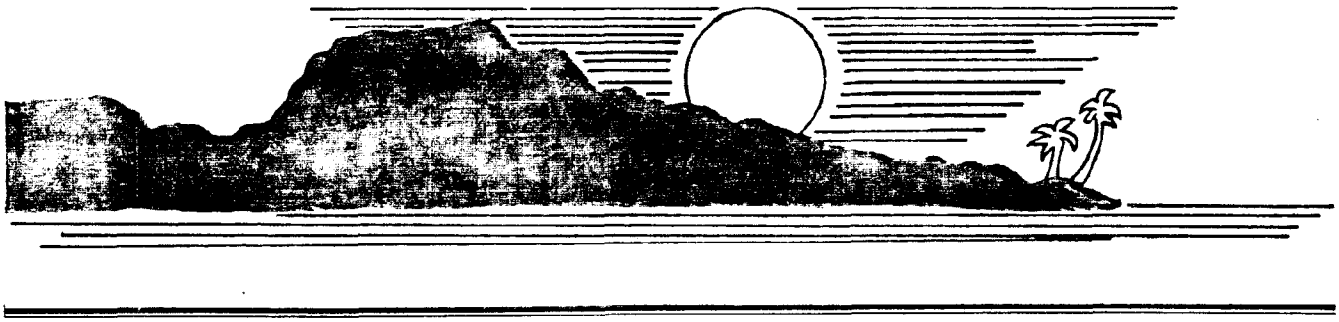
Energy Facility Siting



Coastal Zone Management Plan

AMERICAN SAMOA

ACTION RESOURCES INCORPORATED

COASTAL ZONE MANAGEMENT PROGRAM

ENERGY FACILITY SITING

FOR

THE TERRITORY OF AMERICAN SAMOA

Prepared For:

Development Planning Office
American Samoa Government
Pago Pago, American Samoa 96799

By:

Action Resources Incorporated
1077 Bishop Street, Suite 442
Honolulu, HI 96813
(808) 524-0946

February 21, 1980

This publication is financed in part by a federal grant from the Office of Coastal Zone Management, National Oceanic and Atmospheric Administration, under the provisions of Section 305 of the Coastal Zone Management Act of 1972 (P.L. 92-583, as amended).

PREFACE

Action Resources Incorporated (ARI) was contracted by the Development Planning Office (DPO), American Samoa Government (ASG) to conduct data collection and analysis necessary for the development of a recommended Energy Facility Siting (EFS) Plan as part of the Coastal Zone Management Act, Section 305 planning grant awarded to ASG. Section I provides an introduction to the report. Section III establishes present conditions and develops two scenarios for the future. Sections III through VII contain a description of the analytic approach taken, the results obtained from analysis and the recommended actions that ASG should consider to implement the EFS Plan.

An executive summary of the report and of the recommended Energy Facility Siting Plan will be found in Section II.

Major sources referenced in this report are indicated by a number which corresponds to the number referenced in the bibliography. Other publications, books, periodicals, etc., which were used as general background information are listed in the bibliography as well.

TABLE OF CONTENTS

LIST OF EXHIBITS

GLOSSARY OF TERMS

AEC - Atomic Energy Commission

ARI - Action Resources Incorporated

ASC - American Samoa Code

ASG - American Samoa Government

AV - Aviation (gasoline)

Biomass - The conversion of energy stored in plant and animal material to another form.

CIPC - Capital Improvement Projects Committee

CZMA - Coastal Zone Management Act

CZMP - Coastal Zone Management Plan

DOE - Department of Energy (Federal)

DPO - Development Planning Office

DPW - Department of Public Works

ECAB - Energy Conservation Advisory Board

EDP - Economic Development Plan

EFS - Energy Facility Siting

EIA - Environmental Impact Assessment

EIS - Environmental Impact Statement

EQC - Environmental Quality Commission

EUD - Electric Utility Division

Geothermal - The use of natural sources of heat to create electric power(or for other uses).

Hydropower - Electricity generation through the use of water.

KW - Kilowatt(1000 watts)

Low Potential - As defined and utilized by this report, slopes over 30^{o} would be difficult areas to construct facilities, therefore offer low potential likelihood of energy facility siting.

LPG - Liquid Propane Gas

MW - Megawatt(1000 KW)

OTEC - Ocean Thermal Energy Conversion

OWEC - Ocean Wave Energy Conversion

TEO - Territorial Energy Office

TPC - Territorial Planning Commission

SECTION 1

INTRODUCTION

1.1 Objectives

The objectives of this study have been to:

- Determine the electricity and transportation fuel supply, demand and capacity requirements for the future in order to determine the type and size of energy facilities that might be utilized to meet the needs of the Territory considering
  - Economic Development Plan Goals
  - Energy Conservation Measures
  - Alternative Energy Sources
- Determine the extent that Energy Facility Siting could potentially affect the coastal zone.
- Determine the extent that current territorial laws, related rules & regulations and policy management satisfy the CZMA planning considerations and criteria for EFS.
- Based upon the above objectives, derive recommendations for modifications to current procedures that would conform to CZMA requirements for EFS and design an EFS planning process. Each of the above broad objectives are treated in the ensuing sections.

1.2 Approach

In June, 1979, ARI began reviewing energy programs being implemented by the government and began collecting and reviewing energy-related studies applicable to American Samoa. These studies and programs are listed in Exhibits I-1 and I-2. ARI analysts and engineers subsequently visited American Samoa to collect additional information through data analysis and interviews with various ASG agency personnel. These visits included the review of general materials related to the past trends and future economic development goals of the Territory. This latter effort was assumed to be of significant importance to any energy facility planning. The bibliography contains a complete list of all reference materials used to develop this study. The data and information

EXHIBIT I-1

ENERGY RELATED STUDIES

1. Electrical Power Study 1970-1980, Island of Tutuila, American Samoa, March, 1970, Wilsey and Ham.

2. Reliability Study, Electric Utility System, Island of Tutuila, American Samoa, June, 1972, Keller and Gannon.

3. Geothermal Energy in the Pacific Region, May, 1975, ONR/Colorado School of Mines.

4. State Variable Analysis, Control and Feasibility of Design of an Ocean Thermal Power Plant, December, 1976, Purdue University.

5. Territorial Solid Waste Management Plan, September, 1978, Dames & Moore.

6. An Operations Review of Power Generating Efficiency of the Electric Utility Division, October, 1978, Action Resources Incorporated.

7. Electric Power Generation Study, Island of Tutuila, American Samoa, November, 1979, Parsons, Hawaii.

8. Hydrologic Investigation of Surface Water for Water Supply and Hydropower, Tutuila Island, American Samoa, 1979, Dames & Moore.

EXHIBIT I-2

DOE GRANTS AND CONTRACTS TO AMERICAN SAMOA

1.	Cooperative Agreement	March, 1975 - June, 1976	Fuel allocation, energy conservation and energy resource development.
2.	Cooperative Agreement	June, 1976 - September, 1977	Development State Energy Management Program and Solar Unit Installations.
3.	State Energy Conservation Program	September, 1976 - April, 1978	Planning Grant to develop Territorial Energy Plan.
4.	State Energy Conservation Program	March, 1977 - Continuing	Implementation of Basic Plan.
5.	Supplemental State Energy Conservation Program	September, 1977 - Continuing	Implementation of Supplemental Plan.
6.	Energy Extension Services Program	February, 1978 - Continuing	Study Pilot States Outreach Program.
7.	Appropriate Energy Technology Program	July, 1979 - Continuing	Biomass-anaerobic conversion of Tuna Sludge.
8.	Geothermal Energy Feasibility	September, 1979 - Continuing	Conduct Analysis of Geothermal Potential for Samoa.
9.	Schools, Hospitals, Local Government and Public Care Facilities Energy Audits Program	July, 1979 - Continuing	Conduct PEA's, EA's, TA's, and ECM's on specified eligible buildings.

obtained was used to establish a baseline upon which an EFS planning process could be defined and designed that not only satisfies the CZMA, but more importantly, is appropriate to the culture and unique conditions of the Territory.

Within this perspective, the approach to the performance of the contracted tasking was as follows:

- Describe the existing facilities and demand/capacity
- Develop a forecast of future demand through consideration of two possible scenarios.
  - Status Quo, influenced by energy conservation measures
  - Achievement of Economic Development Plan Goals, influenced by energy conservation measures and by conversion to alternative sources of fuel
- Use the scenario forecasted demand curves to estimate realistic energy facilities that might be utilized to meet demand by considering both conventional and alternative fuel systems
- Evaluate the impacts that the scenario-originated energy facilities may have on the coastal zone
- Develop a planning process that can anticipate and manage the impacts from energy facilities in the coastal zone

1.3 Acknowledgments

In the course of developing this study, much assistance was provided by various staff members of federal offices, ASG agencies and private enterprise which provided valuable input and guidance to its accomplishment. Providing significant assistance were:

- Mr. Paul Templet, CZM Program Manager, Development Planning Office, ASG.
- Mr. Matt T. Le'i, Acting Director, Territorial Energy Office.
- Mr. John Reader, General Manager, Electric Utility Division, ASG.
- Mr. Fred Rohlfing, Amerika Samoa Office - Hawaii.
- Lieutenant Commander Robert S. Illman, U.S. Coast Guard, District 14, Honolulu, Hawaii.
- Mr. Richard Poirier, CZMP Office, Department of Planning and Economic Development, State of Hawaii.

- Mr. Matt Oliver, Project Manager, Parsons, Hawaii.
- Mr. Rusty Betham, Manager, Chevron, USA, Pago Pago.
- Mr. Brant Judy, General Manager, Pago Petroleum (Union Oil Representative).

SECTION 2

SUMMARY

Contained in this section is a summary of the findings and recommendations developed during the conduct of this study.

2.1 Energy Facilities Likely to be Located in the Coastal Zone

Energy demand forecasts were developed for the period 1978 through 1990 using two different scenarios. The first scenario was based on the assumption that the past trends in electric and transportation demands would essentially continue with little significant change in the future, except that attributable to successful achievement of energy conservation measures. The second scenario also considers energy conservation but was based on the assumption that selected goals of the Economic Development Plan (EDP), FY 1978-1983, would be achieved thereby causing a higher demand than the first scenario.

Using these demand curves, a review of expanded and/or new energy facilities to meet future demand was made. For scenario one, only conventional fuel systems and facilities were considered. Essentially, this scenario can be looked upon as the status quo situation. For scenario two, both conventional and alternative fuel systems and facilities were considered. This scenario, can be categorized as an economic and energy self-sufficiency oriented development program. The results of the review process indicated that the following types of energy facilities are viable candidates to meet the future demand of the Territory:

2.1.1 Electrification

Conventional fuel systems that are candidates to be located in the coastal zone include diesel generators, gas turbine, LPG dual cycle turbine, and steam turbine.

Alternative fuel systems considered to be technologically available within the 1978-1990 time frame are solar thermal, photovoltaic, nuclear, wind, biomass, hydropower, geothermal, and ocean thermal energy conversion (OTEC).

With the exception of diesel, gas, and dual cycle systems, none can be situated on the current sites. Thus, a change in the power generating system will require new site locations.

2.1.2 Transportation

Based on the increasing trend of private vehicle ownership, greater fuel storage facilities will be required.

2.1.3 Storage

Increased electrical and transportation (both airlines and motor vehicles) demands will necessitate expansion of the current conventional fuel storage facilities.

Should alternative fuel systems replace existing conventional fuel systems for electrification, then new storage facilities would be required. The alternative systems requiring new storage facilities include nuclear energy (radioactive materials), solar thermal energy (working fluid/gas), ocean thermal energy conversion (working fluid/gas), and biomass (gases).

2.1.4 Fuel Handling Facilities

A number of recommendations for relocating and/or expanding the existing port dockside facilities are currently under consideration by various government agencies. Major changes include consideration of relocating the fuel unloading area. Within the harbor, but further away from the commercial and governmental buildings surrounding the current docking area, installation of an underwater pipeline across Pago Pago Harbor and installation of an underground pipeline from the current fuel farm to the Tafuna power station/industrial park area.

In addition to the expansion of existing handling facilities, the introduction of alternative energy systems will require the construction of new handling facilities for the working medium (fluid/gas) of solar thermal and OTEC systems, radioactive materials for nuclear plants, and organic materials associated to biomass and solid waste systems.

2.2 Site Suitability

Based on the list of candidate energy facilities developed from the scenario projections, a review was made of the possible impacts that each sys-

tem and the possible locations where these systems might be situated. These impacts are discussed in the ensuing paragraphs, as well as the recommended procedures for assessing site suitability.

2.2.1 Expansion of Existing Facilities

The major impacts to be considered when expanding existing facilities are visual intrusion, air, noise, and land pollution. Land condemnation to obtain additional fuel storage space or the conveyance of steam, such as between Sutala and the canneries, might be considered. A change to alternative fuels at existing facilities would add the impact consideration of product decay and incineration as in the case of biomass/solid waste and impacts on local traffic from trucking fuel to the site.

2.2.2 Construction of New Facilities

The impacts related to construction of new facilities were addressed for biomass/solid waste, hydropower, geothermal, ocean, nuclear, solar, and wind alternative systems. In each case, air, land, and water pollution were considered; visual impacts and changes to flora and fauna were considered and energy resource depletion and waste pollution were considered.

2.2.3 Prodedures Recommended

Utilizing a matrix system based on that developed by the State (of Hawaii) Advisory Task Force on Energy Policy has been recommended. This matrix system was modified and expanded to fit Samoa's needs. Fifteen major impact areas are ranked by their degree of severity. This tool can be used to develop an overview of potential impacts when considering the entire territory. The matrix can also be used on a site specific case, comparing alternatives against a single location. In addition, the matrix can be used on a time specific basis, considering only energy systems expected to be available and operational by a specific date.

The results of the matrix evaluation can be utilized by the planning and zoning agencies in considering future energy facility siting.

2.3 Territorial Policies and Techniques for the Management of Energy Facilities and/or Impacts

A review of existing laws, rules and regulations, agency charters and

ASG policies and practices was conducted to determine the extent to which they fulfill the requirements subsection 305(b)(8) of the CZMA. Based on this review, recommended expansion of, or modifications to, existing guidelines were made to improve the management of energy facilities and/or their impacts.

2.3.1 Summary of Existing Policies and Laws

Land ownership in Samoa was reviewed and its breakdown of ownership is listed in Section 6. Over 92% of the territory's land is communally owned. The American Samoa Code (ASC) establishes a Land Commission which ensures that the sale or lease of land is in accordance with the codes. Established by executive order, the Land and Site Use Committee ensures that the use of public lands conforms to government land master planning. The codes establish a zoning board which zones permissible land and structural uses and can grant variances. The Territorial Park and Recreation Control Board established by ASC has the power to acquire land for parks, preserves, or historic or scenic places.

The Territorial Planning Commission established by ASC prepares and recommends a general plan for the Territory and grants business licenses. The Office of Samoan Affairs has, among other duties, responsibility for settling matai title and communal land disputes.

The American Samoa Government has the authority to acquire land as stated by several sections of ASC. The ASC establishes the Environmental Quality Commission which has the power and duty to establish air and water quality standards.

The Territorial Energy Office was established by executive order and is the responsible agency for all energy affairs. Its advisory board, the Energy Conservation Advisory Board (ECAB), consists of people from government and the community and their committee responsibilities range from recommending future energy program endeavors to review of educational curriculum.

2.3.2 Findings

All energy matters are essentially addressed through the EUD, TEO and ECAB. Existing land, building, environment, and energy planning, zoning,

permitting and licensing procedures will satisfy the requirements of CZMA with a single adjustment.

2.3.3 Recommendations

The adjustment recommended to satisfy CZMA is the addition of a clause to the rules and regulations for each of the above agencies which insures that each will consider energy facilities and/or their impacts in their review processes.

2.4 Intergovernmental Coordination

A review of the current governmental infrastructure was made in relationship to energy facilities and/or their impacts to determine if an adequate mechanism for coordination and/or cooperative working arrangements exist among the various agencies of government (both territorial and federal), the energy industry of Samoa and the general public. Based on this review, recommended modifications to or expansions of current coordination mechanisms were made to more clearly delineate responsibilities and authorities, and to ensure the widest participation in the control and management energy facilities and/or their impacts.

2.4.1 Summary of Existing Coordination Mechanisms

The review of existing agencies' charters and policies indicated that with minor alteration they could manage energy facilities and/or their impacts. In Section 7, Exhibit VII-1 illustrates a recommended organizational flow chart for the processing of an application related to an energy facility. The discussion in Section 7 takes the reader on a step by step walk through the application process, whose successful completion leads to application for the building permit. During the application process, facility need, land use, environmental quality, and territorial planning are among the major areas which must be passed. Other existing agencies, committees, and boards are integrated into the flow diagram for managing energy facilities.

2.4.2 Findings

The agencies required to manage energy facility exist within the structure of the American Samoa Government.

2.4.3 Recommendations

It is recommended that agencies shown by Exhibit VII-1 be instructed to design the appropriate rules and regulations consistent with the spirit and intent of Sections 5 through 7 of this report.

SECTION 3

PRESENT FACILITIES AND SCENARIOS FOR THE FUTURE

3.1 Introduction

A portion of the required process of energy facility planning is an identification of energy facilities which are likely to locate in or which may significantly affect the coastal zone. In order to identify energy facilities, baseline data was gathered and assembled and trends were analyzed to determine future requirements. Conventional and renewable resource alternatives were studied to determine their present and future applicability to the islands. In this section, the present energy facilities on the islands of Tutuila, Ofu and Ta'u are discussed. The generating capacity and peak demand of the power system is plotted and shown in exhibits. Fuel storage and handling systems are discussed. Capacities and demand are given and this baseline data is used to project future requirements and the need for facilities.

Two scenarios are created. Scenario One bases future electrical demand growth projections on historical trends with an adjustment downward for energy conservation. This scenario gives us the lower curve when determining the need for future energy facilities. Scenario Two bases future growth on the predictions of the economic development plan. Assuming that economic development occurs according to the plan, business development and population increases will cause an increased demand for electrical power and transportation. Alternative energy sources are considered in assuming some of the new demand load and the future electrical demand curve was again adjusted for energy conservation effects. The assumptions used to create this upper limit of electrical demand are discussed under the categories residential, commercial, tourism, agriculture, industrial, and transportation. Scenarios One and Two provide a minimum/maximum range for making decisions about the need for energy facilities in the future. The results are an organized approach to determining the needs for and exemplifying, the types of energy facilities likely to be established in the coastal zone of American Samoa.

3.2 Present Facilities

Over 90% of the population of American Samoa resides on Tutuila and accordingly the majority of energy storage, generation facilities, transmission systems and roads exist there. Maps, site plans, zoning charts and previous studies listed in the bibliography were reviewed. On-site inspection tours were made of Satala and Tafuna power plants, airport facilities, canneries, marine railway and the Chevron tank farm at Punaoa Valley. Exhibits found here display the approximate locations of these facilities.

3.2.1 Facilities

The major energy facilities are located on the island of Tutuila. The facilities include the power generation system with plants at Tafuna and Satala, the power distribution and transmission network, the fuel handling facilities, fuel storage facilities, and pipelines.

3.2.1.1 Power Generating and Distribution Network[1,25]

Two generating plants operate on Tutuila, one is located in Tafuna, while the other is located in Satala. Exhibit III-1 shows their locations on the island. These plants contain "conventional" diesel engine-generator units. The island presently has 16 diesel units. Ten are located at Satala and 6 at Tafuna. Six of these units (3 at each site) are portable, being leased on a temporary basis from the U.S. Army. Four of the permanent units at Satala are currently operational, while 2 of the 3 permanent units at Tafuna are operational. The non-operational units are expected to be repaired by early 1980 at which time the portable units will be removed. The Satala power plant site plan, Exhibit III-2, indicates the location of the main power plant, the portable stations and the fuel storage tanks. The Tafuna power plant site plan, Exhibit III-3, indicates the location of the power station, the portable plant and the fuel storage tanks.

The Satala power plant has an installed capacity of 14,500kw excluding the portable units. The peak demand is 7,500kw indicating a demand/capacity factor of 52.6%.

Facilities on the Manu'a Islands are the power stations on the islands of Ofu and Ta'u with their respective distribution lines (Exhibit III-4). The Ofu and Ta'u power plants have small 500kw plants operating at 16% and 36% capacities, respectively. Exhibit III-5 lists all existing facilities and

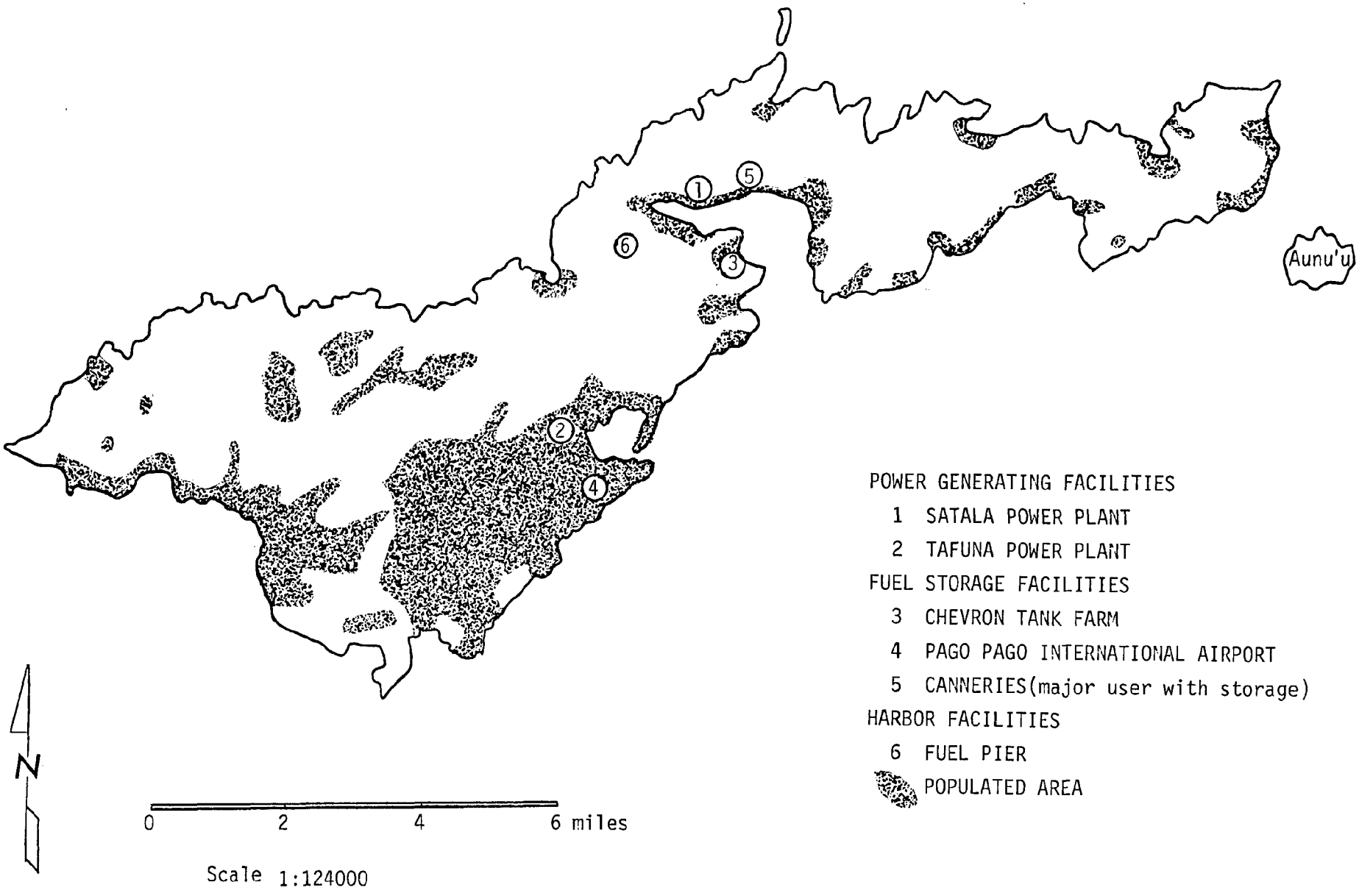
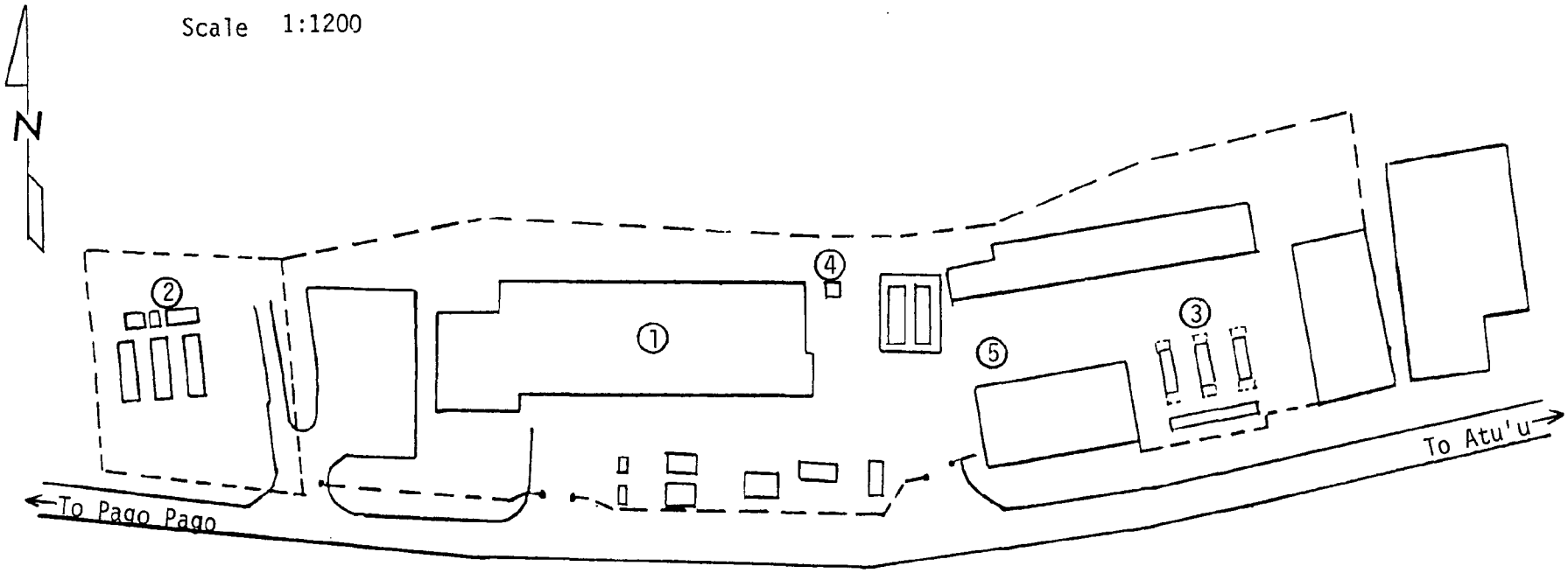


Exhibit III-1 Tutuila Island - Existing Energy Facilities and Populated Areas



① Power Station and Administrative Offices:

Unit No. 1	1,000 KW	Nordberg-Electro Products (1962)
Unit No. 2	1,000 KW	Nordberg-Electro Products (1962)
Unit No. 3	2,000 KW	Nordberg-Electro Products (1964)
Unit No. 4	2,000 KW	Nordberg-Electro Products (1964)
Unit No. 5	3,000 KW	Nordberg-Electro Products (1966)
Unit No. 6	3,000 KW	Nordberg-Electro Products (1971)
Unit No. 7	2,500 KW	General Motors EMD (1977)
TOTAL	14,500 KW	

② Plant "A"
Portable Power Stations (not in use)
3 units at 1,500 KW each = 4,500 KW

③ Plant "B"
Portable Power Stations (currently in use)
3 units at 1,500 KW each = 4,500 KW

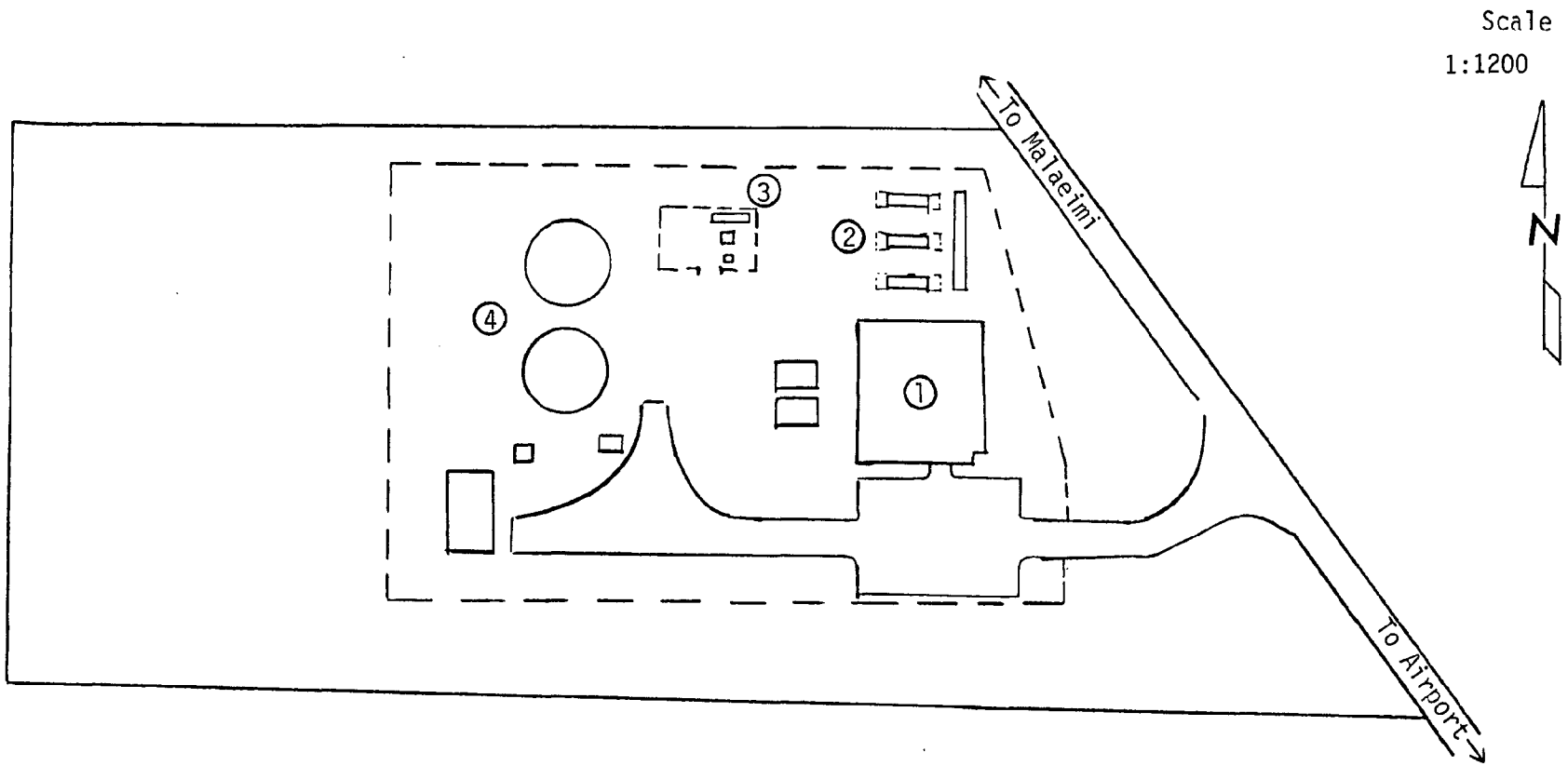
④ 3,000 KVA transformer for Generator Unit No. 7

⑤ Fuel oil storage tanks
Two 24,000 gallon diesel storage tanks

Power Demand-
7,200 KW average
7,500 KW peak

Fuel Consumption-
12,584 gallons/day

Exhibit III-2 Satala Power Station



① Power Station and Administrative Offices:

Unit No. 1	3,500 KW	Nordberg-Ideal (1974)
Unit No. 2	3,500 KW	Nordberg-Ideal (1974)
Unit No. 3	2,500 KW	General Motors EMD (1978)
TOTAL	9,500 KW	

② Plant "C"
Portable Power Station (currently in use)
3 units at 1,500 KW each = 4,500 KW

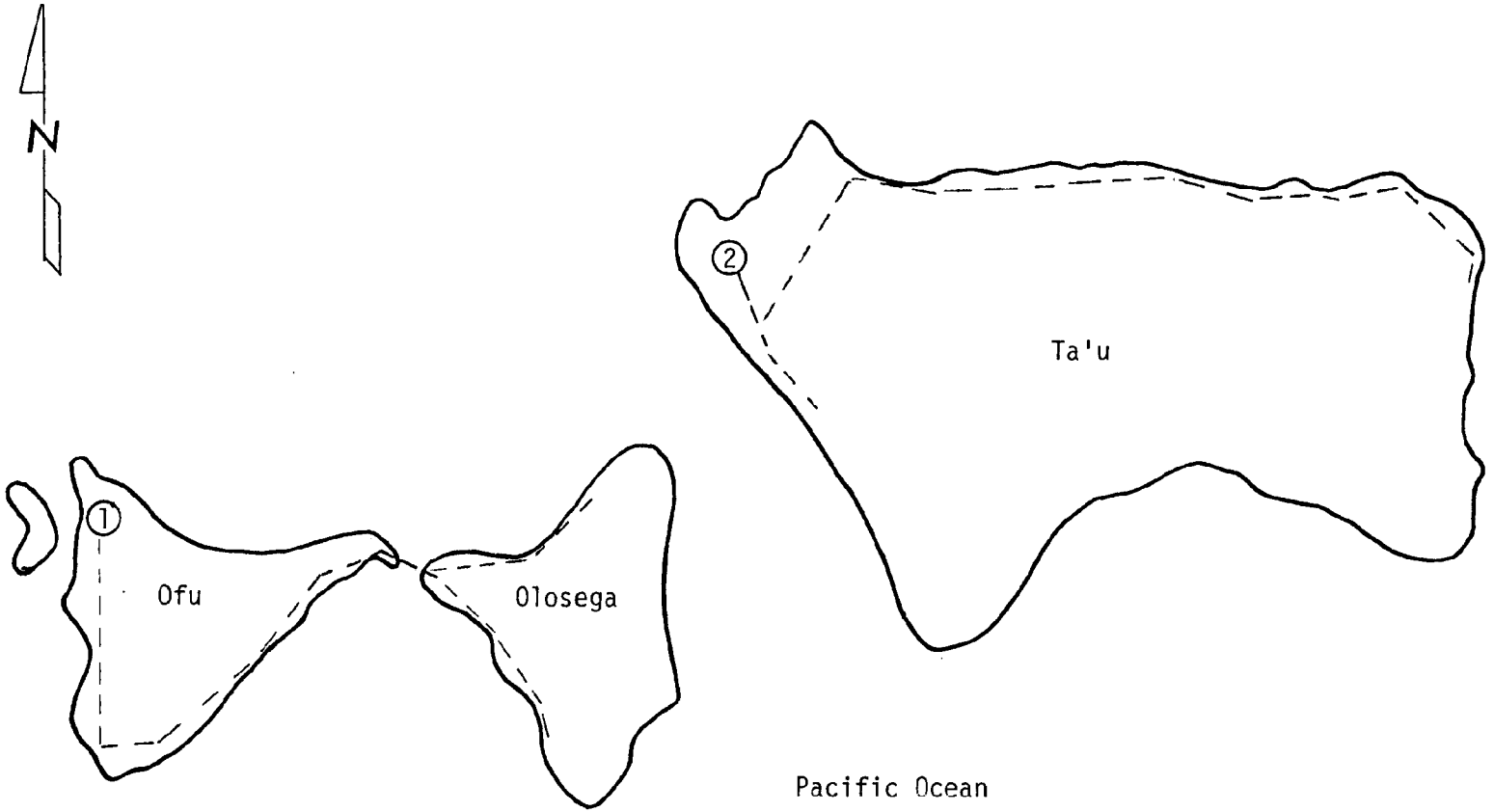
③ 5,000 KVA transformer for tie line

④ Fuel oil storage tanks
Two 100,000 gallon diesel storage tanks

Power Demand-
4,200 KW average
5,000 KW peak

Fuel Consumption-
9,360 gallons/day

Exhibit III-3 Tafuna Power Station



Islands to scale 1: 88,900
Distance between Ofu/Olosega and Ta'u is not to scale

Exhibit III-4 Manu'a Islands - Existing Energy Facilities and Distribution System

	Capacity	Demand	Demand/ Capacity Factor
Power Generation			
Satala Plant	14,500 KW*	7,500 KW (peak)	51.7%
Tafuna Plant	9,500 KW*	5,000 KW (peak)	52.6%
Ofu Plant	500 KW	80 KW	16.0%
Ta'u Plant	500 KW	180 KW	36.0%
Energy Storage			
Chevron Tank Farm			
Diesel	4,536,000 gallons	83,034 gallons/day	55.0 days
Unleaded Gas	512,400 "	3,864 " "	133.0 days
Regular Gas	411,600 "	3,234 " "	128.0 days
Supreme Gas	100,800 "	1,050 " "	97.0 days
Jet Fuel	1,701,000 "	23,016 " "	69.0 days
AV Gas	100,800 "	546 " "	184.6 days
Satala Plant	48,006 gallons	12,600 gallons/day	3.8 days
Tafuna Plant	200,004 gallons	9,366 gallons/day	21.4 days
Airport			
Jet Fuel	109,200 gallons	24,612 gallons/day	4.4 days
AV Gas	25,200 "	491.4 " "	51.0 days

*Additional portable generators are currently in place at Satala (4,500 KW) and Tafuna (9,000 KW). These units are expected to be removed when permanent units are repaired (end of 1979).

Exhibit III-5 Energy Facility Capacity and Demand 1978

details present size or shows the fuel storage capacity for the tank farm, Satala and Tafuna power plants and airport. The demand per day and the number of days of fuel storage per location is given. The most critical is the Satala power plant which has only 3.8 days of fuel capacity. Presently, fuel deliveries occur twice daily by truck.

The distribution and transmission network is shown in Exhibit III-6. The Satala and Tafuna plants are connected by a 13.2kv tie line which is being upgraded to a 34.5kv tie line. The island of Aunu'u at the eastern end of Tutuila is fed from this system by a submarine cable.

3.2.1.2 Fuel Handling

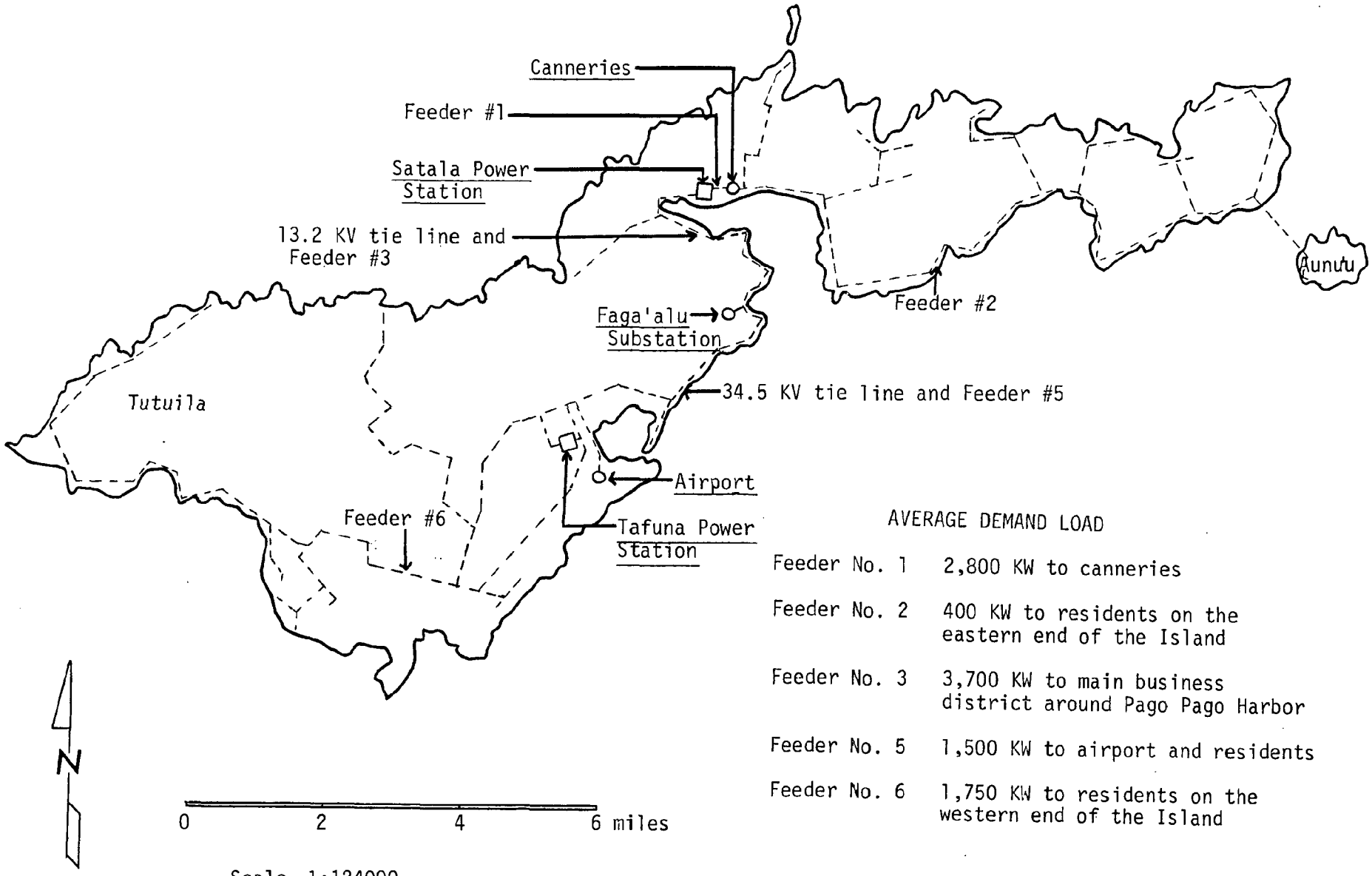
American Samoa is 100% dependent on imported fossil fuels. Approximately every 33 days, a tanker arrives at the fuel pier in Pago Pago Harbor in Utulei. This fuel pier is located next to the Rainmaker Hotel and the Convention Center (Exhibit III-7). Fuel is offloaded and transmitted to the tank farm storage area via underground pipeline. Only refined fuels are imported since there are no refineries in American Samoa.

The imported fuels are gasoline (unleaded, regular, and supreme), aviation gasoline, jet fuel and diesel fuel. Tank trucks deliver fuel from the tank farm to the gasoline stations, power plants, canneries, marine railway, airport and the medical center via the one primary road on the island. Diesel fuel for the fishing fleet is pumped back via pipeline to the fuel pier and onboard.

3.2.1.3 Fuel Storage

The tank farm mentioned above is located in Punaoa Valley (Exhibits III-8 and III-9). This tank farm is owned by the American Samoa Government (ASG) and leased to Chevron, USA Inc. The storage capacities at the tank farm are listed in Exhibit III-5, Column one. The tank farm has storage for diesel fuel, jet fuel, AV gas, unleaded, regular and supreme gasoline.

Fuel storage facilities are also located at the major energy user facilities or retailers such as the seven gasoline stations. The Satala power plant has storage capacity for 48,006 gallons of diesel, the Tafuna plant has storage capacity for 200,004 gallons of diesel, the airport tanks, Exhibit III-10, have storage capacity for 109,200 gallons of jet fuel and



AVERAGE DEMAND LOAD

Feeder No. 1	2,800 KW to canneries
Feeder No. 2	400 KW to residents on the eastern end of the Island
Feeder No. 3	3,700 KW to main business district around Pago Pago Harbor
Feeder No. 5	1,500 KW to airport and residents
Feeder No. 6	1,750 KW to residents on the western end of the Island

Exhibit III-6 Tutuila Island - Existing Electric Distribution System

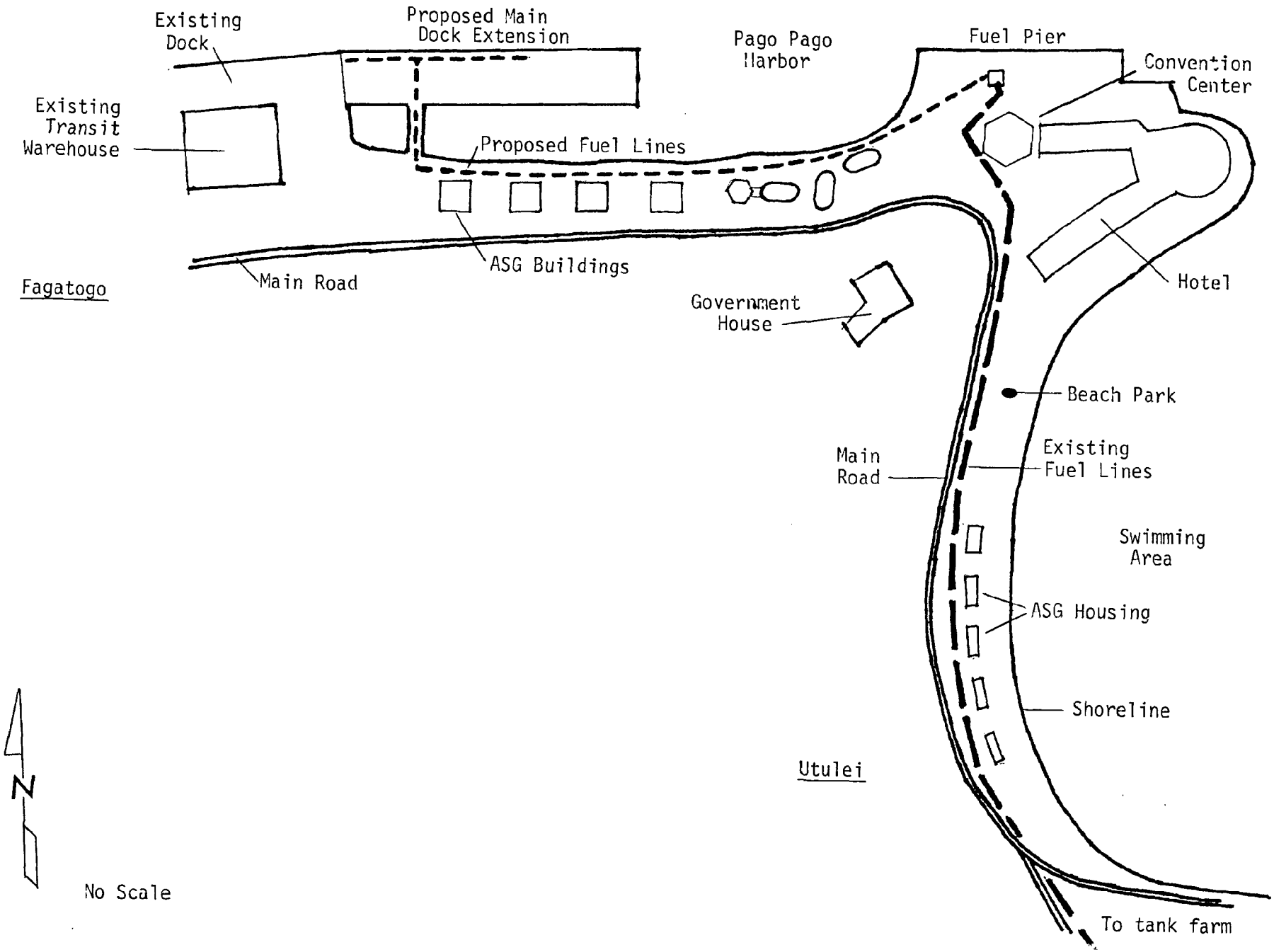


Exhibit III-7 Underground Fuel Lines - Docks to Tank Farm

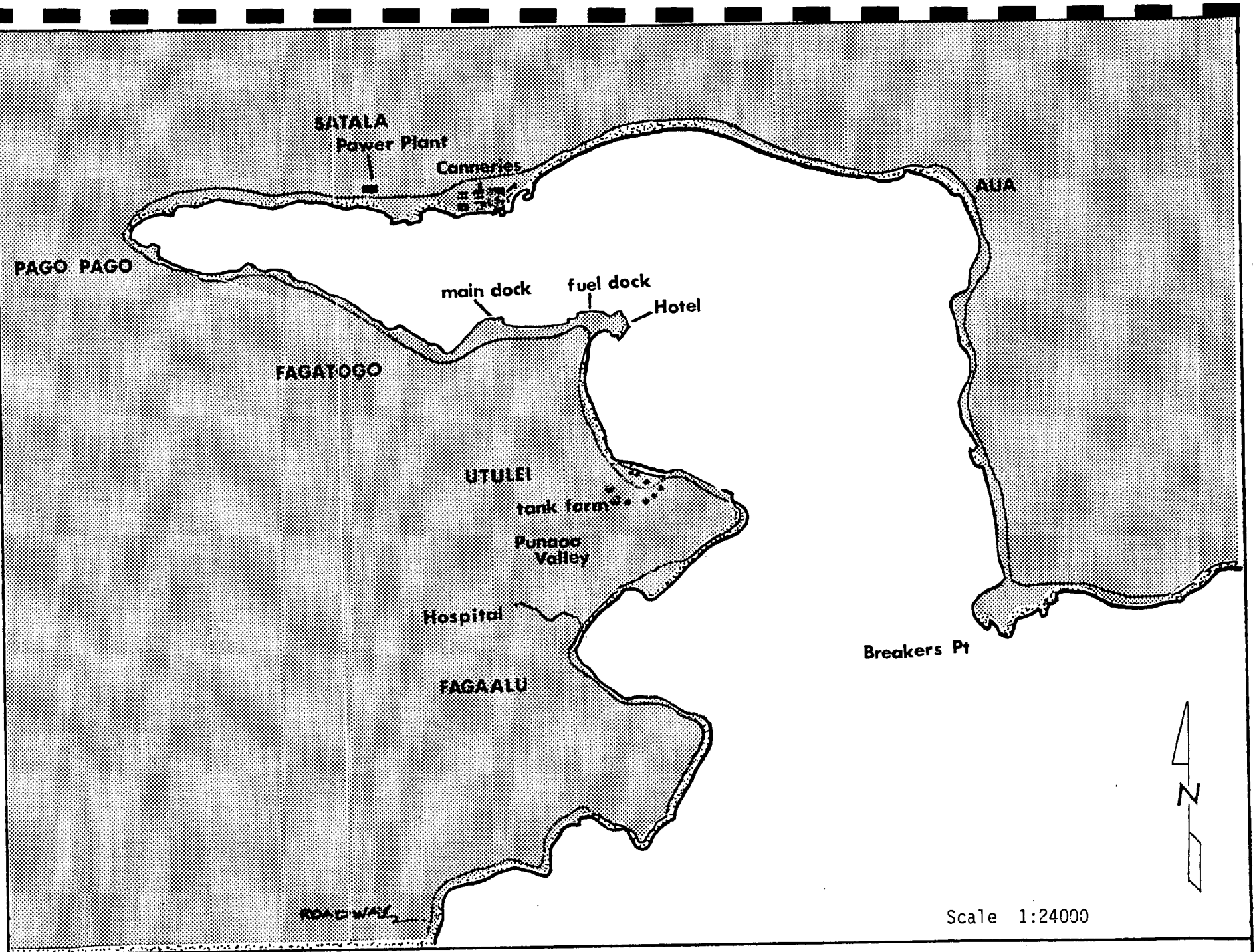


EXHIBIT III-8 PAGO PAGO HARBOR OVERVIEW

ACTION RESOURCES INCORPORATED
1077 BISHOP STREET SUITE 442 HONOLULU, HAWAII 96813

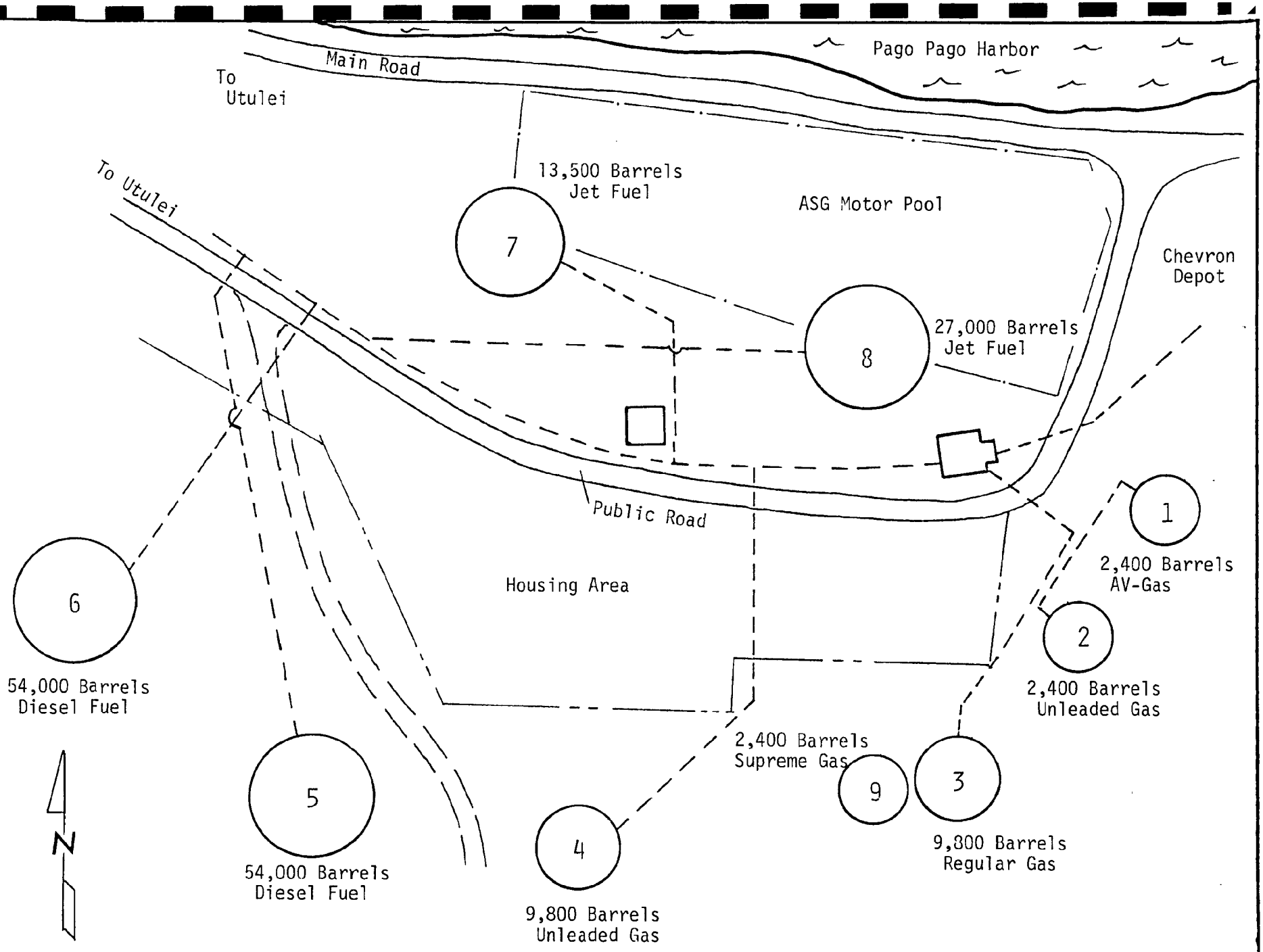


Exhibit III-9 Punaoa Valley - Chevron Tank Farm

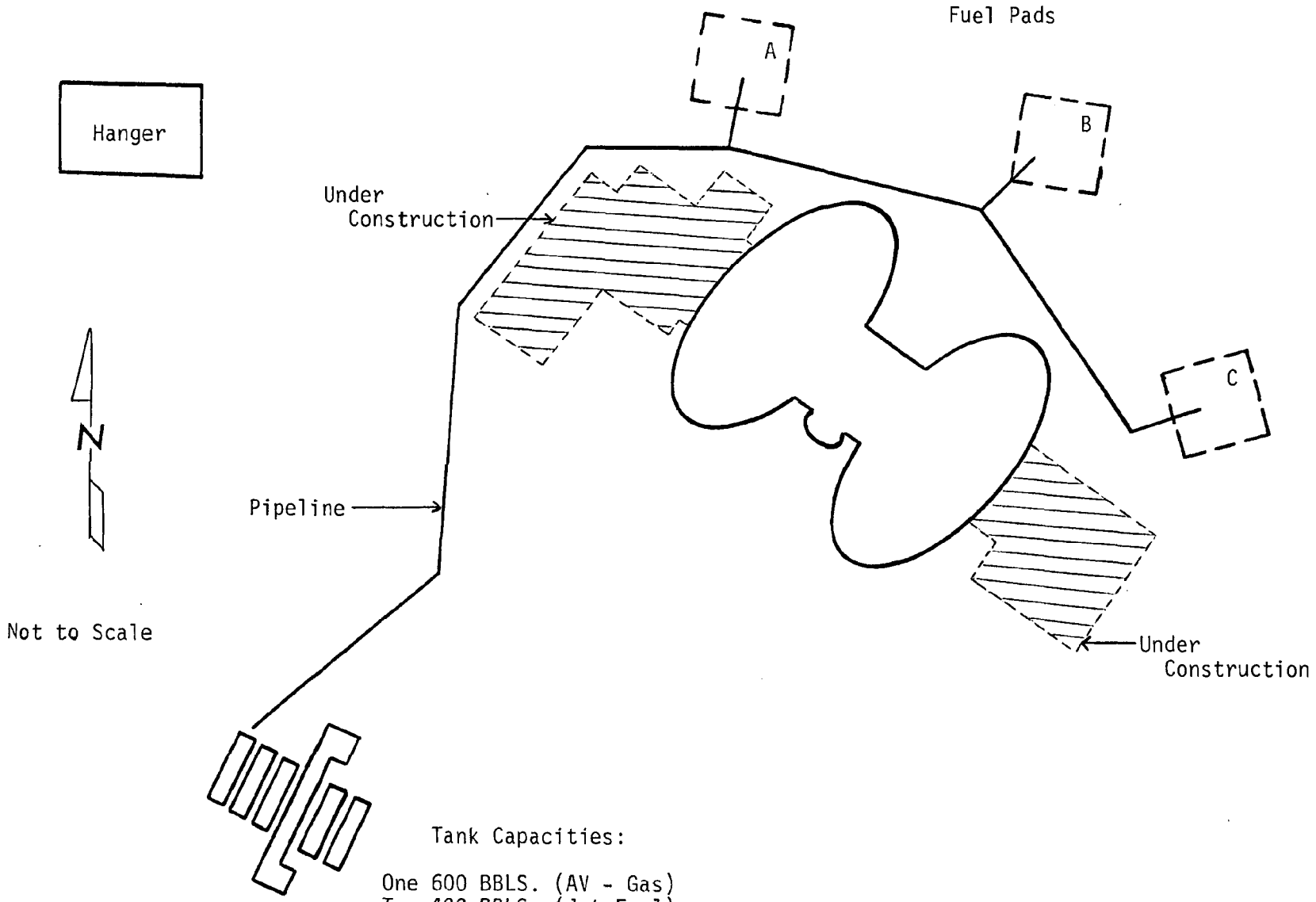


Exhibit III-10 Pago Pago International Airport

25,200 gallons of AV gas. The LBJ Tropical Medical Center in Faga'alu has a diesel engine generator set for emergency power. Normal maintenance practices require weekly operation of the engines and there have been occasions when the power plant, in order to reduce their peak load problems, have requested the medical center to transfer to its own power. The hospital also uses diesel fuel for the hot water system boilers.

The tuna canneries located near the Satala power plant (Exhibit III-8) use diesel fuel to heat water to create process steam.

3.2.2 Transportation [2]

In 1978, there were 3,266 vehicles registered in American Samoa. Of these, 2,488 were private autos. The total number of vehicles in American Samoa has actually decreased during fiscal years 1975-1978. This decline was due to reductions in the number of commercial buses, taxis, and government vehicles. The number of private automobiles has increased by an average rate of 2.3% per year from 1976-1978. American Samoa imported 2,958,789 gallons of gasoline during the fiscal year 1979 (Oct. '78 to Sept. '79), with 1,404,558 gallons being unleaded and 1,554,231 being regular and supreme. The storage capacity of each type at the tank farm is 512,400 gallons of unleaded, 411,600 gallons of regular, and 100,800 gallons of supreme. The demand per day of unleaded fuel was 3,864 gallons. At this rate, unreplenished supplies would last 133 days. The demand per day of regular was 3,234 gallons. At this rate, unreplenished supplies would last 128 days. The demand per day of supreme was 1,050 gallons. At this rate, unreplenished supplies would last 97 days. Diesel fuel imports in FY 1979 were 30,307,531 gallons. The amount used by transportation vehicles is negligible. Most diesel fuel is consumed by the power plants and the tuna fishing fleet and other boats. The Chevron tank farm can store 4,536,000 gallons of diesel fuel. The demand per day in 1979 was 1,977 barrels per day or 83,034 gallons. Unreplenished supplies would last 55 days.

Jet fuel and aviation (AV) gas are also stored at the tank farm. Jet fuel storage is 1,701,000 gallons. Imports in FY 1979 were 8,980,742 gallons giving a daily demand rate of 24,604 gallons. Storage depletion would take 69 days. Jet fuel storage at the airport is 109,200 gallons which indicates that depletion to zero would occur every 4.4 days. AV gas storage at the tank farm is 100,800 gallons. Imports in FY 1979 were 179,462 gallons

indicating a daily demand rate or 492 gallons. Depletion of AV gas would therefore occur after 205 days. The airport stores 25,200 of AV gas which lasts 51 days.

Exhibit III-5 reflects the consumption of gasoline and the present storage capabilities for unleaded, regular and supreme gasoline at the Chevron tank farm. Also shown in this exhibit are the storage capacities and demand for AV gas, jet fuel, and diesel. Storage tank capacities for tanks located at Tafuna and Satala power plants and the airport are shown here.

3.2.2.1 Demand

Peak electrical power demand data was assembled and plotted. The report, "An Operations Review of Power Generating Efficiency - Electric Utility Divison - Action Resources Incorporated, October, 1978," contained the historical peak data. A regression analysis was used to plot a future demand curve based on historical trends. The historical climb of increasing power demand can be seen in Exhibit III-11. In 1970, the peak demand was just under 7 megawatts; in 1972, it had climbed to 7.5 megawatts and one year later was well over 9 megawatts. By 1975, peak electrical demand was surpassing 11 megawatts. Growth was slower in the ensuing years to a peak of 12.5 MW in 1978. The Parsons, Hawaii report also used a regression analysis to plot a future demand curve based on historical trends. From this curve, they plotted two related curves, one showing a 100% reserve equipment capability and one showing a 66% reserve equipment capability. These are redrawn here in Exhibit III-13. Increased demand causes a need for new equipment by 1982. Parsons, Hawaii made this a 6MW increase. In 1987, some of the existing equipment has to be retired. This fact, coupled with increased demand, causes the need for new equipment with a capacity of 15MW (2.5MW more than total present peak demand).

Assuming that the power plant remains a conventional fuel burning system, the increased peak demands will cause a need for more fuel storage capacity. Several avenues have been discussed. These include new storage tanks at the Satala power plant, a fuel barge which could be hauled to and from the fuel pier and moored at the Satala plant, and an undersea pipeline directly from the tank farm to the fuel pier (existing) and underwater to the power plant (new), Exhibit III-12.

ACTION RESOURCES INCORPORATED
1077 BISHOP STREET SUITE 442 HONOLULU, HAWAII 96813

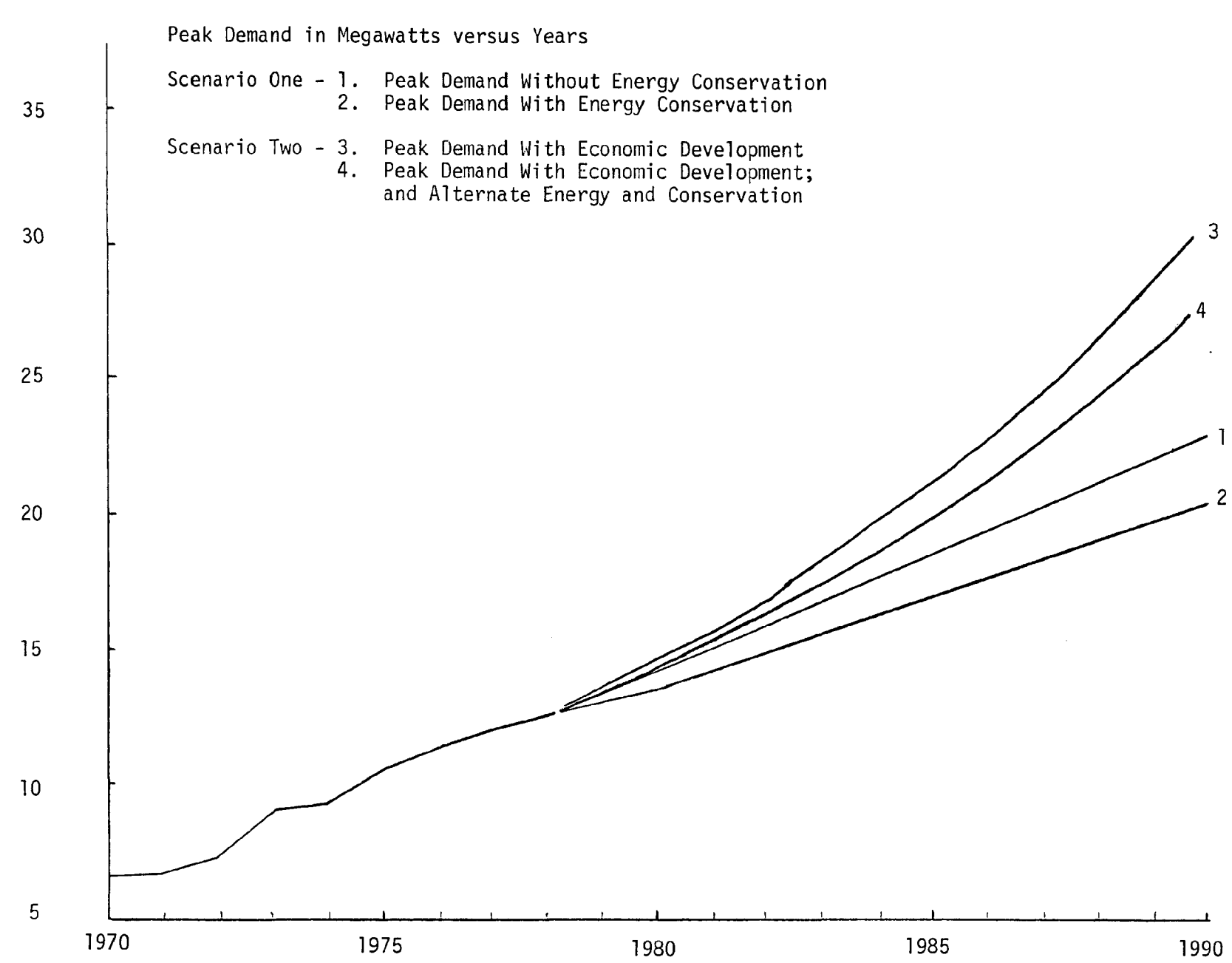


Exhibit III-11 Projected Peak Electrical Demands

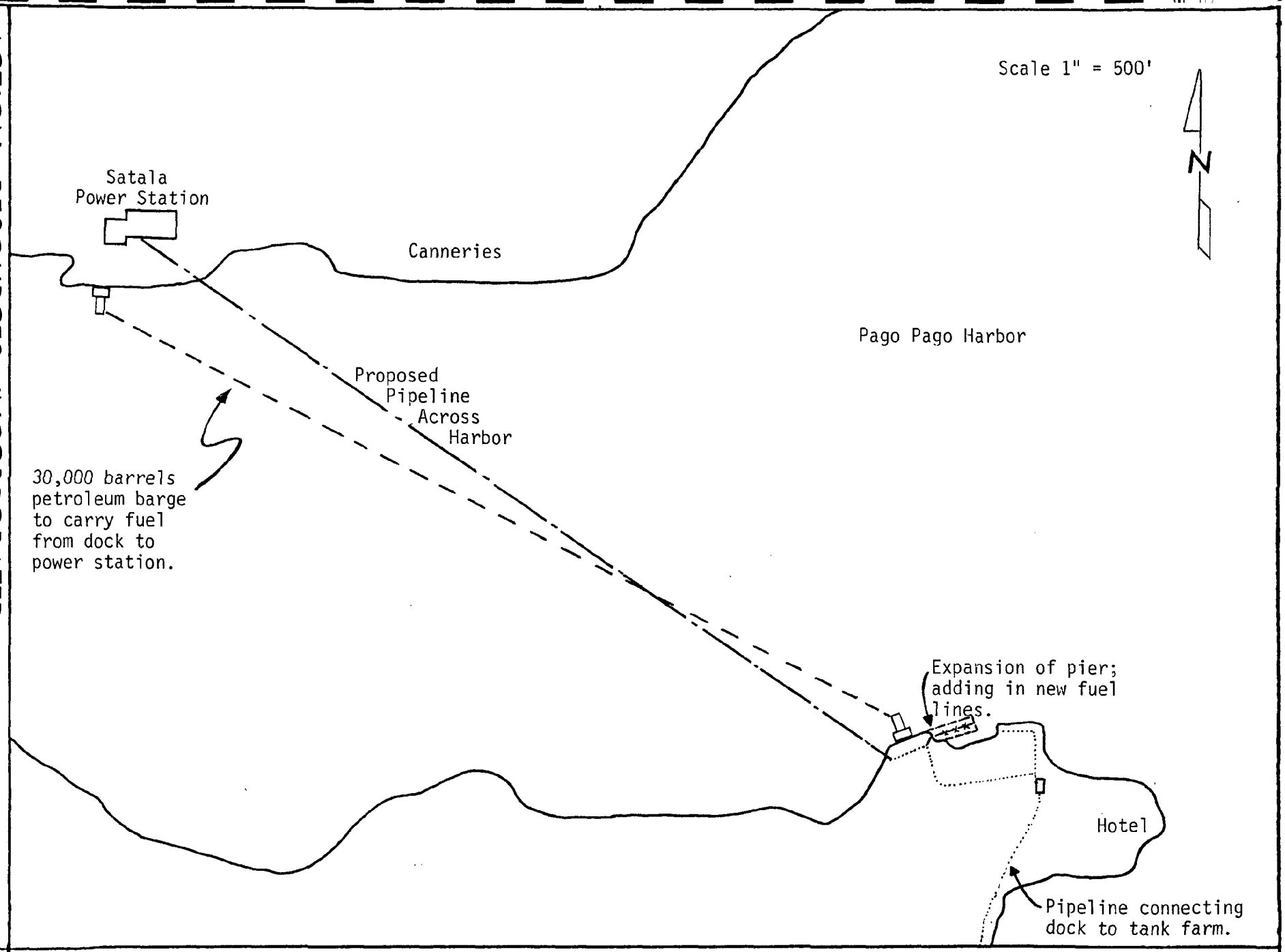


Exhibit III-12 Harbor - Fuel Handling Facilities

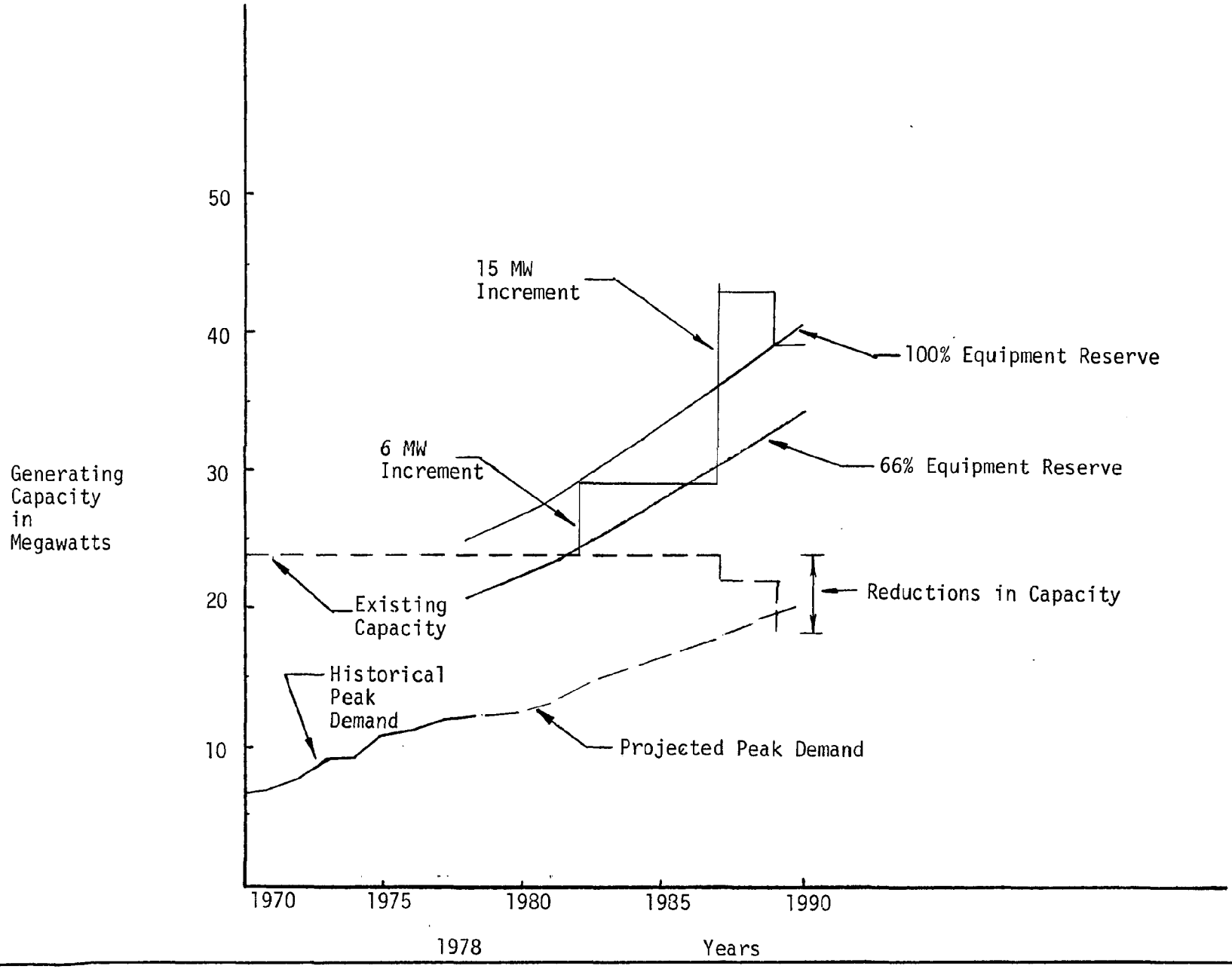


Exhibit III-13 Generating Capacity Requirements - Scenario One

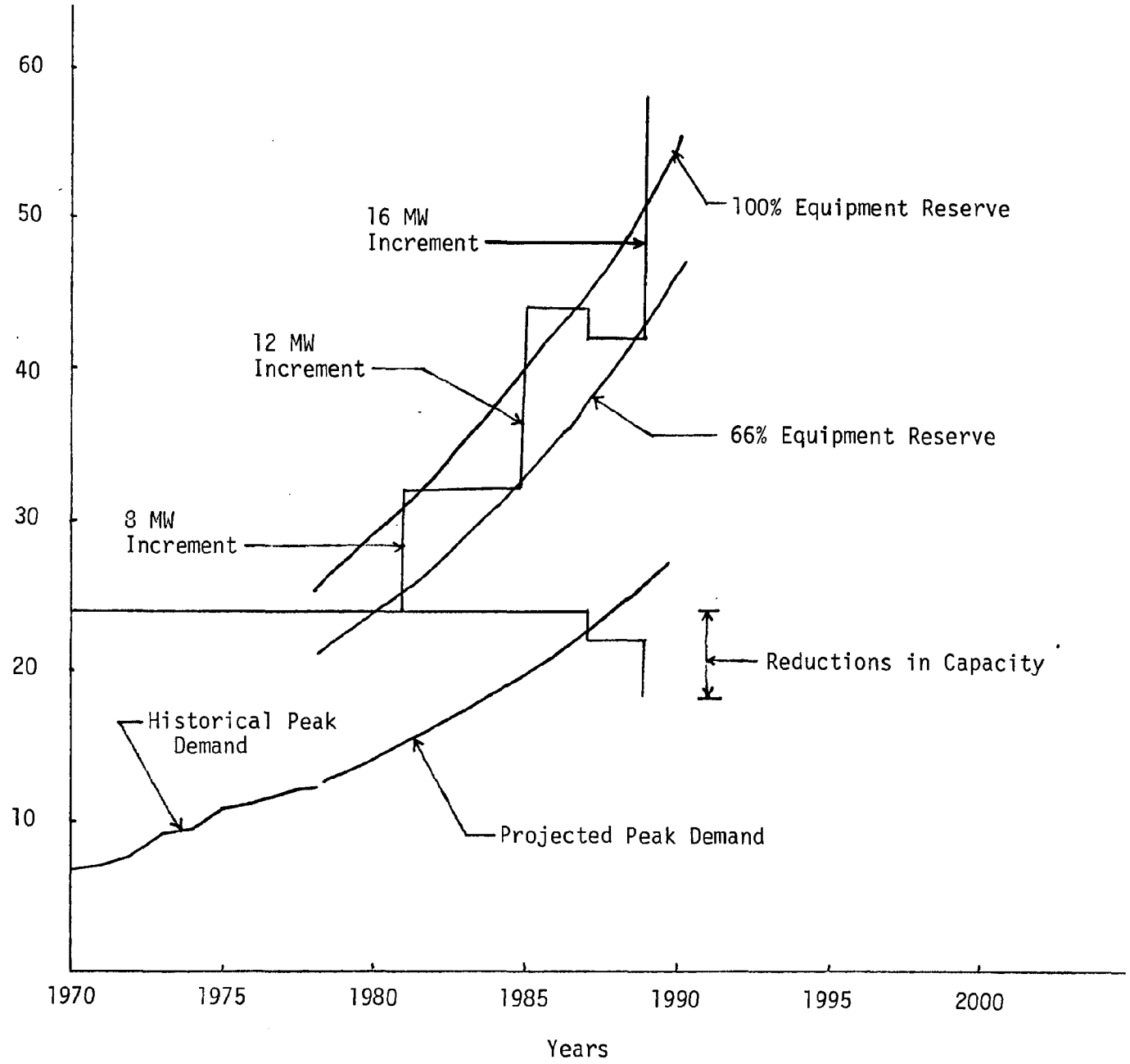


Exhibit III-14 Generating Capacity Requirements - Scenario Two

The purchase of private automobiles is on the rise and air traffic has increased in and out of American Samoa. Gasoline and jet fuel storage capacity may be increased. Presently, jet fuel is trucked from the tank farm to the airport twice daily seven days a week.

3.3 Scenario Development

In order to fulfill the requirements of 305(b)(8) of the Coastal Zone Management Act, a planning process which must be part of the management program, must be able to anticipate and manage the impacts from energy facilities. Part of that process must include an identification of energy facilities which are likely to locate in the coastal zone. To help anticipate energy facility needs, two scenarios were created. These scenarios are described below. Exhibits III-13 and 14 illustrate the generating capacity requirements under the two scenarios and the projected peak electrical demands for each scenario to the year 1990.

3.3.1 Scenario One [1,9,10,25]

Scenario One is based on historical energy demand growth and energy conservation effects through the implementation of the Territorial Energy Office programs. The historical data was gathered during 1978 for the ARI report, and was updated to the present time. Based on the slope of the historical plot, a straightline projection was made. This is shown as graph 1 on Exhibit III-11. The TEO's energy conservation programs have a goal of 5% savings by the year 1980. The Parsons, Hawaii report indicates that the programs have already provided a 3% savings in total growth. It is expected that the programs will have a cumulative effect and there will be a 10% reduction in total peak demand by the year 1990. Exhibit III-11, graph 2 illustrates the Scenario One peak electrical demand projection with energy conservation.

3.3.2 Scenario Two [2,4,9,10]

Scenario Two was based on the Economic Development Plan for American Samoa: FY 1979-1984. Assuming that the plan takes effect and the population, business and development projections become fact, they would increase the need for electrical power and fuels for transportation. At the same time, the TEO's energy conservation programs would continue. Assuming again, as in Scenario One, that they attain their expected goals of 5%

reduction by 1980 and 10% by 1990, the reduced projection was plotted. In addition, alternative energy sources were given consideration. During the years 1980-1990, it is expected that some alternatives will become economically feasible for American Samoa, either in a centralized use as a replacement for existing conventional facilities, or a decentralized smaller scale system which would reduce the overall need for fossil fuel systems. In Exhibit III-11, graph 3 shows Scenario Two peak electrical demand projections with the economic plan taking effect and alternative energy having a replacement value to part of the existing systems. Graph 4 shows the same projection with energy conservation programs considered causing an overall drop in electrical demand. This scenario reflects a higher growth rate rather than the straightline growth projected by Scenario One. Exhibit III-15 is a compilation of data used for peak demand projections. The following is a description of the assumptions made and analyses conducted for this scenario by major consuming sector.

3.3.2.1 Residential

From 1970 to 1978, the population of American Samoa increased at approximately 1.6% per year. During the same period, residential energy consumption increased by 7.0% per year. This far exceeded the 1.6% annual population increase, yielding an annual per capita increase in consumption of 5.3%. The high rate of increase in energy consumption in the residential sector versus the rate of increase of the population is based on the trend of the population towards the adoption of Western lifestyle. More television, more air conditioners and other appliances are being purchased and used by the population. For the 1978-1983 period, it is expected that the population will increase at 2.25% per year. Under Scenario Two, advances in the standard of living will also lead to increases in per capita residential energy demand. Based on the higher population growth, it is estimated that the residential peak electrical demand would increase at a rate of 8% per year through the year 1990.

3.3.2.2 Commercial

This category of electrical user includes the government, as well as retailers and other secondary economy members. In the past, there has been a correlation between employment in government and the secondary economy.

	Peak Demand (KW) 1978[1]	Peak Demand (KW) 1990	Growth Rate per year w/o Conservation	Conservation Goal (KW) 1990 (10%)	Peak Demand 1990 w/Conservation	Growth Rate per year w/Conservation
Residential	3,188	8,028	8.0%	803	7,225	7.1%
Canneries	3,800	8,558	7.0%	856	7,702	6.0%
Commercial/Industrial	4,436	11,171	8.0%	1,117	10,054	7.1%
Tourism	1,076[2]	2,864	8.5%	286	2,578	7.7%
Agriculture	-0-[3]	188	13.0%[4]	19	164	11.3%
TOTAL	12,500	30,809	7.7%	3,081	27,728	6.9%

[1]Based on Parson's analysis of average KW demand for feeder lines, using population data for feeder line areas, and energy consumption data for the first nine months of 1978.

[2]2.92% or 359 KW are consumed by the Rainmaker Hotel at peak period. The remainder is airport demand.

[3]Agricultural peak demand cannot be broken out separately in 1978.

[4]13% compounded beginning in 1983.

Exhibit III-15 Scenario Two: Peak Demand Projections

When government increased its numbers, secondary economy jobs increased. Since government plans to reduce its employment level to a constant by 1982, the Economic Development Plan is supporting and promoting incentives for the development of small industries and commercial enterprises that support primary industries. This will hopefully offset the past trend correlation between government and private industry jobs. These newly created and expanded businesses will increase demand for electricity and fuel for transportation. Their new businesses will need new or modernized buildings, some will have air conditioning and these factors will increase electrical demand. Based on these factors, an 8% annual growth rate is estimated for this category for both electrical demand and fuel consumption.

3.3.2.3 Tourism

American Samoa has one major hotel with approximately 220 rooms and one motel with approximately 17 rooms. Some visitors stay in village lodges or with family or friends. Tourists have access to American Samoa via jet from Honolulu, Auckland, Sydney or Fiji and by propeller aircraft from Tonga and Western Samoa. They also visit the island of Tutuila by passenger liner. The ships dock in Pago Pago Harbor at the main dock and tourists usually visit the hotel beach, restaurants and shops. In 1978, approximately sixteen thousand (16,000) tourists visited American Samoa and stayed an average of 2.5 days. These figures indicate that 110 tourists per day were on the island. In 1978, Pan Am flew in and out of Samoa only twice per week. In May of 1979, Continental Airlines began service in and out of Samoa to Honolulu or Auckland 5 times per week each way. By October, Pan Am had stopped flying to Pago Pago. The increased flights by Continental are expected to increase tourism and overnight transitting passengers. It is expected that the tourist hotel volume will double by 1983. The major hotel of American Samoa had long-term lessees in 1978. These included contract employees, contractors on assignment and government offices. In addition, other rooms were undergoing major renovation and could not be utilized. Based on these facts, occupancy of the hotel by tourists of available rooms was approximately 60%. The demand for rooms is expected to increase with the Continental flight schedule and maybe double by 1984. Rooms are being renovated, government offices have been relocated, and fewer rooms are being let on long-term bases to provide for the increased tourist demand. The peak

electrical demand by hotel and other tourism-related businesses is expected to reach 318kw by 1984.

This growth of 12% per year is expected to continue through 1990. The airport's demand would not vary directly with the growth of visitors and therefore, a 6% growth/year is expected in airport electrical demand.

Demand for jet fuel will be affected somewhat by the increase in tourism. A 5% average per year increase in the demand for air travel to or through American Samoa is estimated.

3.3.2.4 Agriculture

The Economic Development Plan projects an increase of 147 acres of commercial agriculture by 1983. Commercial agriculture production is assumed to be more energy intensive than subsistence type agriculture.

Therefore, it is estimated that the additional acreage of commercial agriculture will increase demand by approximately 80kw. This demand is composed of power requirements for irrigation (20-30kw), livestock raising (20-30kw) and miscellaneous uses (20-30kw). An annual 13% increase in agriculture peak demand is expected in the 1983-1990 timeframe.

3.3.2.5 Industrial/Canneries

Industrial land use has been rising since 1970, but the major industrial users and largest employers are the two canneries in the Pago Pago Harbor. Representatives of Star Kist and Van Camp have indicated that they expect a 14% per year increase in tuna production for the next few years. It is assumed that tax incentives outlined in the Economic Development Plan will act to sustain this growth through 1990. Increased production means increased employment and increased electrical demand, but cannery representatives are well informed of the energy conservation programs of the ASG and can shift expanded production schedules to non-peak hour use. In addition, they are considering installation of their own power systems, cogeneration or purchase of steam from waste heat recovery units that the Satala power plant would install.

The peak electrical demand growth is expected to be lower than the growth in tuna production. Therefore, it is estimated that the peak electrical demand for canneries will increase at a rate of 7% per year on the average through 1990.

In addition to electrical needs, the fishing fleet in order to provide the tuna for increased production will increase diesel fuel consumption at an estimated 10% per year.

3.3.2.6 Transportation

Transportation systems in American Samoa include the Aiga bus system, taxis, passenger cars and trucks, construction equipment, cargo handling, and hauling equipment, boats and aircraft. Fuels for these systems are gasoline, diesel, AV gas and jet fuel. The residential sector, based on facts and assumptions stated above, will increase its use of gasoline by 8% per year through 1990. Economic development will mean increases in construction and renovation and an estimated 10% increase in fuel consumption. The need for taxis and the Aiga bus system will increase as tourism increases.

3.4 Summary

Scenario One and Scenario Two display a likely range of future peak electrical demand in American Samoa. From this range of demand, timing requirements for the expansion of existing, or construction of new electrical generation facilities can be derived. Exhibits III-13 and III-14 detail the sizing and timing of generation facilities given the conditions of Scenario One and Scenario Two respectively. A minimum reserve capacity of 66% was used to determine when new facilities were to be added. A maximum of 100% reserve was the basis by which the size of additional capacity was calculated. These capacity requirements coincide with documented research on back-up capacity for the island of Tutuila. Also, taken into account was the retirement of some of the existing generating units based on their expected life.

Given this analysis, it is expected that a 6MW (Scenario One) to 8MW (Scenario Two) capacity increment will need to be added to the existing capacity of 24MW in the 1981-1982 timeframe. Between 1985 and 1987 is expected that another 12-15MW will be necessary. While under Scenario Two, a 16MW increment will be required in 1989. Therefore, up to a 225% increase (54MW) in existing capacity may be required before 1990. This analysis points to a large demand for expansion, before 1990, of existing and new facilities in American Samoa. Projections of fuel demand were made for the various types of fuel at the tank farm given the assumptions and conditions of both Scenario

One and Scenario Two. These projections were based on a series of end user or consumer growth rates. A comparison was then conducted of the future demand (barrels/day) of these fuels vs. what is considered an acceptable demand to maintain a 45-day storage capacity on Tutuila (See Exhibit III-16). Forty-five (45) days was taken as the minimum cutoff point for planning purposes. Fuel supply tankers presently arrive in Pago Pago Harbor at an approximate rate of 11 per year or 1 every 33 days. Forty-five (45) days of storage allows for 12 days of back-up reserve on the average and this is considered a minimum level of reserve capacity.

Exhibit 16 reflects that diesel oil has the most limited storage capacity in relation to its demand. Under Scenario Two, 45-day capacity will be achieved in mid-1981. Discussions with tuna cannery representatives indicate that diesel fuel consumption by the tuna fleet (the major user of diesel) will most likely resemble Scenario Two in the near term. Therefore, a new diesel fuel tank is needed and a 54,000 barrel tank is currently being proposed for construction at the existing tank farm. Construction of this tank will utilize the remaining expansion potential of the tank farm. Further expansion of fuel storage capacity would require locating additional storage in another area or increasing the size of the existing facility, which could possibly mean using residential land in the area.

Jet fuel storage is also nearing its capacity with the new Continental Airlines flights through Pago Pago International Airport. Under Scenario Two, the 45-day limit could be reached by 1982 (Exhibit III-16).

Gasoline storage tank capacity appears to be less critical. The 45-day point is not expected to be reached before 1990.

Discussions have also revealed a potential need of locating an LPG ship to shore fueling and storage facility in the near future. The location of such a facility on Tutuila heightens the need for additional storage tanks and fuel transport pipelines.

This section has established the baseline information needed to predict the need for and timing of the addition of future energy facilities. The ensuing sections will discuss the energy facilities likely to be selected and will develop a process for siting these facilities.

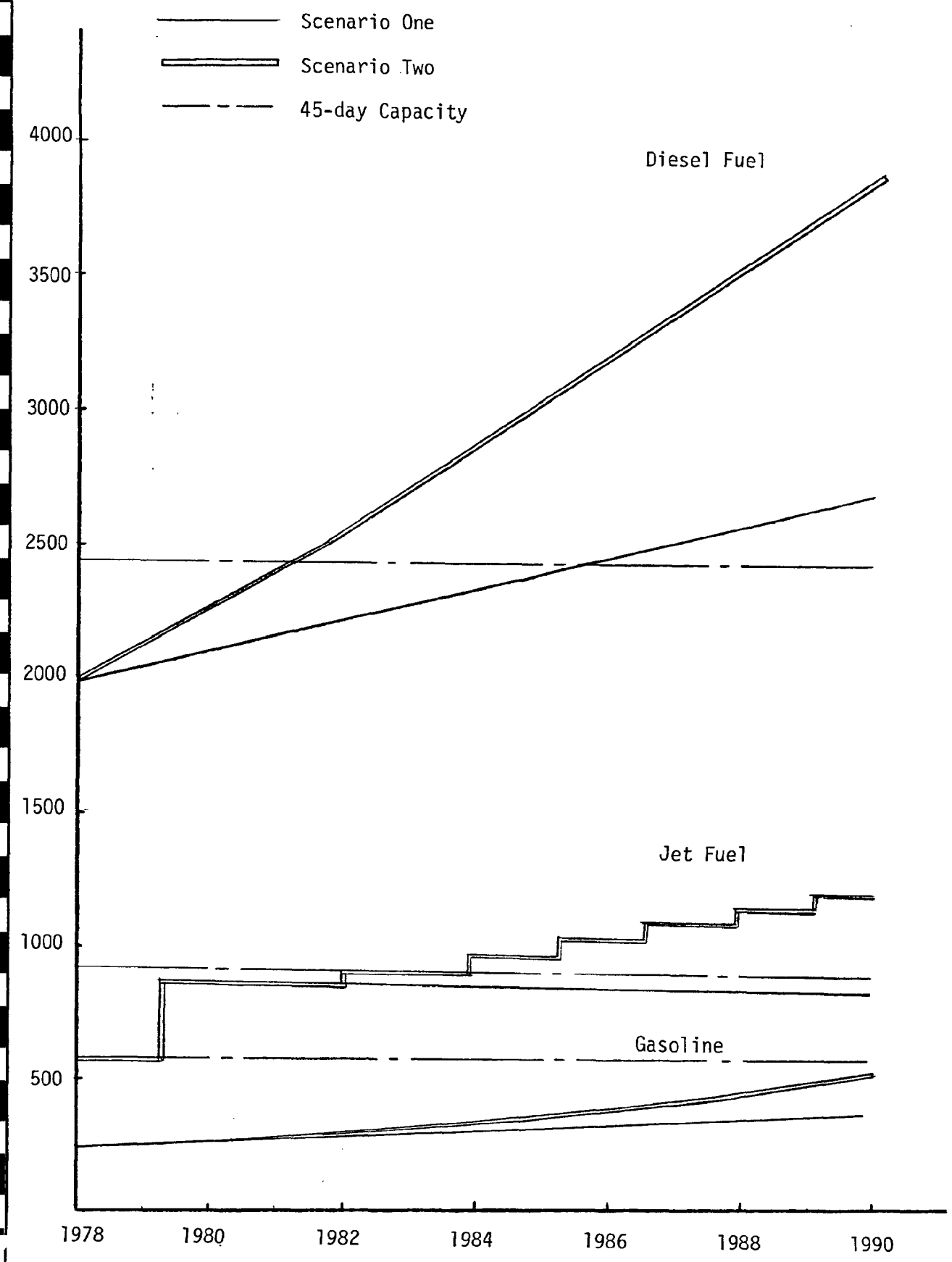


Exhibit III-16 Fuel Demand and Storage Capacities

SECTION 4

FACILITIES LIKELY TO BE LOCATED IN THE COASTAL ZONE

4.1 Overview

This section was developed on the basis of two assumptions: first, that the entire Territory would be considered to be incorporated within the boundaries of the coastal zone, and second, that the projected demand curves presented in Section 3 represent a reasonable range of likelihood. Given these assumptions, an analysis was conducted for the predicted demand compared to both conventional and alternative energy fueled systems in order to determine the candidate systems that could merit the demand.

Fundamental sources for this comparative analysis were the information contained in the Parsons, Hawaii Electric Power Generation Study, Island of Tutuila, 1979; the existing feasibility studies conducted on alternative energy sources as they apply to Samoa; the Governor's Six-Point Energy Plan for the Territory; the programs and plans of the Territorial Energy Office (TEO); and literature review of materials related to alternative energy projects underway in the state of Hawaii.

Prior to discussing the likely candidate facilities, specifically, a key consideration should be mentioned. As noted frequently in the review of previous studies and reports, the majority opinion offered was that the existing power generation facilities and, future expanded/new facilities would be entirely replaced by different generating systems, (i.e., steam, gas turbine) or in totality by an alternative resource. For the purposes of this study, however, ARI considered the possibilities of decentralized, small-scale, site-specific systems, as well as centralized, large systems providing all of the electricity needs of the consumers. It is recognized that frequently alternative energy and decentralized systems are not always as cost effective as centralized, conventionally fueled power generation stations. However, when considering Samoa's 100% dependency on imported fossil fuel and therefore, its potential vulnerability to embargoes, strikes and natural disasters, ARI felt that that cost should not be the only driving consideration; vulnerability is important too.

The ensuing paragraphs will discuss candidate energy facilities (both conventional and alternative sources) in terms of expansion of existing facility

sites, new facility sites and whether or not centralized or decentralized facilities should be considered to meet the demand. Additionally, these factors will be considered in the broad categories of power generation, fuel handling and fuel storage.

4.2 Electric Power Generation (and Distribution) Facilities

4.2.1 Existing Power Site Expansion

Section 3 contained a description of the existing electric power generation facilities. Discussed below are the candidate systems being considered for future expansion of the existing facility sites at the villages of Satala and Tafuna.

4.2.1.1 Conventional Fuel Power Systems [1,25]

Based on the projected demand as developed in Section 3, there are essentially three ways to expand the current facilities using fossil fuel sources of energy. These are to (1) continue with the same type of system now in existence, i.e., diesel generators, (2) phase in gas turbines and (3) phase in a dual cycle system (gas/steam turbines).

New diesel generators would be similar to the larger existing ones. The generators now in existence are directly driven by diesel reciprocating engines, water cooled, with a conventional exhaust system discharging at 450^{o}F through silencers into the air above the generator building. The existing generator sizes vary from 1 to 3 megawatt at Satala and 2.5 to 3.5 megawatt at Tafuna. Most of the units operate at approximately 500 RPM speed. According to EUD records, the existing units generated at an average diesel fuel consumption of 0.076 gal/KWH in FY 1979.

Gas turbines are air coooled and drive the generator through a gear box. The turbine is powered by hot gases rotating the shaft at high speed. The hot gases come from compressed air forced into a combustion chamber where part of the air is burned with either fuel oil, diesel or kerosene. Turbine exhausts are at temperatures up to 1200^{o}F. This exhaust heat can be recovered for a variety of uses. It is estimated that a 6.2 megawatt generator could be operated under reasonable conditions with a fuel consumption of 0.094 gal/KWH.

A dual cycle power plant system would be a gas turbine unit with an exhaust heat recovery system which produces steam. The 6.2 MW gas-

turbine unit described above could be combined with a 2.6 MW steam generating turbine unit producing power at 0.066 gal/KWH.

All three systems are candidates for the Satala Plant, but diesel generator expansion is the only viable system for the Tafuna site. These site assessments were based on the assumption that by-product/waste heat from the gas and dual cycle systems would develop steam and it could be sold to the canneries which are closely located to the Satala site, whereas the Tafuna site has no steam-using customers in its vicinity.

In terms of the Economic Development Plan goals, the encouragement of increased production by the two canneries makes expansion of the Satala Plant a reasonable option, particularly when considering steam applications. If, on the other hand, should feasibility studies show that steam production is not warranted by the EUD, then expansion of the current facilities should probably concentrate on the Tafuna site where much more room exists for expansion. This consideration would also be consistent with other EDP goals of ASG which will be encouraging growth in the Tafuna area, thereby creating a higher demand in that area.

4.2.1.2 Alternative Power Systems

A biomass system converts combustible plant and animal wastes into energy forms such as steam or process heat. Some of the sources for these wastes are solid wastes collected from industry, commerce and residents, plants, trees, and animal wastes. A biomass system is considered a possible alternative for the Satala Power Plant. This assessment was again based on the assumption that steam developed by the system would be sold to the canneries, but the Tafuna site should also be considered. This latter recommendation would be based on the results of a comparative cost benefit analysis between burning both municipal and agricultural waste products (augmented by fossil fuel when necessary) to derive steam for electrical power, versus the life expectancy of the landfill sites and costs to transport waste materials from all over the island to the landfill area in the western district.

In addition to biomass as an alternative energy source that could be located within the boundaries of the current sites, solar thermal conversion and wind conversion systems are possibilities. The cost effectiveness of both systems will require further analysis, however. Of particular importance will be the results of measurements on solar insolation and wind speeds in the area. Descriptions of these systems will be detailed in

Section 4.2.2.2.

4.2.2 New Power Sites

The possibility exists that new power facility sites will be needed in American Samoa and these sites will locate either conventional fuel power generation systems and/or alternative fuel power generation systems.

4.2.2.1 Conventional Fuel Power Systems

Gas turbine and dual cycle generating systems have been proposed for location in the Satala area. The tuna cannery compounds and EUD-owned land adjacent to the Satala generating plant are the two alternative sites that have been considered for location of such a system.

Another conventional fuel power system that has been proposed is a steam turbine generating facility, but no sites have been designated to date.

A privately owned LPG facility has been proposed and is under consideration by ASG. LPG has had limited use in the Territory with the largest user being the canneries. For example, one cannery brings in large LPG containers for use in their can manufacturing plant. Also, one petroleum supplier brings in small home owner size (less than 100 pounds) containers as a service for a few customers. The proposed facility would include tanks located along the shoreline in the Pago Harbor area. A candidate site is the landfill area at Anasosopo because of its proximity to the canneries. If LPG were available at competitive prices/therm (100,000 BTU) at least one of the canneries would consider its use as boiler fuel.

4.2.2.2 Alternative Fuels

Alternative energy resources and their use have been, and continue to be, a controversial proposition. There appears to be as many proponents as opponents to the cost-benefit, cost-effectiveness of such sources and their potential. For the purposes of this study, only systems in use or systems where there is a likelihood that such could be in existence within the timeframe of 1980-1990 were considered. Additionally, the elements of the Governor's Six-Point Energy Plan and the planned objectives of the TEO were taken into account. Based on the aforementioned qualifications, the

alternative energy resources that were considered were:

- biomass
- fuel cell
- hydropower
- geothermal
- nuclear
- ocean (thermal and wave)
- solar (photovoltaic, thermal and direct)
- wind

Exhibit IV-1 and IV-2 provides a graphic presentation of possible sites for these energy sources. The glossary of terms provides definitions for these sources.

4.2.2.2.1 Biomass[14,25]

This alternative has been defined previously. Both centralized, stand alone facilities, and oil-fueled supplemental systems that would augment existing facilities have been studied for their applicability to American Samoa. Of the two, the supplemental system is a more feasible alternative at this time. Biomass is still an available option for Samoa. The Tuna Sludge Conversion Project being conducted by the TEO highlights the continuing review and analysis of biomass alternatives.

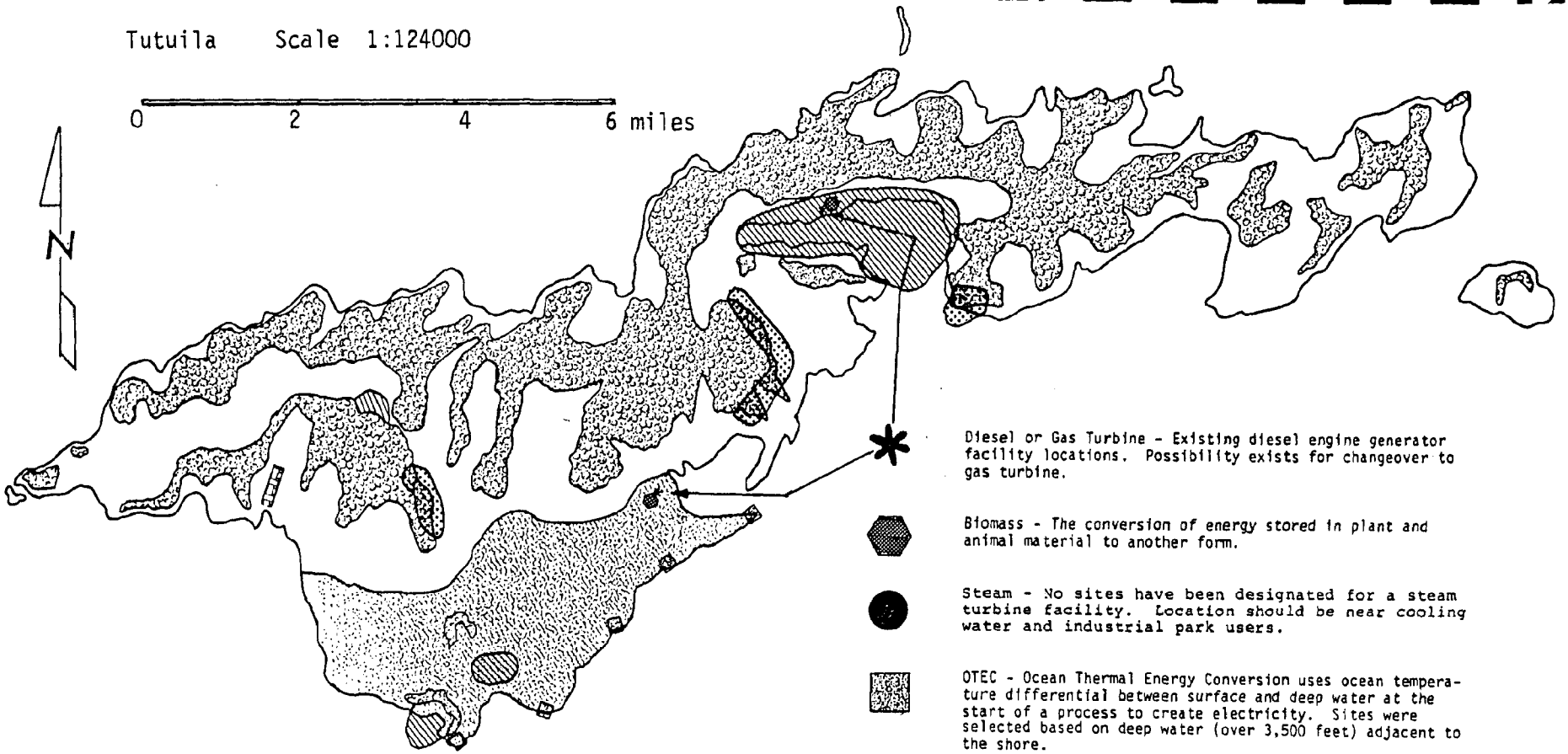
Additionally, a private enterprise has recently been looking into the feasibility of establishing a 10-ton per day coconut processor to produce oil, gas and charcoal in Samoa.

4.2.2.2.2 Fuel Cell

This source of energy is derived from the heat given off by chemical element combinations. For example, by combining hydrogen and oxygen in the presence of a catalyst, or third material, water and an electrical current can be produced. It is a possible system for Samoa, but much more research must be made before recommending this alternative as a viable solution to Samoa's needs. This will be discussed under site suitability (Section 5).

4.2.2.2.3 Hydropower[15]

Hydropower is the production of energy using water from a reservoir or directly from the top of a stream or river waterfall passing



Diesel or Gas Turbine - Existing diesel engine generator facility locations. Possibility exists for changeover to gas turbine.

Biomass - The conversion of energy stored in plant and animal material to another form.

Steam - No sites have been designated for a steam turbine facility. Location should be near cooling water and industrial park users.

OTEC - Ocean Thermal Energy Conversion uses ocean temperature differential between surface and deep water at the start of a process to create electricity. Sites were selected based on deep water (over 3,500 feet) adjacent to the shore.

Hydropower - Electricity generation through the use of water. Potential exists for decentralized unit.

Geothermal - The use of natural sources of heat (steam, hot rock, etc.) to create electric power (or for other uses). Site selected by surface observations and sampling.

Solar - Based on analysis of rainfall data, topography, wind direction and cloud cover observations, these flat land zones were selected for potential solar photovoltaic electric power facilities.

Wind - Based on analysis of prevailing wind direction and land topography, theses zones were selected for potential wind turbine generators.

Low Potential - Land with over 30° slope. Facility siting would be difficult.

Exhibit IV-1 Tutuila - Potential Alternative Energy Zones

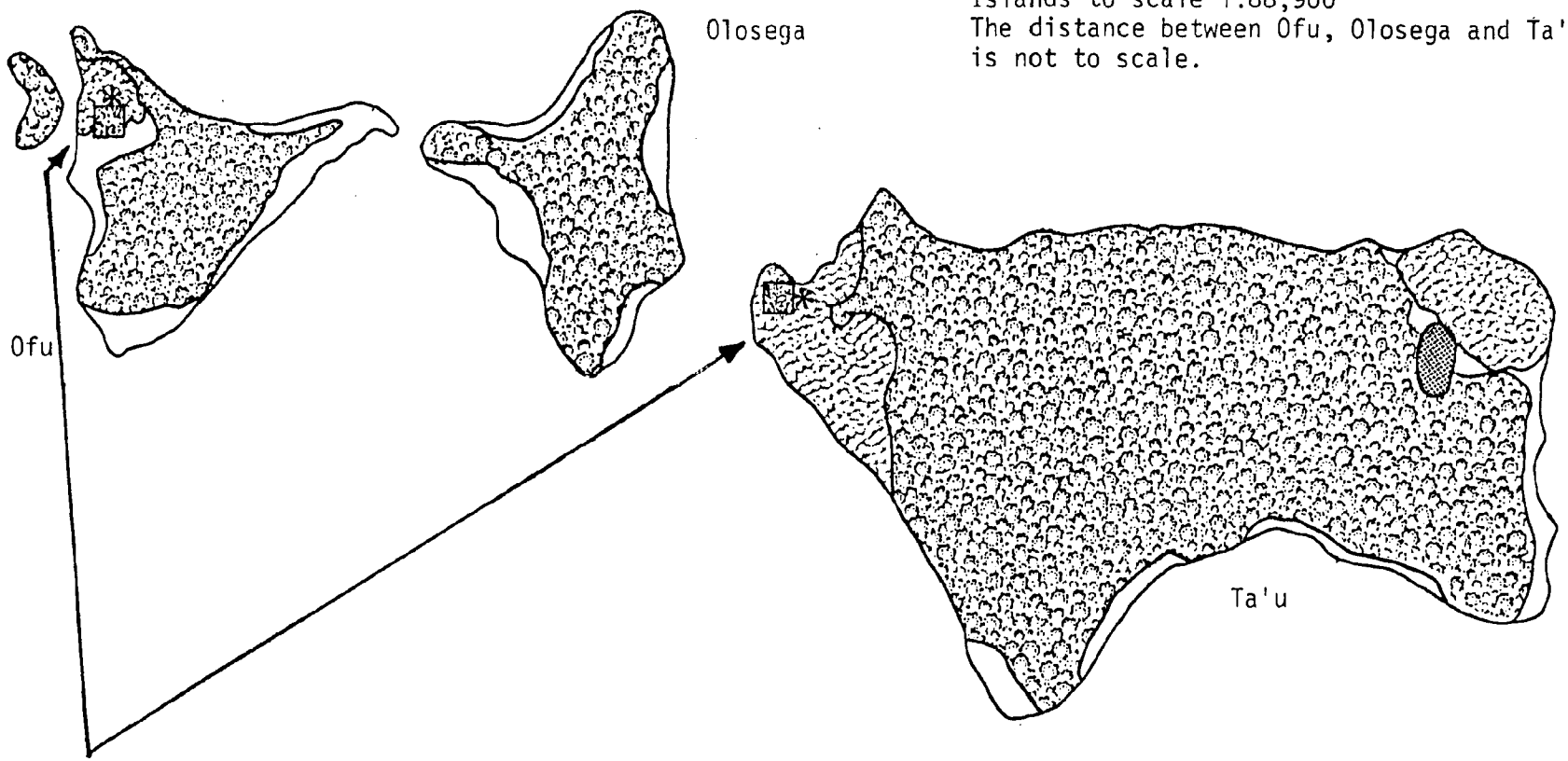


Exhibit IV-2 Manu'a - Potential Alternative Energy Zones

through a pipe (penstock) to a turbine at a lower elevation. The water-driven turbine rotates a generator to produce electricity. The amount of electricity produced depends basically on the amount of water available and the difference in height between the reservoir or top of the waterfall and the turbine. The Army Corps of Engineers - Pacific Division contracted the firm of Dames and Moore to conduct a hydrologic investigation for Tutuila Island. Based on the study results, it does not appear feasible that a centralized hydroelectric system could competitively supply electric power needs on Tutuila Island. However, this study did not consider the possibilities of small-scale, decentralized systems designed to provide "local" power needs. Such systems are utilized elsewhere, and the Federal Department of Energy (DOE) has on-going programs and research in this area. This latter work should be considered in Samoa's plans for facilities that are likely to be considered as candidate systems.

4.2.2.2.4 Geothermal[24,25]

Geothermal energy, the internal heat of the earth, can be tapped by wells. The energy is in the form of dry steam, steam mixed with hot water or dry heat coming from hot rocks without coming in contact with water. This energy can be converted to electricity or used as process heat. Studies and analyses have revealed the potential of geothermal as a candidate alternative resource for Samoa's consideration in its desire for energy self-sufficiency. It should be noted that the TEO has recently been awarded a DOE grant to investigate such potential. The results of this study should assist the Government to determine the real potential of this resource.

4.2.2.2.5 Nuclear

By converting unstable matter (mass), a tremendous amount of heat energy can be produced. As an example, an ounce of mass, totally converted, could produce enough electricity to supply 30,000 average homes for a year. Nuclear power plants in existence use fission of a nuclear fuel, uranium. The fission process can produce enough electricity* to supply 30 average homes for a year. Fusion power, another nuclear process being developed, may be commercially available in 30 years. It has been estimated that the hydrogen in 1 cubic foot of sea water could be converted by a fusion reactor system to provide electricity for the annual consumption of 3 average

* from an ounce of uranium

homes.

Of all the alternative energy resources, nuclear fission is probably the most controversial. In terms of potential for Samoa, many considerations must be evaluated. However, for the purposes of a possible alternative, nuclear energy is a candidate. Section 5 will discuss the socio-political elements of this candidate.

4.2.2.2.6 Ocean Energy

There are 2 categories of ocean-related energy which were considered for this study.

a. Ocean Thermal Energy Conversion (OTEC). Power may be produced by significant differences in temperature of large quantities of water. These temperatures are used to heat and cool a working fluid such as ammonia or propane. This sytem, called a Rankine cycle engine has a hot end (boiler) and cold end (condenser). The closed system working fluid passes from the boiler in vapor form at increased pressure through a turbine. This cools the vapor and it is liquified by passing through the condenser and pumped back to the boiler and the cycle is repeated. The turbine rotates the generator to produce electricity. The ocean contains the water with required temperature differentials in large quantities required for this system. This possible alternative has been theorized for quite some time and proved to be possible only recently with the work done within waters of the state of Hawaii through the "mini-OTEC" experiment. In addition to the aforementioned, OTEC has been investigated as a potential for Samoa. In 1976, the Purdue University undertook a study for possibly locating a small system (24,000 kw) off of Tutuila Island. The report concluded that it was feasible. Through independent research, additional site possibilities were identified (Exhibit IV-1).

b. Other Ocean Energy Conversion. Energy exists in ocean tides, waves and currents. In tides, the energy is dependent on the head (or high to low tidal difference) and the quantity of water passing the machine used to transform tidal energy to electrical power (similar in principle to hydropower). The water flowing due to tidal action turns a turbine connected to an electric generator.

Wave energy is a function of the height of the wave and the wave's length. Wave heights can be increased by constructing artificial shoals on the reefs.

Ocean currents contain energy which can be converted to electric power by propellers or turbines. Generally, currents are low

velocity requiring large volume of water flowing by converters. Exceptions exist where water flows in narrow passages such as between islands or in ocean trenches and straits.

The possibility of tidal power generation has been suggested for Samoa. Wave energy is an alternative, as well. These suggestions could have significant environmental impacts as is discussed in more detail in Section 5 (Site Suitability). Little is known of the currents around American Samoa; however, the strait between Ofu and Olosega and the existence of the Tongan Trench suggests ocean current power could be an energy candidate with accompanying impacts.

4.2.2.2.7 Solar Energy

Like ocean energy, this category includes different types for consideration in Samoa. It should be noted that these systems can be used to supply centralized large-scale power or be used on a small-scale, decentralized basis. Only small systems were considered since large size systems generally exceed the needs of Samoa.

A. Solar Thermal Conversion systems have a collector to catch the sun rays, a concentrator to focus sun rays, and a receiver to absorb the radiant energy. Other requirements for a high temperature system are a liquid that can be converted to vapor by the sun's heat and a turbine generator that uses the vapor to generate electricity.

(a). Total Energy Systems These are on-site systems capable of producing electricity combined with cooling or process heating. Examples of candidate sites for total energy systems are the Satala area with Mt. Alava, Tafuna Industrial Park, the Hospital, the TV and radio facilities, the transit warehouse, and other similar electrical/cooling process heat demand areas.

(b). Small Community Systems These systems are primarily for production of electricity and candidate sites would be any remote village having space for the collector/receiver subsystems.

(c). Remote Systems This proven alternative system is a candidate for providing energy to operate deep well pumps for ground water for domestic use and irrigation systems. Potential site examples would be the Tafuna well area, Taputimu Farm, Olotele Mountain and the Manu'a Islands.

B. Photovoltaic Conversion utilizes solar cells usually made of silicon. When light hits the cells, electricity is generated. High voltage and current, or wattage, is attained when a number of cells are connected. Normally, a flat panel array is used for the cells. A great deal of research is in progress to improve efficiency of photovoltaic conversion. At present, large areas (over six times the space for fossil fuel power generation) are required to produce electrical energy. Candidate sites would be low power demand facilities such as navigational aid beacons and areas where adequate space is available such as the airport clearance zones.

4.2.2.2.8 Wind Energy Conversion Systems These systems are essentially windmills connected to electric generators or pumps. The wind turns a set of blades which rotate a shaft to turn an electric generator or to pump water. Samoa has the natural resources, trade winds and unobstructed ridges of mountains that requires consideration of candidate sites. Examples are Mounts Alava, Olotele, Tau and Pioa on Tutuila and similar locations in the Manu'a Islands.

4.2.3 Power Distribution[25]

Exhibit III-6 illustrates the existing distribution system on Tutuila. The present system is reported in good condition, but the distribution feeder serving the Pago Harbor area is reaching the maximum operating capacity. There are three approaches to meeting the new demands; to install a new feeder on new higher poles, to replace the existing feeder with larger conductors or to use the existing tie line as a feeder and install a new tie line on new poles. Regardless of the option chosen, alterations will have to be made in the future. If the economic development plan takes hold, that future may be as soon as 1981.

4.3 Fuel Storage for Power Production, Commercial/Industrial Applications and Transportation

4.3.1 Conventional Fuels

As was pointed out in Section 3, the successful implementation of the Economic Development Plan (EDP) goals could dynamically change the energy demand in Samoa. Section 4.2 discussed this change in terms of likely facilities to support power production. In order to meet the fuel needs of

this increased power production, there will be a need to expand the current storage facilities. Additionally, the EDP goals are likely to cause an expansion in fuel storage for commercial/industrial needs and for transportation requirements. Described in this section are the possible fuel storage increases and their locations.

4.3.1.1 Diesel Fuel

The principal expansion indicator is that of the increased fishing fleet and second is the increased production at the canneries. However, should the future expansion of the EUD be completed through diesel generator units, then this could also be a major indicator. In terms of site location, it is likely that the increased storage facilities could be located at the existing Tank Farm, cannery plants and the power stations.

4.3.1.2 Jet Fuel

Expansion in jet fuel storage capacity will be dependent upon the decisions made in regards to future electric power generation systems. Both the gas turbine and dual cycle systems utilize this fuel type. Thus, with the increased number of international airliner refuels coupled with the possible use of gas/dual cycle systems, it is probable that the current storage facilities will require realignment and some increase in capacity. It is anticipated that the increased storage facilities could be handled on current power station sites and at planned new facilities at the airport.

4.3.1.3 Motor Vehicle Fuels

The key indicator for expansion needs of this category will be the successful implementation of the EDP goals. As the general economy of the Territory expands, there will likely be a corresponding increase in individual ownership of motor vehicles. Thus, it is likely that increased fuel storage facilities will be required. The extent to which current storage sites can accommodate the increase will be dependent upon the growth of retail gas stations. It is estimated that both current sites and retail gas stations (both current and new) could maintain adequate storage facilities for increased demand.

4.3.1.4 Other Fuels

Of the remaining fuel types, LPG is the only source for which new storage facilities will be required. Since this fuel type is just now

under consideration and its full use not yet resolved, no estimates on quantity or possible storage sites have been made.

4.3.2 Alternative Fuels

Consistent with both national and territorial goals to reduce dependency on conventional fuels, alternative energy systems were considered for the future of Samoa. Described in this section are the likely fuel storage requirements associated to the various alternative systems discussed in Section 4.2. They will be discussed in terms of those systems which would still require importation of a fuel source and those systems for which an indigenous source is available or believed to be available.

4.3.2.1 Systems Requiring Importation of the Fuel Source

For a number of the alternative energy systems, they use elements in the process to produce electricity/heat that are not indigenous to American Samoa. These systems include Solar Thermal (working fluids or gases), Ocean Thermal (working fluids or gases), and Nuclear (radioactive isotopes) as examples. For these systems, storage of the working medium will have to be examined in order to ensure that sufficient replacement capacity is available for emergency conditions. These working media are often toxic and dangerous elements that will require special storage facilities.

4.3.2.2 Systems Using Indigenous Fuel Sources

Systems such as OWEC, Geothermal, Photovoltaic, Wind and Hydropower are examples of potential fuels that are indigenous to Samoa and thus require no importation. Furthermore, storage facilities for these systems are incorporated into the plant layout for each system. Consequently, use of these systems requires consideration of storage impacts on a site specific basis.

4.4 Fuel Handling Facilities

4.4.1 Conventional Fuels

4.4.1.1 Dockside Handling/Port Facilities

Section 3 contained a description of the current facilities and their use. With the consideration of cost-benefit analysis on the current

methods, expected growth in energy demand, safety factors and possible introduction of LPG, some new considerations will be required.

Current proposed expansion of the Pago Pago docking facilities includes the construction of a new pier. These plans are going to require further review by both local and federal agencies. In addition, some consideration has been given to relocating all fuel pier facilities to the Tafuna Plains and Leone areas of the western district.

Dockside handling considerations include the recommendation that a submerged pipeline be constructed from the fuel pier to the EUD/canneries vicinity across Pago Pago Harbor. This fuel would be pumped from ship to Tank Farm and then from the Tank Farm to the user eliminating most, if not all, of the current trucking requirement.

The introduction of LPG will also require new and special dockside handling facilities.

4.4.1.2 Fuel Transporting [25]

In addition to a submerged pipeline across the Harbor, it has been considered that an underground pipeline be installed from the existing Tank Farm to the Tafuna Power Facility/Industrial Park area. This recommendation would reduce/eliminate the current method of trucking fuel. Another method that could be considered is barging fuel across the Harbor to Satala, out to Tafuna and among the outer islands.

4.4.2 Alternative Fuels

4.4.2.1 Non-Indigenous Fuels

The introduction of alternative energy systems will bring new and often unique fuel handling facility requirements. Most of these systems will require the handling of chemicals, gases or radioactive materials. These materials will have to be unloaded at dockside and transported to fuel farms or the specific site. The corrosive nature and/or safety/health handling precautions will involve new handling methods and procedures.

4.4.2.2 Indigenous Fuels

For these systems, there will be no requirements for dockside/port facility handling or transportation from one place to another. However, the on-site handling procedures will be new to Samoa and require careful consideration and planning.

SECTION 5

ASSESSING SUITABILITY OF SITES

5.1 Introduction

Based on the list of candidate energy facilities (Section 4) developed from the scenario projections (Section 3), a review was made of the possible impacts that each system could produce. This review considered both the system and the possible site(s) where these systems might be situated. Following the review of these impacts, a plan was designed for assessing the suitability of sites for locating energy facilities. This plan draws heavily from the work completed by the Committee on Alternative Energy Sources for Hawaii of the State Advisory Task Force on Energy Policy.

5.2 Existing Power Generation Facilities Expansion[23]

5.2.1 Conventional Fuels

As discussed in Section 4, the existing power plant sites could be expanded through the use of diesel generators, gas turbines and/or dual system turbines. For each of these power generation systems, the major impacts to consider are visual intrusion, air, noise, and land pollution. In the situation of the Satala plant and the canneries, expansion of the existing locations could require condemnation of additional surrounding land in order to provide on-site storage of fuel and to locate on-site equipment providing steam to the canneries.

5.2.2 Alternative Fuels

Solid waste/biomass facilities could be located on the grounds of the existing power generation facilities. The major impacts that should be considered are those of air pollution, from both product decay and incineration, waste water disposal, visual intrusion and product storage. In regards to the latter, the use of the current sites must also consider the change in the patterns of the trucking of waste products and impacts on local traffic.

5.3 New Power Generation Facilities

Described in this part are generalized environmental concerns related to suitability of new sites for power generating facilities.

5.3.1 Solid Waste/Biomass

5.3.1.1 Negative Impacts

The conversion of solid waste to oil by the pyrolysis method will create less pollution than incineration because all products produced will be salable or consumed in the process by non-polluting combustion methods. Water produced or used in the process will be treated and cleaned before discharge into disposal wells. The process will be a net producer of energy.

The major environmental problems associated with processing and steam or power generating systems are noise, dust, air emission and waste water disposal. Noise and dust caused by the processing of the solid waste can be controlled by operating within an enclosed building. Air emissions can be controlled with a combination of dust collectors, such as electrostatic precipitators and wet scrubbers. Waste water disposal can be controlled by the installation of clarifiers, ponding basins or ocean outfall.

Anaerobic digestion for methane generation permits harvesting of a fraction of the carbon content of the waste material. Other nutrients such as nitrogen and phosphorus are virtually unaltered in quantity. In the conventional anaerobic digestion process, the waste material would be diluted to about 5 percent total solids. In dewatering the residual sludge, the dilution water will carry with it a large fraction of the nutrients and as such must receive treatment before discharge.

5.3.1.2 Positive Impacts

Resource and energy recovery systems are viable alternatives to resolve the critical solid waste disposal problem in Samoa and to minimize its dependency on fossil fuel to generate power.

The anaerobic digestion process could have a significant advantage in Samoa because of the year-round high temperatures (70-90^{o}F). Further, the residual sludge could be of agronomic benefit as a soil amendment or conditioning material, since the soils are generally low in organic content. This type of soil amendment would effectively improve the soil nutrient and water (moisture) retention capacity of the soil.

5.3.2 Hydropower

The primary advantages of hydropower that result in minimal impact on the environment are: (1) no energy resource depletion; (2) no contribution to air or water pollution since there are no discharges, and (3) does not have wastes which add toxic substances to the environment.

5.3.3 Geothermal[40]

If it turns out that the islands can be exploited for geothermal energy, it is possible that the greatest environmental impact would be noise from exhaust steam during drilling. Exhaust warm water, which, if dumped, could have an environmental impact, would be better reinjected into the ground both as a water conservation measure and for its thermal residual in recycling. The water might be used as a mineral resource before reinjection depending upon its chemistry which is unknown at this time. Chemistry will also be a dominant factor in determining the degree of environmental impact. In places like Larderello, Italy, where geothermal power has been produced for 70 years, vineyards and fields of grain grow right up to the plant where electricity is being produced. The area where the Geysers (California) geothermal plant is located was originally wilderness and used as a forest and game preserve which use has not been affected except for the actual land that is occupied by the plant.

Although in a steam-dominated system noise during drilling can be excessive when clearing the hole with air, this is temporary and can be muffled. Once a hole is completed and tied into steam lines, noise is no greater than with a conventional power plant.

Ground subsidence which occurs in connection with water or other fluid withdrawal in many places, will need to be considered. Effects on water quality due to reinjection needs consideration in relation to fresh water supplies. Inducing seismicity in a basaltic terrain by either removing steam or water or reinjecting water into the ground will require consideration. It also should be noted that this has not been a factor in other geothermal areas--even in those with a low level of natural seismicity.

Air pollution from a geothermal plant, while a matter of concern, is not apt to exceed that of the visual impact of condensing steam. At the Geysers, for example, Bowen (1973) reports that the condensing steam consists of 99.5 percent water. Of the small non-condensing fraction, 80 percent is carbon dioxide with only the 4.5 percent portion represented by hydrogen sulfide which is potentially injurious to plants. While this amount of hydrogen sulfide

at the Geysers is only about one-third that which would be produced using fossil fuel to generate the same amount of electricity. Similarly, an equivalent fossil fuel power plant would produce 20 times as much carbon dioxide for the same electrical output as with a geothermal power plant utilizing steam as at the Geysers.

Although low level radioactivity does characterize some thermal springs which are exploited for therapeutic purposes, this is not regarded as a health hazard, and radioactive monitoring at the Geysers has shown the alpha count to be well below that permissible for drinking water as specified by the U.S. Public Health Service.

5.3.4 Nuclear

There are four major areas of concern in the use of nuclear energy.

5.3.4.1 Construction Activities

A nuclear power plant has about the same impact on the terrestrial environment during construction as a comparable fossil fuel plant. Due to the longer construction period, this disruption would be somewhat longer but would not necessarily encompass a larger area.

5.3.4.2 Thermal Discharges

Once in operation, the primary environmental impact of a nuclear power plant is its thermal discharge. Since a nuclear plant is only 30 percent efficient from a thermal standpoint, 70 percent of the reactor thermal output must be dissipated. This can be done through discharge into adjacent bodies of water and thence to the atmosphere, or directly to the atmosphere through cooling towers. The choice of the system would be site dependent.

5.3.4.3 Radioactive Release

Sufficient controls and safeguards need to be built into nuclear power plants to insure essentially zero release of radioactivity under normal conditions. Furthermore, under conditions of catastrophic failure, redundant safety systems are incorporated to prevent or minimize release of radioactive discharges into public areas. In general, radioactive by-products are contained, concentrated and shipped to AEC-approved storage/disposal sites.

5.3.4.4 Spent Fuel

Spent fuel which is highly radioactive is retained on site for a time and then shipped to reprocessing centers where usable isotopes are recovered

under carefully controlled conditions.

5.3.5 Ocean[41]

There are two types of environmental considerations of concern in any consideration fo the practical application of the OTEC process. A long-range concern that is valid only if one considers applying the OTEC concept on a massive scale is its effect on the oceanic thermal balance. A question of immediate concern, no matter what the scale of application, is the effect produced by large quantities of nutrient rich, cool water brought into the nutrient poor upper realms of tropical oceans.

J. Hilbert Anderson[41] considered the first question and concluded first that heat loss in the surface waters probably would be compensated for by a corresponding decrease in the infra-red radiation into space during nighttime hours. Thus, more of the solar radiation absorbed by the Surface Waters would be retained and the overall temperature of oceanic surface waters would be affected little or not at all. To put this differently, at present, a large amount of the solar radiation received by the earth is re-radiated as IR energy into space at night. Even if OTEC plants were employed on massive scales, so the reasoning goes, the tremendous level of solar radiation incident on the oceans most likely would retain very near the original temperature of the Surface Waters, because any reduction in Surface Water temperature would increase its ability to convert shorter solar wavelengths to heat while reducing the amount of heat lost to space during hours of darkness.

On the question of warming the Intermediate Water, Anderson concludes that the huge mass of Intermediate Water that exists is unlikely to be affected in the foreseeable future by even massive applications of the OTEC concept. However, unless it can be demonstrated that there is a mechanism for renewing the low temperature of Intermediate Water in the oceans, it is believed that this water must be considered a finite resource of undetermined magnitude. The magnitude of the resource can be determined then only by determining its mass and the level to which its temperature can be increased without inducing significant effects on the oceanic thermal balance.

As for localized nutrient effects, the deep-ocean "waste water," which is rich in plant nutrients must be "disposed of" in the best possible way. This will require skillful engineering and fundamental advance research. There are three apparent alternatives that need to be considered:

1. The nutrient-rich water be returned to the ocean in such a way that evident biostimulation is avoided.
2. The nutrient-rich water be returned to the ocean to produce uncontrolled, but environmentally acceptable biostimulation.
3. Controlled biological filtration of deep water nutrients prior to discharge into the ocean surface.

5.3.6 Solar

The environmental advantages of solar energy are unmatched by any other alternative. This is a non-polluting, technically sound energy use, which does not degrade or use irreplaceable resources.

5.3.7 Wind

Wind power plants have many environmental attractions. For example, they consume no fuel and thus emit no pollutants. The greatest concerns would be for visual intrusion, for area committed for conversion, and for use of airspace. The above was assumed for heavy usage of wind energy in medium to large-scale plants, rather than assessing isolated small-scale systems, whose environmental impact should be considerably less.

5.4 Distribution Facilities

There are two primary methods for distributing electric power--by above ground poles and underground/water cable. These methods could also be used in combination. Environmentally, they could impact land, air and water areas. Poles require access paths for maintenance and they result in visual intrusion. Underground/water cables require entrenchment which can affect the balances of ecosystems. And, both require land easement rights.

The delivery of process heat/steam requires the environmental considerations of overhead, or underground piping to the consumer. These can result in visual intrusion or ecosystem disturbance.

5.5 Fuel Storage for Power Production, Commercial/Industrial Applications and Transportation

5.5.1 Conventional Fuels

All of the conventional fuels are normally stored in tank farms above ground. Visual intrusion from large tanks and human safety factors due to

the volatile nature of the fuels are normally the most significant environmental considerations. Tank and connecting pipe leakage into the air, ground or water are also important considerations.

5.5.2 Alternative Fuels

The possible impacts in storage of alternative fuels in Samoa will be similar to that of conventional fuels. Above ground tanks would be used for solar thermal system fluids, OTEC fluids, etc. Nuclear fuel would require special storage systems that occupy large land areas due to the need for protective measures.

5.6 Conclusions And Recommendations [23]

As can be seen from the discussion of the many possible impacts that energy facilities may cause in the coastal zone, site suitability assessment and decision-making procedures must be fairly comprehensive. In order to ensure that the Territory's review process incorporates as many of the impact variables as reasonably possible, ARI recommends the use of a planning tool similar to that shown in Exhibit V-1. This planning tool represents a modification to and expansion of a concept used by the State Advisory Task Force on Energy Policy for the State of Hawaii.

The environmental evaluation matrix displays 15 major potential impact areas (See Exhibit V-11) compared to conventional and alternative fuel power systems. The matrix employs a qualitative method for examining the environmental impacts according to the degree of severity expected. The Hawaii Task Force utilized a four-point scale to rank each impact as follows:

1 - Negligible Impact
2 - Slight
3 - Moderate
4 - Severe

ARI feels that this scale is also reasonable for use in Samoa's planning process and suggests the use of this tool in two manners.

Survey of Impacts of Energy Sources

Impact	Conventional						Alternate Sources									
					Other										Other	
	Diesel	Gas Turbine	Dual System	Steam			Biomass	Solid Waste	Hydroelectric	Wind	Geothermal	Solar	OTEC	Wave	Nuclear	
TOTAL																
Energy resource depletion																
Area committed for conversion																
Area committed for transmission																
Water consumption																
Use of air space																
Air pollution																
Water pollution																
Construction activity																
Heavy metals or toxic substance																
Thermal discharge																
Solid waste																
Visual intrusion																
Noise generation																
Public health																
Transportation hazard																

Impact severity rating: 1-negligible, 2-slight, 3-moderate, 4-severe

IMPACT FACTORS

1. Energy resource depletion in the use of raw materials.
2. Areas (land, air, water) committed for energy conversion.
3. Area committed for storage and/or transmission.
4. Consumption of water in operation.
5. Change in the use of air space.
6. Emission of air pollutants during operation, such as SO_2, NO_2, and CO.
7. Discharge of water pollutants during operation.
8. Impact of construction activity on the surrounding area.
9. Release of heavy metals and other toxic agents.
10. Heat loss during the operation (thermal discharge).
11. Solid wastes, such as sludge, and the disposal of such wastes.
12. Visual intrusion.
13. Noise generation.
14. Public health, physical and mental.
15. Transportation hazards.

5.6.1 Territory-Wide

This tool would be used to develop an overview of the relative potential environmental impacts that can be expected from the various systems by considering the whole coastal zone. In this use, the various systems can be compared in terms of overall environmental impacts and ranked accordingly.

5.6.2 Site-Time Specific

In this situation, the tool is applied to a specific time and/or site to determine the potential environmental impacts. The intention here is to not only evaluate a proposed system for a proposed site, but to also consider other alternatives for the site-time proposed which could meet the need or demand requirements.

There are a number of ways to complete the site-time specific matrix.

Site Specific

- Consider all energy facilities and evaluate relative impacts on a district-by-district basis or a village-by-village basis.
- Predetermine areas where the energy facilities may be located and evaluate. This requires the Zoning Board to designate additional land use areas acceptable for such facilities.

Section 6 discusses the current zone designated areas and the related problems of zoning Samoa's communal lands.

Time Specific

- Using the recommended equipment/facility expansion dates provided by Parsons, Hawaii, compare only those energy systems that can be expected to be available and operational by that date.
- Upon filing of an application, compare only those energy systems that can be expected to be available and operational by the construction completion date.

5.6.3 Utilizing the Matrix

The processes described above will provide planners with an inclusive means of assuring that reasonable consideration of the impacts to energy facility siting in the coastal zone is maintained. It should be remembered that this process is only a tool to place energy facilities into perspective with the

environment. It is from this evaluation process that licensing/permitting agencies will be able to require applicant consideration of perceived likely impacts that must be addressed by future research.

Section 7 of this report contains a discussion on the coordination of relevant agencies involved in energy facility planning and describes the specific role of each agency. It is believed that the planning tool should be initialized and updated by the Energy Conservation Advisory Board (ECAB). This 24-member board is composed of representatives of major energy users, suppliers and government agencies and as such, their assessments will, when aggregated, provide a cross-sector evaluation representing all factions of Samoa's government, private enterprise and the general public.

SECTION 6

ARTICULATION OF PRESENT POLICIES AND OTHER TECHNIQUES FOR THE MANAGEMENT OF ENERGY FACILITIES AND/OR THEIR IMPACTS

6.1 Introduction

The most difficult and the most demanding of concentrated legal attention are those referring to the organization and authority of the program. They require that the Territory (1) has the power to administer land and water use regulations, control development in order to ensure compliance with the management program, resolve conflicts among competing uses, (2) has the authority to acquire land to achieve conformance with the management program, and (3) has a method for assuring that local land and water use regulations within the coastal zone do not unreasonably restrict or exclude uses of regional benefit. Accordingly, a review of existing laws, rules and regulations, agency charters and ASG policies and practices was conducted to determine the extent to which they fulfill the requirements of subsection 305(b)(8) of the CZMA.

6.2 Landownership/Use

6.2.1 Background [4]

One of the most critical elements for management of energy facilities and/or their impacts will be that of land use/ownership. Appendix C to the Economic Development Plan contains a discussion of the statutory definitions and related judicial interpretations affecting the local land tenure system of the Territory of American Samoa. This appendix should be reviewed to gain a thorough perspective so that the discussions contained in this section may be placed in proper context. In summary, landownership is categorized as follows:

Type Ownership	Percent of Total Acreage
Freehold	0.3
Government	3.1
Churches	1.9
Individually	2.4
Communal Family	92.4

Freehold land is the only category that has no restrictions on transfer of title or lease tenure. Government land may be leased or sold to anyone with the approval of the ASG. Church land may be leased with the approval of the ASG, but may not be sold to non-American Samoans. And, individually owned and communal family land cannot be sold to any non-American Samoan and cab only be leased for a period not exceeding 55 years.

6.2.2 Authority to Administer Land Use Regulations

There are several sections of the American Samoa code which delineate the control of land uses as described below:

6.2.2.1 Land Commission

The Land Commission, created in Title 27, Section 202, of the American Samoa Code (ASC), ensures that the sale and lease of all lands in American Samoa is in accordance with the codes. It also prevents the monopolistic ownership of land and makes certain that communal lands are not improperly alienated by those charged with the management and control of them. Additionally, it is to be a recommending body to the Governor for considerations affecting or improving land ownership.

6.2.2.2 Land and Site Use Committee

The Land and Site Use Committee, whose authority was created by executive order, reviews plans and proposals for use of public lands to ensure conformance with government land master planning.

6.2.2.3 Zoning Board

Title 29, Section 13, of the ASC establishes provisions for a local zoning board which is empowered to zone "permissible" land and structural uses for the entire Territory, and to hear requests for variances. Since establishment of the Zoning Board, the Board and its staff, the ASG Development Planning Office, have been reluctant to zone, in any detail, land and structural use in light of the strong tradition of village rule throughout much of the Territory. Consequently, general zoning designations have been established only for the Pago Pago Bay area (Exhibit VI-1), Tula, and lands adjacent to the Tafuna Airport Road. The remaining lands on Tutuila are zoned "watershed - conservation" and Swain's, Aunu'u, and the Manu'a Islands have not yet been zoned.

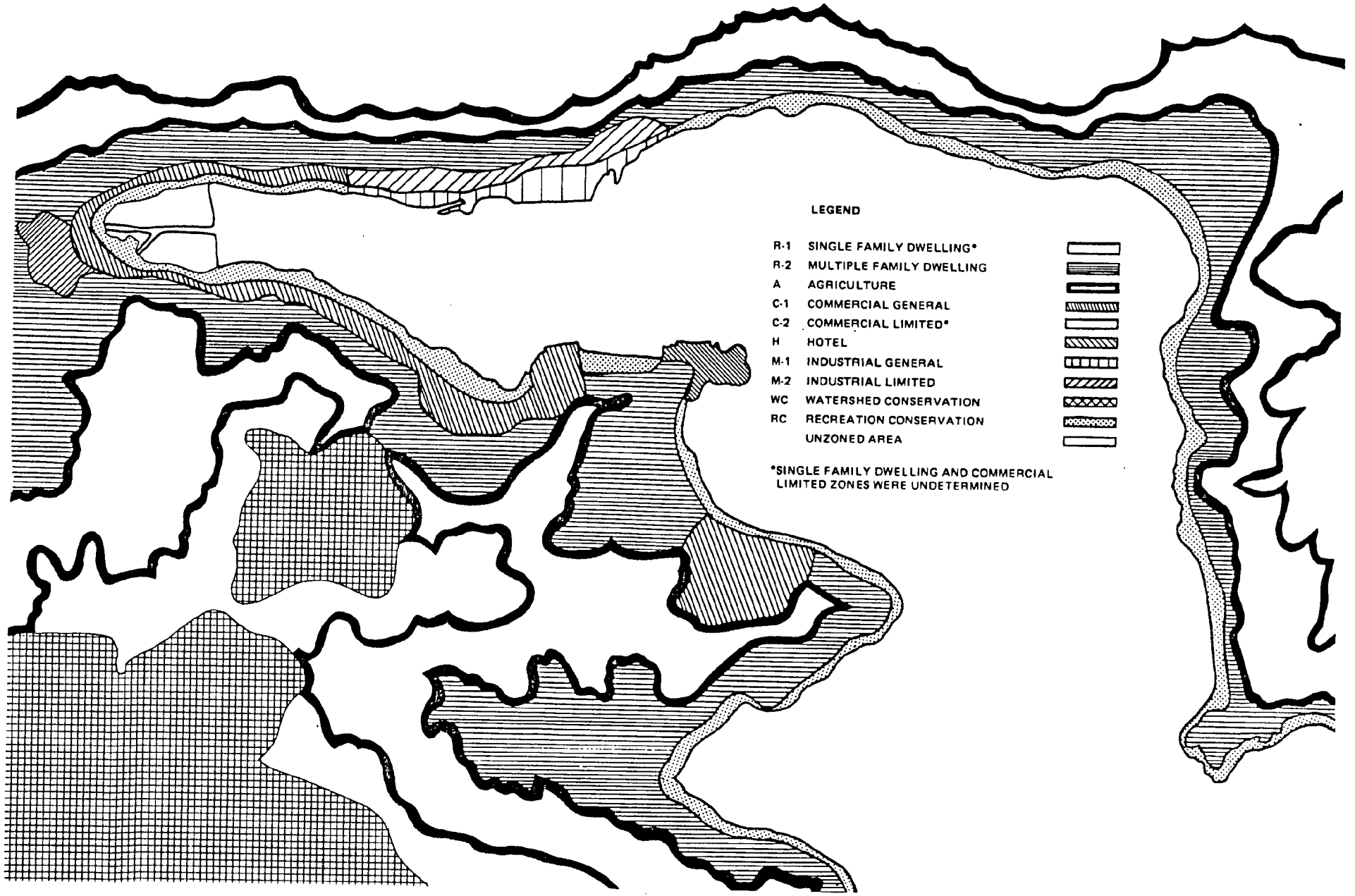


EXHIBIT VI-1

LAND USE ZONING DESIGNATIONS
PAGO PAGO HARBOR AREA

Source:
Economic Development Plan,
American Samoa, reference 4.

6.2.2.4 Territorial Park and Recreation Control Board

The powers and duties of this Board are delineated in Title 32, Section 3, of the ASC. They are to (1) establish a policy for the care, custody, and control of the several parks or preserves owned or controlled by the Territory of American Samoa, (2) to acquire land, subject to the approval of the Governor, for parks or preserves and for scenic or historic places throughout the Territory.

6.2.2.5 Territorial Planning Commission (TPC)

TPC was created by Title 29, Chapter 10, of the ASC. This title also sets up an Advisory Board to the Commission, composed of 7 department and office heads of the American Samoa Government.

The objective of the Commission is to prepare and recommend a general plan which may be concerned with industrial, commercial or agricultural development, with education, social services, housing, essential sewer, water and electric utilities services; with transportation, communications, recreation, conservation, cultural services; and with other relevant aspects of life in American Samoa. The TPC is also responsible for licensing businesses under Title 12, Section 1341 of the American Samoa Code.

6.2.2.6 Office of Samoan Affairs

The Office of Samoan Affairs, also known as the Department of Local Government, operates under the authority of Title 3, Section 201, of the ASC. The Office serves as the link between the traditional leaders of the Samoan people and the Territorial Government. It is directed by the Secretary of Samoan Affairs, who is selected from the ranks of the traditional chiefs of the Samoan people.

The Office of Samoan Affairs is responsible for (1) conducting both general and special elections, (2) planning, coordinating, implementing, and supervising all ceremonial functions of the ASG, (3) conducting the biennial local census, (4) settling of matai titles and communal land disputes, and (5) planning, coordinating, implementing and supervising all programs and activities of local interest.

6.2.2.7 Village Regulations

Local Use

Title 4, Section 405 authorizes each village council to enact

village regulations concerning the cleanliness of the village, planting of lands, making and cleaning of roads, and any other matter of a strictly local nature. It prohibits the regulations from taking effect until they have been approved by the Office of Samoan Affairs, and proclaimed publicly and posted in writing by the pulenu'u (mayor).

Soil Conservation

Title 13, Chapter 13, provides villages with the authority to enact land use ordinances to provide for coordinated soil conservation programs. Such land use ordinances, like other village regulations, are effective when approved by the Secretary of Samoan Affairs.

6.2.3 Authority to Acquire Land

The American Samoa Government has the power to acquire fee simple land or lesser interests. Such authority comes from many sections of the American Samoa Codes and from the cession of Tutuila and Aunu'u signed in 1900, which provides:

> "The Government of the United States of America shall respect and protect the individual rights of all people dwelling in Tutuila to their land and other property in said district; but, if the said Government shall require any land or other thing for Government uses, the government may take the same upon payment of a fair consideration for the land, or other thing, to those who may be deprived of their property on account of the desire of the Government."

In the American Samoa Codes, Title 27, Section 1801, gives the government the authority to purchase property for public purposes, while Section 1601 provides:

> "The American Samoa Government may take any land, easement or right-of-way, or any other property interest in American Samoa, when required for public purposes. Where possible, the Governor shall consult with the legislature about proposed condemnation projects, and shall obtain the advice of the legislature on all such projects. Payment of just compensation shall be made, in accordance with the procedures described in Chapter 123 of Title 11, to those who may be deprived of their property by such taking."

Even the strict limitations on the alienation of land held by Samoans do not appear to have affected the authority of the government to acqurie land. Title 27, Section 204, which imposes the basic restrictions on land

alienation states:

> "This section shall not prohibit the conveyance and transfer of native land for governmental purposes to the United States Government or to the American Samoa Government or to a lawful agent or trustee thereof...; Provided, that the reconveyance and retransfer of land shall be to native Samoans only and in the discretion and upon the approval of the Governor."

6.2.4 Review Findings - Land

In the course of the review on land uses and controls, the principal area of concern was that of zoning. Comparison of Exhibits IV-1 and IV-2 indicate that most of the potential sites for alternative energy systems are found to be in the watershed - conservation zones for Tutuila and for those sites in Manu'a, there are no designated zoning codes. Thus, variances or a declaration of the applicable code will be required. Based on a review of the information presented in the Parsons, Hawaii Report relating to expansion of the current facilities, there does not appear to be a similar problem.

6.3 Building Use/Control

6.3.1 Overview

In addition to the policies related to land use, ASG also utilizes offices, boards and commissions to control the construction of buildings in Samoa. These are discussed below:

6.3.1.1 Building Codes

Title 29, Section 1001 of the ASC charters the building department of the Department of Public Works to be charged with the administration and enforcement of the building codes. This section also stipulates that ASG has adopted the latest available edition of the Uniform Building Code (UBC) as approved by the International Conference of Building Officials. By adoption of the UBC, building permits are required.

6.3.1.2 Capital Improvements Projects Committee (CIPC)

The CIPC was authorized by an Executive Order of the Governor. It acts as an advisory board and performs the following tasks: (1) reviews proposals for the study, design and construction of all capital improvement projects of the Territory, (2) checks the progress of implementing the programs,

(3) recommends a priority for achieving the goals of the capital improvement projects for inclusion of local and federal applications.

6.3.1.3 Clearinghouse Review Committee

The Clearinghouse Committee was created by Executive Order of the Governor. Its functions are (1) to evaluate the significance of proposed federal or federally assisted projects to territory programs, (2) to provide an opportunity to review and comment on the civil rights aspects of a project, and (3) to provide liaison between federal agencies contemplating direct federal development projects and the local governments that have plans or programs that might be affected by the proposed project.

6.3.1.4 Department of Public Works

The Department of Public Works is responsible for providing engineering, design, and support services for all ASC capital improvement projects, maintaining and servicing all ASG buildings, roads, grounds, and other public facilities; and operating and maintaining the electrical, water, sewer and solid waste disposal system in American Samoa.

6.3.1.5 Others

The other elements of building use/control are the Zoning Board, TPC, and the Land and Site Use Committee as were previously described in Section 6.2.2.

6.3.2 Review Findings - Buildings

The review of building use and control focused on governmental agencies, because the ASG is currently the sole provider of all electric energy in Samoa. However, both the Fono (legislature) and the Executive branches of Government have been seriously considering a change in this infrastructure by possibly making the EUD either a quasi-public or privately owned entity. As long as ASG continues to operate and manage the electric utility for the Territory, the aforementioned policies should suffice to properly manage energy facilities and/or their impacts in relation to buildings. However, should the EUD be converted to either a quasi-public or privately operated entity, modifications will be required to agency charters.

6.4 Environmental Quality

6.4.1 Overview

Title 13, Chapter 1 of the ASC created the Environmental Quality Commission (EQC) which has the power and duty to establish air and water quality standards for the Territory and to prepare and develop a comprehensive plan(s) for the prevention, abatement and control of air and water pollution in the Territory. This commission requires stationary air pollution source permits and permits for sources of air or water pollution, or equipment causing or intended to prevent pollution.

6.4.2 Findings - Environmental Quality

The EQC has developed a territorial-wide air and water pollution control implementation plan that appears to be consistant with federal rules and regulations for the Clean Air Act, Water Pollution Control Act and other related federal rules and regulations.

6.5 Energy

6.5.1 General

Ever since the OPEC embargo, ASG has been developing comprehensive plans for the Territory in both energy conservation and alternative sources. Two different organizations have responsibilities for these programs. A third energy-related office is that of the Electric Utility Division (EUD).

6.5.2 Territorial Energy Office

The TEO was created by Executive Order 2-77 in June of 1977. The TEO is to serve as the responsible agency for energy affairs, as identified by the Governor's Office and the United States Department of Energy. It currently administers conservation grants and alternative energy feasibility studies as listed in Exhibit I-2.

6.5.3 Energy Conservation Advisory Board (ECAB)

The ECAB was created by Governor's General Memorandum 4-77 in January of 1977. It was subsequently expanded from its original 5 members to 24 members in July of 1978. There are 4 subcommittees within the ECAB, consisting of (1) the Executive Committee which reviews the status of all energy programs and recommends future endeavors; (2) the Energy Resources Committee which reviews and recommends on matters pertaining to energy/fuel consumption;

(3) the Planning Committee which reviews and recommends on matters pertaining to territory-wide programs, new programs, federal regulations and the appropriateness of all programs to the plans for the future of American Samoa; and (4), the Education and Awareness Committee which reviews educational curriculum and media contents to ensure their appropriateness and utility to the students and citizens of American Samoa.

6.5.4 Electric Utility Division (EUD) of DPW

The EUD is responsible for the generation of electricity throughout the Territory and was officially established in 1962 as part of the Maintenance and Operations Division of DPW. In 1967, it was made a separate division of DPW and a rate structure was established based on REA's recommended systems. In 1970, the Legislature (Fono) established the Enterprise Fund Policy which required the EUD and other ASG agencies to be financially self-operating. Then in 1972, the Fono established a financial policy for EUD that set forth the manner by which setting rates were to be followed.

In terms of operating practices, the EUD/DPW have been the lead agencies for estimating future demand and planning expansion of power facilities. With the creation of the TEO, these two agencies now conduct cooperative efforts on the planning of the energy future for the Territory.

6.5.5 Findings - Energy

All energy matters of Samoa are essentially addressed through the EUD, TEO and ECAB. With the drafting of the EDP, the Government is seriously considering the possibilities of reducing the government size by creating quasi-public agencies for the utilities of Samoa. To this end, two Fono bills have been introduced in the past (Senate Bill 22 of 1978 and Senate Bill 72 of August 3, 1979) to create an Electric Utility Power Authority. Should the most recent bill be passed, electric power generation in Samoa will come under a well-defined charter for future operations.

6.6 Conclusions and Recommendations

Based on a review of the territorial policies and their implementing agencies, it appears that the existing land, building, environment and energy planning,zoning, permitting and licensing procedures can satisfy the requirements of the CZMA, with only relatively minor adjustment to the current charters. It is believed that all adjustments could be effected through executive order by

the Governor. The specific adjustment recommended is that a clause be added to the current operating procedures manuals, rules and regulations or other similar documents for each of the above agencies which insures that each will consider energy facilities and/or their impacts in their reviewing processes. This recommendation will be expanded upon in the following section.

SECTION 7

INTERGOVERNMENTAL COORDINATION

7.1 Introduction

A review of the current governmental infrastructure was made in relationship to energy facilities and/or their impacts to determine if an adequate mechanism for coordination and/or cooperative working arrangements exist among the various agencies of government (both territorial and federal), the energy industry of Samoa and the general public.

Section 6 presented a discussion of the enforceable territorial policies, authorities and techniques that could be applied to energy facilities and/or their impacts. Also, this section provided a brief description of the agencies chartered to perform such responsibilities. The ensuing paragraphs contain a discussion of the findings made from the review of policies and organizations.

7.2 Conclusions and Recommendations

7.2.1 Overview

The review of existing agency charters and policies related to energy facilities indicated that with only relatively minor alteration, these existing agencies could manage the energy facilities and/or their impacts. Exhibit VII-1 shows a recommended organizational flow diagram for the processing of applications related to energy facilities. The organization and application processing steps have been designed to keep application processing costs to the minimum for both the applicant and the government. This would be accomplished through use of a relatively simplified application which would include a description of the intended facility and its attendant parts, the proposed location with artist/architects rendition of the facilities and an initial discussion of the potential impacts and their significance.

The order of steps and the review process is based on the possibilities that the EUD may eventually be a quasi-public operation and that as demand grows, private enterprise may desire to be in the energy business, particularly when considering alternative sources. An explanation of the chart and the recommended responsibilities of the various agencies is contained in the ensuing paragraphs.

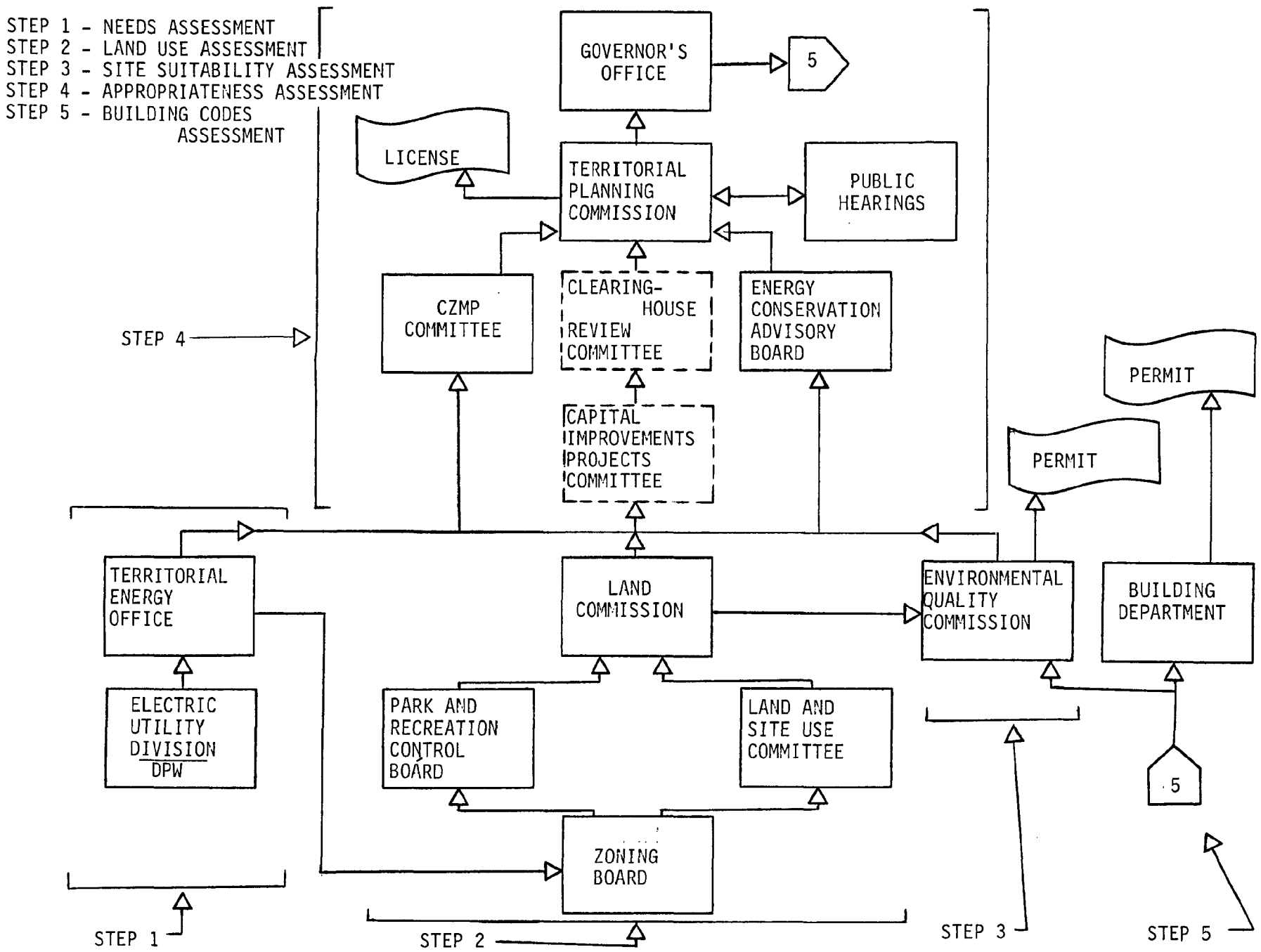


EXHIBIT VII-1 MANAGING ENERGY FACILITIES

7.2.2 Review and Planning Process

7.2.2.1 Step 1 - Needs Assessment

An applicant (whether a government agency or not) would initiate an application approval process by first coordinating with the energy production (electrification) and facilities managers which are the responsibilities of the DPW/EUD of ASG. These offices would verify that expansion of facilities are/are not warranted, discuss how their own agencies could/could not meet the need or demand, comment on the possibilities of interfacing with the applicant, and other such matters.

Following the above review, or conducted simultaneously, would be an examination of the application by the TEO to determine how the proposed energy facilities fit into the overall Territorial Energy Conservation and Alternatives Plan. Additionally, this office would comment on how the proposed application considers both regional and national interests in the planning for and siting of facilities.

Since neither of these agencies have permitting or licensing authorities for such matters, their role is more of an advisory one by which other related agencies may utilize the resources of these 2 offices to gain a base of information and place in perspective the value of the application.

The findings of both the agencies of this step are forwarded to the CZMP Committee*, the ECAB and the Zoning Board. If the application is sponsored by a government agency such as the EUD, then the findings would also be forwarded to the CIPC shown in the broken line boxes.

7.2.2.2 Step 2 - Land Use Assessment

Due to the zoning designation decisions as discussed earlier in Section 6, and the land tenure system employed in Samoa, it is believed that this review stage is necessary and must be completed early in the application process. In this step, there are 4 governmental agencies which are to review and comment on the application.

---

* The CZMP Committee is an author created name for a body which is believed to be needed for the overall coordination of the overall CZMP requirement. This agency will be explained in later paragraphs.

It would be the Zoning Board's responsibility to determine the appropriateness of the proposed activities and location of the facilities compared to the existing area and its zone designation. If the proposed location has not yet been zone designated, then the Board would provide comments on the anticipated impacts to be encountered if the area was to be appropriately zone designated. A recommendation would also be provided. If the proposed location is a zone designated area, but not compatible to the facility activity contained in the application, then the Board would provide comments and recommendations on the possibilities of a waiver or change in zone designation.

After the Zoning Board review, the Land and Site Use Committee and the Park and Recreation Control Board would review the application (with the Zoning Board's inputs) to determine if any conflicts in use would exist. Their comments and recommendations would be forwarded to the Land Commission.

Following the aforementioned reviews, the Land Commission would collate the inputs of the other land utilization review agencies and determine the appropriateness of the application within the land laws of Samoa. Their findings and recommendations would be forwarded to the CZMP Committee (to be explained), the ECAB and the Environmental Quality Commission (EQC). If the application was originated by a government agency, then it would also be provided to the CIPC as shown by the broken line boxes on the exhibit.

7.2.2.3 Step 3 - Site Suitability Assessment

The EQC would be responsible for the determination of the potential environmental impacts that the proposed facility would impose. Based on their findings and recommendations, the applicant may be required to perform an Environmental Assessment/Environmental Impact Statement or the EQC might find no significant impact potential and recommend that appropriate permits be issued upon completion of the review chain.

Following the above review, the EQC would forward its comments and recommendations to the CZMP Committee (to be explained), and the ECAB (also the CIPC if the application is by a government agency). If an EIA/EIS was required, the applicant would conduct such, and report the results back to the EQC prior to any actions being taken by the CZMP Committee or the ECAB. Once the EQC finds the EIA/EIS satisfactory, final recommendations would be provided by the EQC to the next level of review (Step 4).

7.2.2.4 Step 4 - Appropriateness Assessment

This step incorporates intergovernmental agency review and public involvement in the decision process. It should be remembered that at this stage of the review process, essentially 3 assessment packages have been developed - needs, land use and site suitability - and forwarded to the Step 4 organizations of CZMP Committee, ECAB and, if the application was government initiated, the CIP Committee.

The "CZMP Committee" is an author created body which is believed to be needed for the overall coordination of all elements of the CZMP (i.e., erosion, access, boundaries, land and water use, etc.). This "committee" would ensure that all assessment requirements of the CZMA and the Territorial CZMP are completed and not in conflict. If any requirements have been missed or conflicts exist, this "committee" would work with the Step 1-3 agencies and the applicant to rectify them.

The ECAB is, as described previously in Section 6, a multi-subcommittee, multi-sector board with review and recommendation responsibilities related to energy planning, resource demand/capacity and public education and awareness. As such, its membership includes representatives from the executive and legislative branches of ASG, traditional village (or local) government leaders, large energy consumers in the private sector and the energy industry. This body truly represents a cross-section of the directly interested and affected public and private parties that should be involved in the planning process for energy facilities and/or their impacts. This board will provide its review comments and recommendations to the next level of review - the Territorial Planning Commission (TPC).

Step 4 includes a special review process for applications that are originated by government agencies. This process is to be completed in addition to the CZMP Committee and ECAB reviews. This review includes consideration by the CIP Committee to provide comments on the appropriateness of the facilities to the ASG planned projects and funding levels. The Clearinghouse Review Committee provides comments on how the proposed application would fit into ASG overall plans and the involvement of federal funds and requirements.

The Territorial Planning Commission (TPC) would review the aforementioned findings, comments and recommendations in relation to the territory-wide general plans and initiate public hearings as required. Following the review and evaluation of the comments received from the public hearings, the TPC would either recommend licensing of the facility to the Governor or have

additional analysis completed as necessary under the purview of the appropriate agencies in Steps 1 through 3. The analysis results would be processed accordingly in Step 4.

7.2.2.5 Step 5 - Building Codes Assessment

In the case of a favorable recommendation by the TPC and concurrence by the Governor, the applicant would then prepare final construction drawings, etc., and seek a building permit and EQC permits accordingly (this is the final step).

7.2.3 Recommendations

ARI recommends that an ASG Executive Order be developed promulgated to the agencies shown by Exhibit VII-1 that instructs each to design the appropriate rules and regulations consistent with the spirit and intent of Sections 5 through 7. These draft plans would then be submitted to the Governor via the CZMP Committee for comments and recommendations consistent with the requirements of the CZMA.

LIST OF REFERENCES

1 Action Resources Incorporated, An Operations Review of Power Generating Efficiency - Electric Utility Division, October, 1978.

2 American Samoa Government, American Samoa Annual Report, 1978.

3 American Samoa Government, American Samoa Codes 1975 and revisions.

4 American Samoa Government, Development Planning Office, Economic Development Plan for American Samoa 1979-1984, March, 1979.

5 American Samoa Government, Environmental Quality Commission Documents, June, 1973 revised.

6 American Samoa Government, Office of Traffic Safety, American Samoa Highway Safety Plan, FY 1978.

7 American Samoa Government, Senate Bill 72, August 3, 1979.

8 American Samoa Government, ECAB Charter.

9 American Samoa Government, Territorial Energy Office, Energy Conservation Plan, September, 1977.

10 American Samoa Government, Territorial Energy Office, Supplemental Energy Conservation Plan, December, 1977.

11 American Samoa Government, Territorial Energy Office, Energy and Samoa, January, 1979.

12 American Samoa Government, Bay Area Planning Committee, et al, Pago Bay Area Master Plan Report - 1975.

13 Blume, John H. & Associates, Preliminary Design for Pago Pago Harbor - '74 Port Improvements.

14 Dames and Moore, Territorial Solid Waste Management Plan, 1978.

15 Dames and Moore, American Samoa Water Resources Study, Hydrologic Investigation of Surface Water for Water Supply and Hydropower, Tutuila Island, American Samoa, U.S. Army Engineer District, Honolulu, September, 1978.

16 Department of Commerce and State of Hawaii, Department of Planning and Economic Development, State of Hawaii Coastal Management Program and Final Environmental Impact Statement, 1978 - OCZM NOAA.

17 Department of Commerce and State of Hawaii, Department of Planning and Economic Development, State of Hawaii Coastal Zone Management Program and Draft Environmental Impact Statement 1978 - OCZM - NOAA.

18 Eaton, William; Geothermal Energy, 1975.

19 Eckbo, Dean, Austin & Williams, American Samoa - Preliminary General Plan Phase II, October, 1973.

20 Energy Research and Development Administration, Division of Solar Energy, Solar Thermal Power Systems, December, 1978.

21 Enplan Corporation, Pago Pago Harbor - Corridor Transportation Study, 1974.

22 Enplan Corporation, Pago Pago Harbor - Corridor Transportation Study, 1974, Chapter III,"Traffic Changes Harbor Area."

23 Hawaii Natural Energy Institute and Department of Planning and Economic Development, State of Hawaii, Alternate energy Sources for Hawaii, 1975.

24 Office of Naval Research, School of Mines, 1975 Report.

25 Parsons, Hawaii; Electrical Power Generation Study, Island of Tutuila, American Samoa, November, 1979.

26 Randall, Scanlan & Associates, Pago Pago Harbor - Study and Recommended Programs for Development, 1972-1982, December, 1972.

27 School of Electrical Engineering, Purdue University, State Variable Analysis, Control and Feasibility of Design of an Ocean Thermal Power Plant, December, 1976.

28 State of Hawaii, Department of Planning and Economic Development, Draft State Energy Plan, Hawaii, 1979.

29 State of Hawaii, Department of Planning and Economic Development, Energy Use in Hawaii, November, 1977.

30 State of Hawaii, Department of Planning and Economic Development, Hawaii Coastal Zone Management Program-First Year Summary Report 1974-1975, October, 1975.

31 State of Hawaii, Department of Planning and Economic Development, Hawaii Coastal Zone Management Program - Second Year Summary Report: December, 1977.

32 State of Hawaii, Department of Planning and Economic Development, Hawaii Coastal Zone Management Program, A Register of Government Permits Required for Development, December, 1977.

33 URS/John A. Blume & Associates; Harbor Improvements - FY 1974 - Cargo Container Wharf and Storage Yard Expansion, June, 1974.

34 U.S. Army Corps of Engineers, American Samoa - Water Resources Study, December, 1977.

35 U.S. Army Engineer Division, Pacific Ocean, Hawaii Regional Inventory of the National Shoreline Study, August, 1971.

36 United States Senate, Committee on Energy and Natural Resources, Subcommittee on Energy Research and Development, Hearings: The Role of Alternate Energy Resources in Promoting Island Self-Sufficiency.December, 1978.

37 Letter: United States Coast Guard, District 14, to Action Resources Incorporated, 23 November 1979, re: comments on Pago Harbor Alterations.

38 Letter: Manager, Electric Utility Division to Director, Department of Public Works, ASG, December, 1978, re: Facility Expansion.

39 Department of Energy Appropriate Energy Technology Grant for Tuna Sludge Conversion in American Samoa.

40 Bowen, R. G., Environmental Impact of Geothermal Development, Geothermal Energy, 1973.

41 Anderson, J.H. and Anderson, J.H.,Jr., "A Summary of the Anderson and Anderson Analysis of the Solar Sea Power Process 1964-1972", NSF/RANN Technical Report SE/GI-34979/TR/73/5, University of Massachusetts.