GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF CONTRACT ADMINISTRATION

SPONSORED PROJECT INITIATION

no action

Date: April 11, 1977

Project Title: Preparation of a Project Paper for the Cape Verde Desalination and Power System (SAL)

Project No: A-1963

Project Director: N. C. Wall

Sponsor: Agency for International Development

Agreement Period: From 3/2/77 Until 5/1/77

Type Agreement: Contract No. AID/Afr-C-1300

Amount: $37,000

Reports Required: Final (10 copies within five weeks of completion of on-site visit)

Sponsor Contact Person (s):

Technical Matters

Contractual Matters
(thru OCA)

Defense Priority Rating:

Assigned to: Economic Development Laboratory (School/Laboratory)

COPIES TO:

- Project Director
- Division Chief (EES)
- School/Laboratory Director
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- Accounting Office
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- Reports Coordinator (OCA)
- Library, Technical Reports Section
- Office of Computing Services
- Director, Physical Plant
- EES Information Office
- Project File (OCA)
- Project Code (GTRI)
- Other ______

CA–3 (3/76)

GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF CONTRACT ADMINISTRATION

SPONSORED PROJECT TERMINATION

no action
OCS

Date: October 13, 1977

Project Title: *Preparation of a Project Paper for the Cape Verde Desalination & Power System (SAL)*

Project No: *A-1963*

Project Director: *Nelson Wall*

Sponsor: *Agency for International Development*

Effective Termination Date: *9/1/77*

Clearance of Accounting Charges: *9/30/77*

Grant/Contract Closeout Actions Remaining:

NONE

- _ Final Invoice and Closing Documents
- _ Final Fiscal Report
- _ Final Report of Inventions
- _ Govt. Property Inventory & Related Certificate
- _ Classified Material Certificate
- _ Other ____________

Assigned to: *International Programs Office* (School/Laboratory)

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Director, Physical Plant
EES Information Office
Project File (OCA)
Project Code (GTRI)
Other ____________

CA–4 (3/76)

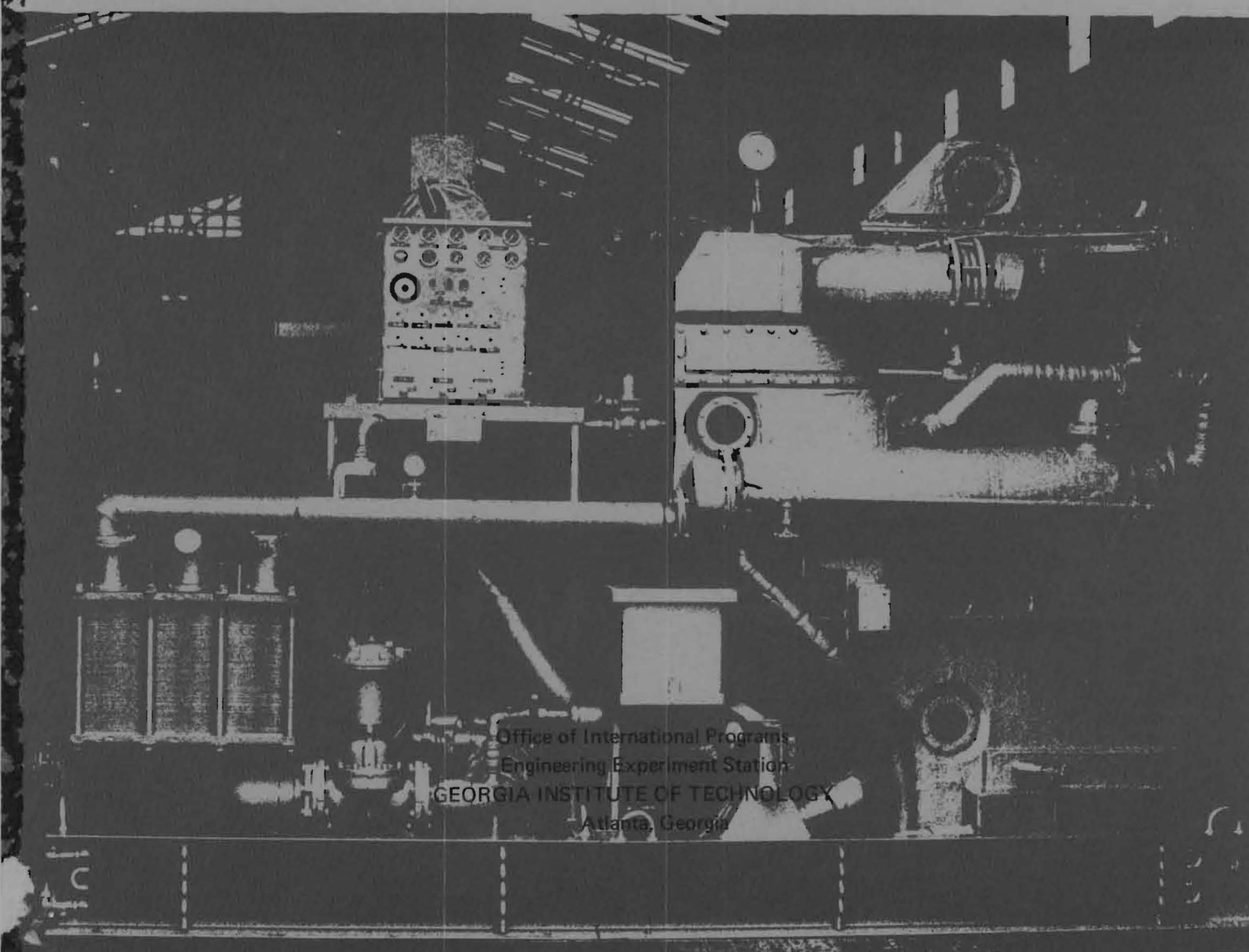
Unclassified

Department of State
Agency for International Development
Washington, D.C. 20523

PROJECT PAPER

CAPE VERDE – DESALINATION AND POWER (SAL)

VOLUME I



Office of International Programs
Engineering Experiment Station
GEORGIA INSTITUTE OF TECHNOLOGY
Atlanta, Georgia

Project A-1963

UNCLASSIFIED

DEPARTMENT OF STATE
AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON, D.C. 20523

PROJECT PAPER
CAPE VERDE-DESALINATION AND POWER (SAL)

Proposal and Recommendations
For Review by the
Executive Committee for Project Review

by

Project Analysis Team

VOLUME I

Office of International Programs
Engineering Experiment Station
GEORGIA INSTITUTE OF TECHNOLOGY
Atlanta, Georgia
August 1977

Table of Contents

		Page
Foreword		i
Project Analysis Team		ii
I.	SUMMARY AND RECOMMENDATIONS	1
	A. Face Sheet Data	2
	B. Recommendations	4
	C. Description of Project	4
	D. Soundness of Project	6
	1. Technical	7
	2. Financial	7
	3. Social	8
	4. Economic	8
	E. Project Issues	10
	1. From the Project Committee Review of the PP	10
	2. From the ECPR Review of the PRP	13
II.	PROJECT BACKGROUND AND DETAILED DESCRIPTION	16
	A. Background	17
	B. Detailed Description	19
	1. Overview	19
	2. Project Goals and Anticipated Outputs	19
	3. Estimated Inputs	22
	4. End-of-Project Status	22
III.	PROJECT ANALYSIS	24
	A. Technical Analysis	25
	1. Present System for Water and Power Production and Distribution and Wastewater Removal	25
	2. Proposed System for Water and Power Production, Delivery, and Distribution and for Wastewater Removal	26
	3. Capability of the GOCV to Operate and Maintain the Proposed Technology	28
	4. Environmental Assessment	29
	B. Financial Analysis	30
	1. Financial Rate of Return	30
	2. Financial Plan	31
	3. Recurrent Budget Analysis and Organizational Plan	36

	Page
C. Social Analysis	39
1. Population Overview	40
2. Income Distribution	43
3. Labor Force	43
4. Distribution of Time	46
5. Health	46
6. Medical Services and Health Problems	49
7. Implications of Increase in Availability of Water and Power	49
8. Role of Women	50
D. Economic Analysis	52
1. Impact on Households	52
2. Impact on Government, Commerce, and Industry	54
3. GOCV Industrial Development Plans	55
4. Internal Rate of Return	56
5. Foreign Exchange Impact	58
IV. IMPLEMENTATION PLAN	63
A. Administrative Arrangements	64
B. Implementation Plan and PPTNC	64
C. Evaluation	68
D. Conditions and Covenants	69

Annexes

Volume I:

1. Log Frame
2. 611(e) Certification
3. Letter Requesting Assistance
4. PAF Parts I and II
5. Initial Environmental Examination and Project Team Environmental Assessment

Volume II:

6. Technical Analysis
7. Financial Analysis
8. Social Analysis
9. Potential Industrial Activities and Industrial Surveys

Page

Maps

1. Cape Verde Islands iv
2. Sal Island v

Tables

1. Electric Power Generation, Sal Island 25
2. Electric Power Consumption, 1976 26
3. Projected Cash Flow Summary 31
4. Financial Plan Summary: Capital Costs, Cases IIB and IIBi 32
5. Financial Plan Summary: Annual Operating Costs, Cases IIB and IIBi 33
6. Financial Plan Summary: Profit and Loss, Cases IIB and IIBi 34
7. Financial Plan Summary: Capital Costs, Wastewater System 35
8. Population Dispersion, Sal Island, 1975 40
9. Age Distribution, Sal Island, 1977 42
10. Population Distribution by Sex, Sal Island, 1977 42
11. Population Projection, Sal Island 46
12. Summary of Present Value of Costs and Benefits, Proposed Water/Power Project, Sal Island (Cases IIB and IIBi) 60
13. Project Capital Cost Summary 61
14. Government of Cape Verde Capital Cost Summary 61
15. Project Annual Cost Summary 62

Figures

1. Proposed Organizational Plan, National Water and Power Authority, Republic of Cape Verde 37
2. Proposed Organizational Plan, Water and Power Facility, Palmeira, Sal Island 38
3. Age Distribution, Sal Island, 1977 41
4. Sample Household Budget Distribution 44
5. Per Capita Allocation, Sample Household Budget 45
6. Sample Allocation of Time for Household Tasks 47
7. Water/Power Cost, Cases IIB and IIBi 57

Foreword

This Project Paper is based on a research study conducted on Sal Island, Republic of Cape Verde, by a technical team under contract to the Agency for International Development (AID). Field research was initiated on March 2, 1977, by a six-person team under the leadership of Richard Ray Solem, Design Officer, U.S. Agency for International Development.

The team, guided by Mr. Solem, remained on site for a two-week period. Upon returning to the U.S.A., the team assisted the team leader in preparing this final report and in developing conclusions and recommendations.

The sections that follow in this document present the findings and engineering solutions for the desired water/power system for Sal Island, as well as the economic viability of the recommended solution.

PROJECT ANALYSIS TEAM

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Angel Diaz, AFR/RA

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Robert Huddleston, AID Affairs Officer

Edward Dragon, AFR/GC

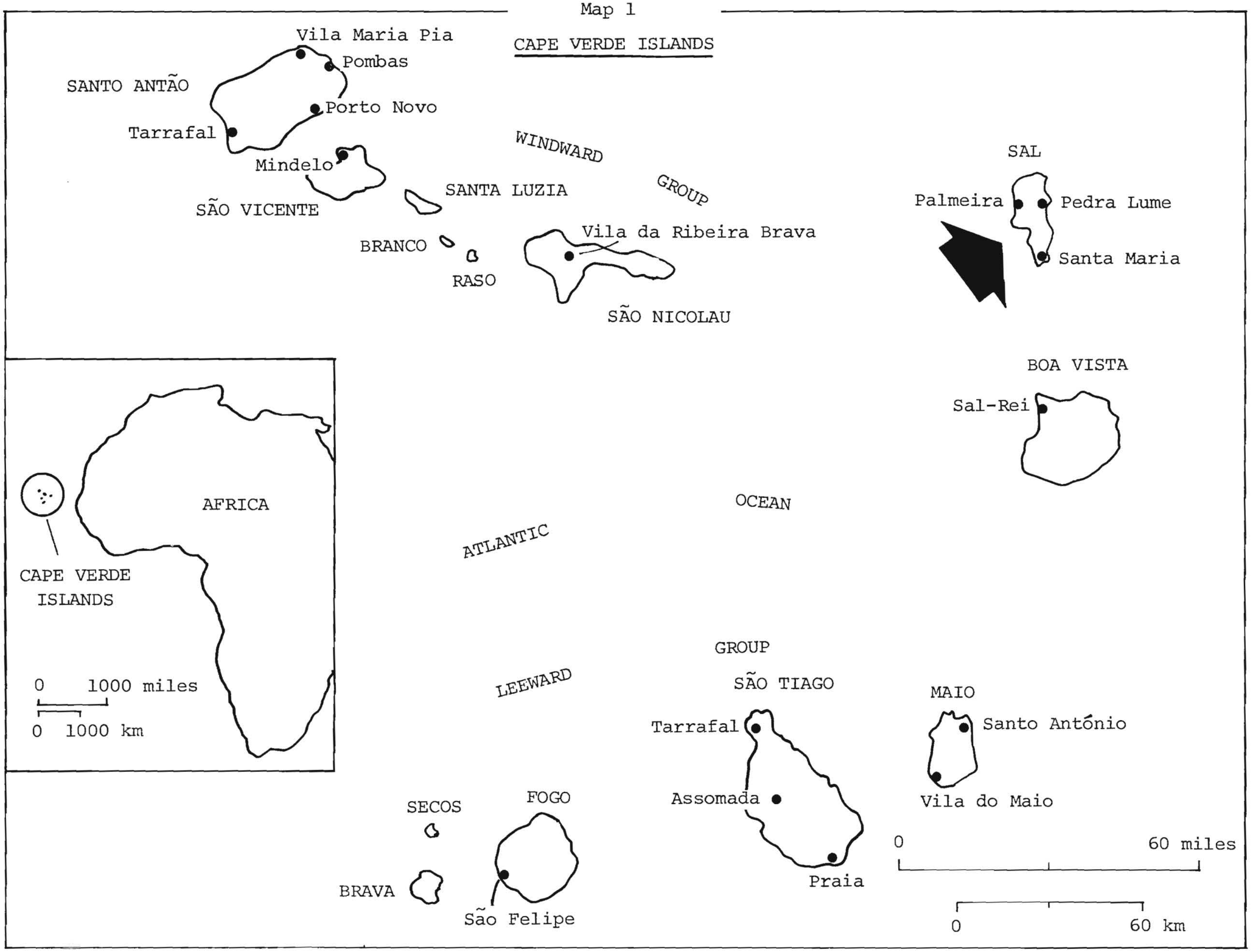
Forest Duncan, AFR/DP

John Welty, PPC/DPRE

James Cooperman, SER/ENGR

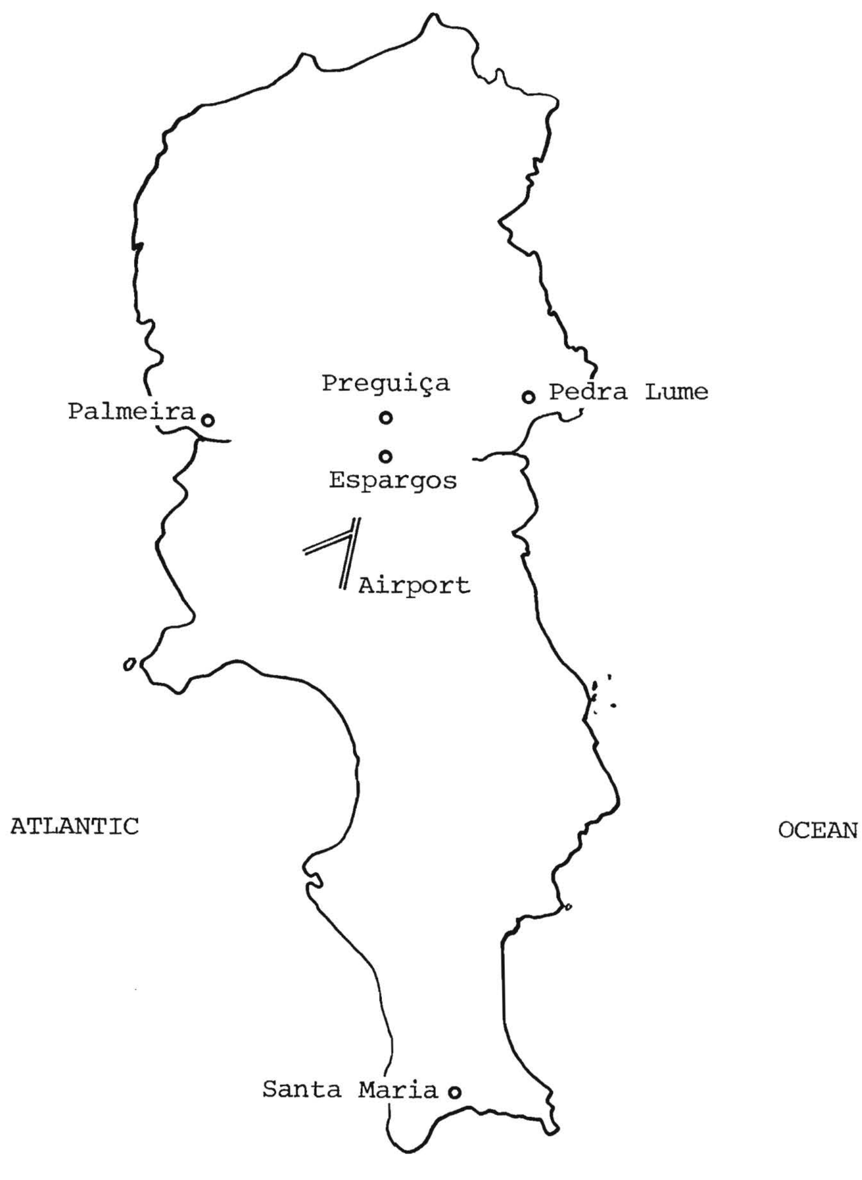
Map 1

CAPE VERDE ISLANDS



Map 2

SAL ISLAND



Chapter I

SUMMARY AND RECOMMENDATIONS

A. Face Sheet Data

AGENCY FOR INTERNATIONAL DEVELOPMENT **PROJECT PAPER FACESHEET**	1. TRANSACTION CODE [ ] A ADD, C CHANGE, D DELETE	PP 2. DOCUMENT CODE 3
3. COUNTRY ENTITY Cape Verde	4. DOCUMENT REVISION NUMBER [ ]	
5. PROJECT NUMBER (7 digits) [ ]	6. BUREAU OFFICE: A. SYMBOL AFR; B. CODE [1]	7. PROJECT TITLE (Maximum 40 characters) [Cape Verde-Desalination and Power (Sal)]
8. ESTIMATED FY OF PROJECT COMPLETION: FY [8 1]	9. ESTIMATED DATE OF OBLIGATION: A. INITIAL FY [7 8]; B. QUARTER [1] (Enter 1, 2, 3, or 4); C. FINAL FY [8 0]	

10. ESTIMATED COSTS ($000 OR EQUIVALENT $1 –)

A. FUNDING SOURCE	FIRST FY			LIFE OF PROJECT		
	B. FX	C. L/C	D. TOTAL	E. FX	F. L/C	G. TOTAL
AID APPROPRIATED TOTAL						
(GRANT)	(525)	(74)	(599)	(525)	(222)	(747)
(LOAN)	(7,765)	(736)	(6,501)	(5,765)	(2,208)	(7,973)
OTHER U.S. 1.						
OTHER U.S. 2.						
HOST COUNTRY						
OTHER DONOR(S)						
TOTALS						

11. PROPOSED BUDGET APPROPRIATED FUNDS ($000)

A. APPROPRIATION	B. PRIMARY PURPOSE CODE	PRIMARY TECH. CODE		E. 1ST FY		H. 2ND FY		K. 3RD FY	
		C. GRANT	D. LOAN	F. GRANT	G. LOAN	I. GRANT	J. LOAN	L. GRANT	M. LOAN
(1) Health	514	544		525					
(2) SD	723		825/826		5,775				
(3)									
(4)									
TOTALS									

A. APPROPRIATION	N. 4TH FY		Q. 5TH FY		LIFE OF PROJECT	
	O. GRANT	P. LOAN	R. GRANT	S. LOAN	T. GRANT	U. LOAN
(1) Health					525	
(2) SD						5,765
(3)						
(4)						
TOTALS						

12. IN-DEPTH EVALUATION SCHEDULED: MM | YY

13. DATA CHANGE INDICATOR. WERE CHANGES MADE IN THE PID FACESHEET DATA, BLOCKS 12, 13, 14, OR 15 OR IN PRP FACESHEET DATA, BLOCK 12? IF YES, ATTACH CHANGED PID FACESHEET.
Revised PID facesheet attached hereon.

[2] 1 = NO, 2 = YES

14. ORIGINATING OFFICE CLEARANCE		15. DATE DOCUMENT RECEIVED IN AID/W, OR FOR AID/W DOCUMENTS, DATE OF DISTRIBUTION
SIGNATURE		
TITLE Dennis Conroy AID/AFR/RA	DATE SIGNED: MM DD YY	MM DD YY

AID 1330-4 (3-76)

AGENCY FOR INTERNATIONAL DEVELOPMENT

PROJECT IDENTIFICATION DOCUMENT FACESHEET

TO BE COMPLETED BY ORIGINATING OFFICE

1. TRANSACTION CODE: C (A = ADD, C = CHANGE, D = DELETE)

PID

2. DOCUMENT CODE: 1

3. COUNTRY/ENTITY: Cape Verde

4. DOCUMENT REVISION NUMBER:

5. PROJECT NUMBER (7 DIGITS): [ ]

6. BUREAU/OFFICE: A. SYMBOL: AFR; B. CODE: 1

7. PROJECT TITLE (MAXIMUM 40 CHARACTERS): Cape Verde - Desalination and Power (Sal)

8. PROPOSED NEXT DOCUMENT

A. 3 (2 = PRP, 3 = PP)

B. DATE: MM 10 YY 77

9. ESTIMATED FY OF AUTHORIZATION/OBLIGATION

a. INITIAL FY 78 b. FINAL FY 80

10. ESTIMATED COSTS ($000 OR EQUIVALENT, $1 =)

FUNDING SOURCE	
A. AID APPROPRIATED	
B. OTHER U.S. 1.	
B. OTHER U.S. 2.	
C. HOST COUNTRY	
D. OTHER DONOR(S)	
TOTAL	

11. PROPOSED BUDGET AID APPROPRIATED FUNDS ($000)

A. APPROPRIATION	B. PRIMARY PURPOSE CODE	PRIMARY TECH. CODE: C. GRANT	PRIMARY TECH. CODE: D. LOAN	E. FIRST FY: F. GRANT	E. FIRST FY: G. LOAN	LIFE OF PROJECT: H. GRANT	LIFE OF PROJECT: I. LOAN
(1) Health	514	544		525	5,765	525	5,765
(2) SD	723		825/826				
(3)							
(4)							
TOTAL							

12. SECONDARY TECHNICAL CODES *(maximum six codes of three positions each)*

13. SPECIAL CONCERNS CODES (MAXIMUM SIX CODES OF FOUR POSITIONS EACH)

14. SECONDARY PURPOSE CODE

15. PROJECT GOAL (MAXIMUM 240 CHARACTERS)

Establish a basis for economic growth and acceptable standards of public health on Sal Island.

16. PROJECT PURPOSE (MAXIMUM 480 CHARACTERS)

Establish technically and economically viable public water and power systems for the communities of Santa Maria, Espargos, Preguiça, Palmeira, and Pedra Lume.

17. PLANNING RESOURCE REQUIREMENTS *(staff/funds)*

Approximately $55,000 was required in development of the PRP and PP.

18. ORIGINATING OFFICE CLEARANCE

Signature

Title

Date Signed MM DD YY

19. DATE DOCUMENT RECEIVED IN AID/W, OR FOR AID/W DOCUMENTS, DATE OF DISTRIBUTION

MM DD YY

AID 1330-2 (3-76)

B. Recommendations (Rounded to Next 000)

AID Loan (Foreign Exchange)	$5,765
AID Grant (Foreign Exchange)	525
Subtotal (AID)	$6,290
GOCV Grant (Labor and Materials)	1,206
GOCV Grant (Land, Site, Right of Way)	1,000
GOCV Grant (Sewage System)	222
Subtotal (GOCV)	$2,428
Total (AID and GOCV)	8,718

Of this total, AID is participating with 72% and the GOCV with 28%.

It is further recommended that the loan covering foreign exchange costs be amortized over a 40-year period, at 2% per annum interest for years 1-10 and 3% per annum during years 11-40 with years 1-10 requiring interest only.

C. Description of Project

It is the ultimate goal of this project to establish a basis for continuing economic growth on Sal Island in the Republic of Cape Verde. The project also will improve substantially the existing standards of living, public health and, in general, the quality of life.

This project proposes to attain the above goals by increasing the availability of potable water and electric energy to the population. The project analysis demonstrates that it is technically, financially, socially, and economically feasible to produce both potable water and electric power and to distribute these two products to virtually every household on the island, as well as to support an appropriate sewage removal system.

An immediate accomplishment resulting from this project will be to increase the level of per capita water consumption from 2.5% of the average in developed countries (10 liters per day vs. 400 liters per day) to 12.5% of the average (50 liters per day) while also greatly improving the quality of the potable water and related sanitation and public health. At the same time, the existing households will have a higher access to electric energy for household use from a present 20% to a proposed 99%. It is anticipated that as a result of these changes there will be a marked reduction in the incidence of water and food-related diseases.

These marked improvements in standards of living, public health, and quality of life are attainable at little or no cost to the uniformly poor household consumers because of: 1) substantial improvements in the water/power production technology proposed over that which is presently installed, and 2) proposed pricing policy which discriminates in favor of the household consumer. With the production technology and pricing policy proposed herein, it will be possible to provide the household consumer of Sal Island with over five times as much water as is presently consumed for the same household budget. Meanwhile, the price charged to government, commercial, and industrial consumers (those discriminated against) still will be less than the high price charged today.

Power pricing policy will not make the same distinction (domestic consumer vs. government, commercial and industrial consumer), offering instead a uniform price for electricity just below the most favorable rate enjoyed under the present installed system. The net effect of such power pricing policy will be an average reduction of 18% in the price of power (from \$0.142/KWH to \$0.188/KWH paid today to the proposed \$0.135/KWH). At the same time that such water and power price reductions are enacted, the cost of producing water and power will be reduced by an even larger amount, thus enabling water and power production to go on a nonsubsidized basis for the first time.

Two important benefits are expected to result from the successful implementation of this proposed project:

1. Improved public health (less water and food storage-related disease), given home access to pure water and refrigeration.
2. Increased growth in the industrial sector, given an assured expandable supply of pure water and electric energy at costs below present levels, necessitating no capital investment by the consumer.

Specific outputs anticipated from this project are highlighted below:

1. A combined desalination/power facility capable of producing up to 750 m^3/day of potable water (compared to 120 m^3/day at present) and 41,000 KWH per day of electricity for export (compared to about 5,500 KWH per day presently available).

2. A complete water delivery network to carry the plant output from plant site to header tanks in each of the five communities on Sal Island.

3. A water distribution system within each of the five communities to deliver water to up to 1,300 households.

4. A simple but appropriate sewage removal system for each of the five communities on Sal Island and treatment plants to serve the three larger communities (Espargos, Preguiça, and Sta. Maria).

5. A power delivery network to provide energy to the transformers situated in each of the five communities.

6. A power distribution system for each of the five communities to provide electric energy to up to 1,000 additional households (about 300 are already receiving electricity).

Financing for this project will be shared by the Agency for International Development (AID) and the Government of Cape Verde (GOCV). The proposed AID share shall include $5,764,809 of development loan funds to cover all the foreign exchange costs required to provide the water/power production, delivery, and distribution system and a $524,000 grant fund for the appropriate sewage removal system. The GOCV share will cover all local costs, including labor and materials ($1,427,107) and land for the plant site and the right of way for the water/power distribution network ($1,000,000). The project will be implemented by the GOCV via contract with (1) a U.S. consulting engineering firm which will provide the project design and supervision and (2) a U.S. contracting firm for actual project implementation, provision of commodities, and all training programs related to both operations and maintenance.

The project implementation period shall be no more than four years from the date of project agreement. The bulk of the design work will be carried out between the third and sixth month of the project life. The civil construction should be conducted between completion of design work (the sixth month) and the middle of the third project year (the 30th month). Technical training programs will be offered between the sixth and the 36th month of the project. The fourth year of the project life is reserved for contingencies such as possible additional technical training needs.

D. Soundness of Project

The project design team has carefully scrutinized the proposed project for technical, financial, social, and economic soundness and has determined that it is viable in each case.

1. Technical. The technology proposed--diesel engines, driving electric generators, together with electrically powered vapor compression desalination units--will provide water and power to be distributed to communities and households throughout the island. The water distribution system will utilize standard asbestos cement main lines and PVC connecting lines to service up to 1,300 households. Standard electric high-tension and distribution lines will be used for the electric power system. All of the proposed technologies are well within the grasp and capabilities of the technicians presently available in the Republic of Cape Verde, and they should be able to operate and maintain the system once they have been trained. The desalination/power plant, as proposed, offers great advantage over present systems installed in Sal Island and other parts of the country. The proposed vapor compression system operates at much lower heat levels than the traditional steam (multi-stage-flash) and requires minimal chemical treatment and control. Summary information on these two technologies are presented under the heading of Technical Analysis in Chapter III of this document; additional details are presented in Annex 6.

2. Financial. The financial analysis for this proposed project was based on a very conservative plant efficiency factor of 83% for the production of water and a power availability factor of 83%. The demand for power and water was likewise projected in a very conservative manner. The projected fivefold increase in water consumption will be charged at a range equalling one fifth present cost, thus having no net effect on household budgets. The projected increase in power consumption (estimated at between five and 10 times present household consumption) will not be entirely offset by price and will require some reallocation of household expenditures. However, it was the concerted opinion of the GOCV Department of Energy representatives on the project analysis team that such reallocations are well within the means of the consumer and will indeed be realized.

The substantially lower costs envisioned for water and power production are due to the technology proposed, which technology is far more efficient and more easily maintained than the present poorly operated and maintained desalination and power plants located at several locations around the island. To ensure the minimal demand necessary for project viability, the GOCV has given assurance that the present level of consumption by government users (currently, the major power consumer is the airport) for both power and water would be guaranteed. Existing GOCV equipment for power and water production will either be put on standby or shipped to other islands where there is a continued need for power and water.

Given these very conservative parameters, the total installation is viable and should operate without need for GOCV subsidy under the power and water policies envisioned. Details and supporting data follow in Chapter III, Section B (Financial Analysis) and in Annex 7.

3. Social. From the field research conducted and from the interviews covering a 2% population sample in the project area, a number of conclusions have been drawn in reference to the projected social impact of this project.

a. Limited availability of water makes it difficult for the population to bathe, wash clothing, and in general maintain minimal levels of hygiene. By making potable water available, significant improvements in family hygiene are expected to result.

b. Over 10% of the household time allocated to chores in a 12-hour period is used in getting water from the nearest water point. Piped-in water to household will release about 1.2 hours per family day of the time assigned to "chores."

c. Lack of electrical energy for refrigeration limits household food storage usage in the case of certain perishables.

d. Lack of electrical energy for household lighting makes it nearly impossible for anyone to "better himself" through reading or study since this is usually done during off-time from work (i.e., at night).

4. Economic. The economic analysis of this project focused on the following factors: (1) impact on household water/power consumers; (2) impact on government, commercial, and industrial consumers; (3) impact on GOCV development plans for Sal Island; (4) internal rate of return; and (5) impact on GOCV foreign exchange earnings. A summary statement of conclusions drawn in each of these cases is offered below:

Impact on Household Consumers. This subject is explored in the Economic Analysis section (Chapter III, Section D) in an effort to determine effective demand for the water and power production increases as projected. In the case of water, a nearly fivefold increase in per capita water consumption, from 11 liters per day to 50 liters per day, by the household consumer is seen as feasible based on the proposed reduced rate for household water to less than one fifth present prices. In the case of power, an increase in electricity consumption is projected in view of the fact that 1,000 new households will be receiving electric power for the first time.

Impact on Government, Commercial, and Industrial Consumers. This was considered important given the desire of the GOCV to stabilize existing government and private sector-owned installations on Sal Island while paving the way for future growth. Sal Island is both Cape Verde's "window to the outside world," due to its large international airport, and her "industrial heartland," due to the presence of virtually all of Cape Verde's fledgling industrial base thereon.

The largest single revenue-generating employer in Cape Verde is the Almicar Cabral International Airport on Sal Island with its reported 600 employees. Development of stable power and pure water supplies is critical to its continued suitability to international air carriers. Likewise, if the air traffic is to grow at Sal International Airport, it is considered critical that sufficient first-class hotel accommodations be developed to support a planeload of 747 passengers in the event of technical difficulties during refueling. Construction of such a 150-unit hotel is presently under consideration, but here again, availability of a reliable source of water and power is seen as critical. The other major industries on Sal Island (a tuna plant and two salt mines) are also dependent upon stable supplies of water and power for survival. As a result of a careful look at each of these industries during project analysis, it was concluded that the project will have a very positive impact on government, commercial, and industrial consumers.

Impact on GOCV Development Plans. The GOCV feels that some of its major opportunities for stimulating economic growth lie on barren Sal Island. Probably Cape Verde's greatest untapped natural resources are its many miles of white sand beaches combined with excellent climate year round, and it lies within six hours flying time of major population centers in Europe and the U.S.A. There is already much talk and some action toward developing this potential for tourism.

At the same time, the GOCV is looking at development of a lobster plant, a milk processing plant, and hothouse agriculture with desalinated wastewater (possibly flowers for air shipment to Europe), as well as other ideas presented in Annex 9. All of these depend to varying degree upon development of stable water and power supplies.

Internal Rate of Return. The project, as designed, is expected to show a rate of return of 6.58% for years 1-10 and 18.16% for years 11-40, as shown in Table 6 (Chapter III, Section B).

Foreign Exchange Impact. Another benefit resulting from this proposed project is the favorable impact of foreign exchange on the economy of Cape Verde. The three principal development projects for Sal Island presently being considered by the GOCV all are characterized by high foreign exchange impact: (1) tourism, (2) increased air transportation, and (3) lobster processing for export. The installation of one 150-unit hotel would probably produce a net benefit of about $460,000 per year in foreign exchange. The increase of six jumbo jets per day through the Almicar Cabral Airport represents better than $2.8 million per year in landing fees only. A lobster processing plant is now being completed and, when it starts operating, it will generate over $600,000 per year in foreign exchange. (See Chapter III, Section D.)

E. Project Issues

From the Project Committee Review of the PP

1. Apparent High Family Income on Sal Island. Data generated by the Social Analysis survey of a 2% population sample indicate that the average household income is about $175 per month. The GOCV disputes this figure, arguing that it is considerably lower. However, the government is unable to provide hard information of its own concerning Sal Island, or even the country at large. What seems likely is that the average income on Sal Island is above the national average, thus raising the question of why project assistance should be provided to Sal Islanders. Two approaches are required to answer this question:

(a) A discussion of the importance of Sal Island to the overall economy of Cape Verde, and

(b) An assessment of the cost of living on Sal Island vis-a-vis living costs on other islands of Cape Verde.

The Economic Importance of Sal Island is discussed in the Project Paper, Chapter III, Section D (Economic Analysis). The thrust of points made therein is that Sal represents the principal communication point between Cape Verde and the outside world due to its large, international airport, and it also represents the industrial center of Cape Verde due to its several small mining, fishing, and processing industries and the still unrealized potential for tourism. None of these industries would count for much in most countries, but in Cape Verde they represent just about all there is today and the basis for hopes of industrial growth in the future.

The Cost of Living on Sal Island does not receive specific treatment in the PP since it is not central to the subject treated. The point which needs to be made herein, however, is simply that given the facts of live on Sal Island, it is neither surprising nor disturbing that the family income is above the national average. The economy of Sal Island is 100% commercialized. Having received no rain in more than seven years, there is no alternative to employment in one of Sal's commercial, industrial, or governmental establishments. The principal employer (the airport, with well over half of the island jobs) requires a fairly high degree of technical competency of many of its employees, and thus pays relatively higher salaries. If one is not thus employed on Sal Island, one must either leave or depend upon relatives for subsistence. All foodstuffs, fuel, clothing, etc., are imported at high cost. Subsistence living is not possible over time.

2. Two-Stepping the Loan. This issue was raised for consideration first by AFR/RA as something which might interest the GOCV and later by AFR/GC as a possible requirement, given the income earning nature of the project proposed. With regard to AFR/RA's concerns, this issue was raised with the Minister of the Economy as a possibility he might consider, particularly if the project executor should turn out to be an independent water/power authority. The Minister expressed no interest in such "complications," stating that his main interest is to "get the proposed water/power installation on a profitable, businesslike basis, free of government subsidization."

With regard to AFR/GC's concerns that AID regulations may require "two-stepping" the loan, the Project Officer reviewed AID Manual Orders back to 1963 with Bill Fradenburg of SER/MP and found that the guidance therein is that AID may elect to "two-step" loans to income earning enterprises but is not so required. Discussions were then broadened to include Norm Cohen of PPC and the determination thus arrived at was that the spirit of the guidelines of yesterday and today is that if an enterprise is largely governmental or largely serves useful social purposes, it would not be AID policy to require "two-stepping" to arrive at higher interest rates to the borrower, i.e., if the GOCV in this case does not want to charge the water/power authority for its loan guaranty, it need not.

3. Strengthen the Economic Analysis. The section dealing with the economic analysis of the project has been expanded to cover impact on households, impact on government, commerce, and industry, as well as a complete benefit-cost projection. Other portions also presented deal with the subject of GOCV economic development plans and impact of this project on foreign exchange.

4. Small-Scale Irrigation System as a By-Product of Sewage Treatment. The disposal of the used potable water can create a health hazard if not properly treated. Furthermore, the treated used water can well be used to irrigate land for farming. Sal Island can ill afford to waste any desalinated water. It is suggested, therefore, that treated wastewater be used for irrigation purposes. The sanitary sewerage system proposed for Espargos, Preguiça and Santa Maria and the corresponding treatment plant would generate enough water to irrigate 50 acres per day at Espargos and Preguiça as well as 25 acres per day in Santa Maria. This is based on approximately 90% of the water being returned to the treatment system. The two small-scale irrigation systems are included as components of the sanitary sewerage system in Annex 6, Technical Analysis.

5. Possibility of Increased Use of International Airport. At present, the Almicar Cabral International Airport serves four to five flights per day for an average of about 32 flights per week. About one half of these flights are jumbo jets (B-747) used by South African Airways. The GOCV plans to increase the use of the international airport by foreign carriers, once water and power become available as proposed. It is anticipated that an additional six jumbo jets per day will be using the existing facilities.

6. GOCV Administrative Capability. The project design team is well aware of the existing limitations and some of the problems that have existed in the past. This project will provide a very comprehensive training program for over 30 persons (a total of 403 man-weeks of training). Details are presented in Annex 6 of this report. To further impact on this problem, the proposed project envisions building 20 modest single-family dwellings for the technical/administrative staff of the water and power system, as well as an administrative building, warehouses, a cafeteria, a first aid station, a grocery store, and a vehicle maintenance facility for service vehicles, as shown in Annex 7.

7. Reorganization of Water and Power Authority into One Body. Most countries or municipalities requiring seawater distillation for production of

potable water take advantage of the economic synergism obtainable by combining desalination with power generation. For the purpose of the Sal Island facility, it is the opinion of the design team that the "water and power authority" should be one body. Whether it is a ministry or an authority is not important; what is important is that it be a single unit that includes both power and water production, distribution, delivery and sales. The establishment of such dual authority in one body is a condition to Project Agreement as envisioned by the design team. In Chapter III, an organizational plan is presented for this administrative unit.

8. Implications of Increased Salaries for Desalination/Power Plant Employees. The proposed salaries for the plant staff as well as for the power/water distribution staff appear as part of Annex 6. The suggested salaries were determined from the existing salary range for comparable jobs at the Almicar Cabral International Airport, also presented in Annex 6. In order to offer some inducements to potential employees, the project provides for a series of tangible benefits--partially subsidized housing (with such modern amenities as plumbing and kitchen appliances), company store, training programs, medical services, vehicle pool, and others.

9. Recurring Costs and Maintenance. The operation and maintenance (O&M) costs are discussed in detail in each respective section dealing with the desalination/power plant, water distribution and delivery, and power distribution and delivery. The O&M costs are summarized in Table 5 of the report (Chapter III, Financial Analysis).

From the ECPR Review of the PRP

1. Environmental Impact. Per ECPR guidance, an environmental impact statement was prepared prior to commencing PP analysis. A conditional negative determination was made, depending upon the results of the PP analysis. An updated environmental impact statement is presented as Annex 5 of this document.

2. Sewage Removal. The PP analysis team took an in-depth look at the water distribution component from the viewpoint of impact on present sewerage removal facilities and concluded that a sewerage removal component should be added to the overall project in order to insure that an environmental and health problem would not be created. A sewerage removal system has been integrated into the total project, but since it will be grant funded, it is not calculated in determining the financial viability of the water/power production

and distribution system. Full details of the recommended sewerage system for Sal Island are presented in Annex 6 of this paper.

3. Water/Power Administrative Unit. At the time the PP field analysis was conducted, this question had not yet been satisfactorily dealt with. At present, authority for desalination activities is held by a division of the Ministry for Rural Development and the authority for electrical power generation is within a department of the Ministry of the Economy. It is the consensus of the project analysis team that authority for the combined desalination/power activity, as proposed herein, should be the responsibility of only one unit of the government. This opinion was expressed to the GOCV, which currently is considering the matter. It is the recommendation of the project committee that resolution of this dual authority question be a condition precedent to signing a Project Agreement, but not a condition to Project Authorization. It is believed that, given the high importance the GOCV attaches to resolving the water/power problem on Sal Island, authorization of the project with such a condition attached will facilitate settlement of these already live issues. A proposed organization is presented in Chapter IV of this report under the title of Implementation Plan.

4. Water/Power Combination. In order to ensure a thorough treatment of questions raised in this regard, a top desalination engineer from the U.S. Department of the Interior who had expressed strong concern as to the hazards of this approach was invited to participate as a member of this team. The summary findings resulting from the in-depth analysis conducted and the corresponding "give and take" type of discussions are reported in Chapter III, Sections A and B, under the heading Project Analysis.

5. FAA Funding Categories, SDP vs. Health. The outcome of project analysis indicated that there is a logical distinction between the water/power production and distribution activity and the sewage removal and treatment system, the latter activity being very closely related, but probably not critical to the success of the former. The PP analysis team, therefore, recommends that the water/power production and distribution function, which has a rationale in both areas of economic and health, be funded under the available SDP loan funds, whereas the sewage removal system should be funded with available health grant funds.

6. Economic and Social Impact on Poor. In Chapter III, Sections C and D (social and economic analysis) of this document, the project team made a

strong effort to analyze type and degree of benefit incidence, from both the micro and macro viewpoints. The relevant conclusion derived from such analysis is that the target population (rural poor) will be the ones most favored if this project is implemented.

Loan Repayment. A special look at the foreign exchange generation impact of the project is presented in Chapter III, Section D of this document. Due to the international orientation of all major industrial/commercial activities on Sal Island, i.e., airport, hotel, lobster processing, tuna fish processing, and others, growth in foreign exchange generation resultant (at least partially) from provision of more abundant and less expensive water and power are projected to greatly surpass the projected debt service burden.

Chapter II

PROJECT BACKGROUND AND DETAILED DESCRIPTION

II. PROJECT BACKGROUND AND DETAILED DESCRIPTION

A. Background

The Cape Verde archipelago is composed of a total of 12 islands (Santa Antão, São Vicente, Santa Luzia, Branco, Raso, São Nicolau, Sal, Boa Vista, Maio, São Tiago, Fogo, and Brava) and several islets between 18° to 14° north latitude and 21° to 26° west longitude. The archipelago is about 2,000 kilometers south of the Canary Islands and some 800 kilometers west of Dakar, Senegal.

The islands, in general, are very mountainous and are within the Sahel arid belt which also affects a great portion of North Africa. The total land area is under 4,000 square kilometers, and the population was estimated in 1974 to be about 300,000 persons. Sal Island (Sal), located in the windward group, is one of the smaller of these 12 islands. Sal has an area of about 450 square kilometers, or under 12% of the total land area of the country, and about 8,000 inhabitants, which is about 2.6% of the total population.

Much as her sister islands in the archipelago, Sal is characterized by sandy, rocky terrain, little or no vegetation, hot and windy climate, and little or no rainfall. According to field data gathered by the project team, Sal has had virtually no rainfall for the past seven to nine years. Because of this, the groundwater resources are nearly depleted and wells usually are 15 to 17 meters deep. Much "water mining" has taken place in the past years, and by now saltwater intrusion has reached a point where groundwater has a salt content between 2,000 to 5,000 parts per million (ppm), which is about 10 times the internationally acceptable 200 to 500 ppm for potable water. In very simple terms, the groundwater is brackish.

During the many years of Portuguese administration, since discovery in the middle 1400's until independence in 1975, different ideas were implemented to ameliorate the water problem on Sal. The last Portuguese administration installed in 1971 a 90 cubic meter per day (m^3/d) capacity steam desalination plant which was also rated to produce about 65 kilowatts (KW) of electricity for the local consumers. In recent years, this plant has been operating at less than 67% efficiency; consequently, about 60 m^3/d of water is presently available to the population. The low plant output is due mainly to lack of maintenance, plant deterioration, and nonexistence of spare parts.

On Sal Island, another desalination plant has been installed at the Almicar Cabral Airport and a solar desalination plant is being built by the owners of the Hotel Morabeza. Full details are presented in other sections of this document, but for now it is sufficient to say that with the existing supply of desalinated water, a more or less balanced situation exists as long as the population is willing to do with small quantities of pure water. Under the above conditions, there is no viable way for the population to grow and all economic expansion must be discouraged.

Together with the water problem, Sal is also poor in electrical energy. The island has no coal, oil, timber, or hydraulic resources, so all electrical energy must be generated by importing fuel. There are several small, inefficient generators and a larger unit at the airport. The present cost of electric power is very high and its availability is limited primarily to the government and the airport.

Sal Island has a very limited economy largely dependent upon the airport, two hotels, and a few fishing activities, together with two brine evaporator operations producing salt for export. The very limited industrial/commercial activities include such enterprises as bread making, tuna canning, and fertilizer production. On the other hand, the population of Sal Island has to import most of its food, with the republic as a whole importing well over 49,000 tons of food commodities in 1975 at a value of well over $10 million.

The recently established government under the leadership of Aristides Pereira has been studying the water/power problem on Sal. The government considers this problem to be twofold: (a) growth barrier and (b) health hazard. The previous government studies have determined the following options:

1. To do nothing and allow continued high rates of emigration to other nations, together with continuing poor health conditions and high infant mortality rates.

2. To engage in an all-out campaign to lower birth rates to the level of zero growth.

3. To establish a basis for economic growth and acceptable international standards of public health.

The GOCV has opted for the third solution and is considering the use of an Agency for International Development (AID) loan and grant package to implement the proposed solution.

The project team fully supports the GOCV decision "to establish a basis for economic growth and acceptable international standards of public health on Sal Island." In order to do this, it will be necessary to deal with the problem of scarce, high-cost potable water and electric power. From on-site experience, the team believes that from all traditional analysis viewpoints the project proposed by the GOCV and scrutinized herein is viable and realistic, is appropriate to the needs, and is deserving of AID project funding.

B. Detailed Description

1. Overview. The project proposed is a four-year planning, construction, installation, and training effort. The principal focus is on providing 50 liters of water per day to each of 8,000 persons and 100 KWH of electrical energy per month to 1,300 households. To this end, the project proposes to finance (a) the purchase and installation of a water desalination/power generating plant, (b) a water delivery system to all five communities on the island, (c) a water distribution system to 1,300 households plus business and government consumers, (d) a power delivery system to the five existing communities, and (e) a power distribution system to 1,300 households plus business and government consumers. Under a separate grant, it is also proposed to purchase and install a sewage water collection system, building, where feasible, upon existing facilities to minimize cost and avoid duplication.

Financing for this project is proposed through a $5,764,809 AID loan to the GOCV (to cover commodities, technical assistance, and training to be procured in the U.S.A.) and a GOCV contribution of $2,205,607 to cover local labor costs, plant site, and rights of way. In addition, a $524,200 AID grant is anticipated to cover the commodities and technical assistance costs of developing an appropriate sewage collection system, and a $221,500 GOCV contribution will cover local costs of the system. The AID loan of $5,764,809 to the GOCV would be amortized over 40 years at 2% per annum interest for years 1-10 and 3% for years 11-40, with years 1-10 requiring interest only.

2. Project Goals and Anticipated Outputs

Goal. Establish a basis for economic growth and acceptable standards of public health on Sal Island.

Sub-Goal. Increase the availability to the population of Sal Island of potable water and electrical energy, both at lower than present costs per unit.

Purpose. Establish a technically and economically viable public water and electric power system for the communities of Santa Maria, Espargos, Preguiça, Palmeira, and Pedra Lume, and the households therein.

Anticipated Outputs

a. Desalination and Power

(1) Design, procure, and install a seawater desalination plant with an output of 750 m^3/d of potable water and an electrical power generating capacity of 50,400 KW. AID inputs to this anticipated output include some $2,200,000 in machinery, engineering, services and equipment. The GOCV input includes plant site, labor and local materials.

(2) Construct foundations, support buildings, water and fuel storage tanks, fuel intake structure, and site access roads appropriate to the water/power plant. Twenty homes and an administration building also will be constructed and furnished. The AID input to this anticipated output includes about $700,000 in design and imported materials. The GOCV input will be in land, supervision, labor, and local materials.

b. Water Delivery to Communities

Design and construct a freshwater delivery system from the water/power plant site to appropriate header tanks and to the individual communities on the island. The AID input to this anticipated output includes about $640,000 in design, materials, equipment parts, and other imported commodities. The GOCV input will be in rights of way, supervision, local materials, and labor.

c. Water Distribution to Individual Consumers

Design and construct a potable water distribution system to serve 1,300 existing households as well as existing governmental, industrial, or commercial facilities. AID input to this anticipated output includes about $400,000 to cover engineering, design, pipes, meters, and other necessary commodities and supplies. The GOCV input will cover supervision, local labor, and local materials.

d. Power Delivery to Communities

Design and construct a high-tension power delivery system to connect the water/power plant to each of the five communities. The AID input to this anticipated output includes some $560,000 to cover engineering, construction, materials, and commodities. The GOCV input will be in rights of way, supervision, and labor.

e. Power Distribution to Individual Consumers

Design and construct a five-community electrification system to provide electric power to about 1,300 households (about 1,000 of which do not presently enjoy any electrical hookup) as well as all existing governmental, industrial, and commercial facilities. AID input to this anticipated output includes some $250,000 to cover materials, engineering, supervision, and commodities. The GOCV input will cover local materials, labor, and supervision.

f. Sanitary Sewage Collection, Treatment, and Irrigation System

Design and construct a sewage collection system for the five communities and water treatment plants in the larger communities to provide secondary use for the available sewage water. AID input to this anticipated output includes some $524,200 from a grant fund to cover engineering, materials, supplies, and other imported commodities. GOCV input will be in land, labor, local materials, and supervision.

g. Operation and Maintenance

(1) Design and carry out technical training plans for the entire staff of the water/power plant and for the staff which will take care of the water and power distribution and delivery system. AID input to this anticipated output covers some $160,000 for overseas training costs and consultation. GOCV inputs cover personnel, salaries, and in-country training as well as overhead.

(2) Design and establish a system for measuring individual user consumption of water and power, billing, payments, and general maintenance of such a system. AID input to this anticipated output covers some $50,000 for technical assistance. The GOCV input covers direct staff time.

3. Estimated Inputs

	USAID	GOCV
Desalination/Power Plant	$3,322,498	$ 258,913
Water Distribution and Delivery	1,305,113	477,840
Power Distribution and Delivery	806,447	314,974
Training	160,000	33,760
Employee Service and Support	170,751	120,120
Subtotal (includes 10% contingency)	$5,764,809	$1,205,607
Sanitary Sewerage System	524,200*	221,500
Land, Rights of Way, etc.	-	1,000,000
Total	$6,289,009	$2,427,107
Rounded to	$6,290,000	$2,428,000

*USAID Grant.

4. End-of-Project Status (EOPS)

The successful establishment of a viable water and power base for economic growth and acceptable health standards will be evidenced by the following indicators:

a. Each household (1,300) on Sal Island will enjoy in-house access to fresh, potable water.

b. Time spent by the average family in pursuit of water will be reduced from 1.2 hours to 0 hours per day.

c. The unit price to the household consumer for desalinated water will be reduced from the present $\$2.52/m^3$ (involving $5.35 GOCV subsidization) to an unsubsidized price of $\$0.45/m^3$.

d. Average quality of drinking water will be improved from 1,750 ppm salt content to less than 100 ppm.

e. Average availability of drinking water will be raised from 11.25 liters/person/day to 50 liters/person/day.

f. Incidence of impure water-related diseases will be decreased about 50% (according to World Health Organization figures).

g. Each of the 1,300 households on Sal Island will enjoy individual access to electric power.

h. The unit price to the consumer for electric power will be reduced from the present $0.142 KWH to $0.188 KWH (depending on source) to $0.135 per KWH.

i. Sewage treatment plants for the communities of Espargos, Preguiça, and Santa Maria will provide sufficient treated water to irrigate up to 75 acres of farm land.

j. Desalination/power infrastructure will generate enough revenues (despite reduced price to population) to pay back all costs, show a 7% profit for the GOCV in years 1-10 and an 18% profit for the balance of the 40 years.

k. The water/power system will create over 50 new jobs and an annual payroll of over $120,000 per year for the population of the island.

Chapter III

PROJECT ANALYSIS

III. PROJECT ANALYSIS

A. Technical Analysis

Over the past 25 years, significant advances have been made in the areas of distillation; freezing, and membrane technology for both sea and brackish water desalination. An ample discussion of the general state of the art is presented as part of Annex 6 under the title of Technical Analysis. The sections that follow are summaries of the material presented in that annex.

1. Present System for Water and Power Production and Distribution and Wastewater Removal. Table 1, below, lists the five locations on Sal Island where diesel-electric power currently is generated.

Table 1

ELECTRIC POWER GENERATION, SAL ISLAND

Location	Electric Power Generating Equipment	Installed Capacity
Airport	Two 440 KW generators (only one in operation)	880 KW
	One standby generator for landing strip and emergency, 150 KW	150 KW
	One additional 440 KW generator on order-not delivered	-
Pedra Lume	Two generators, each rated at 150 KW	300 KW
	One standby generator at 100 KW	100 KW
Santa Maria	One 90 KW generator using 25 KW internal operation	65 KW
Morabeza	One 20 KW generator for use of the hotel	20 KW
Palmeira	Two 250 KW generators at Shell tank farm for their internal use	500 KW
	Total	2,015 KW

The generated electric power is sold to industrial and commercial consumers at \$0.188/KWH, to government installations at \$0.135/KWH, and to households at \$0.142/KWH. For the year 1976, the following electric power consumption was reported. (Table 2.)

Table 2

ELECTRIC POWER CONSUMPTION, 1976

Consumer	Total KWH
Industry and Commerce	372,982
Government, Airport, Illumination	1,353,606
Domestic	135,272
Total	1,861,860

There are two desalination plants in operation on Sal Island: Almicar Cabral Airport has a plant with a capacity of about 40 m^3/day and the Santa Maria plant is rated at 90 m^3/day, but at best produces 80 m^3/day. Total potable water produced is on the order of 120 m^3/day to satisfy the needs of about 8,000 persons plus local industry, commerce, and government facilities. Water produced by the Santa Maria plant costs about \$7.87/m^3 and is sold to the public at \$2.52/m^3 (the GOCV subsidizes \$5.35/m^3). Domestic consumers also purchase some 50 m^3 of brackish water per day produced by the local wells. As indicated in Annex 6, Table 3, it is reasonable to say that the population of 8,000 persons has available some 140 m^3 of water per day of which 90/m^3 is pure water and 50/m^3 is brackish water. Pure water sells at about \$2.52/m^3 and brackish at \$2.36/m^3.

There are modest power delivery systems in the area near the airport, servicing Espargos and Preguiça as well as Santa Maria, Pedra Lume, and Palmeira. A total of some 300 households have electric power at present. There is also a water distribution system at the airport and nearby communities as well as a small one in Santa Maria. In most instances, these systems do not function because of lack of pressure, faulty equipment, and deterioration of the components. In Santa Maria, there is a small saltwater system for flushing toilets and other sanitary devices. All things considered, however, the sanitary sewerage system in operation on Sal Island is woefully inadequate.

2. Proposed System for Water and Power Production, Delivery, and Distribution and for Wastewater Removal. The proposed system is described in detail in Annex 6 of this report. A summary of the different components is presented below.

Water/Power Plant. The recommended plant is a diesel electric/vapor compression desalination unit. This system will produce both potable water and electrical energy. Table 11 in Annex 6 provides details of the equipment capacity, operating costs, and other specifications. The recommended system will have an installed electricity generation capacity of 50,400 KWH and an installed water production capacity of 900 m^3/d. The production is ample for present and immediate future needs of the population of Sal Island. The principal elements of the recommended plant design include the following:

3 units - 700 KW diesel generators

3 units - 300 m^3/d motor-driven V.C. distillation plants

3 units - 20 HP vertical intake pumps

Electrical switchgear

Plant maintenance shop equipment

Laboratory equipment and fixtures

Water Delivery and Distribution. The proposed system will be able to transport 750 m^3 of potable water per day from the water/power plant to the five existing communities and the airport. If the population (domestic consumer) uses 50 liters of water per person per day (five times as much as present), the demand will total about 397 m^3/d, which leaves about 352 m^3/d available for government, industrial, and commercial users. Present non-domestic users are consuming about 30 m^3/d, and it is estimated that the available amount of water will be ample for future economic growth. The proposed system will distribute water to each of 1,300 households at between 2 and 4 kg/cm^2 pressure at the house tap, with a velocity in water mains of less than 1.2 m/sec. The system also includes a storage capacity of about 8,000 m^3.

Power Delivery and Distribution. Three basic elements make up the proposed system: (a) power delivery, (b) power distribution, and (c) house wiring. The delivery-distribution system will take available power for export from the water/power plant and conduct it through underground cables to load-center substations at each of the five communities and the airport. substation, power will continue through underground cables to the nearest concrete pole and thence aerially along the village streets to individual households and public illumination.

The project also will provide for the wiring of 1,000 homes so that they may use the available electric power. Typical service to a residence will consist of four 40-watt lamp bulbs in the ceiling of the home, plus four convenience outlets per home located to provide 220V service for refrigerator, iron, radio, and other appliances. Complete details, drawings, and cost estimates are presented in Annex 6 of the report. Table 9 of the same annex has a forecast of electric power requirements for domestic consumers (4,372 KWH/d); government airport and illumination (5,875 KWH/d), and industrial-commercial (4,671 KWH/d).

Sanitary Sewerage System. Two small sanitary sewerage systems are proposed by this project, one serving Espargos and Preguiça and another serving Santa Maria. The system would consist of collection sewers, a wastewater treatment plant, and a spray irrigation system for the treated wastewater. The proposed treatment plants are package-activated, sludge-type units. Not only will the proposed system resolve a health problem, it also will make available enough treated wastewater to irrigate 50 acres in the Espargos-Preguiça area and another 25 acres at Santa Maria.

3. Capability of the GOCV to Operate and Maintain the Proposed Technology. The Cape Verdians are historically much more familiar with diesel engine technology (motor vehicles, marine engines) than with the more traditional boilers and steam turbines. Power generation on most of Sal Island is by diesel engine and the power generation plant at the port city of Mindelo is also of the diesel engine type. Several representatives of the GOCV indicated to members of the project team that they would prefer diesel power for the plant at Sal Island. The team members believe that the operational skills required to keep the plant operating efficiently are more readily obtainable for a diesel-engine unit.

The project includes a series of additional safeguards to insure the operation and maintenance of the proposed systems. The water/power plant is initially provided with spare parts for five years; a sinking fund is established (2% of cost of equipment per year) to allow for major repairs of the water/power plant every 10 to 15 years as needed; a technical assistance component is calculated in the equipment costs; an ample supply of spare parts also is made available to the water/power distribution and delivery system. Equally critical to the project success will be the quality and continuity of key staff personnel. Seven training programs have been suggested for the plant and system staff. An organization has also been suggested to provide complete coverage of all operation and maintenance requirements for production, distribution, revenue collection, and personnel administration. Full details of all the above concepts as well as job descriptions, proposed salaries, and other items are presented as part of Annex 6.

4. Environmental Assessment. The major features of the proposed project include a centralized water and power production facility, transmission lines, and house-to-house distribution of both power and water. A more detailed environmental assessment is presented as Annex 5, but a summary of the highlights follows below:

Land Use. Some moderate increases in population are anticipated as a result of the increased employment opportunities projected.

Water Quality. A moderate favorable impact on the ecological balance is foreseen as the drawdown of groundwater supplies slows down or comes to a complete halt. Should the rains return to Sal Island, this may allow natural increase of groundwater supply over the years.

Atmospheric. No significant effects envisioned.

Natural Resources. Some moderate effect on groundwater resources is expected as desalinated water replaces groundwater as a source of domestic water and treated wastewater goes back into the soil through the irrigation system.

Cultural. No effects envisioned.

Socioeconomic. The project will have a significant effect on employment and economic patterns. As a result of the availability of pure water and electric power, Sal Island will develop tourist hotels, expand the usage of the international airport, and generate light industries. These new actions will, in turn, provide a basis for a moderate population growth and assist in slowing down emigration.

Health. The project should have a very favorable impact on public health. The distribution of piped-in pure water to each household on Sal Island and the operation of a sanitary sewerage system and treatment plant should reduce the incidence of diseases related to impure water and poor sanitation. Installation of an irrigation system will facilitate the growing of fresh agricultural products, resulting in improved nutrition.

General. The proposed project should have a favorable effect as standards of public health are improved, drawdown of groundwater is slowed, and some irrigated agriculture is initiated.

B. Financial Analysis

In this section the wastewater removal and treatment component is discussed along with other components except in the Financial Rate of Return subsection. It was not included in that subsection because: (1) as a grant-funded component, it is not under the same pressure to "pay its own way," and (2) it is a discrete system which will be managed separately.

1. Financial Rate of Return. The GOCV is presently subsidizing the production of potable water at a cost of some $234,000 a year. (See Table 2, Annex 6.) No reliable information was available on the true production cost of power, but it may also be receiving subsidization by the GOCV. In considering the financial rate of return of this proposed project, other indirect factors need to be highlighted:

a. A two-tiered water pricing policy is assumed with a proposed price of $0.45/m^3$ for pure desalinated water on tap in households (a figure less than one fifth the present price of $2.29 for combined pure and brackish water or 5.6 times less than present pure water price of $2.52) and a proposed price of $0.90/m^3$ for pure water sold to government, commercial, and industrial consumers.

b. A single-tiered power pricing policy is assumed with a proposed price of $0.135 per KWH, representing a reduction of about 18% from the present range of $0.142 to $0.188 per KWH.

c. The proposed water/power plant is assumed to operate at a very conservative 83% of capacity with ample power generation reserves.

d. All yearly costs for amortization, sinking fund, power distribution and delivery, water distribution and delivery, operation and maintenance, staff training, and employee services and support are fully covered.

e. All AID capital investment costs for the proposed project carry an annual fixed charge of 2% per annum interest for years 1-10 and a 3% per annum interest during years 11-40 with years 1-10 requiring interest only. A 2% fee per year (1-40) is also charged on the cost of the water/power plant equipment to establish a sinking fund which will allow major plant overhaul and equipment replacement every 15 years.

f. All GOCV capital costs are also charged to the project in equal increments over 40 years with no interest load.

The projected cash flow for the full life of the loan is presented in Table 3. Full details are presented in Annex 7 under the title Financial Analysis.

Table 3

PROJECTED CASH FLOW SUMMARY

Income	Years 1-10	Years 11-40
Water	$ 96,496	$ 146,360
Power	732,490	1,227,784
Gross Income	828,986	1,374,144
Annual Costs	774,424	1,124,518
Net Return	54,562	249,626
Rate of Return	6.58%	18.16%

2. Financial Plan. Detailed breakdowns for each component of the proposed system appear in the Technical Annex to this document. The detailed plan is so lengthy that only a summary is offered here, but each component of the proposed system is identified and marked so the reader may refer to the detail in the corresponding section. In calculating the proposed project, nine alternative engineering solutions were considered for the water/power plant; two of these were selected as most appropriate and proposed to the GOCV at the close of the project analysis team's visit as best alternatives. The difference between the alternatives was essentially one of capacity. The unanimous opinion of the GOCV (a committee including major department heads from the ministries most concerned) was to opt for the larger-capacity alternative so to ensure responsiveness to projected future demand growth.

The summaries that follow in Tables 4-7 recapitulate the financial plan for the proposed project. Note that in the Annual Costs and Profit and Loss statements two different output levels are presented (IIB and IIBi), so as to better illustrate economies to be realized as greater water/power demand materialize. No annual operating costs were established for the wastewater removal, treatment, and irrigation system since it is a separate, grant-funded system.

Table 4

FINANCIAL PLAN SUMMARY:
CAPITAL COSTS, CASES IIB AND IIBi

Item	AID	GOCV
A. Water/Power Plant		
1. Equipment CIF Mindelo	$2,067,230	-
2. Site Work	509,525	$ 235,375
3. Management	443,698	-
4. Contingency (10%)	302,045	23,538
Subtotal	3,322,498	258,913
B. Water Distribution and Delivery		
1. Water Distribution		
2. Water Delivery		
3. Management		
4. Contingency (10%)		
Subtotal	1,305,113	477,840
C. Power Distribution and Delivery		
1. Power Distribution	503,600	138,340
2. Power Delivery	49,500	58,000
3. House Wiring	90,000	90,000
4. Management	90,034	-
5. Contingency (10%)	73,313	28,634
Subtotal	806,447	314,974
D. Training	160,000	33,760
E. Employees Service and Support	170,751	120,120
Total Capital Investment (A + B + C + D + E)	$5,764,809	$1,205,607
Total Project (AID + GOCV)	$6,970,416	

Table 5

FINANCIAL PLAN SUMMARY:
ANNUAL OPERATING COSTS, CASES IIB AND IIBi

Item	Years 1-10 IIB	Years 1-10 IIBi	Years 11-40 IIB	Years 11-40 IIBi
A. Loan Costs				
1. Amortization (2% Interest Years 1-10; 0.02 x TCI-AID)	$115,292	$115,292		
2. Amortization (3% Interest Compound Rate Years 11-40; 0.051 x TCI-AID)			$294,001	$ 294,001
3. Sinking Fund (2% of Plant Equipment)	41,344	41,344	41,344	41,344
Subtotal	156,636	156,636	335,345	335,345
B. Operation and Maintenance				
1. Water/Power Plant	68,916	68,916	68,916	68,916
2. Water Distr. and Delivery	11,514	11,514	11,514	11,514
3. Power Distr. and Delivery	11,514	11,514	11,514	11,514
4. Gen. Administration (40%)	36,778	36,778	36,778	36,778
5. Fuel (Gas/Oil at $155/T)	420,480	587,365	420,480	587,365
6. Chemicals and Supplies	38,446	42,946	38,446	42,946
Subtotal	587,648	759,033	587,648	759,033
C. GOCV Internal Cost				
1. Straight-Line Pay-Back, No Interest, 40 Years	30,140	30,140	30,140	30,140
Total Annual Cost (A + B + C)	$774,424	$945,809	$953,133	$1,124,518

Table 6

FINANCIAL PLAN SUMMARY:
ANNUAL PROFIT AND LOSS, CASES IIB AND IIBi

Item	Unit	Years 1-10 IIB	Years 11-40 IIBi
A. Production Capacity			
Water: 900 m^3/day at 83% Factor for 365 Days	m^3	272,655	272,655
Power: 50,400 KWH/day at 83% Availability Factor for 365 Days	KWH	15,268,680	15,268,680
B. Projected Export (Sales)			
Water:			
Domestic	m^3	145,087	220,062
Ind., Comm., and Gov.	m^3	34,675	52,593
Subtotal		179,762	272,655
Power	KWH	5,425,859	9,094,703
C. Annual Income (Gross)			
Water:			
Domestic at $0.45/$m^3$	$	65,289	99,027
Ind., Comm., and Gov. at $0.90/$m^3$	$	31,207	47,333
Power:			
All at $0.135/KWH	$	732,490	1,227,784
Annual Gross Income	$	828,986	1,374,144
D. Profit/(Loss)			
Annual Gross Income	$	828,986	1,374,144
Annual Cost	$	774,424	1,124,518
Net Return	$	54,562	249,626
Rate of Return	%	6.58	18.16

Table 7

FINANCIAL PLAN SUMMARY:
CAPITAL COSTS, WASTEWATER SYSTEM

Item	AID	GOCV
A. Espargos-Preguiça		
Collection System	$208,300	$104,200
Treatment Plant	108,000	36,000
Irrigation System	54,000	19,300
Subtotal	370,300	159,500
B. Santa Maria		
Collection System	58,800	30,000
Treatment Plant	72,000	24,000
Irrigation System	23,100	8,000
Subtotal	153,900	62,000
Total Capital Costs	$524,200	$221,500

3. Recurrent Budget Analysis and Organizational Plan. Most countries or municipalities requiring seawater distillation for expanding needs for potable water take advantage of the economic synergism obtainable by combining with power generation. Since each product is produced on the same site, it is only logical that management and operation of the facility also be under the same administrative roof, e.g., Kuwait's and Qatar's Ministries of Electricity and Water, Curacao's and the Virgin Islands' Water and Power Authorities, and Las Palmas' municipally owned facilities.

For the proposed Sal facility, it is the opinion of the design team that such undivided responsibility be an absolute precondition to project recommendation. Equally critical to project success will be the quality and continuity of employment of key staff, both administrative and technical. Care in selection of personnel, coupled with the training program proposed later in this section and presented in detail in Annex 6, should be a good beginning. Nevertheless, there is considerable concern that the increasing demand in other countries for trained, experienced desalting/power plant operations and maintenance (O&M) personnel will present a strong temptation to emigrate, particularly if better salary, benefits and/or career expectations are offered.

GOCV and design team personnel have discussed (and hereby recommend) an organizational approach which could provide flexibility to offer counter-inducements. This plan is comprised of the following elements:

- Establishment of a national water and power authority to operate as an entirely self-supporting entity, reporting to a Board of Directors but with planning and policy directed by the Council of Ministers.
- Authorization for all personnel administration (hiring, promotion, termination, salaries) to be handled independently of Civil Service regulations.
- Provision of tangible benefits (e.g., partially subsidized housing with modern amenities such as plumbing, kitchen appliances, etc.). These are presented in more detail in Annex 7.

The proposed national organization (Figure 1) probably should be located in San Vicente. The proposed organization for Sal Island (Figure 2) is intended to provide complete coverage of all O&M requirements for production, distribution, revenue collection, and personnel administration. If so desired by the GOCV, the wastewater removal, treatment, and irrigation system

Figure 1

PROPOSED ORGANIZATIONAL PLAN
NATIONAL WATER AND POWER AUTHORITY
REPUBLIC OF CAPE VERDE

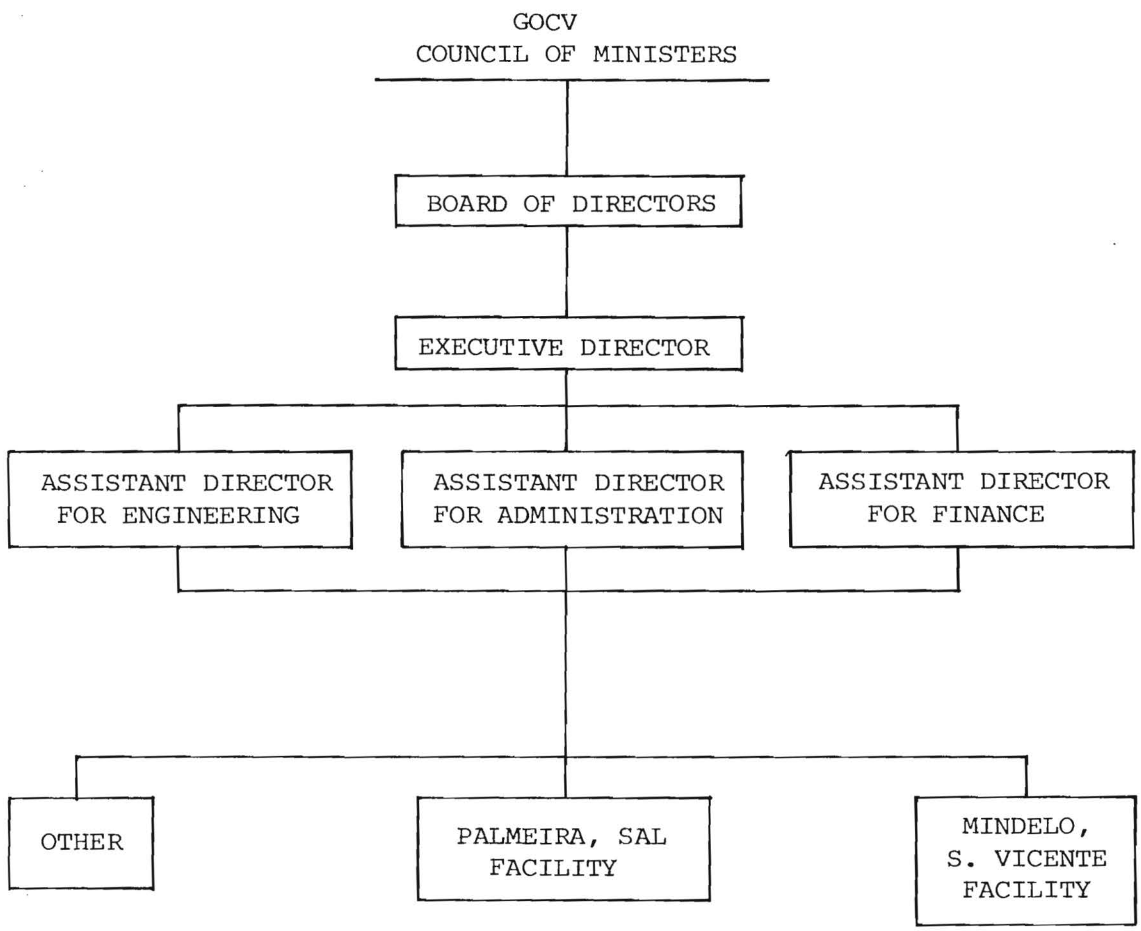
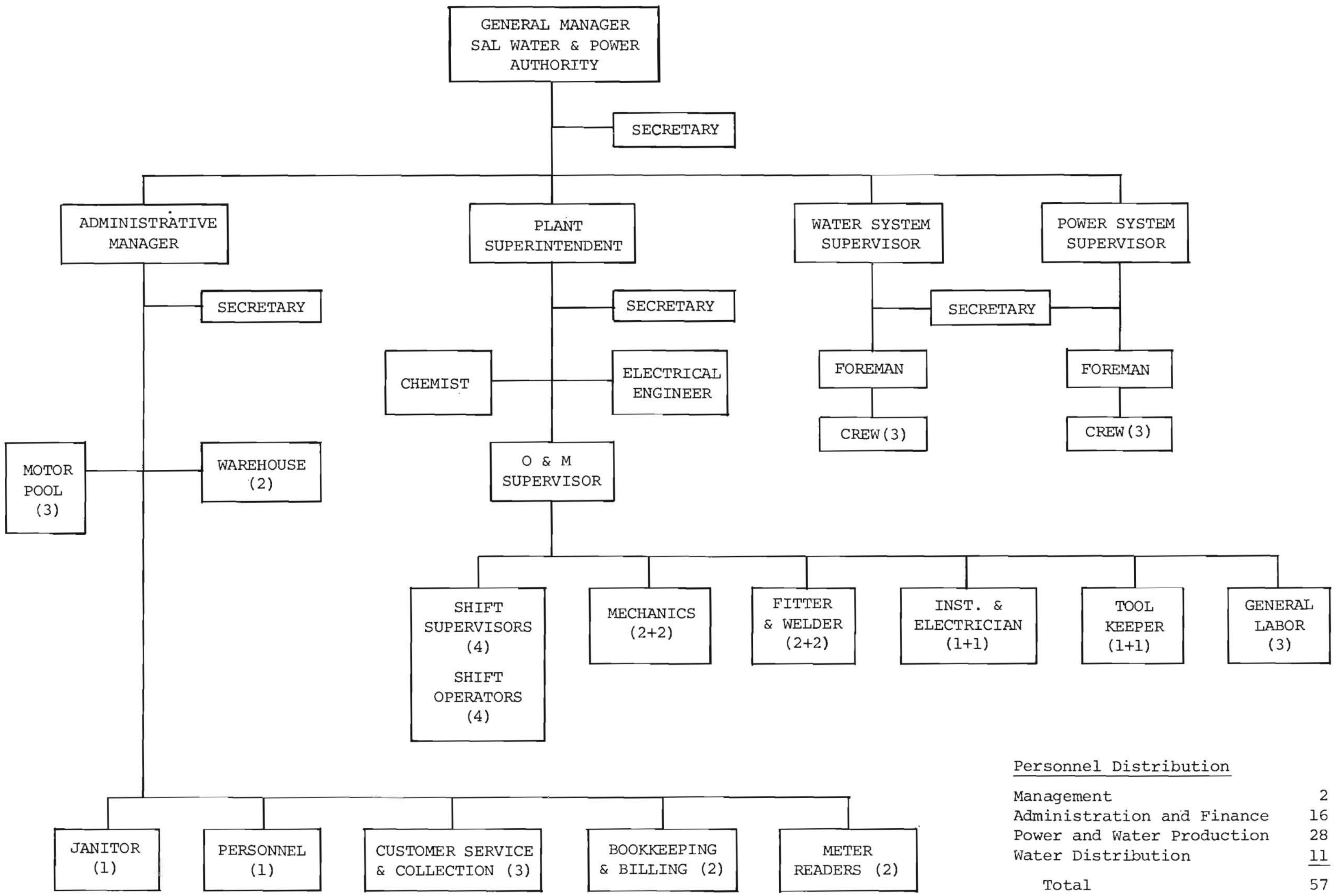


Figure 2

PROPOSED ORGANIZATIONAL PLAN
WATER AND POWER FACILITY
PALMEIRA, SAL ISLAND



Personnel Distribution

Management	2
Administration and Finance	16
Power and Water Production	28
Water Distribution	11
Total	57

also could report to the general manager of the water and power facility or it could be totally separated from this system.

Seven different training needs have been identified by the project team. A complete training program, including cost figures, is presented as part of Annex 6. This activity will represent a $160,000 investment.

This project also proposes to provide other incentives in order to retain the trained staff members. These incentives are:

Housing. 20 single-family units, two or three bedrooms, modern kitchen, etc.

Company Store. A general store will be provided at Palmeira. This is to be a nonprofit service.

Medical Service. First aid room and full-time nurse.

Administration. The administration building has been expanded to house some of the support services.

Transportation (vehicle pool). A total of 12 vehicles are included in the project. These are for normal operations and maintenance activities.

Annex 7 presents all of the above in detail under the heading of Employee Service and Support. The same annex also has the cost breakdown. Total capital cost is $170,751 (AID) and $120,120 (GOCV).

C. Social Analysis

The majority of the inhabitants of Sal Island are located in the central east-west section of the island. This concentration is directly related to the location of the island's principal industry, the Almicar Cabral International Airport. Near the airport are located the two principal cities--Espargos and Preguiça. According to the industry survey conducted by the project team (Annex 9), some 600 persons are employed directly or indirectly by the international airport.

The economy of Sal Island has two other sources of primary employment: (1) the two salt production facilities and (2) the fish cannery and lobster fishing facilities. All of the 10 principal enterprises of the island were surveyed by the project team; descriptions of these enterprises are presented as part of Annex 9.

1. Population Overview. A recent study conducted by an AID team determined the population on Sal Island to be about 8,000 persons living mainly in five communities and dispersed as shown in Table 8.

Table 8

POPULATION DISPERSION, SAL ISLAND, 1975

Community	Population	% of Total
Santa Maria	1,500	18.87
Espargos	2,750	34.59
Preguiça	2,750	34.59
Palmeira	600	7.55
Pedra Lume	350	4.40
Total	7,950	100.00

Source: "Project Review Paper, Cape Verde Desalination and Power," R. R. Solem, Bruce Watson, and Kenneth Soares, unpublished, 1976, p. 8.

In an effort to expand upon the information gathered by the PRP analysis team, the PP analysis team conducted a random sampling of the population in order to gather factual information in reference to the social conditions, income, expenditures, and other factors. Native volunteers conducted interviews of 82 households under the guidance of government officials. Questionnaires used were prepared by a member of the project team. The results of this random sample are as follows:

The population is very young, with nearly 60% under 17 years of age. Figure 3 and Table 9 present data from the 41 usable household responses to this question.

From Figure 3, the team concluded that the job market must be characterized by very early entry (if one accepts that some 5,000 persons are employed or underemployed, as reported by the Solem, Watson, and Soares team). This early entry into the labor force provides little opportunity for full employment of the population and is one additional reason for the continuing out-migration.

Figure 3

AGE DISTRIBUTION
SAL ISLAND, 1977

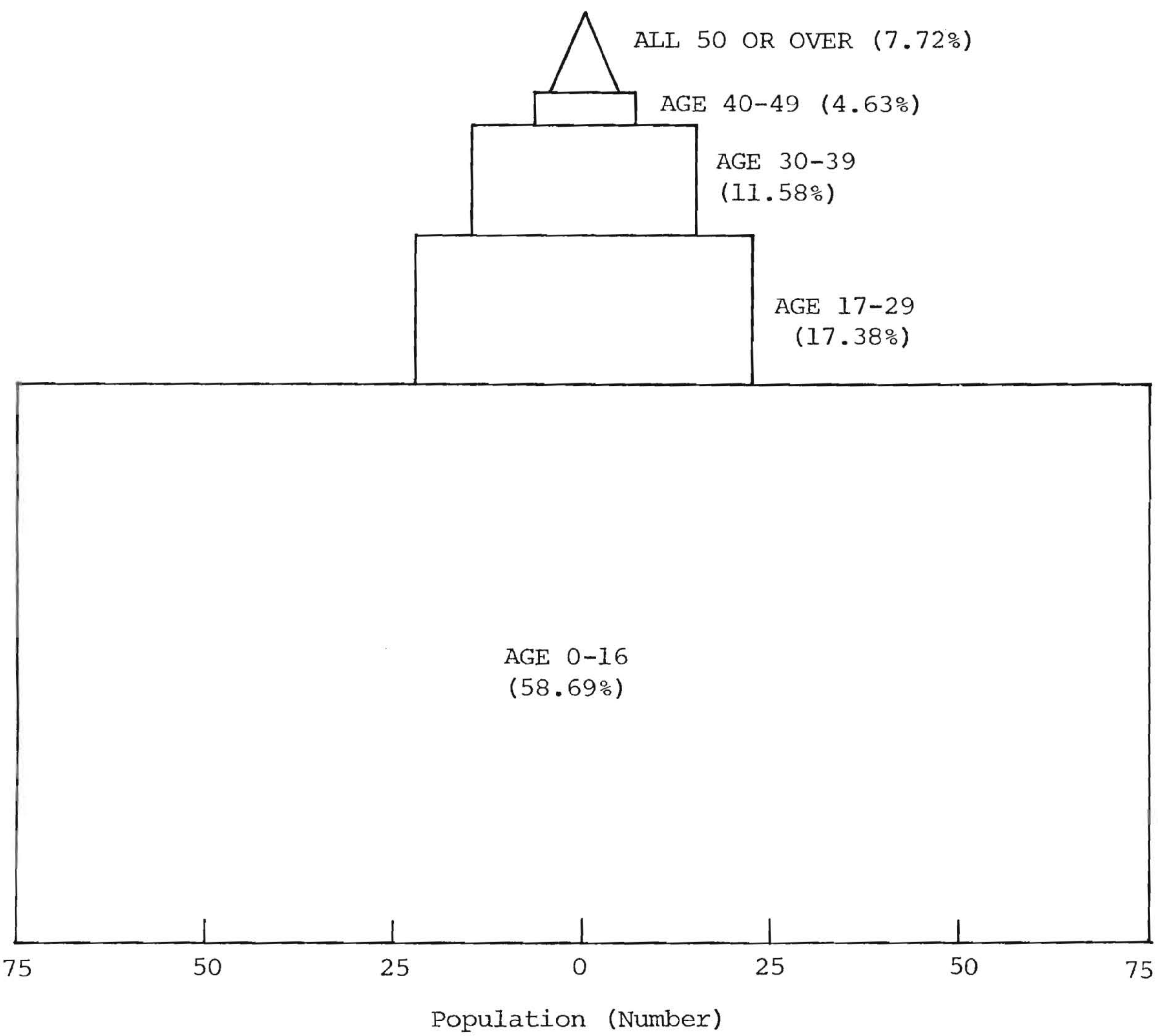


Table 9

AGE DISTRIBUTION, SAL ISLAND, 1977

Age Group	No. in Sample	% of Total	Projection to 8,000 Population
0-16	152	58.69	4,696
17-29	45	17.38	1,390
30-39	30	11.58	927
40-49	12	4.63	370
50-59	9	3.48	278
60-69	8	3.09	247
70 and over	3	1.15	92
Total	259	100.00	8,000

Source: On-site data gathered by project team.

All of the 82 sample households answered the question relating to distribution of the population by sex. The 82 samples reported a total of 569 persons (an average of 6.93 persons per household), but of these only 489 were indicated by sex. Table 10 presents a summary of the distribution by sex resulting from the sample.

Table 10

POPULATION DISTRIBUTION BY SEX
SAL ISLAND, 1977

Classification	No. in Sample	% of Total	Projection to 8,000 Population
Total Population	489	100.00	8,000
Male	265	54.19	4,335
Child	144	29.44	2,355
Adult	121	24.75	1,980
Female	224	45.81	3,665
Child	107	21.89	1,751
Adult	117	23.92	1,914

If the sample is representative, the male population of Sal Island represents 54.19% of the total and the female population is 45.81% of the total.

2. Income Distribution. The earlier study by Solem, Watson, and Soares also indicated that some 2,400 persons are fully employed, 3,000 are underemployed, and 250 are unemployed. In an industrial survey, the project team contacted all principal industrial/commercial activities on the island and could identify only about 960 full-time employees and 109 part-time employees.

The team also identified the most prevalent wage levels for employees on the island of Sal. Details are presented in Annex 6 of this report. From the data gathered, it is apparent that the salary range for Sal Island is about as follows:

Upper	$250 - $450/month
Middle	150 - 250/month
Lower	50 - 150/month

On the subject of household income and income distribution within the household budget, only 31 of the 82 samples were sufficiently complete to be used. The 31 sampled households reported 208 persons sharing a total reported income of 174,045 escudos (E) per month or an average of 5,614 E per household (about $175 per month). It appears that the random sample touched only the middle-income group and did not get inputs from the lower-income population.

The 31 sampled households also reported monthly expenditures per household on food, rent, water, power, medical services, clothing, and school. The results are presented in Figure 4 by household and in Figure 5 on a per capita basis.

3. Labor Force. The project team was unable to obtain reliable information on the number of persons at present employed or underemployed on Sal Island. However, from the age distribution shown in Figure 3 and the reported distribution by sex as shown in Table 10, it is obvious that, even allowing for very early entry into the labor force, there are about 4,100 persons classified as "children." This means that about 51% of the population is not old enough to work. To this must be added another 4% over 60 years of age, or 339 persons. Thus, well over 55% of the population is not capable of employment. The remaining 45%, 3,600, probably comprises approximately 1,950 males and 1,650 females of working age. The industrial survey accounted for 960 fully

Figure 4

SAMPLE HOUSEHOLD BUDGET DISTRIBUTION
Average Monthly Household Income of E5,614 ($175)

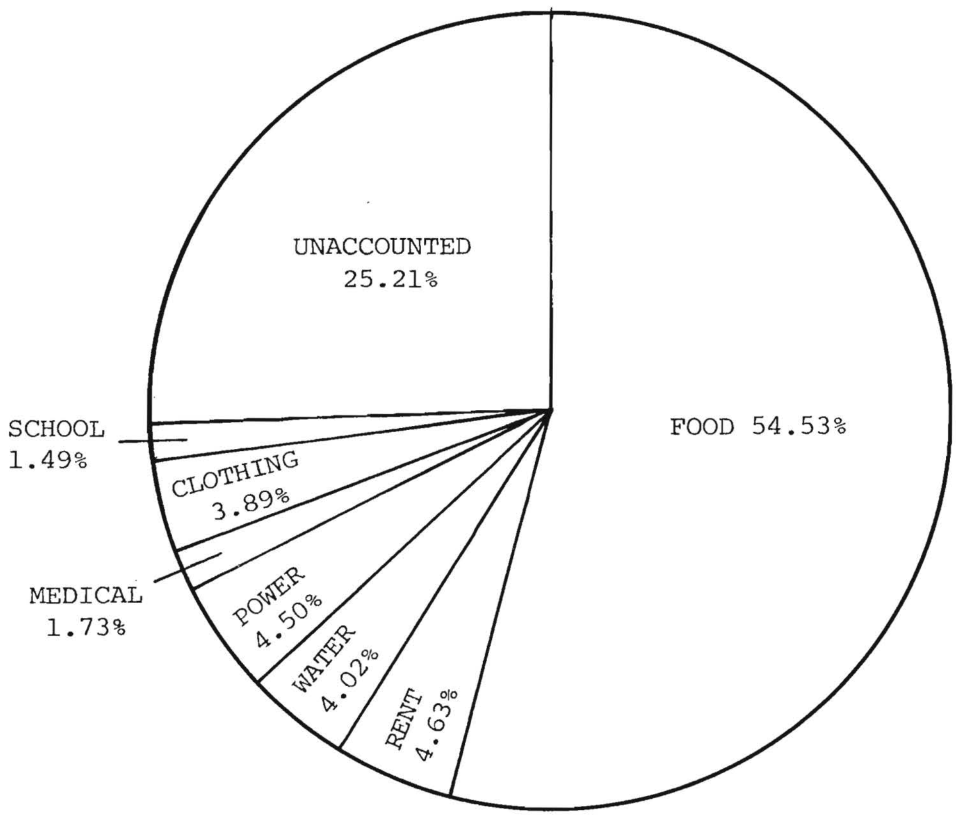
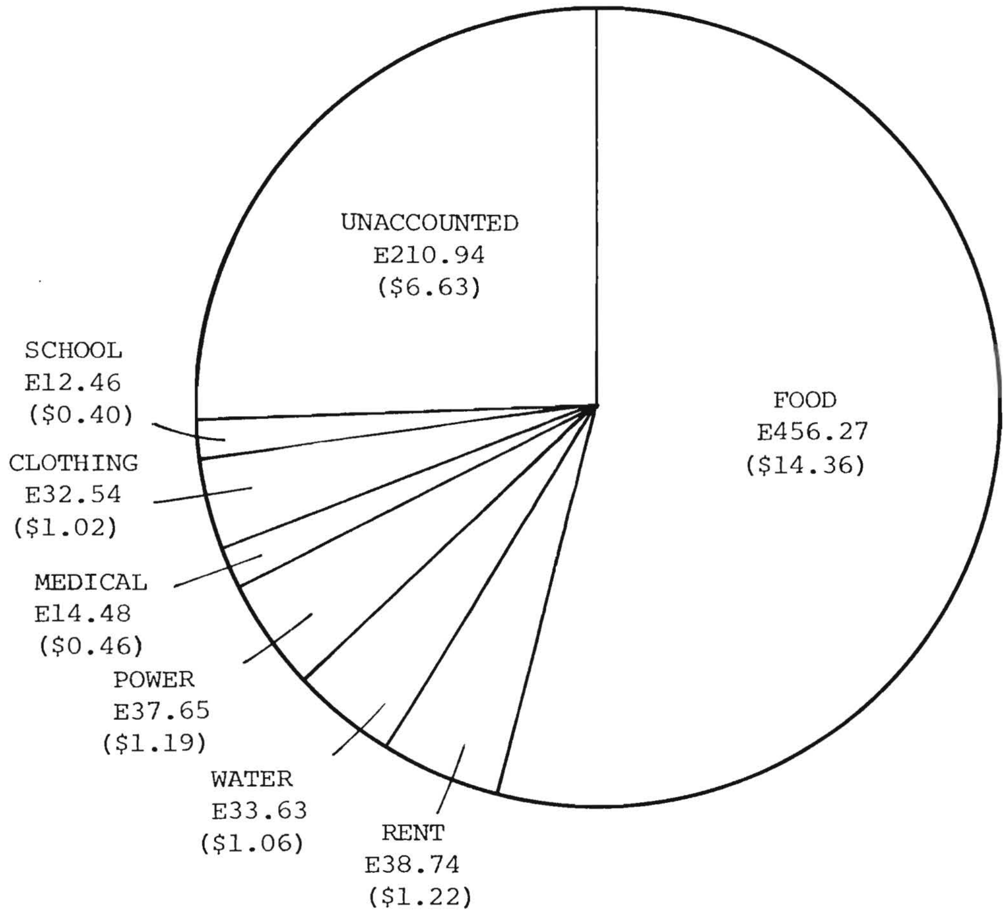


Figure 5

PER CAPITA ALLOCATION, SAMPLE HOUSEHOLD BUDGET
Average Monthly per Capita Income of E836.75 ($26.34)



employed or 27% of the estimated labor force, and the balance is either employed elsewhere, underemployed, or unemployed. Table 11 gives the labor force profile for Sal Island, based on the recently gathered information.

Table 11

POPULATION PROJECTION, SAL ISLAND

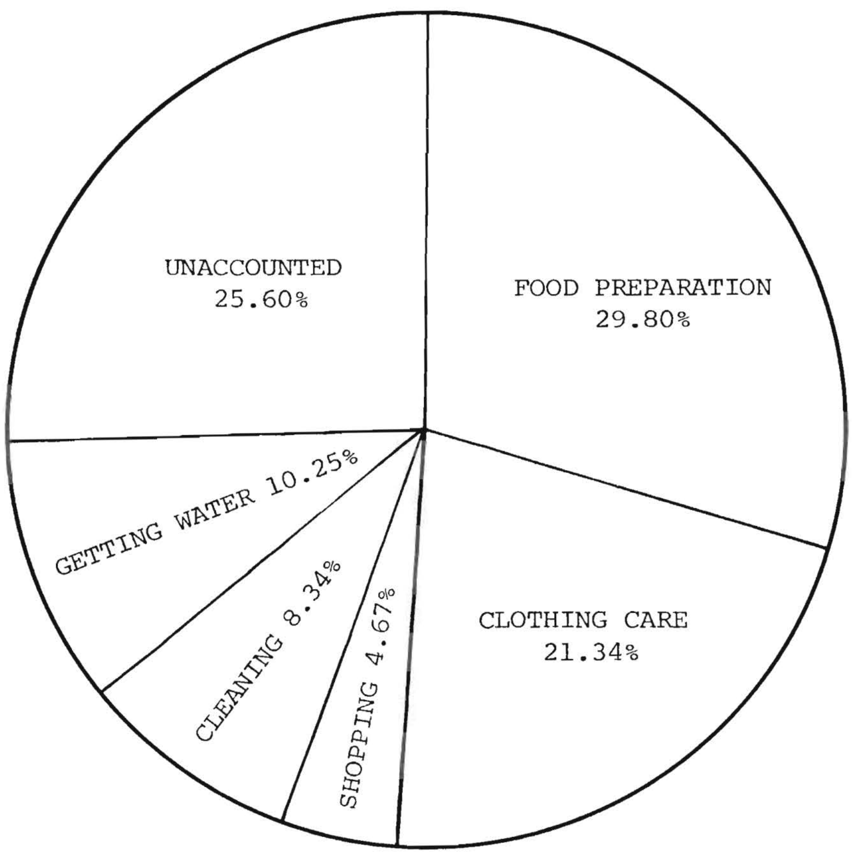
Classification	Projection of 8,000 Persons Number	Percent
Children (under age)	4,106	51.33
Adults over 60 years	339	4.24
Available labor force	3,555	44.43
Total	8,000	100.00

4. Distribution of Time. At the household level, the female members are responsible for the traditional tasks associated with the home, while the male members are household heads and are responsible for the provision of funds and food for the family. The random dwellings visited by the project team consisted in general of a living room, two sleeping areas, kitchen, eating area, courtyard, and bathroom. The female members of the family are responsible for the upkeep, cleaning, and general maintenance of the living quarters together with other regular chores. An attempt has been made in the random survey to determine the distribution of time among various tasks by the persons responsible for the household; out of 82 responses only 31 were usable (38%). The results of the usable sample are presented in Figure 6. Additional information may be found in Annex 8.

5. Health. Very few homes in Sal Island have piped-in water and only some 300 appear to have electric power. As was indicated earlier in this report, water is usually brought into the home via a wooden barrel rolled from the nearest water point. The used water (both gray and brown) is dumped outside. Since few families have toilet facilities or septic tanks, the human waste (night waste) usually is disposed of either by dumping into a hole leading to a septic tank or by using a container which is later emptied into any open area away from the household. Both of the above systems generate flies (which are plentiful) and serve as breeding places for many diseases.

Figure 6

SAMPLE ALLOCATION OF TIME FOR HOUSEHOLD TASKS
Basis of 12 Hours per Day x 7 Days per Week



It is a fact that an improvement in the water supply and sanitation of a community can generate interrelated improvements in health, income, and general social welfare. This project does not intend to use the health benefits as a means to justify the suggested investment expenditure; nevertheless, there are many possible health benefits that may well be derived from the water supply and sanitation portion of this proposed program. The important relationship between water and public health is highlighted in the general discussion below.

Water-related diseases that directly affect the health of the population are relatively widespread and abundant in most developing countries, Sal Island included. The incidence of these known diseases naturally will depend on the local climate, geography, culture, sanitary habits, sanitary facilities and, most of all, on the quality and quantity of water available to the population.

The well-known Dr. David J. Bradley, in a research paper entitled "Infective Disease and Domestic Water Supplies" edited by the University of Dar es Salaam and presented in 1971, indicates that there are five principal groups of water-related diseases:

- Waterborne Diseases. Water acts only as a passive infecting agent. All of these diseases also depend on poor sanitation.
- Water-Washed Diseases. Lack of water and poor personal hygiene create conditions favorable for their spread. The intestinal infections in this group also depend on lack of proper human waste disposal.
- Water-Based Diseases. A necessary part of the life cycle of the infecting agent takes place in an aquatic animal. Some are also affected by waste disposal. Infections spread other than by contact with or ingestion of water have been excluded.
- Diseases with Water-Related Insect Vectors. Infections are spread by insects that breed in water or bite near it. Adequate piped supplies may remove population from the biting areas or enable them to dispense with water storage jars where the insects breed. Unaffected by waste disposal.
- Diseases Related to Fecal Disposal and Very Little Affected by Water More Directly. These are one extreme of a spectrum of diseases, mostly water-washed, together with a group of water-

based type infections likely to be acquired only by eating uncooked fish or other large aquatic organisms.

Details of these groups of water-related diseases and other information abstracted from studies by Saunders and Warford appear as part of the material presented in Annex 8.

6. Medical Services and Health Problems. Sal Island has one "hospital," located in Espargos. This facility has two wards and, at present, seven beds. One doctor and three nurses are available. There is a smaller facility at the airport staffed by one nurse and an assistant. No other facilities are available on the island. Details on medical and hospital services appear in Annex 8. Typical reported diseases requiring treatment are as follows:

Disease Type	Hospital Comment
Children	
Gastroenteritis	Waterborne
Throat Infections and Colds	Common
Measles	Epidemic-periodic
Typhoid	Isolated cases
Vitamin Deficiency	Poor diet
Adults	
Gastroenteritis	Waterborne
Pregnancy	Malnutrition-infant mortality 90/1,000 at birth
Vitamin Deficiency	Poor diet
Throat Infection	Common

7. Implications of Increase in Availability of Water and Power. Bacteriological analyses of the Sal Island water supplies are not available. During the years of Portuguese government, water tests were made, but the present government does not consider them reliable. Local medical staff on Sal Island agree that pure, piped-in, potable water would make a tremendous contribution toward improving the present health standards and in reducing prevalent diseases. This is further supported by the information presented earlier in this same section. As proposed at the beginning of this project, it is the desire of the GOCV to provide each person with 50 liters of pure water per day and each household with 200 KW of electrical energy per month.

In addition to the obvious beneficial effect of pure water on the general health of the population, other social benefits would be generated by the proposed provision of power and water, such as:

- o Increased personal bathing and better body hygiene.
- o Improved food preparation hygiene and generally better cooking conditions.
- o Better laundering methods, resulting in general improvements in the appearance of the people.
- o Better food storage methods--iceboxes, refrigerators, etc.
- o Improved eating habits through amelioration of the feast or famine conditions.
- o Reduction in time required for basic household tasks.
- o Enhancement of the role of the female household members by alleviation of some of the more sordid tasks.

8. Role of Women. The traditional role of women in Cape Verde is that generally identified for women on the African mainland. It has been shaped in the past and continues to be sustained today by the following factors:

- o Physical deterioration associated with repeated droughts. "The most common causes for malnutrition and undernourishment (women, mothers and young children) were an uncertain food supply, especially in dryland areas (i.e., the Sahel), particularly at the end of the dry season when supplies ran out; inadequate national food crop programs; lack of money to buy food; and the customary dietary habits of some women."1/
- o Traditions of the dominant Portuguese culture which defined the role as in the home.
- o Uninterrupted childbearing and subsequent child care.
- o Lack of adequate water and power, directly and indirectly relating to the performance of household chores.
- o Lack of household aids which would lessen or eliminate many hours of repetitive tasks and possibly free women for a more constructive and creative participation in society.

1/African Women in Rural Development, Research Trends and Priorities, by Achola O. Pala, Institute for Development Studies, University of Nairobi, Nairobi, Kenya, and Ph.D. Candidate, Department of Anthropology, Harvard University, Cambridge, Mass. 02138, U.S.A., OLC Paper No. 12, December 1976.

Power/Water vis-a-vis the Role of Women. The withdrawal of the Portuguese colonial structure in Cape Verde has created a need for productive and healthy participation in all phases of reconstruction by all members of the society. Women especially would benefit by the development of technological resources because of the direct bearing that has to their present tasks and role within the home. An increase in power and safe, piped-in water supply would:

- Reduce incidence of waterborne or related diseases, with the obvious improvement in physical well-being.
- Reduce the amount of time-consuming, often nonproductive chores.
- Permit reallocation of time for more creative and qualitative activities within the home.

Any real analysis of the role of women requires an extended period of time, far greater than presently authorized, to reach more substantial and valid conclusions. It is suggested that the sponsor consider undertaking further research of this kind.

It also would be beneficial, and highly relevant, to assure that any future participants be made aware that present methods of data collection are deficient in projecting women's roles. "The claim that the formulation of the research is foreign and does not reflect the aspirations and development practices of African people discourages African planners from duly considering women's role."[1/] Any future study should be conducted by host country agencies, where possible, preceded by careful preparation and analysis of the desired objectives.[2/]

Further research concerning women's roles in rural Africa should involve the following activities: (1) the training of African women and men in the techniques of data collection and analysis to reflect the differential roles of men and women in their societies; (2) the assembly and synthesis of published and unpublished sources concerning African women in the rural economies; and (3) the establishment of research priorities in accordance with each African country's resource capabilities, focusing on key issues of primary significance for women and their nations.

1/ Pala, Abstract (based on data collected for an earlier work, "The Role of African Women in Rural Development: Research Priorities," Discussion Paper No. 203, Institute for Development Studies, University of Nairobi, 1974.)

2/ Ibid.

D. Economic Analysis

The limited income of the population on Sal Island is a negative factor when considering the demand for both the water and power to be produced by the proposed plant. The project is economically viable, nevertheless, for the following reasons:

- o Present-day demand for pure water and electric power at the proposed rates (household water-\$0.45/m^3, non-household water-\$0.90/m^3, electrical power-\$0.135/KWH) will enable the proposed plant and distribution delivery system to operate at a profit.
- o Only through the establishment of the much-needed water/power infrastructure will the GOCV be able to attract economic investment on the island and assure the future economic growth of Sal.

The following analysis reviews the principal economic impacts of the proposed activity:

1. Impact on Households. The project team looked into the effective demand for both power and water and the following facts were established:

a. At present, the population of Sal Island consumes 90 m^3 per day of pure water and 50 m^3 per day of brackish water; the industrial/commercial enterprises consume an additional 30 m^3 per day of pure water. Present-day facilities are producing all the water that can be produced with the existing installations. The available supply of 120 m^3 of pure water and 50 m^3 of brackish water per day is not sufficient, and the population is having to live on an average of 11.25 liters of pure water per person per day. (See Table 3 of Annex 6.)

b. The average citizen on Sal Island is purchasing pure water at \$2.52 per m^3 and brackish water at \$2.36. (See Table 3, Annex 6.) At these prices, there is a demand, as indicated in the preceding paragraph. The population of Sal Island is spending a total of \$321.30 per day for the available 170 m^3 of combined pure and brackish water.

c. The proposed project would provide pure water directly to each individual household or industrial/commercial installation at the suggested price of \$0.45. At the same time, up to 747 m^3 of pure water could be made available per day.

d. Per capita consumption of water at present levels and prices indicates that each person on Sal Island averages a daily expenditure of $0.04 for his or her 17.5 liters of pure and brackish water. From the same $0.04 per day at the proposed water price, the individual could purchase 88.8 liters of water per day (five times as much). The anticipated water demand under the proposed project was established at 50 liters of water per person per day.

e. The households on Sal Island that were sampled reported an average income of $175 per month and an expenditure of $7.35 per month (4.02% of income) on water for the persons living in the household (an average of about 6.5 persons per household). At the current price of water, the $7.35 would purchase about 3.2 m^3 of water a month. At the proposed price of $0.45, that same household budget allocation would purchase some 16.3 m^3 of water, well over five times the volume of pure water presently purchased.

f. Although a conservative forecast of 50 liters of water per person per day was made by the project team, it is a known fact that a major inhibitor to consumption is access. Since water is now proposed to be piped into the households, it is anticipated that consumption will be even greater than forecast.

g. The effective demand for power is less certain because the lack of connections to the households has never allowed the market to develop. The on-site study indicated that at best there are some 300 households connected to the existing electric power network. These 300 households consumed in 1976 some 135,246 KWH and paid for this power an average price of $0.142 per KWH, as shown in the Technical Analysis, Annex 6.

h. The proposed project will connect each of the existing households to the power network and, although each home will consume the power it can afford, it is estimated that on an average each household will use no less than 100 KWH per month. Power rates, as proposed ($0.135/KWH), will be reduced from the present average household rate of $0.142 on Sal Island.

i. The random sample taken by the project team indicated that 4.5% of the average household income of $175 was used to purchase electric power, or about $7.87 per month. The above average represented only 23 households that reported having electric power installed.

j. The projected average consumption of 100 KWH per household per month at the proposed rate would represent a power bill of about $13.50 per average household per month. At present, the existing allocation in the household budget generated from the random sample shows about $44.00 per month as "unaccounted," so part of this amount could be used to cover the additional purchased electric power.

2. Impact on Government, Commerce, and Industry. These activities are also highly favored by the proposed project.

a. The GOCV currently is having to spend about $234,300 (Table 2, Annex 6) per year to subsidize the existing water/power system on Sal Island. The proposed project will provide a water/power system that pays for itself and shows a yearly profit. As a result, the GOCV will be able to invest these subsidy funds in other social programs or in industrial development programs.

b. The existing industries surveyed (Annex 9) employ some 960 persons but are limited to sharing about 30 m^3 of water a day available to the commercial/industrial community. Availability of pure, piped-in water will allow many of them to expand (the existing Hotel Morabeza and the airport, among others). The present price of $2.29 per m^3 of water is another factor inhibiting the growth of these activities.

c. The forecast for the proposed project anticipates that government, commercial, and industrial activities will greatly increase their water usage. Details of this forecast are shown in Annex 6. At present, these non-household consumers are paying $2.50 per m^3 of pure water; the proposed plan will provide these consumers with water at $0.90 per m^3 or about one third of the present price.

d. Government installations will continue to have electric power at the same price they are now charging themselves ($0.135/KWH). However, more power will be available if needed, whereas the generators installed at present are at their top capacity.

e. Power rates will be reduced for industrial and commercial enterprises from the present $0.188 per KWH, as shown in Annex 6, to a proposed $0.135 per KWH. It is further anticipated that this sector will greatly increase its power consumption, as discussed later in the section entitled GOCV Industrial Development Plans.

f. The proposed water/power system and wastewater treatment and irrigation will create about 57 new permanent jobs and an annual payroll of over $128,000. This represents an average of $2,258 a year. The proposed water/power and treatment irrigation system will be the second largest single employer on the island, following the Almicar Cabral airport facility.

3. GOCV Industrial Development Plans. As has been indicated in an earlier section of this document, the GOCV feels that Sal Island offers one of the major opportunities for stimulating economic growth in the Republic of Cape Verde. The island is only six hours flying time from many of the major population centers of Europe and the U.S.A.; should an aggressive tourism development scheme be implemented, there is a strong possibility for the island to become a tourist attraction.

Sal Island is one of the principal communication points between the Republic of Cape Verde and the outside world. The well-equipped international airport located at Sal Island is a real asset, together with the existing industrial activities which were surveyed by the project team (Annex 9).

During the on-site research by the project team, meetings were held with several government officials to discuss the industrial development plans that they had in mind after the implementation of this proposed project. The following new industrial/commercial activities are scheduled for implementation in the next five years:

a. Tourist Hotel. Plans have been completed for a new 150-room tourist hotel on the island, and construction should start in 1977. This hotel will require about 30 m^3 of water and about 360 KWH of electrical energy per day. It is anticipated that about 50 persons will be employed by the new hotel.

b. Hotel Morabeza. This facility is being expanded by 14 new units to bring the total capacity up to 60 units. Additional water and power will be required when completed. It is forecasted that the expansion will represent added demand of 7 m^3 for water and 120 KWH for power per day. The hotel staff will be expanded by another 12 persons.

c. Almicar Cabral Airport. It is anticipated that new carriers will use the facilities, and the forecast calls for a traffic increase from two jumbo jets to six jumbo jets per day. Water needs at the airport will be increased by about 28 m^3 per day, but no power estimates were available. The staff would be increased by about 25 persons.

d. Lobster Plant. This plant is now 99% completed and they are awaiting the arrival of a refrigeration unit. The lobster plant, when in operation, will use about 250 KWH per day of electric power. Water estimates were not yet available. The plant will employ about 40 persons.

e. Agricultural Schemes. This general area of activity is being considered on the basis of 75 acres (about 30 hectares) of irrigated land resulting from the wastewater treatment and irrigation system. A recent in-depth agricultural study entitled "Irrigation in Tarrafal, Cape Verde," by Mr. Ray Solem, indicates (pp. 30-34) that crops such as bananas, Irish potatoes, peppers, and onions will give a gross return of $6,000 to $12,000 per acre.

f. Hothouse Flowers. Another interesting concept is to establish a flower raising and exporting industry using the available treated wastewater. The Canary Islands have very successfully exploited this activity and are now earning a vast amount of dollars by exporting flowers by air to the European market.

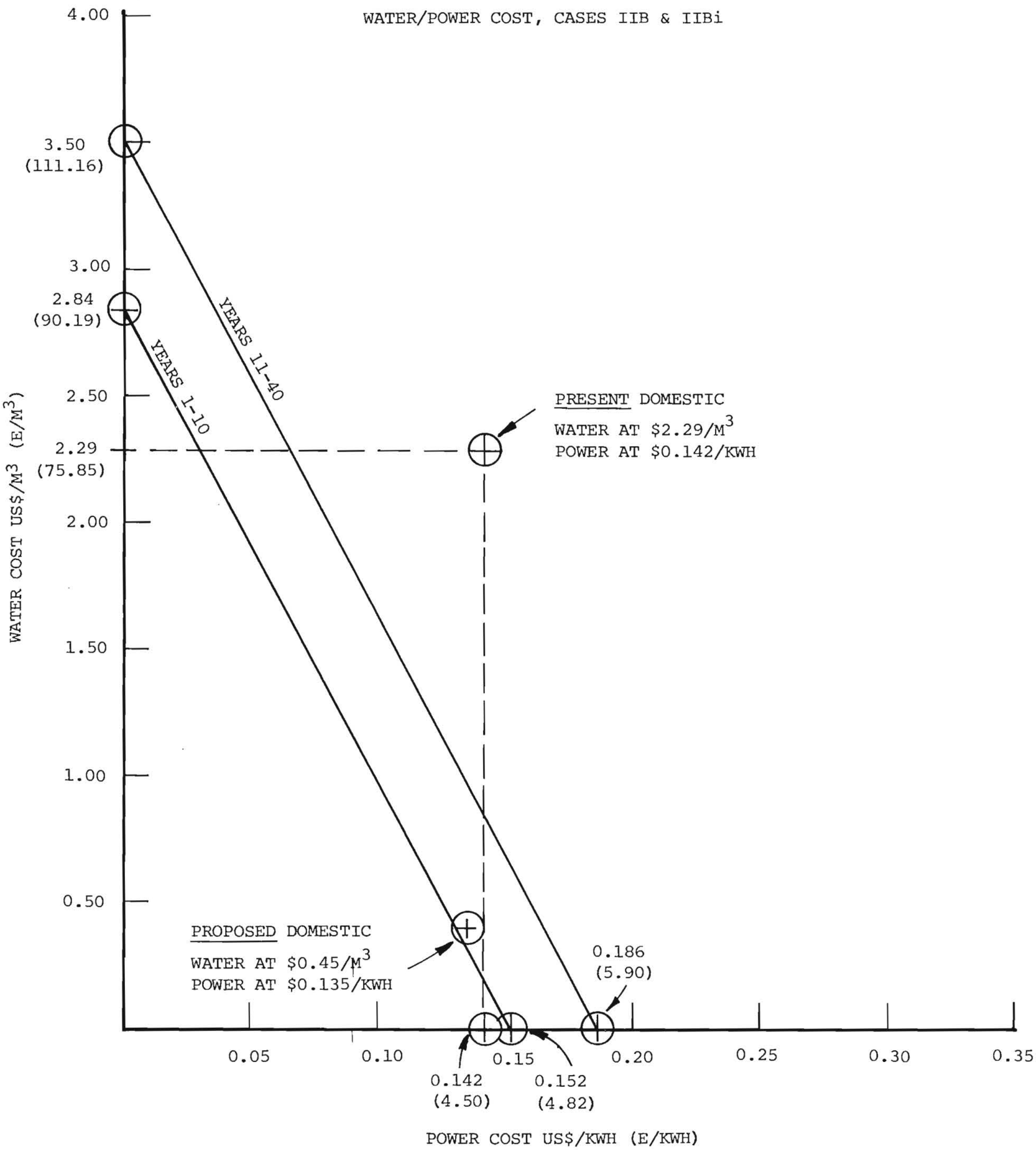
None of the above-mentioned activities are possible unless water and power are made available. The new activities represent well over 150 new jobs plus the 57 created by the new water/power plant, or a total of over 200 new jobs, as an immediate result of this proposed project. At an average rate of $188 per job per month, the annual payroll would be over $450,000 a year. This new payroll would have a tremendous impact on the economy of Sal Island.

Figure 7 was prepared to assist in establishing the suggested water and power rates. In the future, as industrial projects are implemented the GOCV may vary the price structure along the lines plotted by the curve.

4. Internal Rate of Return. As part of the economic analysis of the proposed project, a benefit/cost analysis was conducted in order to indicate the social benefits that would be generated through the installation of a water/power system on Sal Island.

Figure 7

WATER/POWER COST, CASES IIB & IIBi



The simplest benefit/cost formula,

$$BC = \frac{\text{Present Worth of Benefits}}{\text{Present Worth of Costs}}$$, was used with the following

result:

$$BC = \frac{8,478,485}{8,476,361} = 1.00*$$

*using a discount factor of 15.

In developing the benefit/cost ratio, only the AID capital cost (Table 13) was used and this cost was spread equally over a four-year period at an average of $1,441,202 per year. The operation and maintenance costs are itemized in Table 15. For Year 2, only 50% was charged as the plant would be test running at 50% capacity. Loan costs or amortization were charged at the rate of Case IIB for years 1-10 and Case IIBi for years 11-40, as per Annex 6. The sinking fund is set to generate over $400,000 every 10 years to cover major plant overhaul, thus ensuring a maximum plant life. In establishing the benefits, the income shown for power and water was taken from Table 6 considering that in Year 2 the production would be at 50% since the plant would be test running, as per case IIB; after Year 10, the production level would be that indicated for case IIBi. Details are presented in Table 6. In Year 20, the plant and system are considered to be in very good condition to continue to operate for another 20 years; consequently, a value of $3,000,000 was assigned to it, as shown in Table 12.

In establishing the system net return, Table 6 was used. For years 1-10 a net return of $54,562 per year was used as per Case IIB; the following years would yield a net return of $249,626 as per Case IIBi. Year 1 shows no net return and Year 2 shows only 50% of that for years 3-10.

The payroll generated is quite large and is the summation of payroll during years 1-4 in setting up the system, buildings, etc., and the permanent staff payroll as presented in Annex 6 for years 2 to 40. The complete tabulation of the benefit/cost analysis appears as Tables 12-15, which will assist the reader in identifying the different cost items.

5. Foreign Exchange Impact. Another benefit resulting from this proposed project is the impact of foreign exchange. The short-term industrial development projects of the GOCV are basically in the areas of tourism, export of seafood, and air transportation. All three of these general areas can be

developed given ample supply of both water and power; once developed, all three areas will be generators of additional foreign exchange.

a. Tourism. A tourist hotel with 150 rooms is in the process of being constructed to serve as a tourist center on Sal Island. Assuming only a 60% occupancy on an annual average and considering a modest charge of $20 per room, the hotel could generate some $657,000 per year of which 99% would be foreign exchange. The foreign exchange component of operating costs would probably be about 30% of the gross; therefore, the hotel could produce a net benefit of about $460,000 per year in foreign exchange.

The tourists at the hotel probably would generate an average of $10.00 per person per day of outside expenses (taxis, beverages, shopping, etc.), thus injecting into the local economy another $328,500 per year. If the services cost up to 50%, this would still leave a net benefit in foreign exchange of over $160,000 per year.

To serve these hotel guests, it is estimated that as many as 50 persons would be employed by the tourist hotel.

b. Air Transportation. The Almicar Cabral Airport at present serves four to five foreign planes per day for an average of over 32 flights per week. Of these, 14 flights per week (two per day) are B747's belonging to South African Airways. These 747's purchase about 1 m^3 of water per landing and sufficient fuel to continue to London or Johannesburg. At the Almicar Cabral Airport, the B747's are charged about $1,300 for landing rights and the 707's pay about $630 for that privilege. The present income for landing rights is about $29,540 per week or $1,536,080 a year.

The GOCV plans to increase the use of the airport by foreign carriers. They forecast up to six jumbo jets per night, if they have water and power to support them. The additional air traffic would generate an additional income (landing rights only) of $2,847,000 per year in foreign exchange.

c. New Lobster Plant. The new lobster plant will be going "on stream" some time this year. No estimates or forecasts are available on the anticipated production, but all of the finished product will be exported to Europe. Lobsters wholesale in Europe are purchased at about $2.50 to $3.00 per kilo. Live lobsters are purchased on Sal Island from the fishing fleet at about $1.50 to $1.70 per kilo. Assuming a small production of only 1,000 kilograms per day, the plant could generate a foreign exchange cash flow of well over $650,000 per year.

Table 12

SUMMARY OF PRESENT VALUE OF COSTS AND BENEFITS
PROPOSED WATER/POWER PROJECT, SAL ISLAND (CASES IIB AND IIBi)

Year	Capital Costs	O&M Costs	Loan Costs	Sinking Fund Costs	Gross Costs	Disc. Factor 15%	Present Worth	Income Power and Water	Subsidy Present Plant	System Net Return	Payroll Generated	Gross Benefit	Disc. Factor 15%	Present Worth
1	$1,441,202	-	$ 115,292	$ 41,344	$ 1,597,838	0.870	$1,390,119	-	-	-	$ 262,931 c/	$ 262,931	0.870	$ 228,749
2	1,441,202	$ 293,824	115,292	41,344	1,891,662	0.756	1,430,096	$ 414,493	$ 617,165 b/	$ 27,281	327,291 d/	1,386,230	0.756	1,047,989
3	1,441,202	587,648	115,292	41,344	2,185,486	0.658	1,438,049	828,986	234,330	54,562	391,651 e/	1,509,529	0.658	993.270
4	1,441,202	587,648	115,292	41,344	2,185,486	0.572	1,250,097	828,986	234,330	54,562	391,651	1,509,529	0.572	863,450
5	-	587,648	115,292	41,344	744,284	0.497	369,909	828,986	234,330	54,562	128,720	1,246,598	0.497	619,559
6	-	587,648	115,292	41,344	744,284	0.432	321,530	828,986	234,330	54,562	128,720	1,246,598	0.432	538,530
7	-	587,648	115,292	41,344	744,284	0.376	279,850	828,986	234,330	54,562	128,720	1,246,598	0.376	468,720
8	-	587,648	115,292	41,344	744,284	0.327	243,380	828,986	234,330	54,562	128,720	1,246,598	0.327	407,637
9	-	587,648	115,292	41,344	744,284	0.284	211,376	828,986	234,330	54,562	128,720	1,246,598	0.284	354,033
10	-	587,648	115,292	41,344	744,284	0.247	183,838	828,986	234,330	54,562	128,720	1,246,598	0.247	307,909
11	-	759,033	294,001	41,344	1,094,378	0.215	235,291	1,374,144	234,330	249,626	128,720	1,986,820	0.215	427,166
12	-	759,033	294,001	41,344	1,094,378	0.187	204,648	1,374,144	234,330	249,626	128,720	1,986,820	0.187	371,535
13	-	759,033	294,001	41,344	1,094,378	0.163	178,383	1,374,144	234,330	249,626	128,720	1,986,820	0.163	323,851
14	-	759,033	294,001	41,344	1,094,378	0.141	154,307	1,374,144	234,330	249,626	128,720	1,986,820	0.141	280,141
15	-	759,033	294,001	41,344	1,094,378	0.123	134,608	1,374,144	234,330	249,626	128,720	1,986,820	0.123	244,378
16	-	759,033	294,001	41,344	1,094,378	0.107	117,098	1,374,144	234,330	249,626	128,720	1,986,820	0.107	212,589
17	-	759,033	294,001	41,344	1,094,378	0.093	101,777	1,374,144	234,330	249,626	128,720	1,986,820	0.093	184,774
18	-	759,033	294,001	41,344	1,094,378	0.081	88,644	1,374,144	234,330	249,626	128,720	1,986,820	0.081	160,932
19	-	759,033	294,001	41,344	1,094,378	0.070	76,604	1,374,144	234,330	249,626	128,720	1,986,820	0.070	139,077
20	-	759,033	294,001	41,344	1,094,378	0.061	66,757	4,374,144 a/	234,330	249,626	128,720	4,986,820	0.061	304,196
Total	$5,764,808	$12,585,338	$4,092,930	$826,880	$23,269,956		$8,476,361	$23,787,821	$4,835,105	$2,960,037	$3,433,044	$35,016,007		$8,478,485

Benefit/Cost Ratio at 15% = $\frac{8,478,485}{8,476,361}$ = 1.00

a/ Includes a $3,000,000 value of proposed system by Year 20.

b/ Includes a $500,000 value of Sta. Maria Plant.

c/ System installation total of $1,051,727 charged over a four-year period at $262,931/year.

d/ Includes "c" plus 50% of system permanent staff payroll of $128,720.

e/ Includes "c" plus 100% of system permanent staff payroll.

Table 13

PROJECT CAPITAL COST
SUMMARY

Item	AID Total	GOCV Total	AID & GOCV Total
Water and Power Plant IIB	$3,322,498	$ 258,913	$3,581,411
Water Distribution and Delivery	1,305,113	477,840	1,782,953
Power Distribution and Delivery	806,447	314,974	1,121,421
Training	160,000	33,760	193,760
Employee Service and Support	170,751	120,120	290,871
Total Capital Cost	$5,764,809	$1,205,607	$6,970,416

AID 82.70%
GOCV 17.30%

Table 14

GOVERNMENT OF CAPE VERDE CAPITAL COST
SUMMARY

Item	Total Cost
Water and Power Plant IIB	$ 258,913
Water Distribution and Delivery	477,840
Power Distribution and Delivery	314,974
Training	33,760
Employee Service and Support	120,120
Total GOCV Capital Cost	$1,205,607
Pay Back Over 40 Years, No Interest - Total Annual Cost	$30,140

Table 15

PROJECT ANNUAL COST
SUMMARY

Item	Unit	Diesel and Vapor Compression, Case IIB IIB Projected	IIBi Full Capacity	IIBii Lower Water Capacity	IIBiii Power Water Pres. Level
Years 1-10					
Plant Annual Cost	$/Yr	663,201	834,586	589,607	366,063
Water Distribution & Delivery Annual Cost	$/Yr	42,221	42,221	42,221	42,221
Power Distribution & Delivery Annual Cost	$/Yr	32,247	32,247	32,247	32,247
Training Annual Cost	$/Yr	3,200	3,200	3,200	3,200
Employee Serv. & Supp. Annual Cost	$/Yr	3,415	3,415	3,415	3,415
GOCV Annual Cost	$/Yr	30,140	30,140	30,140	30,140
Total Annual Cost	$/Yr	774,424	945,809	700,830	477,286
Annual Water Export	m^3/Yr	272,655	272,655	179,762	62,415
Annual Power Export	KWH/Yr	5,110,000	9,094,705	5,110,000	1,861,500
Power Free-Water Cost	$/$m^3$	2.84	3.46	3.80	7.64
Water Free-Power Cost	$/KWH	0.152	0.103	0.137	0.256
Years 11-40					
Plant Annual Cost	$/Yr	766,199	937,584	692,605	469,061
Water Distribution & Delivery Annual Cost	$/Yr	82,679	82,679	82,679	82,679
Power Distribution & Delivery Annual Cost	$/Yr	57,247	57,247	57,247	57,247
Training Annual Cost	$/Yr	8,160	8,160	8,160	8,160
Employee Serv. & Supp. Annual Cost	$/Yr	8,708	8,708	8,708	8,708
GOCV Annual Cost	$/Yr	30,140	30,140	30,140	30,140
Total Annual Cost	$/Yr	953,133	1,124,518	879,539	655,995
Annual Water Export	m^3/Yr	272,655	272,655	183,960	62,415
Annual Power Export	KWH/Yr	5,110,000	9,094,705	5,110,000	1,861,500
Power Free-Water Cost	$/$m^3$	3.50	4.13	4.78	10.51
Water Free-Power Cost	$/KWH	0.186	0.124	0.172	0.352

Chapter IV

IMPLEMENTATION PLAN

IV. IMPLEMENTATION PLAN

A. Administrative Arrangements

Once the Project Agreement has been signed, it is suggested that the AID and GOCV representatives meet and determine the following:

1. Contract specifications to be used in procuring the services of an "engineering and administration" firm (E/A firm). This firm is of critical importance to the project. The contracted E/A firm must have special expertise in desalination plant design and materials specifications, as well as having qualified personnel to handle power plant, power transmission, water distribution, water treatment, and irrigation systems design. To assure continuity in overall responsibility for the technical success of the project, it is further suggested that a single firm be employed for the detailed design of the final project, preparation of procurement specifications, preparation of bid packages, and general construction supervision for the GOCV.

2. Detailed specifications for the procurement of equipment and technical services for:

   a. Desalination/power plant
   b. Water distribution and delivery system
   c. Power distribution and delivery system
   d. Wastewater collection, treatment, and irrigation system
   e. Training and operation system
   f. Employee service and support system

3. The selected E/A firm will also have the responsibility of preparing a detailed implementation plan acceptable to both AID, the GOCV, and the present plant.

B. Implementation Plan

The general implementation plan is based on an estimated total of 48 months elapsed time from signing of the Project Agreement to project completion. This may be shortened at a later date if the E/A firm can establish a shorter implementation plan. Full project completion is to include a one-year period for start-up, acceptance, testing, operator training, and production performance evaluation during the equipment warranty period.

There will be essentially three principal phases:

Design

Construction

Operational Training

Each phase will require about 16 months as shown in the Planned Performance Tracking Network Chart (PPTNC).

1. Design. The E/A firm is responsible for the detailed design of the project, preparation of procurement specifications for major items of equipment, preparation of the complete bid package for a general construction contractor, and provision of construction supervision for the GOCV. The E/A firm will also develop a detailed training program for key personnel and make all arrangements for training courses in equipment manufacturers' facilities and appropriate operating water/power plants.

During this phase, the equipment bids should be received by the GOCV, which will be assisted by the E/A firm in the evaluation of all bids, selection of suppliers, and the selection of the general contractor.

2. Construction. A delay of a year or more in receipt of all project materials is anticipated, with the desalination/power plant being the last component to arrive. During this hiatus, the GOCV, through the selected general construction contractor, will start on survey and construction work relevant to laying of pipe and power lines, construction of water storage facilities, and other activities. The general contractor will be responsible for the construction of all plant site work, installation and start-up of equipment, construction of the water and power distribution system complete with feeders to individual homes, construction of the wastewater collector, treatment, and irrigation system, as well as the facilities for the employee support system.

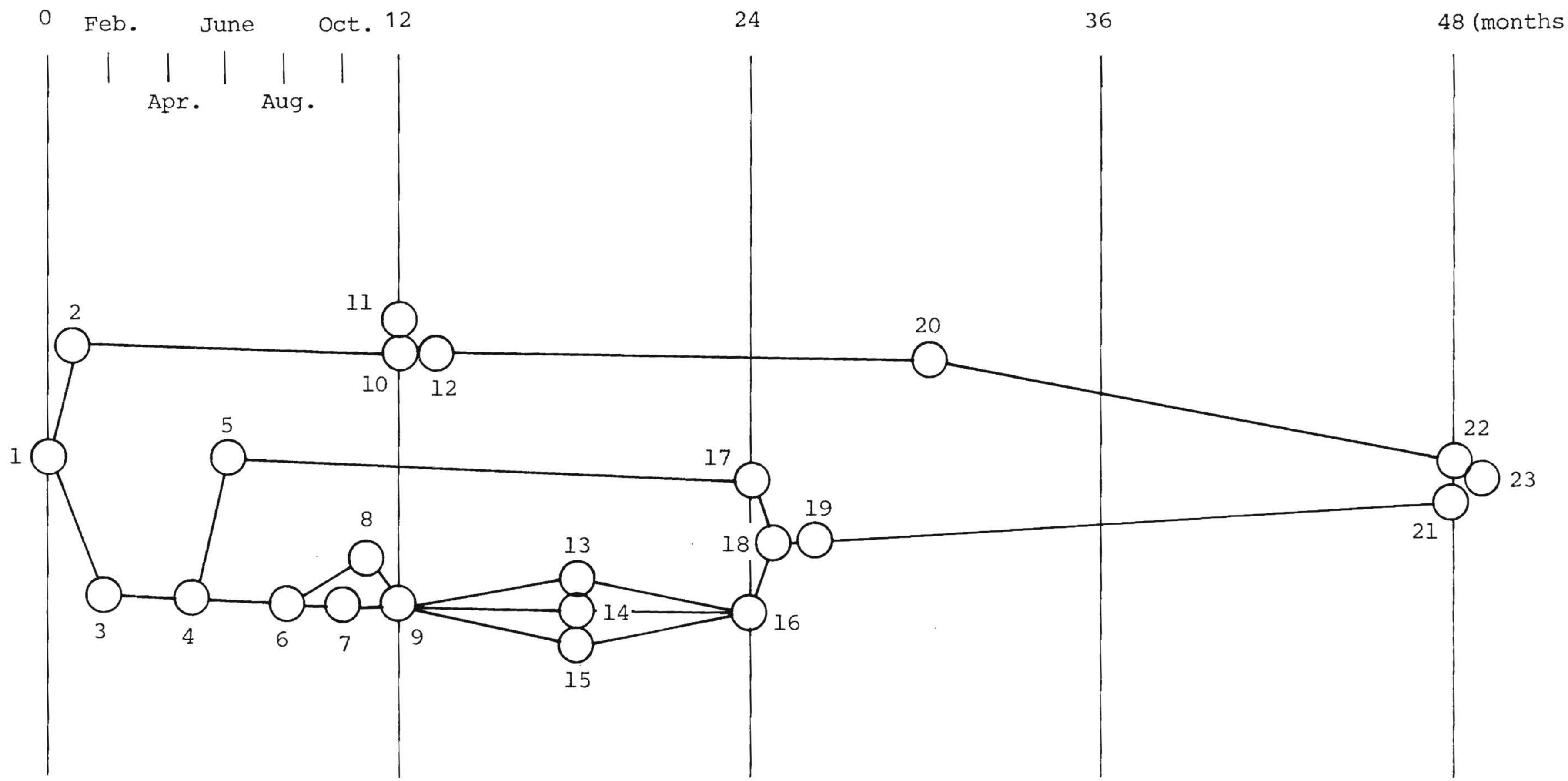
As part of this phase, the construction contractor will procure all necessary materials and equipment, both locally available and imported, to complete the project and place all systems in operational conditions. The construction contractor also will be responsible for hiring local labor to the extent that the required skills are available and to supplement this work force with foreign personnel as needed to expeditiously and efficiently complete the project.

IMPLEMENTATION PLAN

		Time (Months)
1.	Sign Project Agreement	0
2.	Start Opening Trenches and Others	1
3.	Prepare RFP and E/A Proposals	2
4.	Contract E/A	5
5.	Start Training Program	6
6.	Project Design and Specifications - Bid Package	8
7.	Purchase Long Lead/Terms	10
8.	Select Construction Contractor	11
9.	Start Construction Plant	12
10.	Complete Opening of Trenches	12
11.	Start Closing Trenches	12
12.	Start Employee Support Facilities	13
13.	Test Switchgear	18
14.	Test Lines	18
15.	Start Equipment Installation	18
16.	Conduct Plant Start-up Acceptance Tests	24
17.	Complete Training Program	24
18.	Start on-the-Job Training	25
19.	Plant and System on Stream	26
20.	Complete Employee Support Facilities	30
21.	Complete Acceptance Tests	48
22.	Complete Construction	48
23.	Conduct Project Evaluation	48

PLANNED PERFORMANCE TRACKING NETWORK CHART (PPTNC)

POWER/WATER-SAL



3. Operational Training. The third and last 16-month phase will begin when the plant equipment has been installed and is ready for initial operation. During this period, the plant staff will receive on-the-job training and will remain in training until all systems are understood and are operating effectively. The E/A firm will provide follow-up maintenance checks for the duration of the contract. During this phase, the E/A firm will remain on site to test and evaluate the total system and the components. Should any funds remain, the E/A firm will coordinate with the GOCV on the utilization of these funds for additional technical assistance and training.

C. Evaluation

As has been indicated, the last 16 months of the project period involve full systems utilization and continued on-the-job training of all staff. It is recommended that the GOCV retain a reputable consulting engineer for this period to evaluate the following:

1. Plant performance
2. Personnel performance
3. Stock control procedures
4. Adequacy of spare parts and stock items inventory
5. Overall effectiveness of the staffing plans

The GOCV should set up a system to keep detailed records of water and power usage in order to evaluate consumption patterns and trends as an aid in predicting future requirements. Detailed analysis of consumption patterns will also provide the information required to schedule water production effectively in order to stabilize the electrical load on the plant and improve overall efficiency.

At the end of the first eight-month operating period, the consultant will prepare a final evaluation report with recommendations for improving overall system efficiency. In addition to technical analysis, this report also should evaluate the effectiveness of pricing policy and consumer educational efforts in accomplishing the goals of the project.

It is further suggested that a year after completion, an evaluation be conducted by AID or an AID consultant to determine the project's impact on economic growth, public health, and improvement in the general quality of life for the population of Sal Island. The information generated from such an evaluation would be of great value to other teams in the future when designing projects related to the establishment of a basis for economic growth and acceptable standards of public health.

D. Conditions and Covenants

The project design team believes that some actions should be taken by the GOCV prior to the signing of the project agreement. The suggested actions are as follows:

1. The GOCV needs to create or establish a water and power authority as discussed in this report.

2. The GOCV needs to define the legal status of said authority, as well as that of the water/power plant, the distribution and delivery system, and the wastewater treatment and irrigation system.

3. The GOCV needs to define the mode of operation and general policy for the proposed plant and support system.

4. The GOCV needs to establish its water and power pricing policy for the above authority and determine the use of any profits resulting from this operation.

All of the above points should be resolved prior to signing the Project Agreement and should be incorporated into the Project Agreement.

Annex 1

LOG FRAME

AID 1020-28 (7-71)
SUPPLEMENT 1

PROJECT DESIGN SUMMARY
LOGICAL FRAMEWORK

(INSTRUCTION: THIS IS AN OPTIONAL FORM WHICH CAN BE USED AS AN AID TO ORGANIZING DATA FOR THE PAR REPORT. IT NEED NOT BE RETAINED OR SUBMITTED.)

Life of Project:
From FY 78 to FY 82
Total U.S. Funding $6,290,000
Date Prepared: April 1977

Project Title & Number: Cape Verde-Desalination and Power (Sal)

NARRATIVE SUMMARY	OBJECTIVELY VERIFIABLE INDICATORS	MEANS OF VERIFICATION	IMPORTANT ASSUMPTIONS
Program or Sector Goal: The broader objective to which this project contributes:	Measures of Goal Achievement:		Assumptions for achieving goal targets:
Establish a basis for economic growth and acceptable standards of public health on Sal Island, Cape Verde.	Increased investment, job generation, and economic development on Sal Island. Increased employment opportunities for natives of Cape Verde.	Baseline data study of industrial activities at start and end of project.	The presence of abuhdant and inexpensive water and power will assist in developing additional industries.

AID 1020-28 (7-71)
SUPPLEMENT I

PROJECT DESIGN SUMMARY
LOGICAL FRAMEWORK

Life of Project:
From FY 78 to FY 82
Total U.S. Funding $6,290,000
Date Prepared: April 1977

Project Title & Number: Cape Verde - Desalination and Power (Sal)

NARRATIVE SUMMARY	OBJECTIVELY VERIFIABLE INDICATORS	MEANS OF VERIFICATION	IMPORTANT ASSUMPTIONS
Project Purpose: Establish technically and economically viable water/power production system, water/power distribution and delivery system, training system, employees service and support system, and waste-water treatment and irrigation system for the five principal communities of Santa Maria, Espargos, Preguiça, Palmeira, and Pedra Lume on the Island of Sal.	**Conditions that will indicate purpose has been achieved: End of project status.** 1. Each of 1,300 households on Sal Island will have in-house access to fresh potable water. 2. Time spent by average family in pursuit of water reduced from 1.2 to 0 hours per day. 3. Unit price to domestic consumer of water reduced from $\$2.52/m^3$ to $\$0.45/m^3$. 4. Average quality of drinking water improved from 1,750 ppm to less than 100 ppm. 5. Incidence of impure water-related diseases decreased at least 50%. 6. One thousand additional homes on Sal Island will enjoy at-home access to electrical power. 7. Electrical power rate made available to all consumers at $0.135/KWH from present price range of $0.14 to $0.18/KWH. 8. Desalination/power infra-structure and other systems will generate ample revenue to pay all costs of operation, maintenance, loan, sinking fund, and others and still show a profit. 9. Irrigation of 75 acres by using treated wastewater from the system. 10. Generation of over 50 new permanent jobs on Sal Island.	Survey and observation.	**Assumptions for achieving purpose:** That the GOCV will enter the Project Agreement and will construct and operate the system as recommended.

AID 1020-28 (7-71)
SUPPLEMENT I

PROJECT DESIGN SUMMARY
LOGICAL FRAMEWORK

Life of Project:
From FY 78 to FY 82
Total U.S. Funding $6,290,000
Date Prepared: April 1977

Project Title & Number: Cape Verde Desalination and Power (Sal)

NARRATIVE SUMMARY	OBJECTIVELY VERIFIABLE INDICATORS	MEANS OF VERIFICATION	IMPORTANT ASSUMPTIONS
Outputs: 1. Desalination and Power a. Design, procure, and install a seawater desalination plant with 900 m^3/day capacity and with an electrical power generation capacity of 50,400 KW per day. b. Construct foundations, support buildings, water and fuel storage tanks, and site access roads as needed for such a seawater desalination/power plant. 2. Water Delivery and Distribution a. Design and construct a freshwater delivery and distribution system originating at plant site (water/power plant) and connecting it with community storage tanks and then to 1,300 individual users in the communities of Santa Maria, Espargos, Preguiça, Palmeira, and Pedra Lume. b. Procure nonlocal materials, technology, and equipment for the systems. 3. Power Delivery and Distribution a. Design and construct a high-tension power delivery system connecting the water/power plant to five community substations, one at each of the	**Magnitude of Outputs:** Observation Outputs (Continued): five locations mentioned. b. Design and construct a power distribution system to provide electric power to each of 1,000 households in the five communities. c. Wire 1,000 homes to receive the supply of electrical energy. 4. Operation and Maintenance a. Design and implement a technical training program for the entire system staff. b. Establish system to measure, bill, and collect payments for both water and power used by consumers. c. Establish water and power pricing policies for Sal Island which would enable adequate revenue generation to support the operation, maintenance, loan charges, and other costs of the project. 5. Wastewater Treatment and Irrigation a. Design and construct a wastewater collection, treatment, and irrigation system for the	Project Reports Outputs (Continued): communities of Santa Maria, Espargos, and Preguiça.	**Assumptions for achieving outputs:** 1. GOCV cooperation in implementing the proposed program. 2. Determination by GOCV to establish a water/power authority for Sal Island.

AID 1020-28 (7-71)
SUPPLEMENT I

PROJECT DESIGN SUMMARY
LOGICAL FRAMEWORK

Life of Project:
From FY 78 to FY 82
Total U.S. Funding $6,290,000
Date Prepared: April 1977

Project Title & Number: Cape Verde - Desalination and Power (Sal)

NARRATIVE SUMMARY			OBJECTIVELY VERIFIABLE INDICATORS	MEANS OF VERIFICATION	IMPORTANT ASSUMPTIONS
Inputs:			Implementation Target (Type and Quantity)		Assumptions for providing inputs:
	AID	GOCV			
Desalination/Power Plant	$3,322,498	$ 258,913	Observation, monitoring by E/A firm and AID staff.	Project monthly status reports, quarterly and yearly reports.	Acceptance by AID and GOCV of proposed project.
Water Delivery & Distrib.	1,305,113	477,840			
Power Delivery & Distrib.	806,447	314,974			
Training	160,000	33,760			
Employees Service & Support	170,751	120,120			
Subtotal (includes 10% contingency)	5,764,809	1,205,607			
Sanitary Sewage System	524,200*	221,500			
Land, Right of Way, etc.	-	1,000,000			
Total	$6,289,009	$2,427,107			
Rounded to	6,290,000	2,428,000			

*USAID Grant.

Annex 2

611(e) CERTIFICATION
(Submitted Separately)

Annex 3

LETTER REQUESTING ASSISTANCE
(Submitted Separately)

Annex 4

PAF PARTS I AND II
(Submitted Separately)

Annex 5

INITIAL ENVIRONMENTAL EXAMINATION AND PROJECT TEAM ENVIRONMENTAL ASSESSMENT

CAPE VERDE - DESALINATION AND POWER (SAL)

Initial Environmental Examination

Project Location: Cape Verde

Project Title: Desalination and Power (Sal)

Funding Amount: AID Loan $4,500,000
AID Grant $500,000
GOCV Grant $1,950,000

Life of Project: Three Years

IEE Prepared by: Richard Ray Solem, AFR/DR/CAWARAP

Date: December 18, 1976

Environmental Action Recommended: Negative Determination

Concurrence:

____________________ ____________________
Graham Thompson, AFR/DR/CAWARAP Date

Assistant Administrator's Decision

Approve ____________________

Disapprove ____________________

____________________ ____________________
Stanley S. Scott, AA/AFR Date

IMPACT IDENTIFICATION AND EVALUATION FORM

Impact Areas and Sub-areas[1]	Impact Identification and Evaluation[2]
A. Land Use	
1. Changing the character of the land through:	
a. Increasing the population	M
b. Extracting natural resources	N
c. Land clearing	N
d. Changing soil character	N
2. Altering natural defenses	N
3. Foreclosing important uses	N
4. Jeopardizing man or his works	N
5. Other factors	
Sprinkler Irrigation	N
B. Water Quality	
1. Physical state of water	N
2. Chemical and biological states	N
3. Ecological balance	M
4. Other factors	
Quality of water consumed will improve as desalinated water replaces brackish ground water for drinking use.	

[1] See Explanatory Notes for this form.

[2] Use the following symbols:
- N - No environmental impact
- L - Little environmental impact
- M - Moderate environmental impact
- H - High environmental impact
- U - Unknown environmental impact

August 1976

C. Atmospheric

1. Air additives	N
2. Air pollution	N
3. Noise pollution	N
4. Other factors	N
______________	______
______________	______

D. Natural Resources

1. Diversion, altered use of water	M
2. Irreversible, inefficient commitments	N
3. Other factors	N
______________	______
______________	______

E. Cultural

1. Altering physical symbols	N
2. Dilution of cultural traditions	N
3. Other factors	N
______________	______
______________	______

F. Socioeconomic

1. Changes in economic/employment patterns	H
2. Changes in population	M
3. Changes in cultural patterns	N
4. Other factors	N
______________	______
______________	______

G. Health

1. Changing a natural environment — H

2. Eliminating an ecosystem element — N

3. Other factors

Possible increase in sewage load at Espargos and Preguiça

H. General

1. International impacts — N

2. Controversial impacts — N

3. Larger program impacts — N

4. Other factors

I. Other Possible Impacts (not listed above)

See attached Discussion of Impacts.

A. Description of the Project

The project proposed herein is a three-year water and power production and distribution effort. Its focus is on establishing a means to produce desalinated water and electric power efficiently, at a fraction of their present production cost, and to use such production cost savings to (1) finance an internal water and power distribution network which reaches all of the people in their homes, (2) lower the price of water to consumers, and (3) pay all the costs of such facilities so that GOCV subsidization will no longer be necessary. It is expected that, as a result of this project activity, there will be two distinct effects: (1) a decrease in impure water-related diseases, and (2) increased employment opportunities in industries whose development has been frustrated by lack of reasonably priced pure water and power.

B. Identification and Evaluation of Environmental Impacts

1. Land Use. Some moderate increases in population are anticipated as a result of the increased employment opportunities projected. These increases will stem from reduced emigration and thus will be gradual. It also is probable that such population growth will remain within the confines of existing cities.

2. Water Quality. A moderate favorable impact on the ecological balance is foreseen as the drawdown of groundwater supplies for drinking slows or comes to a complete halt. If the rains return to Sal Island, this may allow natural recharge to rejuvenate the groundwater supply over time.

Quality of water consumed for drinking will be much improved as pure, desalinated water replaces the very brackish groundwater presently available.

3. Atmospheric. No significant effects envisioned.

4. Natural Resources. Some moderate effect on groundwater resources is expected as desalinated water takes the place of groundwater as a source of drinking water.

5. Cultural. No effects envisioned.

6. Socioeconomic. The project is expected to have a high effect on employment/economic patterns. Indications are that use of Sal International Airport as a fueling stop for international carriers, establishment of tourist hotels on Sal's beautiful beaches, and development of light industry

will all be stimulated by assurance of a steady supply of reasonably priced pure water and electric power. These phenomena, in turn, are expected to provide a basis for moderate population increases through slowing the emigration.

7. Health. This project should have a very favorable impact on public health on Sal Island as it will enable general access to larger quantities of pure water at lower cost. A marked reduction in impure water-related diseases is anticipated.

An item of some concern in this realm is whether increased consumption of pure water (from seven to as much as 100 liters per person per day) will significantly increase sewage, and whether the existing sewage removal system can handle such increases. This question will be explored further during PP analysis with the help of a civil engineer team member.

8. General. In general, the proposed project activity should have a favorable environmental effect as standards of public health are improved, drawdown on groundwater is slowed, and possibly at some future date a means to support irrigated agriculture (hothouse agriculture) with desalinated water is developed.

PROJECT TEAM
ENVIRONMENTAL ASSESSMENT

1. Project Description

The principal purposes of the proposed project are to provide a basis for continued economic growth on Sal Island in the Republic of Cape Verde and substantially improve the standard of living and quality of life for the population by providing minimum adequate supplies of water and electric power throughout the island. The major features of the project include a centralized water and power production facility, transmission lines, and house-to-house distribution systems in the five existing population centers.

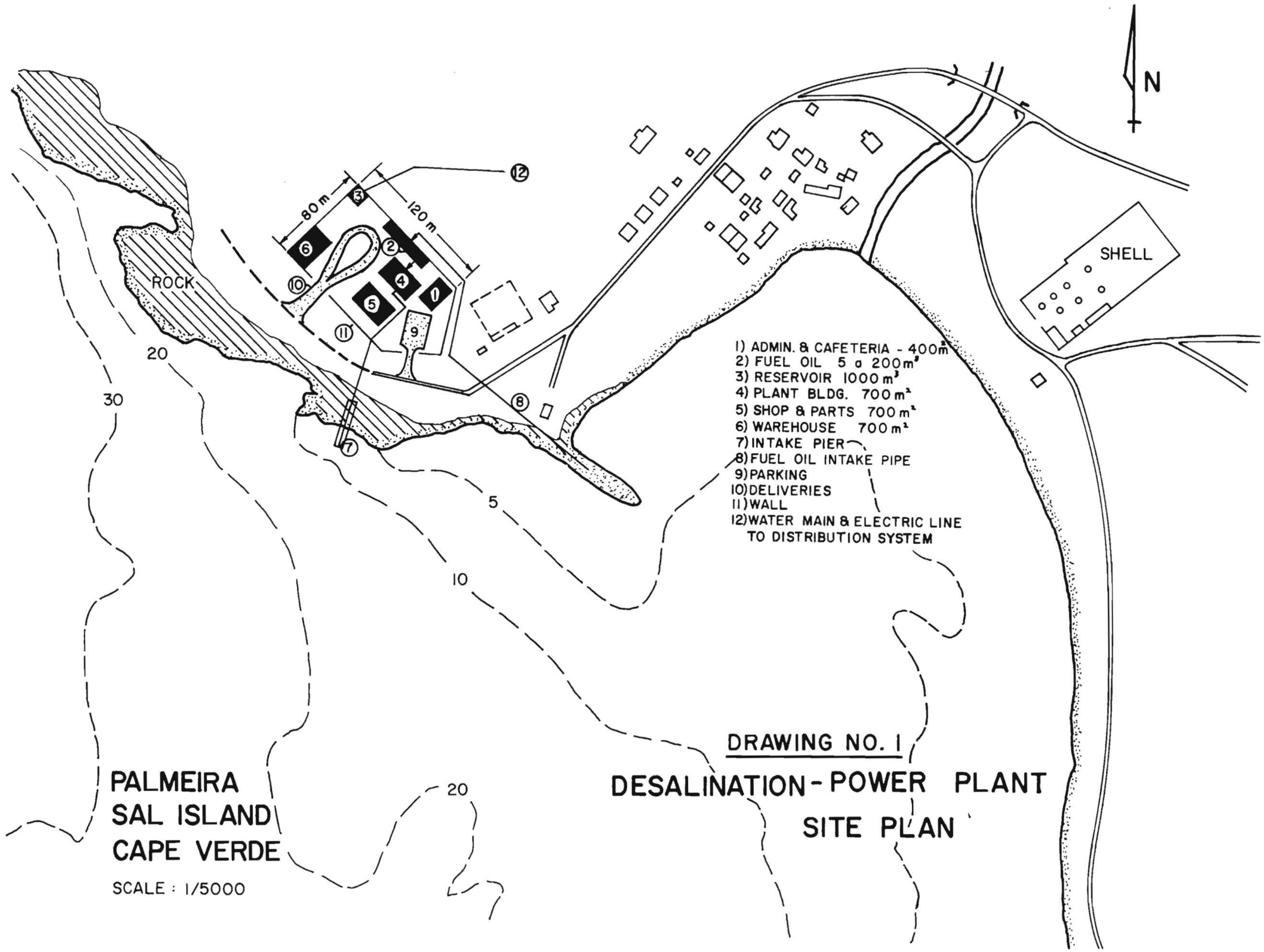
The production facility will contain multiple diesel electric driven, vapor compression type seawater desalination units, administrative buildings and facilities, storage building, warehouses, shops, and other maintenance facilities. The total area of the central plant facility will be approximately 1.5 hectares with associated roads and other paved areas as shown in the proposed site layout drawing of this annex. The main site will contain a fuel oil storage facility which will be replenished through an underground line from the off-loading dock at the Port of Palmeira. Seawater will be supplied to the desalting facility through an underground line from the intake pumps located on a pier 150 meters south of the plant site.

The main transmission lines for water and power will be laid in underground trenches. Water will be pumped to a major high elevation storage tank for gravity distribution to individual head tanks in the major population centers. The water distribution system to individual users also will be underground. High-voltage power from the main transmission lines will be stepped down in voltage at the main distribution points for overhead transmission to individual users.

A complete technical description and engineering data for the proposed water/power plant, along with layout drawings of the plant, site, and power and water distribution systems, are given in the main body of this report.

2. Existing Environment

Sal Island is characterized by sandy, rocky terrain with little or no vegetation. The climate is hot and windy, and there has been virtually no


N
SHELL
ROCK
80 m
120 m
30
20
5
10
20
1) ADMIN. & CAFETERIA - 400m²
2) FUEL OIL 5 a 200m³
3) RESERVOIR 1000 m³
4) PLANT BLDG. 700 m²
5) SHOP & PARTS 700 m²
6) WAREHOUSE 700 m²
7) INTAKE PIER
8) FUEL OIL INTAKE PIPE
9) PARKING
10) DELIVERIES
11) WALL
12) WATER MAIN & ELECTRIC LINE TO DISTRIBUTION SYSTEM
DRAWING NO. 1
DESALINATION - POWER PLANT
SITE PLAN
PALMEIRA
SAL ISLAND
CAPE VERDE
SCALE : 1/5000

rainfall for the past seven to nine years. The island has approximately 8,000 inhabitants, with most of the industrial activity located at the airport and the Pedra Lume salt production facility. All population centers are located on the windward side of the proposed plant site.

Natural water resources are limited to shallow, brackish water (2000-5000 ppm) wells. A small quantity of desalinated water is made available to the general population at a relatively high cost, and it must be carried to the home in small-size containers. Electric power is not generally available in the homes.

The plant site is generally level and situated adjacent to the coastline on the side of the Port of Palmeira. The ocean bottom falls off rapidly to depths greater than 30 meters south and west of the plant site, affording access to clean, relatively cool seawater feed for the plant and easy disposal of warm concentrated brine/cooling water in deep water.

3. Environmental Effects and Analysis of Significance

Desalination/Power Plant. Installation and operation of the plant will have effects on the existing environment in the following areas:

a. Land. Essentially virgin land will be modified for commercial use. The proposed site is a relatively flat area of rock and sand with essentially no vegetation. The land has no known beneficial uses at the present time. It is similar in character to large areas of coastline on the island and has little or no discrete esthetic value in comparison with other similar coastal areas. Commercialization of the general area surrounding the port is already in the planning stage; consequently, installation of the plant will be consistent with anticipated land use in the area.

b. Water. Operation of the water/power plant will require withdrawal of up to 5,343 tons of seawater per day for feed to the desalting plant and for diesel engine cooling. The reject brine from the desalting units will be discharged into the sea. No adverse effects should be anticipated from these emissions. The constant offshore winds will further assure that the emissions will be undetectable over any part of the island.

c. Noise. The primary source of noise will be the diesel engines. The plant building will be designed with high overhead ceilings and sound absorbing linings to keep general plant noise levels below 70 db. Local sources of noise will be suitably insulated to assure a maximum noise level of 90 db at a distance of one meter from the source. Noise levels in adjacent office spaces and other buildings are estimated to be less than 20 db by virtue of the planned layout of the site. Because of the prevailing winds, the noises emanating from the plant should be below the background level in the town of Palmeira and any other inhabited section of the island. Local noise levels in the plant building will be sufficiently high to impact on operating personnel for brief periods during their working day. Suitable ear protection devices will be provided to minimize the effects on operating personnel. No other significant effect is anticipated.

d. Fuel Handling. Whenever fuel is stored, transferred, or otherwise handled, the possibility of spills exists. This possibility is continuous in nature only within the confines of the plant site. The tank farm will be built inside a containment wall so that the total inventory of fuel oil will be confined within the walls in the event that all tanks simultaneously develop ruptures. Minor spills in the plant undoubtedly will occur from time to time, but these will have no adverse effects on the surrounding environment.

Transfer of oil from barges in the port to the tank farm via an underground transfer line will present the possibility of contamination of the dock area and the surrounding water. The transfer line will contain protective check valves to prevent back flow. Operating procedures will emphasize the precautions required to prevent spills and to minimize the effects of equipment failures and personnel errors that would result in oil spills. The fact that such fuel transfers will be made only four or five times per year makes the risks acceptable.

4. Overall Analysis

The beneficial aspects of providing water and power for the population and industry on Sal Island are discussed in the detailed description of the project. Benefits will accrue in raising living standards, reducing health risks, and improving economic conditions on the island. It is concluded from the analysis of environmental effects given above that there will be no significant adverse effects as a result of the construction and operation of the desalination power plant portion of the project as proposed.

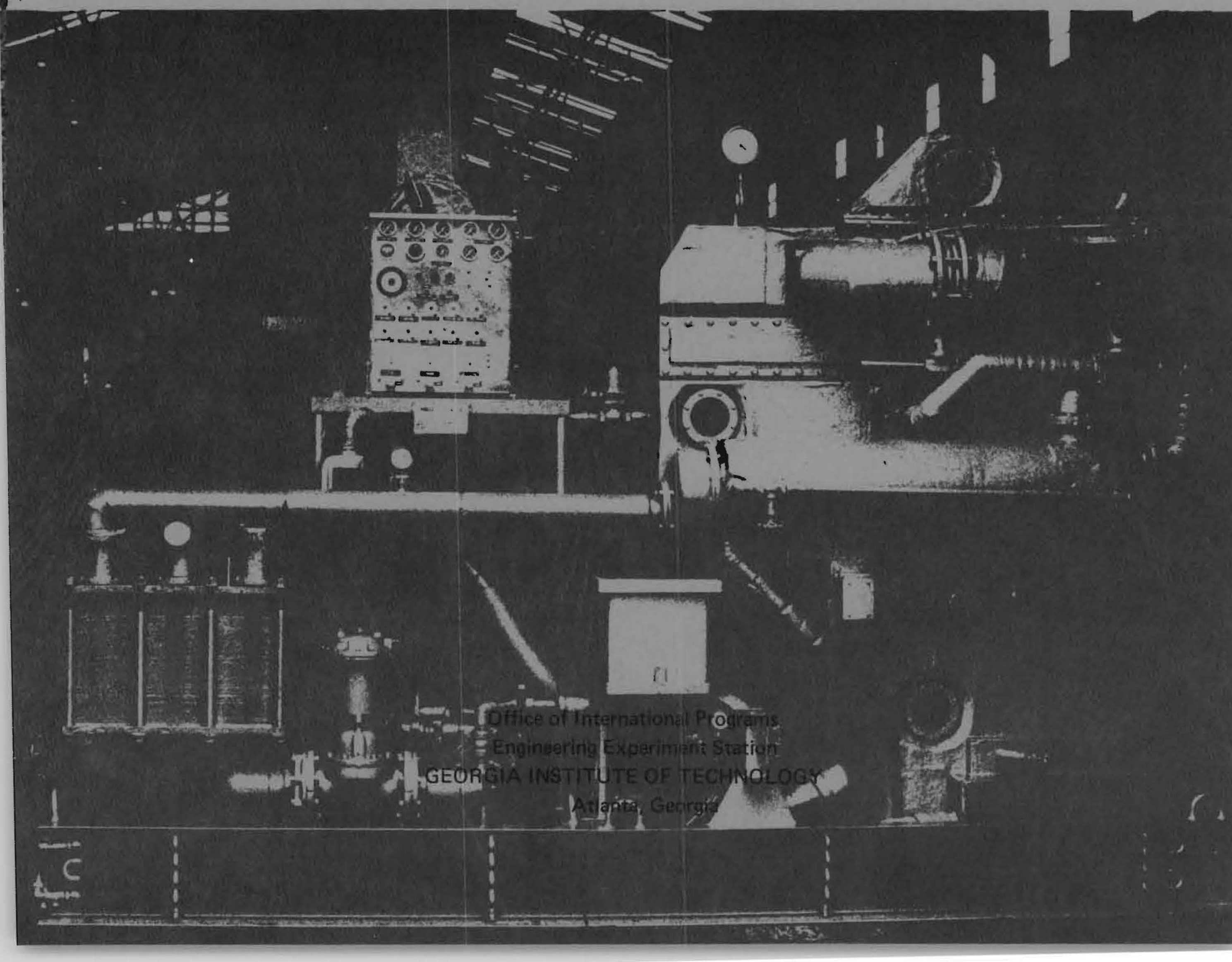
Unclassified

Department of State
Agency for International Development
Washington, D.C. 20523

PROJECT PAPER

CAPE VERDE – DESALINATION AND POWER (SAL)

VOLUME II
Annexes 6, 7, 8, and 9



Office of International Programs
Engineering Experiment Station
GEORGIA INSTITUTE OF TECHNOLOGY
Atlanta, Georgia

Project A-1963

UNCLASSIFIED

DEPARTMENT OF STATE
AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON, D.C. 20523

PROJECT PAPER
CAPE VERDE-DESALINATION AND POWER (SAL)

Proposal and Recommendations
For Review by the
Executive Committee for Project Review

by

Project Analysis Team

VOLUME II

Annexes 6, 7, 8 and 9

Office of International Programs
Engineering Experiment Station
GEORGIA INSTITUTE OF TECHNOLOGY
Atlanta, Georgia
August 1977

Table of Contents

Page

ANNEX 6: TECHNICAL ANALYSIS

A. Technical Analysis 6-3
   1. Potable Water Availability and Consumption 6-3
   2. Groundwater Availability and Consumption 6-6
   3. Projected Water Requirement 6-12
   4. Power Availability and Requirements 6-14
   5. Projected Power Requirement 6-15

B. Water/Power Technical Overview 6-18
   1. Distillation Processes 6-18
   2. Freezing Processes 6-21
   3. Membrane Processes 6-22
   4. Power Generation 6-22
   5. Dual-Purpose Power/Water Production 6-23

C. Technology Proposed 6-24
   1. Desalination/Power Plant Subsystem 6-24
   2. Desalination/Power Plant Subsystem Design 6-28
   3. Water Distribution and Delivery Subsystem 6-39
   4. Power Distribution and Delivery Subsystem 6-42
   5. Training Needs 6-53
   6. Job Descriptions and Suggested Salaries 6-65

* * *

Maps

   1. Cape Verde 6-1
   2. Sal Island 6-2
   3. Cape Verde-Sal Island Existing Water Sources 6-7

Drawings

   1. Cape Verde-Sal Island Proposed Water Distribution System (Schematic) 6-43
   2. Cape Verde-Sal Island Proposed Water Distribution System (Map) 6-44

Page

Drawings (Continued)

3. Proposed 6300V Electrical Distribution Map, Sal Island-Cape Verde 6-55

4. Proposed Single Line Diagram, Sal Island-Cape Verde 6-56

Tables

1. Allocation of Potable Water 6-5

2. Potable Water Expenditures by GOCV and Population, 1977 6-5

3. Water Available to Population, Sal Island 6-11

4. Population Concentration and Water Requirements 6-12

5. Water Requirement Analysis 6-13

6. Electric Power Generation, Sal Island 6-15

7. Reported Power Consumption, 1975-1976 6-15

8. Electric Power Expenditures by GOCV and Population, 1975 6-16

9. Power Requirement Analysis 6-17

10a. Capital Cost: Steam-Electric and MSF, Case IA 6-29

10b. Capital Cost: Steam-Electric and MSF, Case IB 6-30

10c. Capital Cost: Steam-Electric and MSF, Case IC 6-31

10d. Capital Cost: Diesel-Electric and VC, Case IIA 6-32

10e. Capital Cost: Diesel-Electric and VC, Case IIB 6-33

10f. Capital Cost: Diesel-Electric and VC, Case IIC 6-34

11. Water/Power Plant Data Summary 6-35

12. Chemicals and Supplies, Water/Power Plant 6-36

13. Projected Water Distribution and Delivery 6-40

14. Water Distribution and Delivery, Full Production (Case IIB) 6-41

15. Capital Cost Summary: Water Distribution and Delivery 6-45

16. Capital Cost Summary: Power Distribution and Delivery 6-54

17. Present Salary Scale, Almicar Cabral Airport 6-67

18. Proposed Salary Scale, Sal Project 6-68

19. Proposed Indirect Staff, Sal Power and Water Administration 6-69

20. Proposed Direct Staff, Power and Water Plant 6-70

21. Proposed Direct Staff, Power Distribution System 6-71

22. Proposed Direct Staff, Water Distribution System 6-71

Page

Figures

1. Desalination/Power Plant at Santa Maria 6-4
2. Desalination/Power Plant at Almicar Cabral Airport 6-4
3. Poço Verde and Caretaker House 6-8
4. Inside View of Poço Verde 6-8
5. Palmeira Well No. 1 6-9
6. Garden at Palmeira Well No. 1 6-9
7. Typical Water Barrel Used in Transporting Water 6-10
8. 300 m^3/d Once-Through MSF Distillation Plant 6-19
9. 50,000 GPD Vapor Compression Distiller 6-20
10. Multi-Stage Flash Desalination System 6-25
11. Vapor Compression Desalination System 6-26
12. Detail: Typical Reinforced Concrete Pole 6-48
13. Typical Residence Wiring 6-50
14. Floor Plan of Typical Home and Proposed Wiring 6-51

ANNEX 7: FINANCIAL ANALYSIS

Financial Rate of Return 7-1
Financial Plan 7-2
Recurrent Budget Analysis and Organizational Plan 7-7
Training Needs 7-8
Employee Service and Support 7-11

* * *

Tables

1. Project Cash Flow Summary 7-2
2. Financial Plan Summary: Capital Costs, Cases IIB and IIBi 7-3
3. Financial Plan Summary: Annual Operating Costs, Cases IIB and IIBi 7-4
4. Financial Plan Summary: Profit and Loss, Cases IIB and IIBi 7-5
5. Financial Plan Summary: Capital Costs, Wastewater System 7-6
6. Employee Service and Support Summary 7-15

Page

Figures

1. Proposed Organizational Plan, National Water and Power Authority, Republic of Cape Verde 7-9

2. Proposed Organizational Plan, Water and Power Facility, Palmeira, Sal Island 7-10

3. Employee House Floor Plans, Cape Verde-Sal Island 7-12

4. Water/Power Administration Building Floor Plan, Cape Verde-Sal Island-Palmeira 7-13

ANNEX 8: SOCIAL ANALYSIS

1. Historical Overview 8-1

2. Emigration 8-2

3. Population Overview 8-2

4. Income Distribution 8-5

5. Labor Force 8-7

6. Distribution of Time 8-8

7. Health 8-8

8. Medical Services and Health Problems 8-13

9. Implications of Increase in Availability of Water and Power 8-14

* * *

Tables

1. Population Dispersion, Sal Island, 1975 8-3

2. Age Distribution, Sal Island, 1977 8-4

3. Population Distribution by Sex, Sal Island, 1977 8-5

4. Representative Salaries and Wages, Sal Island, 1977 8-6

5. Population Projection, Sal Island 8-7

6. Diseases Related to Deficiencies in Water Supply or Sanitation 8-11

7. Rates of Reduction of Diseases through Provision of Potable Water 8-12

Page

Figures

1. Hypothetical Relations between Village Health and Costs of Water Supply Project 8-10

2. Group of Children, Sal Island 8-15

3. Children Getting Water for the Household 8-15

ANNEX 9: INDUSTRIAL SURVEY AND POTENTIAL INDUSTRIAL ACTIVITIES

Industrial Survey of Sal Island 9-1

Santa Maria 9-1

Espargos 9-7

Pedra Lume 9-8

Palmeira 9-10

Potential Industry Mini Profiles 9-13

Case 1: Production of Block Ice 9-13

Case 2: Production of Domestic Ice Refrigerators 9-16

Case 3: Production of Reconstituted Dry Milk 9-20

* * *

Figures

1. Fishing Vessels, Sal Island 9-3

2. Hotel Morabeza 9-5

3. Salt Pans at Salin du Cap Vert 9-9

4. Small Vessels Used in Transporting Salt out to Be Loaded on Seagoing Ships 9-9

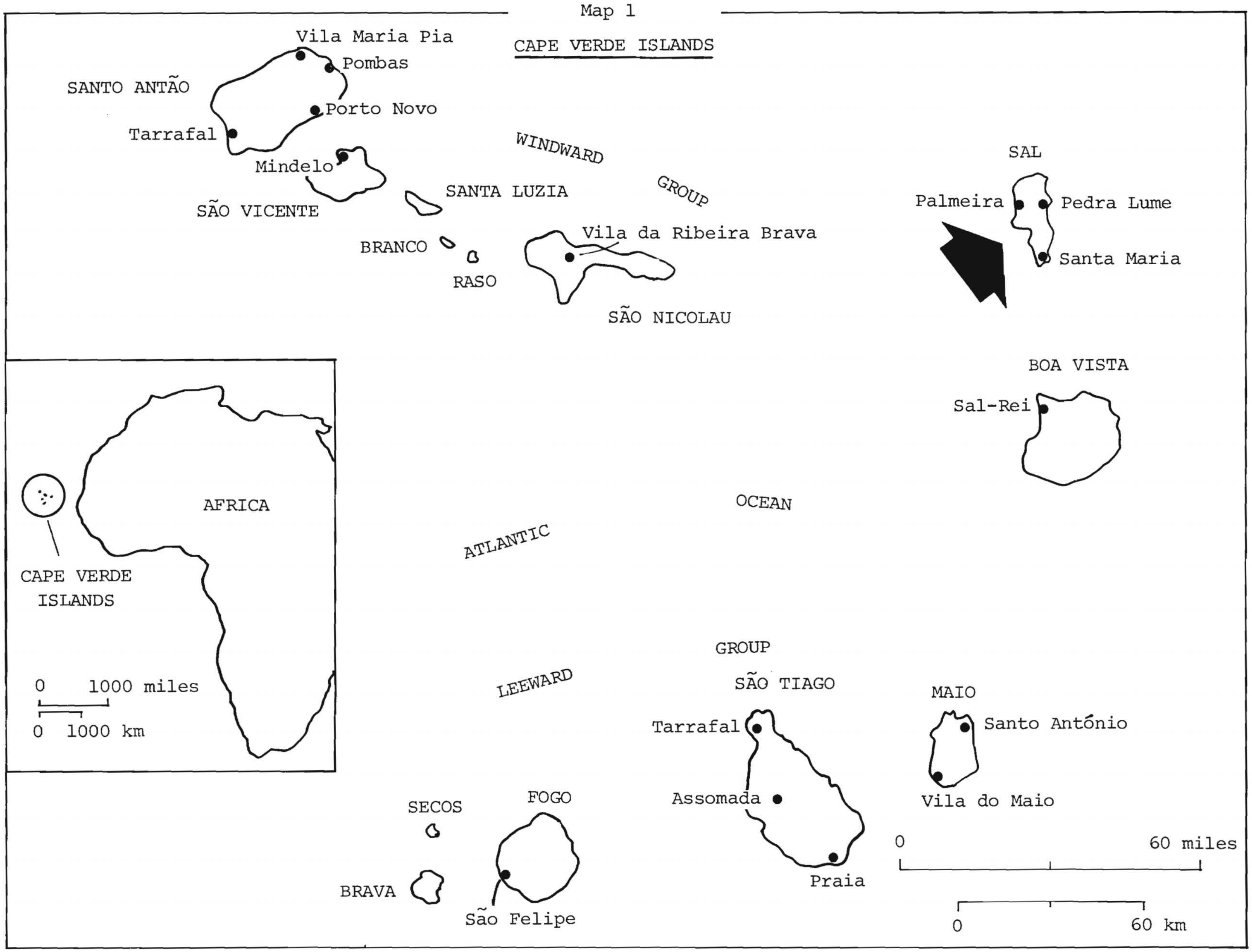
5. Shell Oil Company in Palmeira 9-10

6. Transportation Facilities 9-11

7. Suggested Equipment for Mixing Nonfat Dry Milk with Water or Separated Milk 9-22

Annex 6

TECHNICAL ANALYSIS



Map 1

CAPE VERDE ISLANDS

Map 2

SAL ISLAND

TECHNICAL AND ECONOMIC ANALYSIS

A. Technical Analysis

In the process of conducting the field research for this document, the team was able to determine that the GOCV has had experience in the field of operating water desalination plants and distribution systems. At present, they operate two plants on Sal Island as well as one at Mindelo on São Vicente Island. The past records of these steam plants indicate that their operations have been unreliable, sporadic, undercapacity, and in general, "poor." The plants have suffered from equipment shortages, lack of proper maintenance, and in most cases, lack of appropriate use of chemicals in the operating boilers. In a nutshell, it may be said that the available plants are poorly operated or maintained and the output of potable water is below the capacity of the installed equipment.

There appear to be no major problems in the area of water delivery to households or in metering and bill collection. Thus, it is assumed that the level of general administration is appropriate.

In the area of power generation and distribution, it appears that the generating unit at the airport on Sal Island is operating without difficulty.

The proposed water/power technology is new to the GOCV staff. Extensive training and initial supervision will be required to assure the production outputs indicated in this paper as well as maintenance of the life span of the equipment.

1. Potable Water Availability and Consumption. Present availability of potable water on Sal Island for the existing population is on the order of 11.25 liters per person per day. There are two desalination plants in operation on the island: (a) the Almicar Cabral Airport plant with a capacity of about 40 m^3/day and (b) the Santa Maria plant, which is rated at 90 m^3/d, but at best produces 80 m^3/d. The total output of both plants--120 m^3/d--serves a population of about 8,000 persons plus the local industry, commerce, and government facilities. These plants are pictured in Figures 1 and 2.

The 120 m^3/d produced by the two plants shown in Figures 1 and 2 are distributed as presented in Table 1.

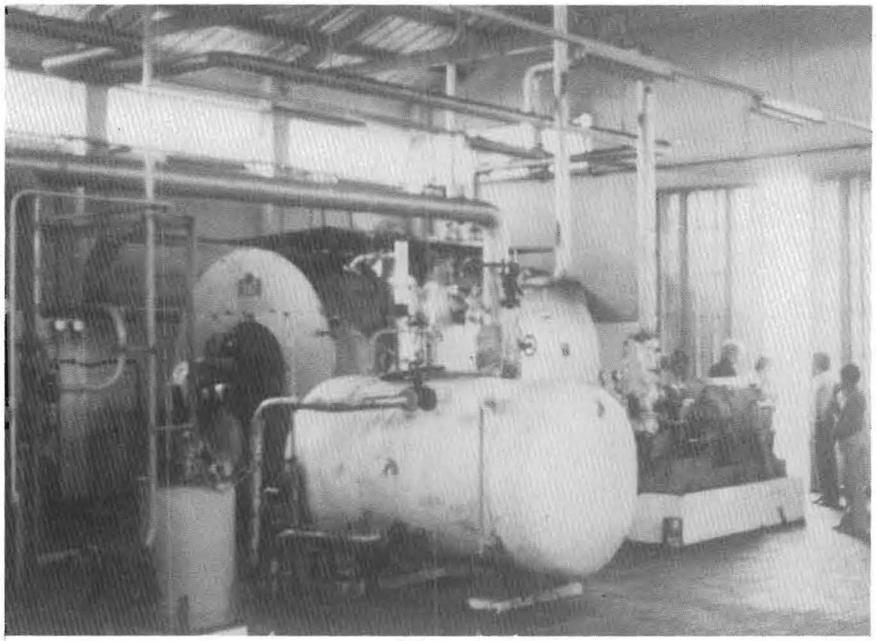


Figure 1

DESALINATION/POWER PLANT AT SANTA MARIA

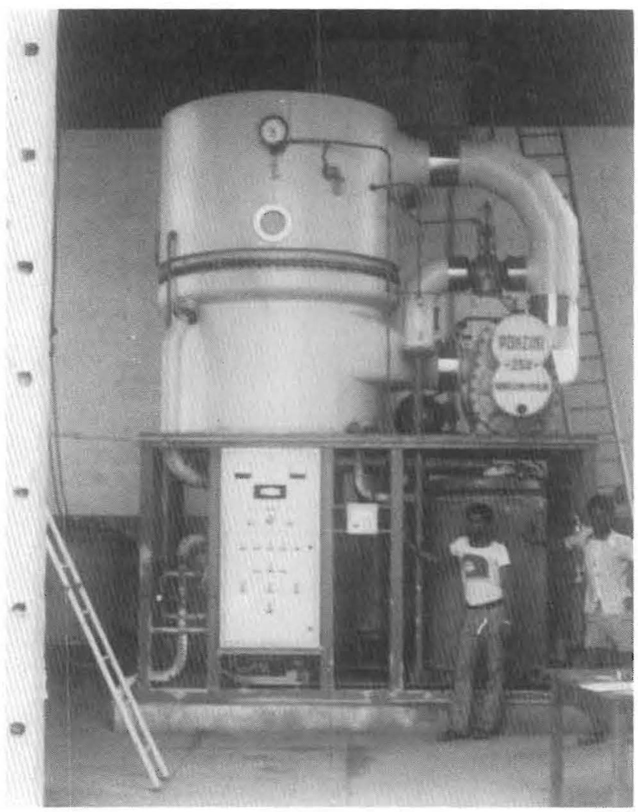


Figure 2

DESALINATION/POWER PLANT AT ALMICAR CABRAL AIRPORT

Table 1

ALLOCATION OF POTABLE WATER

Location	Volume per Day
Palmeira Port Area	6 m^3
Airport Facilities	14 m^3
Hotel Morabeza	10 m^3
Population	90 m^3
Total Potable Water	120 m^3

On the basis of 90 m^3/day to a population of 8,000, the daily per-person average is about 11.25 liters.

The plant at Santa Maria produces water at an estimated cost of \$7.87/m^3 or \$0.787/liter. This water is subsidized by the GOCV and sold to the public at about \$2.52/m^3 or \$0.252/liter. The GOCV then hauls water from these two plants to different locations on the island. No data could be obtained on the production cost of water from the plant at the airport, but it was determined that all pure water from either plant sold for about 80 escudos/m^3 or \$2.52/m^3.

Table 2 recapitulates the availability of pure water and the cost of this product to the GOCV and the population of Sal Island.

Table 2

POTABLE WATER EXPENDITURES BY GOCV AND POPULATION, 1977

	Water Volume (m^3)		Purchased at \$2.52/m^3		GOCV Subsidy at \$5.35/m^3		Total Expenditure at \$7.87/m^3	
Consumer	Daily	Annual	Daily	Annual	Daily	Annual	Daily	Annual
Palmeira Port	6	2,190	15.12	5,518.80	32.10	11,716.50	47.22	17,235.30
Airport Hotel	14	5,110	35.28	12,877.20	74.90	27,338.50	110.18	40,215.70
Morabeza	10	3,650	25.20	9,198.00	53.50	19,527.50	78.70	28,725.50
Population	90	32,850	226.80	82,782.00	481.50	175,747.50	708.30	258,529.50
Total	120	43,800	302.40	110,376.00	642.00	234,330.00	944.40	344,706.00

From Table 2, it is apparent that the population purchases about \$226.80 per day of pure water and it costs the GOCV well over \$230,000 a year to subsidize the production of potable water on Sal Island.

From the on-site survey conducted by the project team and presented in more detail under the title of Social Analysis, Annex 8, it was determined that the households in the sample spent an average of E225.74 per month for water (\$7.10); on a per capita basis, they expended E33.64 per month on water or E1.12 per day (\$0.035). The \$226.80 daily expenditure by the total population of 8,000 for potable water shown in Table 2 gives an average of about \$0.028 per person per day or E0.90 per person per day. Due to the limited population covered by the sample, the project team agreed that the figures presented in Table 2 were possibly more nearly accurate, and they will be used later in this document in establishing the price for water produced by the proposed desalination plant.

2. Groundwater Availability and Consumption. Several wells are on the island, as shown in Map 3. A brief description is presented below.

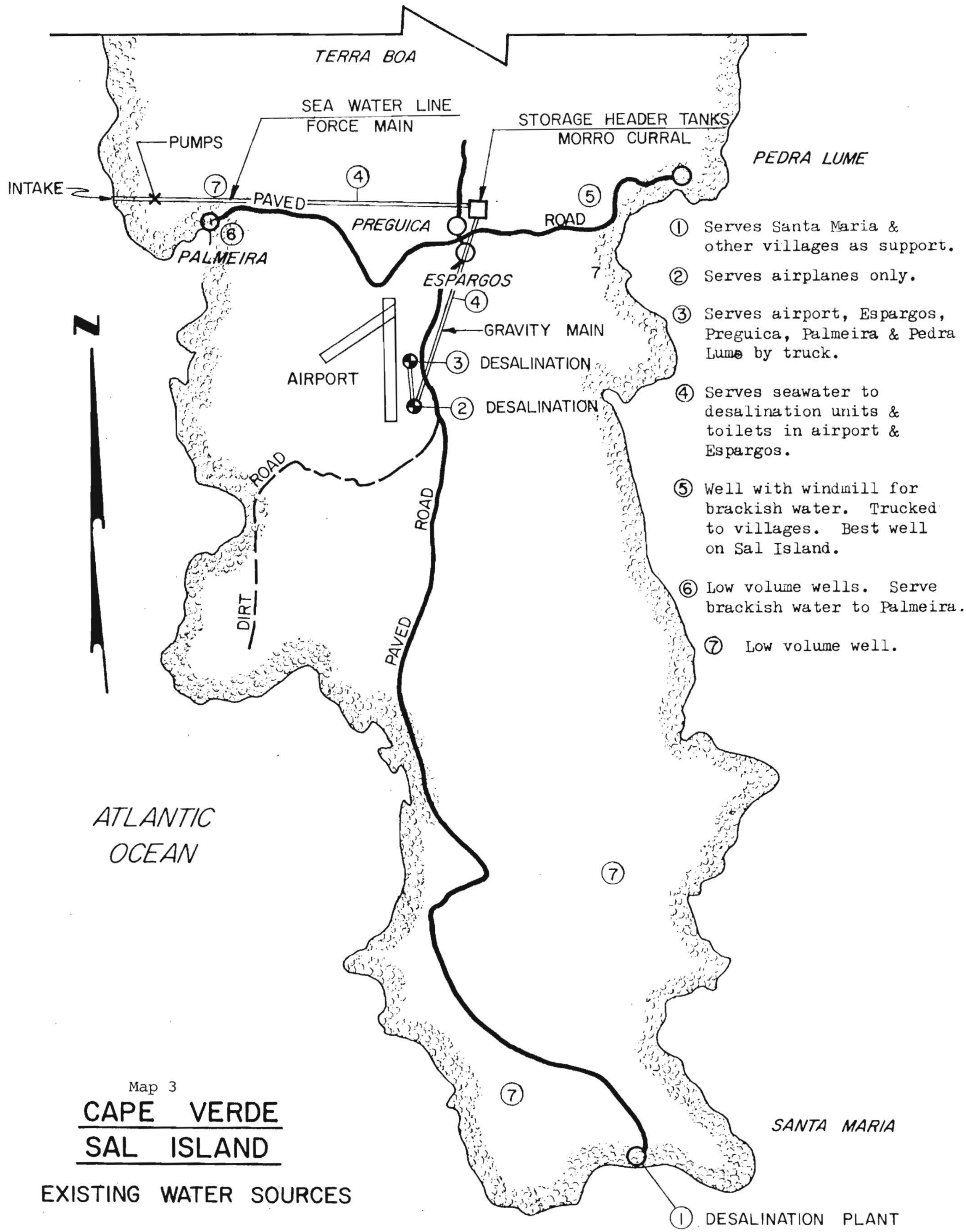
Poço Verde. This well in the area of the community of Preguiça is the best well on the island. It has a depth of about 17 meters and produces between 18 and 25 m^3 per day. There is a caretaker and a windmill to pump the water, which is purchased at well side for about E15/m^3 (\$0.472/m^3). An average of three trucks per day are sent to the nearby communities, and in town the water is sold to the consumer at E75/m^3 (\$2.36/m^3). The water is brackish and is used mostly for washing clothing, cooking, and bathing.

Figures 3 and 4 present the general installation and the inside of Poço Verde.

The caretaker at Poço Verde indicated that about 75% of the average daily production (18.75 m^3) was taken by trucks to be sold in town and he only sold about 25% of the production (6.25 m^3) daily at well side.

Palmeira Well No. 1. This is one of four wells in the area. It is located on the other side of the road to Palmeira at the site of the home of the owner, Mr. Herculano Cotão Andrade. The well is about 12 meters deep and yields some 15 drums (55 liters/drum) of brackish water per day.

The well production of 825 liters (.825 m^3/day) is all used in marginal agriculture. Figures 5 and 6 are of the area around this well.



Map 3

CAPE VERDE
SAL ISLAND

EXISTING WATER SOURCES

Figure 3

POÇO VERDE AND CARETAKER HOUSE

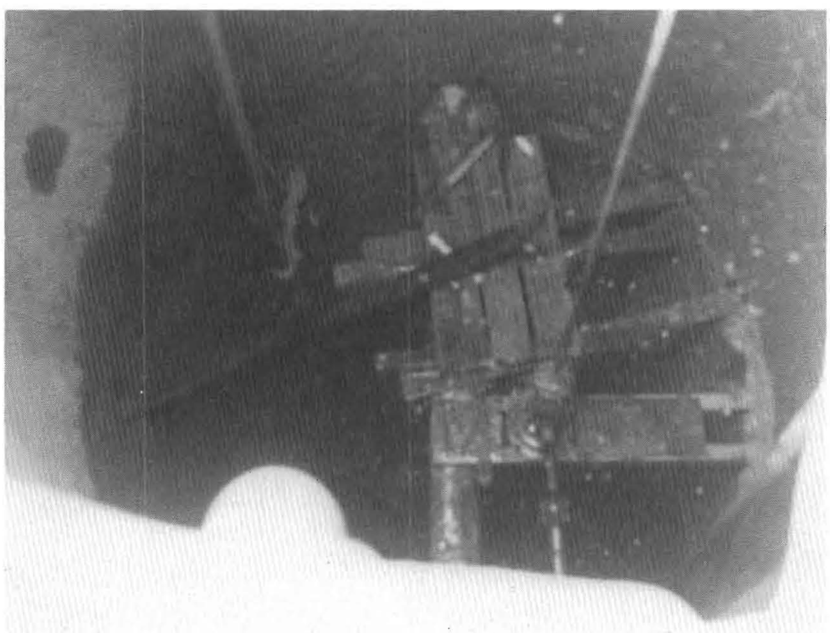


Figure 4

INSIDE VIEW OF POÇO VERDE

Figure 5

PALMEIRA WELL NO. 1

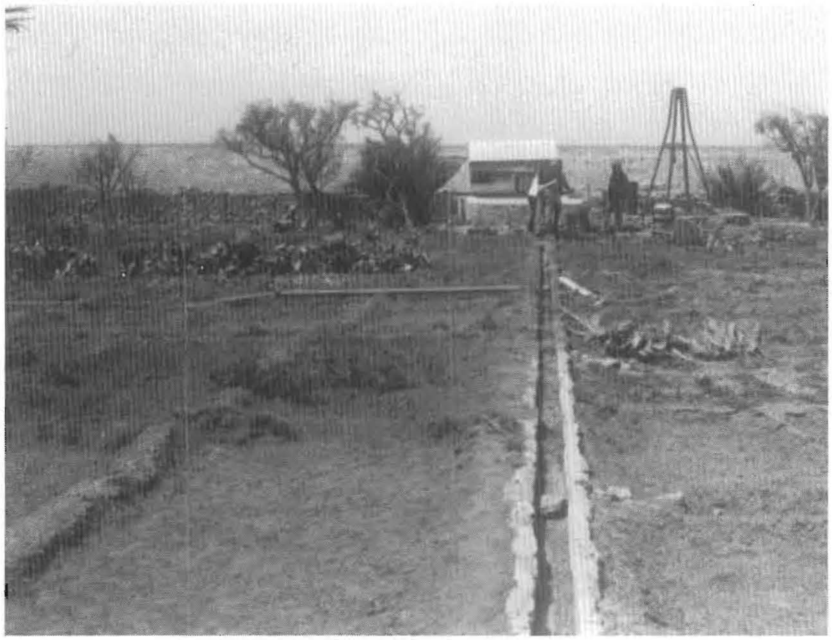


Figure 6

GARDEN AT PALMEIRA WELL NO. 1

Palmeira Well No. 2. This well has nearly sweet water and is used by the population of Palmeira and the three families living around the well. This state-owned well sells water to the population at well side at E50/ barrel of 55 liters--about E0.90/liter or E90/m^3. Each family drains three barrels per day; the balance produced is bought by individuals and hauled to Palmeira using the type of barrels shown in Figure 7. It is estimated that some 20 barrels of 55 liters each are sold per day. Total production, therefore, would be 29 or 30 barrels per day, equivalent to 1.7 m^3 per day.

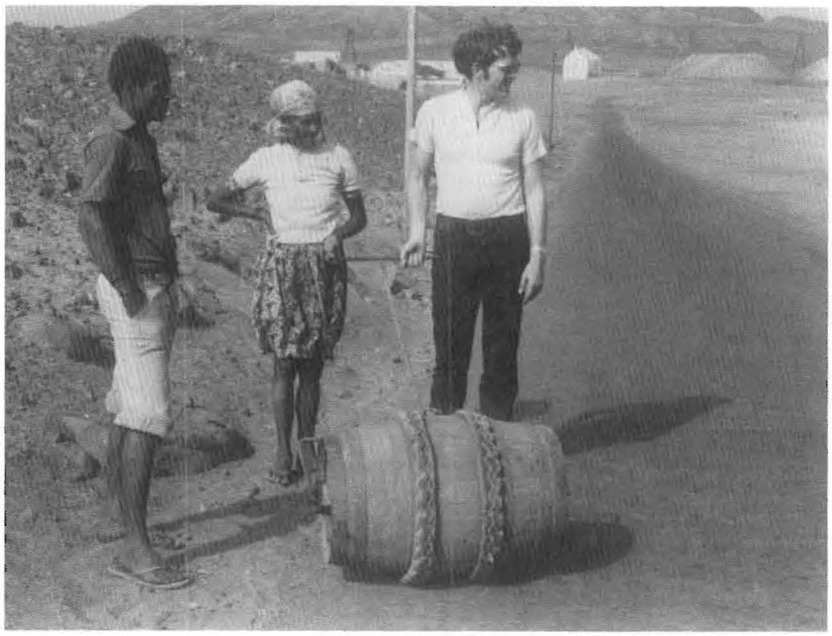


Figure 7

TYPICAL WATER BARREL USED IN TRANSPORTING WATER

Palmeira Well No. 3. This well is close to the Shell tank farm and is used exclusively by the armed forces. The persons interviewed indicated that the water produced is brackish.

Terra Boa Well No. 1. Located on a farm at Terra Boa. This 20-meter-deep well produces brackish water used for irrigation of the small farm. The well is equipped with a windmill and motor.

Terra Boa Well No. 2. Second garden well in the area of Terra Boa producing brackish water used for marginal farming. Well is about 18 meters deep and is equipped with a windmill.

Terra Boa Well No. 3. Privately owned well about 17 meters deep producing brackish water. On Sundays and holidays, some water is sold to local population at well side.

Well Southeast of Preguiça. Small well used for farming but now practically dried out. Water produced was brackish.

Santa Maria Well No. 1. Another privately owned well used for limited agricultural purposes. The well is presently nearly dry. When productive, the water is brackish.

It is apparent from the on-site review that although some nine wells are in existence, only Poço Verde is really productive, providing about 25 m^3 per day, which is consumed by the population. For the purpose of this study, it has been assumed that all other wells produce an equivalent of 25 m^3, which is also consumed by the population, or a total of 50 m^3 per day of available groundwater (brackish).

Table 3 recapitulates the availability and cost of water for the population of Sal Island.

Table 3

WATER AVAILABLE TO POPULATION, SAL ISLAND

Type of Water	Daily Vol. m^3	Unit Price E	Unit Price $	Daily Expense E	Daily Expense $	Yearly Cost E	Yearly Cost $
Pure	90.0	80.00	2.52	7,200.00	226.80	2,628,000.00	82,782.00
Brackish-Well	12.5	15.00	0.48	187.50	6.00	68,437.50	2,190.00
Brackish-Town	37.5	75.00	2.36	2,812.50	88.50	1,026,562.50	32,302.50
Total	140.0			10,200.00	321.30	3,723,000.00	117,274.50

Note: All escudos in this study are calculated at the present rate of 1 dollar = 31.76 escudos.

From Table 3, it is then reasonable to say that the total population of 8,000 persons shares some 140 m^3 of water (both pure and brackish) per day or about 17.5 liters per day, of which 11.25 liters are pure water and 6.25 liters are brackish water. The average unit price from Table 3 would be E72.85/m^3 or about \$2.29/m^3 for the combined pure water and brackish water price.

3. <u>Projected Water Requirements</u>. The GOCV has indicated that it wishes to provide every person on Sal Island with not less than 50 liters of pure water per day for the same amount of money now being spent for water. On the basis of this desire, the population will require 400 m^3 of pure water per day and, if possible, this is to be provided to the people for the same amount of money they now spend on water or less. Present expenditure from Table 3 is about $321.30 per day or about $0.04 per person per day, which is equivalent to E1.27 per person per day.

The island population lives in five communities and is distributed as shown in Table 4, which also presents the desired water allocation for this population.

Table 4

POPULATION CONCENTRATION AND WATER REQUIREMENTS

Community	Population Estimate	Present Water Available (liters) Pure	Brackish	Total	Proposed Water (50 lit/d/person)
Santa Maria	1,500	16,875	9,375	26,250	75,000
Espargos	2,750	30,938	17,188	48,126	137,500
Preguiça	2,750	30,938	17,188	48,126	137,500
Palmeira	600	6,750	3,750	10,500	30,000
Pedra Lume	350	3,938	2,187	6,125	17,500
Total	7,950	89,439	49,688	139,127	397,500

As indicated in Table 4, the GOCV goal of providing each person on Sal Island with a minimum of 50 liters of pure water per day will require a water production level equivalent to 397,500 liters or, in round numbers, 400 m^3 per day.

There are also some projected increases in water needs for expansion of existing industrial or commercial installations as well as for some new projects now being implemented. The industrial and commercial demand is projected at 95,000 liters per day. Table 5 summarizes the present and the

Table 5

WATER REQUIREMENT ANALYSIS

Item	Daily Liters: Pure Water	Daily Liters: Brackish Water	Daily Liters: Total Water	% of Total
A. Current Population				
Santa Maria (1,500)	16,875	9,375	26,250	18.86
Espargos (2,750)	30,938	17,188	48,126	34.60
Preguiça (2,750)	30,938	17,188	48,126	34.60
Palmeira (600)	6,750	3,750	10,500	7.54
Pedra Lume (350)	3,938	2,187	6,125	4.40
Subtotal	89,439	49,688	139,127	100.00
B. Projected Population (50 lit/person/day)				
Santa Maria (1,500)	75,000		75,000	18.86
Espargos (2,750)	137,500		137,500	34.60
Preguiça (2,750)	137,500		137,500	34.60
Palmeira (600)	30,000		30,000	7.54
Pedra Lume (350)	17,500		17,500	4.40
Subtotal	397,500		397,500	100.00
C. Current Industrial and Commercial				
Palmeira Port	6,000		6,000	20.00
Airport (2 jumbo jets/day)	14,000		14,000	46.66
Hotel Morabeza (46 rooms)	10,000		10,000	33.34
Subtotal	30,000		30,000	100.00
D. Projected Industrial and Commercial (as per GOCV)				
Palmeira Port	6,000		6,000	6.31
Airport (6 jumbo jets/day)	42,000		42,000	44.21
Hotel Morabeza (60 rooms)	17,000		17,000	17.89
New Hotel (150 rooms)	30,000		30,000	31.59
Subtotal	95,000		95,000	100.00
E. Summary-Projected				
Population (B)	397,500		397,500	80.71
Ind. and Commercial (D)	95,000		95,000	19.29
Total Projected	492,500		492,500	100.00

anticipated water demand. The total water demand from the proposed desalination plant is established at 492,500 liters per day or, in round numbers, 500 m^3/day. This plant output is over three and one half times the present volume of water available on Sal Island. From years 11 to 40, the water demand is forecasted at about 750 m^3/day.

4. Power Availability and Requirements. Present availability of electric power on Sal Island for the existing population is on the order of about 350.73 KWH/day. Table 6 outlines the present electric power situation.

During the on-site research, it was possible to obtain the power consumption figures for 1975 and the first two quarters of 1976 as reported by the airport facility and the Santa Maria facility. Table 7 recapitulates these data for 1975 and the first half of 1976.

The present cost of producing this power ranges upward from about \$0.142 KWH at the airport facility to \$0.22 KWH at other less-efficient installations. This power is sold at about \$0.188 KWH to industrial/commercial enterprises, \$0.135 to the government installations, and at about \$0.142 to domestic consumers. Table 8 presents the expenditures by GOCV and inhabitants of Sal Island on electric power.

The overall average price for power as shown in Table 8 is equivalent to \$0.142 per KWH or E4.52, and the GOCV apparently is making a small profit equivalent to \$0.007 per KWH.

The project team was told by a government representative that on Mindelo the average household pays E150 per month for power. This information is in conflict with the data gathered in the survey. According to the random samples taken, the average household pays about E252 per month. (See Annex 8, "Social Analysis.") Assuming that the given figure of E150 for power per month per household is correct, then on the basis of E4.52/KWH, the average household today is using about 33.18 KWH per month. Applying this to the total domestic monthly consumption of 10,667 KWH, based on the 1975 figures (Table 7), this means there are 320 homes using power on the island.

5. Projected Power Requirement. The GOCV has indicated that it wishes to provide every household on Sal Island with between 100 and 200 KWH of electric power per month. It also indicated that the power bill should not be more than E150 a month, which is what the government claims each household

Table 6

ELECTRIC POWER GENERATION, SAL ISLAND

Location	Electric Power Generating Equipment	Installed Capacity
Airport	Two 440 KW generators (only one in operation)	880 KW
	One standby generator for landing strip and emergency, 150 KW	150 KW
	One additional 440 KW generator on order-not delivered	
Pedra Lume	Two generators, each rated at 150 KW	300 KW
	One standby generator at 100 KW	100 KW
Santa Maria	One 90 KW generator using 25 KW internal operation	65 KW
Morabeza	One 20 KW generator for use of the hotel	20 KW
Palmeira	Two 250 KW generators at Shell tank farm for their internal use	500 KW
	Total	2,015 KW

Table 7

REPORTED POWER CONSUMPTION, 1975-1976
(in kilowatt-hours)

	Industry & Commerce	Gov't., Airport, Illumination	Domestic	Total
1975				
1st Quarter	78,756	419,765	28,189	526,710
2nd Quarter	74,743	433,384	29,683	537,810
3rd Quarter	56,295	426,817	34,778	517,890
4th Quarter	53,761	362,445	35,364	451,570
Total	263,555	1,642,411	128,014	2,033,980
1976				
1st Quarter	79,961	349,765	33,534	463,260
2nd Quarter	106,530	327,038	34,102	467,670
Total	186,491	676,803	67,636	930,930

Table 8

ELECTRIC POWER EXPENDITURES BY
GOCV AND POPULATION, 1975

	Industry & Commerce	Government	Domestic	Total
KWH Used				
Monthly	21,962	136,867	10,667	169,496
Yearly	263,544	1,642,404	128,004	2,033,952
Sales Price per KWH				
Escudos	6.00	4.28	4.50	
Dollars	0.188	0.135	0.142	
Monthly Bill				
Escudos	131,772	585,791	48,001	765,564
Dollars	4,129	18,477	1,515	24,121
Yearly Bill				
Escudos	1,581,264	7,029,489	576,018	9,186,771
Dollars	49,546	221,725	18,177	289,448

now spends on an average per month. To provide every household on the island with a minimum of 100 KWH per month, the following amount of additional power would be needed:

300 households (presently using 33.18 KWH/mo.) need 66.82 KWH/mo. additional power to reach 100 KWH/mo.	20,046 KWH/mo.
1,000 households (no power at present) need 100 KWH/mo.	100,000 KWH/mo.
Total estimated additional power needed for domestic use	120,046 KWH/mo.

This is equivalent to 4,001 KWH/day in addition to other present consumption.

The GOCV also plans or is implementing projects to expand or establish new governmental, industrial, and commercial activities requiring additional electrical power. The total demand, current plus projected increase, that the proposed power generating plant will need to supply is about 14,865 KWH per day, as shown in Table 9. Thus, implementation of this project will increase the amount of electric power available by a factor of 2.9.

Table 9

POWER REQUIREMENT ANALYSIS

Item	Daily KWH	% of Total
A. Current Consumption (1976)		
Domestic	370.60	7.27
Government, Airport and Illumination	3,708.50	72.70
Industrial and Commercial	1,021.86	20.03
Subtotal	5,100.96	100.00
B. Projected Domestic		
300 Houses at 66.82 KWH/mo.	668.19	15.28
1,000 Houses at 100 KWH/mo.	3,333.33	76.24
Present Domestic	370.60	8.48
Subtotal	4,372.12	100.00
C. Projected Government, etc.		
Future Growth	2,166.67	36.88
Present	3,708.50	63.12
Subtotal	5,875.17	100.00
D. Projected Industry and Commerce		
New or Expansion		
Morabeza Hotel	120.00	2.59
New Hotel	360.00	7.79
Pedra Lume	700.00	15.16
Lobster Plant	250.00	5.42
Others - Not Identified	2,166.67	46.92
Present	1,021.86	22.12
Subtotal	4,618.53	100.00
E. Summary Projected Power Requirements (B + C + D)		
Domestic	4,372.12	29.41
Government, Airport, and Illumination	5,875.17	39.52
Industrial and Commercial	4,618.53	31.07
Total	14,865.82	100.00

B. Water/Power Technical Overview

Over the past 25 years, significant advances have been made in distillation, freezing, and membrane technology for both sea and brackish water desalination. However, although some newer processes project potentially better overall economics for a given situation, only commercially proven equipment should be considered viable for use by developing nations. The general state of the art is discussed below to give some indication of the alternatives considered in arriving at the technology proposed for this project.

1. Distillation Processes. In the commercial market, the oldest desalination technology involves evaporation or distillation type processes. Single, double, and triple effect submerged-tube seawater evaporators came into large-scale use for seagoing vessels during World War II. Heat-transfer coefficients were low and scale formation was a constant problem. The postwar period saw the introduction of multi-stage flash distillation (MSF), which has now almost completely replaced submerged-tube evaporators for large-scale distillation. A typical installation is presented as Figure 8.

At the present time, a 2-5 MGD plant can be constructed and placed in operation at the user's site for about $3.50 per daily gallon in the continental U.S.A., somewhat more in the Virgin Islands and Puerto Rico, and up to $6.00 per daily gallon in Saudi Arabia. This is for a plant with a nominal performance ratio of 10 pounds of product water per pound of steam.

Vapor compression distillation (VC) is a process used throughout the world for smaller demands and is second, in number of units, only to MSF. Specific energy requirements for this process are very low, but its full potential has never been exploited in large-scale land-based desalting. The mechanical energy of a vapor compressor is used, thus eliminating the need for a boiler to produce steam. With recent fuel cost escalations, VC's high process efficiency is attractive enough to promote the development of larger, more efficient and reliable vapor compressors. The growing market for medium-size (up to 900 m^3/d) vapor compression plants is spurring the industry to accelerated efforts in this area. Capital costs range between $3.00 and $4.00 per GPD, FOB vendor's plant. A representative installation appears as Figure 9 of this document.

Over the past 12 years, the continuing refinement of the multiple-effect, vertical-tube, falling-film (VTME) process also promises lower specific

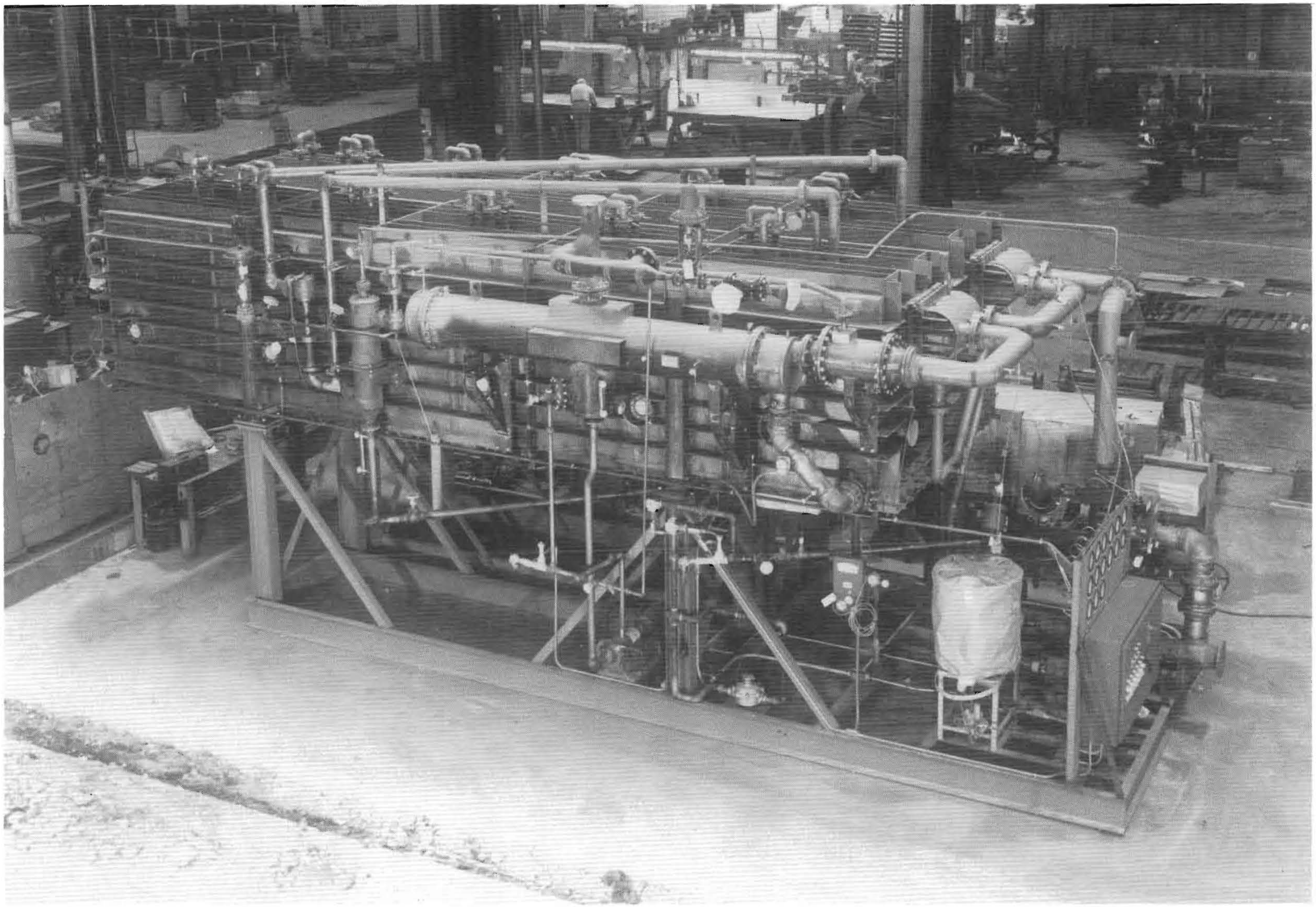


Figure 8

300 M^3/D ONCE-THROUGH MSF DISTILLATION PLANT
(Performance ratio about 6 kg distillate/16 steam)

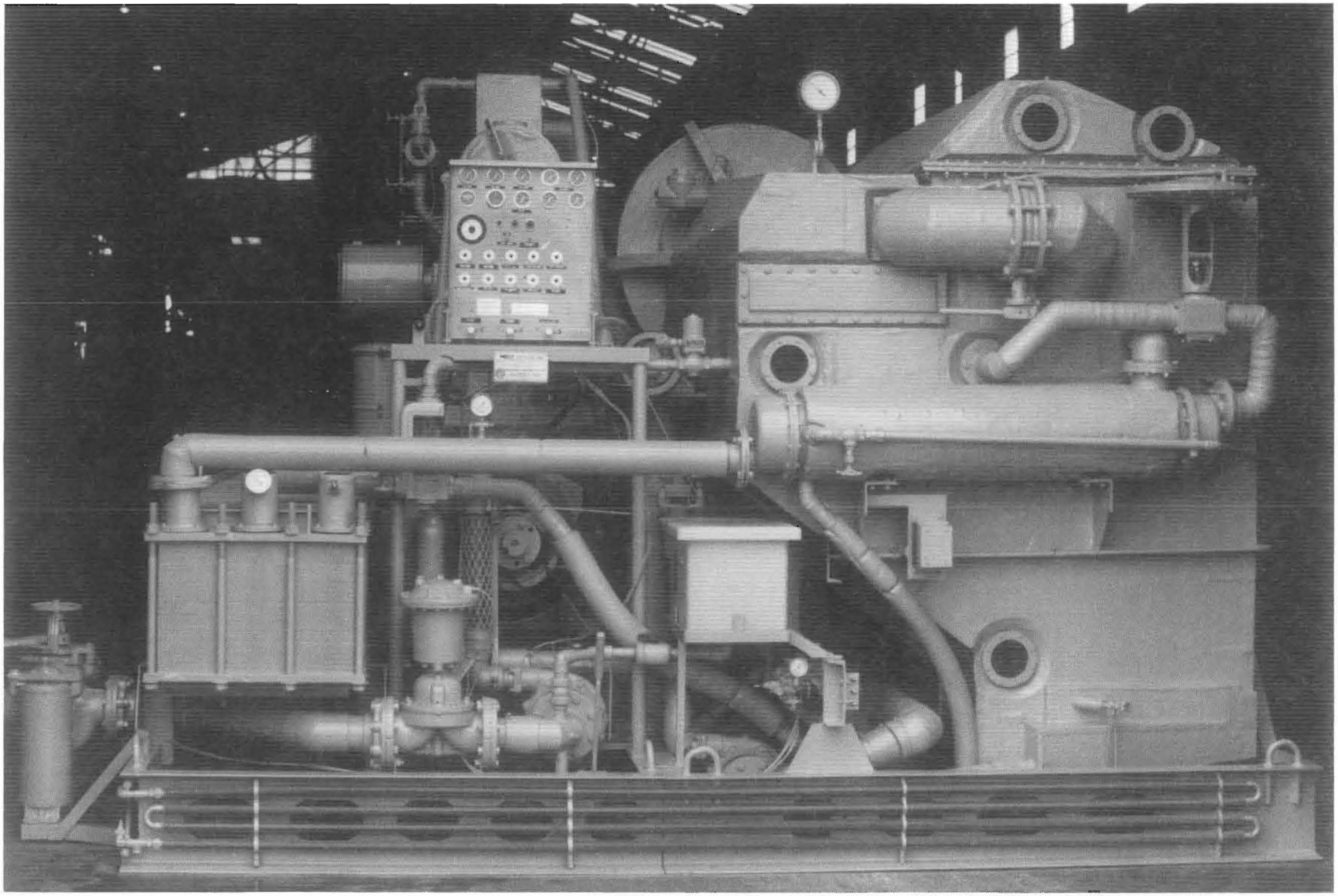


Figure 9

50,000 GPD VAPOR COMPRESSION DISTILLER

energy consumption per unit of capital cost. However, it is not yet widely accepted commercially. A few enhanced-tube VTME plants have been constructed, notably in the Virgin Islands and the U.S.S.R. The process is new enough so that design errors are still being made. Capital and operating costs are still expected to be lower than MSF. The plants are considered to be very stable in operation and reliable. In large plants (above 20,000 m^3/d), overall costs are projected to be as much as 20% lower than MSF. The margin diminishes at lower capacities. Performance ratios up to 15 to 1 are attainable, if so dictated by fuel costs.

The combination of the vapor compression cycle with the vertical-tube evaporator (VC/VTME) has been explored in the conceptual design stage and because of its very high energy efficiency could well be the preferred distillation-type plant in the not too distant future. Increased market demand and continued escalation in fuel costs could be the controlling factors in accelerating commercial acceptance.

Similar in overall concept to the VTME multiple-effect design is the newer horizontal-tube multiple-effect distillation process (HTME). Because of its flexibility, this process has good potential for dual-purpose power/water plants in the future, although commercial experience is limited at this time.

The inherent advantage of solar distillation is its ability to use radiation from the sun as a free source of energy. In the simplest form, solar distillation systems use a black-bottomed shallow basin filled with saline water, covered with transparent material, vapor sealed and fully insulated to minimize heat loss to the surroundings. Under ideal conditions, such a still can produce up to 50 tons per hectare per day. Capital costs of approximately \$40/m^2 are estimated, bringing the installed cost of a 500 t/d unit up to \$4,228,000. However, maintenance costs are unpredictable and there is no experience with installations larger than 50 t/d.

2. Freezing Processes. Freeze-desalting processes are based on the fact that individual ice crystals formed in the partial freezing of a saline water feed completely reject salt and can be melted to form pure water after separation from the salt brine. From an energy standpoint, freezing processes are superior to distillation in that only 15% of the energy transfer required to produce a pound of steam is required to produce a pound of ice. However,

these processes are less well developed at this time and their full commercial potential has not yet been realized.

Projections indicate capital costs in the range of $3.00 a gallon in large sizes (5 MGD), with a power consumption of about 40 KWH per 1,000 gallons of product water.

3. Membrane Processes. The first successful membrane desalting plants were based on the electrodialysis (ED) process, which selectively removes salts from saline solution in their ionic form. In general, power consumption is directly proportional to the ionic content (salinity) of the feed water. Commercial applications, therefore, have been for treatment of brackish waters with relatively low salinity. Currently, two-stage ED plants are successfully desalting seawater in pilot plant tests, and further improvements could bring this process to the commercial market for seawater desalting in the future.

Reverse osmosis (RO) is the newest development in desalting which can be classified as commercialized. Presently, the worldwide capacity in brackish water desalting is growing rapidly. An expanding market and a highly competitive industry should assure the long-term viability of RO for brackish water desalting. Energy costs, as for ED, are generally proportional to the salinity of the reject brine. Only pressure energy is required, since there is no phase change or electrically induced ion movement. However, careful attention to feed pretreatment is necessary to prevent membrane fouling and deterioration, and its application for seawater desalting is not yet fully commercialized.

Capital costs for each process on seawater are projected to be $2.00 to $3.00 per daily gallon for the basic plant.

4. Power Generation. With the rapidly increasing cost of fossil fuels, it has become popular to consider solar, geothermal, and wind energy for both power generation and special desalination applications. While progress in their development is being made, the equipment currently available must be considered experimental. Power production from these energy sources, therefore, was dropped from further consideration for this project. Given the logistics problems for the Republic of Cape Verde and the lack of local fuel resources, only oil could be considered as a viable source of energy, despite its delivered cost.

Power cycles considered were limited to medium-pressure steam turbine generators (with exhaust steam for desalination) and diesel power generation. Gross comparisons between the steam turbine cycle and the diesel cycle normally would indicate a preference for the diesel plant in power-only production. The nominal heat rate (based on fuel input) for small-capacity, medium-pressure steam turbine generating plants is approximately 15,000 Btu/KWH as compared with 10,000 Btu/KWH required by a diesel generator. Even with relatively inefficient back-pressure turbines, capital costs of basic equipment (boilers and turbo-generators vs. diesel generators) show the steam system some 25% higher at the 2-2.5 MW level.

5. Dual-Purpose Power/Water Production. There are three basic scheme combinations which can be considered as having synergistic possibilities for energy cost reduction:

(i) steam power production, with turbine exhaust steam condensed by, and therefore supplying heat to, MSF or ME distillation plants

(ii) diesel power production, with electrically driven vapor compression distillation

(iii) diesel power production, with vapor-phase waste heat recovery supplying heat to MSF or ME distillation plants

Site and labor sharing is, of course, a common benefit.

The last scheme is the most economical because distillation heat energy supply is essentially free. However, even with optimum distillation technology, no more than 0.018 m^3 of water per KWH of generator output would be obtainable (vs. the 0.03 m^3/KWH required for the lowest water/power case studied for Sal). Therefore, this approach had to be discarded.

The water/power cycle most applicable to the particular requirements for Sal then had to be determined through detailed comparative analyses of the steam/MSF and diesel/VC schemes, based on the best water/power demand information available.

C. Technology Proposed

1. Desalination/Power Plant Subsystem. For reasons of long operating experience, the only desalting technology recommended for consideration is either:

- once-through MSF, with maximum temperature about $95^{\circ}C$ - $100^{\circ}C$, or
- single-effect VC, with maximum temperature about $95^{\circ}C$ - $100^{\circ}C$

Seawater pretreatment with continuous acid injection can permit higher temperatures (allowing greater energy economy in some cases) or long periods without cleaning. However, due to its history of corrosion damage, the problem of supply and price uncertainty, plus potential personnel hazards, acid treatment is definitely not recommended.

The two basic water/power cases considered in this study are as follows:

Case I - a medium-pressure boiler, supplying a back-pressure steam turbine for power generation, and a multi-stage flash (MSF) desalination system operating on exhaust steam from the turbine (Figure 10)

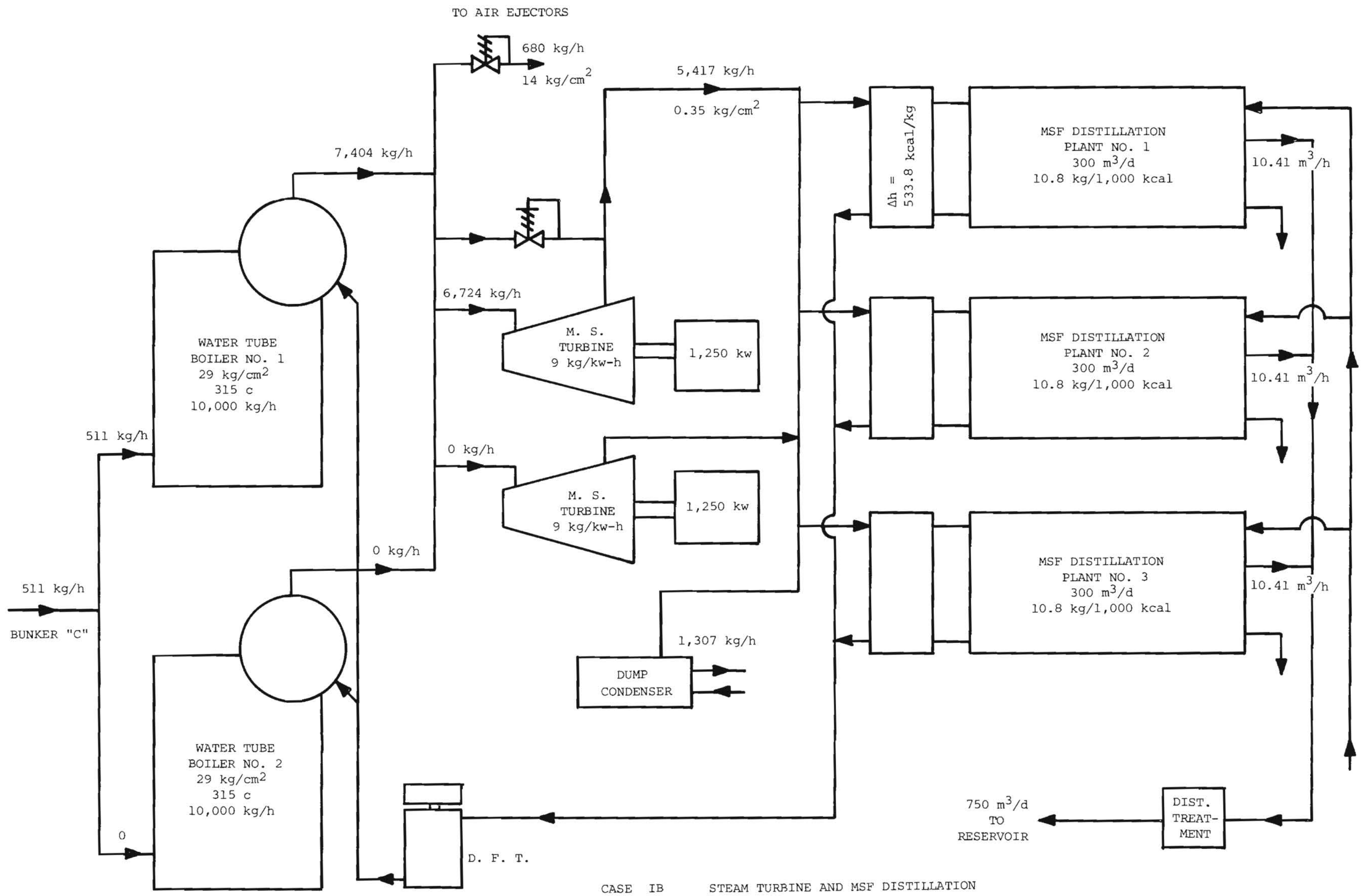
Case II - diesel engine power generation with an electrically driven vapor compression (VC) desalination system (Figure 11)

To compare these two cases in light of the flexibility desired for future expansion, three different water/power demand situations were defined and complete cost estimates were developed for each. On the basis of costs alone, diesel electric/vapor compression desalting is clearly preferable. Even if the cost advantage had not been so pronounced, the operational flexibility of the diesel/VC system would have been a significant factor favoring the choice of this system.

The water/power demand situations studied were as follows:

Subcase A This subcase was based on the project team's best estimate of firm water/power demand at completion of the project assuming commercial projects now in the active planning stage are actually completed. The estimated external consumption under these conditions was 500 m^3/d of water and 14,000 KWH/d of electricity.

Subcase B It was assumed that water demand could increase through greater individual use from 50 to 75 lpd, given a reasonably



CASE IB STEAM TURBINE AND MSF DISTILLATION

Figure 10

MULTI-STAGE FLASH DESALINATION SYSTEM

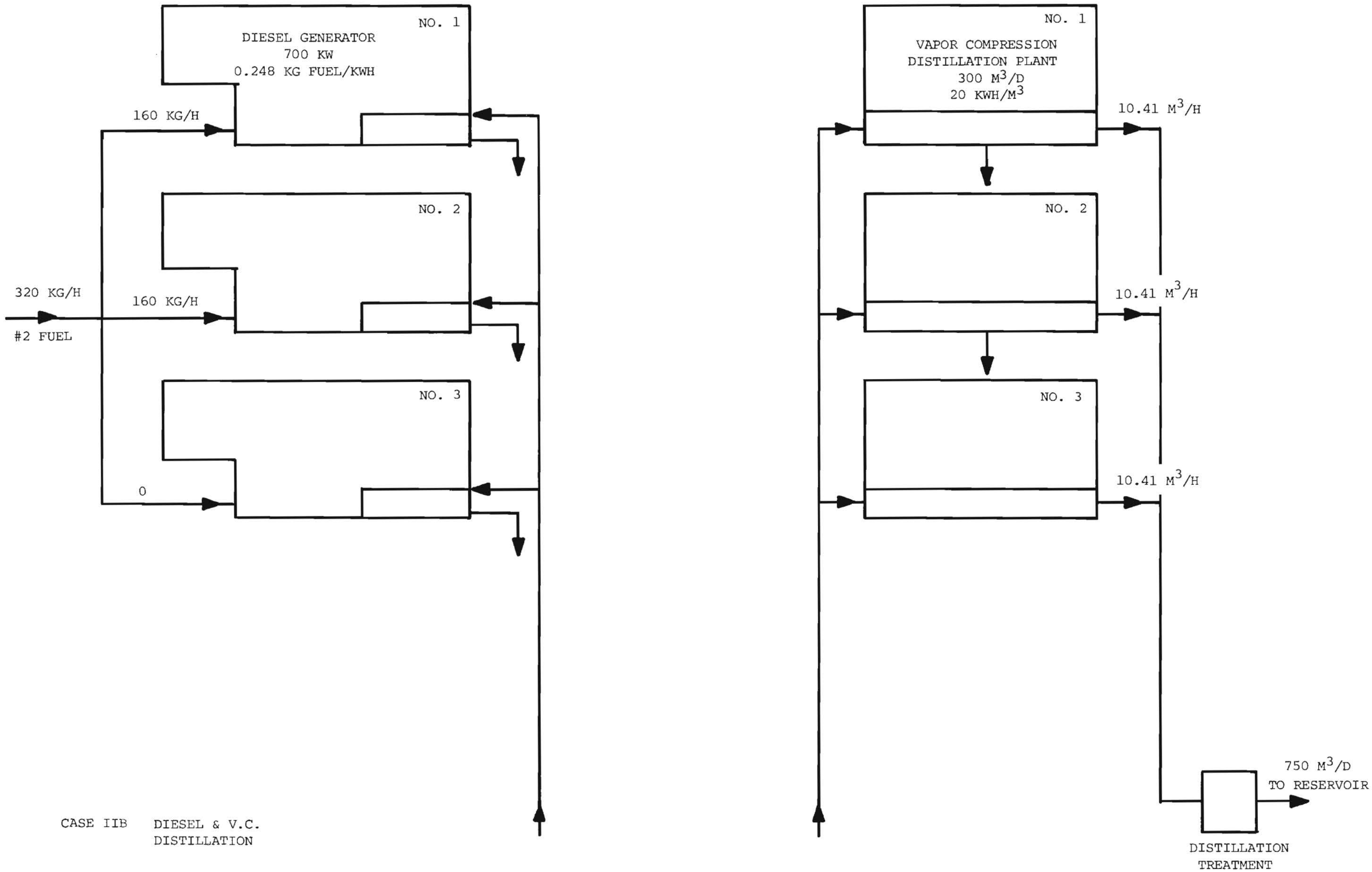


Figure 11

VAPOR COMPRESSION DESALINATION SYSTEM

low cost of production and, therefore, selling price. Because of practical limits on purchasing power, no significant use of electrical appliances could be predicted. External demand, therefore, was set at 750 m^3/d of water and 14,000 KWH/d of electricity.

Subcase C. This subcase was developed to evaluate the effect on production costs should water demand again rise at an unspecified future time to 1000 m^3/d. Again, power demand was considered to be relatively inflexible and was estimated to remain at 14,000 KWH/d for production cost estimating.

It should be noted that the installed capacity for power generation in all cases was set at a sufficiently high level to allow for redundancy.

Suboptimum Scheme - Case I. In analyzing Case IA (dual-purpose steam and MSF), it becomes evident that the optimum dual-purpose plant can only obtain under a baseload condition. The Sal Island project does not meet this criterion since the new water/power plant will be the total system and will be required to react to total system demand.

Secondly, with rising water demand (Cases IB and IC), the installation of more water capacity will "de-optimize" the system. The added inflexibility of this dual-purpose system becomes quite evident.

For example, a typical daily power demand curve is shown in Appendix 6. Since turbine steam flow is directly proportional to the power output, it is evident that the exhaust steam available to the MSF desalting plant could fluctuate widely over a 24-hour period. An MSF plant cannot operate effectively with a fluctuating steam supply. (The multiple-effect (ME) processes are more flexible in this particular regard, but as referred to earlier, were excluded from consideration because currently commercialized designs do not have the extensive operating experience of MSF.) Provisions, therefore, were included in the conceptual design to pass excess exhaust steam to a dump condenser or to provide additional steam as required directly from the boiler.

In either case, the overall efficiency of the system is adversely affected, and, therefore, a true dual-purpose water/power system does not meet the demand conditions for Sal Island.

Optimum Scheme - Case II. In the diesel electric/vapor compression desalination scheme, water and power production are not only independent, but each is individually the most economical of energy use.

On the other hand, the Case I system supplies the MSF plants with low-cost heat from the turbine generator exhaust, while the vapor compression plant requires relatively high-cost electrical energy. Also, diesel fuel (gas oil currently estimated at $155.00 per ton) is almost 50% more expensive than the bunker 'C' fuel oil ($110.00 per ton) usable in boilers.

Thus, the choice of technology to be recommended for Sal Island was by no means obvious. A complete cost comparison for each case studied at the several water/power demand situations is included as Tables 10 a, b, c, d, e, and f. Tables 11 and 12 present the chemicals and supplies required in each case.

It may be seen that at the estimated demand in all subcases, the diesel electric/vapor compression desalination system (Case II) is the lowest-cost system from both capital and operating cost standpoints. However, under any forseeable circumstance, the total water/power production costs are the lowest for Case II.

Subjectively, the Cape Verdians are historically much more familiar with diesel engines (motor vehicles and boats) than with boilers and steam turbines. Therefore, the operational skills required to keep the plant operating efficiently are more easily obtainable for a diesel installation. In fact, power generation at the port city of Mindelo is by diesel engine. The GOCV has also indicated a preference for diesel power on Sal Island; it also can point to very successful operation of two vapor compression desalination plants at the airport on Sal Island. These factors, combined with lower costs and expansion flexibility, led to the choice of the Case II system for this project.

2. Desalination/Power Plant Subsystem Design (see Figure 11). The principal elements of the Case IIB design are as follows:

(a) 3 each 700 KW diesel generators
(Typical: Fairbanks-Morse, Model 38 $D^1/8$)
Fuel - gas oil, HV 10,960 kcal/kg
S.G. 60/60F 0.825

Table 10a

CAPITAL COST
STEAM-ELECTRIC AND MSF
CASE IA

Items	Cost ($) AID	Cost ($) GOCV	% AID	% GOCV
Equipment - CIF Mindelo				
2 ea. WT boilers, 29 kg/cm^2, 316°C, 11.4 t/h, c/w deaerator and feed system	385,000	-	100	-
2 ea. turbo-generators, 1250 KW	391,000	-	100	-
2 ea. once-thru MSF distribution plants, 300 t/d, PR 5.5	715,000	-	100	-
3 ea. 50% intake pumps, screens & chlorination	19,500	-	100	-
Maintenance and lab. equipment	175,000	-	100	-
Remote instrumentation	20,000	-	100	-
Chemical feeding equipment	5,000	-	100	-
Facility switchgear	139,000	-	100	-
5 years' spare parts at 10%	184,950	-	100	-
Subtotal	2,034,450	-	100	-
Site Work				
Equipment installation (25% less spares)	346,781	115,594	75	25
Grading	-	5,000	-	100
Plant offices, 150 m^2	13,500	9,000	75	25
Plant bldg. & control room, 700 m^2	65,625	21,875	60	40
Workshop and stores, 700 m^2	7,000	63,000	10	90
Fuel tanks, 5 at 200 m^3	58,500	6,500	90	10
Intake pier and pump house	12,500	12,500	50	50
Subtotal	503,906	233,469	68	32
Management				
Technical assistance (AID)	50,000	-	100	-
Engineering at 14% (less tech. asst.)	388,056	-	100	-
Subtotal	438,056	-	100	-
Total, Equip., Site and Management	2,976,412	233,469	93	7
Contingency (10%)	297,641	23,347		
Total Capital Cost	3,274,053	256,816	93	7
AID & GOCV Total Cost		3,530,869		

	Years 1-10		Years 11-40	
Amortization (AID)	.02	65,481	.051	166,976
Sinking Fund (Equip.)	.02	40,689	.02	40,689
(AID) Plant Annual Cost		106,170		207,665

Table 10b

CAPITAL COST
STEAM-ELECTRIC AND MSF
CASE IB

Items	Cost ($) AID	Cost ($) GOCV	% AID	% GOCV
Equipment - CIF Mindelo				
2 ea. WT boilers, 29 kg/cm^2, 316 ^oC, 11.4 t/h, c/w deaerator and feed system	385,000	-	100	-
2 ea. turbo-generators, 1250 KW	391,000	-	100	-
3 ea. once-thru MSF dist. plants, 300 t/d, PR 5.5	1,072,500	-	100	-
3 ea. 50% intake pumps, screens and chlorinator	29,250	-	100	-
Maintenance and lab. equipment	175,000	-	100	-
Remote instrumentation	24,000	-	100	-
Chemical feeding equipment	6,000	-	100	-
Facility switchgear	166,800	-	100	-
5 years' spare parts at 10%	224,955	-	100	-
Subtotal	2,474,505	-	100	-
Site Work				
Equipment installation (25% less spares)	421,791	140,597	75	25
Grading	-	5,000	-	100
Plant offices, 150 m^2	13,500	9,000	75	25
Plant buildings and control room, 700 m^2	65,625	21,875	60	40
Workshop and stores, 700 m^2	7,000	63,000	10	90
Fuel tanks, 5 at 200 m^3	58,500	6,500	90	10
Intake pier and pump house	12,500	12,500	50	50
Subtotal	578,916	258,472	69	31
Management				
Technical assistance (AID)	50,000	-	100	-
Engineering at 14% (less tech. asst.)	463,665	-	100	-
Subtotal	513,665	-	100	-
Total Equip., Site and Management	3,567,086	258,472	93	7
Contingency (10%)	356,708	25,847		
Total Capital Cost	3,923,794	284,319	93	7
AID and GOCV Total Cost		4,208,113		

	Years 1-10		Years 11-40	
Amortization (AID)	.02	78,475	.051	200,113
Sinking Fund (Equip.)	.02	49,490	.02	49,490
AID Plant Annual Cost		127,965		249,603

Table 10c

CAPITAL COST
STEAM-ELECTRIC AND MSF
CASE IC

Items	Cost ($) AID	Cost ($) GOCV	% AID	% GOCV
Equipment - CIF Mindelo				
2 ea. WT boilers, 29 kg/cm^2, 316^{o}C, 11.4 t/h, c/w deaerator and feed system	385,000	-	100	-
2 ea. turbo-generators, 1250 KW	391,000	-	100	-
4 ea. once-thru MSF dist. plants, 300 t/d, PR 5.5	1,430,000	-	100	-
3 ea. 50% intake pumps, screens and chlorination	39,000	-	100	-
Maintenance and lab. equipment	175,000	-	100	-
Remote instrumentation	28,000	-	100	-
Chemical feeding equipment	7,000	-	100	-
Facility switchgear	194,600	-	100	-
5 years' spare parts at 10%	264,960	-	100	-
Subtotal	2,914,560	-	100	-
Site Work				
Equipment installation (25% less spares)	496,800	165,600	75	25
Grading	-	5,000	-	100
Plant offices, 150 m^2	13,500	9,000	75	25
Plant buildings and control room, 700 m^2	65,625	21,875	60	40
Workshop and stores, 700 m^2	7,000	63,000	10	90
Fuel tanks, 5 at 200 m^3	58,500	6,500	90	10
Intake pier and pump house	12,500	12,500	50	50
Subtotal	653,925	283,475	70	30
Management				
Technical assistance (AID)	50,000	-	100	-
Engineering at 14% (less tech. asst.)	539,274	-	100	-
Subtotal	589,274	-	100	-
Total Equip., Site and Management	4,157,759	283,475	93	7
Contingency (10%)	415,776	28,348		
Total Capital Cost	4,573,535	311,823	93	7
AID and GOCV Total Cost		4,885,358		

	Years 1-10		Years 11-40	
Amortization (AID)	.02	91,470	.051	233,250
Sinking Fund (Equip.)	.02	58,291	.02	58,291
AID Plant Annual Cost		149,761		291,541

Table 10d

CAPITAL COST
DIESEL-ELECTRIC AND VC
CASE IIA

Items	Cost ($) AID	Cost ($) GOCV	% AID	% GOCV
Equipment - CIF Mindelo				
3 ea. diesel-generators, 700 KW	528,000	-	100	-
2 ea. VC distillation plants at 300 t/d	640,000	-	100	-
3 ea. 50% intake pumps, screens and chlorination	16,500	-	100	-
Maintenance and lab. equipment	175,000	-	100	-
Remote instrumentation	20,000	-	100	-
Chemical feeding equipment	5,000	-	100	-
Facility switchgear	139,000	-	100	-
5 years' spare parts at 10%	152,350	-	100	-
Subtotal	1,675,850	-	100	-
Site Work				
Equipment installation (25% less spares)	285,700	95,200	75	25
Grading	-	5,000	0	100
Plant offices, 150 m^2	13,500	9,000	75	25
Plant buildings and control room, 700 m^2	65,625	21,875	60	40
Workshop and stores, 700 m^2	7,000	63,000	10	90
Fuel tanks, 5 at 200 m^3	58,500	6,500	90	10
Intake pier and pump house	12,500	12,500	50	50
Subtotal	442,825	213,075	68	32
Management				
Technical assistance (AID)	50,000	-	100	-
Engineering at 14% (less tech. asst.)	326,445	-	100	-
Subtotal	376,445	-	100	-
Total Equip., Site and Management	2,495,120	213,075	92	8
Contingency (10%)	249,512	21,308		
Total Capital Cost	2,744,632	234,383	92	8
AID and GOCV Total Cost		2,979,015		

	Years 1-10		Years 11-40	
Amortization (AID)	.02	59,580	.051	151,929
Sinking Fund (Equip.)	.02	35,517	.02	33,517
AID Plant Annual Cost		95,097		185,446

Table 10e

CAPITAL COST
DIESEL-ELECTRIC AND VC
CASE IIB

Items	Cost ($) AID	Cost ($) GOCV	% AID	% GOCV
Equipment - CIF Mindelo				
3 ea. diesel-generators, 700 KW	528,000	-	100	-
3 ea. VC distillation plants at 300 t/d	960,000	-	100	-
3 ea. 50% intake pumps, screens and chlorination	19,500	-	100	-
Maintenance and lab. equipment	175,000	-	100	-
Remote instrumentation	24,000	-	100	-
Chemical feeding equipment	6,000	-	100	-
Facility switchgear	166,800	-	100	-
5 years' spare parts at 10%	187,930	-	100	-
Subtotal	2,067,230	-	100	-
Site Work				
Equipment installation (25% less spares)	352,400	117,500	75	25
Grading	-	5,000	-	100
Plant offices, 150 m^2	13,500	9,000	75	25
Plant buildings and control room, 700 m^2	65,625	21,875	60	40
Workshop and stores, 700 m^2	7,000	63,000	10	90
Fuel tanks, 5 at 200 m^3	58,500	6,500	90	10
Intake pier and pump house	12,500	12,500	50	50
Subtotal	509,525	235,375	68	32
Management				
Technical assistance (AID)	50,000	-	100	-
Engineering at 14% (less tech. asst.)	393,698	-	100	-
Subtotal	443,698	-	100	-
Total Equip., Site and Management	3,020,453	235,375	93	7
Contingency (10%)	302,045	23,538		
Total Capital Cost	3,322,498	258,913	93	7
AID and GOCV Total Cost		3,581,411		

	Years 1-10		Years 11-40	
Amortization (AID)	.02	66,449	.051	169,447
Sinking Fund (Equip.)	.02	41,344	.02	41,344
AID Plant Annual Cost		107,793		210,791

Table 10f

CAPITAL COST
DIESEL-ELECTRIC AND VC
CASE IIC

Items	Cost ($) AID	Cost ($) GOCV	% AID	% GOCV
Equipment - CIF Mindelo				
3 ea. diesel-generators, 700 KW	528,000	-	100	-
4 ea. VC distillation plants at 300 t/d	1,280,000	-	100	-
3 ea. 50% intake pumps, screen and chlorination	19,500	-	100	-
Maintenance and lab. equipment	175,000	-	100	-
Remote instrumentation	28,000	-	100	-
Chemical feeding equipment	7,000	-	100	-
Facility switchgear	194,600	-	100	-
5 years' spare parts at 10%	223,210	-	100	-
Subtotal	2,455,310	-	100	-
Site Work				
Equipment installation (25% less spares)	413,900	138,000	75	25
Grading	-	5,000	-	100
Plant offices, 150 m^2	13,500	9,000	75	25
Plant buildings and control room, 700 m^2	65,625	21,875	60	40
Workshop and stores, 700 m^2	7,000	63,000	10	90
Fuel tanks, 5 at 200 m^3	58,500	6,500	90	10
Intake pier and pump house	12,500	12,500	50	50
Subtotal	571,025	255,875	69	31
Management				
Technical assistance (AID)	50,000	-	100	-
Engineering at 14% (less tech. asst.)	459,509	-	100	-
Subtotal	509,509	-	100	-
Total Equip., Site and Management	3,535,844	255,875	93	7
Contingency (10%)	353,584	25,588		
Total Capital Cost	3,889,428	281,463	93	7
AID and GOCV Total Cost		4,170,891		

	Years 1-10		Years 11-40	
Amortization (AID)	.02	77,788	.051	198,360
Sinking Fund (Equip.)	.02	49,106	.02	49,106
AID Plant Annual Cost		126,804		247,466

Table 11

WATER/POWER PLANT DATA SUMMARY

Item	Units	Steam & MSF Case IA	Steam & MSF Case IB	Steam & MSF Case IC	Diesel and VC Case II A	Diesel and VC Case II B	Diesel and VC Case II C	Case IIB i Full Capacity	Case IIB ii Lower Water Cap.	Case IIB iii P/W Pres. Level
A. Plant & Capacity Data										
Steam & MSF	none	yes	yes	yes	no	no	no	no	no	no
Diesel & VC	none	no	no	no	yes	yes	yes	yes	yes	yes
Installed Water Capacity	m^3/d	600	900	1,200	600	900	1,200	900	900	900
Water Plant Factor	%	83	83	83	83	83	83	83	54	19
Available Water	m^3/d	498	747	996	498	747	498	747	486	171
In-House Water Consumption	m^3/d	-	-	-	-	-	-	-	-	-
Anticipated Water Demand	m^3/d	498	747	996	498	747	996	747	486	171
Reserve Water Capacity	m^3/d	-	-	-	-	-	-	-	261	729
Installed Power Capacity	KW	2,500	2,500	2,500	2,100	2,100	2,100	2,100	2,100	2,100
Installed Power Capacity	KWH/d	60,000	60,000	50,400	50,400	50,400	50,400	50,400	50,400	50,400
Power Availability Factor	%	83	83	83	83	83	83	83	100	33
Available Power	KWH/d	49,800	49,800	49,800	41,832	41,832	41,832	41,832	50,400	16,632
In-House Power Consumption	KWH/d	3,240	3,930	4,620	11,770	16,915	22,070	16,915	11,940	4,760
Anticipated Power Demand	KWH/d	14,000	14,000	14,000	14,000	14,000	14,000	24,917	14,000	5,100
Reserve Power Capacity	KWH/d	32,560	31,870	31,180	16,062	10,917	5,762	-	24,460	6,772
B. Plant Operating Costs										
Fuel, Bunker C at $110/T	$/Yr	460,098	492,400	524,680	-	-	-	-	-	-
Fuel, Gas Oil at $155/T	$/Yr	-	-	-	350,400	420,480	490,560	587,365	351,386	134,087
Chemicals & Supplies	$/Yr	52,812	69,963	89,614	29,366	38,446	47,692	42,946	33,946	27,701
Labor (Inc. 40% G.A.)	$/Yr	96,482	96,482	96,482	96,482	96,482	96,482	96,482	96,482	96,482
Subtotal	$/Yr	609,392	658,845	710,776	476,248	555,408	634,734	726,793	481,814	258,270
C. Plant Annual Costs (AID Capital Only)										
Amortization (Years 1-10)	$/Yr	65,481	78,475	91,470	59,580	66,449	77,788	66,449	66,449	66,449
Amortization (Years 11-40)	$/Yr	166,976	200,113	233,250	151,929	169,447	198,360	169,447	169,447	169,447
Plant Operating Cost (B)	$/Yr	609,392	658,845	710,776	476,248	555,408	634,734	726,793	481,814	258,270
Sinking Fund (Years 1-40)	$/Yr	40,689	49,490	58,291	35,517	41,344	49,106	41,344	41,344	41,344
Total Annual (Years 1-10)	$/Yr	715,562	786,810	860,537	571,345	663,201	761,628	834,586	589,607	366,063
Total Annual (Years 11-40)	$/Yr	817,057	908,448	1,002,317	663,694	766,199	882,200	937,584	692,605	469,061
D. Unit Plant Costs										
Annual Water Export	m^3/Yr	181,770	272,655	363,540	181,770	272,655	363,540	272,655	179,762	62,415
Annual Power Export	KWH/Yr	5,110,000	5,110,000	5,110,000	5,110,000	5,110,000	5,110,000	9,094,705	5,110,000	1,861,500
Power Free-Water Cost (1-10)	$/m^3	3.94	2.89	2.37	3.14	2.43	2.10	3.06	3.20	5.86
Water Free-Power Cost (1-10)	$/KWH	0.14	0.15	0.17	0.11	0.13	0.15	0.09	0.12	0.20
Power Free-Water Cost (11-40)	$/m^3	4.50	3.33	2.76	3.65	2.81	2.43	3.44	3.76	7.51
Water Free-Power Cost (11-40)	$/KWH	0.16	0.18	0.20	0.13	0.15	0.17	0.10	0.14	0.25

Table 12

CHEMICALS AND SUPPLIES, WATER/POWER PLANT

Item	Unit	Steam and MSF Case IA	 Case IB	 Case IC	Diesel and VC Case IIA	 Case IIB	 Case IIC	Case IIB i Full Capacity	 ii Lower Water Cap.	 iii P/W Pres. Level
Chemicals										
Scale Inhibitors	$/Yr	18,000	27,000	36,000	8,250	12,250	16,500	16,500	8,250	2,805
Chlorine	$/Yr	1,000	1,500	2,000	500	750	1,000	1,000	500	200
Boiler Treatment	$/Yr	7,500	7,500	10,000	-	-	-	-	-	-
Cleaning Chemicals	$/Yr	2,500	5,000	7,500	1,000	1,250	1,500	1,250	1,000	500
Subtotal		29,000	41,000	55,500	9,750	14,250	19,000	18,750	9,750	3,505
Supplies & Materials										
At 1% of Direct Capital Cost P/W Plant and Equipment Installation		23,812	28,963	34,114	19,616	24,196	28,692	24,196	24,196	24,196
Total Chemicals and Supplies		52,812	69,963	89,614	29,366	38,446	47,692	42,946	33,946	27,701

No. of cylinders	6
BHP/cyl	170 at 720 rpm
SFC at 100% load	0.237 kg/KWH
Heat to coolant at 100%	539,784 kcal/h
Seawater flow at 100% and 7.5 rise	74,970 kg/h
Generator output	4160^V 3-phase 50 Hz pf - 0.8

Engine, generator, and all accessories and controls preassembled on common bedplate. Each unit equipped with thermostatically controlled seawater-cooled jacket water and lub-oil coolers, speed governor, voltage regulator and all instruments and safety devices for reliable, hazard-free operation. Five years' spare parts.

(b) 900 m^3/d total capacity motor-driven VC distillation plants (minimum 3 units)

Specific power consumption	20 KWH/m^3
Compression type	centrifugal
Maximum evaporating temperature	100°C
Feed treatment	polyphosphate or carboxylic polymer
Maximum brine CF	2
Make-up heat	electric immersion heaters
Evaporation	climbing or spray film
Motors	enclosed, 380^V 3 phase 50 Hz
Materials of construction	
Compressor	monel or SS
Heat exchangers	nonferrous
Shell	nonferrous or coated steel
Pipes and valve bodies	nonferrous
Pump internals and valve trim	monel or SS

Each unit to be preassembled on baseplate, completed with all chemical closing equipment, controls and instruments for safe and reliable operation. Five years' spare parts.

(c) 3 each 20 HP vertical intake pumps

Capacity (ea.)	175 m^3/h
Total head	20 m

Motor enclosed, 380^V 3 phase 50 Hz

Materials of construction monel or SS

Complete with motor controllers and ammeters plus five years' spares.

(d) Electrical switchgear

Primary (4260^V): 1000 kva transformers, generator parallel controls, metering, feeders, etc.

Secondary ($200/380^V$): 1200A feeders to distillation plants, miscellaneous to various facilities

Motor control center: 3 ea. 25 HP product water booster pumps, 3 ea. 20 HP seawater intake pumps and miscellaneous

(e) Plant maintenance shop equipment

Lathe (1), drill presses (3), grinder (2), power saw (1), pipe threading machine (1), welders (2), oxy-acetylene equipment (2), service air compressors (2), jackhammers (2), plus all necessary accessories

Power tools (air or electric): wrenches (4), drills (4), grinders (4), plus all accessories

Hydraulic tools: jacks (4), wheel-pullers (4), plus accessories

Diesel engine maintenance tools and equipment: 2 full sets as recommended by suppliers

Hand tools (general): 4 sets--wrenches (pipe, box, open-end, adjustable, socket), drill bits (metal, wood, masonry, etc.), hammers (sledge, ball-peen, etc.), screwdriver (slot, Phillips, etc.), hack saws, shears, punches, wedges, cold chisels, etc.

Machine shop instruments: 2 sets micrometers, feeler gauges, scribing sets, calipers, scales

Instrumentation test equipment and tools: 2 sets

Stock of general maintenance supplies: gasket, materials, packing, asbestos sheeting, nuts, bolts, washers, screws, bar stock, plate, welding rods, brazing and solder stock, wire, rope, compounds, cements, etc.

(f) Laboratory equipment and fixtures

Sinks, cabinets, benches, counters, drying racks, desks, chairs, and tools

Vacuum pump, air compressor, hot water heater, still or deionizer, drying oven, muffle furnace, refrigerator and propane gas system

Analytical balance and beam scales

Spectrophotometer, conductivity meter, lab pH meters, microscope

Hot plates, stirrers (magnetic and mechanical, shaker), bath

Automatic burettes, pipette sets, thermometers, hydrometers

Dessicators, crucibles, funnels, vacuum flasks

Flasks, cylinders, beakers, reagent bottles, test tubes, watch glasses, glass and rubber tubing, corks, stirring rods, filter papers, Bunsen burners, pinch clamps, support stands and holders, tongs

Reagents and indicators for following determinations:

pH (colorimetric)
chloride
total hardness
calcium
sulfate
chlorine
alkalinity
total iron
total copper
chromium (hexavalent)
phosphate

3. Water Distribution and Delivery Subsystem. The Government of Cape Verde is desirous of constructing a distribution system on Sal Island to distribute potable water produced by a desalination water plant to be constructed on the island. This system is to serve the five existing major communities and the international airport located on the island. This section of the report outlines the proposed system and the estimated construction, maintenance, and operational costs.

a. Existing Water Systems. Reliable water systems are almost nonexistent on the island. The existing water supply consists of two desalination plants at the airport and one at Santa Maria. All three of these units operate below their design capacity because of the need for major maintenance.

There is no distribution system from these units to serve the communities. The water from these units is trucked to the various communities, and the people carry the water to their homes in buckets. The existing wells produce a brackish water which is used by the people as necessary. Salt water is used for sanitary needs and is obtained locally. However, seawater is distributed at Palmeira, portions of Espargos, and at the airport from the saltwater supply line to the airport's desalination plants.

b. Requirements of Proposed Distribution System. The proposed distribution system is designed to transport the 750 tons of potable water per day produced by the desalination plant to the five existing communities and the airport. The average daily capacity to be available to each community and the airport is shown in Table 13.

Table 13

PROJECTED WATER DISTRIBUTION AND DELIVERY

Location	Projected Distribution (m^3/d)
Almicar Cabral Airport	65
Espargos	205
Palmeira	45
Pedra Lume	25
Preguiça	205
Santa Maria	205
	750

As shown in Table 5, if the present-day population of Sal Island increases its average daily consumption to 50 liters per person, domestic water requirements will total 397.5 m^3/day. The water desalination plant will be capable of delivering approximately 750 m^3/day, as indicated in Table 11 (Case IIB); consequently, the balance of 352.5 m^3/day will be available for industrial/commercial use and future growth, as presented in Table 14.

Table 14

WATER DISTRIBUTION AND DELIVERY,
FULL PRODUCTION (CASE IIB)

Location	Current Population	Demand at 50 Lit./Person/Day (m^3/d)	Available for Ind. Use or Future Growth (m^3/d)
Airport	-	-	65.0
Espargos	2,750	137.5	67.5
Palmeira	600	30.0	15.0
Pedra Lume	350	17.5	7.5
Preguiça	2,750	137.5	67.5
Santa Maria	1,500	75.0	130.0
Total	7,950	397.5	352.5

Of the 352.5 m^3/d balance, 30 m^3 are presently being used by industry/commerce and projections of new activities call for this consumption to increase to about 95 m^3/day within the next year.

Other requirements are that the system is to be designed to provide between 2 and 4 kg/cm at the house tap with a velocity in the water mains of less than 1.2 m/sec. and that the system shall include a storage capacity of 8,000 m^3.

c. Proposed System. The proposed system will consist of a 1,000 m^3 storage reservoir at the desalination plant site to receive the discharge from the plant. Water will be pumped from the reservoir at Palmeira to a 6,000 m^3 storage reservoir located on Morro Curral north of the community of Preguiça. The five communities and the airport will be fed by gravity from the reservoir. An additional 1,000 m^3 storage reservoir will be located north of Santa Maria on the road to the airport.

The distribution system is designed for a peak flow of two times the average daily requirements. An eight-inch water main is required from the plant site to the storage on Morro Curral. A six-inch water main will be installed along established roads which will provide service to Palmeira, Preguiça, Espargos, and the airport. The distribution mains within the communities will consist of four-inch mains.

Because of the low elevation of Palmeira and Pedra Lume, pressure regulating valves will be used to control high pressure. The storage reservoir north of Santa Maria will be used to control pressure to Santa Maria.

The house service will consist of 3/4-inch pipe.

The pumps at the plant site will be controlled by the water level in the reservoir on Morro Curral. An altitude valve will be utilized to prevent overflowing the reservoir north of Santa Maria.

The system is delineated on Drawings No. 1 and 2.

d. Estimated Cost. The estimated costs are based on the use of materials manufactured in the U.S.A. and delivered to Sal Island and the maximum use of local labor to perform the work of constructing the system. The estimated costs are based on current prices; should the project be delayed for an extensive period of time, a review of these cost should be considered. A summary of the capital cost is presented in Table 15.

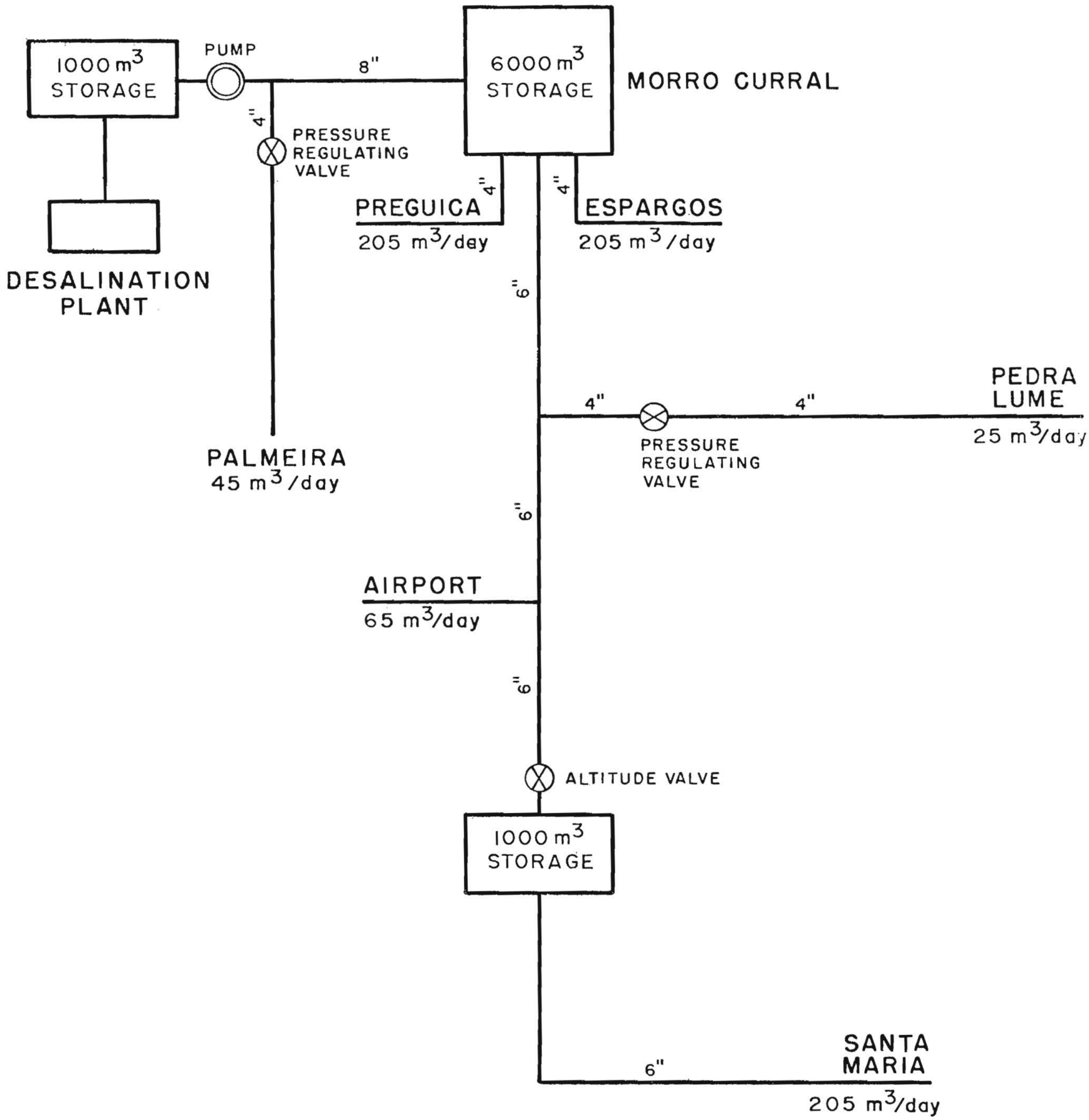
e. Maintenance and Operation. The maintenance and operating responsibilities consist of the following:

Operation of the pumping station and controls
Operation of reservoirs
Operation of altitude valves and pump regulating valves
Installation of new water mains
Installation of new service connections
Repairs to water mains and water services

Performance of this work will require a foreman and a crew of three persons. The foreman should have mechanical ability with a knowledge of pipeline hydraulics, pump and electrical motor operation, and electrical controls. The crew members should have mechanical abilities with knowledge of pipe installations and service connections. All details of operation and maintenance tasks and staff, as well as needed payroll, are discussed in another section of this document.

4. Power Distribution and Delivery Subsystem. This subsystem has three basic elements in its design, as follows:

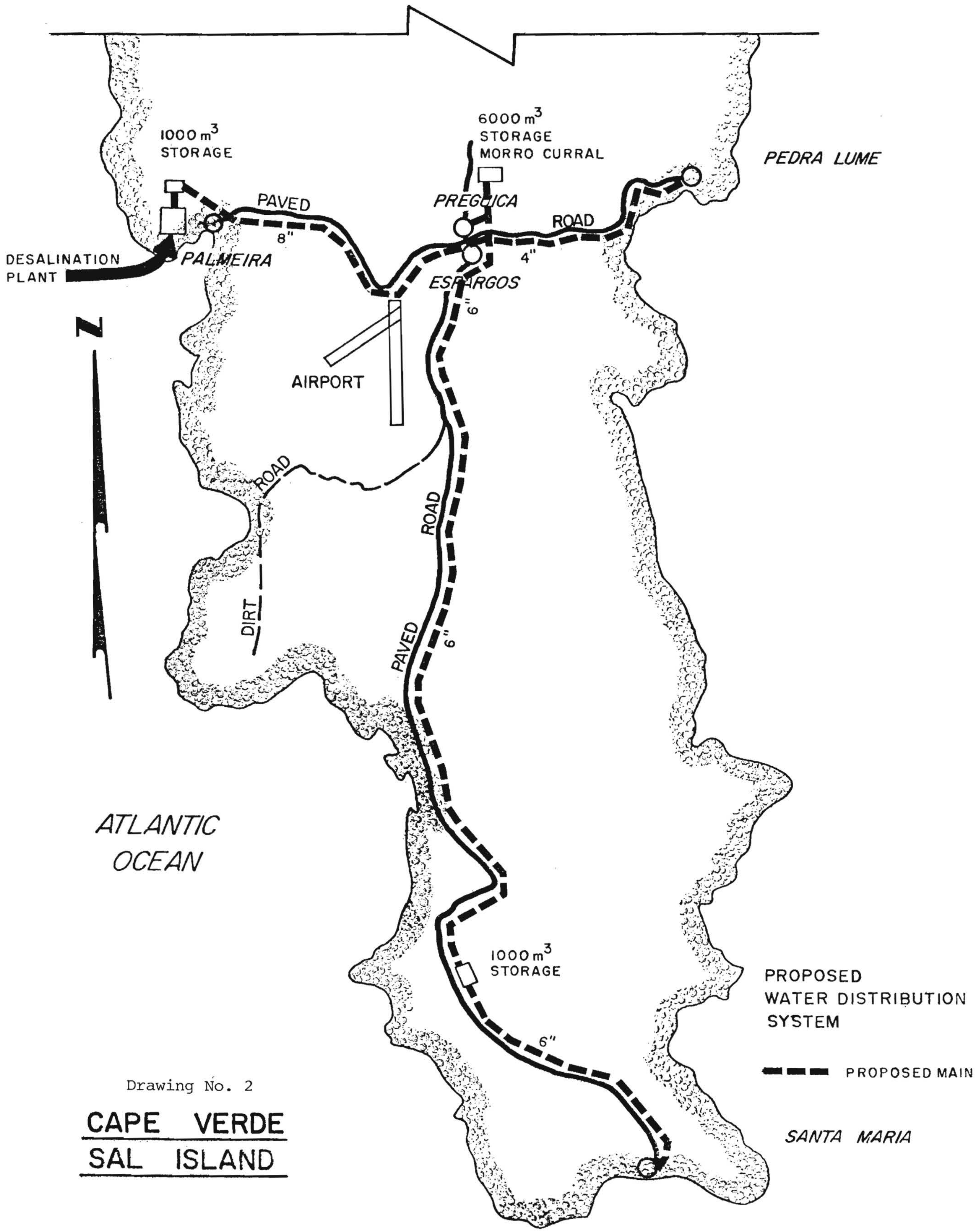
a. Power distribution
b. Power delivery
c. House wiring



CAPE VERDE
SAL ISLAND

PROPOSED WATER
DISTRIBUTION SYSTEM

DRAWING NO. I



Drawing No. 2

CAPE VERDE
SAL ISLAND

Table 15

CAPITAL COST SUMMARY
WATER DISTRIBUTION AND DELIVERY

Item	AID Cost	AID % of Total	GOCV Cost	GOCV % of Total
Pump Station	$ 15,360	54	$ 12,960	46
Water Main	555,000	80	136,920	20
Storage Reservoirs	68,400	33	136,800	64
Community Distribution	199,200	74	69,720	26
Individual Services (1300)	202,800	72	78,000	28
Engineering (14%)	145,706	100	-	-
Subtotal	$1,186,466	73	$434,400	27
Contingency (10%)	118,647		43,440	
Total Capital Cost	$1,305,113	73	$477,840	27

	Years 1-10		Years 11-40	
Amortization (AID)	.02	$26,102	.051	$66,560
Operating Cost (Labor)		16,119		16,119
Total Annual		$42,221		$82,679

The power distribution and delivery subsystem will take available power for export from the desalination/power plant bus at 6,300V, 3-phase, 50 HZ primary and distribute underground with direct burial 15 KV cable (laid in the same trench with the water line where practicable) to load-center substations located in buildings at Palmeira, Preguiça, Pedra Lume, the airport and Santa Maria.

Voltage from substations will be 220/380V, 3-phase, 4-wire underground to nearest concrete pole(s) and thence aerial along village street on concrete poles to serve street lights and residential buildings at 220V, 2-wire, 1-phase and commercial/industrial buildings at 220/380V, 3-wire, 3-phase with aerial service drops (some commercial/industrial loads will require underground service from poles). Street lights are supplied and installed on these same poles.

Service to typical residences will consist of four 40-watt lamp bulbs in the ceiling of each of 1,000 homes to be wired, plus four convenience outlets per home, located to provide 220V service for refrigerator, iron, radio (stereo), and miscellaneous appliances. Each lighting fixture is to be switched. Main service to each residence is to be complete with main service device and two-circuit load center.

Once installed and operative, the electrical delivery system is expected to be relatively maintenance free, since it is a static-element system. Each homeowner will assume responsibility for operation and maintenance of the residential system once installed. Service calls should be limited to routine new-service calls and emergency calls of a routine nature. Close liaison will be maintained with large load users to assure minimal problems with the power delivery subsystem. Such operations and maintenance will be under the direct charge of a power system supervisor and a foreman supported by three crew members, with service vehicles to facilitate pole setting and routine maintenance and repairs.

The three basic elements making up this subsystem may be described as follows:

a. Power Distribution

- Power taken from water/power plant bus in Palmeira.
- 6300V, DELTA, 3-phase, 3-wire, 50 HZ system.
- Distribution underground with direct burial cable.

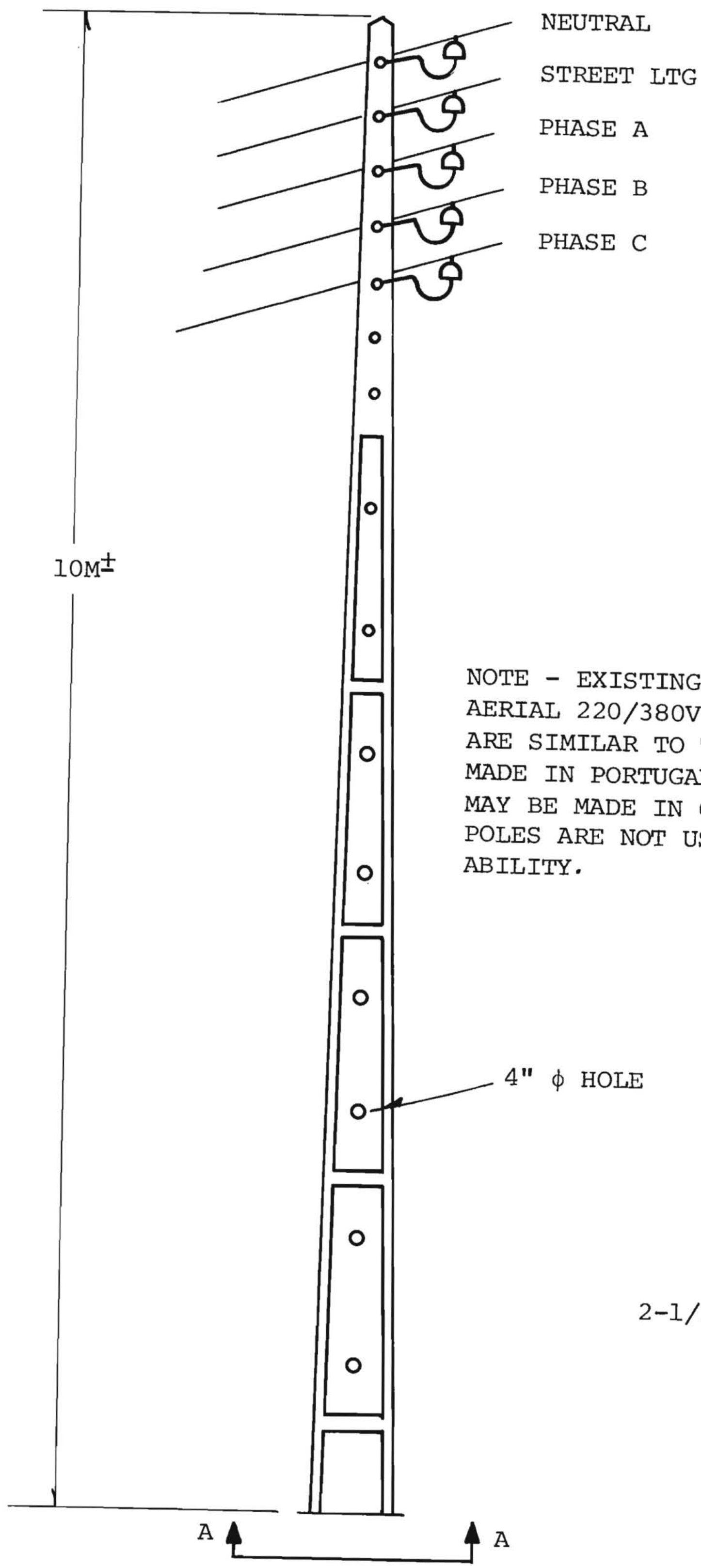
- Interfaced with existing airport 1260 KVA power plant, to remain as standby power source for Espargos, Sea Water, Shell and Airport Water Plant Intake substations.
- Distributed to substations at strategic locations (in villages and other load centers) to be housed in building structures.
- High material cost items (switchgear, substations and cable), low maintenance.
- All material imported to Cape Verde.
- Highly skilled journeymen required to install electrical equipment.
- Unskilled labor required to open trenches (36 km total estimate) and backfill.
- Cable splices made direct underground every 1.0 km.

b. Power Delivery

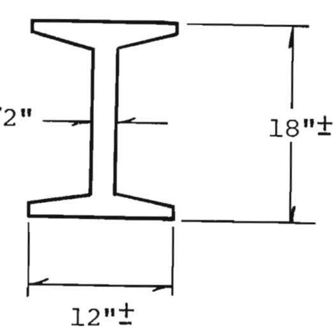
- From substations strategically located.
- 200/380V, 3-phase, 4-wire, 50 HZ.
- Distribution aerially on concrete poles (Figure 12), copper conductors, consisting of:
    - Neutral conductor (top position)
    - Street lighting (220V)
        - 80-watt lamps (presently used)
        - 125-watt lamps (presently used)
    - Phase conductor A
    - Phase conductor B
    - Phase conductor C
- Supplement existing systems in Santa Maria, Espargos, Preguiça.
- New systems in Palmeira and Pedra Lume.
- Concrete poles on nominal 10 m centers.
- Concrete poles may be fabricated locally in Cape Verde (otherwise, best source is Portugal).
- Includes 2-wire (220V, 1-phase) aerial cut-in to residences, and 3 or 4-wire (220/380V, 3-phase) aerial or underground cut-ins to industrial/commercial facilities.

Figure 12

DETAIL
TYPICAL REINFORCED CONCRETE POLE
(For Village Aerial Distribution, 220/380V)



NOTE - EXISTING CAPE VERDE CONCRETE POLES FOR AERIAL 220/380V DISTRIBUTION SCHEME IN VILLAGES ARE SIMILAR TO THIS DETAIL, ALL REPORTED TO BE MADE IN PORTUGAL. INVESTIGATION REVEALED THESE MAY BE MADE IN CAPE VERDE. CREOSOTED WOOD POLES ARE NOT USED DUE TO EXPENSE AND UNAVAILABILITY.



BOTTOM (A-A)

- Skilled journeymen required to install, low maintenance.
- All material (except possibly concrete poles) imported to Cape Verde.
- No layout prepared this report (to be prepared at final design from existing plans and village maps).

c. House Wiring

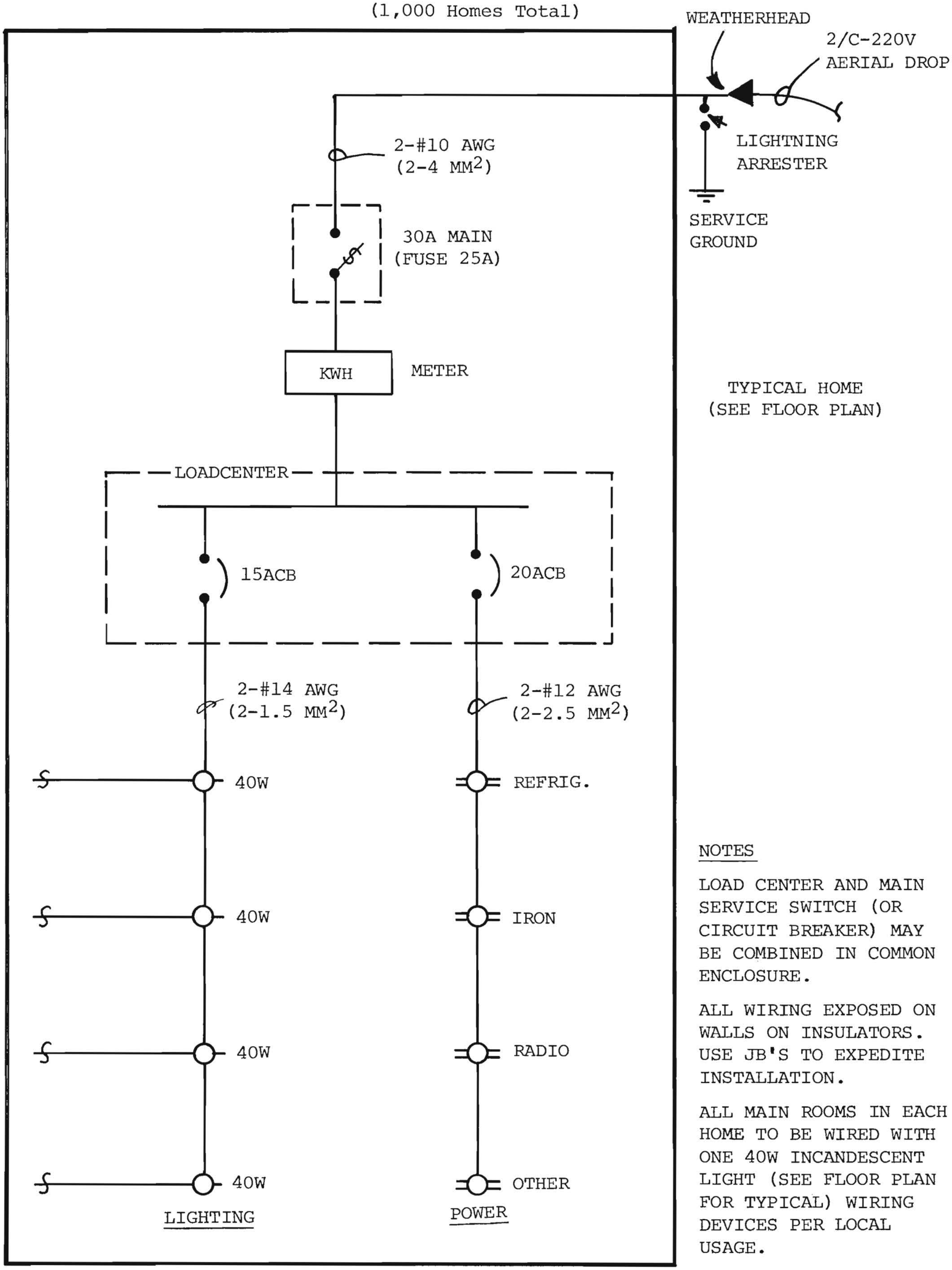
- Service into house from 2-wire aerial drop - 220V, 1-phase, #10 AWG ($4mm^2$), as per Figures 13 and 14.
- Lightning arrester on service mast.
- Main switch and fuse.
- Meter (watt-hour).
- Load center, circuit breaker type
  - Lighting circuit (15A)
  - Power circuit (20A)
- Lighting branch circuit wiring #14 AWG ($1.5\ mm^2$) for:
  - 4 lights (40W each)
  - 4 switches (for lights)
- Power branch circuit wiring #12 AWG ($2.5\ mm^2$) for receptacles (20A rating):
  - Refrigerator
  - Iron
  - Radio
  - Other
- All wiring exposed on wall on insulators, PVC jacketed, 2-conductor.
- 1,000 homes included in program.

All new 6300V primary distribution will be underground, with cable of 1/3C configuration for direct burial, to a desired depth not to exceed 1 meter. Where practicable, water and power lines may be installed in same open ditch. Evidence is that (given relatively inexpensive labor) underground distribution is no more costly than aerial distribution (given the expense of poles). Aerial primary distribution would be affected by the salty atmosphere of Sal Island. There are no existing aerial distribution power lines on Sal Island.

To respond to the desire of Cape Verde officials to retain the present airport power generating facility as a standby power source during new power

Figure 13

TYPICAL RESIDENCE WIRING
(1,000 Homes Total)



NOTES

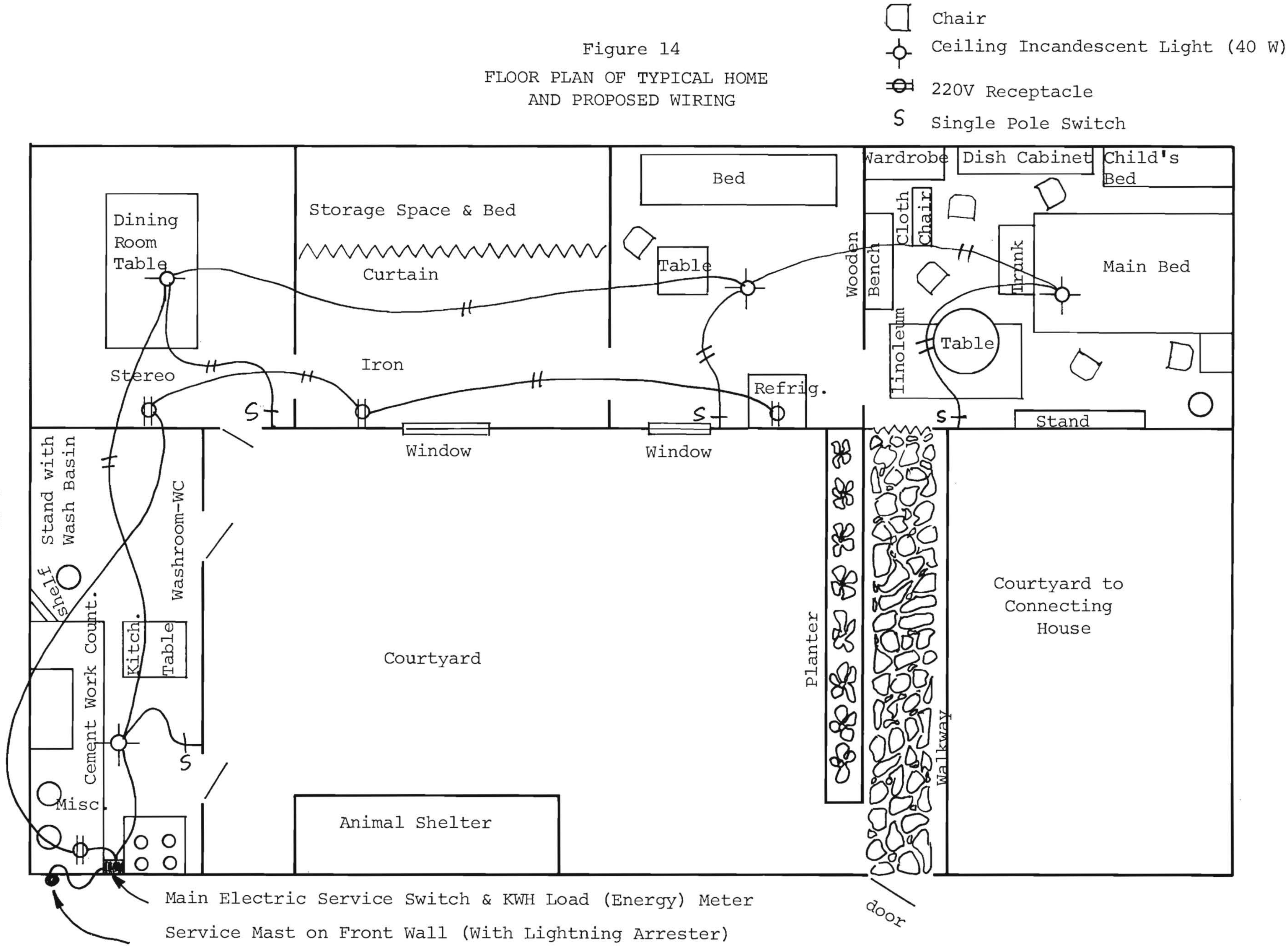
LOAD CENTER AND MAIN SERVICE SWITCH (OR CIRCUIT BREAKER) MAY BE COMBINED IN COMMON ENCLOSURE.

ALL WIRING EXPOSED ON WALLS ON INSULATORS. USE JB'S TO EXPEDITE INSTALLATION.

ALL MAIN ROOMS IN EACH HOME TO BE WIRED WITH ONE 40W INCANDESCENT LIGHT (SEE FLOOR PLAN FOR TYPICAL) WIRING DEVICES PER LOCAL USAGE.

Figure 14

FLOOR PLAN OF TYPICAL HOME
AND PROPOSED WIRING



plant outages, provisions are made for interlocking automatically the new power plant feeder to the airport bus in the airport powerhouse, to facilitate automatic source transfer.

The Espargos, Preguiça, Lomba Branca, Water Plant Intake (for airport), Sea Water Intake (Espargos) and Shell Oil Pumping Facility substations are reused, and existing feeders from the airport bus are reconnected through new manually operated transfer switches to the new power plant source.

The cost estimate for the electrical power subsystem installation includes electrical feeders from water/power plant bus and switchgear. Plant switchgear requirements have been coordinated and the cost estimate prepared as a separate item for inclusion in the plant budget.

The feeder (main) from Palmeira to the switching station at Espargos is sized with enough ampacity to accommodate the total 2100 KVA output of the installed plant generators. This exceeds the nominal 600 KVA power available for export from the new power plant, thereby permitting the distribution system to absorb any reasonable future load growth.

Operations and maintenance for the electrical distribution system should be integrated with the water/power authority for Sal Island. Personnel should be local Cape Verdians, ideally chosen from the workmen used for installation. Evidently there is a nucleus of trained personnel operating the existing airport electrical system. Apparently there is also a staff operating and maintaining the power delivery systems for Espargos and Santa Maria, including some system for meter reading and collection procedures. Technical skills required would be knowledge of high-voltage (6300V) switchgear, substations and cable; low-voltage distribution systems (220/380V); house wiring techniques and procedures, and maintaining and servicing plant generating units, including anticipated sophisticated automatic plant instrumentation and control systems to interface the water/power generation to peak load/reserve capabilities. The power system supervisor should be an electrical engineer, or at least an engineering technician, supported by a hands-on electrician foreman capable of doing field work and by a minimum of three helpers. Also needed are a minimum of three vehicles--one crane truck for concrete, pole setting and two pick-up trucks. The cost of the vehicles is not included in this cost estimate. Plant shop tools may be utilized for maintenance. The life expectancy of the system is nominally 40 years, since it is a static system with no moving parts. Obsolescence before 40 years would result from load (KVA) growth exceeding designed and installed capacities. It is estimated that operation, maintenance, and replacement should be funded at 1% per annum of total initial capital investment for the electrical delivery system.

Capital cost of the entire subsystem is presented in Table 16, which follows. Complete engineering drawings of the power subsystem are presented as Drawings No. 3 and 4.

5. Training Needs. A total of seven different training needs have been identified by the project team, as follows:

a. Utility Management, Planning and Policies
b. Water and Power Distribution
c. Principles and Practices of Seawater Distillation
d. Principles and Practices of Diesel Power Generation
e. Instrumentation and Controls
f. Chemical Analysis for Scale and Water Quality Control
g. Shift Supervision in Power and Water Plant

This section will review each of the above training needs, indicating number of persons to be trained, suggested type of training, possible location of training program, and estimated cost.

a. Utility Management, Planning and Policies

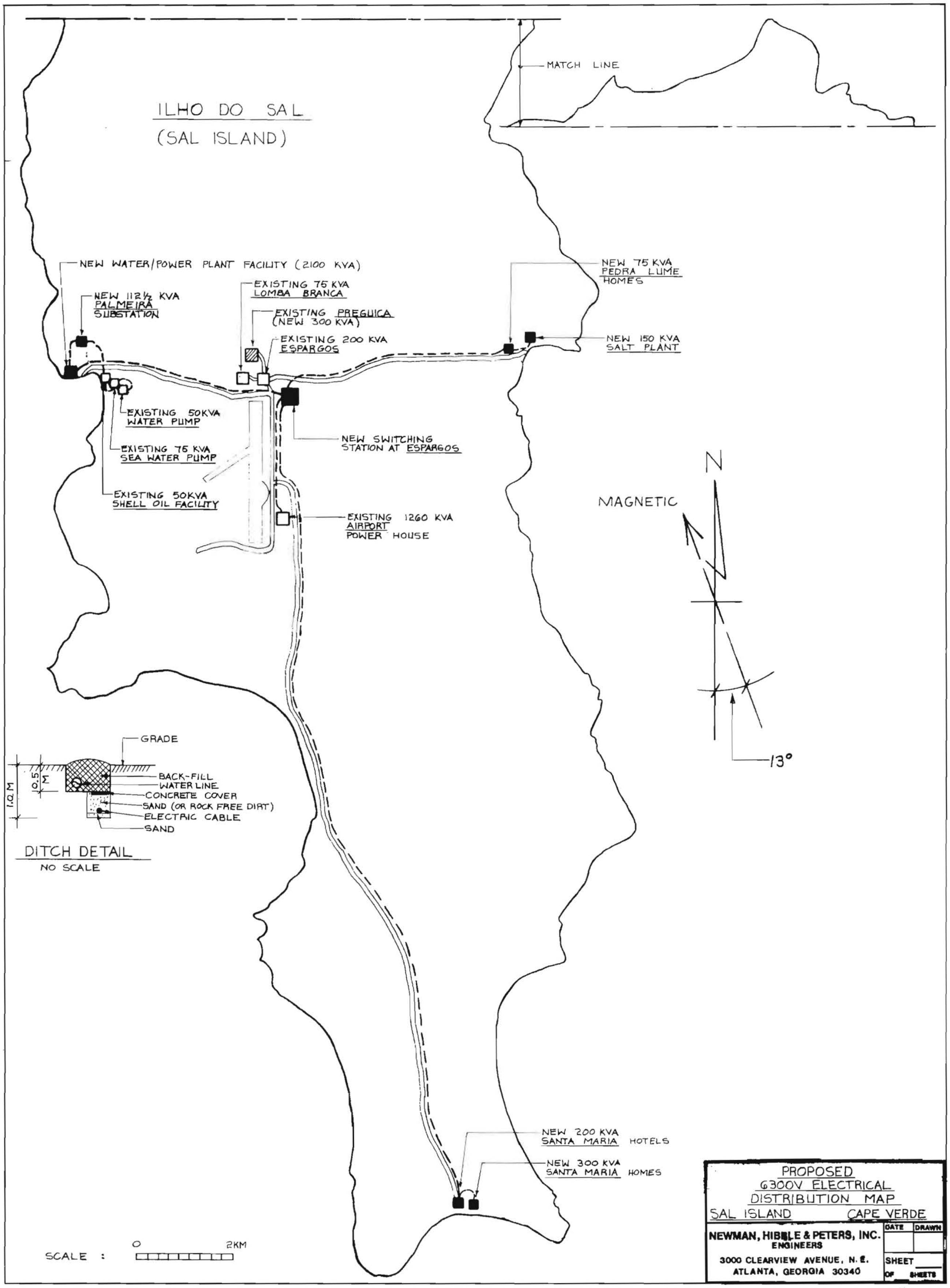
Suggested Courses	General Administration
	Financial Management
	Policy Making
	Decision Making
	Technical Planning
Participants	Executive Director
	Assistant Director for Administration
	Assistant Director for Engineering
Total-6 persons	Assistant Director for Finance
	General Manager - Sal
	Plant Superintendent - Sal

Table 16

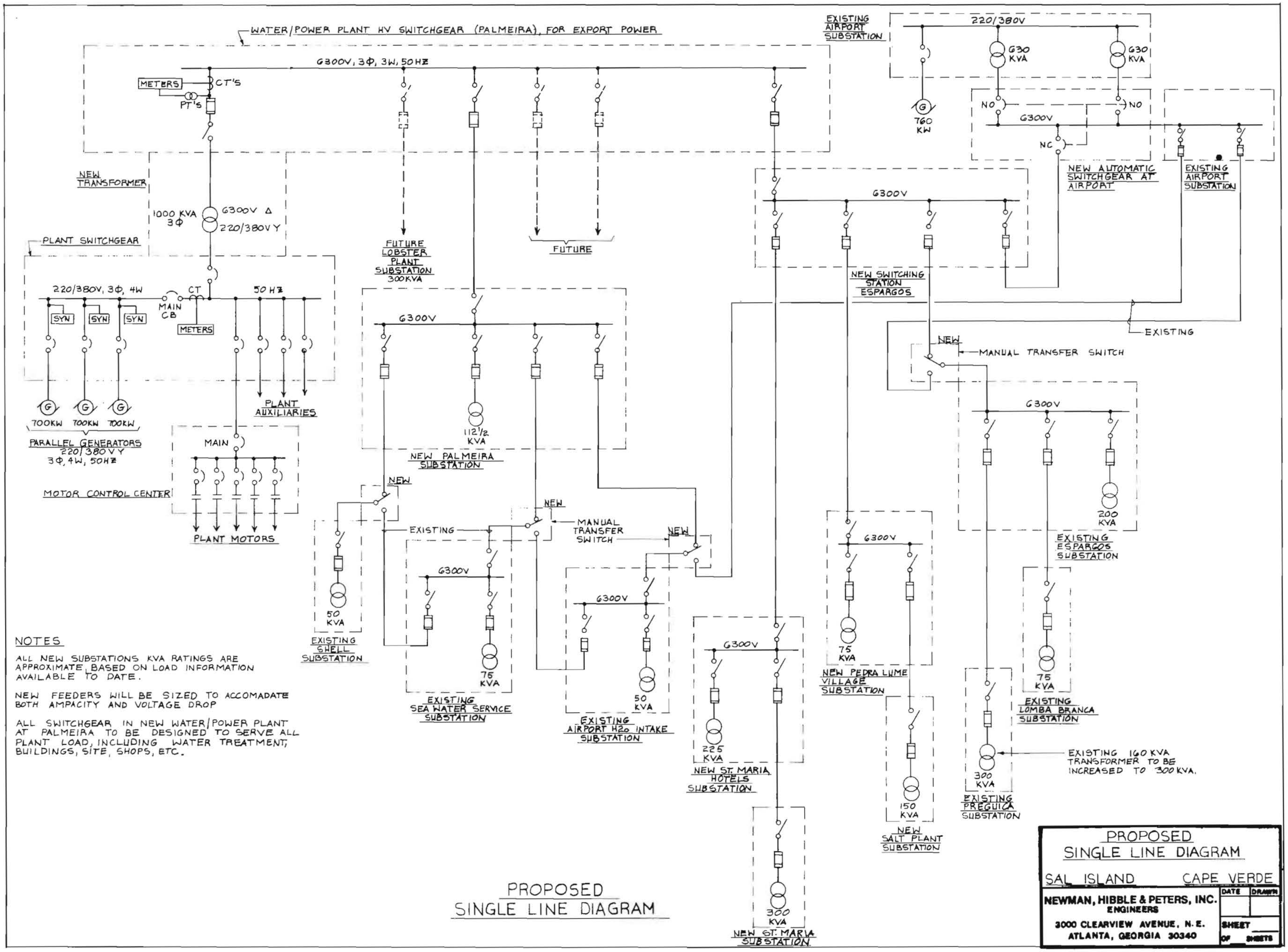
CAPITAL COST SUMMARY
POWER DISTRIBUTION AND DELIVERY

	AID		GOCV				AID/
Item	Cost	% of Total	Unskilled Labor	Skilled Labor	Total	% of Total	GOCV Total
Power Distribution	$503,600	78	$ 71,800	$ 66,540	$138,340	22	$ 641,940
Power Delivery	49,500	46	8,000	50,000	58,000	54	107,500
House Wiring	90,000	50	20,000	70,000	90,000	50	180,000
Engineering (14%)	90,034	100	-	-	-	-	90,034
Subtotal	$733,134	72	$ 99,800	$186,540	$286,340	28	$1,019,474
Contingency (10%)	73,313		9,980	18,654	28,634		101,947
Total Capital Cost	$806,447	72	$109,780	$205,194	$314,974	28	$1,121,421

	Years			
	1-10		11-40	
Amortization (AID)	.02	$16,128	.051	$41,128
Operating Cost (Labor)		16,119		16,119
Total Annual		$32,247		$57,247


MATCH LINE
ILHO DO SAL
(SAL ISLAND)
NEW WATER/POWER PLANT FACILITY (2100 KVA)
NEW 112½ KVA PALMEIRA SUBSTATION
EXISTING 75 KVA LOMBA BRANCA
EXISTING PREGUICA (NEW 300 KVA)
EXISTING 200 KVA ESPARGOS
NEW 75 KVA PEDRA LUME HOMES
NEW 150 KVA SALT PLANT
EXISTING 50KVA WATER PUMP
EXISTING 75 KVA SEA WATER PUMP
EXISTING 50KVA SHELL OIL FACILITY
NEW SWITCHING STATION AT ESPARGOS
EXISTING 1260 KVA AIRPORT POWER HOUSE
N
MAGNETIC
13°
GRADE
BACK-FILL
WATER LINE
CONCRETE COVER
SAND (OR ROCK FREE DIRT)
ELECTRIC CABLE
SAND
1.0 M
0.5 M
DITCH DETAIL
NO SCALE
NEW 200 KVA SANTA MARIA HOTELS
NEW 300 KVA SANTA MARIA HOMES
SCALE : 0 2KM
PROPOSED
6300V ELECTRICAL
DISTRIBUTION MAP
SAL ISLAND CAPE VERDE
NEWMAN, HIBBLE & PETERS, INC.
ENGINEERS
3000 CLEARVIEW AVENUE, N.E.
ATLANTA, GEORGIA 30340
DATE DRAWN
SHEET
OF SHEETS

Drawing No. 3



WATER/POWER PLANT HV SWITCHGEAR (PALMEIRA), FOR EXPORT POWER
6300V, 3Φ, 3W, 50HZ
METERS
CT'S
PT'S
NEW TRANSFORMER
1000 KVA 3Φ
6300V Δ
220/380V Y
PLANT SWITCHGEAR
220/380V, 3Φ, 4W
CT
50 HZ
MAIN CB
SYN
METERS
700KW 700KW 700KW
PARALLEL GENERATORS 220/380V Y 3Φ, 4W, 50HZ
PLANT AUXILIARIES
MAIN
MOTOR CONTROL CENTER
PLANT MOTORS
FUTURE LOBSTER PLANT SUBSTATION 300KVA
FUTURE
6300V
112½ KVA
NEW PALMEIRA SUBSTATION
NEW
EXISTING
MANUAL TRANSFER SWITCH
50 KVA
EXISTING SHELL SUBSTATION
75 KVA
EXISTING SEA WATER SERVICE SUBSTATION
50 KVA
EXISTING AIRPORT H2O INTAKE SUBSTATION
225 KVA
NEW ST. MARIA HOTELS SUBSTATION
300 KVA
NEW ST. MARIA SUBSTATION
EXISTING AIRPORT SUBSTATION
220/380V
630 KVA
630 KVA
760 KW
NO
NC
NEW AUTOMATIC SWITCHGEAR AT AIRPORT
EXISTING AIRPORT SUBSTATION
NEW SWITCHING STATION ESPARGOS
EXISTING
MANUAL TRANSFER SWITCH
200 KVA
EXISTING ESPARGOS SUBSTATION
75 KVA
NEW PEDRA LUME VILLAGE SUBSTATION
150 KVA
NEW SALT PLANT SUBSTATION
75 KVA
EXISTING LOMBA BRANCA SUBSTATION
300 KVA
EXISTING PREGUICA SUBSTATION
EXISTING 160 KVA TRANSFORMER TO BE INCREASED TO 300 KVA.
NOTES
ALL NEW SUBSTATIONS KVA RATINGS ARE APPROXIMATE, BASED ON LOAD INFORMATION AVAILABLE TO DATE.
NEW FEEDERS WILL BE SIZED TO ACCOMADATE BOTH AMPACITY AND VOLTAGE DROP
ALL SWITCHGEAR IN NEW WATER/POWER PLANT AT PALMEIRA TO BE DESIGNED TO SERVE ALL PLANT LOAD, INCLUDING WATER TREATMENT, BUILDINGS, SITE, SHOPS, ETC.
PROPOSED SINGLE LINE DIAGRAM
PROPOSED SINGLE LINE DIAGRAM
SAL ISLAND CAPE VERDE
NEWMAN, HIBBLE & PETERS, INC. ENGINEERS
3000 CLEARVIEW AVENUE, N.E. ATLANTA, GEORGIA 30340
DATE DRAWN
SHEET OF SHEETS

Drawing No. 4

Course Location

U.S.A.	3 - 4 month special course at Georgia Tech or similar institution To also include field trips to Key West and U.S. Virgin Islands water/power plants and selected individual power/water utilities in the area
Canary Islands	1 month visiting Cabildo Insulares and other plants at Gran Canaria, Lazarote, and Fuerteventura

Estimated Cost

U.S.A.	Training fee at $2,000/week for 6 persons for 13 weeks	$26,000
	Travel to U.S., six persons	9,000
	Per diem - 13 weeks at $30/day, 6 persons	16,380
		$51,380
Canary Islands	Per diem - 4 weeks at $30/day, 6 persons	5,040
	Internal travel at $200 per person	1,200
		$ 6,240
Total Estimated Cost		$57,620

b. Water and Power Distribution

Suggested Courses	Operation and Maintenance Systems Preventive Maintenance Repair Scheduling Customer Services Billing and Collection General Accounting
Participants Total-4 persons	General Manager - Sal Water Distribution Supervisor Power Distribution Supervisor Administrative Manager

Course Location

Portugal	2-month program at municipal water and power distribution organizations in that country	
Mindelo	1 month working at JAIDA	

Estimated Cost

Portugal	Training fee at $400/week for 4 persons for 8 weeks	$ 3,200
	Per diem - 8 weeks, 4 persons at $30/day	6,720
	Travel at $600 per person	2,400
		$12,320
Mindelo	Per diem at $12/day for 4 weeks, 4 persons	1,344
	Travel at $50/person	200
		$ 1,544
Total Estimated Cost		$13,864

c. Principles and Practices of Seawater Distillation

Suggested Courses
- Process Design and Control
- Mechanical Design
- Components and Materials
- Chemistry of Scale and Corrosion
- Trouble Shooting and Maintenance Procedures
- Specific Equipment Familiarization for Operation and Maintenance

Participants

Total-4 persons
- Assistant Director for Engineering
- Plant Superintendent
- Chemist
- Operations Maintenance Supervisor

Course Location

U.S.A.	2-month special course at Georgia Tech or similar institution to include visits to selected manufacturers of plants, pumps, controls, and instrumentation
	1 month at representative manufacturing facilities of the specific distillation equipment to be supplied
U.S.A. or Other	2 weeks at an operating facility presently using the specific distillation equipment to be supplied

Estimated Cost

U.S.A.	Training fee at $2,000/week, 4 persons for 8 weeks	$16,000
	Travel to U.S.A., 4 persons	6,000
	Per diem-8 weeks at $30/day, 4 persons	6,720
		$28,720
U.S.A.	Per diem-4 weeks for 4 persons at $30/day	$ 3,360
	U.S.A. travel at $200/person	800
		$ 4,160
U.S.A. or Other	Travel at $500/person in U.S.A. for 4 persons	$ 2,000
	Per diem at $30/day for 4 persons, 2 weeks	1,680
		$ 3,680
Total Estimated Cost		$36,560

d. Principles and Practices of Diesel Power Generation

Suggested Courses	Diesel Engine Design Application and Control of Diesel Engines Generator Design Application and Control of Generators Components and Materials Trouble Shooting and Maintenance Procedures Specific Equipment Familiarization for Operation and Maintenance
Participants	Assistant Director for Engineering Plant Superintendent
Total-4 persons	Electrical Engineer Operations and Maintenance Supervisor
Course Location	
U.S.A.	2-month specific course at Georgia Tech or similar institution to include visits to selected manufacturers of engines, generators, and subcomponents 1 month at representative manufacturers of specific engine and generator to be supplied
U.S.A. or Other	2 weeks at an operating facility using specific equipment to be supplied
Estimated Cost	
U.S.A.	

Training fee at $2,000/week for 4 persons, 8 weeks	$16,000
Travel to U.S.A., 4 persons	6,000
Per diem-8 weeks at $30/day, 4 persons	6,720
	$28,720

U.S.A.	Per diem-4 weeks for 4 persons at $30/day	$ 3,360
	U.S.A. travel at $200/ person	800
		$ 4,160
U.S.A. or Other	Travel at $500/person in U.S.A. for 4 persons	$ 2,000
	Per diem at $30/day for 4 persons, 2 weeks	1,680
		$ 3,680
Total Estimated Cost		$36,560

e. Instrumentation and Control

Suggested Courses	Theory of Instrumentation and Control
	Practice for Instrumentation and Control Calibration
	Repair and Maintenance of Instrumentation and Controls
Participants	Operation and Maintenance Supervisor
	Electrical Engineer
Total-3 persons	Instrument and Electrical Technician
Course Location	
Portugal or Spain	2 weeks at a technical trade school
Canary Islands	2 weeks of on-site practice at selected water/power facility

Estimated Cost

Portugal or Spain	Training fee at $200/week for 2 weeks	$ 400
	Travel at $300 per person for 3 persons	900
	Per diem at $30/day, 3 persons for 2 weeks	1,260
		$2,560

Canary Islands	Training fee at $200/week for 2 weeks	$ 400
	Travel at $200/person for 3 persons	600
	Per diem at $30/day, 3 persons for 2 weeks	1,260
		$2,260
Total Estimated Cost		$4,820

f. Chemical Analysis for Scale and Water Quality Control

Suggested Courses	Utility Laboratory Equipment and Management Report Writing and Practices Wet and Solid Analytical Procedures and Apparatus Specific to Facility Requirements Quality Control Data Analysis, Diagnosis and Treatment Prescription Chemical Feeding and Process Cleaning Procedures
Participants	Assistant Director for Engineering Plant Superintendent - Sal
Total-4 persons	Chemist Instrument and Electrical Technician
Course Location	
Portugal	2-week training program at technical trade school
Mindelo	1 month on-the-job training at JAIDA
Estimated Cost	

Portugal	Training fee at $300/week for 4 persons for 2 weeks	$ 600
	Travel to Portugal at $300 per person for 4 persons	1,200
	Per diem at $30/day for 4 persons, 2 weeks	1,680
		$3,480

Mindelo	Travel at $50/person for 4 persons	$ 200
	Per diem at $12/day per person for 4 weeks	1,344
		$1,544
Total Estimated Cost		$5,024

g. Shift Supervision in Power and Water Plant

Suggested Courses	Plant Component Familiarization	
	Plant System Familiarization	
	Operational Planning	
	Data Gathering and Use	
	Distribution Network Water	
	Distribution Network Power	
	On-Job Training at Mindelo	
Participants	Operation and Maintenance Supervisor	
Total-5 persons	Shift Supervisors (4)	
Course Location		
Sal	1-month initial with engineers from U.S.A.	
Mindelo	1-month on-the-job training at JAIDA	
Sal	1-month on-the-job training at proposed plant	
Estimated Cost		
Sal	Per diem at $12/day per person, 4 weeks, 5 persons	$1,680
Mindelo	Same as above	1,680
Sal	Same as above	1,680
		$5,040
Total Estimated Cost		$5,040

TRAINING SUMMARY: ESTIMATED COST-AID

1.	Utility Management, Planning and Policies	$ 57,620
2.	Water and Power Distribution	13,864
3.	Principles and Practices of Seawater Distillation	36,560
4.	Principles and Practices of Diesel Power Generation	36,560
5.	Instrumentation and Control	4,820
6.	Chemical Analysis for Scale and Water Quality Control	5,024
7.	Shift Supervision Power and Water Plant	5,040
	Total	$159,488
	Rounded to	$160,000

30 persons - average $5,333/person trained

403 man-weeks of training - average $397/man-week of training - total

	Years 1-10		Years 11-40	
Amortization (AID)	.02	3,200	.051	8,160

TRAINING NEEDS: GOCV COST - SALARIES

Program	Persons	Wks.	Total Manpower (Man-Wks.)	Average Salary ($/Man-Week)	Total Cost
1. Utility Management	6	21	126	90	$11,340
2. Water Power Distribution	4	13	52	80	4,160
3. Seawater Distillation	4	15	60	80	4,800
4. Diesel Power Generation	4	15	60	80	4,800
5. Instrumentation & Control	3	4	12	90	1,080
6. Chemical Analysis	4	7	28	85	2,380
7. Supervision P/W Plant	5	13	65	80	5,200
Total	30	88	403		$33,760

6. Job Descriptions and Suggested Salaries. Key position descriptions and required qualifications are as follows:

Executive Director	o Administrative background (5 years minimum) o Business experience (utility management preferred) o Engineering degree (M.E., C.E., or E.E.)
Assistant Director for Engineering	o Engineering degree (M.E., Ch.E., C.E., or E.E.) o Project engineering experience o Planning and economic analysis
Assistant Director for Administration	o Business administration or economics degree o Personnel management experience (utility preferred)
Assistant Director for Finance	o Business and/or accounting degrees o Financial management experience (utility preferred)
General Manager - Sal	o Administrative background o Business experience (utility management preferred) o Business administration or engineering degree
Plant Superintendent	o Engineering degree or equivalent (marine, M.E., E.E.) o Utility O & M experience (5 years minimum) o Broad knowledge of thermo-electric processes and equipment, including theory and practice of heat transfer, hydraulics, mechanical transmission; electrical power generation, switching and distribution; chemical treatment
Manager for Administration	o Business administration, personnel, accounting experience and training

Electrical Engineer	o Electrical engineering degree o Project engineering experience (1-2 years) o Utility O & M experience preferred
Plant Operation and Maintenance Supervisor	o Marine or power plant supervisory experience (5 years minimum) o Trades training and experience: diesel engine O & M, electric power generation and distribution, fitting and machining, pipefitting, welding, instrument maintenance, electrical maintenance, and chemical feeding and control
Chemist	o Utility O & M experience preferred o Industrial or full degree in analytical or physical chemistry o 1-2 years process control experience preferred
Water System Supervisor	o Appropriate supervisory experience o Trades training and experience: plumbing/pipefitting, welding, vehicle and field equipment maintenance
Power System Supervisor	o Appropriate supervisory experience o Trades training and experience: electrical, mechanical fitting, welding, vehicle and field equipment maintenance

Salaries presently paid at Almicar Cabral Airport were used as a basis for drawing up the proposed salary scale for the Sal Island project. (See Tables 17 and 18.) Labor costs are itemized by positions and by number of persons needed in each position in Tables 19-22.

Table 17

PRESENT SALARY SCALE
ALMICAR CABRAL AIRPORT
(Selected Positions)

Position	Salary in Escudos		Salary in Dollars	
	Monthly	Annual	Monthly	Annual
Director	13,900	166,800	437	5,251
Deputy Director (Tech.)	10,400	124,800	327	3,929
Air Traffic Officer	10,400	124,800	327	3,929
Communications Technician	8,000	96,000	252	3,024
Mechanic, Telecomunication	6,800	81,600	214	2,569
Mechanic, Radio	5,600	67,200	176	2,115
Mechanic, Electrical	6,800	81,600	214	2,569
Mechanic, Diesel	5,000	60,000	158	1,896
Trade Helper (Mech.)	4,100	49,200	129	1,549
Administrative Manager	8,700	104,400	273	3,287
Secretary	4,100	49,200	129	1,549
Janitor	3,300	39,600	103	1,246

Note: US$1 = E31.76.

Table 18

PROPOSED SALARY SCALE
SAL PROJECT

Position	Salary in Escudos		Salary in Dollars	
	Monthly	Annual	Monthly	Annual
Sal General Manager	15,000	180,000	472	5,664
Plant Superintendent	13,500	162,000	425	5,100
Electrical Engineer	12,000	144,000	378	4,536
Plant Operation and Maintenance	12,000	144,000	378	4,536
Chemist	10,000	120,000	315	3,780
Water System Supervisor	10,000	120,000	315	3,780
Power System Supervisor	10,000	120,000	315	3,780
Diesel Mechanic	9,000	108,000	283	3,396
Shift Supervisor	9,000	108,000	283	3,396
Administrative Manager	8,000	96,000	252	3,024
Water System Foreman	8,000	96,000	252	3,024
Power System Foreman	8,000	96,000	252	3,024
Instrument and Electrical Tech.	8,000	96,000	252	3,024
Fitter and Welder	7,000	84,000	220	2,644
Bookkeeper	5,000	60,000	158	1,896
Personnel Clerk	5,000	60,000	158	1,896
Motor Pool Mechanic	5,000	60,000	158	1,896
Shift Operator	5,000	60,000	158	1,896
Toolkeeper	5,000	60,000	158	1,896
Service and Collection	4,000	48,000	125	1,500
Secretary	4,000	48,000	125	1,500
Warehouseman	4,000	48,000	125	1,500
Meter Reader	3,500	42,000	110	1,320
Trade Helper (Tech.)	3,500	42,000	110	1,320
Laborer - Janitor	3,000	36,000	94	1,128

Note: US$1 = E31.76.

Table 19

PROPOSED INDIRECT STAFF
SAL POWER AND WATER ADMINISTRATION

Position	No. Needed	Monthly Rate Escudos	Monthly Rate Dollars	Total Payroll (US$) Monthly	Total Payroll (US$) Annual
Management					
General Manager	1	15,000	472	472	5,664
Secretary	1	4,000	125	125	1,500
Subtotal		19,000	597	597	7,164
Adm. and Financial					
Administrative Manager	1	8,000	252	252	3,024
Secretary	1	4,000	125	125	1,500
Personnel Clerk	1	5,000	158	158	1,896
Bookkeeper	2	5,000	158	316	3,792
Service and Collec. Clerk	3	4,000	125	375	4,500
Motor Pool Mechanic	1	5,000	158	158	1,896
Warehouseman	1	4,000	125	125	1,500
Meter Reader	2	3,500	110	220	2,640
Trade Helper (Mech.)	2	3,500	110	220	2,640
Laborer - Janitor	2	3,000	94	188	2,256
Subtotal	16			2,137	25,644
Total Indirect Staff	18			2,734	32,808
Income from 40% of Direct Staff Costs					
a. Power/Water Plant					27,566
b. Water System					4,605
c. Power System					4,605
Total Income					36,776
Less Indirect Staff Cost					32,808
Reserve General Adm. Fund for W/P Authority					3,968

Table 20

PROPOSED DIRECT STAFF
POWER AND WATER PLANT

Position	No. Needed	Monthly Rate Escudos	Monthly Rate Dollars	Total Payroll (US$) Monthly	Total Payroll (US$) Annual
P/W Plant Superintendent	1	13,500	425	425	5,100
Electrical Engineer	1	12,000	378	378	4,536
Chemist	1	10,000	315	315	3,780
Op. and Maint. Supv.	1	12,000	378	378	4,536
Diesel Mechanic	2	9,000	283	566	6,792
Shift Supervisor	4	9,000	283	1,132	13,584
Fitter and Welder	2	7,000	220	440	5,280
Instrument and Elec. Technician	1	8,000	252	252	3,024
Tool Keeper	1	5,000	158	158	1,896
Shift Operator	4	5,000	158	632	7,584
Trade Helper	6	3,500	110	660	7,920
Secretary	1	4,000	125	125	1,500
Laborer - Janitor	3	3,000	94	282	3,384
Total P/W Plant	28			5,743	68,916
Add 40% for Gen. Adm.				2,297	27,566
Total Annual Cost P/W Labor					96,482

Table 21

PROPOSED DIRECT STAFF
POWER DISTRIBUTION SYSTEM

Position	No. Needed	Monthly Rate Escudos	Monthly Rate Dollars	Total Payroll (US$) Monthly	Total Payroll (US$) Annual
Power System Supv.	1	10,000	315	315.00	3,780
Power System Foreman	1	8,000	252	252.00	3,024
Secretary	1/2	4,000	125	62.50	750
Trade Helper (Tech.)	3	3,500	110	330.00	3,960
Total Power System	5-1/2			959.50	11,514
Add 40% for Gen. Adm.					4,605
Total Annual Cost Power System Labor					$16,119

Table 22

PROPOSED DIRECT STAFF
WATER DISTRIBUTION SYSTEM

Position	No. Needed	Monthly Rate Escudos	Monthly Rate Dollars	Total Payroll (US$) Monthly	Total Payroll (US$) Annual
Water System Supv.	1	10,000	315	315.00	3,780
Water System Foreman	1	8,000	252	252.00	3,024
Secretary	1/2	4,000	125	62.50	750
Trade Helper (Tech.)	3	3,500	110	330.00	3,960
Total Water System	5-1/2			959.50	11,514
Add 40% for Gen. Adm.					4,605
Total Annual Cost Water System Labor					16,119

Annex 7

FINANCIAL ANALYSIS

FINANCIAL ANALYSIS

This annex will review the financial viability of the proposed project to determine if the present population of Sal Island and the GOCV are capable of assuming the financial responsibility and the operational and maintenance costs of the proposed system. Finally, a financial plan for the proposed project will be presented in detail to show the inputs and outputs that are anticipated.

Financial Rate of Return

As has been indicated earlier in this study, the GOCV is presently subsidizing the production of potable water at a level of some $234,000 a year. No reliable information was available on the production cost of power, but it may also be subsidized by the GOCV. In considering the financial rate of return of this proposed project, other indirect factors need to be remembered.

1. The proposed price of $0.45/m^3 for pure desalinated water on tap in each household is 5.08 times less than the present price of $2.29 for combined pure and brackish water. It is also 5.6 times less than the present pure water price and 5.24 times less than the price of brackish water sold in town. Nondomestic water consumers will pay $0.90/m^3.

2. The price of electric power will remain the same for all GOCV facilities and the Almicar Cabral Airport. The electric power rate for domestic consumers will be reduced from the present $0.142/KWH to the proposed $0.135 (about 4.9%), and the industrial-commercial rate will be reduced from the present $0.188 to the proposed $0.135/KWH.

3. Output of the proposed water/power plant is estimated very conservatively at 83% of capacity, with ample power generation reserve.

4. All yearly costs for amortization, sinking fund, power distribution and delivery, water distribution and delivery, operation and maintenance, staff training, and employee services and support are fully covered.

5. All AID capital investment costs for the proposed project carry an annual fixed charge of 2% per annum interest for years 1-10 and 3% per annum during years 11-40, with years 1-10 requiring interest only. A 2% fee per year (1-40) is also charged on the cost of the water/power plant equipment

to establish a sinking fund which will allow major plant overhaul and equipment replacement every 15 years.

6. All GOCV capital costs also are charged to the project in a straight line over the 40 years with no interest load.

The projected cash flow for the full life of the loan is shown in Table 1.

Table 1

PROJECT CASH FLOW SUMMARY

Income	Years 1-10	Years 11-40
Water	$ 96,496	$ 146,360
Power	732,490	1,227,784
Gross Income	828,986	1,374,144
Annual Costs	774,424	1,124,518
Net Return	54,562	249,626
Rate of Return	6.58%	18.16%

Financial Plan

Detailed breakdowns for each component of the proposed system appear in Annex 6 of this document. The detailed plan is so lengthy that only a summary is offered here, but each component of the proposed system is identified and marked so the reader may refer to the detail in the corresponding section. In calculating the proposed project, nine alternative engineering solutions were considered for the water/power plant; two of these were selected and proposed. The two alternatives are for the same identical water/power plant, but in Case IIB the plant is producing the projected volume of water and power estimated for years 1-10 and in Case IIBi the same plant is at full capacity, as projected for the demand anticipated for years 11-40.

The summaries that follow in Tables 2-5 recapitulate the financial plan for the proposed project.

Table 2

FINANCIAL PLAN SUMMARY:
CAPITAL COSTS, CASES IIB AND IIBi

Item	AID	GOCV
A. Water/Power Plant		
1. Equipment CIF Mindelo	$2,067,230	-
2. Site Work	509,525	$ 235,375
3. Management	443,698	-
4. Contingency (10%)	302,045	23,538
Subtotal	3,322,498	258,913
B. Water Distribution and Delivery		
1. Water Distribution		
2. Water Delivery		
3. Management		
4. Contingency (10%)		
Subtotal	1,305,113	477,840
C. Power Distribution and Delivery		
1. Power Distribution	503,600	138,340
2. Power Delivery	49,500	58,000
3. House Wiring	90,000	90,000
4. Management	90,034	-
5. Contingency (10%)	73,313	28,634
Subtotal	806,447	314,974
D. Training	160,000	33,760
E. Employees Service and Support	170,751	120,120
Total Capital Investment (A + B + C + D + E)	$5,764,809	$1,205,607
Total Project (AID + GOCV)	$6,970,416	

Table 3

FINANCIAL PLAN SUMMARY:
ANNUAL OPERATING COSTS, CASES IIB AND IIBi

	Years 1-10		Years 11-40	
Item	IIB	IIBi	IIB	IIBi
A. Loan Costs				
1. Amortization (2% Interest Years 1-10; 0.02 x TCI-AID)	$115,292	$115,292		
2. Amortization (3% Interest Compound Rate Years 11-40; 0.051 x TCI-AID)			$294,001	$ 294,001
3. Sinking Fund (2% of Plant Equipment)	41,344	41,344	41,344	41,344
Subtotal	156,636	156,636	335,345	335,345
B. Operation and Maintenance				
1. Water/Power Plant	68,916	68,916	68,916	68,916
2. Water Distr. and Delivery	11,514	11,514	11,514	11,514
3. Power Distr. and Delivery	11,514	11,514	11,514	11,514
4. Gen. Administration (40%)	36,778	36,778	36,778	36,778
5. Fuel (Gas/Oil at $155/T)	420,480	587,365	420,480	587,365
6. Chemicals and Supplies	38,446	42,946	38,446	42,946
Subtotal	587,648	759,033	587,648	759,033
C. GOCV Internal Cost				
1. Straight-Line Pay-Back, No Interest, 40 Years	30,140	30,140	30,140	30,140
Total Annual Cost (A + B + C)	$774,424	$945,809	$953,133	$1,124,518

Table 4

FINANCIAL PLAN SUMMARY:
ANNUAL PROFIT AND LOSS, CASES IIB AND IIBi

Item	Unit	Years 1-10 IIB	Years 11-40 IIBi
A. Production Capacity			
Water: 900 m^3/day at 83% Factor for 365 Days	m^3	272,655	272,655
Power: 50,400 KWH/day at 83% Availability Factor for 365 Days	KWH	15,268,680	15,268,680
B. Projected Export (Sales)			
Water:			
Domestic	m^3	145,087	220,062
Ind., Comm., and Gov.	m^3	34,675	52,593
Subtotal		179,762	272,655
Power	KWH	5,425,859	9,094,703
C. Annual Income (Gross)			
Water:			
Domestic at $0.45/$m^3$	$	65,289	99,027
Ind., Comm., and Gov. at $0.90/$m^3$	$	31,207	47,333
Power:			
All at $0.135/KWH	$	732,490	1,227,784
Annual Gross Income	$	828,986	1,374,144
D. Profit/(Loss)			
Annual Gross Income	$	828,986	1,374,144
Annual Cost	$	774,424	1,124,518
Net Return	$	54,562	249,626
Rate of Return	%	6.58	18.16

Table 5

FINANCIAL PLAN SUMMARY:
CAPITAL COSTS, WASTEWATER SYSTEM

Item	AID	GOCV
A. Espargos-Preguiça		
Collection System	$208,300	$104,200
Treatment Plant	108,000	36,000
Irrigation System	54,000	19,300
Subtotal	370,300	159,500
B. Santa Maria		
Collection System	58,800	30,000
Treatment Plant	72,000	24,000
Irrigation System	23,100	8,000
Subtotal	153,900	62,000
Total Capital Costs	$524,200	$221,500

Two main financial issues are left unresolved. One is that of reaching an understanding with the GOCV as to its acceptance of the suggested water and power rates. The second point is to determine how the excess revenue will be used. The project team recommends that the excess revenue be invested in industrial development programs on Sal Island.

Recurrent Budget Analysis and Organizational Plan

Most countries or municipalities requiring seawater distillation for expanding needs for potable water take advantage of the economic synergism obtainable by combining with power generation. Since each product is produced on the same site, it is only logical that management and operation of the facility also be under the same administrative roof, e.g., Kuwait's and Qatar's Ministries of Electricity and Water, Curacao's and the Virgin Islands' Water and Power Authorities, and Las Palmas' municipally owned facilities.

For the proposed Sal facility, it is the unanimous team opinion that such undivided responsibility be an absolute precondition to project recommendation. Equally critical to project success will be the quality and continuity of employment of key staff, both administrative and technical. Care in selection of personnel, coupled with the training program proposed later in this section and presented in detail in Annex 6, should be a good beginning. However, there is considerable concern that the increasing demand in other countries for trained, experienced desalting/power plant operation and maintenance (O&M) personnel will present a strong temptation to emigrate, particularly if better salary, benefits and/or career expectations are offered.

GOCV and design team personnel have discussed (and hereby recommend) an organizational approach which could provide flexibility to offer counter-inducements. This plan is composed of the following elements:

- Establishment of a national water and power authority to operate as an entirely self-supporting entity, reporting to a Board of Directors but with planning and policy directed by the Council of Ministers.
- Authorization for all personnel administration (hiring, promotion, termination, and salaries) to be handled independently of Civil Service regulations.
- Provision of tangible benefits (e.g., partially subsidized housing with modern amenities such as plumbing, kitchen appliances, etc.). These are presented in more detail later in this section.

GOCV officials who are aware of current O&M personnel attitudes have stated that turnover of key personnel could be limited by a combination of selective, moderate salary increases and the development of an esprit de corps inherent in a lean, efficient, and self-supporting organizational unit.

The national organization (Figure 1) probably should be located in São Vicente, which is also the site of the JAIDA administration, the older 2,200 m^3/d distillation plant, and its planned expansion (Mindelo 'B', 6,000 m^3/d and 5-10 MW). Some of the more obvious benefits derived from a national authority are:

- Coordination of national project planning for all islands with GOCV.
- Centralization of purchasing of consumables for greater economy.
- Centralization of personnel and salary administration to avoid interisland competition.
- Mobilization of skilled engineering and financial expertise as required for specific problems.

The proposed organization for Sal Island is intended to provide complete coverage of all O&M requirements for production, distribution, revenue collection, and personnel administration.

Figure 2 delineates the organization that is proposed for Sal Island. Full details, including individual job descriptions, salary scale, and number of employees, are presented in Annex 6.

Training Needs

Seven different training needs have been identified by the project team and technical staff. These training needs are as follows:

- Utility management planning and policies.
- Water and power distribution.
- Principles and practices of seawater distillation.
- Principles and practices of diesel power generation.
- Instrumentation and control.
- Chemical analysis for scale and water quality control.
- Shift supervision power and water plant.

As previously indicated, a training program has been designed. A description of the training program and a detailed cost breakdown are

Figure 1

PROPOSED ORGANIZATIONAL PLAN
NATIONAL WATER AND POWER AUTHORITY
REPUBLIC OF CAPE VERDE

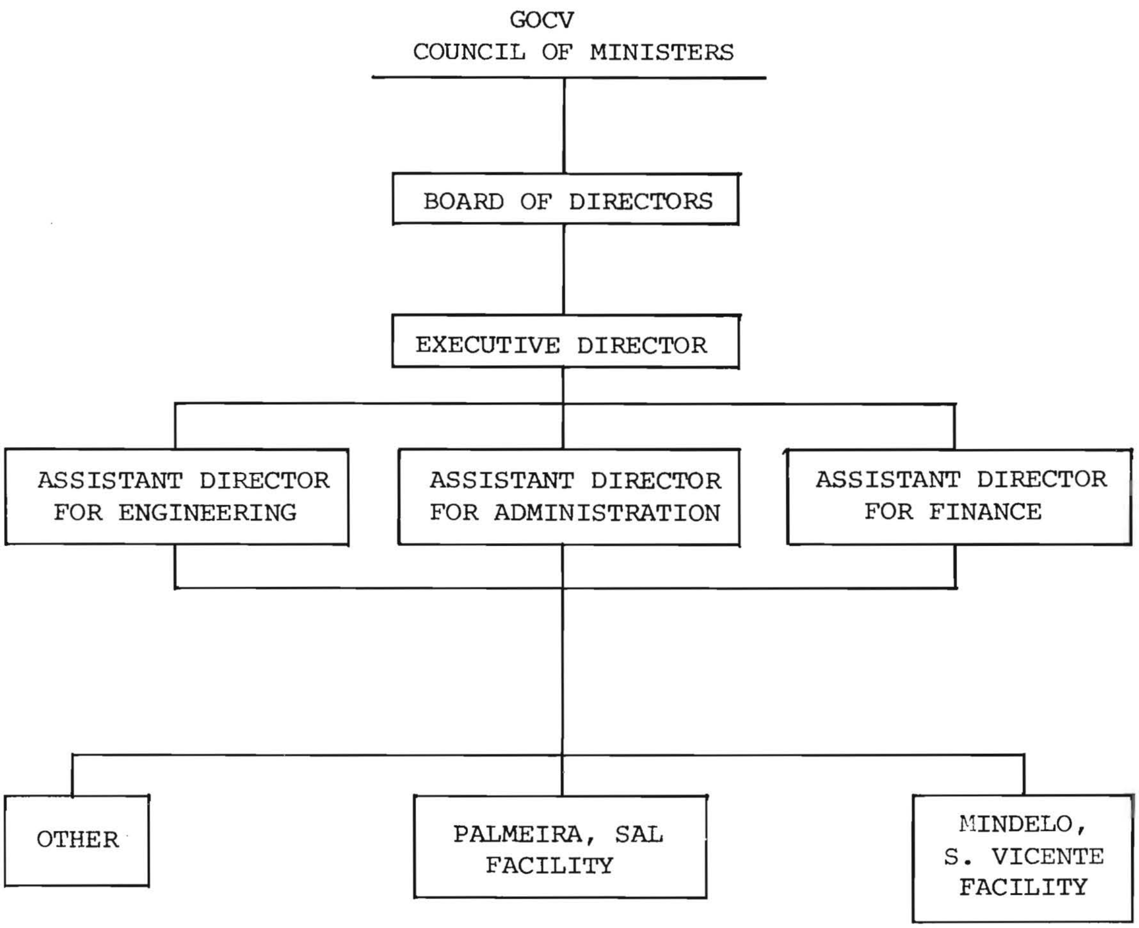
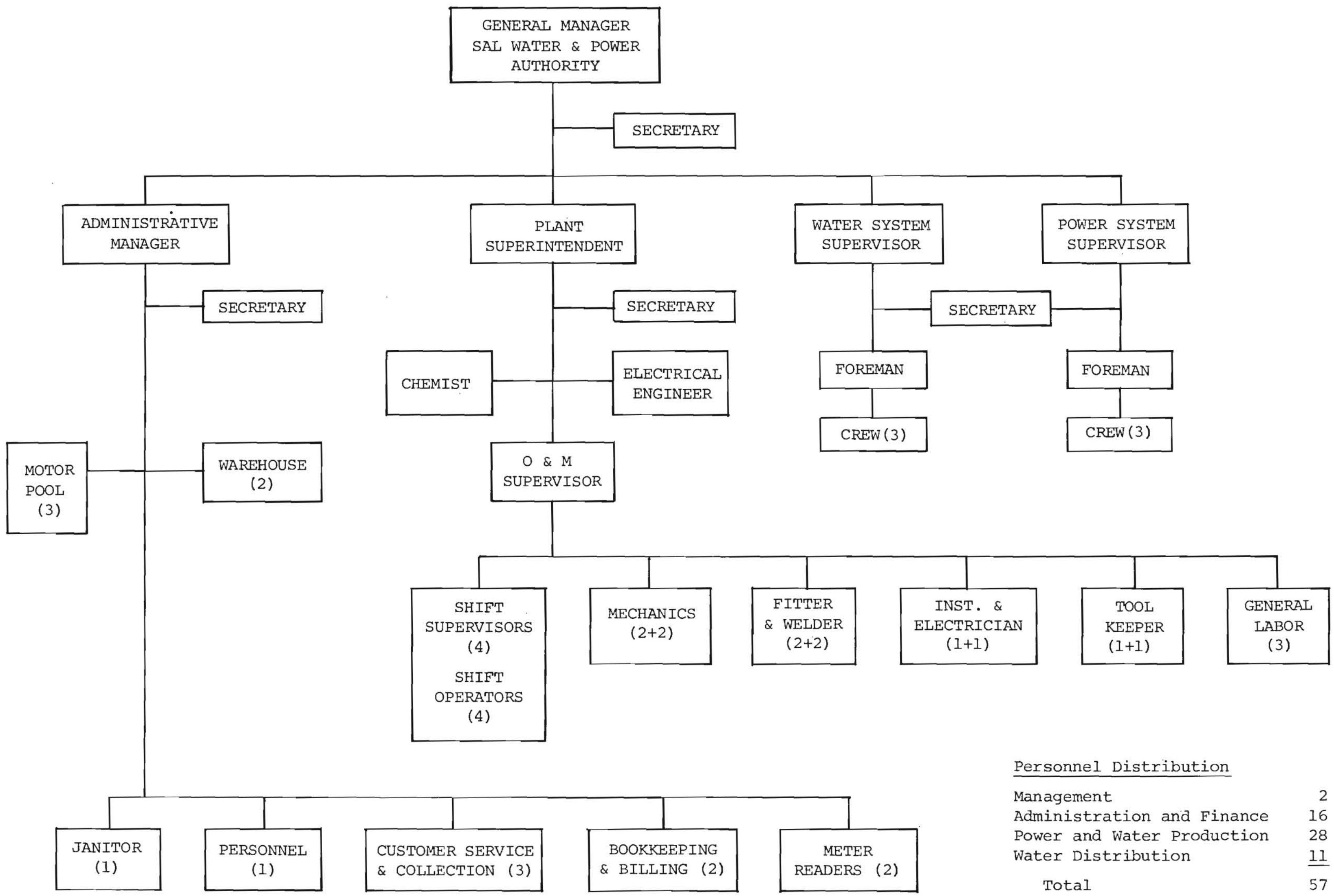


Figure 2

PROPOSED ORGANIZATIONAL PLAN
WATER AND POWER FACILITY
PALMEIRA, SAL ISLAND



Personnel Distribution

Management	2
Administration and Finance	16
Power and Water Production	28
Water Distribution	11
Total	57

presented in Annex 6. The required training program represents an additional cost of $160,000 for AID and $33,760 by the GOCV. On the basis of $160,000 for training, the annual amortization would be $3,200 for years 1-10 and $8,160 for the balance of the loan.

Employee Service and Support

The better-trained staff members presently in Cape Verde generally are seeking other employment away from Cape Verde. If the GOCV plans to retain this well-trained staff as proposed, it needs to initiate a series of selective tangible benefits for the permanent staff.

This project proposes to build 20 homes for the use of the key personnel which would include modern amenities (i.e., plumbing, kitchen, appliances, electric power, and other facilities).

Housing. Single-family housing will be provided for 20 employees. These houses will include two to three bedrooms, kitchen, bath, living room, and storage room. The kitchen will contain a stove, sink, refrigerator, and cabinets. The bath will include a commode, sink, and shower. A septic tank will be provided for sanitary treatment. Figure 3 presents the floor plan for a typical house as proposed.

Company Store. A general store will be provided at Palmeira. It will be stocked with food, clothing, medical supplies, fuel and other simple items needed by employees. A cold storage locker will be provided to allow storage for stock perishables. The store will be operated under lease but supervised by the water/power authority and will be nonprofit.

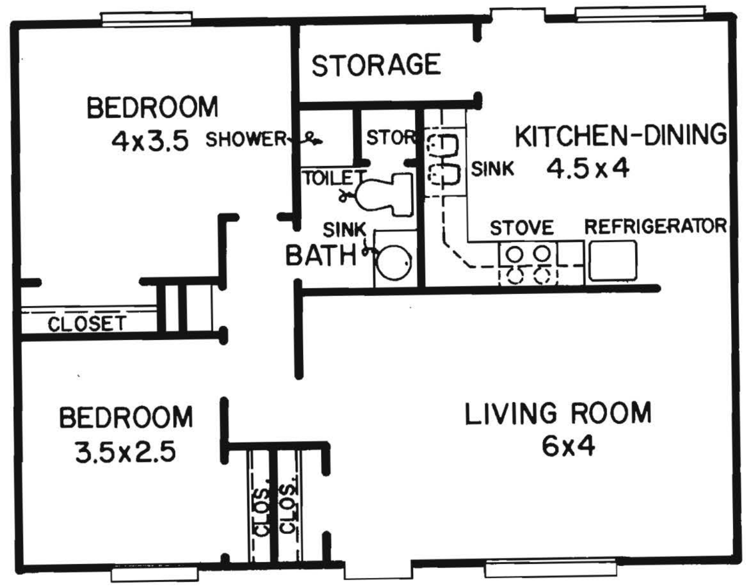
Medical Service. A first aid room will be included in the administration building for use by a nurse. She will administer first aid and will be assisted by a medical doctor for major medical needs.

Administration. The administration building has been expanded to house some of these support services. Figure 4 presents the floor plan of the proposed administration building.

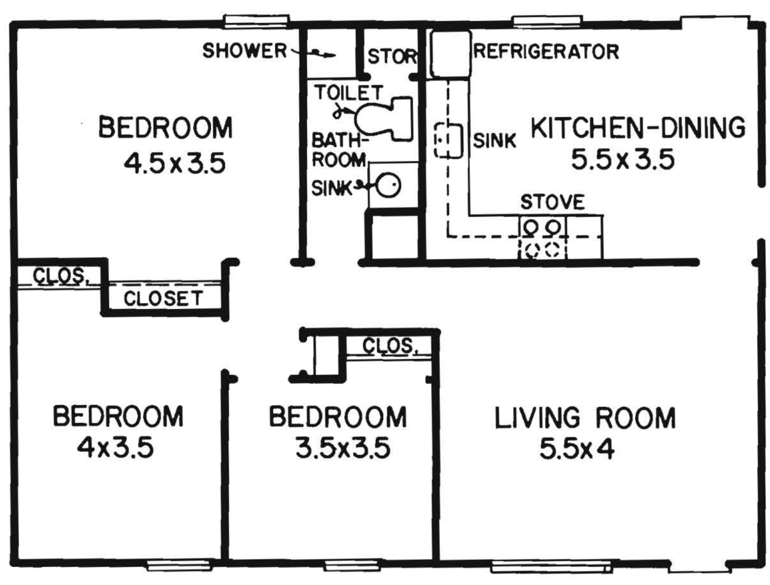
Transportation (Vehicle Pool). Twelve vehicles are needed to support the water/power plant, water system, power system, meter reading, billing, customer services, and other functions. These vehicles are also included in the proposed project. A 15-seat mini-bus also is included to be used if

Figure 3

EMPLOYEE HOUSE FLOOR PLANS



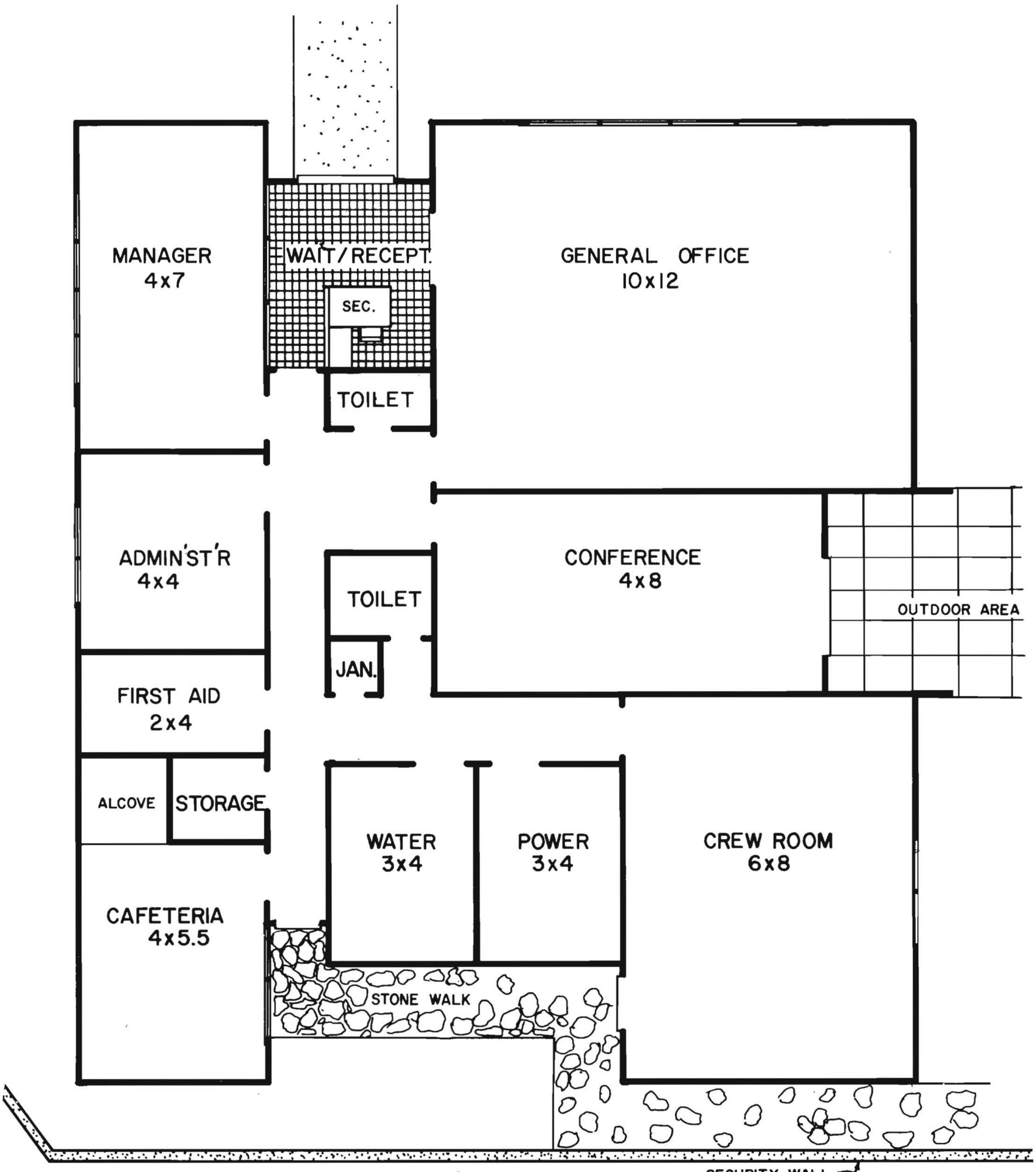
2 - BEDROOM



3 - BEDROOM

CAPE VERDE
SAL ISLAND

Figure 4



WATER / POWER
ADMINISTRATION BUILDING
FLOOR PLAN

CAPE VERDE
SAL ISLAND
PALMEIRA

needed in collecting and returning employees; otherwise, it will be used during normal maintenance and operation activities.

Table 6 presents a summary of the costs for the items under Employee Service and Support. Total capital costs are $170,751 for AID and $120,120 for the GOCV. The AID loan portion would be amortized at a rate of $3,415 per year for years 1-10 and $8,708 per year for years 11-40.

Table 6

EMPLOYEE SERVICE AND SUPPORT SUMMARY

Item	AID	GOCV	Total
A. Housing			
20 single-family homes as per typical house plan, complete kitchen with stove, sink, refrigerator, and cabinet at $7,000 per unit	$ 56,000	$ 84,000	$140,000
B. Administration Building			
355 m^2 building to house administrative offices of W/P system	16,800	25,200	42,000
C. Vehicle Pool - CIF Mindelo			
W/P Plant Subsystem:			
Pickup truck	4,140		4,140
Forklift	16,100		16,100
Power Subsystem:			
Winch truck	10,005		10,005
Pickup truck	4,140		4,140
Water Subsystem:			
Pickup truck	4,140		4,140
1-1/2 ton flatbed truck	8,855		8,855
General Service:			
Mini-bus	6,670		6,670
2 motor bikes	1,035		1,035
2 cars, administrative use	8,280		8,280
Total (A + B + C)	$136,165	$109,200	$245,365
Engineering, 14% (A + B)	19,063		19,063
Subtotal	155,228	109,200	264,428
Contingency, 10%	15,523	10,920	26,443
Grand Total	$170,751	$120,120	$290,871

AID (59%) GOCV (41%)

	Years			
	1-10		11-40	
AID Amortization	.02	$3,415	.051	$8,708

Annex 8

SOCIAL ANALYSIS

SOCIAL ANALYSIS

The majority of the inhabitants of Sal Island are located in the central east-west section of the island. This concentration is directly related to the location of the islands' principal industry, the Almicar Cabral International Airport. Near the airport are located the two principal cities -- Espargos and Preguiça. According to the industry survey conducted by the project team (Annex 9), some 600 persons are employed directly or indirectly by the international airport.

The economy of Sal Island has two other sources of primary employment: (1) the two salt production facilities and (2) the fish cannery and lobster fishing facilities. All of the 10 principal enterprises of the island were surveyed by the project team; descriptions of these enterprises are presented as part of Annex 9.

1. Historical Overview. The Cape Verde Archipelago apparently was visited by Arab sailors during the 12th century, but was not discovered and claimed by the Crown of Portugal until 1456 when a Portuguese vessel was shipwrecked on the island of Boa Vista. The Portuguese colonized the Cape Verde Islands and for the following 300 years used the archipelago as a way station for Portuguese ships. The slave traders used the Cape Verde Islands as a staging point for the ships on the triangular route Europe, Africa, South America. As long as the slave trade flourished, the Cape Verde Islands prospered, but by the 19th century, the archipelago had been facing economic depression for some time. To further aggravate this condition, the islands suffered cyclical droughts and epidemics. According to local records, the drought (the Sahel and belt) was recorded as far back as 1580. Typical entries in local records read as follows:

1685 - 1689	400 dead - Island São Tiago
1773 - 1775	28,000 dead - total archipelago
1830 - 1833	30,000 dead - total archipelago
1850 - 1865	11,000 dead - cholera
1940 - 1945	30,000 dead - total archipelago

Following the emancipation of the slaves on Cape Verde in 1875, a steady emigration of the free population started to take place. These emigrants went mainly to the United States, Brazil, and Senegal. Later, others went to Holland, France, and Italy. The emigration was still in progress at the turn of the century, with some of the people of the archipelago going to Angola, Guinea, Mozambique, and Portugal.

Early in 1960, the liberation movement started in most of the Portuguese territories in mainland Africa. As a result of this movement, there developed an informal bond or alliance between Cape Verde and Guinea-Bissau. Independence followed, and in 1975 Cape Verde emerged as a nation.

2. Emigration. The project team tried to determine, while on Sal, the number of inhabitants who had family or relatives living in the United States, but no reliable information was obtained. Later a contact was made with representatives of the Cape Verde colony living in the state of Massachusetts, and the following information was provided.

It is estimated that there are 275,000 to 300,000 Cape Verdians living in the state of Massachusetts. At present, when they arrive in Massachusetts, they tend to move into the Roxbury section of Boston, where there are some 6,000 Cape Verdians in residence. The largest single colony (descendents of Cape Verdians) consists of some 17,000 persons living in New Bedford, Massachusetts. The team was informed that between 80 and 90 visas are issued each month to citizens of Cape Verde.

Social security and other financial assistance from the U.S. Cape Verde colony to families still on the islands continues to play an important economic role. In 1975, it was estimated that about $6 million per year was sent by the U.S. relatives to the families on Cape Verde. Approximately $960,000 per year is paid by Social Security, Veterans Administration, and other government agencies to Cape Verde residents. These benefits are received by approximately 700 persons in the Cape Verde Islands and the Azores.

3. Population Overview. As was indicated earlier in this section, the Portuguese populated the archipelago, including Sal Island. A recent study conducted by an AID team determined the population on Sal Island to be about 8,000 persons living mainly in five communities and dispersed as presented in Table 1.

Table 1

POPULATION DISPERSION,
SAL ISLAND, 1975

Community	Population	% of Total
Santa Maria	1,500	18.87
Espargos	2,750	34.59
Preguiça	2,750	34.59
Palmeira	600	7.55
Pedra Lume	350	4.40
Total	7,950	100.00

Source: "Project Review Paper, Cape Verde Desalination and Power," R. R. Solem, Bruce Watson, and Kennette Soares, unpublished, 1976, p. 8.

The Portuguese who came to the Cape Verde Islands during the years of the colony were mainly soldiers and administrators. They also imported slaves from Africa, and the present population is basically a mix of these two basic groups. There is some interisland movement of population, usually directly influenced by the availability of work. During the planting and harvesting seasons, members of the population of Sal Island will move to São Nicolau or other islands to work for a period of time and then return to their home island. This movement is estimated at about 500 to 1,000 persons per year. The main problem faced by the inhabitants is the continuing drought which, in turn, forces them to import nearly all food products from the other islands or from the mainland.

The team decided to conduct a simple random sampling of the population in order to gather factual information in reference to the social conditions, income, expenditures, and other factors. Interviews were conducted by native volunteers under the guidance of government officials; the questionnaires were prepared by the project team. The results of the survey are discussed in this section, but the team recognizes that this sample is not statistically correct nor was it gathered under the methodological guidelines utilized in gathering census data.

The total sample covered 82 households on the island in three communities--Santa Maria, Espargos, and Preguiça. In many instances the resulting questionnaires were considered void or unusable because the replies were incoherent, obviously in error, or simply not legible. The caveats concerning the sample survey data always should be considered in reading this section.

On the subject of age distribution within the sampled households, 41 questionnaires were usable (50% of a total of 82). The results were projected for a total population of 8,000 (rounded from 7,950), as presented in Table 2.

The AID team of Solem, Watson, and Soares indicated that "50% of the population is 15 years of age or younger," and this appears to be true in the random sample as presented in Table 2. If these figures are presented graphically, the resulting "pyramid" has a nontraditional configuration. (See Figure 3 in the main body of this report.)

Table 2

AGE DISTRIBUTION,
SAL ISLAND, 1977

Age Group	No. in Sample	% of Total	Projection to 8,000 Population
0-16	152	58.69	4,696
17-29	45	17.38	1,390
30-39	30	11.58	927
40-49	12	4.63	370
50-59	9	3.48	278
60-69	8	3.09	247
70 and over	3	1.15	92
Total	259	100.00	8,000

Source: On-site data gathered by project team.

From Table 2, the team concluded that the job market must be characterized by very early entry if some 5,000 persons are employed or underemployed, as reported by the Solem, Watson, and Soares team. This early entry into the labor force provides little opportunity for full employment of the population and is one additional reason for the continuing out-migration.

All of the 82 sample households answered the question relating to distribution of the population by sex. The 82 samples reported a total of 569 persons (an average of 6.93 persons per household), but of these only 489 were indicated by sex. Table 3 presents a summary of the distribution by sex resulting from the random sample.

Table 3

POPULATION DISTRIBUTION
BY SEX, SAL ISLAND, 1977

Classification	No. in Sample	% of Total	Projection to 8,000 Population
Total Population	489	100.00	8,000
Male	265	54.19	4,335
Child	144	29.44	2,355
Adult	121	24.75	1,980
Female	224	45.81	3,665
Child	107	21.89	1,751
Adult	117	23.92	1,914

If the sample is representative, the male population of Sal Island represents 54.17% of the total and the female population is 45.81% of the total.

4. Income Distribution. The earlier study by Solem, Watson and Soares indicated that some 2,400 persons were fully employed, 3,000 were under-employed and 250 were unemployed. In an industrial survey, the project team contacted all principal industrial/commercial activities on the island and could identify only about 960 full-time employees and 109 part-time employees. In the process of gathering this information, the team also identified the most prevalent wage levels for employees on the island of Sal. Table 4 presents this information.

Table 4

REPRESENTATIVE SALARIES AND WAGES,
SAL ISLAND, 1977

Position	Monthly Salary or Wage Escudos	Monthly Salary or Wage Dollars
At Almicar Cabral Airport:		
Director	13,900	437
Deputy Director (Technical)	10,400	327
Communications Technician	8,000	252
Mechanic-Telecommunication	6,800	214
Mechanic-Diesel	5,000	158
Trade Helper (Mechanical)	4,100	129
Secretary	4,100	129
Janitor	3,300	103
Driver	4,100	129
Nurse/Social Service	6,000	188
Stone Mason	3,800	119
Carpenter (Top Class)	4,200	132
At Other Locations: (Annex 9)		
Salt Collector	1,760	55
Mechanic	2,860	90
Welder	2,640	83
Cook	3,500	110
Water	2,000	63
Cleaning Staff	1,500	48
From Samples of 82 Households:		
Sailor	2,000	63
Taxi Driver	3,000	95
Radio Mechanic	5,800	182
Receptionist	3,700	116
Teacher	3,000	95
House Maid	1,500	48
Store Clerk	2,300	73
Fisherman	4,700	148

From Table 4, it is apparent that the salary range for Sal Island is about as follows:

Upper	\$250-\$450/month
Middle	150- 250/month
Lower	150- 50/month

On the subject of household income and income distribution within the household budget, only 31 of the 82 samples were sufficiently complete to be used. The 31 sampled households reported 208 persons sharing a total reported income of 174,045 escudos (E) per month or an average of 5,614 E per household (about \$175 per month). It appears that the random sample touched only the middle-income group and did not get inputs from the lower-income population.

5. Labor Force. The project team was unable to obtain reliable information on the number of persons at present employed or underemployed on Sal Island. However, from the age distribution shown in Table 2 and the reported distribution by sex as shown in Table 3, it is obvious that, even allowing for very early entry into the labor force, there are about 4,100 persons classified as "children." Consequently, about 51% of the population is not old enough to work. To this, one must add another 4% over 60 years of age, or 339 persons. Thus, well over 55% of the population is not capable of employment. The remaining 45%, 3,600, probably comprises approximately 1,950 males and 1,650 females of working age. The industrial survey accounted for 960 fully employed or 27% of the estimated labor force, and the balance is either employed elsewhere, underemployed, or unemployed. Table 5 presents the labor force profile for Sal Island, based on the recently gathered information.

Table 5

POPULATION PROJECTION, SAL ISLAND

Classification	Projection to 8,000 Persons: Number	Percent
Children (under age)	4,106	51.33
Adults over 60 years	339	4.24
Available labor force	3,555	44.43
Total	8,000	100.00

It is also apparent from on-site observation that most females (about 3,665 persons or 45,81% of the population) are not gainfully employed. They are usually occupied in such traditional pursuits as continuous child-bearing, house chores, fetching water or fuel, and other similar activities. If one considers the available labor force of 3,555 and the female average of 45.81% or 1,629 persons is deducted, that only leaves 1,926 men in the labor force of whom 960 are presently fully employed, according to the industry survey presented in Annex 9.

6. Distribution of Time. At the household level, the female members are responsible for the traditional tasks associated with the home, while the male members are household heads and are responsible for the provision of funds and food for the family. The random dwellings visited by the project team consisted in general of a living room, two sleeping areas, kitchen, eating area, courtyard, and bathroom. The female members of the family are responsible for the upkeep, cleaning, and general maintenance of the living quarters together with other regular chores. An attempt was made in the random survey to determine the distribution of time among various tasks by the persons responsible for the household; out of 82 responses, only 31 were usable (38%).

According to the information gathered from the random sample, the typical household day is divided as follows:

Hours	Activities
3.58	Preparing food
2.56	Caring for clothing
0.56	Shopping
1.00	Cleaning house
1.23	Fetching water
12.00	Eating, sleeping, and nighttime
3.07	Unaccounted
24.00	

7. Health. Very few homes in Sal Island have piped-in water and only some 300 appear to have electric power. As was indicated earlier in this report, water is usually brought into the home via a wooden barrel rolled from the nearest water point. The used water (both gray and brown) is dumped outside. Since few families have toilet facilities or septic tanks, the

human waste (night waste) usually is disposed of either by dumping into a hole leading to a septic tank or by using a container which is later emptied into any open area away from the household. Both of the above systems generate flies (which are plentiful) and serve as breeding places for many diseases.

It is a fact that an improvement in the water supply and sanitation of a community can generate interrelated improvements in health, income, and general social welfare. This project does not intend to use the health benefits as a means to justify the suggested investment expenditures; nevertheless, there are many possible health benefits that may well be derived from the water supply and sanitation portion of this proposed program.

Water-related diseases that directly affect the health of the population are relatively widespread and abundant in most developing countries; Sal Island is not an exception. The incidence of these known diseases will depend on the local climate, geography, culture, sanitary habits, sanitary facilities and, most of all, on the quality and quantity of water available to the population.

The well-known Dr. David J. Bradley, in a research paper entitled "Infective Disease and Domestic Water Supplies" edited by the University of Dar es Salaam and presented in 1971, indicates that there are five principal groups of water-related diseases:

Waterborne Diseases. Water acts only as a passive infecting agent. All of these diseases also depend on poor sanitation.

Water-Washed Diseases. Lack of water and poor personal hygiene create conditions favorable for their spread. The intestinal infections in this group also depend on lack of proper human waste disposal.

Water-Based Diseases. A necessary part of the life cycle of the infecting agent takes place in an aquatic animal. Some are also affected by waste disposal. Infections spread other than by contact with or ingestion of water have been excluded.

Diseases with Water-Related Insect Vectors. Infections are spread by insects that breed in water or bite near it. Adequate piped supplies may remove population from the biting areas or enable them to dispense with water storage jars where the insects breed. Unaffected by waste disposal.

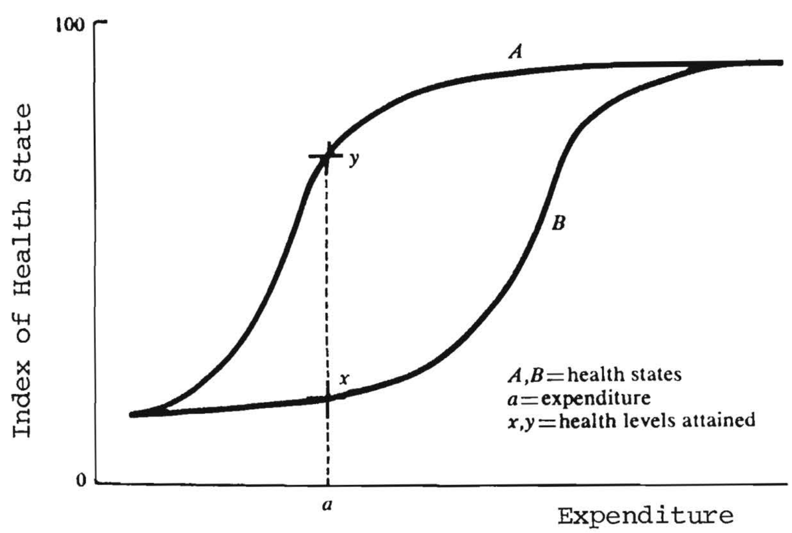
Diseases Related to Fecal Disposal and Very Little Affected by Water More Directly. These are one extreme of a spectrum of diseases, mostly water-washed, together with a group of water-based type infections likely to be acquired only by eating uncooked fish or other large aquatic organisms.

A research report on village water supply, conducted by the team of Saunders and Warford, summarizes these water-related diseases as shown in Table 6. The same study also indicates that water-related diseases would be greatly reduced if pure, potable water were provided. Table 7 presents the expected rates of reduction given in the study.

Another interesting point discussed in the Saunders-Warford study is the relation between village health and the cost of supplying pure water. This hypothetical relationship was delineated by the research team as shown in Figure 1.

Figure 1

HYPOTHETICAL RELATIONS BETWEEN VILLAGE HEALTH AND COSTS OF WATER SUPPLY PROJECT



Source: Saunders and Warford, p. 115.

Table 6

DISEASES RELATED TO DEFICIENCIES
IN WATER SUPPLY OR SANITATION

Group	Diseases	Route Leaving Man[a/]	Route Entering Man[a/]
Waterborne Diseases	Cholera	F	O
	Typhoid	F,U	O
	Leptospirosis	U,F	P,O
	Giardiasis	F	O
	Amoebiasis[b/]	F	O
	Infectious hepatitis[b/]	F	O
Water-Washed Diseases	Scabies	C	C
	Skin sepsis	C	C
	Yaws	C	C
	Leprosy	N(?)	?
	Lice and typhus	B	B
	Trachoma	C	C
	Conjunctivitis	C	C
	Bacillary dysentery	F	O
	Salmonellosis	F	O
	Enterovirus diarrheas	F	O
	Paratyphoid fever	F	O
	Ascariasis	F	O
	Trichuriasis	F	O
	Whipworm (Enterobius)	F	O
	Hookworm (Ankylostoma)	F	O,P
Water-Based Diseases	Urinary schistosomiasis	U	P
	Rectal schistosomiasis	F	P
	Dracunculosis (guinea worm)	C	O
Water-Related Vectors	Yellow fever	B	B mosquito
	Dengue plus dengue hemorrhagic fever	B	B mosquito
	West-Nile and Rift Valley fever	B	B mosquito
	Arbovirus encephalitides	B	B mosquito
	Bancroftion filariasis	B	B mosquito
	Malaria[c/]	B	B mosquito
	Onchocerciasis[c/]	B	B Similium fly
	Sleeping sickness[c/]	B	B tsetse
Fecal Disposal Diseases	Hookworm (Necator)	F	P
	Clonorchiasis	F	Fish
	Diphyllobothriasis	F	Fish
	Fasciolopsiasis	F	Edible plant
	Paragonimiasis	F,S	Crayfish

[a/] F = feces; O = oral; U = urine; P = percutaneous; C = cutaneous; B = bite; N = nose; S = sputum.

[b/] Though sometimes waterborne, more often water washed.

[c/] Unusual for domestic water to affect these much.

Source: Robert J. Saunders and Jeremy J. Warford, Village Water Supply, Economics and Policy in the Developing World, the Johns Hopkins University Press, Baltimore, Md., 1976, p. 32.

Table 7

RATES OF REDUCTION OF DISEASES
THROUGH PROVISION OF POTABLE WATER

Diseases	Percent Reduction
Typhoid	80
Paratyphoid and other Salmonella diseases	40
Bacillary dysentery	50
Amebiasis	50
Dysentery, unspecified	50
Louseborne typhus	40
Urinary schistosomiasis	80
Intestinal schistosomiasis	40
Schistosomiasis, unspecified	60
Ascariasis	40
Guinea-worm infestation	100
Louseborne relapsing fever	40
Leptospirosis	80
Yaws	70
Trachoma	60
Trypanosomiasis (T. gambiense)	80
Trypanosomiasis, unspecified	10
Scabies	80
Inflammatory eye diseases	70
Otitis externa	40
Dental caries	10
Gastroenteritis (age 4 weeks to 2 years)	50
Gastroenteritis (over 2 years)	50
Skin and subcutaneous infections	50
Chronic skin (leg) ulcer	40
Diarrhea of the newborn	50
Tinea	50

Source: Saunders and Warford, p. 114.

In conducting this research, the project team also noted that the quantity of water used by individuals has been found to be associated with the incidence and prevalence of several of the diseases common to the population of less-developed countries and the "rural poor." The World Health Organization (WHO), in its "Community Water Supply and Sewage Disposal in Developing Countries," Statistics Report, Vol. 26, No. 11, has indicated that there are great variations in the amount of water consumed, but always reports higher consumption in the case of water being available through a "house connection." It is apparent that the relative convenience (nearness) of a water tap influences the health of water users because (a) they tend to consume more water and (b) the water is less likely to be contaminated.

The study by Messrs. Saunders and Warford concludes with the following observation on health-related benefits: "A review of twenty-eight empirical studies that examine the relation between the quality and quantity of water consumed, sanitary facilities, and the level of various water and sanitation-associated diseases, provides some evidence that more and better water and better sanitary facilities are associated with better health."

8. Medical Services and Health Problems. Sal Island has one "hospital," located in Espargos. This facility has two wards and, at present, seven beds. One doctor and three nurses are available. There is a smaller facility at the airport staffed by one nurse and an assistant. No other facilities are available on the island.

All medical services are free, including medications. The Espargos hospital reports caring for 30 to 40 patients per day. Typical diseases requiring treatment are:

Children

Disease Type	Hospital Comment
Gastroenteritis	Waterborne
Throat Infections and Colds	Common
Measles	Epidemic-periodic
Typhoid	Isolated cases
Vitamin Deficiency	Poor diet

Adults

Disease Type	Hospital Comment
Gastroenteritis	Waterborne
Pregnancy	Malnutrition-infant mortality 90/1,000 at birth
Vitamin Deficiency	Poor diet
Throat Infection	Common

9. Implications of Increase in Availability of Water and Power. Bacteriological analyses of the Sal Island water supplies are not available. During the years of Portuguese government, water tests were made, but present government does not consider them reliable. Local medical staff on Sal Island agree that pure, piped-in potable water would make a tremendous contribution toward improving the present health standards and in reducing prevalent diseases. This is further supported by the information presented earlier in this same section. As proposed at the beginning of this project, it is the desire of the GOCV to provide each person with 50 liters of pure water per day and each household with 100 KW of electrical energy per month.

In addition to the obvious beneficial effect of pure water on the general health of the population, other social benefits would be generated by the proposed provision of power and water, such as:

- Increased personal bathing and better body hygiene.
- Improved food preparation hygiene and generally better cooking conditions.
- Better laundering methods, resulting in general improvements in the appearance of the people.
- Better food storage methods--iceboxes, refrigerators, etc.
- Improved eating habits through amelioration of the present "feast or famine" conditions.
- Reduction in time required for basic household tasks.
- Enhancement of the role of the female household members by alleviation of some of the more sordid tasks.

Figures 2 and 3 are indicative of the way of life on Sal Island.

Figure 2

GROUP OF CHILDREN, SAL ISLAND

Figure 3

CHILDREN GETTING WATER FOR THE HOUSEHOLD

Annex 9

INDUSTRIAL SURVEY AND POTENTIAL INDUSTRIAL ACTIVITIES

INDUSTRIAL SURVEY OF SAL ISLAND

Santa Maria

Companhia de Fomento Cape Verde (CFCV). This company produces salt from seawater through solar evaporation. It was established on Sal Island on or about 1827, and the same Portuguese family has been in this business all these years. They employ 80 persons full time and an additional 40 persons when the ship is being loaded with the export salt. They produce 1,000 metric tons per month and could produce more, but the demand is not that high. The ship formerly came in every month to load, but now it only comes in every two months and takes 2,000 tons of salt. The salt is transported to Zaire, where it is sold locally and a small portion is refined for table salt. In Zaire, there is a fair demand for this type of unrefined salt for use in salting meat and food for preserving.

The 80 full-time employees are paid about 80 escudos a day (US$2.52). The laborer's output is measured in wheelbarrows of salt (given size); this is salt that is collected from the "salt pan." Each worker is paid by the number of wheelbarrows he fills per day. A good worker earns his 80 escudos in about six hours.

The salt is bagged in 18 kg bags (plastic material) at the time the ship is about to arrive. The bags are then stored in a small warehouse. When the ship arrives, all salt gathering is stopped and the 80 employees, plus 40 additional persons, are used in bagging and carrying bags. The 18 kg bags are carried to the barges and then from there to the ship. The salt collectors (62 persons) are all male. Of the 40 part-time help, as many as 50% may be female.

The supervisors and long-time employees (over 15 years of service) are provided with houses by the company.

Not counting the office staff, the monthly payroll is about $4,294. To this must be added the additional 40 persons every two months for bagging and loading. The loading people can load about 500 tons per day and are employed about four days every two months to do this.

Particulars on the 80 full-time employees are as follows:

Type of Work	No. Emp.	Average Salary/Day E	Average Salary/Day $	Average Monthly/Salary E	Average Monthly/Salary $	Monthly Payroll E	Monthly Payroll $
Salt Collector	62	80	2.52	1,760	55.41	109,120	3,435.42
Mechanic	4	130	4.10	2,860	90.05	11,440	360.20
Welder	1	120	3.78	2,640	83.12	2,640	83.12
Carpenter	3	120	3.78	2,640	83.12	7,920	249.36
Helper	4	60	1.89	1,320	41.56	5,280	166.24
Office	6	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Total	80					136,400	4,294.34

The company has a garage, a blacksmith shop, and a carpentry shop. It has no water supply and only one electric outlet to run the welding machine. No water or power is used by the process and what little is needed is purchased from the local plant.

Nascimento e Cia. This local plant fishes and processes tuna fish and also produce fertilizer as a by-product. Company is Portuguese and has been in business since about 1925.

(1) Fishing Fleet. They have four fishing boats, but only two are in use at present. Each boat has a crew of 12 persons, including the captain and the cook. The ship first fishes for bait using nets. Once the live bait is gathered, the ship continues to the usual location of the tuna. Live bait is thrown overboard until the tuna are attracted to the ship, then all the crew fishes using poles with two-meter lines and unbaited hooks. In about 45 minutes they can usually pull out 1-1/2 metric tons of tuna. When the ship has a full load of between four and five tons, it heads back to the port. The fleet currently employs 25 persons during the fishing season.

Several of the ships used by the fishing fleet appear in Figure 1.

(2) Cannery. The cannery imports sheet metal and produces its own cans of assorted sizes, from the smallest (sardine can) to a large 2-1/2 kg can. The tuna brought in by the fishing fleet is then opened and cleaned; the meat is cooked and then packed into cans by hand. It is packed either in oil or in water. The cannery operates only about six months out of the year. It has a staff of 25 persons of whom four are male and 21 are female. They are paid an average of 5 escudos per hour or about 40 escudos per day ($1.26 per eight-hour day).

Figure 1

FISHING VESSELS, SAL ISLAND

There are 10 additional persons at the cannery who take care of the ship repairs, plant maintenance, and other duties. They are paid on a monthly basis.

The cannery also purchases tuna from other local fishermen at about E5/kg. However, the plant is limited to five tons of tuna per day. If it receives five tons from the company's boat, it cannot handle more and must throw live tuna back to the sea.

(3) Fertilizer. This is a one-person operation producing about a half ton a day of fertilizer. About 10% of the tuna, by weight, is used in fertilizer production. The heads, tails, bones, and innards are sun dried, bagged, and exported to Portugal for agricultural use.

	Number Employed		Average Salary (E/Day)	
Type of Work	Full Time	Part Time	Full Time	Part Time
Fishing Fleet	25	-	90	-
Cannery	-	25	-	40
Maintenance	10	-	100	-
Fertilizer	1	-	80	-
Total	36	25		

No water or power data were made available at this interview.

Lobster Fishing. This group is operated by a local person and in reality is the joint effort of two small operations. Between them they have a total of five fishing boats. The first group of three boats uses only lobster traps and the second group with two boats uses only divers.

(1) Lobster Traps. The three boats involved customarily lay out traps at a depth of 100 to 150 meters. The traps are left underwater for about one week and then pulled out. The catch is about 20 to 25 kg per week. The trap is rebaited and again dropped for another week. Each of these ships will average 500 to 700 kg per week of lobster from the 25 to 30 traps they harvest. This type of boat will use four to five persons, so about 12 to 15 persons are employed in this activity.

(2) Divers. The two boats used in gathering lobster through divers are different from the ones using traps. Each boat with an air compressor will have five divers. The diver goes down to about 25 meters, wearing a rubber suit and an air hose (no helmet). He then gathers the lobsters, placing them in a sack which goes topside when full. A good diver in season can make up to about 12,000 escudos per month.

After the lobsters are caught, they are brought into Santa Maria and held in a holding tank. Once 500 or 600 kg are available, the lobsters are packed in cardboard cases and are flown to Lisbon alive. A carton of lobster will weigh 25 kg net. The lobster buyer pays E60/kg to the ship crews, who must pay for fuel and food. The boat is provided by the owner (buyer). A boat with divers carries a crew of seven persons, so the two diver boats have a crew of 14 persons. There is no lobster fishing from July to October.

Type of Boat	No. of Crew	No. of Boats	Employment	Average Salary (E/Day)
Trap	5	3	15	857
Diver	7	2	14	857

Assuming E857 per day in season and a nine-month season, the annual daily average is then down to E642 per day for the whole year.

They identified no water or power usage.

Morabeza Hotel. This hotel was constructed in 1971 by a Belgian gentleman, and his wife is the person in charge of the operation of the establishment. They currently have 46 rooms available and are building 14 more units to bring the total up to 60 units. The hotel has a contract with South African Airways (SAA) and with SAFAIR (South African Air Cargo) to house their crews. Up to January 15, 1977, they received daily one cockpit and one cabin crew. This represents four persons in the cockpit and 18 in the cabin of a Boeing 747, which is what SAA flies in daily. At the time of the project team's visit, SAA was changing only the cockpit crew and the cabin crew was continuing to London or Johannesburg. By the spring of 1977, SAA was to resume the old schedule of changing both crews at Sal Island. Figure 2 shows part of Hotel Morabeza.

The hotel operates now with an average occupancy of 50%. A typical room rents for about 400 escudos per day; therefore, at 50% capacity, the estimated income is about 9,200 escudos per day.

Morabeza Hotel produces its own power; its equipment consists of two generators at 11 KW each, one generator capable of 6 KW, and another of 25 KW capacity. The equipment is not compatible, so maximum production is limited to 25 KWH.

At present, they purchase water from the Santa Maria plant, about 10 tons per day at a price of 100 escudos for the first 150 tons and 120 escudos per ton for additional water.

Their monthly water bill is as follows:

10 tons/day x 15 days at E100/ton	E15,000
10 tons/day x 15 days at E120/ton	E18,000
	E33,000

Figure 2

HOTEL MORABEZA

Therefore, water is costing the hotel about E100 per ton ($3.46/ton or $0.346/liter).

In the future, the hotel will produce its own water by using a solar evaporator that is being imported. This unit will generate up to 12 tons per day in clear weather and 8 tons per day in bad weather.

The hotel employs 16 persons and an additional 15 persons are used when the construction of new units is in process. The average monthly wage is E2,000 for general help and E3,500 for the maintenance supervisor, cooks, and administrative staff. The cleaning staff gets about E1,500 a month.

Type of Work	No. Employed	Average Salary (E/Month)	Total Average (E/Month)
Management and Office	2	3,500	7,000
Maintenance	1	3,500	3,500
Cook	1	3,500	3,500
Service	8	2,000	16,000
Cleaning	4	1,500	6,000
Total	16		36,000

The administrative staff, maintenance man, and cook are provided with housing and meals. The service and cleaning crews get one meal.

Eventually, the hotel will expand to 100 rooms. They plan to purchase power if it is available under the present level of E5.50.

Water/Power Plant. This is a government enterprise built to provide power and water through a steam process. The plant is four years old and employs eight persons. The capacity of the plant is 90 tons per day of water and up to 150 KW from the steam turbine. In reality, it can produce only about 80 tons per day of water and generate about 60 KW. The cost of water is established at well over E200 per ton ($6.29/ton or $0.629/liter), and the power is estimated to cost well over E5 per KWH ($0.1574/KWH).

The plant has a 160-ton reserve tank and a 17-ton tower tank. A distribution system is installed, but it is not in use.

Type of Work	No. Employed	Average Salary (E/Month)	Total Average (E/Month)
Mechanic	6	3,000	18,000
Supervisor	2	3,500	7,000
	8		25,000

Espargos

Almicar Cabral Airport. The landing strip of the airport is about 1 km long, at an altitude of about 218 feet above sea level, and it can accommodate up to four jumbo jets (747's) at one time. The usual frequency is about two Boeing 747's per night from South African Airways. The airport is eight years old, but the terminal is only six years old. The airport is the single largest employer in Sal and the single largest source of revenue. Reported employment is 600 persons, including the catering facility, fuel pumping, generator, water plant, and all support facilities.

The water plant at the airport was manufactured in Italy and it is about one year old. This plant is capable of producing up to 40 tons per day, but at present it supplies a demand of only about 18 to 20 tons per day.

The airport facility and staff use 100 tons per week or 14.28 tons per day, and the balance of about 30 tons per week is sold to the public. The staff price for water is E62 per ton, and that for outsiders is E80 per ton.

Each 747 will take close to one ton of water at the time it is refueled at the airport. The following airlines come into the airport:

Company	Frequency	Aircraft	Service
TAP	3 planes/week	707 & one 747	Fuel
SAA	2 to 3 planes/night (up to 5)	747	Fuel and water
Varig	1 per month	707	Fuel and water
Aerovias Argentinas	3/week	707	Fuel and water
SAFAIR	3/month	C-130	Fuel and water
TACV	4/day 4/day	Convair Islander	Fuel Fuel

The 707's pay about E20,000 for landing rights and the 747's about E40,000. There are no landing charges for TACV aircraft.

The air terminal also houses the post office and a bank. No information was available on type of employment and salaries.

Hotel Atlantico. This is a converted military establishment now being used as a 30-room motel. It was originally further down the street, where it first opened in 1938. After independence, it moved into the old military compound, where it has now been for about one year. The old barracks were refurbished and converted into a 30-room motel/hotel. Rooms rent for about E480 per day ($15.11). They draw water and power from the airport facility. The occupancy rate is about 60%. Most of the occupancy consists of one-night stops for persons in transit to Lisbon.

The local government officials eat at the hotel and have a special rate. The airplane crews usually stay at the Morabeza Hotel. Employment is 20 persons.

Pedra Lume

Salin du Cap Vert. This is a large French-owned salt producer located in the crater of an extinct volcano in Pedra Lume. The company is over 100 years old; the tunnel into the volcano was built in 1836 by the company. They produce the best salt on the island, using brine at about 30% solution which is on the ground inside the volcano. They produce about 1,000 tons per month and it is all shipped to Zaire. The crate is about 900 meters in diameter and about two thirds of the area is presently in evaporating pans.

Eighty persons are employed, and Pedra Lume has a population of about 368 persons. The local power plant has two generators rated at 150 KW each, but only one is in operation. It also has an old 100 KW generator as a standby. Power is provided to the 80 households, as well as 5 liters per day of pure water per person, free of charge. The houses belong to the company and are leased at low rent to the people.

A company truck travels each day to Espargos and buys water at the airport plant. A load of water also comes in from Paço Verde for washing and cleaning.

The product is exported in 18 kg bags through the port, which has the largest crane (10 tons) on the island.

At the top of the old volcano crater the salt pans look as shown in Figure 3. At the bay the salt is transported in small company vessels as shown in Figure 4.

Figure 3

SALT PANS AT SALIN DU CAP VERT

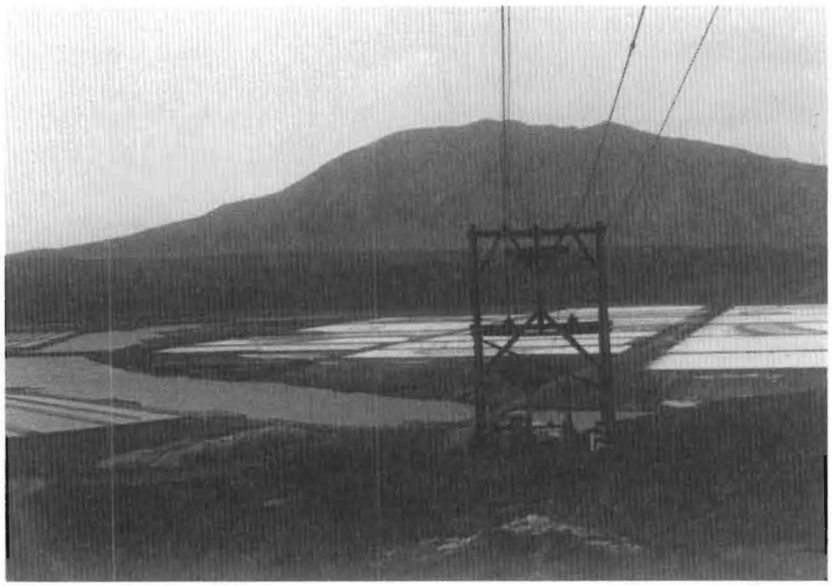


Figure 4

SMALL VESSELS USED IN TRANSPORTING
SALT OUT TO BE LOADED ON SEAGOING SHIPS

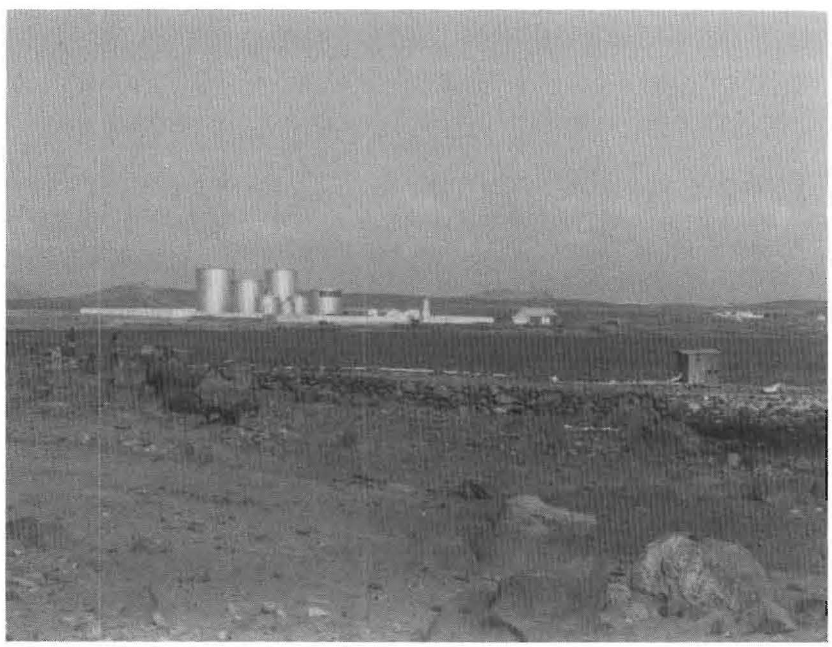
Palmeira

Shell Oil Company of Cape Verde. This is the only oil distribution company on Sal Island. It receives about two tankers per month which carry only jet fuel. Other fuels, i.e., gasoline, diesel, kerosene, all are received in 55-gallon drums. The installation has a total of seven tanks, plus a pumping station to carry fuel through a pipeline to the airport and seawater for sanitary purposes. The fuel laboratory (quality control) is at the airport. They employ about 90 persons. They have their own generators (two generators, 250 KW each), but all the power is used in support of their operation.

Shell also has a facility at the port to handle fuel from the tankers. The underwater line runs from the four marker buoys to the plant. No information was available on employment levels and salaries. Figure 5 shows the Shell installation in Palmeira.

Figure 5

SHELL OIL COMPANY IN PALMEIRA



Mr. A. Figueredo. This gentleman from the Azores has the only public transportation service available. He is in the following activities: (1) transportation, (2) service station, (3) fishing fleet, (4) mechanical-carpentry shop, and (5) cinder block plant.

(1) Transportation. Mr. Figueredo has two dump trucks and two buses. The buses run from Espargos to Santa Maria once a day and they also make two or three trips per night for the airplane crews and transit passengers. This activity employs four drivers and the trucks employ two more for a total of six drivers. One of the trucks appears in Figure 6, which was taken in the Palmeira port area.

(2) Service Station. This Shell service station sells gasoline, diesel, kerosene, and oil. One person is employed here.

Figure 6

TRANSPORTATION FACILITIES

(3) Fishing Fleet. The fleet has three boats used for fishing for lobsters. They use traps and lobsters are exported by air to Lisbon. Fifteen persons are employed in this activity.

(4) Mechanical-Carpentry Shop. This service is probably the only one available in the area. Two mechanics and three carpenters are employed.

(5) Cinder Block Plant. The installation is capable of producing 800 to 1,000 blocks per day and is the only such plant on the island. It employs three persons when in operation.

The Figueredo activities employ a total of 30 persons.

The 10 companies presented below employ 960 persons or 40% of the reported employed population of 2,400. They also use 109 of the 3,000 underemployed persons (3.6%). Together, these 10 activities account for 18.9% of the available work force of 5,650 persons. No figures were available from government services and other activities.

Employment Survey Summary

Enterprise	Full Time	Part Time	Total
Companhia de Fomento Cape Verde	80	40	120
Nascimento e Cia.	36	25	61
Lobster Fishing	-	29	29
Morabeza Hotel	16	15	31
Water/Power Plant	8	-	8
Almicar Cabral Airport	600	-	600
Hotel Atlantico	20	-	20
Salin du Cap Vert	80	-	80
Shell Oil Co. of Cape Verde	90	-	90
Figueredo	30	-	30
Total	960	109	1,069

POTENTIAL INDUSTRY-MINI PROFILE

Case 1

Production of Block Ice

A. General Evaluation

Ice making is highly suited for a developing country as this type of activity is one where the market is least affected by unfavorable economic conditions and where the demand consistently increases with the growth of the population. Since the ice industry also plays a major role in the development of a nation's fishing industry, this type of business should play a vital part in the socioeconomic program of the Government of Sal Island in its desire to attain some level of self-sufficiency in food production.

It was observed while on site that the locally produced fish are not adequately supplied with ice, resulting in either a high percentage of spoilage or the need to eat the total daily catch regardless of volume. Due to lack of water and power, no ice is available on Sal Island. However, once this is resolved, as proposed by this document, the manufacture of block ice will be a viable enterprise.

It is well worth noting that Sal Island has no ice-making facility to serve its 8,000 inhabitants and the small fishing fleet that operates from the island. This condition should place the potential ice-plant owner in a very favorable position, since he would have a locked-in market.

B. Product Description

Block ice to be purchased at a daily average rate of 100 blocks of 300-pound crystal-clear ice.

C. Market Aspects

1. Users. Potential of 1,300 households, restaurants, hotels, stores, airport, and fishing vessels.

2. Sales Channels and Methods. Initially the product will be sold by door-to-door (route) salespersons who will purchase at wholesale price from the producer and retail to households. It is possible that the plant owner may wish to establish his own distribution sales system.

3. Geographical Extent of Market. The five communities of Sal Island would be the total potential market.

4. Competition. Competition should not pose a serious problem and could be controlled by the GOCV in its industrial promotion plans.

5. Market Need for Plant. The geographical features and hot climate of Sal Island create a "ready-made" demand for ice. No plant is in existence at this time on the island.

6. Possible Plant Site. It is economically advantageous for the plant to be adjacent to the water/power plant, so there can be a central facility for support and maintenance as well as supply of water and power at the off-peak hours. The suggested plant site is also near the two largest communities of Espargos-Preguiça and the port of Palmeira.

D. Production Requirements

1. Raw Materials. Basic materials needed are pure water supplied by the desalination plant, salt locally produced, and ammonia to be imported.

2. Annual Capacity. 100 blocks of ice at 300 pounds per block to be produced 300 days per year. Total output 30,000 blocks of ice, 300 pounds each.

3. Machinery and Equipment

Ammonia compressor and connections
Electric equipment
Freezing and storage room equipment
Ice-making equipment
Ammonia condenser, liquid receiver and connecting tank
Rubber conveyor

4. Manpower Requirements

Direct Labor

Machine operator	3
Assistant operator	3
Laborer	6
	12

Indirect Labor

Plant supervisor	1
Foreman, shift	3
Maintenance	2
	6

Administrative

Manager	1
Clerk	3
Janitor	1
	5

Sales

Salesman/driver	3
Helper	3
	6
Total	29 persons

E. Estimated Capital Requirements

Fixed Capital

Land	N.A.
Building	$15,000
Machines & Equipment	50,000
Furniture & Fixtures	5,000
	$70,000

F. Load on Power/Water System

15 m^3 of water per day

15 KW per hour load

POTENTIAL INDUSTRY-MINI PROFILE

Case 2

Production of Domestic Ice Refrigerators

General Evaluation

The manufacture of domestic ice refrigerators was a booming industry in many of the developed nations up to World War II. The first ice refrigerators in general use were the lift-lid type. Both food and ice were placed in the box by means of a door or lid located in the top of the unit. This model evolved to the top-icer type where the ice was placed in a separate compartment at the top of the unit through a door at the front of the box. This unit also had a single or double door for the food compartment. Several different models evolved later and were manufactured in mass by such companies as: Belding-Hall, Bohn Refrigerator Company, Crystal Refrigerator Company, White-Steel Refrigerator, Herrick Refrigerator Company, Jewett Refrigerator Company, Grand Rapids Refrigerator Company, McCray Refrigerator, North Star Refrigerator Company, and others too many to mention.

The technology is well known and was proven to be very successful for a great number of years while electric power was not available to all communities in the U.S.A. or the purchasing power of the population was too low to allow for the purchase of electric appliances.

The study conducted on Sal Island assumed that "at best" 40% of the population would be able eventually to afford an electric refrigerator. At least 60% of the households on Sal Island (780 households) would be potential buyers of domestic ice refrigerators plus many of the poor households on the other 11 islands in the Republic of Cape Verde.

A small-scale manufacturer of domestic ice refrigerators could well serve the local population as well as the balance of the country.

Product Description

Outer Case. The outer case of these traditional-type ice refrigerators is of wood. The most used species are ash, oak, fir, and spruce; in some cases, pine is used. In most cases, a wood panel construction is used. Clearance is left for the panels to expand and contract. Some manufacturers used metal outer cases such as porcelain enamel on steel, baked white enamel on steel, sheet steel zinc plated with a white baked enamel surface, and white opal glass and monel metal.

Wall Construction. Several types of wall construction were employed with varying types of insulation materials. A typical wall would be composed of a wood case, insulating paper, mineral wool, insulating paper, wood, insulating paper, dead air space, insulating paper, dead air space, and porcelain or metal lining.

Linings. The lining is probably the most important part of the ice refrigerator. The lining material needs to have a smooth, hard, and preferably white surface. The following linings were in common use:

Baked white porcelain on sheet iron
Solid porcelain
Solid stone
White opal glass
Galvanized iron
Enamel on steel
Wood
Ceramic tile
Rust-resistant metal
Cement

Market Aspects

1. Users. Potential of over 1,000 households on Sal Island and up to 250,000 population on the other 11 islands, as well as restaurants, hotels, stores, and others.

2. Sales Channels and Methods. Initially the product would be sold at the plant and possibly by means of one door-to-door salesman on Sal Island. Later, it would be desirable to have agents on the other islands.

3. Geographic Extent of Market. The five communities on Sal Island would be the initial market. At a later date, all 12 islands could be served.

4. Competition. Competition should not pose a serious problem and could be controlled by the GOCV in its industrial promotion plans.

5. Market Need for Plant. The geographical features and hot climate of Sal Island create a "ready-made" demand for food preservation and cool water (drinks). No ice refrigerators are now in existence or available on the island at this time.

6. Possible Plant Site. The "industrial zone" now being considered by the GOCV on Sal Island.

Production Requirements

1. Raw Materials. Basic raw materials will vary depending on the type of ice refrigerators selected for production.

2. Annual Capacity. 100 units per year (two per week).

3. Machinery and Equipment

Woodworking tools and machines
Sheet metal bending and forming equipment
Welding and soldering equipment
Pipe bending equipment
Enameling kiln or paint booth
General machine tools

4. Manpower Requirements

Direct Labor

Machine operator	5
Assistant operator	5
Laborer	10
	20

Indirect Labor

Plant supervisor	1
Shift foreman	2
Maintenance	3
	6

Administrative

Manager	1
Clerk	3
Janitor	2
	6

Sales

Salesman	2
Driver	1
Helper	2
	5
Total	37 persons

Estimated Capital Requirement

Fixed Capital	
Land	N.A.
Building	$20,000
Machines & Equipment	70,000
Furniture & Fixtures	7,000
	$97,000

Load on Power/Water System

2 m^2 of water per day

10 KW per hour load

POTENTIAL INDUSTRY-MINI PROFILE

Case 3

Production of Reconstituted Dry Milk

A. General Evaluation

Reconstituted dry milk is well suited to the needs of developing countries. This product has both storage and use advantages. In terms of storage, dry milk requires: no refrigeration, and therefore loss from refrigeration failures cannot result; no milk storage equipment; and, minimum storage space. In terms of usage, dry milk possesses the following advantages: economy of purchase; low handling costs; uniformity of product; minimum daily variation in quality of finished product; uniform flavor and texture; available year round; all of each day's requirements of reconstituted dry milk may be prepared in one operation.

In addition, dry milk, especially nonfat dry milk, is an economical source of protein, lactose, B vitamins, calcium, and other essential nutrients for human development.

Reconstituted dry milk can be prepared daily in amounts necessary for daily household and business consumption and thereby eliminate the need for storage equipment for fluid milk.

The household and business consumers generally will consume each day's purchase immediately, or, as a result of improved household and commercial refrigeration facilities, be able to store the product for a short while.

Reconstituted dry milk can be produced from water or separated milk. Once Sal's water problems are resolved, as proposed by this document, the use of water in the reconstitution process will present no problem. Water is preferable to separated milk, as the storage requirements are minimal.

B. Product Description

Reconstituted dry milk to be purchased at an average daily rate of 1,200 quarts (300 gallons).

C. Market Aspects

1. Users. Potential of 1,300 households, restaurants, hotels.

2. Sales Channels and Methods. Several distribution systems are feasible: plant-operated delivery system to individual household and commercial consumers; independent delivery system, where salespersons purchase at wholesale price from producer and sell at retail price to consumers; plant-operated facility where consumers pick up their day's order.

3. Geographical Extent of Market. The five communities of Sal Island would be the total potential market.

4. Competition. Competition is not viewed as a serious problem and could be controlled by the GOCV in its industrial promotion plans.

5. Market Need for Plant. Concern for the well being and nutritional needs of the Sal population indicates the need for this proposed production facility. No plant is in existence at this time on the island.

6. Possible Plant Site. Ideally, the plant would be situated adjacent to or near the water/power plant. This area also would be near the two largest Sal communities, which probably would be the two largest market segments.

D. Production Requirements

1. Raw Materials. Basic materials needed are dry milk, which will be imported, and pure water supplied by the desalination plant. It is essential that the water used be low in minerals, bacteria, sediment, and chemical inhibitors.

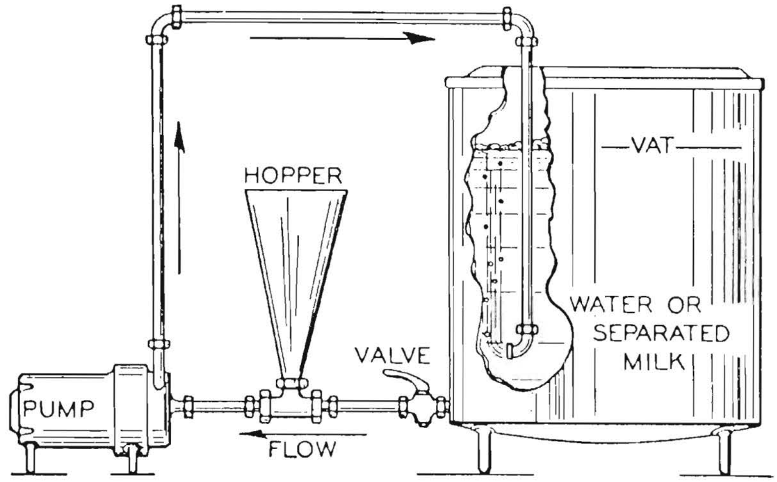
2. Annual Capacity. 1,200 quarts (300 gallons) of reconstituted dry milk to be produced 300 days per year. Total daily output of 3,600 quarts (900 gallons).

3. Machinery and Equipment. The necessary equipment can be assembled from parts found in most dairy plants. Those items not available in Cape Verde most probably could be purchased second hand from neighboring countries.

See Figure 7 for suggested system. In addition to the illustrated equipment, a facility for heating the water (60^{o}-90^{o}F) and storing the final product until purchase (refrigeration) is necessary. Milk containers (plastic bags involve less upkeep than reusable glass containers) are also required.

Figure 7

SUGGESTED EQUIPMENT FOR MIXING NONFAT
DRY MILK WITH WATER OR SEPARATED MILK



When nonfat dry milk is produced, the vat of the blending equipment shown in the diagram is filled to the desired level with water or fluid dairy products. The pump is started and the outlet valve adjusted to start circulation. The outlet valve is throttled to create a slight negative pressure at the dry milk inlet tee. Nonfat dry milk is poured into the hopper fast enough for blending into the liquid. In the batch method, the water or fluid dairy products may be placed in the mix vat and the nonfat dry milk sifted slowly onto the surface of the liquid at the point of greatest agitation. The temperature of the liquid in the vat should not be above 90^{o}F when nonfat dry milk is incorporated.

For best results, the tee shown below the stainless steel hopper should be 1/2" larger in diameter than the sanitary line. The distance between the tee and pump should be as short as possible.

Source: American Dry Milk Institute.

4. Manpower Requirements

Direct Labor	
Machine Operator	2
Assistant Operator	2
Laborer	8
	12
Indirect Labor	
Plant Supervisor	1
Shift Foreman	2
Maintenance	2
	5
Administrative	
Manager	1
Clerk	3
Janitor	1
	5
Sales	
Salesperson/Driver	5
Helper	5
	10
Total	32 persons

E. Estimated Capital Requirements

Fixed Capital	
Land	N.A.
Building	$15,000
Machines and Equipment	25,000
Furniture and Fixtures	7,000
Total	$47,000

F. Load on Power/Water System

Water. The table below illustrates the quantities of water necessary to reconstitute nonfat dry milk to various solids levels. To produce 300 gallons of reconstituted milk per day at a solids content of 11.0%, approximately 280 gallons of water per day are necessary.

QUANTITIES OF WATER TO RECONSTITUTE 100 LBS
OF NONFAT DRY MILK* TO VARIOUS SOLIDS LEVELS

Solids Content	Water		Reconstituted Milk	
Percent	Lbs.	Gals.	Lbs.	Gals.
10.0	870	104.5	970	113.0
10.5	824	99.0	924	107.5
11.0	782	93.5	882	101.75
11.5	744	89.25	844	97.5
12.0	708	85.0	808	93.5

*Based on 3% moisture in nonfat dry milk.

Source: American Dry Milk Institute.