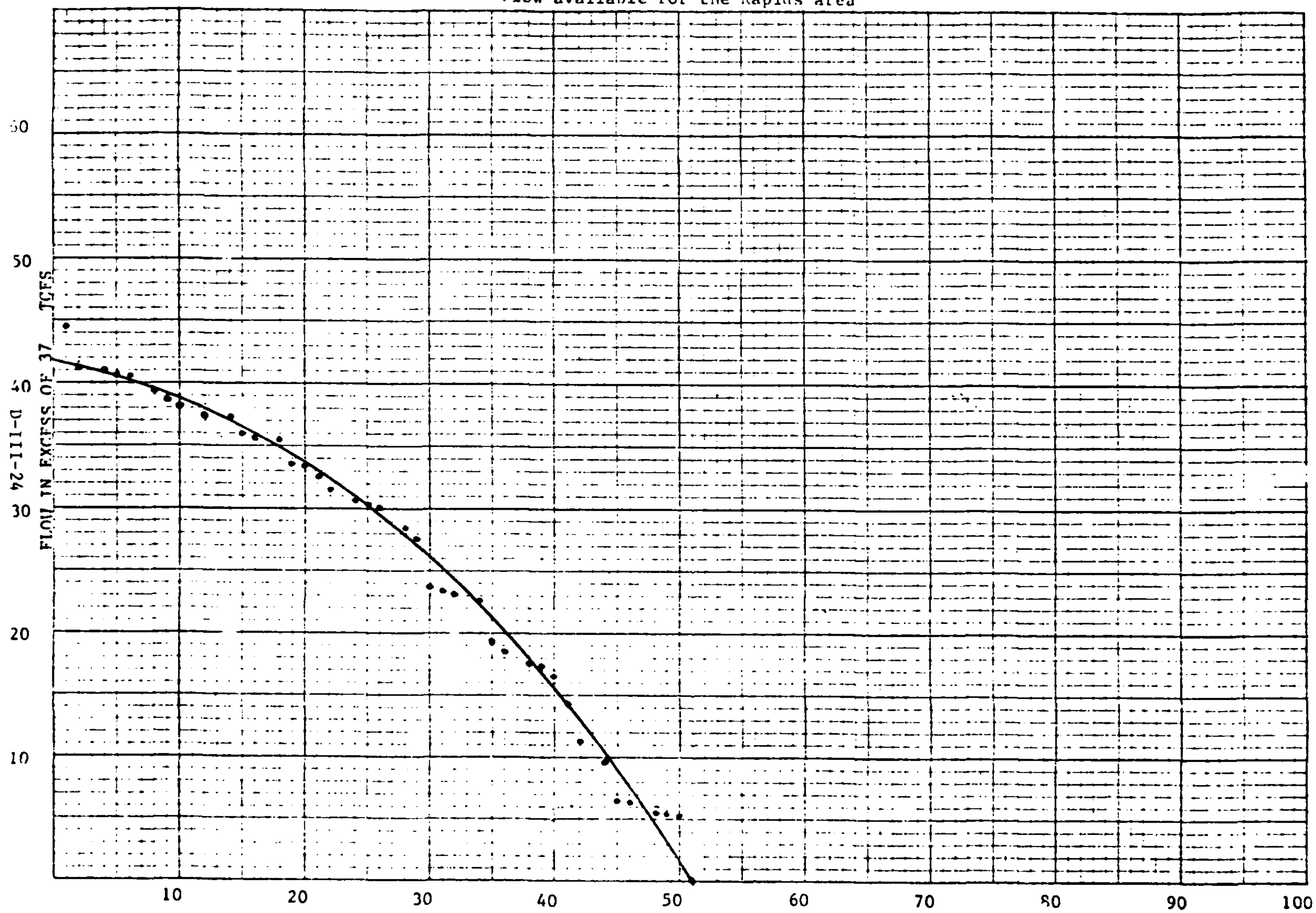
SEPTEMBER

Flow available for the Rapids area



OCTOBER

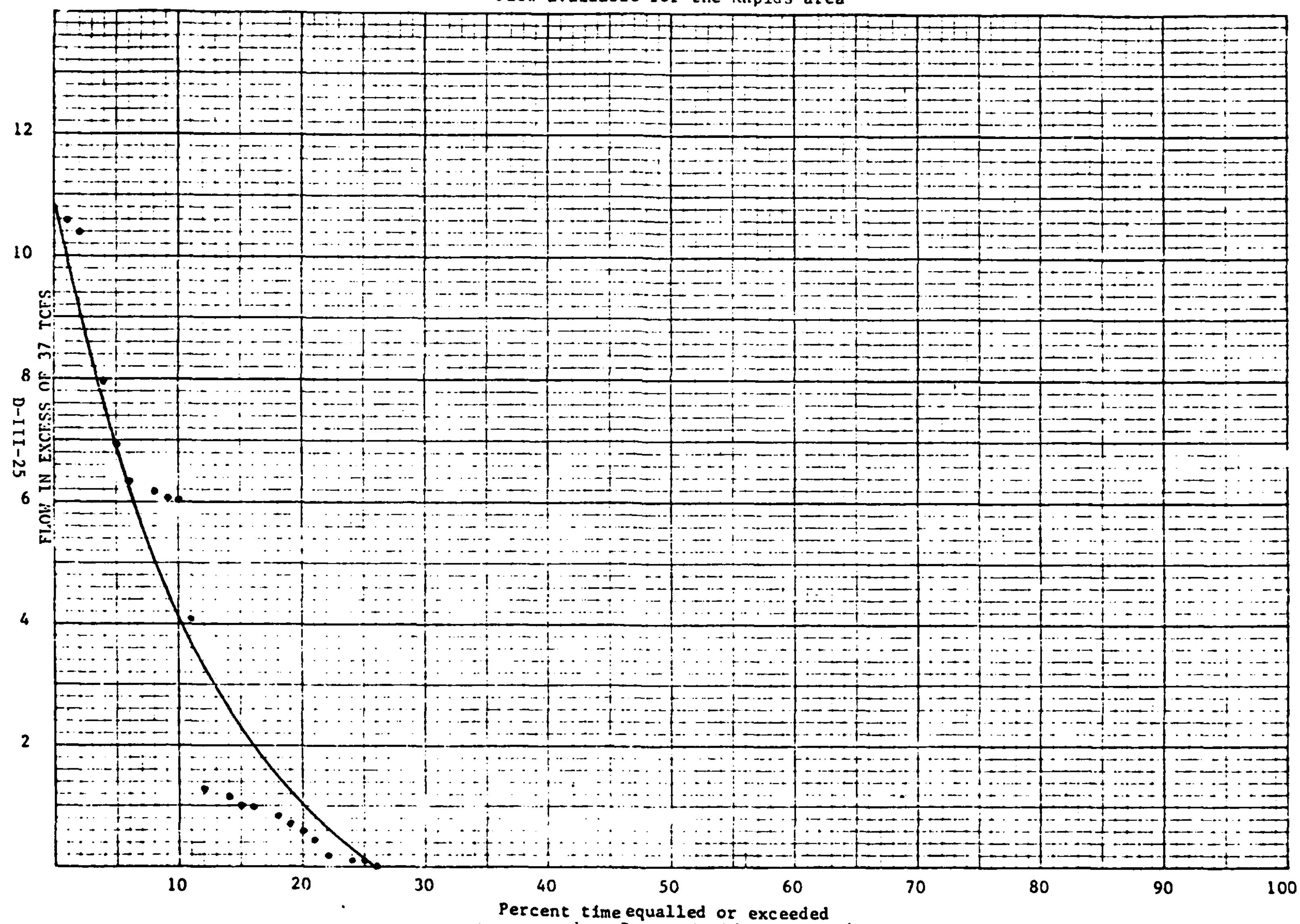
Flow available for the Rapids area



Percent time equalled or exceeded

NOVEMBER

Flow available for the Rapids area



DECEMBER

D-III-25

APPENDIX D

SECTION IV

IMPACT ASSESSMENT

APPENDIX D-IV

IMPACT ASSESSMENT

Impact assessment is the identification, description, and, if possible, measurement (qualitatively and quantitatively) of the effects of the different alternative plans on the projected without project condition. Impact assessment provides for analyzing the significant effects of each alternative. These are the economic, social, or environmental consequences of an alternative which would be likely to have a material bearing on the decision-making process. Impact assessment requires forecasting where and when significant primary and higher order effects could result from implementing a given alternative. This determination requires analyzing and displaying monetary and non-monetary changes in an objective manner based on professional and technical assessment of the resources.

The absence of change or no net change from the projected without condition could also be a significant impact in certain instances, and care must be taken to surface such information during this task. Describing impacts does not reflect societal preferences; these preferences are determined through subsequent evaluation. Activities to be carried out in impact assessment are as follows:

a. Determine Sources of Impacts. The aspects of each alternative that could cause significant impacts will be identified and specified. This requires analyzing the inputs, measures, and outputs associated with the alternatives to determine causative factors that could impact on elements of the projected without condition.

b. Identify and Trace Impacts. The causative factors related to each alternative should be compared to the elements of the projected without condition for the purpose of identifying impacts. Identifying impacts requires forecasting whether these factors could cause significant changes from the projected without condition. Accomplishing this requires cause and effect analysis to identify and trace through those impacts which are significant.

c. Specify Incidence of Impacts. The geographical location of each impact should be identified. In addition, it will be necessary to establish when impacts are expected and their duration.

d. Measure Impacts. As precisely as possible, the magnitude of each impact should be determined. The impacts should be quantified using either appropriate monetary or non-monetary units or concisely characterizing them in a written description.

The following is a preliminary listing of effects to be evaluated during this process. Other effects may be added to the list as required by the particular alternatives being evaluated.

SOCIAL EFFECTS

- Noise
- Displacement of People
- Esthetic Values
- Community Cohesion
- Community Growth

ECONOMIC EFFECTS

- Tax Revenues
- Property Values
- Public Facilities
- Public Services
- Regional Growth
- Employment/labor Force
- Business and Industrial Activity
- Power Costs and Benefits

ENVIRONMENTAL EFFECTS

- Man-Made Resources
- Natural Resources
- Air Quality
- Water Quality

APPENDIX E

SOCIOLOGICAL STUDIES

Department of the Army
Detroit District, Corps of Engineers

APPENDIX E

SOCIOLOGICAL STUDIES

TABLE OF CONTENTS

TABLES

APPENDIX E
SOCIOLOGICAL STUDIES

INTRODUCTION

Two kinds of social impacts are explored here: (1) demographic characteristics, and (2) social impacts directly related to project activities. More knowledge about the network system, characteristics and relationships among various agencies, and technological considerations have to be weighed before determining definitive social impacts.

As Edison Sault purchases more and more electricity from Consumers Power Company, additional cables will be required to transmit this energy. Even with these extra cables, the risk of a power failure increases as a service area receives more of its electricity from utilities outside its territory. This blackout problem could be magnified if, in the future, Consumers Power Company cannot meet both the demands of its own customers and still be able to sell the additional electricity to Edison Sault. If more electricity needs to be generated somewhere in the region, the St. Marys River could well be the best source.

The safest and cheapest way of providing more electricity is through hydroelectric power. More costly and controversial means of providing electricity such as nuclear energy are likelier to arouse social controversy. The Consumers Power Company's major sources of electricity are coal and oil. In 1977, 24% of their electrical power was provided by nuclear energy; this proportion decreased to 15% in 1978 and 1979. Hydro-electric power, depending upon the movement of water, is an inexhaustable natural resource unlike coal and oil. Water movement involves no threat of radioactive fallout nor risks the health in mining it. Current national policies favor using such natural resources wisely to benefit the general public. Even if the benefit/cost ratio is very low, the nonquantitative social benefits of using a natural, safe and inexpensive source of electrical power should be considered quite seriously in this project.

Moreover, decreasing dependance on electricity purchases from utilities outside the territory lessens chances of power failures.

DEMOGRAPHIC CHARACTERISTICS

Population growth, age distribution, and employment characteristics all affect electric consumption and are affected by utility rates. Figures of 1960-1980, presented in Table E-1, would seem to indicate declining population in these sparsely habitated areas of a growing state. Estimates for 1985, 1990, and 2000, displayed in Table E-2, portray the growth rate of the four counties as considerably greater than that of the state. The population growth between 1960 and 1980 is far smaller than that which is projected for the next 20 years. If population continues to grow faster as projected, then consumption of electricity may be expected to increase.

Old people on fixed pensions are likelier to have difficulty paying utility bills than those earning wages and salaries. Children consume electricity but do not contribute towards meeting its costs. An area with a higher proportion of people too old and too young for the labor market would seem to have difficulty paying higher costs for utilities. According to data presented in Tables E-3 and E-4, this area does have both a greater proportion of retirement folks and school age children than the state. A place with colder weather would further aggravate the problems of meeting higher utility costs for an area with this kind of age distribution.

In Table E-5, data from weather stations is presented. Comparing average temperatures from 1940 to 1970, the weather is colder in the Sault Ste. Marie area than the overall climate throughout the state. More energy is required during colder weather. Unemployed people, as the elderly, are likely to be living on fixed small incomes. Beyond the problem of meeting higher utility bills with a higher proportion of unemployed, is the greater difficulty of what higher utility costs might do to the employment situation in the area.

TABLE E-1

POPULATION OF COUNTIES IN ESELCO SERVICE AREA, 1960, 1970, AND 1980

Area	1960	1970	1980[1/]	% Growth 1960 to 1980	% Growth 1970 to 1980
Chippewa	32,655	32,412	28,158	-13.8	-13.1
Luce	7,827	6,789	6,475	-17.3	- 4.6
Mackinac	10,853	9,660	9,960	- 8.2	+ 3.1
Schoolcraft	8,953	8,226	8,574	- 4.2	+ 4.2
Region	60,288	57,087	53,167	-11.8	- 6.9
Michigan	7,823,194	8,875,083	9,236,891	+18.1	+ 3.9

Source: U.S. Census cf Population, 1970.

1/ Preliminary U.S. Census of Population data.

TABLE E-2

PROJECTED POPULATION GROWTH OF COUNTIES IN SERVICE AREA

1980 to 2000

Area	1980*	1985	1990	2000	% Growth 1980-1985	% Growth 1980-2000
Chippewa	28,158	30,300	32,100	33,800	7.1	16.7
Luce	6,475	8,500	9,200	9,900	23.8	34.6
Mackinac	9,960	11,700	12,200	13,100	14.9	24.0
Schoolcraft	8,574	9,600	10,100	11,000	10.7	22.1
Region	53,167	60,100	63,600	67,800	11.5	21.6
Michigan	9,236,891	9,703,000	10,046,000	10,505,000	4.8	12.1

Source: Michigan Department of Management and Budget, 1978 figures.

*Preliminary U.S. Census of Population data.

TABLE E-3

AGE DISTRIBUTION - COUNTIES IN SERVICE AREA

Area	0-15		16-65		66 & Older	
	#	%	#	%	#	%
Four Counties	18,718	32.8	32,897	57.6	5,472	9.6
Michigan	2,895,295	32.6	5,285,467	59.6	694,321	7.8

Source: U.S. Census of Population, 1970.

TABLE E-4

POPULATION ENROLLED IN SCHOOL BY AGE IN COUNTIES OF SERVICE AREA

Students

	Four Counties		Michigan	
Age	#	%	#	%
3- 4	176	.3	33,804	.4
5- 6	1,838	3.2	295,145	3.3
7-13	8,936	15.7	1,322,498	14.9
14-15	2,546	4.5	377,628	4.3
16-17	2,155	3.8	327,723	3.7
18-19	1,028	1.8	185,117	2.1
	16,679	29.3	2,541,915	28.7

Source: U.S. Census of Population, 1970.

TABLE E-5

TEMPERATURE* - SAULT STE. MARIE AND MICHIGAN

Stations	January	July	Average
Sault Ste. Marie	14.2°	63.8°	40.0°
Michigan	23.2°	68.9°	45.6°

Source: Michigan Weather Service, Climate of Michigan by Stations (Lansing: 1974).

*Temperatures are in degrees Fahrenheit.

The unemployment rate is quite high in the four upper peninsula counties as indicated by data presented in Table E-6. The growth rate in the number of jobs is quite low as indicated by figures displayed in Table E-7. Jobs increase during the warm weather tourist season. Overall employment improves in the years with good tourist seasons. The June 1980 figures in Table E-6 indicate lower unemployment for three of the four counties. Employment generally increases in June once the tourist season starts.

Businesses with a higher proportion of employees, sensitive to the vicissitudes of tourist seasons, are entertainment and recreation services, eating and drinking places, food stores and personal services. Such small businesses may be very sensitive to any changes in overhead costs. Data from Table E-8 would indicate that this area has a higher proportion of people employed in these lines of work than the state. The higher proportion of public school teachers may reflect the higher proportion of school age youngsters; and the higher proportion of hospital personnel may be related to the higher proportion of people aged 65 and older. The four counties also have a higher proportion of construction workers which may contribute to social impacts resulting from project execution.

PROJECT CONSTRUCTION

Community members may either perceive the project as providing employment for their construction industry or bringing more workers to the upper peninsula for temporary jobs, adding to long term unemployment after project construction. Knowing the amount of workers required to execute each of the alternative project plans and the current unemployment rate among construction workers may be helpful for assessing their perceptions. Other social impacts of project construction, including noise, possible detriments to health, displacement of people and farms, disruptions to life styles, desirable community growth, community cohesion, public services and facilities, property values and tax revenues, will be examined in subsequent stage reports.

TABLE E-6

UNEMPLOYMENT IN COUNTIES OF SERVICE AREA

Areas	1978		1979		June 1980	
	#	%	#	%	#	%
Schoolcraft	475	12.8	550	14.5	450	11.5
Luce	725	22.1	350	11.7	400	12.3
Mackinac	750	11.6	1,100	17.3	825	9.8
Chippewa	2,325	18.9	2,075	18.0	1,800	15.5

Source: Michigan Employment and Security Commission, 1980.

TABLE E-7

EMPLOYMENT IN COUNTIES OF SERVICE AREA

Areas	1976	1977	1978	1979	% Growth 1976-1979
Schoolcraft	3,000	3,125	3,250	3,225	7.5
Luce	2,600	3,275	2,550	2,650	1.9
Mackinac	5,325	5,600	5,700	5,250	-1.4
Chippewa	10,500	10,700	9,975	9,425	-11.4
Michigan	3,678,378	3,849,682	4,033,231	--	

Source: Michigan Employment and Security Commission, 1980.

TABLE E-8

EMPLOYMENT BY INDUSTRIES IN COUNTIES OF SERVICE AREA

Industries	Four Counties		Michigan	
	#	%	#	%
Agriculture, Forestry and Fisheries	411	3	58,707	2
Mining	536	4	13,880	0.4
Construction	1,240	8	155,637	5
Furniture, Lumber and Wood Products	436	3	34,743	1.1
Metal Industries	40	0.3	164,392	5
Machinery	49	0.3	202,000	6
Motor Vehicles	58	0.4	453,779	14
Other Durable Goods	141	1	98,260	3
Food and Kindred Products	99	1	41,836	1
Nondurable Goods	294	2	173,530	5
Transportation and Communication	775	5	124,550	4
Utilities and Sanitary Service	286	2	45,758	1
Wholesale Trade	348	2	119,197	4
Food, Bakery and Dairy Stores	568	4	80,721	2
Eating and Drinking Places	835	6	105,625	3
General Merchandise Relating	509	3	87,864	3
Motor Vehicle and Service Retailing	575	4	70,747	2
Other Retail Trade	913	6	168,442	5
Banking and Credit Agencies	186	1.3	48,601	1.5
Insurance, Real Estate and Finance	180	1.2	81,863	3
Personal Services	1,153	8	199,723	6
Entertainment and Recreation Services	110	1	21,677	1
Hospitals	1,255	8	123,960	4
Other Health Services	190	1.3	67,632	2
Public Education	1,383	9	193,062	6
Other Educational & Professional Services	860	6	191,690	6
Public Administration	1,337	9	124,954	4
Total	14,767	100.0	3,252,830	100.0

Source: U.S. Census of Population, 1970.

CONCLUSION

In summary, ESELCO's customers are increasing their demand for output. Customer consumption increased 10.7% between 1975-1979, while Edison output decreased 2.9% during these years. Whether other power companies could provide Sault customers, even if the Edison plant became a mere transformer station, depends on their capacity to meet overall demands. Electric service from other utilities like Consumers Power Company is more expensive; however, increases in rates are subject to the authority of the Public Service Commission.

Social benefits, in terms of having an adequate supply of inexpensive electricity, depend on overall capacity and the decisions of the Public Service Commission (PSC). Edison Sault could cease functioning as a utility and residents of the four counties may still have all the electricity they wish to consume at comparable rates. This possibility would be unlikely, and would depend on two contingencies: Ample supplies of electricity without any generation from Edison Sault and the PSC allowing preferential rates for Edison customers. Even so, with more and more electricity purchased from outside the area, Edison Sault would require additional cables. Chances of a power failure increase in direct proportion to the number of different cables required to bring electrical services into a certain area. Since the four counties produce less electricity than they consume and the St. Marys River provides a renewable, safe, natural, and inexpensive source of hydroelectric power, increasing generation efficiency at Sault Ste. Marie, Michigan, may be the most logical decision.

Even if benefits of the project just nominally exceed costs from an economic standpoint, the nonquantifiable social benefits of utilizing natural water resources for the public's benefit are considerable. To establish the need for increased electrical output and that Edison Sault's increasing dependency on Consumers Power Company has or will result in rate increases will require the cooperation of the Public Service Commission.

Edison Sault customers may be particularly vulnerable to an increase in utility rates. If M.D.M.B. (Michigan Department of Management and Budget) estimates are correct, then these four counties will grow at a much faster rate than previously. Demand for electricity will increase with growth and with greater reliance on Consumers Power Company, rates will increase pending the approval of the Public Service Commission.

The four counties have a greater proportion of unemployed, old and young people. Meeting higher utility costs should be more difficult for those areas which have proportionately fewer people working in the labor force. Utility rate increases are more detrimental to those customers who live in cold weather climates who consume a greater amount of energy per capita. These counties have a greater proportion of construction workers than the state as a whole. The project could either mean another job for a local construction firm or an influx of more workers who will later become unemployed.

APPENDIX F

PUBLIC INVOLVEMENT AND
PERTINENT CORRESPONDENCE

Department of the Army
Detroit District, Corps of Engineers

APPENDIX F

PUBLIC INVOLVEMENT AND PERTINENT CORRESPONDENCE

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PUBLIC INVOLVEMENT AND PERTINENT CORRESPONDENCE

Part I
Public Involvement Program

INTRODUCTION

Public involvement is a key to the development of acceptable and implementable plans. With this in mind, a public involvement plan has been developed. It is designed to create awareness and stimulate two-way communication, in order that the public may participate in the planning and decision-making process of the study.

The process of identifying water resources issues, exploring alternatives, and selecting a feasible and desirable plan requires a continuous two-way communication process between the study planners and identifiable public--public officials, public and private groups and the study area citizenry.

Along with the main goal of establishing this two-way communication process, the objectives shown below would also be established.

OBJECTIVES

a. Inform the public and promote full public understanding of the Sault Ste. Marie Power Plant Redevelopment Feasibility Study--the study process, progress, implications and results.

b. Develop a process of interaction and instill in the public a desire to participate and become involved in the study.

c. Identify affected and interested individuals and groups within the study area, which include determining and describing channels of communication to be used in involving them in the study.

d. Acquire sufficient information from the broadest practical cross-section of concerned citizens, groups, and governmental agencies to identify area problems, issues, needs, priorities, and preferences.

e. Promote wide public review and evaluation of the planning process and study results at the end of each stage of planning, so that public desires and expectations will help guide the scope, nature, and direction of the study.

CRITERIA

Two important criteria are considered in the design of the public involvement program. First, the public involvement program should be designed to obtain information from the public which will be useful in meeting study objectives. There will be a purpose for each contact with the public, so that information collected will be pertinent to the study.

Second, the public involvement program will attempt to satisfy the needs of the public. The individuals and groups participating in the study must be well-informed, and need to feel that they are being heard when expressing opinions or voicing concerns over problems.

To insure adequate participation by the public, the public involvement techniques that are being used will be carefully evaluated periodically during the study to insure that adequate input from the public is being obtained. The public involvement program will be flexible enough to accommodate changes if necessary.

Analysis of public input consists of summarizing, describing, and arranging the large quantities of information that will be received from the public. It involves the identification of underlying values, attitudes, and opinions held by the people involved in the study. The content, nature, and extent of public input will have to be summarized before evaluation of that input can be accomplished, and before recommendations and decisions based on public input can be made.

INTERAGENCY COORDINATION

The Corps of Engineers is required to coordinate its water resources planning studies with other Federal, state and local agencies, as well as with individual and private groups.

For the purpose of this study, the public is classified into four main groups: elected officials, governmental agencies, organized groups, and the general public.

a. Elected officials. One of the major sources of information is from elected officials who represent various interests and concerns. Their input, representing their constituencies, is vital to the program. A list of elected officials includes:

U.S. Senator Donald W. Riegle, Jr.
U.S. Senator Carl Levin
U.S. Representative Robert W. Davis, 11th Congressional District
State Senator Mitch Irwin, 37th District
State Representative Charles H. Varnum, 107th District
State Representative D. J. Jacobetti, 108th District
State Representative Jack L. Gingrass, 109th District
State Representative Donald M. Koivisto, 110th District

b. Governmental agencies. Many Federal, State, regional, and local agencies are interested in water resources and contribute to the public involvement process of this study. A partial list of governmental agencies and units is included:

INTERNATIONAL and FEDERAL AGENCIES

International Joint Commission

International Lake Superior Board of Control

Environmental Protection Agency

Federal Energy Regulatory Commission

Department of Energy

U.S. Department of State

U.S. Department of the Interior

- U.S. Fish and Wildlife Service
- Heritage Conservation and Recreation Service

U.S. Department of Transportation

- U.S. Coast Guard

Rural Electrification Administration

STATE AGENCIES

Department of Commerce

- Economic Development Administration

Office of the Governor (including the State Clearinghouse)

Michigan Department of State - History Division

Michigan Department of Natural Resources

Michigan Department of State Highways and Transportation

State of Michigan - Office of Economic Development

Michigan Public Service Commission

Michigan Energy Administration

REGIONAL

Great Lakes Commission

Great Lakes Basin Commission

LOCAL

Chippewa County, Michigan
City of Sault Ste. Marie, Michigan
Northeast Michigan Regional Planning and Development Commission
Newberry Water and Light Board

c. Organized groups. These groups usually have varied interests and concerns. Some have major interests in a water resources study while others have only peripheral interests. They include such interests as business and conservation and are identified because they may have some impact on, or may be impacted by the study results. The following is a list of organized groups:

Michigan United Conservation Clubs
Cloverland Electric Cooperative
Alger-Delta Cooperative
Edison Sault Electric Company
Michigan Municipal Electric Association

d. General public. This includes individuals not represented by any of the above groups or organizations. These individuals will be influential in the final approval or rejection of study plans, and the public involvement program will attempt to involve them in the planning process.

PUBLIC INVOLVEMENT

Public involvement for this study began with the development of a mailing list that would include all levels of the public: staff of other Federal, State, and local Governmental agencies, elected officials at all levels of government, leaders and members of organized groups and identifiable interests, the general public, and news media located in the study area. The current mailing list contains 150 addressees.

A public workshop was held at Sault Ste. Marie, Michigan, on 21 August 1980. The objective of this workshop was to present the study objectives and preliminary alternatives under consideration for possible redevelopment of the existing hydropower facilities at Sault Ste. Marie, Michigan. Public views on the objectives and alternatives were solicited from the 44 attendees and incorporated into the study.

Future public involvement activities that will take place during the course of this study include, but are not limited to, the following items. Actions will be accomplished approximately in the timeframes indicated.

a. After the Reconnaissance Report is approved by NCD, it will be made available to interested publics. Notices of availability, as well as a fact sheet summarizing the report, will be sent to all addressees on our mailing list. A news release summarizing the report and announcing its availability will be sent to the study area media.

(1) Write/print notice and summary for public - February 1981.
(2) Write news release for media - February 1981.
(3) Mail out notices, fact sheets, and news releases - February 1981.
(4) Mail out reports - February 1981.
(5) Review any comments on report.

b. During Stage 2, Development of Intermediate Plans, another workshop will be held in the study area. Meeting notices, as well as a fact sheet summarizing information on the alternatives will be sent to all addressees. A news release announcing the workshop will be sent to study area media.

(1) Make workshop arrangements - July 1981.
(2) Prepare notice and fact sheet for the public - July 1981.
(3) Mail out meeting notice and fact sheet - July 1981.
(4) Write news release - July 1981.
(5) Mail out news release - August 1981.
(6) Finalize workshop arrangements - August 1981.
(7) Hold workshop - August 1981.
(8) Review workshop comments.

c. After the Draft Feasibility Report and the Draft Environmental Impact Statement have been approved by NCD, they will be made available to the interested publics. A formal public meeting will also be held. A notice announcing the availability of the reports, a notice announcing the public meeting, and a fact sheet summarizing the reports will be sent to all addressees. A news release summarizing the reports, announcing their availability and the public meeting will be sent to area media.

(1) Make workshop arrangements - May 1982.
(2) Write/print notices and fact sheets for public - May 1982.
(3) Write news release for media - May 1982.
(4) Mail notices, fact sheets - May 1982.
(5) Mail news release - late May/early June 1982.
(6) Mail reports - May/June 1982.
(7) Finalize meeting arrangements - June 1982.
(8) Hold public meeting - June 1982.
(9) Review and incorporate comments.

d. After the Final Feasibility Report and the Final Environmental Impact Statement have been approved by NCD, they will also be made available to interested publics.

(1) Prepare Division Engineer's Notice on Final Feasibility Report - September 1982.
(2) Write news release for media - September 1982.
(3) Mail Division Engineer's Notice and news release - 30 September 1982.
(4) Distribute Final Feasibility Report/Final EIS - October 1982 and after.

e. During the Washington level review process, a news release and fact sheet on the status of the study would be sent out periodically, in order to keep all interested publics informed on the progress of the study.

Write and mail news releases and fact sheets - February 1983, August 1983, February 1984, August 1984, etc.

For any information concerning the study, requests can be made to: U.S. Army Engineer District - Detroit, ATTN: NCEED-PB, P.O. Box 1027, Detroit, Michigan 48231.

Part II

Pertinent Correspondence

INTRODUCTION

This section is devoted to correspondence pertaining to this reconnaissance study.

Page	Date	Correspondence
F-II-2	19 May 1980	Governor, State of Michigan
F-II-3	No Date	U.S. Fish and Wildlife Service
F-II-4	9 Jun 1980	State of Michigan, History Division
F-II-5	16 Jun 1980	International Joint Commission
F-II-6	8 Jul 1980	CP Rail
F-II-8	11 Aug 1980	International Joint Commission
F-II-9	21 Aug 1980	Statement of Edison Sault Electric Company
F-II-95	26 Jun 1980	Department of State, Washington, D.C.
F-II-97	26 Aug 1980	Federal Energy Regulatory Commission
F-II-101	4 Sep 1980	Michigan Municipal Electric Association

STATE OF MICHIGAN

OFFICE OF THE GOVERNOR

LANSING

WILLIAM G MILLIKEN
GOVERNOR

May 19, 1980

Colonel Robert V. Vermillion
District Engineer
U. S. Corps of Engineers
P. O. Box 1027
Detroit, Michigan 48231

Dear Colonel Vermillion:

Thank you for your letter concerning the initiation of a feasibility study for redevelopment of hydropower at Sault Ste. Marie, Michigan.

The State of Michigan is very interested in the development of In-state energy sources. Therefore, I request that you coordinate your efforts in this regard with the Department of Natural Resources and the Energy Administration, Department of Commerce.

Again, thank you for advising me of the feasibility study.

Kind personal regards.

Sincerely,

William G. Milliken
Governor

United States Department of the Interior

FISH AND WILDLIFE SERVICE

IN REPLY REFER TO:

East Lansing Area Office
Manly Miles Building, Room 202
1405 South Harrison Road
East Lansing, Michigan 48823

Colonel Robert V. Vermillion
U.S. Army Engineer District
Detroit
P.O. Box 1027
Detroit, Michigan 48231

Dear Colonel Vermillion:

While gathering information in connection with the Sault Ste. Marie Power Plant Redevelopment Feasibility Study, Stage I, the Fish and Wildlife Service recognizes that there may be an opportunity to substantially enhance the fisheries of the St. Marys River.

Regulation of the outflow from Lake Superior by the compensating works fluctuates the discharge over the St. Marys Rapids from approximately 3000 cfs (½ gate open) to 60,000 cfs (16 gates open). Under the minimum flow conditions (less than 4 gates open), significant portions of the St. Marys Rapids and Whitefish Channel become dewatered. Fish become entrapped in isolated pools and bottom dwelling organisms desicate and die. During high-flow periods (7 to 16 gates open), aquatic organisms as well as incubating fish eggs are subjected to extreme velocities and are washed away.

This is a request to have alternatives developed for the hydropower Feasibility Study that would enhance the flow of water over the St. Marys Rapids area for the purpose of increasing the fishery value of the Rapids toward optimum conditions.

We would appreciate your serious consideration for the development of these alternative solutions. Our East Lansing Field Office will be pleased to provide you and your staff with any assistance they can in this effort. Should you or your staff have questions, please contact Mr. T. J. Miller (FTS 374-6649).

Sincerely yours,

John Popowski

Area Manager

MICHIGAN DEPARTMENT OF STATE
RICHARD H. AUSTIN SECRETARY OF STATE

LANSING
MICHIGAN 48918

MICHIGAN HISTORY DIVISION
ADMINISTRATION, ARCHIVES, HISTORIC SITES, AND PUBLICATIONS
3423 N. Logan Street
517-373-0510
STATE MUSEUM
505 N. Washington Avenue
517-373-0515

June 9, 1980

Colonel Robert V. Vermillion
Department of the Army
Detroit District
Corps of Engineers
P. O. Box 1027
Detroit, Michigan 48231

In reply refer to: ER-4209
Hydropower Redevelopment
at Sault Ste. Marie, MI

Dear Col. Vermillion:

More detailed information on the location of the project is necessary before a determination can be made as to whether or not this project will affect archaeologically, historically, or architecturally significant sites. Please send maps, a brief description of the project, and photographs of any existing building which will be altered or demolished as a result of this project.

Sincerely yours,

Donald E. Weston

Donald E. Weston
Environmental Review Officer
Michigan History Division

DEW/sl

INTERNATIONAL JOINT COMMISSION
UNITED STATES AND CANADA
WASHINGTON, D. C. 20440

CHAIRMAN
UNITED STATES
SECTION

June 16, 1980

Col. Robert V. Vermillion
Detroit District, Corps of Engineers
Box 1027
Detroit, Michigan 48231

Dear Col. Vermillion:

Thanks for your letter of May 21, 1980 regarding the redevelopment of the existing power facilities in U. S. waters at Sault Ste. Marie, Michigan.

I have referred your letter to the Commission and you will be further advised as appropriate.

Sincerely,

Robert J. Sugarman

RJS:ejw

cc: Commissioners

Windsor Station Montreal Quebec H3C 3E4
Tel (514) 395-7032

CP Rail

Office of the
Chief Engineer
J Fox

J S Smith

July 8, 1980 6-334-00

Department of the Army
Corps of Engineers
Sault Ste. Marie
Michigan 49783

Attention: Mr. James M. Bray
Area Engineer

Re: Sault Ste. Marie Railway Bridges

Dear Sir:

Further to the informal meeting in your office on June 12, 1980 between yourself and Canadian Pacific representatives, attached are copies of our preliminary plan no. B-1-3492-1 dated July 8, 1980 showing the proposed work.

Due to the age and condition of the various structures under the jurisdiction of the Sault Ste. Marie Bridge Company, reconstruction and repairs are being investigated as shown.

Reconstruction of the International Bridge, Mile 134.06, appears to be the most problematical as it spans the international boundary.

Two alternatives are being evaluated at this time. Alternative 1, through trusses, would obviate any new substructure construction, and Alternative 2, ballasted deck spans, would necessitate new piers.

As you are presently evaluating energy requirements in this area, we would like you to consider also the influence of the possible bridge reconstruction program.

I would appreciate your comments on the preliminary plan, particularly regarding choice of Alternatives 1 or 2 for the International Bridge replacement. When our study is complete, Canadian Pacific will take all steps to obtain the necessary approvals from all bodies having jurisdiction.

Yours truly,

Chief Engineer
encl. FOR

INTERNATIONAL JOINT COMMISSION
UNITED STATES AND CANADA
WASHINGTON, D.C. 20440

August 11, 1980

Robert V. Vermillion
Colonel, Corps of Engineers
District Engineer
Department of the Army
Detroit District
Box 1027
Detroit, Michigan 48231

Dear Colonel Vemillion:

Thank you for your letter of May 21, 1980, to Chairman Sugarman regarding the feasibility study on hydropower redevelopment at Sault Ste. Marie, Michigan

The Commission would appreciate being provided with information regarding the study as it becomes available and trusts that any matters requiring Commission action will be initiated by the United States Government in a timely fashion.

Sincerely,

David LaRoche

David A. LaRoche
Secretary
United States Section

cc:
Wingate Lloyd, Department of State

DEPARTMENT OF THE ARMY

DETROIT DISTRICT CORPS OF ENGINEERS

PUBLIC WORKSHOP

WALKER CISLER COLLEGE CENTER

LAKE SUPERIOR STATE COLLEGE

AUGUST 21, 1980

STATEMENT

OF

EDISON SAULT ELECTRIC COMPANY

STATEMENT

OF

EDISON SAULT ELECTRIC COMPANY

Edison Sault Electric Company, responsive to the Notice in the above matter published July 18, 1980, respectfully submits its Statement in relation to Hydro Power Redevelopment of Existing Hydroelectric Power Facilities in the St. Marys River.

Our Statement will, of course, be generalized and will be basically historical, factual and the legal position of Edison Sault Electric Company and possible financial aspects upon the shareholders and customers of Edison Sault Electric Company by any redevelopment.

HISTORICAL AND LEGISLATIVE

(1) Edison Sault Electric Company is an electric public utility organized under the laws of the State of Michigan in 1892. It serves the Eastern Upper Peninsula, in the Counties of Chippewa, Mackinac and Schoolcraft. Edison Sault has used for a valuable consideration, paid to the United States, the surplus waters of the St. Marys River for the generation of electric energy.

(2) Edison Sault constructed the first hydroelectric facility in 1906 on the St. Marys River, which plant was located at or about the site of the present United States facility at the St. Marys Falls Canal.

(3) Section 11 of the Rivers and Harbors Act of 1909, authorized the Government of the United States to obtain by purchase or condemnation, all lands and riparian rights lying north of the St. Marys Falls Canal.

(4) Pursuant to said legislation, condemnation proceedings were

instituted by the United States. In accordance with the Stipulation, the Edison Sault facility was acquired by the United States and as a part of the Stipulation, the facility was leased by the Government to Edison Sault for a period of 30 years. This lease was extended by short term extensions to 1951. See US vs Chandler Dunbar 229 US 53.

(5) Pursuant to Section 2 of an Act of Congress, approved March 2, 1945, Public Law 14, the present hydroelectric plant at the St. Marys Falls Canal was constructed and Edison Sault entered into Contract DA-20-064-ENG-632, dated November 1, 1951, purchasing the output of the facility, less lock use and subject to delivery of power to the United States and preference customers. This lease was extended by Supplemental Agreement Number Four to June 1, 1980.

(6) By Supplemental Agreement Number Eight, the tenure of Contract DA-20-064-ENG-632 was extended to June 1, 2000, subject to certain modifications.

C O N T R A C T DA-20-064-ENG-632

(1) The Michigan Lake Superior Power Company constructed the present hydroelectric facility located in Sault Ste. Marie, Michigan, in 1902, presently owned by Edison Sault. The International Joint Commission entered its Order of Approval for its construction and operation, May 26, 1914.

(2) Michigan Northern Power Company, successor to the Michigan Lake Superior Power Company, entered into a lease with the Secretary of War, dated May 28, 1914, with the right to divert the surplus waters of the St. Marys River for the operation of this facility.

(3) This lease was renegotiated pursuant to Section 2 of an Act of Congress, approved March 2, 1945, with a term from July 1, 1950 to

June 1, 1980, with Carbide Power Company, successor to Michigan Northern Power Company.

(4) Edison Sault Electric Company purchased for a valuable consideration, this hydroelectric facility, May 3, 1963, from Carbide Power Company and succeeded to its rights under Contract DA-20-064-ENG-88 by Novation Agreement, approved by the Secretary of Army, May 3, 1963, being Supplemental Agreement Number Four. Edison Sault converted the plant from 25-cycle power to 60-cycle power, incurring a large capital investment for this purchase and conversion of approximately $3 million.

(5) Edison Sault Electric Company, in its own behalf and in behalf of the City of Sault Ste. Marie, Michigan, filed an Application with the Secretary of Army, February 20, 1969, for an Extension of Contract DA-20-064-ENG-88 to June 30, 2000. The Application, as it related to the City of Sault Ste. Marie, is fully described in the Application on Page 12, and a copy of the Application, without exhibits, is hereto attached and marked EXHIBIT "A".

(6) Under date of June 30, 1970, the Secretary of Army granted the extension requested but as a condition of said extension, it was specifically recited that Edison Sault enter into a contract with Cloverland Electric Cooperative agreeing to furnish Cloverland Electric Cooperative with energy from Edison Sault's hydro plant, operated with the surplus waters of the St. Marys River. The plants output and expenses are being shared between Edison Sault and Cloverland Electric, effective July 1, 1980. This contract is marked EXHIBIT "B" and is hereto attached.

(7) Edison Sault, as a consideration for the extension of Contract DA-20-064-ENG-88, entered into an Agreement with the City of Sault Ste. Marie, Michigan, to assist them with an annual payment for the balance

of the lease to reconstruct its existing bridges. These matters are all fully covered in a letter to Mr. Philip McCallister, Chief, Engineering Division, Department of the Army, Detroit District, Corps of Engineers, under date of May 22, 1980, together with the attachments referred to in said letter which are self-explanatory. Said letter is attached as EXHIBIT "C".

(8) Edison Sault has a firm contract with the Secretary of Army for the use of the surplus waters of the St. Marys River for its facility as provided for in Contract DA-20-064-ENG-88 for a full term to June 30, 2000, all as set forth in a letter to Philip McCallister, under date of May 22, 1980, hereinbefore referred to.

(9) Edison Sault owns its canal, intake, and hydro generating plant for which it paid a substantial consideration and is the fee owner of said property and which said facility is entitled under its contract with the Secretary of Army, being Contract DA-20-064-ENG-88, to use the surplus waters of the St. Marys River until June 30, 2000, and is a valuable asset of the Company and which contributes a substantial portion of the energy used to serve its customers.

(10) As Edison Sault has previously advised the Corps of Engineers under date of May 22, 1980, we will and have fully cooperated in this study. Provided, however, Edison Sault has an obligation to its customers and shareholders to fully protect the integrity of Contract DA-20-064-ENG-88 and its viability as a public utility furnishing reliable electric service.

Edison Sault has, by its commitments to Cloverland Electric Cooperative, Inc. and the City of Sault Ste. Marie, Michigan, as hereinbefore set forth, made substantial concessions for said extension of Contract

DA-20-064-ENG-88 to June 30, 2000 for the use of the surplus waters of the St. Marys River for the operation of its hydroelectric facility, and its Contract DA-20-064-ENG-88 is a firm contract with the United States.

SUMMARY OF EDISON SAULT ELECTRIC COMPANY'S RELATIONSHIP WITH CLOVERLAND ELECTRIC COOPERATIVE

Edison Sault Electric Company and Cloverland Electric Cooperative have a long history of working together, particularly in the area of power supply, to the benefit of the customers of both utilities. This history dates back to the very beginning of the cooperative in 1938 and has continued through to the present. There has been a regular exchange of information, projected load growth and future power and transmission requirements. The utilities share in the output of both the U. S. Government and Edison Sault hydroelectric plants located on the St. Marys River. Other sources of power from the Edison Sault tie to Consumers Power via submarine cable across the Straits of Mackinac and from diesel generating plants owned by each of the parties are utilized by both in the most efficient and economical manner possible.

This close relationship has led to a Transmission Coordination Agreement between the two utilities which was dated May 1, 1977. The joint construction of 46 miles of 138 KV line from the Straits to Engadine is slated for completion in the fall of 1981. The transmission facilities of either party may be used by the other for serving its loads at no cost for wheeling following completion of the new transmission line. Due to this arrangement duplication of facilities is eliminated and reduced costs are experienced by the customers. It is the intent of both Cloverland Electric and Edison Sault to continue the close cooperation of the past into the future.

ELECTRIC ENERGY SOURCES

The sources of energy used in the Edison Sault and Cloverland Electric system for 1979 and the relative cost per kilowatt-hour are recapped below:

	YEAR 1979 Energy Received (KWH)	YEAR 1979 Average Cost per 1979 KWH
Hydro Sources		
Company Plant	246,883	0.32¢
U. S. Corps of Engr. Plant	146,065	0.53
Total Hydro	392,948	0.40
Other Sources		
Consumers Power Company	105,379	2.76
Cloverland Elec. Coop.	8,829	4.40
Diesel Plants	2,779	5.50
Total Other	116,987	2.93
System Total	509,935	9.98¢

WATER AVAILABLE FOR POWER USE

As most people are aware, the water available for power use on the American side of the St. Marys River will decrease with the completion of the new Canadian hydro plant.

In 1979, Stone and Webster Management Consultants, Inc. performed for Edison Sault Electric Company a study of its hydroelectric operation to determine the impact of the expansion of the Canadian hydro plant on Edison Sault and to examine how the Edison Sault and U. S. Government plant might be operated after the completion of the Canadian expansion. A copy of this study was presented to Mr. Jakovich of the U. S. Corps of Engineers in May of 1980.

The study compared the additional power costs required due to the Canadian expansion, assuming a four-gate opening as outlined in the "Plan of 1977" and also a one-half gate opening. In the study, the general structure of the Consumers Power purchased power rate was maintained with demand rates examined to escalate 12% annually starting in 1981 and to reach about $14.50 per KW in 1990. Energy costs escalated at 10% annually and were projected to reach 4.3¢ per KWH in 1990.

The study concluded that the major impact of the Canadian hydro expansion will be an increased purchased power expense and a reduction in the total energy generated at the Edison Sault plant. Increased power costs will range from $600,000 to $1,600,000 in 1981, depending upon the number of gates opened. It will increase from $1,300,000 to $3,300,000 in 1990.

In summary, water availability is one of the keys to power economics. Edison Sault's present plans assumes the International Joint Commission utilizing the "Plan of 1977" with four compensating gates open at all times.

In a like manner, the economics of any new proposed hydro development will also depend upon assumptions for water available for power purchases compared to water passed through the St. Marys Rapids.

GENERAL IMPACT OF EXPANDED HYDRO CAPACITY UPON PURCHASED POWER COSTS

The following data is meant solely to be illustrative and does not represent the firm projection of Edison Sault Electric Company. It is proposed to show that there can be significant savings associated with increased hydro capacity. These savings must then be compared to the capital cost of the project and the cost of operation and amortization of capital costs.

Under Alternative 2. (a), Extending the U. S. Government Plant and Discontinuing the ESELCO Plant, one can develop a range of increased hydro capacity in the area of 7 to 12 megawatts for illustrative purposes. The data below assumes increased hydro capacity of 11 megawatts, which operating at 100% load factor, will increase annual energy into the system by approximately 96,000,000 KWHS. The table below reflects an example of the possible savings involved under present rates of purchased power and those projected in 1990 in the Stone and Webster Report of 1979:

Year	Demand (Per KW)	Annual Demand Savings 11,000 KW	Average Energy (Per KWHS)	Annual Energy Savings 96,000,000 KWHS	Savings Total
Rates effective 10/1/80	$ 8.00	$1,056,000	2.48¢	$2,095,000	$3,151,000
1990	14.50	1,914,000	4.3¢	4,128,000	6,042,000

REDEVELOPMENT OF EDISON SAULT HYDRO PLANT

Edison Sault Electric Company has already considered the redevelopment of its present hydroelectric power plant, assuming no change in the canal configuration. This study was performed by Stone and Webster Engineering Corporation under date of September 2, 1979. It was a preliminary engineering study to see if more detailed plans should be developed. The conclusion from the study was that the investment required could not be justified in terms of savings in power costs. In other words, the increase in power output was minimal compared to the cost of investment. In considering our cost of making such an investment, annual fixed charges were assigned at 20%, which includes depreciation, cost of capital including the necessary revenue requirements to pay Federal Income Taxes and insurance. A copy of this study has been presented to Mr. Jakovich of the U. S. Corps of Engineers.

SUMMARY OF SIGNIFICANT ISSUES

Edison Sault Electric Company, therefore, feels the significant issues as outlined in detail in this statement are as follows:

(1) Protecting the integrity of Contracts DA-20-064-ENG-632 and DA-20-064-ENG-88 and to be assured that the interest of its shareholders and customers are considered at all times. This is evidenced by a resolution, adopted by its Board of Directors on August 18, 1980, EXHIBIT "D" attached.

(2) The determination of water available and its effect on power costs in accordance with International Joint Commission Rules and Regulations.

Other issues which are not directly a responsibility of the U. S. Corps of Engineers but which Edison Sault can be greatly assisted by if this project proceeds to reality are as follows:

(1) Jurisdiction of the Michigan Public Service Commission over the setting of power rates. Consideration of costs versus savings in the short run versus the long run.

(2) Assimilation of present working force involved in the hydro plant operation through employee attrition and retraining for other jobs in the Company. The more definite the construction timetable and the more advanced notice that is received will allow Edison Sault Electric Company to accomplish this objective.

Respectfully submitted,

EDISON SAULT ELECTRIC COMPANY

By
WILLIAM R. GREGORY
President

By
ROBERT C. KLINE, JR.
General Counsel

WRG/RCK:jmm

Attachments

INDEX OF EXHIBITS

EDISON SAULT ELECTRIC COMPANY

906-632-2221

EDISON BUILDING
SAULT STE. MARIE
MICHIGAN 49783

February 20, 1969

The Honorable Stanley R. Resor
Secretary of the Army
Washington, D. C.

Dear Sir:

Edison Sault Electric Company, a Corporation organized and existing under the laws of the State of Michigan, on May 29, 1963, purchased from Carbide Power Company, successor to Michigan Northern Power Company (both Carbide Power and Michigan Northern Power Companies were wholly owned subsidiaries of Union Carbide Company), a water power canal and hydroelectric plant in Sault Ste. Marie, Michigan. The water for the operation of said canal and hydroelectric plant is obtained by diverting the waters of the St. Marys River at a point immediately northwest of the United States St. Marys Falls Canal, into Edison Sault Electric Company water power canal which traverses the heart of the City of Sault Ste. Marie for approximately two miles to the location of Edison Sault Electric Company's Hydroelectric Plant at which point the water is returned to the St. Marys River.

The diversion and use of said water is authorized by a certain lease executed by the Secretary of the Army for and in behalf of the United States of America, as Lessor and Carbide Power Company as Lessee, under date of June 22, 1950, being designated as "Contract Number DA-20-064-ENG-88".

Edison Sault Electric Company succeeded to the position of Carbide Power Company as Lessee under said "Contract Number DA-20-064-ENG-88" by and with the consent of the Secretary of the Army by virtue of a Novation Agreement approved by the Secretary of the Army May 3, 1963, and formally described as Supplemental Agreement No. Four to Contract DA-20-064-ENG-88.

Contract Number DA-20-064-ENG-88 was negotiated and executed pursuant to Section 2 of an Act of Congress, approved March 2, 1945, (Public Law 14-79th Congress) entitled "An Act Authorizing the Constitution Preservation of Certain Public Works on Rivers and Harbors, and for other Purposes", authorizing the Secretary of War to lease any

EXHIBIT "A"

surplus water available to the United States of America in the St. Marys River, which was not required for the operation of facilities owned by the United States, upon such terms and conditions as he should determine. The term of said lease is thirty (30) years commencing July 1, 1950 and terminating June 30, 1980. The lease has a present unexpired tenure of eleven years from and after June 30, 1969.

There are four supplemental agreements to said lease. A copy of said Contract DA-20-064-ENG-88, Supplemental Agreement Number 1, Supplemental Agreement Number 2, Supplemental Agreement Number 3 and Supplemental Agreement Number 4, are hereto attached and respectively marked Exhibits, A, B, C, D, and E respectively.

The surplus waters of the St. Marys River have been diverted into Edison Sault Electric Company's power canal for the operation of its hydroelectric plant for the generation of electric energy since May 29, 1963, and continuously by its predecessors since 1902 by and with the authorization and consent of the United States Government.

The said water power canal and hydroelectric plant has a capability of 30,000 kw at average head of 18.2 feet. These facilities have since May 29, 1963 constituted our base generating facility and without which we would not be able to serve our present connected load.

Edison Sault Electric Company, at the time of its purchase in 1963, was fully cognizant that the surplus water lease possessed a remaining tenure of seventeen years. However, Edison was also cognizant that the facilities so purchased has used the surplus waters of the St. Marys River for a period in excess of sixty years since 1902.

Edison Sault Electric Company, in accordance with standard utility practice has projected its system loads for a period inclusive of June 30, 1980. Which said forecast defines the need for the continued operation of said facility beyond said period in order to serve the Eastern Upper Peninsula of Michigan. Therefore, in order to provide for adequate power facilities to meet its projected system demands, and in accordance with standard utility practice for long range planning for power generation requirements, Edison Sault Electric Company respectfully requests that Contract DA-20-064-ENG-88 be extended for a period of nineteen years from and after June 30, 1980 which said extension would constitute a firm period of 30 years from and after June 30, 1969.

Edison Sault Electric Company's request is submitted at this time in its own behalf but said request is also precipitated at this time by the request of the City of Sault Ste. Marie, Michigan, for the reasons set forth in the "Statement of Matters Relevant to the

Application of Edison Sault Electric Company For An Extension of Contract DA-20-064-ENG-88" hereto attached and made a part hereof under the heading, "City of Sault Ste. Marie Power Canal Bridges."

Respectfully submitted,

EDISON SAULT ELECTRIC COMPANY

By

Robert C. Kline, Jr.
Vice Chairman of
Board of Directors

STATEMENT OF MATTERS RELEVANT
TO THE APPLICATION OF EDISON SAULT ELECTRIC
COMPANY FOR AN EXTENSION OF
CONTRACT DA-20-064-ENG-88

HISTORICAL and DESCRIPTIVE

1. Edison Sault Electric Company is a corporation organized and existing under the laws of the State of Michigan. It is a public utility principally engaged in the generation, transmission, and distribution of electric energy to the public.

Edison Sault Electric Company was organized in 1892 and has continuously served the Eastern Upper Peninsula of Michigan for a period in excess of 76 years. The Edison Sault Electric Company serves the Counties of Chippewa, Mackinac, and Schoolcraft and the principal cities of Sault Ste. Marie, St. Ignace, Manistique and Mackinac Island. It serves approximately 13,000 customers. A map of its territory is hereto attached and marked Exhibit F.

Edison Sault Electric Company has been engaged in the use of surplus water of the St. Marys River for the generation of electric energy since 1892. It constructed the first hydroelectric plant on the St. Marys River, which plant was on the site of the present United States Government Hydroelectric Plant. The Edison Sault Electric Company plant was acquired by the United States Government by condemnation proceedings instituted in 1909. See United States vs. Chandler-Dunbar Water Power Company, 229 US 53, 57 L.Ed 1063. Thereafter Edison Sault Electric Company leased the plant from the United States Government until 1951. Edison now purchases the entire output of the United States St. Marys Falls Canal Hydroelectric Plant less lock use and makes power delivery to the United

States and preference customers at switchboard costs pursuant to Contract Number DA-20-064-ENG-632. The contractual relationship between Edison Sault Electric Company and the United States of America has extended over a period of 56 years.

2. Construction of the water power canal now owned by Edison Sault Electric Company was commenced by the St. Mary's Falls Water Power Company in 1887 and completed by the Michigan Lake Superior Power Company in 1903.

St. Mary's Falls Water Company and Michigan Lake Superior Power Company were incorporated under Act No. 39 P. Acts of Michigan 1883, which said act specifically authorized the incorporation of power companies for the purpose of the development of electric energy through the diversion of waters from Lake Superior and the St. Marys River.

3. Under the Rivers and Harbors Act of June 13, 1902, the Michigan Lake Superior Company, its successors and assigns, after first obtaining the consent of the Secretary of the War and the Chief of Engineers was authorized:

> "xx to divert water from the St. Mary's River into its power canal now being constructed at Sault Sainte Marie, Michigan, for water power purposes while and so long as such works and diversion of water from said river shall not injuriously affect navigation therein, nor impair or diminish the water levels or any natural increase thereof either in Lake Superior or in the United States Ship Canal and locks on the navigable channels, locks or ship canals connected therewith, whether natural or artificial, now existing on which may hereafter be established or created by the United States for navigation purposes."

It is obvious from the foregoing language of the 1902 legislation that the primary concern of the Congress was the protection and development unimpeded, of the rights of navigation upon the navigable bodies of the Great Lakes and the connecting waters of the St. Marys River.

4. The plans of the Michigan Lake Superior Power Company were submitted as required and approved by Elihu Root, then Secretary of War, December 12, 1902.

The Rivers and Harbors Act, approved March 3, 1909 amended the Rivers and Harbors Act of 1902 relating to the St. Marys River, authorizing the Secretary of War to lease the surplus waters of the St. Marys River not necessary for navigation and the operation of Government facilities.

A lease pursuant to said legislation was executed by the Secretary of War to Michigan Northern Power Company, successor to Michigan Lake Superior Power Company for a period commencing June 1, 1914 and terminating June 30, 1944. This lease was extended to June 30, 1950 by various extension agreements.

5. Pursuant to Section 2 of an Act of Congress, approved March 2, 1945 (Public Law 14 - 79th Congress) which provided in part as follows:

> "xxx and any surplus water available to the United States may be leased by the Secretary of War upon such terms and conditions as he shall determine."

The Secretary of War executed a lease of said surplus waters to Michigan Northern Power Company for a period commencing July 1, 1950 and terminating June 30, 1980, pursuant to said Public Law 14 - 79th Congress.

6. Michigan Northern Power Company, was a wholly owned subsidiary of Union Carbide Company, and all of its rights under said lease were duly assigned to Carbide Power Company, a Michigan Corporation, and a wholly owned subsidiary of Union Carbide Company in 1951.

7. Edison Sault Electric Company purchased said Power Canal and Hydroelectric Plant from Carbide Power Company and received an assignment of Contract DA-20-064-ENG-88, by and with the consent of the Secretary of the Army, executed May 12, 1963. Edison Sault

Electric Company has been the Lessee thereunder since said date.

Contract DA-20-064-ENG-88

1. As will be observed from the foregoing, the diversion of the surplus waters of the St. Marys River, subject to the priority of navigation and the use of said waters required for the operation of facilities of the United States Government, into the Power Canal at Sault Ste. Marie, Michigan, and the return of said waters to the St. Marys River at Edison Sault Electric Company's Hydroelectric Plant, has been a continuous operation since 1902, a period of 66 years.

2. Contract DA-20-064-ENG-88 contains provisions for the benefit of the United States:

A. Section 2 specifically provides for the complete reservation of all water necessary from time to time for navigation and the operation of Government facilities to the extent that all water may be used for such purposes even during the tenure of the lease; to wit.

> "SECTION 2 - It is mutually understood and agreed that this lease is made subject to the riparian rights of the lessor and to the rights of any lessee or lessees under any lease or leases for water power already made by the lessor and to any rules and regulations established or recommended by any International Commission that have or shall become operative, and is expressly subject to the right of the lessor to use all the water in the Saint Marys River for navigation and to the right of the lessor to diminish at any time and for any period of time and by any amount the quantity of water available for the use of the lessee for power purposes whenever, in the opinion of the lessor, the regulation of the level of Lake Superior or of the flow of the Saint Marys River in the interest of navigation or the requirements for the operation of facilities now owned by the lessor or presently authorized by law make necessary such diminution, and the lessee shall neither assert nor make any claim for damages as against the lessor by reason of any such diminution made for such cause."

B. Subsection (6) of Section 5 as amended by Supplemental Agreement Number 1 and as further amended by Supplemental Agreement Number 2, provides for the furnishing by the Lessee to the United States of America of emergency break-down power to a miximum of 5,000 kilowatts in the event of a break-down in the United States St. Marys Falls Hydroelectric Plant and for "low-head" condition. This is of fundamental importance for the operation of the United States St. Marys Falls Locks, and defense establishments being Kincheloe Air Force Base, 753rd Radar Squadron, Raco Air Force Missile Base, and the United States Coast Guard.

Subsection (b) Section 5 provides:

> "(b) The Lessee agrees that, at such times as any power generating unit in the U. S. Hydro-Electric Power Plant presently under construction or any main feeder cable from said U. S. Hydro-Electric Power Plant is out of services by reason of breakdown, the Lessee will furnish to the Lessor on request, electric power in an amount not to exceed a maximum demand of 5,000 kilowatts, during the period that such power generating unit or main feeder cable is out of service by reason of such breakdown; and the amount of electric power so furnished, up to the above mentioned maximum demand of 5,000 kilowatts is hereinafter referred to as "emergency break-down power." Said emergency break-down power shall be delivered to the Lessor, or to the Lessor's agent, at 4400 volts and a frequency of 60 cycles per second from and at the bus of the Lessee's power plant and shall be metered by the Lessee at said point of delivery.
>
> "The Lessee further agrees that during the period when said emergency breakdown power is being furnished to the Lessor, the Lessee will permit the Lessor or its agent, to make use of such of the lessee's then existing facilities for transmission of electric power as are capable of being used for transmission of 4400 volt - 60 cycle - electric power and are not in use at that time by the Lessee for other purposes, for the purpose of transmitting the said emergency break-down power over the Lessee's property to such point on the boundary of the Lessee's property as may be most advantageous for connection to the transmission facilities of the Lessor or its agent.
>
> "The Lessee further agrees to permit the Lessor or the Lessor's

agent to construct and maintain on the Lessee's land any and all transmission lines and supporting structures necessary for taking and transmission of said emergency break-down power."

C. Since 1902 the Lessee of the surplus waters of the St. Marys River have maintained and operated the existing compensating works in the rapids of the St. Marys River for and in behalf of and at the direction of the United States, to wit:

"Section 10 - It is mutually agreed that the lessee will maintain and operate the existing compensating works in the rapids of the said Saint Marys River in such manner as the said lessor shall consider necessary to comply with any order of approval of and with any rules promulgated by any International Commission for the regulation of the flow of said river and of the level of Lake Superior and for the safety and benefit of navigation; that in case it be found necessary to alter or modify in any way and for any reason the said existing compensating works, upon demand of the lessor, the lessee shall furnish such labor and material as may be required and shall make such alterations or modifications, the lessee to have the right to reimburse itself for the cost and expense of such work in the manner hereinafter provided; that upon the demand of the lessor the lessee shall, under the supervision of the lessor, furnish such labor and supplies and do such further work in connection with the construction, maintenance, operation and repair of the said compensating works as the lessor shall direct from time to time, and in such event, the lessee shall have the right to reimburse itself for the cost and expense of all such work in the manner hereinafter provided, to wit: For the purpose of reimbursing itself for the payments made to cover the cost and expense incurred in connection with the construction, operation, maintenance and repair or alterations or modifications (if required) of the said compensating works as above specified, the lessee shall retain water rentals hereunder as they accrue from time to time, on and after the 1st day of July 1950; provided, that the lessee shall so reimburse itself only insofar as such costs and expenses, approved by the lessor, have been actually incurred and paid for by the lessee and provided further that the extent of such alterations or modifications during any one calendar year shall be limited in cost to the amount of anticipated water rentals for the ensuing twelve month period. And the lessor hereby grants to the lessee the right of ingress, egress, and regress over any of its lands and structures in the vicinity of the rapids of the Saint Marys River as in the opinion of the lessor may be reasonably necessary for the economical and convenient construction, maintenance, operation and repair or alterations or modifications of the said compensating works."

D. The Edison Sault Electric Company pays to the United States of America $100,000.00 per year for such surplus water as it receives, to wit:

> "Section 6 - From and after the effective date hereof the Lessee shall pay to the Lessor as rental for all water taken the sum of $100,000 per year payable in equal monthly installments on or before the 15th day of each month, subject nevertheless to the provisions herein made in Section 10 for deductions and reimbursements from the rental hereunder. No reduction in rental will be allowed by reason of the reduction in the quantity of water available to the Lessee as provided in Section 4 above, except that reimbursement will be made when the mean rate of flow available to the Lessee is less than 18,500 c.f s. throughout any period consisting of 12 consecutive months or more. The adjusted rental for such period or periods will be that proportion of $100,000 per annum which the average of the mean monthly rate of flow throughout the period bears to 18,500. The period shall commence with the first day of the month in which the mean monthly rate of flow is reduced below 18.500 c.f.s. The period shall end on the last day of the 12th month thereafter or on the last day of any succeeding month at the option of the Lessee. Such periods may include intervals during which the mean monthly rate of flow available to the Lessee exceeds 18,500 c.f.s. The computation for the adjusted rentals shall be based upon an average of the mean rate of flow for the entire period based on monthly flow records."

We again emphasize that the Acts of Congress approved March 2, 1945, in no manner limits the Secretary of War. now Secretary of the Army, as to the tenure of any lease, and under the existing legislation the Secretary of the Army does have legislative authority to extend the said contract DA-20-064-ENG-88 for a period of 19 years from and after June 30, 1980.

<u>Land and River Regulation</u>

The discharge capacity of Edison Sault Electric Company's power canal is half the total discharge capacity on the United States side of the boundary. The proper regulation of the levels of Lake Superior and of St. Marys River depends on the discharge of this canal.

By consulting the attached map (Exhibit G), it will be seen that this canal is in the best location to serve the purpose of such regulation. Without this canal, as located, the large amount of water now by-passed around the lock system by said canal would have to flow across the entrance to the navigation canals, adding greatly to the cross currents with which navigation must contend at the extremity of the northwest pier, shown on the map. Satisfactory regulation of the lake and river levels has been maintained by the present system of power canals and compensating works.

The whole discharge capacity of Edison Sault Electric Company's canal has been included in all estimates of the means of regulating lake and river levels, and its full use for this purpose has been found necessary.

It is thought that the duty of the canal in lake and river regulation and the privilege of using available water to produce power are complementary functions to be considered together in the disposition of the water to be discharged at Sault Ste. Marie and in arriving at the terms and conditions upon which an extension of the lease shall be made.

<u>Present Condition of Hydroelectric Plant and Canal</u>

1. The Edison Sault Electric Company's power canal and hydroelectric turbines and generators as constructed and installed represent good engineering design and practice and are well maintained.

2. In 1963 when the canal and plant were purchased, the generating facilities consisted of the following:

(A.) 55 units - 25-cycle - main shaft

(B.) 7 units - 60-cycle - main shaft

(C.) 2 units - Exciter - main shaft

(D1.) 2 units - 25-cycle - main shaft

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(D2) 2 units - Exciter - extended shaft of D1.

(E1.) 12 units - 25-cycle - main shaft

(E2.) 12 units - 60-cycle - extend shaft of E1.

Total - 92 units 78 on main, 14 on extended shafts

3. Commencing with acquisition on May 29, 1963, the following improvements were made and completed by April 1, 1964, as follows:

1. Removal of the 55 25-cycle units (A) and replacement with 55 new 60-cycle 650 kva units.

2. Edison Sault has removed the windings of the 14 25-cycle generating units on main shafts (D1 and E1) and ultimately will remove them; and in their position on the main shaft place the two exciters (D2) and 12 60-cycle units (E2).

3. No. 42 Exciter (C) and Nos. 75, 78, 79 and 80 60-cycle units (B) were completely rewound.

4. Additionally, the Company has fabricated and installed a new style of trash rack in 1968 for that half of the hydro plant east of the spillway. The west half of the plant will likewise be refitted.

This consists of individual turbine protection by steel grids positioned over turbine gate openings, and will enable the complete removal of the existing trash rack structure at the entrance to the canal forebay, the recovery of approximately 6 inches loss of head that results therefrom, and an easier and more complete removal of trash and debris entering the canal.

5. Since the acquisition of the power canal, the Company has expended upon the canal in excess of $500,000 in order to maintain and improve the flow to make optimum use

of the water.

6. The Company by its improvements and its operation of the plant as a part of an intergrated public utility system has operated the plant at full capacity twenty-four hours per day thus obtaining the maximum use of the water. The Company uses said plant as its base load generation facility.

7. The Company in accordance with standard and good utility practice intends to continue improvement of the plant and canal and would be in a position to expend more funds in improvements on a tenure of its lease for 30 years rather than on an unexpired 11 years.

SERVICE TERRITORY AND CONNECTED LOAD

1. Edison Sault Electric Company serves 13,000 customers in the Counties of Chippewa, Mackinac, and Schoolcraft. The principal cities of Sault Ste. Marie, St. Ignace, Mackinac Island and Manistique. See Exhibit F.

2. Edison serves the principal industries in the area being the Manistique Pulp and Paper Company, Michigan Limestone Company, at Cedarville, and the Lakehead Pipeline Company.

3. Edison serves all government and military establishments in the area being United States Coast Guard, Kincheloe Air Force Base, 753rd Radar Squadron and Raco Missile Site.

4. Edison Sault Electric Company, in 1968, had a peak demand of 60,000 kw. Its projected connected load for the year 1980 will create a demand of 109,482 kw. We presently have dependable generating capacity or power supply as follows:

United States Hydroelectric Plant	15,000 KW
Edison Hydroelectric Plant	27,500 KW
St. Ignace Diesel Plant	3,000 KW

Manistique Diesel Plant	2,000 KW
Mackinac Island Diesel Plant	1,000 KW
Cloverland REA Diesel Plant	9,000 KW
Consumers Power Co. Straits of Mackinac Interconnection	30,000 KW
	87,500 KW

Therefore, it will be readily apparent that the continued operation of our Hydroelectric Plant is essential. In addition, the Company will have to acquire additional base and reserve generating facilities. In the determination of the capacity to be acquired or constructed, the decision on this application is of critical importance.

5. In addition to the customers of Edison Sault Electric Company hereinbefore referred to Cloverland Rural Electric Co-operative has been a customer of Edison Sault Electric Company since its inception.

Cloverland Electric Rural Co-operative is a third party beneficiary to Contract DA-20-064-ENG-632.

In addition, in 1963, at the time Edison Sault Electric Company acquired the Carbide Power Company hydroelectric facility, it entered into a firm agreement to furnish Cloverland Rural Electric Co-operative from this facility 9,000 KW which was then anticipated as one third of the output of said facility for a period of approximately one-third of the remaining life of the water lease. Said contract may be terminated by Edison Sault Electric Company on 24 months notice given at any time subsequent to June 1, 1969.

Edison and Cloverland have now entered into negotiations for an extended contract in the event said contract DA-20-064-ENG-88 is extended. The negotiations are related to a new contract with Cloverland predicated on the full proposed extended term of Contract DA-20-064-ENG-88.

The extension of Contract DA-20-064-ENG-88 will benefit not only Edison but Cloverland Electric Rural Co-operative and their respective customers as well.

ECONOMIC SITUATION

Edison Sault Electric Company, its power canal and Hydroelectric Plant constitutes 22% of the assessed valuation of the City of Sault Ste. Marie, Michigan, in 1968 the Edison Sault Electric Company paid in local taxes to City of Sault Ste. Marie Treasurer $435,142.00. If said extension is not granted, the power canal and hydroelectric plant would possess only salvage value for the reason that without the water they would be valueless and a liability rather then an asset and the City would loose its principal source of assessed and taxable valuation.

Sault Ste. Marie, Michigan is and has been an economically depressed area. It has over the last 15 years lost all of its major industries and major employers occassioning the loss of its industrial tax base. The water power canal and hydroelectric plant are assessed at $5,355,900. This loss of taxable valuation would be disasterous to the City of Sault Ste. Marie, Michigan.

CITY OF SAULT STE. MARIE, MICHIGAN - POWER CANAL BRIDGES

1. We have hereinbefore set forth that the Power Canal completed in 1902 transverses the heart of the City. The canal is approximately 11,200 feet long, 200 feet wide at surface and 23 feet deep. The canal creates an island of the central business district and prohibits industrial development of its waterfront areas. A photograph of the power canal and said bridges is attached as Exhibit I.

2. In order to provide reasonable means of access to and from various sections of the City, the City in 1902 built and constructed 6 steel bridges at the following streets: Ashmun, Bingham, Fort, Johnstone, Portage and Spruce. These bridges were single span and were constructed to accommodate primarily horse drawn vehicles. While they were

adequate in 1902, they were not designed for modern day traffic or for the weight of present motor vehicles and particularly trucks. Their condition has steadily deteriorated and have only limited use.

3. In 1934, the State of Michigan designated Ashmun Street as a part of Highway I-75 Business Spur and replaced the Ashmun Street Bridge. This bridge is maintained by the State of Michigan. It is the only modern bridge in the City and is capable of carrying modern traffic.

4. The City of Sault Ste. Marie recognizing the need to replace the remaining five bridges in order to intergrate the City for development and economic reasons, and for the safety of its inhabitants applied to the Economic Development Administration for funds to redevelop the City through the construction of new bridges.

The City was granted by said Economic Development Administration the sum of $1,254,000 for replacement of the Fort Street Bridge, and Portage Avenue Bridge plus the access roads thereto, and access roads to I-75.

The City, in addition to said Federal allocated funds, required $414,000 additionally for the project and the electors voted upon and approved a 30-year bond issue as a general obligation of the City in said amount.

Attached hereto and marked Exhibit H are copies of articles from the Evening News describing the project.

This will give the City three modern bridges, Ashmun, Fort and Portage. It leaves the City with three bridges of 1902 vintage which are inadequate and unsafe, Bingham, Spruce and Johnstone.

It creates a critical situation for the reason that Bingham Avenue which runs parallel to Ashmun Street, the principal thoroughfare of the City, is essential to a desirable traffic pattern to relieve the congestion from Ashmun Street. Johnstone and Spruce Street Bridges are of importance but Bingham is critical to the redevelopment of the City. If a new bridge at Bingham could be constructed, the Central Section of the City would be adequately served by the three new bridges and the existing Ashmun Street Bridge.

4. The cost of construction of bridges has constantly escalated attributable to the the increase in material and labor costs. The new bridges for Portage and Fort Street will be constructed in 1969. The City determined by advice of their bridge engineers, Steinman, Boynton and Gronquist, that if the Bingham Avenue Bridge could be constructed during the period that the other two bridges were being built and while bridge contractors had their equipment and key personnel in the City, a considerable savings could be effected.

The City, therefore, in July, 1968, filed with the offices of Senator Philip Hart, Senator Robert Griffin and Congressman Philip Ruppe, a memorandum requesting the assistance of their respective offices in obtaining an allocation of a portion of the annual rental paid by Edison Sault Electric Company to the United States of America, pursuant to Contract Number DA-20-064-ENG-88 for a period of thirty years in order to predicate a revenue bond issue thereon in sufficient amount to retire said bond issue for said bridges.

The City recognizing that the unexpired tenure of said Contract Number DA-20-064-ENG-88 was for only a period expiring June 30, 1980 recited in said memorandum the necessity of extending said lease for a period of 19 years to provide a 30 year period upon which to predicate said revenue bond issue. The City further recognized in said memorandum that said extension could be accomplished only by and between the contracting parties, the United States of America and Edison Sault Electric Company.

5. Edison Sault Electric Company at the request of the City of Sault Ste. Marie, agreed to file its application with the Secretary of the Army for an extension of said

Contract DA-20-064-ENG-88 for a period of nineteen years from and after June 30, 1980. Edison realizing the need of the City for said new Bingham Avenue Bridge and the economic advantage to the City to construct said bridge in connection with the Portage Avenue Bridge and Fort Street Bridge.

The extension would create a firm period under lease of thirty years upon which the City could predicate a revenue bond issue supported by funds allocated to the City from the rentals paid by Edison Sault Electric Company in the event enabling legislation is passed by the Congress of the United States or in lieu thereof a binding commitment between Edison Sault Electric Company directly to the City of Sault Ste. Marie of annual funds to assist it in retiring said revenue bond issue, in the event said extension of 19 years is satisfactorily negotiated. This phase of the matter has not been resolved other than an understanding between the Edison Sault Electric Company and the City that in lieu of said legislation, and upon the satisfactory negotiation of said extension, the Company is agreeable to negotiating with the City a legal commitment to make to the City an annual payment of at present an undetermined amount, to assist the City in retiring a revenue bond issue for the construction of Bingham Avenue Bridge over a 30 year period expiring on the date of the extension.

6. While the Company is desirous of an extension of said Contract DA-20-064-ENG-88, its present application is primarily precipated at this time by the need and request of the City of Sault Ste. Marie, Michigan.

AGREEMENT

THIS AGREEMENT made by and between EDISON SAULT ELECTRIC COMPANY, a corporation organized and existing under the Laws of the State of Michigan, with principal offices at 725 East Portage Avenue, Sault Ste. Marie, Michigan, hereinafter termed the "Company," and CLOVERLAND ELECTRIC COOPERATIVE, a corporation organized and existing under the Laws of the State of Michigan, with its principal offices at U. S. Highway #2, Sault Ste. Marie, Michigan, hereinafter termed the "Cooperative."

WHEREAS, Edison Sault Electric Company is operating its hydro-electric plant in the City of Sault Ste. Marie, with water, the rights for which expire on June 30, 1980, under the provisions of Contract #DA-20-064-ENG-88 with the United States Government, and

WHEREAS, the generating capacity of the Edison hydro-electric plant is now absorbed by the customers and members of Edison Sault Electric Company and Cloverland Electric Cooperative (including the Village of Newberry), utilities, whose existing service areas are continguous to the aforementioned water rights, pursuant to a contract between the Company and the Cooperative dated January 27, 1964, terminable by either party upon twenty-four months written notice subsequent to June 1, 1969, and

WHEREAS, said water rights should continue to be shared on a basis equitable to all the ultimate consumers of these systems within the service areas which they presently occupy, and

WHEREAS, the Company has made Application to the Secretary of the Army for an extension of its lease to the aforementioned water rights at its hydro-electric plant for the period from July 1, 1980 to June 30, 2000, with the approval of the Cooperative based upon the understanding herein contained.

NOW, THEREFORE, in the event the water rights associated with the

Company's said hydro-electric plant under the provisions of Contract #DA-20-064-ENG-88 are extended pursuant to and in accordance with the Application of the Company or a modification thereof acceptable to the Company, the parties hereto agree as follows:

1. Contract of January 27, 1964.

The Contract between the parties relating to energy from the said hydro-electric plant of the Company dated January 27, 1964, shall be amended by the deletion of Paragraph 14 of said Contract and a new paragraph 14 as hereinafter set forth, substituted therefor, to-wit:

"14. TERM.
This Agreement shall continue in full force and effect until June 30, 1980."

All other provisions of said Contract of January 27, 1964, shall remain as in said Contract provided.

2. Sharing of Power Associated with Company's Hydro-Electric Plant for Period July 1, 1980 to June 30, 2000.

Effective for the period from July 1, 1980, to the termination of the extension of Contract #DA-20-064-ENG-88 (June 30, 2000) the Company and the Cooperative will share at all times both the generating capability and the energy production of the Company's said hydro-electric plant in Sault Ste. Marie, on a basis equal to the ratio that the maximum demand for each system bears to be sum of the maximum demands of the two systems for the preceding calendar year.

A. The maximum demand of each system in any calendar year shall be defined as the average kilowatt load imposed upon each system in any 15 minute period (or such other period as may be mutually agreed upon from time to time) of said calendar year for which that average is the greatest except that the following demands shall not be included.

(1) Demands created by either system upon the other.

(2) Demands created on either system by the United States Government facilities for which provisions are made in Contract #DA-20-064-ENG-632 or extension thereof, between Edison Sault Electric Company and the United States Government.

(3) Demands created by any other electric utility that may now or in the future be inter-connected with either the "Company" or the "Cooperative" and which said utility is not located wholly within the service area of either system as of the date of this Contract;

Provided, however, the "Company's" demand shall include the full coincidental demand of the Eastern Upper Peninsula Distribution System of Wisconsin-Michigan Power Company and the Cooperative's demand shall include the full coincidental demand of the Village of Newberry.

B. The share of capacity and energy for the Company and the Cooperative under this paragraph will be determined annually on the 1st day of January of each year commencing with the year 1980 except that the first allocation shall be predicated on the maximum demand created during the twelve months ending June 30, 1980, and shall be effective for the period commencing July 1, 1980, and terminate December 31, 1980. Thereafter the share of the Company and Cooperative shall be predicated on the preceding calendar year.

C. The "actual capacity" of said hydro-electric plant shall be the energy generated in any given fifteen minute period, in any given hour, in any given day, less station use.

(1) The "actual capacity" of the said hydro-electric plant at any time the Company is furnishing to the United States of America pursuant to Paragraph 5 (b) of Contract DA-20-064-ENG-88 "low head" or"emergency break down power," shall be reduced by the amount of power so delivered to the United States Government.

3. Delivery of Power from Company to Cooperative and Point of Delivery.

The Company shall make available for delivery to the Cooperative at all times, its pro rata share of energy generated at said hydro-electric plant as determined by Paragraph 2 hereof, and in accordance with its scheduled demand less line losses. (There is attached as a part hereof by way of explanation and interpretation an Exhibit "A" which demonstrates the manner in which power will be shared.)

A. The Company and the Cooperative will each be entitled each month to the energy which is or may be generated by the Edison hydro plant in accordance with the capacity allocation. Neither party's share of the energy shall include any energy taken at any time in excess of that associated with the capacity allocated, less line losses associated with said capacity. In the event that either the Company or the Cooperative do not use the full amount of its energy entitlement, and the other party is able to use said energy for resale to its ultimate consumers, such will be permitted, and the net flows of energy of this type will be offset one against the other with the account settled at the end of each calendar year by payment at a rate equivalent to the then existing dump rate net as defined in the sentence following, or at such other rate as mutually agreed upon. In the event the Cooperative does not use the full amount of its energy entitlement and the Company is unable to utilize the unused portion for sales to its own customers, then the Company may contract to sell the unused portion as "dump" energy, if a market for such exists and will pay the Cooperative for the quantity of its unused entitlement that is so sold at a rate per Kwh equal to the Company's selling price less the Company's costs incurred in such transactions.

B. The point of delivery of all electric energy to be furnished hereunder by the Company to the Cooperative at the present point of Inter-connection of their respective facilities and such point or points as may be established by mutual agreement.

C. All electric energy to be furnished the Cooperative hereunder shall be alternating current three phases, 60 cycle per second at approximately 69,000 volts or as mutually agreed to by the parties.

4. Power Factor, Load Balance and Use of Service.

Under normal operating conditions, transfer of energy hereto will be at lagging power factor of not less than eighty-five per cent (85%) at peak demand. The Company and the Cooperative shall so arrange their circuits and operations as to avoid a three-phase unbalance of more than fifteen per cent (15%) between the low and high phases. The Company and the Cooperative and their consumers shall so use the service as not to disturb and interfere with the other party's service to its other consumers. No type of electrically-operated device causing objectionable operating conditions on the other party's system shall be attached by either party without the consent of the other party.

5. Parallel Operation.

It is contemplated by the Company and the Cooperative that their respective systems will normally be operated in parallel. The Company and the Cooperative agree to install and properly maintain suitable approved protective appliances and devices and to provide sufficient trained personnel to protect its equipment and service and the equipment and services of the other party from injury or interruptions which might be caused by a flow of current to or from the lines of either party, and to assume any loss, liability or damage caused by a lack of such protection.

6. Place of Metering of Energy to be Furnished.

Metering of the energy delivered by the Company to the Cooperative shall take place at such point mutually agreed upon on the Cooperative's system.

7. Metering.

The metering of the electric energy delivered hereunder shall be in accordance with Order Number 1692 of the Michigan Public Service Commission presently in force and as hereinafter amended.

8. Facilities to be Furnished.

A. By the Company:

In addition to its said meters and metering equipment and protective equipment, the Company shall furnish, own and maintain all lines and other facilities necessary for the delivery of electric energy to the Cooperative at the point of delivery.

B. By the Cooperative:

In addition to its protective equipment, the Cooperative shall furnish, own and maintain all lines and other facilities necessary for the receipt of electric energy from the Company at the point of delivery.

9. Maintenance and Operation of Company Hydro-Electric Plant.

The Company shall maintain its said hydro-electric plant and canal in good operating condition at all times, and shall operate the same at the full capacity of the facilities in accordance with the head and flow existing at the time, unless prevented by uncontrollable forces but does not guarantee uninterrupted service, and neither party shall be liable to the other for damages for any act, omission or circumstance occasioned by or in consequence of any Act of God, labor disturbance, act of the public enemy, war, insurrection, riot, fire, storm, or flood, explosion, breakage or accident to machinery or equipment, or by any other cause or causes beyond the other party's control, including any curtailment, order, regulation or restriction imposed by governmental, military or lawfully established civilian authorities.

The Company may remove facilities from service for maintenance repairs, replacements, installations of equipment, investigations, and inspections. The Company will give the Cooperative, except in the cases of emergency, reasonable advance notice of such removal from service. The work necessary to restore the facilities to serviceable condition will be performed with diligence.

The Cooperative agrees that this Agreement in no manner abridges or modifies any of the Company's right, privileges, responsibilities or obligations to unilaterally control its operation and maintenance of its said hydro-electric plant in accordance with accepted utility practice.

10. Cost of Energy to Cooperative.

The Cooperative shall annually reimburse the Company for its pro rata share of the capacity and energy equal to its pro rata share as determined in Paragraph 2 hereof and predicated upon the Company's cost plus a fair return upon the Company's net plant investment and allowance for working capital. Said determination of reimbursable costs shall be made annually on the 1st day of April predicated on the costs of the preceding calendar year. The first determination hereunder shall be predicated on the calendar year 1979 and shall be effective for the period July 1, 1980, to December 31, 1980. Thereafter each determination shall be effective for the calendar year in which the determination is made.

A. The reimbursable costs to the Company shall be and include the following:

(1) The amounts recorded annually upon the books of the Company included in the Company's annual report to the Federal Power Commission on present Form FPC No. 1 in the accounts hereinafter enumerated or such accounts in effect under the Federal Power Commission regulations in substitution thereof then in effect during the period July 1, 1980 to and inclusive June 30, 2000, To-Wit:

535	Operation Supervision & Engineering
536	Water For Power
537	Hydraulic Expenses
538	Electric Expenses
539	Misc. Hydraulic Power Generation Expense
540	Rents
541	Maintenance Supervision & Engineering
542	Maintenance of Structures
543	Maintenance of Reservoirs, Dams & Waterw
544	Maintenance of Electric Plant
545	Maintenance of Misc. Hydraulic Plant

(a) In addition thereto, the annual amount of indirect fringe benefit costs applicable to the payroll costs included in the above accounts determined as follows: The amount recorded on the books of the Company for total payroll costs associated with the hydro-electric plant divided by the amount shown in the report of the Company to the Federal Power Commission under the heading, "Distribution of Salaries and Wages," to determine the percentage thereof, which said percentage shall be applied to the amounts recorded by the Company in Federal Power Commission Report Number 1 included in Accounts 926 and 925.

(2) The annual cost of insurance upon the hydro-electric plant paid by the Company.

(3) Direct payroll costs of office and clerical personnel associated with the annual review and determination of charges as set forth in this Agreement.

(4) A reasonable allocation of Administrative and General Expenses, Accounts 920 - 932, not already allocated in (1) through (3) above.

(5) Depreciation to be determined as follows, To-Wit: The net investment of the Company as of December 31, 1979, amortized over the remaining period of the extended lease and any additional investments in and to said hydro plant capitalized subsequent thereto will be amortized over the remaining life of the extended lease.

(6) The annual amount of State, County, School District and City taxes levied upon the real and personal property associated with the canal and hydro-electric plant, and any future tax or license fee levied by the Federal Government, State of Michigan, or any political subdivision upon said hydro plant or its output or the revenue derived therefrom.

(7) The annual amount paid by the Company to the City of Sault Ste. Marie or any other political subdivision for the right to maintain the canal or relief from any obligations presently provided in any ordinance of the City of Sault Ste. Marie.

B. The Cooperative shall pay to the Company its pro rata share as determined by Paragraph 2 hereof of a fair rate of return as established by the Michigan Public Service Commission in effect December 31, 1979 and thereafter during the tenure of this Agreement on its net plant investment in facilities at the said hydro-electric plant including the canal and allocable general plant and 1/8th of its costs as reflected in Paragraphs (1) through (4) of Subsection A of this paragraph 10 hereof as working capital, together with a proper allowance for Federal and State Income Tax to permit the Company to realize its proper rate of return.

Exhibit B is hereto attached by way of explanation and interpretation of the application of this paragraph using the calendar year 1968 and assuming Contract #DA-20-064-ENG-88 had been extended at this time to June 30, 2000.

11. Delivery Charge to Cooperative.

In addition to the payments required by Paragraph 10 hereof the Cooperative shall annually pay to the Company a reasonable wheeling charge for the facilities of the Company reserved and capable of delivering to the Cooperative its allocation under this Contract from the Company's said hydro plant to the Cooperative's system as described in Subsection B, Paragraph 3 hereof. Said wheeling charge shall be predicated upon the Company's net plant investment in facilities to deliver the energy to the Cooperative which shall be determined by the same formula as is presently applied by the Company to the delivery of energy to the Cooperative of its allocation of power from the United States Government hydro plant pursuant to Contract DA-20-064-ENG-632 and in accordance with the Contract between the Company and the Cooperative dated January 2, 1952.

The wheeling charge will be redetermined annually on or before the 1st day of April of each year. The first determination hereunder shall be predicated on the calendar year 1979 and shall be effective for the period July 1, 1980 to December 31, 1980. Thereafter each determination shall be effective for the calendar year for which the determination is made.

Attached hereto and made a part hereof is Exhibit C by way of explanation and interpretation to demonstrate the effect of this paragraph as if said Contract was effective at the present time.

12. Billing and Payment.

A. The Company shall keep an accurate account of the electric power delivered by the Company to the Cooperative from said hydro-electric plant and furnish the Cooperative a statement on or before the 10th day of each month together with supporting data showing the electric power delivered to the Cooperative during the preceding calendar month.

B. The Company will furnish to the Cooperative on or before the 10th day of each month a statement setting forth 1/12th of the fixed annual charge last determined as set forth in Paragraph 10 hereof and 1/12th of the annual wheeling charge as last determined in Paragraph 11 hereof. Provided, however, that the statement rendered in the Month of April of each year shall reflect any increases or decreases due for the Months of January, February, and March, pursuant to said above referred to paragraphs.

C. All bills shall be paid within twenty (20) days from date of rendering.

13. Records.

The Company agrees to maintain and preserve and make available to the Cooperative upon request, all records and entries in its books in relation to the investment and costs in said hydro-electric plant and records of production of generation.

14. Disputes.

In the event there is a dispute concerning the application and interpretation of Paragraphs 2, 3, 10, or 11, the parties hereto agree that in the event the dispute cannot be resolved by mutual agreement, the matter will be submitted by a joint petition executed by the Company and the Cooperative to the Michigan Public Service Commission and its decision thereon shall be final and binding upon the parties.

15. Governmental Authority.

This Agreement is subject to valid laws, orders, rules and regulations of duly constituted authorities having jurisdiction and is made upon the specific condition that it shall not become effective or binding upon the parties until the Cooperative has received the written approval of this Agreement by the Administrator of the Rural Electrification Administration and the Company and Cooperative are in receipt of an order of the Michigan Public Service Commission authorizing the parties to make the Agreement effective in accordance with its terms and provisions.

16. Term.

This Agreement, subject to the provisions of Paragraph 15, hereof, and the granting by the Secretary of the Army to the Company of an extension of Contract DA-20-064-ENG-88 satisfactory to the Company of the water rights for its hydro-electric plant, shall be effective as of the date of execution and shall continue in full force and effect until June 30, 2000. Provided, however, in the event the Company's gross investment in said hydro-electric plant and canal at any time exceeds $3,500,000 from the date of this Agreement or during its specific tenure, the Cooperative shall have the option to terminate this Agreement as it relates to the period July 1, 1980 to June 30, 2000, upon 12 months written notice to the Company. This Agreement, unless extended by mutual agreement of the parties hereto, shall become null and void if the lease of water rights to the Company has not been granted by December 31, 1971.

17. Successors and Assigns.

This Agreement shall inure to the benefit of and be binding upon the successors and assigns of the respective parties hereto. The Cooperative may assign this Agreement to the United States of America at any time without the consent of the other party. Subject only to this exception, this Agreement shall not be transferred or otherwise alienated by either party without the other party's written consent, which consent shall not unreasonably be withheld.

IN WITNESS WHEREOF, This Agreement has been executed on behalf of the Company and Cooperative by their duly authorized officers as of June 30, 1970.

In Presence Of:	EDISON SAULT ELECTRIC COMPANY
Leonard E. Brawley	By Richard Y. Burnett, President
James P. Hunt	By Stewart T. Moran, Secretary
In Presence Of:	CLOVERLAND ELECTRIC COOPERATIVE
Jack Church	By John Galorowic, President
Jack Holt	By Albert Schopp, Secretary

F-II-50

EXHIBIT "A"

Disposition of Edison Hydro Output for 1968.

Maximum Demands (15 minutes) established during year 1967:

	ESELCO 12/26/67 6:30 P.M.	Cloverland* 10/11/67 8:00 P.M.
Maximum demand (excluding all resale)	47,946	11,160
Plus Wisconsin - Mich. Power Co. (or) Newberry	818	-
Less U. S. Gov't negotiated accounts	8,143	-
Less small Gov't facilities (328.89 ÷ 1.50)	219	-
Net maximum demand applicable on KW	40,402	11,160

*Cloverland's peak as recorded by ESELCO demand meter (Cloverland currently using instantaneous)

Edison Hydro Plant estimated net capability

Cloverland Allocation $= \frac{11,160}{51,562} =$ (21.64%)

ESELCO Allocation $= \frac{40,402}{51,562} =$ (78.36%)

1968	KWH Net Output Edison Hydro	KWH Allocation to Cloverland (21.64%)	KWH (**) System Use by Cloverland	KWH Cloverland Allocation available as dump
January	22,166,256	4,796,778	3,025,760	1,771,081
February	20,308,837	4,394,832	2,886,288	1,508,544
March	21,120,236	4,570,419	2,317,976	2,252,443
April	21,940,756	4,747,980	3,043,887	1,704,093
May	23,705,242	5,129,814	3,197,680	1,932,134
June	24,026,302	5,199,292	3,520,276	1,679,016
July	23,875,192	5,166,592	3,822,276	1,344,316
August	23,584,066	5,103,592	3,692,384	1,411,208
September	23,036,051	4,985,001	3,639,972	1,345,029
October	21,789,600	4,715,269	3,800,276	914,993
November	21,425,600	4,636,500	3,571,176	1,065,324
December	23,839,200	5,158,803	3,225,276	1,933,527
Total 1968	270,817,338	58,604,872	39,743,227	18,861,645

** Does not include Cloverland's allocation from U. S. Hydro

EDISON SAULT ELECTRIC COMPANY

Reimbursable Costs Pursuant to 10 A(1)
1968 Cost of Hydraulic Power Generation

(000) OMITTED

A/C#	----- OPERATIONS --------	Amount
535	Operation Supervision and Engineering	$ 18
536	Water For Water	100
537	Hydraulic Expenses	25
538	Electric Expenses	99
539	Misc. Hydraulic Power Generation Expenses	29
540	Rents	—
		$ 271
	----- MAINTENANCE --------	
541	Maintenance Supervision & Engineering	$ 11
542	Maintenance of Structures	11
543	Maintenance of Reserviors, Dams & Waterways	102
544	Maintenance of Electric Plant	27
545	Maintenance of Misc. Hydraulic Plant	11
		$ 162
	TOTAL OPERATION AND MAINTENANCE OF HYDRAULIC POWER GENERATION PLANT	$ 433

EDISON SAULT ELECTRIC COMPANY

Reimbursable Costs Pursuant to 10 A-1 (a)
Fringe Benefit Costs Associated With
Hydraulic Generation Payroll

(000) OMITTED

		A/C 925 Injuries and Damages	A/C 926 Employee Fringe Benefit	TOTAL
(1)	Total Company	$ 20	$ 142	$ 162
(2)	Payroll Costs of Hydraulic Power Generation:			
	Operation		153	
	Maintenance		59	212
(3)	Payroll Cost of The Edison Company			1,153
(4)	Percentage of Hydraulic Power Generation Payroll Costs to Total Company Payroll Costs			18.4%
(5)	Fringe Benefit Costs Associated With Hydraulic Power Generation Payroll Costs (1) x (4)			$ 30

EDISON SAULT ELECTRIC COMPANY

Reimbursable Costs Pursuant to 10 A (2)
Annual Cost of Insurance Associated With
Hydro Generation Facilities

(1) Liability Policies

Limits	$ 300,000	$ 5,013
Limits	$2,000,000	2,083
Limits	$5,000,000	601
		$ 7,697
	Plant is approximately 20% of total valuation	x 20%
		$ 1,540

(2) Fire Insurance

Annual Premium	$ 6,764
Fire Insurance contents is 27% of total fire insurance valuation	x 27%
	$ 1,826

(3) Building Fire Insurance Premium on Hydro Plant	2,332
(4) Log Boom Premium	236
Insurance Premium Associated with Hydraulic Power Generation Facilities (1) - (4)	$ 5,934

EDISON SAULT ELECTRIC COMPANY

Reimbursable Costs Pursuant to 10 A (3)

Direct payroll costs of Officers and Clerical personnel for annual review and determination of costs under Section 10 A and 10 B of agreement	$ 3,000

EDISON SAULT ELECTRIC COMPANY

Reimbursable Costs Pursuant to 10 A (4)

1968 Costs of Administrative and General Expenses

(000) OMITTED

920	Administrative and General Salaries	$ 201
921	Office Supplies and Expense	62
922	Administrative Expenses Transferred – (Cr.)	(44)
923	Outside Services Employed	88
928	Regulatory Commission Expenses	3
929	Duplicate Charges – (Cr.)	(42)
930	Miscellaneous General Expenses	43
931	Rents	7
932	Maintenance of General Plant	11
		$ 329
	Applicable Portion of Costs to Hydro Electric Generation Based on the Ratio of supervised Hydro Electric operation and maintenance expensed to total supervised electric operation and maintenance expenses	21.8%
	Reimbursable Costs Pursuant to 10 A (4)	72

EDISON SAULT ELECTRIC COMPANY

Reimbursable Costs Pursuant to 10 A (5)
Depreciation on Hydraulic Power Generation Facilities
and Allocated General Plant

(000) OMITTED

Plant Investment in Hydro Electric Facilities at December 31, 1968	$ 2,413	
LESS: Depreciation Accrued to December 31, 1968	(677)	
Net Investment	$ 1,736	
Annual Depreciation assuming a remaining life at December 31, 1968 upon renewal of lease to June 30, 1999; a period of 30½ years		$ 57
Net Investment in Allocated General Plant	$ 113	
Annual Depreciation at average rate of 3%		3
Total Depreciation Pursuant to 10 A (5)		$ 60

EDISON SAULT ELECTRIC COMPANY

Reimbursable Costs Pursuant to 10 A (6)

TAXES

City of Sault Ste. Marie, Michigan (July 1, 1968)	$ 147,000
Chippewa County, Public Schools of Sault Ste. Marie, Michigan (December 1, 1968)	231,000
TOTAL	$ 378,000

EDISON SAULT ELECTRIC COMPANY

Reimbursable Costs Pursuant to 10 A (7)

City of Sault Ste. Marie, Michigan (assumed as if extension in effect)	$ 50,000

EDISON SAULT ELECTRIC COMPANY

Reimbursement Required Under Section
10.B. of Agreement

(000) OMITTED

Net Investment in Hydro-Electric Plant per Exhibit "B", page 6	$ 1,736	
Associated Net Investment in General Plant:		
*Structures and Improvements ($211 x 20.6%)	43	
Transportation -- Directly Associated	32	
Furniture and Fixtures -- Directly Associated	38	
Working Capital Allowance (1/3 of Costs under Section 10 A(1) to 10 A(4).)	68	
	$ 1,917	
21.64% Pro Rata Share of Cloverland	415	
Allowable Rate of Return	8%)	
Allowance needed to provide for Income Tax	7.2%)	15.2%
Allowable Return	$ 63	

* Administrative office building - investment allocated based on ratio of employees

EDISON SAULT ELECTRIC COMPANY

Summary of Determination of Costs of Energy to Cooperative Pursuant to Paragraph 10

(000) OMITTED

10 A(1)	$ 433
10 A(1) (a)	30
10 A(2)	6
10 A(4)	68
10 A(5)	60
10 A(6)	378
10 A(7)	50
	$1,025
Annual Cost allocated on the ratio per paragraph 2	x21.64%
Cooperative Portion of allocated costs	222
Direct Costs under 10 A(3)	3
Return allowed under 10 B	63
TOTAL COSTS pursuant to paragraph 10	$ 288

E X H I B I T "C"

Example of 1968 facilities charge to deliver 7381 kw to Cloverland Electric Co-op from Edison Sault Electric Company Hydro Plant.

1. Hydro Plant Substation

2 Transformers 15/20/25 MVA	$ 92,350
3 69KV Oil Circuit Breakers	46,998
Lot - Busses, Switches and Appurtenances	30,919
Site and Yard Improvements	2,916
TOTAL	$173,183
Cloverland Allocation 21.64%	37,475
Percent Annual Charge	19.8%
Annual Cost per Year	7,420

2. Transmission Line Cost Edison Sault Electric Company Hydro Plant to Cloverland Electric Substation (one half cost of double circuit line)

Land and Land Rights	$ 4,628
Poles and Fixtures	36,845
Overhead Conductors	37,374
TOTAL	$ 78,847
Cloverland Allocation 100%	78,847
Percent Annual Charge	16.8%
Annual Cost per year	13,246

3. Total 1968 facilities charge to wheel unit purchase to Cloverland REA — $ 20,666

SUPPLEMENTAL AGREEMENT
NUMBER ONE TO CONTRACT
BETWEEN EDISON SAULT ELECTRIC COMPANY AND
CLOVERLAND ELECTRIC COOPERATIVE
DATED AS OF JUNE 30, 1970

This Supplemental Agreement Number One, effective as of June 30, 1970, between Edison Sault Electric Company, a Michigan Corporation, with principal offices at 725 East Portage Avenue, Sault Ste. Marie, Michigan, hereinafter termed the "Company", and Cloverland Electric Cooperative, a Michigan Corporation, with principal offices at U. S. Highway Number 2, Sault Ste. Marie, Michigan, hereinafter termed the "Cooperative".

WHEREAS, the Company and Cooperative heretofore agreed to contract under date as of June 30, 1970, a true copy of which is hereto attached marked EXHIBIT "A" and made a part hereof;

WHEREAS, said contract by its terms amended paragraph 14 of a certain contract between the Company and the Cooperative under date of January 27, 1964, a true copy of which is hereto attached marked EXHIBIT "B" and made a part hereof, and also provided for the sharing of power associated with the Company's hydro-electric plant at Sault Ste. Marie, Michigan operated by the use of the surplus waters of the St. Marys River pursuant to Contract DA-20-064-ENG-88 between the Company and the Secretary of Army of the United States, for the period July 1, 1980 to June 30, 2000;

WHEREAS, said contract between the Company and the Cooperative dated as of June 30, 1970 was conditioned and to become effective only in the event of the granting by the Secretary of Army to the Company of an extension of the term of said Contract DA-20-064-ENG-88 to June 30, 2000;

WHEREAS, said above referred to extension of Contract DA-20-064-ENG-88 has been executed by the Secretary of Army as of June 30, 1970, a true copy of which is hereto attached and marked EXHIBIT "C" and made a part hereof, and said contract between the Company and Cooperative is now effective and the Company and the Cooperative desire to acknowledge the same in writing and to modify the contract of June 30, 1970 between the parties to state its effectiveness as of June 30, 1970;

WITNESSETH:

1.

Paragraph 14 of the Contract between the Company and Cooperative under date of January 27, 1964, (attached marked EXHIBIT "B") which reads and provides as follows:

"14. TERM

Unless sooner terminated as specifically provided herein, this Agreement shall extend for an initial period of five (5) years from and after the complete conversion of the hydro-electric plant of the Company at Sault Ste. Marie, Michigan, formerly known as Carbide Power Plant, from 25-cycle generation to 60-cycle generation, expected to be on or about March 1, 1964, and from year to year thereafter until terminated by mutual consent or by either party giving the other at least twenty-four (24) months written notice of its desire to terminate.

The Company shall notify the Customer in writing at least fifteen (15) days before the conversion is completed and the date set forth therein shall constitute the first day of the term hereunder.

The notice to terminate provided for by this paragraph shall date from the date of mailing by registered mail but in no event shall be effective until the full expiration of the firm five (5) year initial period."

is hereby amended and modified to read and provide as follows:

"14. TERM.

This Agreement shall continue in full force and effect until June 30, 1980."

All other provisions of said Contract of January 27, 1964, shall remain as in said Contract provided.

2.

Paragraph 16 of the contract between the Company and Cooperative dated as of June 30, 1970 which reads and provides as follows:

"16. TERM.

This Agreement, subject to the provisions of Paragraph 15 hereof, and the granting by the Secretary of the Army to the Company of an extension of Contract DA-20-064-ENG-88 satisfactory to the Company of the water rights for its hydro-electric plant, shall be effective as of the date of execution and shall continue in full force and effect until June 30, 2000. Provided, however, in the event the Company's gross investment in said hydro-electric plant and canal at any time exceeds $3,500,000 from the date of this Agreement or during its specific tenure, the Cooperative shall have the option to terminate this Agreement as it relates to the period July 1, 1980 to June 30, 2000, upon 12 months written notice to the Company. This Agreement, unless extended by mutual agreement of the parties hereto, shall become null and void if the lease of water rights to the Company has not been granted by December 31, 1971."

is hereby amended and modified to read and provide as follows:

"16. Term.

This Agreement, subject to the provisions of Paragraph 15, hereof, shall be effective as of June 30, 1970 and shall continue in full force and effect until June 30, 2000. Provided, however, in the event the Company's gross investment in said hydro-electric plant and canal at any time exceeds $3,500,000 from the date of this Agreement or during its specific tenure, the Cooperative shall have the option to terminate this Agreement as it relates to the period July 1, 1980 to June 30, 2000, upon 12 months written notice to the Company."

All other provisions of said contract of June 30, 1970 shall remain as in said contract provided except herein this Supplemental Agreement Number One amended.

IN WITNESS WHEREOF, This Agreement has been executed on behalf of the Company and Cooperative by their duly authorized officers as of June 30, 1970.

In Presence Of:	EDISON SAULT ELECTRIC COMPANY
Leonard E. Brawley	By Richard Y. Burnett, President
James P. Hunt	By Stewart T. Moran, Secretary
In Presence Of:	CLOVERLAND ELECTRIC COOPERATIVE
Jack Church	By John Galorowic, President
Jack Holt	By Albert Schopp, Secretary

SUPPLEMENTAL AGREEMENT
NUMBER TWO TO CONTRACT
BETWEEN EDISON SAULT ELECTRIC COMPANY AND
CLOVERLAND ELECTRIC COOPERATIVE
DATED AS OF JUNE 30, 1970

This Supplemental Agreement Number Two, effective as of June 30, 1970, between Edison Sault Electric Company, a Michigan Corporation, with principal offices at 725 East Portage Avenue, Sault Ste. Marie, Michigan, hereinafter termed the "Company", and Cloverland Electric Cooperative, a Michigan Corporation, with principal offices at U.S. Highway Number 2, Sault Ste. Marie, Michigan, hereinafter termed the "Cooperative".

WHEREAS, the Company and the Cooperative heretofore executed a Contract under date as of June 30, 1970, and further amended said Contract by Supplemental Agreement Number One as of June 30, 1970;

WHEREAS, The Cooperative has requested the Company to further amend said Contract between the Company and the Cooperative and the Company is agreeable thereto;

W I T N E S S E T H :

1.

Section B of Paragraph 10 which reads and provides as follows:

"B. The Cooperative shall pay to the Company its pro rata share as determined by Paragraph 2 hereof of a fair rate of return as established by the Michigan Public Service Commission in effect December 31, 1979 and thereafter during the tenure of this Agreement on its net plant investment in facilities at the said hydro-electric plant including the canal and allocable general plant and 1/8th of its costs as reflected in Paragraphs

(1) through (4) of Subsection A of this paragraph 10 hereof as working capital, together with a proper allowance for Federal and State Income Tax to permit the Company to realize its proper rate of return.

Exhibit B is hereto attached by way of explanation and interpretation of the application of this paragraph using the calendar year 1968 and assuming Contract DA-20-064-ENG-88 had been extended at this time to June 30, 2000."

is hereby amended to read and provide as follows:

"B. The Cooperative shall pay to the Company its pro rata share as determined by Paragraph 2 hereof of a fair rate of return as established by the Michigan Public Service Commission, or such other regulatory agency having jurisdiction thereof, in effect December 31, 1979, and thereafter during the tenure of this Agreement on its net plant investment in facilities at the said hydro-electric plant including the canal and allocable general plant and 1/8th of its costs as reflected in Paragraphs (1) through (4) of Subsection A of this paragraph 10 hereof as working capital, together with a proper allowance for Federal and State Income Tax to Permit the Company to realize its proper rate of return.

Exhibit B is hereby attached by way of explanation and interpretation of the application of this paragraph using the calendar year 1968 and assuming Contract #DA-20-064-ENG-88 had been extended at this time to June 30, 2000."

2.

Paragraph 14, which reads and provides as follows:

"14. Disputes.

In the event there is a dispute concerning the application and interpretation of Paragraphs 2, 3, 10, or 11, the parties hereto agree that in the event the dispute cannot be resolved by mutual agreement, the matter will be submitted by a joint petition executed by the Company and the Cooperative to the Michigan Public Service Commission and its decision thereon shall be final and finding upon the parties."

is hereby amended to read and provide as follows:

14. Disputes.

In the event there is a dispute concerning the application and interpretation of Paragraphs 2, 3, 10 or 11, the parties hereto agree that in the event the dispute cannot be resolved by mutual agreement, the matter will be submitted by a joint petition executed by the Company and the Cooperative to the Michigan Public Service Commission or such other regulatory agency having jurisdiction thereof, and its decision thereon shall be final and binding upon the parties.

3.

All other provisions of said contract between the Company and the Cooperative dated as of June 30, 1970, shall remain as in said Contract provided, except as amended by Supplemental Agreement Number One and except as herein amended by this Supplemental Agreement Number Two.

IN WITNESS WHEREOF, This Agreement has been executed on behalf of the Company and the Cooperative by their duly authorized officers as of June 30, 1970.

In Presence of

Leonard E. Brawley

Leonard E. Brawley

James P. Hunt

James P. Hunt

EDISON SAULT ELECTRIC CO.

By Richard Y. Burnett

Richard Y. Burnett, President

By Stewart T. Moran

Stewart T. Moran, Secretary

In Presence of

Jack Shwedt

CLOVERLAND ELECTRIC COOPERATIVE

By John J. Galorowic Pres

John Galorowic, President

By Albert Schopp

Albert Schopp, Secretary

SUPPLEMENTAL AGREEMENT NUMBER THREE (3)
TO AGREEMENT
JUNE 30, 1970, AS AMENDED
BETWEEN
EDISON SAULT ELECTRIC COMPANY
AND
CLOVERLAND ELECTRIC COOPERATIVE, INC.

This Supplemental Agreement Number Three (3) as of the 1st day of March 1979, by and between the Edison Sault Electric Company, a Michigan Corporation, hereinafter called the "Company" and the Cloverland Electric Cooperative, Inc., a Michigan Corporation, hereinafter called the "Customer".

WHEREAS, the Company and the Customer entered into a certain agreement under date of June 30, 1970, in relation to the sale and delivery of energy to the Customer;

WHEREAS, the parties heretofore entered into a Transmission Coordination Agreement, dated as of May 1, 1977;

WHEREAS, the Transmission Coordination Agreement provides for Transmission Investment Responsibility and a charge for deficiency pursuant to Section 2.04, thereof;

WHEREAS, the Contract of June 30, 1970 provides for the payment by the Customer to the Company of a Delivery Charge for energy delivered;

WHEREAS, it is necessary to modify said contract of June 30, 1970 accordingly to reflect the intent of the parties;

NOW, THEREFORE, IT IS AGREED BY AND BETWEEN THE PARTIES HERETO AS FOLLOWS:

1. That Section 11 of the Contract of June 30, 1970 be amended and modified to provide as follows;

11. Delivery Charge to Cooperative

In addition to the payments required by Paragraph 10 hereof the Cooperative shall annually pay to the Company a reasonable wheeling charge for the facilities of the Company reserved and capable of delivering to the Cooperative its allocation under this Contract from the Company's said hydro plant to the Cooperative's system as described in Subsection B, Paragraph 3 hereof. Said wheeling charge shall be predicated upon the Company's net plant investment in facilities to deliver the energy to the Cooperative which shall be determined by the same formula as is presently applied by the Company to the delivery of energy to the Cooperative of its allocation of power from the United States Government hydro plant pursuant to Contract DA-20-064-ENG-632 and in accordance with the Contract between the Company and the Cooperative, dated January 2, 1952.

The wheeling charge will be redetermined annually on or before the 1st day of April of each year. The first determination hereunder shall be predicated on the calendar year 1979 and shall be effective for the period July 1, 1980 to December 31, 1980. Thereafter each determination shall be effective for the calendar year for which the determination is made.

Attached hereto and made a part hereof is Exhibit C by the way of explanation and interpretation to demonstrate the effect of this paragraph as if said Contract was effective at the present time.

The delivery charge herein provided shall terminate at 12:00 p.m., December 31, of the year in which the 138 KV line to Engadine, undertaken pursuant to the Tranmission Coordination Agreement between the parties, is energized.

2. It is specifically agreed by and between the parties hereto that all of the provisions of said Contract of June 30, 1970, except as hereinbefore modified and as in this Agreement modified, shall remain in full force and effect.

IN WITNESS WHEREOF the parties hereto have executed this Supplemental Agreement Number ~~___~~ Three (3), as of the day and year first above written.

Executed by EDISON SAULT ELECTRIC COMPANY the 12th day of March, 1979.

In Presence of:

Stewart T. Moran

Geraldine M. Maltaci

EDISON SAULT ELECTRIC COMPANY

By William R. Gregory
WILLIAM R. GREGORY
Its President

Executed by CLOVERLAND ELECTRIC COOPERATIVE, INC. the 14th day of March, 1979.

In Presence of:

John F. Holt

Shirley J. Farquist

CLOVERLAND ELECTRIC COOPERATIVE, INC.

By [signature]
Its President

EDISON SAULT ELECTRIC COMPANY

906-632-2221
ROBERT C. KLINE, JR.
General Counsel

EDISON BUILDING
SAULT STE MARIE
MICHIGAN 49783

May 22, 1980

Mr. P. McCallister
Chief, Engineering Division
Department of the Army
Detroit District, Corps of Engineers
Box 1027
Detroit, MI 48231

Re: NCEED-PB

Dear Mr. McCallister:

This will acknowledge receipt of your letter of May 15, 1980.

As a matter of record, I wish to advise you that under Edison's By-Laws, I retired as Chairman of the Board under date of May 6, 1980, but remain as General Counsel and will be actively associated with this matter as I have in the past. I observe from your letter that further communications will be with your Sault area office. These communications should be addressed to William R. Gregory, President, with a copy to me.

I am forwarding a copy of this letter to James Bray, your local Area Engineer, for his information.

Your letter had a list of technical data attached, needed for your study which you requested prior to June 1, 1980. This only avails us nine working days and with our limited staff, it may be difficult to meet this schedule. However, please be assured we will assemble such data as is available as expeditiously as possible. I also wish to advise you that we acquired our hydroelectric facility from Carbide Power Company, May 22, 1963. Carbide Power had operated the facility prior to that time for over 40 years and their records are not available to us.

We will furnish your Sault office each item of data requested as it is developed and available.

I believe it would be appropriate for us to make the following comments in relation to the study you are undertaking. These comments may relate to factual and legal matters which you are fully aware of and our comments are solely to enumerate them to insure their consideration.

EXHIBIT "C"

(1) Your letter states that your study is initiated under the authority of Section 102 of the River and Harbor Act of 1966 (P.L. 89-789). Your study will, of course, involve the legal integrity of our Contract DA-20-064-ENG-88 which relates to Public Law 14, 79th Congress 1945 which provided in part as follows:

> "Saint Marys River, Michigan; the construction of a new hydroelectric power plant in accordance with the plan recommended in House Document Numbered 339, Seventy-Seventh Congress: PROVIDED, That only the first step of the recommended develop ment, involving an installation of approximately fourteen thousand kilowatts at an estimated cost of $3,500,000, shall be constructed at this time, and no further development in addition to said first step shall be undertaken until here after authorized by law; PROVIDED FURTHER, That the existing United States hydroelectric power plant at Sault Sainte Marie shall be abandoned upon completion of the new plant; PROVIDED FURTHER, That the electric energy generated in the operation of said new plant, shall be sold by the Secretary of War, and any surplus water available to the United States which is not required for the operation of facilities owned by the United States may be leased by the Secretary of War upon such terms and conditions as he shall determine; AND PROVIDED FURTHER, That pending construction of the new United States plant he may also enter into such arrangements for continued operation of the existing Government plant and the use of water as he may deem advisable in the public interest."

(underlining ours)

You will observe that the Act only authorized the construction of the present existing plant and contained the following language as to the second stage, "and no further development in addition to the first step shall be undertaken until hereafter authorized by law".

Our Contract DA-20-064-ENG-88 to which Carbide Power Company was the original Lessee and duly assigned to us, provided in part in Section 2, as follows:

> " * * and is expressly subject to the right of the lessor to use all the water in the Saint Marys River for navigation and to the right of the lessor to diminish at any time and for any period of time and by any amount the quantity of water avail able for the use of the lessee for power purposes whenever, in the opinion of the lessor, the regulation of the level of Lake Superior or of the flow of the Saint Marys River in the interest of navigation or the requirements for the operation of facilities now owned by the lessor or presently authorized by law make

necessary such diminution, and the lessee shall neither assert nor make claim for damages as against the lessor by reason of any such diminution made for such cause."

Section 4 of said Contract DA-20-064-ENG-88 provides in part as follows:

"It is further agreed that at such times as the regulation of the level of Lake Superior and of the flow of St. Marys River in the interest of navigation and the requirements for operation of facilities now owned by he lessor or presently authorized by law require a reduction in the maximum rate of flow of 33,000 c.f.s., the lessee will reduce such flow accordingly."

(underlining ours)

You will, therefore, observe that the language used in Contract DA-20-064-ENG-88 uses the exact language included in Public Law 14, "authorized by law".

The contract was executed by the Secretary of Army and Carbide in 1950 only after extensive Congressional hearings and negotiations. The language used in Contract DA-20-064-ENG-88 was inserted to prevent any further diminution of water under Contract DA-20-064-ENG-88 to be used by Government facilities in accordance with Public Law 14 except that which were then "authorized by law" at the date of Contract DA-20-064-ENG-88, to wit, July 30, 1950.

(2) I have taken the liberty to forward a copy of your letter to Cloverland Electric Cooperative in view of the fact they are an interested party. Rather than comment at length on this matter, I enclose a copy of my letter to Robert Gregory, under date of January 30, 1978, which comments fully on Cloverland's interest.

(3) The above referred to letter also comments upon Edison's commitment to the City of Sault Ste. Marie and we herewith attach a copy of that Ordinance (No. 85) establishing our obligation based on the extension of Contract DA-20-064-ENG-88.

I will not burden you further with information which we are of the opinion is relevant to the study but will furnish the same to James Bray, Area Engineer, in accordance with your letter.

I sincerely trust that your study will comment on the Supplemental Orders of Approval issued by the International Joint Commission. I am of the opinion they were not legally adopted for reasons set forth in my letter of July 27, 1979 (copy attached). It would be our hope that your study recommend the State Department petition for an amendment to these Supplemental Orders in view of our energy crisis.

This is to advise you that we will deliver some of the documents and information requested this date to your Soo Area Corps of Engineers.

You are assured of our cooperation and we would appreciate your advising us from time to time of the thrust of your study and conclusions.

Sincerely yours,

EDISON SAULT ELECTRIC COMPANY

By ______________________
ROBERT C. KLINE, JR.
General Counsel

RCK:jmm

Attachments

cc: W. R. Gregory
James Bray, Area Engineer
W. L. Chance
S. T. Moran
Cloverland Electric Cooperative

ESELCO

EDISON SAULT ELECTRIC COMPANY

OFFICE OF CHAIRMAN BOARD OF DIRECTORS

ROBERT C. KLINE, JR.

311 JOPA PROFESSIONAL CENTER
SAULT STE. MARIE
MICHIGAN 49783
(906) 632-[illegible]295

January 30, 1978

Mr. Robert Gregory, Assistant Chief of the
Great Lakes Hydropogy and Hydrolics Branch
Department of the Army
Detroit District, Corps of Engineers
Box 1027
Detroit, Michigan 48232

Re: Contract DA-20-064-ENG-632

Dear Bob:

This will supplement my letter to you of January 23, 1978, with reference to the above matter in relation to that portion of the letter relating to extension of Contract DA-20-064-ENG-632.

In my letter of the 23rd, I stated to you that in view of our formal Application to the Secretary of Army and the letter of September 7, of Charles R. Ford, Acting Assistant Secretary of Army, to Congressman Philip E. Runpe, a copy of which has been heretofore furnished you, that all that was involved was a simple extension modification similar to Modification No. 4 to Contract DA-20-064-ENG-88.

In our conference in Detroit under date ofJanuary 20, 1978, you indicated that in view of directives you have received, that the extension negotiations will involve proposals to modify Contract DA-20-064-ENG-88 in certain areas.

Additionally, you advised me that additional directives to you relate to new considerations as to determination of costs of power for the period subsequent to June 30, 1980.

Our authority from the Board of Directors of Edison Sault Electric Company was limited to the matters set forth in our Application to the Secretary of Army and we have no authority to negotiate modifications of Contract DA-20-064-ENG-88 as management and our Board did not consider this to be a factor involved in the extension of Contract DA-20-064-ENG-632. In view ofthe tenure of Contract DA-20-064-ENG-88 to June 30, 2000.

A review of your files relating to Contract DA-20-064-ENG-88 and specifically to Supplemental Agreement No. 5, when the tenure of Contract DA-20-064-ENG-88 was extended in 1970 to June 30, 2000, will document that Edison Sault Electric Company made substantial concessions for the benefit of the Government.

We agreed effective June 30, 1980, to share the output of our hydro electric facility with Cloverland Electric Cooperative on a basis comparable to allocations made to Third Party Beneficiaries under Contract DA-20-064-ENG-632. The Supplemental Agreement Number 5 so recited as a part of the consideration, and the Contract between Edison and Cloverland was attached to Suppelemental Agreement No. 5, as Exhibit A.

Your files may or may not show the basic reason for the Application for extension having been filed.

The canal for the operation of our hydro facility in Sault Ste.Marie, Michigan, extends from a point at or near the St. Marys Falls Canal, 2½ miles through the City of Sault Ste. Marie to our hydro plant on St. Marys River.

The City, in order to provide access to the various sections of the City, have had to maintain six bridges since 1902. These bridges were single span and were originally constructed to accomodate horse drawn vehicles. The location and necessity of replacing the bridges was fully covered in our Application to the Secretary of Army and is hereinafter specifically referred to.

In July, 1968, the City of Sault Ste. Marie, Michigan, filed a statement and request with Senator Griffin, Senator Hart and Congressman Ruppe, requesting the assistance of their offices in the enactment of legislation to provide for diversion of a portion of the annual $100,000 rental paid by Edison under Contract DA-20-064-ENG-88 for replacement of said bridges. This matter had been pursued by the City on innumerable prior occasions without success.

The City, recognizing the then existing tenure of Contract DA-20-064-ENG-88 was limited to June 30, 1980, requested the lease be extended to June 30, 2000 upon which the City could predicate a revenue bond issue of 30 years for bridges and maintenance.

Representatives of Edison were invoted to a subsequent meeting in Washington at which representatives of the Corps of Engineers were present and at which meeting the City was advised that Edison was the only party who could file an Application for extension.

At this meeting it was emphasized by representatives of the Government the difficulty of the passage of special legislation and it was suggested that in lieu of legislation upon negotiations of the extension, Edison commit itself to the City to make an annual payment to the City for a 30 year period to permit bonding.

Subsequent to the Washington meeting, Edison Board of Directors authorized the filing of the Application and commitment in lieu of legislation, in the event legislation was not adopted.

This is merely an encapsulized comment on this phase of the matter which was fully set forth in the Application of Edison Sault Electric Company to the Secretary of Army for the extension. It is contained under the heading "City of Sault Ste. Marie, Michigan - Power Canal Bridges", on page 12 of the Application.

In view of the fact you may not have a copy of the Application in your file, we herewith enclose a copy for reference.

Immediately contemporaneously with the granting and extension of the tenure of Contract DA-20-064-ENG-88, Edison fulfilled its commitment to the City by accepting an amendment to Ordinance Number LXXXII by Ordinance Number 85 with Edison agreeing to pay the City annually, the sum of $42,320 for a 30 year period to the year 2000. This Commitment by Edison obligates it to ultimately pay to the City, $1,269,000 under the Ordinance.

A copy of the Ordinance is attached for reference.

It will be obvious to you, I am certain, from the foregoing, that with the concessions amde and commitments undertaken, as a consideration for the Extension of Contract DA-20-064-ENG-88, as set forth in Supplemental Agreement Number 5 of 1970, the Board of Directors of Edison would be not favorably disposed to further modify Contract DA-20-064-ENG-88 as relates to its tenure and integrity.

In view of the fact I am making a rather in-depth statement relative to the historical background in relation to contractual relationship with the Secretary of Army relating to power generation, I call to your attention that the original hydro-electric plant in the St. Marys River was constructed by the Edison Sault Electric Company. This facility was acquired by the Government in 1911 pursuant to Section 11 of an Act of Congress March 3, 1909. The Secretary of Army leased back the plant to Edison until the construction of the new plant in 1952, under Contract DA-20-064-ENG-632 of 1952, Edison was the contracting party.

Mr. Robert Gregory
page 4
January 30, 1978

Therefore, Edison and the United States have had contractual relations relative to the hydro electric generation for a period of in excess of 78 years. This relationship has been, I believe, mutually beneficial and cooperative.

The service territory of Edison Sault Electric Company extends from Sault Ste. Marie west to Manistique, Michigan, and South to the Straits of Mackinac. We are in an isolated section of the Upper Peninsula. We are the only public utility servicing this area with the exception of Cloverland Electric Cooperative who is possessed of no base system generation and possesses only limited peaking capacity with diesels. Edison furnishes to Cloverland, its base system load.

The Edison Sault Electric Company is a completely intergrated system. It possesses its own hydro facility in Sault Ste. Marie, Michigan. Diesel units in Manistique, St. Ignace, and Mackinac Island. We are interconnected with Consumers Power Company via the Straits of Mackinac by a 138 kv cable installed by Edison in 1975 at a cost of $3,700,000 and by a 46 kv cable installed by Edison in 1955 which presently is held in reserve. The United States Government facilities located in the eastern Upper Peninsula are located in our service territory and we are presently served by Edison under Contract DA-20-064-ENG-632. We are the only utility with the facilities to contract for the output of the Government Plant and to dispatch and distribute the same.

I do not want to give you the impression that this letter is in any respect argumentative. It is solely for the purpose of bringing certain matters of background to your attention which for reasons of passage of time, may not be readily available to you.

With the limited time remaining prior to the termination of Contract DA-20-064-ENG-632, we hope the extension negotiations can proceed expeditiously and it appears that a formal conference is desirable so that each of our formal positions may be stated and explored.

Our staff have reviewed procedural matters in both Contract DA-20-064-ENG-632 and Contract DA-20-064-ENG-88 and are prepared to discuss them with you for modifications in the event the extension is negotiated.

Mr. Robert Gregory
Page 5
January 30, 1978

We, therefore, are ready to meet with you at your convenience at such time and place as meets your convenience, and will await your advice.

Sincerely yours,

EDISON SAULT ELECTRIC CO.

By ______________________
Robert C. Kline, Jr.
Chairman of the Board

RCK/dsk

ORDINANCE NO. 85

AN ORDINANCE TO AMEND ORDINANCE NUMBER LXXXII BY AMENDING SECTION 10, AND REPEALING SECTIONS 12 AND 13 OF ORDINANCE NUMBER LXXXII.

THE CITY OF SAULT STE. MARIE ORDAINS:

Section 1. Section 12 and Section 13 of Ordinance Number LXXXII entitled, "An Ordinance granting to Edward V. Douglas, of Philadephia, Pennsylvania, and his assigns, permission to deepen, enlarge, improve and change the course of a certain existing water course in the City of Sault Ste. Marie, heretofore established for public drainage and sewerage purposes, and to do other acts in connection herewith", are hereby repealed.

Section 2. Section 10 of Ordinance Number LXXXII as amended by Ordinance CXXIV, entitled, "An Ordinance granting to Edward V. Douglas, of Philadelphia, Pennsylvania, and his assigns, permission to deepen, enlarge, improve and change the course of and make a diversion from the course of a certain existing water course in the City of Sault Ste. Marie, heretofore established for public drainage and sewerage purposes, and to do other acts in connection therewith", be amended to read as follows:

Sec. 10. Edison Sault Electric Company, an assignee of Carbide Power Company, successor to Michigan Lake Superior Power Company, assignee of Edward V. Douglas, shall pay to the City of Sault Ste. Marie, on January 30th, 1971, and on January 30th of each year thereafter to and including the year 2000, the sum of Forty-two Thousand Three Hundred Twenty and no/100 ($42,320.00) Dollars, for the maintenance, repairs, replacement of all bridges and abutments presently or in the future crossing the canal watercourse authorized by this Ordinance. The aforesaid payments provided for in this section shall constitute a full and complete discharge of the grantee of any and all obligations for the existence and/or operation of said watercourse or any other obligations under any ordinances of the City of Sault Ste. Marie, past or future. The adoption of this Ordinance constitutes an acknowledgement by the City of Sault Ste. Marie, that all obligations of the grantees under prior ordinances has been discharged.

Section 3. This Ordinance shall be void and of no effect unless the said grantee, its successors and assign shall within five day after its passage, signify their acceptance thereof in writing filed with the Clerk of the City.

Section 4. This Ordinance is declared to be an emergency ordinance necessary for the preservation of safety and is hereby given immediate effect upon publication or posting, and shall be published by posting copies thereof in conspicuous locations in three (3) public places in the City of Sault Ste. Marie, Michigan.

We Hereby Certify, That the foregoing Ordinance was adopted by the City Commission of the City of Sault Ste. Marie, Michigan, on the 16th day of November, A.D., 1970.

FRANK PINGATORE,
Mayor Pro Tem

D K Strickland

D. K. STRICKLAND,
City Clerk

I Hereby Certify, That the foregoing Ordinance was posted in the following public places within the City of Sault Ste. Marie, Michigan, on November 17, 1970.

Lobby of City-County Building
Lobby of Federal Building
Lobby of U.S. Post Office

D K Strickland

D. K. STRICKLAND,
City Clerk

EDISON SAULT ELECTRIC COMPANY

906-632-2221

EDISON BUILDING
SAULT STE MARIE
MICHIGAN 49783

July 27, 1979

Mr. D. LaRoche, Secretary
United States Section
International Joint Commission
1717 H. Street, N.W., Rm 203
Washington, D. C. 20440

Mr. D. G. Chance, Secretary
Canadian Section
International Joint Commission
Berger Building, 18th Floor
100 Metcalf Street
Ottawa, Ontario KIP 5M1
Canada

Gentlemen:

Edison Sault Electric Company, responsive to the Public Notice of the International Joint Commission entitled, "International Joint Commission Public Notice Regulating Lake Superior" - undated - received June 29, 1979, in which notice the International Joint Commission stated in part as follows:

> "The Commission, before making a decision on amending the the 1914 Orders of Approval, which would permit the implementation of Plan, 1977, wishes to provide the public with an opportunity to comment on this additional information which was not available when the Commission held public hearings on this matter in 1978-1979."

files this Statement.

We respectfully submit that the matter presently pending before the Commission was initiated by the United States of America and the Dominion of Canada, by a reference to the International Joint Commission pursuant to Article IX of the Boundary Waters Treaty of 1909 under date of October 7, 1964. The reference provided in part as follows:

> "In order to determine whether measures within the Great Lakes Basin can be taken in the public interest to regulate further the levels of the Great Lakes or any of them and their connecting waters

so as to reduce the extremes of stage which have been experienced, and for the beneficial effects in these waters described hereunder, the Governments of Canada and the United States have agreed to refer the matter to the International Joint Commission for investigation and report pursuant to Article IX of the Boundary Waters Treaty of 1909.

"It is desired that the Commission study the various factors which affect the fluctuations of these water levels and determine whether, in its judgment, action would be practicable and in the public interest from the points of view of both Governments for the purposes of bringing about a more beneficial range of stage for, and improvement in:

(a) domestic water supply and sanitation
(b) navigation
(c) water for power and industry
(d) flood control
(e) agriculture
(f) fish and wildlife
(g) recreation and
(h) other beneficial public purposes."

Article IX of the Boundary Waters Treaty of 1909 specifically provides for reference to the International Joint Commission, but such references do not vest in the Commission the right to act upon its recommendations without specific granted authority by the respective governments.

Article IX specifically provides, in part, as follows:

"The International Joint Commission is authorized in each case so referred to examine into and report upon the facts and circumstances of the particular questions and matters referred, together with such conclusions and recommendations as may be appropriate; subject, however, to any restrictions or exceptions which may be imposed with respect thereto by the terms of the reference.

"Such reports of the Commission shall not be regarded as decisions of the questions or matters so submitted either on the facts or the law, and shall in no way have the character of an arbitral award.

The Commission has conducted extensive studies since the date of the reference in 1964 and has filed with the respective governments Interim

Reports from time to time and a final report was submitted to the respective Governments in 1976.

These reports were submitted to the Governments and constituted only findings and recommendations as provided in said Article IX with the ultimate section, if any, being only by specific authorization of the Governments.

We respectfully submit that the International Joint Commission, by its own determination, determined that it had no jurisdiction to modify the Orders of Approval of 1914 to change the criteria of regulation of Lake Superior without specific authorization of the respective Governments.

The June 1973 Interim Report of the International Joint Commission provided, in part, as follows:

> "However, it needs to be understood that adoption of a regulation plan for Lake Superior which takes into account the levels of Lakes Michigan-Huron constitutes a departure from the objectives and criteria prescribed in the Commission's Orders of Approval of May 26 and 27, 1914. It is the Commission's considered opinion that it cannot adopt the new objective and criteria under the terms of these Orders of Approval, which are still in force. Moreover, in these Orders of Approval, the Commission did not retain jurisdiction to amend the Orders so as to establish new regulations and criteria."

We respectfully submit that we assume that the Department of State and the Department of Army of the United States have open lines of communication on matters affecting the United States and on matters in which each department has a specific involvement. The letter of Richard D. Vine, of the Department of State, under date of February 17, 1977, to the International Joint Commission, stated, in part, as follows:

> "As the Commission is aware, both Governments continue to support this objective. The Governments concur that consideration of formal amendment of the governing Orders to reflect this

objective would be appropriate. In this regard, however, the two Governments wish to inform the Commission that they do not intend at the present time to initiate action to formally amend the Orders. Such action on the part of the United States Government would require preparation of an Environmental Impact Statement and the enactment of legislation clarifying applicable domestic law so as to facilitate permanent implementation of the regulatory objective. The Commission is aware that United States Government action in response to the 1973 Report would necessarily await such developments. Proposed legislation for this purpose was unsuccessfully introduced by the Administration in the 94th Congress, and we anticipate that it may be re-introduced in the new Congress."

The reference to the submission of legislation to the Congress undoubtedly referred to the letter of Charles Ford, Deputy Secretary of Army to the Honorable Carl Albert, Speaker of the House of Representatives, under date of August 26, 1976, which states as follows:

Purpose of the Legislation

"The Secretary of Army, acting through the Chief of Engineers, is presently authorized to operate lake regulation control works under his jurisdiction at the outlet of Lake Superior in the St. Marys River at Sault Ste. Marie, Michigan, with the objective of maintenance and assisting navigation on the Great Lakes. The proposed legislation would authorize the Secretary to operate the subject works to accomplish the additional regulatory objective at reducing demands to shore property on the Great Lakes during periods of high lake levels.

"Regulation to accomplish this additional objective has been temporarily employed on Lake Superior on an emergency basis since February 1, 1973, as a result of an International Joint Commission directive on January 30, 1973. This I.J.C. directive, in turn, resulted from requests for assistance from the Government of the United States and expressions of concern by the Government of Canada caused by extremely high lake levels at that time. The Department of the Army has determined, however, that our authority to cooperate in the employment of this regulatory objective on a permanent basis will require the enactment of legislation such as is enclosed."

This demonstrates unequivocally that the United states concurred wholly with the jurisdictional position of the International Joint Commission in its Interim Report of June 1973, heretofore set forth.

Therefore, we respectfully submit that no authorization to the International Joint Commission has been received to modify the criteria of regulation established by the Orders of Approval of 1914, by the respective Governments, and the United States, while initiating authorizing legislation, has not been successful in obtaining the same.

We assume the Commission is proceeding on the strength of the Statement contained in the letter of February 17, 1977, from the Department of State, in which it was stated:

> "With respect to the jurisdiction of the Commission to proceed itself to formal amendment, in light of the concern in both countries over extreme level conditions and the views of the two Governments, the Governments generally concur in the Commission's statement of the continuing nature of its jurisdiction. I would note the views expressed by the United States Government in a submission of September 24, 1974, regarding an analogous jurisdictional question arising in proceedings under Docket 46.
>
> "If the Commission were to initiate a process of amendment, the Governments would expect that the Commission in so doing would proceed consistent with the provisions of the Boundary Waters Treaty of 1909 and with the Commission's Rules of Procedure, and that adequate opportunities will be afforded for public review and comment."

It is difficult for us to rationalize the jurisdiction of the Commission in view of its own prior determination, the letter of the Department of Army to the Congress, and the Department of States acknowledgment that legislation had been requested, but not acted upon, all as hereinbefore referred to.

Therefore, assuming for the purpose of this Statement, and for that only, that the Commission has jurisdiction to change the criteria of regulation on the basis of a letter of authorization by the United States and Canada, we respectfully submit as follows:

The proceedings herein by the International Joint Commission were solely proceedings initiated pursuant to Article IX and were only recommendations to the Governments for their action, if any. Assuming the Letter of February 17, 1977, from the Department of State, constituted authorization to change the criteria, we respectfully submit that the letter from Richard D. Vine, Deputy Secretary of State to the International Joint Commission, under date of September 1, 1978, and a similar letter from the Under Secretary of State of Canada in relation to the reference must be considered an express limitation on the action to be taken by the Commission in relation to the matters of reference.

Both letters stated:

> "The Governments believe, therefore, that in view of their clear intention to provide for appropriate measures to protect the St. Marys sport fishery, in accordance with the International Lake Superior Board of Control's feasibility study of remedial works in the St. Marys Rapids at Sault Ste. Marie, dated September 1974, there is no need for the Commission to consider other actions, such as the maintenance of larger minimum flows through the rapids, which could have undesirable consequences for power interests in both countries."

We, therefore, submit that these specific directions from the United States and Canada, qualified the extent of the authority of the International Joint Commission to adopt new regulation plans and directly instructed the International Joint Commission "not to consider other actions, such maintenance or larger minimum flows through the rapids, which would have <u>undesirable effects upon power interests."</u> (Underlining ours)

Despite these directions by the two Governments, Supplementary

Orders of Approval in Dockets 6 and 8 were issued under date of September 27, 1978, in relation to Edison, its Order of Approval was not then before the Commission in any matter, and was issued without notice, and without hearing and related to minumum flows for the St. Marys Rapids Fishery.

The reports of the International Great Lakes Level Board to the International Joint Commission specifically refer to the historical practice in regulation to permit discharge for navigation purposes, and power generation with the excess discharged through the compensating gates.

In their report entitled, "Report on Great Lakes Power Corporation Limited Re-Development", they stated to-wit;

> "The division of flow between the U. S. and Canadian facilities is determined monthly and is based upon the total release specified by the approved regulation plan. The current allocation procedure consists of deducting from the total plan flow that amount which is required by navigation and that amount which is required to maintain the minimum flow in the rapids; the balance is divided between the U. S. and Canadian power facilities according to their respective capacities. When the total flow assigned to Canadian power exceeds the capacity of the Canadian power plant (approximately 18,500 cfs.), the balance is used by the U. S. power plants. Of the water assigned to U. S. power usage, the initial allocation is to the U. S. Government Plant (approximately 12,700 cfs) with the balance being allocated to Edison Sault Electric Company Plant. If the amount assigned to Edison Sault exceeds its maximum capacity (approximately 30,500 cfs), the balance is released through the Compensating Works by opening additional gates over and above the minimum (1/2 gates) required setting. To meet the current needs of all interests, including a minimum setting of the compensating works, requires a plan release from Lake Superior of approximately 66,000 cfs. Upon completion of the proposed Great Lakes Power Corporation (GLPC) development, this capacity would increase to approximately 82,000 cfs."

The Plan of 1977 as presently drafted makes no recognition of the increased discharge capacity of the power canals upon completion of the

Great Lakes Power Corporation development.

This water constitutes a valuable resource to the citizens of the United States and Canada. With the present energy crisis in both countries and the failure to recognize and provide for the use of this resource for power purposes would constitute a serious detriment to Lake Superior interests.

We have reviewed the Environmental Evaluation of Lake Superior Regulation Plan of 1977 Report and recognize it does not purport to constitute an Environmental Impact Statement as understood in the United States and Canada However, the sociological impact comments are minimal and it is disturbing to find only the following comment with reference to Lake Superior power interests, as follows:

> "The total number of occurrences of available full water usage by the Sault Ste. Marie power facilities would be increased under Plan 1977, however, the greater number of flow occurrences below 58,000 c.f.s. would require greater average flow reductions than under the Basis-of-Comparison. The output of the plants at Sault Ste. Marie are normally supplemented by power purchased from Consumers Power Company (another Michigan system) at fixed rates. The purchase of this commodity may increase company costs slightly."

This statement gave no recognition to our Statement of December 14, 1978 and the Boards own report to the International Joint Commission in the Great Lakes Power hearing which demonstrated that unless 82,000 cfs discharge was permitted under the Rule of 1977, the 26,000 customers served in the Eastern Upper Peninsula would suffer increased power costs of $3,000,000 annually under existing wholesale rates.

In conclusion, we respectfully submit that in the event the Plan of 1977 is adopted, that the International Joint Commission modify said Plan by the inclusion of the following provision:

> "The maximum discharge authorized by Plan 1977 be 82,000 cfs in the side canals plus the number of compensating gates necessary to obtain the discharge required by Plan 1977 but in no case greater than the total discharge as authorized by the 1955 Modified Rule of 1949."

That the International Joint Commission consider as a part hereof our Statement filed December 14, 1978 and the Statements therein incorporated by reference.

Respectfully submitted,

EDISON SAULT ELECTRIC COMPANY

By Robert C. Kline Jr.
ROBERT C. KLINE, JR.
Chairman of the Board of Directors

RCK:jmm

RESOLUTION ADOPTED AT REGULAR MEETING OF DIRECTORS OF

EDISON SAULT ELECTRIC COMPANY, HELD AUGUST 18, 1980

WHEREAS, under date of May 15, 1980, the Department of Army, Detroit District Corps of Engineers, advised Edison Sault Electric Company that the Corps of Engineers will undertake a feasibility study on hydro power redevelopment at Sault Ste. Marie;

WHEREAS, the study will include evaluation of the impact of the 1979 Supplemental Orders of the International Joint Commission, the impact of the Great Lakes Power Corporation hydroelectric redevelopment, the impact of existing Contracts DA-20-064-ENG-632 and DA-20-064-ENG-88 and redevelopment of the existing U. S. Hydro Plant and Edison's hydroelectric plant;

NOW, THEREFORE BE IT RESOLVED:

That management is directed to participate in said study and to protect the integrity of Contracts DA-20-064-ENG-632 and DA-20-064-ENG-88 in accordance with the letter of Edison Sault Electric Company under date of May 22, 1980;

That management be directed to do all acts necessary and desirable for the protection of its shareholders in its investment and for customers of the Company.

EXHIBIT "D"

DEPARTMENT OF STATE

Washington, D.C. 20520

June 26, 1980

Mr. George Rejhon
Counsellor-Environment
Embassy of Canada
Washington, DC

Dear George:

As part of the Administration's initiative advocating hydroelectric power installations to help meet critical energy needs, the Corps of Engineers has initiated a feasibility study on hydropower redevelopment at Sault Ste. Marie, Michigan, under the authority of Section 102 of the River and Harbor Act of 1966 (Public Law 89-789).

The purpose of the study is to determine the feasibility of possible redevelopment of the existing power facilities in U.S. waters at Sault Ste. Marie, Michigan, and to determine the extent of any recommended Federal participation. The study would follow normal Corps of Engineers pre-authorization survey study procedures in assessing all engineering, environmental, economic, social, and institutional considerations. The institutional considerations will include a discussion of the approvals required from the International Joint Commission under the Boundary Water Treaty. The Final Feasibility Report together with an Environmental Impact Statement would be forwarded to the Board of Engineers for Rivers and Harbors by the Division Engineer and, following official Washington level review, the report would be forwarded to the Congress for possible authorization of any improvement which might be recommended.

Three important considerations will be evaluated in formulating a recommendation.

First, the evaluation of the impact of the regulation of Lake Superior and the availability of water resulting under the International Joint Commission, 1979 Supplementary Order of Approval. This order curtails, at times, available water for power production for both the U.S. and Canada in order to meet certain lake level and environmental requirements.

Secondly, the evaluation of the impact of the ongoing redevelopment of the Canadian hydro-facilities at Sault Ste. Marie, Ontario, Canada. The new Great Lakes Power Corporation's hydropower plant is expected to be commissioned in 1982 at which time the plant (during periods of average and below average flows) will be able to use its full share of the available water. Historically, the U.S. has been able to use this water. The redevelopment would impact on this availability.

Finally, the evaluation of the impact of existing agreements between the U.S. Government acting through the Secretary of the Army and the Edison Sault Electric Company, concerning St. Marys River waters and the power generated at the U.S. Government hydropower plants. Both of these contracts expire in year 2000. Recommendations forthcoming from this study may have some impact on our obligations under these contracts. Full consideration to these obligations will be given in the study and impacts defined.

The International Joint Commission has been advised of the terms of this study. Should the Government of Canada have any comments or views to submit on this feasibility study the Department would be pleased to receive and transmit them to the Corps of Engineers.

If you desire any further information on the study, please let me know.

Sincerely,

Sid

Sidney Friedland
Environmental Officer
Office of Canadian Affairs

FEDERAL ENERGY REGULATORY COMMISSION
CHICAGO REGIONAL OFFICE
230 SOUTH DEARBORN STREET, ROOM 3130
CHICAGO, ILLINOIS 60604

August 26, 1980

Mr. Philip McCallister
Chief, Engineering Division
Detroit District
Corps of Engineers
U.S. Department of the Army
Box 1027
Detroit, Michigan 48231

Dear Mr. McCallister:

Your July 18, 1980 letter requests power values for four hydroelectric power redevelopment alternatives on the Ste. Marys River at Sault Ste. Marie, Michigan. The alternatives are as follows:

	1	2	3 & 4
Installed hydro capacity in megawatts:	30	40	52.5
Annual production in gigawatt-hours:	223.59	293.10	432.09

In order to implement any one of the proposed alternatives under study, it is our understanding that the present 41 megawatt Edison Sault hydropower plant must be removed from service. This plant consists of 78 small units that were constructed between 1916 and 1964. Under present operation, water for the Edison Sault plant is purchased under contract from the U.S. Government. Alternative 1 would require removal of the Edison Sault plant. Alternatives 2-4, while not requiring physical removal of Edison Sault's plant, would each divert all available flows and, therefore, result in closing the plant.

Since the existing government hydropower plant, together with Edison Sault's plant, are capable of using all available river flows, it appears that the only immediate net gain in hydropower production under each of the proposed alternatives would be a slightly better energy conversion efficiency using newer technology. As pointed out to Dr. Chowdiah, Project Manager, we believe that the economic evaluation of each of these alternatives must recognize the effect on the complete hydropower system. This would include the effect of curtailed generation at the existing Edison Sault plant.

The power values provided do not include the loss of benefits associated with shutdown of Edison Sault's plant. They have been computed based on the assumption that the Edison Sault plant was not in service and that there was unused water sufficient to generate the annual energy shown. Based on this assumption, and using a coal-fueled steam electric plant as the most likely alternative to each of the proposed hydropower alternatives, "at-site" power values have been computed and summarized in the attached table.

The preliminary power values are based on July 1980 price levels and reflect the following general assumptions.

Overall Procedure of Calculating Power Values

Power values are a measure of the benefits of power produced by a hydroelectric plant. As a surrogate for society's willingness to pay, power values are based on the resource costs of constructing and operating the most likely alternative to be implemented in the absence of the hydroelectric plant. This resource cost is given as the investment cost (capacity value) necessary to construct the most likely alternative and the production cost (energy value) which results from operation of the alternative.

Power values are developed based on an analysis of the difference in "system" costs resulting from the system being operated with the most likely alternative and with the proposed hydropower additions. System operating costs are simulated using a probabilistic production costing computer model.

Electric "System" Used in the Model

The Michigan Electric Coordinated System, as it is projected to exist in 1990, was selected as the system simulated by the probabilistic production costing model. In 1990, the energy requirement for this system is projected to be 85,000 GWH with a peak load of 16,000 MW.

Adjustment Factors Applied to Power Values

A hydro capacity value credit of 5% is included in the capacity value to reflect its greater operating flexibility and a credit, as shown in the attached table, is included to reflect its operating reliability.

Values based on private financing are included for your information. Final power values will be provided following their review and approval by our Washington Office.

If you have any questions regarding these power values, please let us know.

Sincerely,

Lawrence F. Coffill

Lawrence F. Coffill
Regional Engineer

Enclosures:
As stated

Proposed Sault Ste. Marie Project

Alternative	1	2	3 and 4
Description	18.4 MW Corps Plant + 30 MW Edison Sault Plant	16.4 MW Corps Plant + 40 MW Corps Plant	52.5 MW Corps Plant using all of U.S.A. water
GWH Annual Hydro Production	223.59	293.10	432.09
Mills/KWH Energy Value Adjustment	0	0	0
Mills/KWH Final Energy Value Based on current fuel cost of coal-steam alternative with production cost of 19.82 mills/KWH	22.93	22.70	24.42
Mills/KWH Final energy value based on lifetime levelized real cost fuel escalation. Annual rate of finance -			
7.125% (Esc. Coeff. = 1.281)	29.37	29.08	31.28
11.5% (Esc. Coeff. = 1.233)	28.27	27.99	30.11
% Hydro reliability capacity value adjustment	+28.9	+28.9	+28.9
$/KW-year capacity value. Annual rate of finance -			
7.125%	129.37	129.95	130.31
11.5%	265.27	266.26	266.87

Michigan Municipal Electric Association
818 COWLEY AVENUE
EAST LANSING, MICHIGAN 48823

Telephone (517) 351-6469

September 4, 1980

Dr. Attru M. Chowdiah
Department of the Army
Detroit District, Corps of Engineers
Box 1027
Detroit, Michigan 48231

Dear Dr. Chowdiah,

The Michigan Municipal Electric Association, a non-profit Michigan corporation which represents 36 municipally owned electric utilities expresses great interest relative to the various proposals by the Corps of Engineers aimed at redeveloping hydropower facilities at Sault Ste. Marie, Michigan.

The Association stands ready to cooperate in every way with the feasibility study now underway. Additional electric power is essential for the members of the Association, particularly those members in Michigan's Upper Peninsula.

A major concern of the Association is the treatment of municipally and cooperatively owned electric utilities in accordance with the well established preference customer doctrine. The Association believes that the one member of its organization that now participates in a purchase power agreement related to the Corps of Engineers present facility at the Sault, the Village of Newberry, does not receive its fair share of electric power as the result of what the Association believes to be an atypical contractual arrangement. The Association takes the position that any expansion or other improvement of the hydroelectric facilities at Sault Ste Marie, Michigan should incorporate a full and complete recognition of the needs of preference customers in the region.

Moreover, the Association takes the position that at the outset of the feasibility study and at the earliest possible moment when the decision is being made relative to the various options proposed, a complete statement of the service area of the project should be made. A satisfactory decision relative to the area and customers to be served by any proposed project will determine whether or not the Association will lend support, oppose, or propose modifications to the project.

The Association offers to make available any information that it may have, including engineering and financial studies, that may expedite the project.

S. Don Potter
Executive Secretary, Legislative Agent

APPENDIX G

STUDY COST ESTIMATE/NETWORK OF ACTIVITIES

Department of the Army
Detroit District, Corps of Engineers

APPENDIX G

STUDY COST ESTIMATE/NETWORK OF ACTIVITIES

The work sequence and timeframes of major study activities are displayed on the Network of Activities. This diagram will serve as a guide to address the issues, needs, and opportunities during Stage 2 and Stage 3.

The total cost of the study is estimated at $955,000. The yearly breakdown of funding is summarized below.

FY 1980	$240,000
FY 1981	$415,000
FY 1982	$300,000

The Study Cost estimate in stages is shown on Form PB-6.

RCS DAEN-CWB-12

STUDY COST ESTIMATE (PB-6)
($000)
For use of this form, see ER 11-2-220

APPROPRIATION TITLE: General Investigations
CATEGORY: Surveys & Examinations
CLASS: Survey

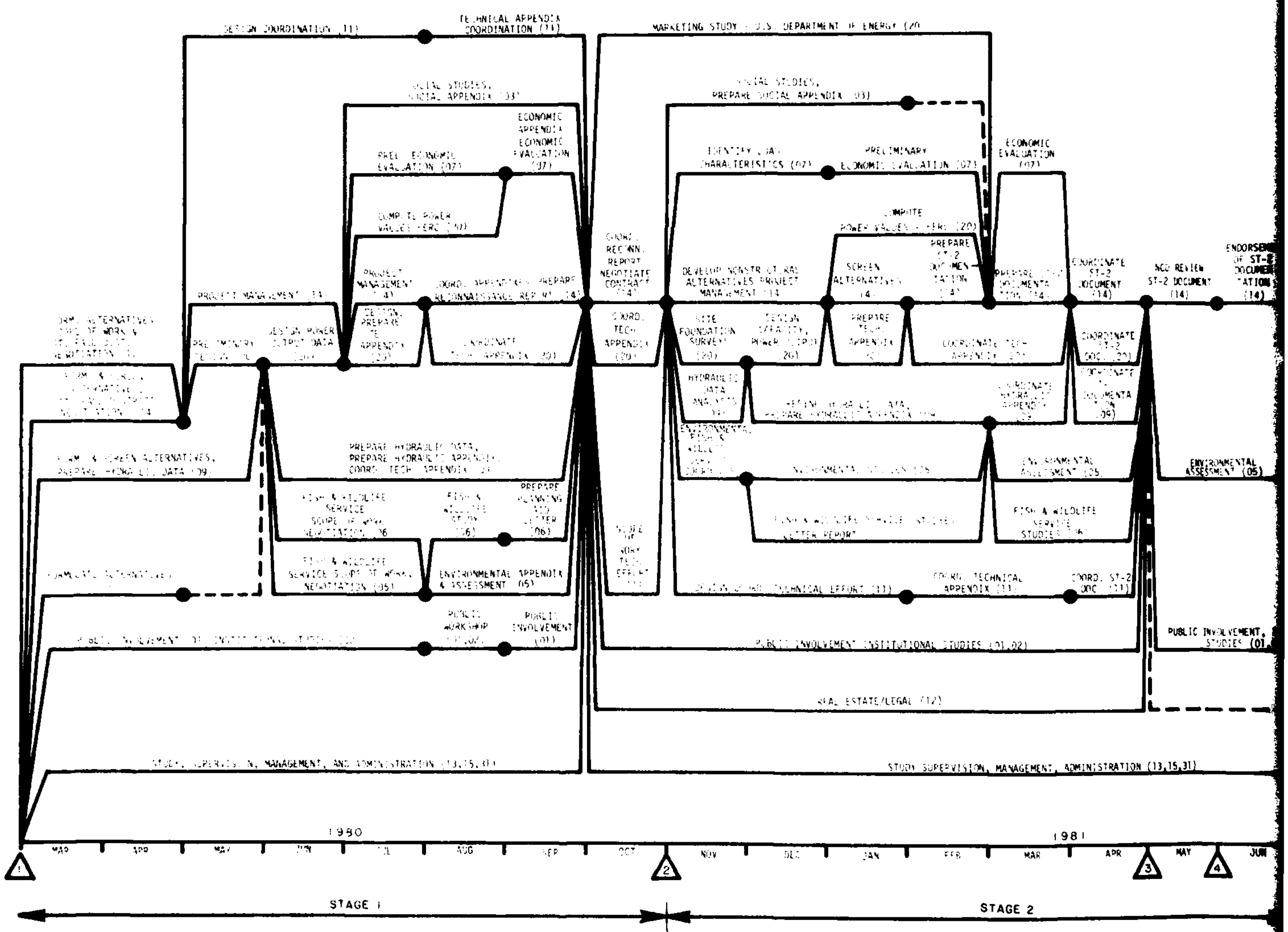
NAME OF STUDY: SAULT STE. MARIE POWER PLANT REDEVELOPMENT, MICHIGAN
SUBCLASS: HYDROPOWER

NUMBER (a)	TITLE (b)	STAGE 1 (c)	STAGE 2 (d)	STAGE 3 (e)	TOTAL (f)	PREVIOUS FEDERAL COST ESTIMATE AND DATE APPROVED (g)	REMARKS (h)
00	Costs through 30 Sep 79	$ 0	$ 0	$ 0	$ 0		
01	Public Involvement	1	2	5	8		
02	Institutional Studies	1	1	2	4		
03	Social Studies	4	4	6	14		
04	Cultural Resource Studies						
05	Environmental Studies	7	17	28	52		
06	Fish & Wildlife Studies	5	19	15	39		
07	Economic Studies	8	8	13	29		
08	Surveying & Mapping						
09	Hydrology & Hydraulics	25	11	15	51		
10	Foundations & Materials						
11	Design & Cost Estimates	25	16	21	62		
12	Real Estate Studies		1	7	8		
13	Study Management	12	21	39	72		
14	Plan Formulation	36	58	116	210		
15	Report Preparation	7	10	24	41		
20	Other Studies	76	100	63	239		
31	Supervision & Admin.						
	(Overhead Incl. in S&A)	33	32	61	126		
	TOTAL	$240	$300	$415	$955		

DATE PREPARED: 30 Sep 1980
DIVISION: North Central
DISTRICT: Detroit
REGION: GREAT LAKES
BASIN:
Page 1 of 1

SAULT STE. MARIE POWER PLANT

NETW

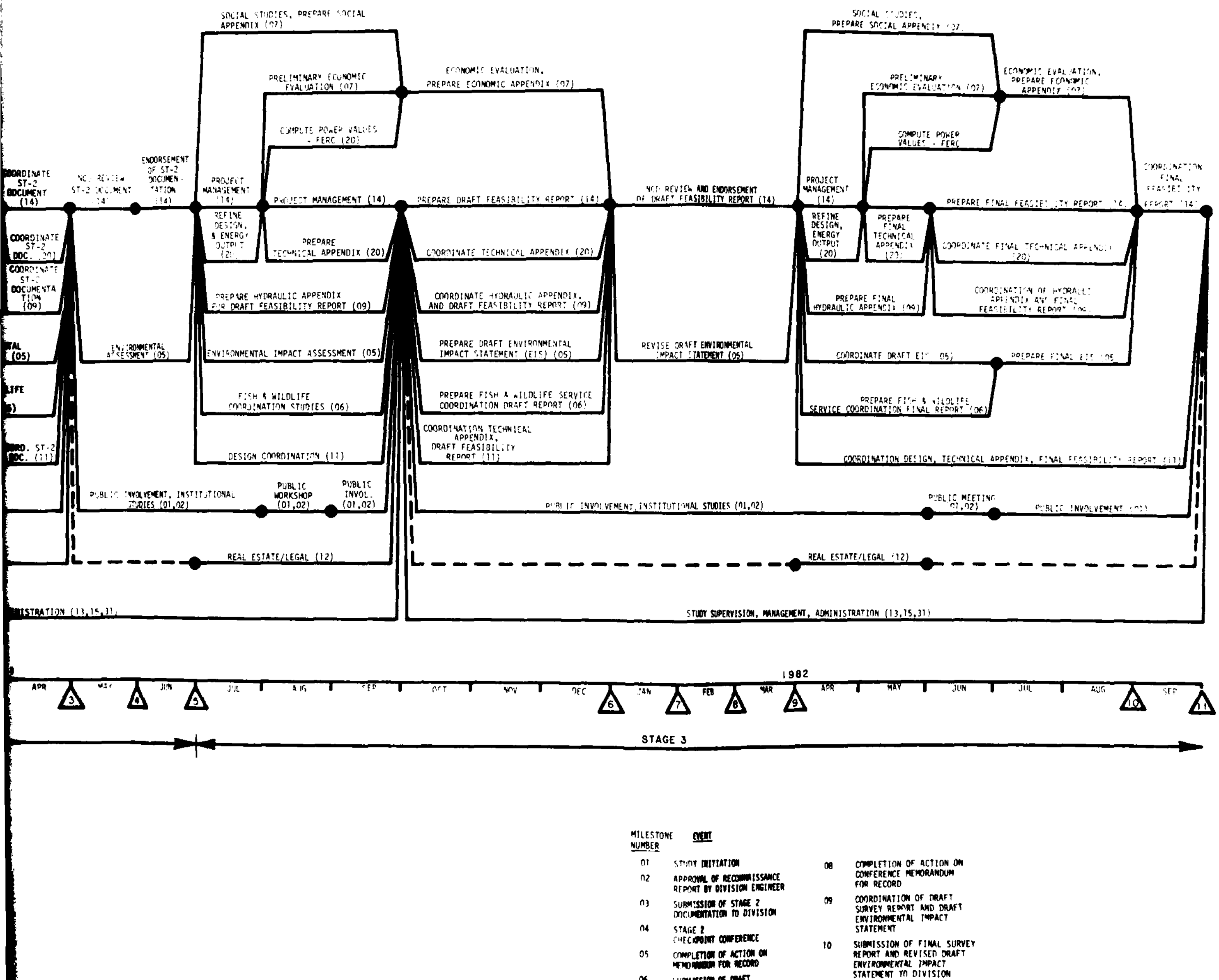


REPRESENTS MILESTONES

( ) NUMBERS IN PARENTHESIS AFTER THE ACTIVITY CORRESPOND TO THE ACTIVITY NUMBERS IN FORM PB-6

E POWER PLANT REDEVELOPMENT MICHIGAN FEASIBILITY STUDY

NETWORK OF ACTIVITIES



MILESTONE NUMBER	EVENT
01	STUDY INITIATION
02	APPROVAL OF RECONNAISSANCE REPORT BY DIVISION ENGINEER
03	SUBMISSION OF STAGE 2 DOCUMENTATION TO DIVISION
04	STAGE 2 CHECKPOINT CONFERENCE
05	COMPLETION OF ACTION ON MEMORANDUM FOR RECORD
06	SUBMISSION OF DRAFT SURVEY REPORT INCLUDING DRAFT ENVIRONMENTAL IMPACT STATEMENT TO DIVISION
07	STAGE 3 CHECKPOINT CONFERENCE
08	COMPLETION OF ACTION ON CONFERENCE MEMORANDUM FOR RECORD
09	COORDINATION OF DRAFT SURVEY REPORT AND DRAFT ENVIRONMENTAL IMPACT STATEMENT
10	SUBMISSION OF FINAL SURVEY REPORT AND REVISED DRAFT ENVIRONMENTAL IMPACT STATEMENT TO DIVISION
11	RELEASE OF DIVISION ENGINEER'S PUBLIC NOTICE AND SUBMISSION OF REPORT TO BOARD OF ENGINEERS FOR RIVERS AND HARBORS

APPENDIX H

ABBREVIATIONS AND GLOSSARY

Department of the Army

Detroit District, Corps of Engineers

APPENDIX H

ABBREVIATIONS AND GLOSSARY

ABBREVIATIONS

benefit-cost ratio	B/C	kilovolt	kV
cubic feet	ft^3	kilovolt-ampere	kVA
cubic feet per second	cfs	kilowatt	kW
cubic yard	cu yd	kilowatt-hours	kWh
dollars	$	megavolt ampere	MVA
feet	ft	megawatt	MW
feet per second	fps	megawatt-hours	MWh
flow in cfs	Q	percent	%
gigawatt	GW	square yards	sq yd
head in feet	H	Streamflow Reliability Percentage	SRP
Hertz	Hz	tons per square foot	tsf
horsepower	hp		
International Great Lakes Datum	IGLD		

GLOSSARY

AVERAGE LOAD - the hypothetical constant load over a specified time period that would produce the same energy as the actual load would produce for the same period.

BENEFIT-COST RATIO (B/C) - the ratio of the present value of the benefit stream to the present value of the project cost stream computed for comparable price level assumptions.

BENEFITS (ECONOMIC) - the increase in economic value produced by the hydropower addition project, typically represented as a time stream of value produced by the generation of hydroelectric power. In small hydro projects this is often limited for analysis purposes to the stream of costs that would be representative of the least costly alternative source of equivalent power.

BUS - an electrical conductor which serves as a common connection for two or more electrical circuits. A bus may be in the form of rigid bars, either circular or rectangular in cross section, or in form of stranded-conductor overhead cables held under tension.

CAPACITY - the maximum power output or load for which a turbine-generator, station, or system is rated.

CAPACITY VALUE - that part of the market value of electric power which is assigned to dependable capacity.

CAPITAL RECOVERY FACTOR - a mathematics of finance value used to convert a lump sum amount to an equivalent uniform annual stream of values.

CIRCUIT BREAKER - a switch that automatically opens an electric circuit carrying power when an abnormal condition occurs.

COSTS (ECONOMIC) - the stream of value required to produce the hydro electric power. In small hydro projects this is often limited to the management and construction cost required to develop the power plant, and the administration, operations, maintenance and replacement costs required to continue the power plant in service.

COST OF SERVICE - cost of producing electric energy at the point of ownership transfer.

DEPENDABLE CAPACITY - the load carrying ability of a hydropower plant under adverse hydrologic conditions for the time interval and period specified of a particular system load.

ECAR - East Central Area Reliability Coordination Agreement: 23 utilities operating in the east central region of the U.S. constitute ECAR since 1967.

ENERGY - the capacity for performing work. The electrical energy term generally used is kilowatt-hours and represents power (kilowatts) operating for some time period (hours).

ENERGY VALUE - that part of the market value of electric power which is assigned to energy generated.

ELECTRIC RATE SCHEDULE - a statement of the terms and conditions governing the sale of electric service to a particular class of customers.

FEASIBILITY STUDY - an investigation performed to formulate a hydropower project and definitively assess its desirability for implementation.

FEDERAL ENERGY REGULATORY COMMISSION (FERC) - an agency in the Department of Energy which licenses non-Federal hydropower projects and regulates interstate transfer of electric energy. Formerly the Federal Power Commission (FPC).

FOSSIL FUELS - refers to coal, oil and natural gas.

GENERATOR - a machine which converts mechanical energy into electric energy.

GIGAWATT (GW) - one million kilowatts.

HEAD, GROSS (H) - the difference in elevation between the headwater surface above and the tailwater surface below a hydroelectric power plant, under specified conditions.

HERTZ (Hz) - cycles per second.

HYDROELECTRIC PLANT or HYDROPOWER PLANT - an electric power plant in which the turbine-generators are driven by falling water.

INSTALLED CAPACITY - the total of the capacities shown on the nameplates of the generating units in a hydropower plant.

KILOVOLT (kV) - one thousand volts.

KILOWATT (kW) - one thousand watts.

KILOWATT-HOUR (kWh) - the amount of electrical energy involved with a one kilowatt demand over a period of one hour. It is equivalent to 3,413 Btu of heat energy.

LOAD - the amount of power needed to be delivered at a given point on an electric system.

LOAD FACTOR - the ratio of the average load during a designated period to the peak or maximum load occurring in that period.

LOW HEAD HYDROPOWER - hydropower that operates with a head of 20 meters (66 feet) or less.

(AT) MARKET VALUE - the value of power at the load center as measured by the cost of producing and delivering equivalent alternative power to the market.

MEGAWATT (MW) - one thousand kilowatts.

MEGAWATT-HOURS (MWh) - one thousand kilowatt hours.

NUCLEAR ENERGY - energy produced largely in the form of heat during nuclear reactions, which, with conventional generating equipment can be transferred into electric energy.

NUCLEAR POWER - power released from the heat of nuclear reactions, which is converted to electric power by a turbine-generator unit.

OUTAGE - the period in which a generating unit, transmission line, or other facility, is out of service.

PEAKING CAPACITY - that part of a system's capacity which is operated during the hours of highest power demand.

PEAK LOAD - the maximum load in a stated period of time.

PLANT FACTOR - ratio of the average load to the installed capacity of the plant, expressed as an annual percentage.

POWER (ELECTRIC) - the rate of generation or use of electric energy, usually measured in kilowatts.

POWER FACTOR - the percentage ratio of the amount of power, measured in kilowatts, used by a consuming electric facility to the apparent power measured in kilovolt-amperes.

POWER POOL - two of more electric systems which are interconnected and coordinated to a greater or lesser degree to supply, in the most economical manner, electric power for their combined loads.

PREFERENCE CUSTOMERS - publicly-owned systems and nonprofit cooperatives which by law have preference over investor-owned systems for the purchase of power from Federal projects.

RECONNAISSANCE STUDY - a preliminary feasibility study designated to ascertain whether a feasibility study is warranted.

SURPLUS POWER - generating capacity which is not needed on the system at the time it is available.

THERMAL PLANT - a generating plant which uses heat to produce electricity. Such plants may burn coal, gas, oil or use nuclear energy to produce thermal energy.

TRANSFORMER - an electromagnetic device for changing the voltage of alternating current electricity.

TRANSMISSION - the act or process of transporting electric energy in bulk.

TURBINE - the part of a generating unit which is spun by the force of water or steam to drive an electric generator. The turbine usually consists of a series of curved vanes or blades on a central spindle.

TURBINE-GENERATOR - a rotary-type unit consisting of a turbine and an electric generator. (See TURBINE & GENERATOR)

WATT - the rate of energy transfer equivalent to one ampere under a pressure of one volt at unity power factor.