JAPAN INTERNATIONAL COOPERATION AGENCY

SAINT LUCIA
MINISTRY OF AGRICULTURE, LANDS, FORESTRY
AND FISHERIES

BASIC DESIGN STUDY REPORT
ON
THE PROJECT FOR DENNERY FISH LANDING-BASE CONSTRUCTION
IN
SAINT LUCIA

JANUARY 1993

PACIFIC CONSULTANTS INTERNATIONAL

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PREFACE

In response to a request from the Government of Saint Lucia, the Government of Japan decided to conduct a basic design study for the Project for DENNERY FISH LANDING-BASE CONSTRUCTION, and entrusted the Japan International Cooperation Agency (JICA).

JICA sent to Saint Lucia a study team headed by Mr. Yukio Tsubota, Deputy Director, Fishing Ports Construction Division of the Fisheries Agency and constituted by member of Pacific Consultants International, from 29 August 1992 to 25 September 1992.

The team held discussions with the officials concerned of the Government of Saint Lucia, and conducted a field study at the study area. After the team returned to Japan, further studies were made. Then, a mission was sent to Saint Lucia in order to discuss a draft report and present report was prepared.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of Saint Lucia for their close cooperation extended to the team.

January 1993

Kensuke Yanagiya
President
Japan International Cooperation Agency

January 12, 1993

Mr. Kensuke Yanagiya
President
Japan International Cooperation Agency
Tokyo, Japan

Letter of Transmittal

We are pleased to submit to you the basic design study report on the Project for Dennery Fish Landing-Base Construction in Saint Lucia.

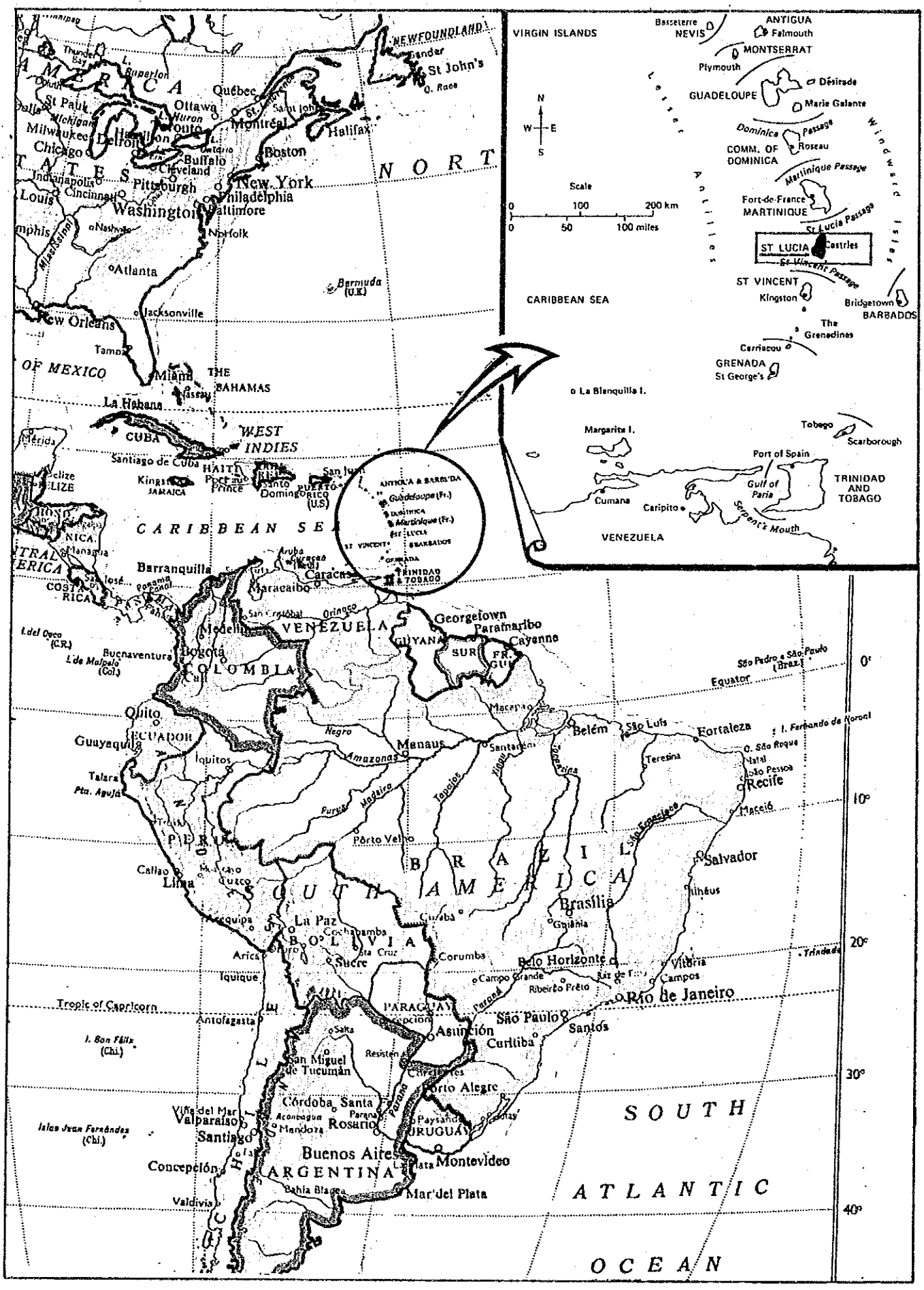
This study has been made by Pacific Consultants International, based on a contract with JICA, from August 21, 1992 to January 12, 1993. Throughout the study, we have taken into full consideration of the present situation in Saint Lucia, and have planned the most appropriate project in the scheme of Japan's grant aid.

We wish to take this opportunity to express our sincere gratitude to the officials concerned of JICA, the Ministry of Foreign Affairs, and Fisheries Agency. We also wish to express our deep gratitude to the officials concerned of the Ministry of Agriculture, Forestry, Land and Fisheries, JICA Experts of Fisheries, Japanese Embassy in Trinidad and Tobago for their close cooperation and assistance during our study.

At last, we hope that this report will be effectively used for the promotion of the project.

Very truly yours,

Team leader, Hiroshi NISHIMAKI
Basic design study team on
the Project for Dennery
Fish Landing-Base Construction
Pacific Consultants International



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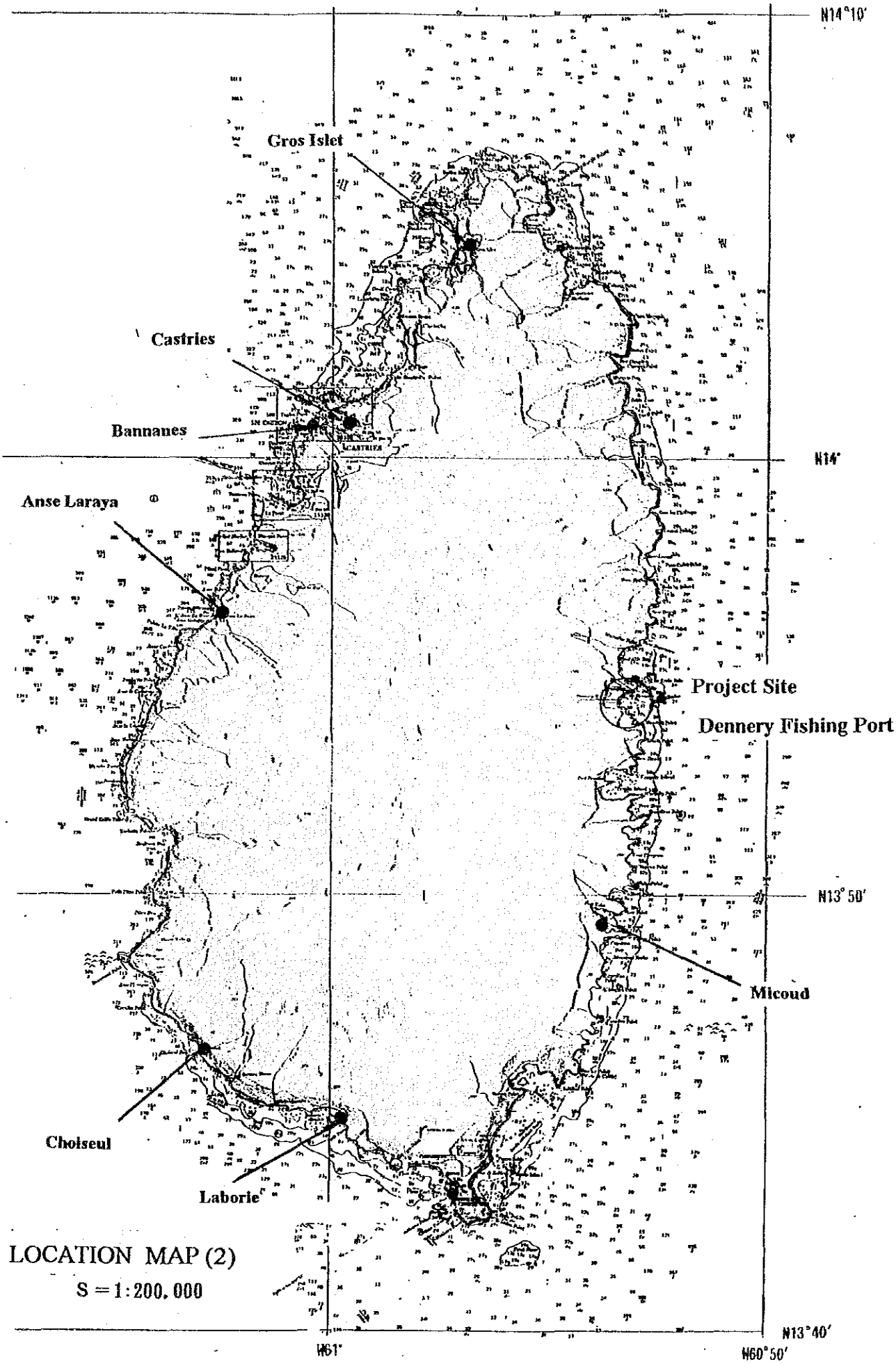

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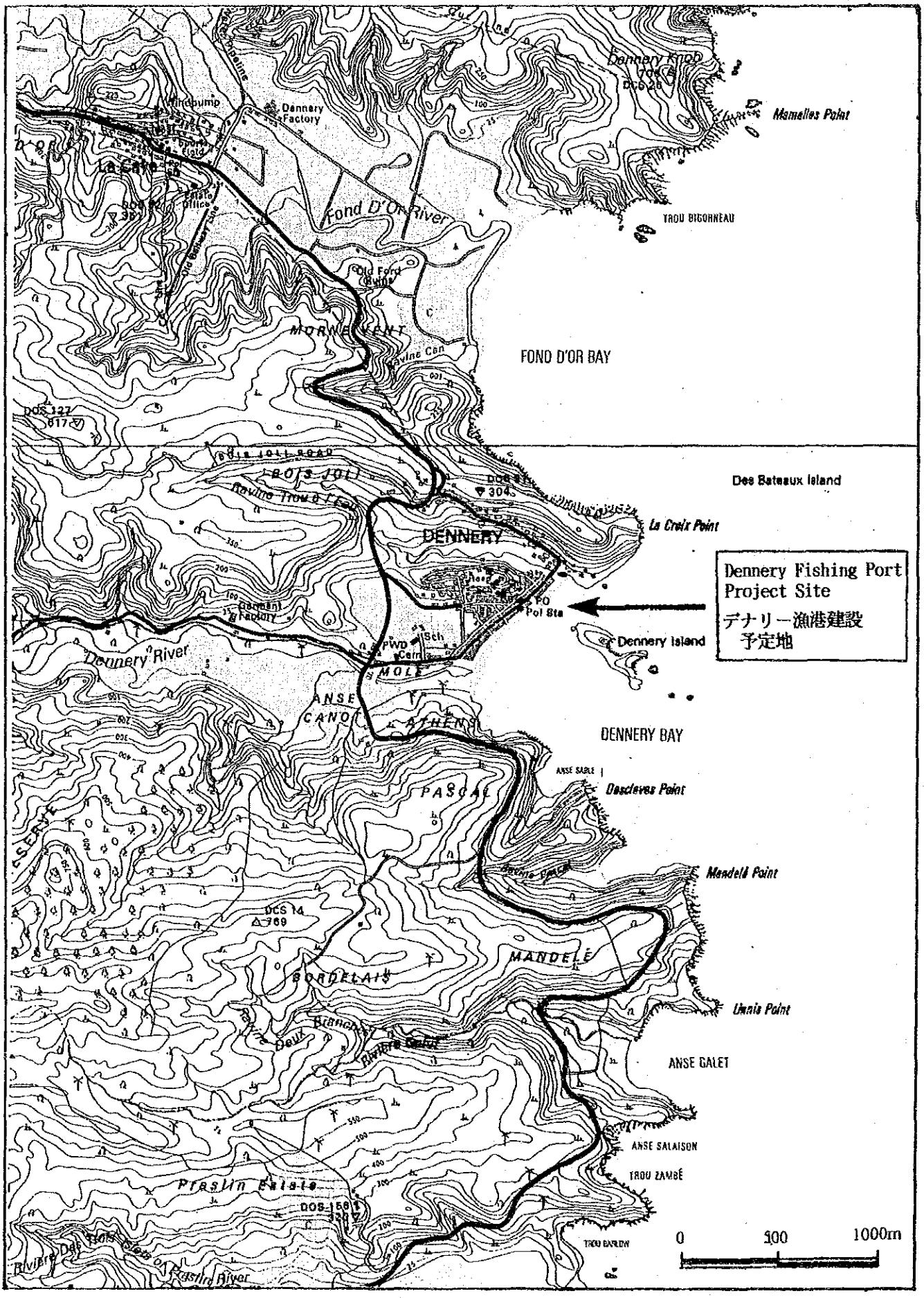
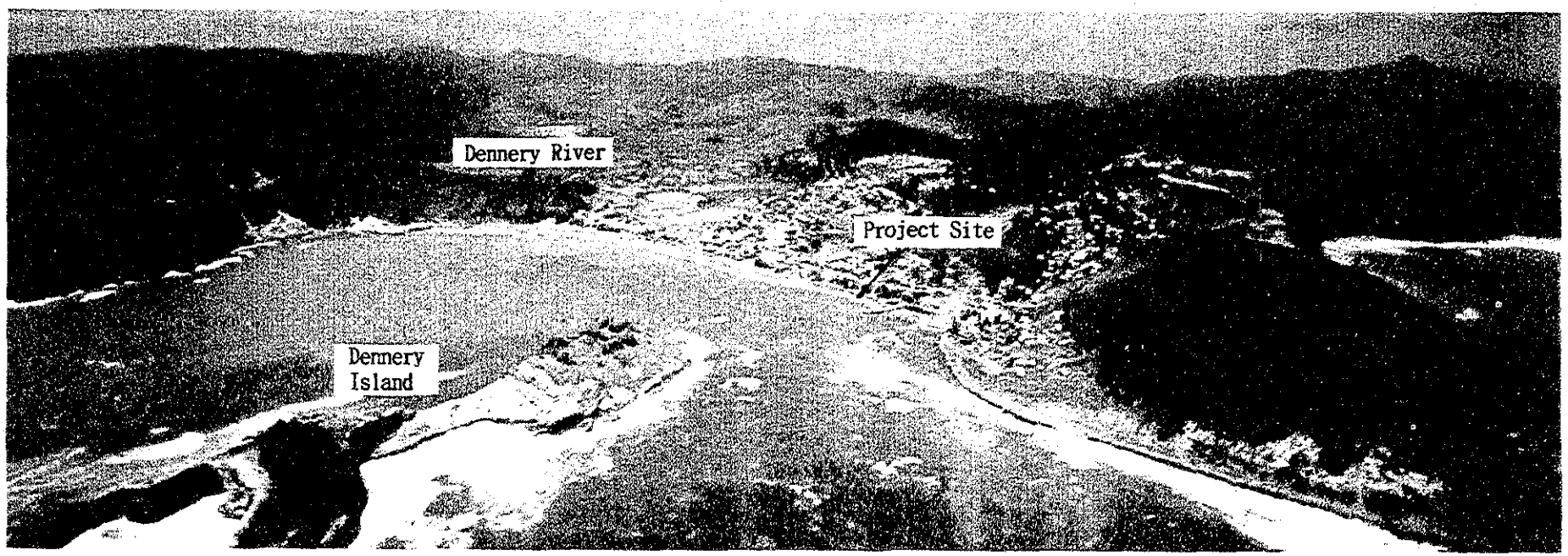
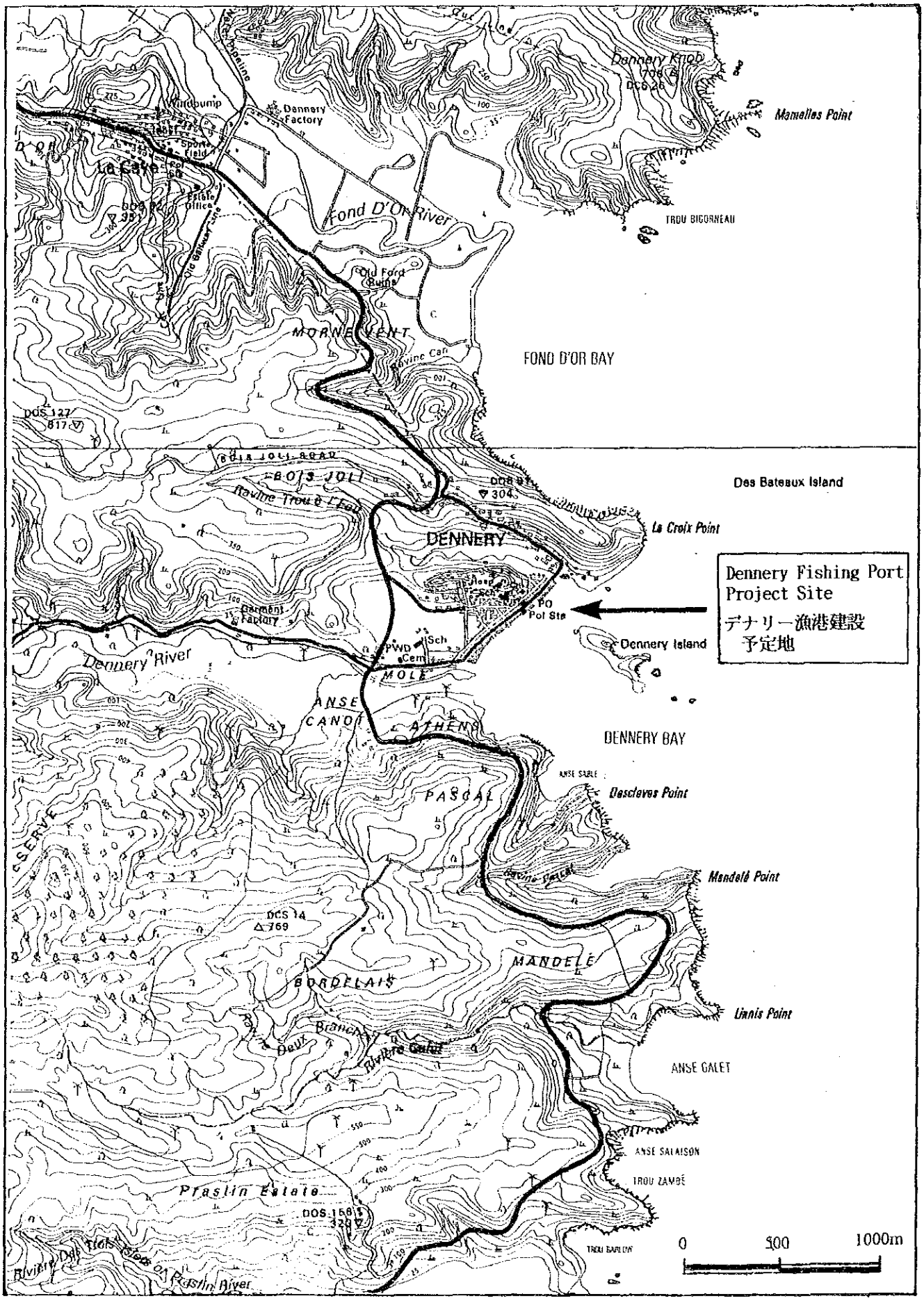


PROJECT SITE MAP



View of Dennery Fishing Village. The wave from the Atlantic Ocean always hits on the Dennery beach. The Project Site for Dennery Fishing Port is located behind of Dennery island since no direct wave will hit these coast.



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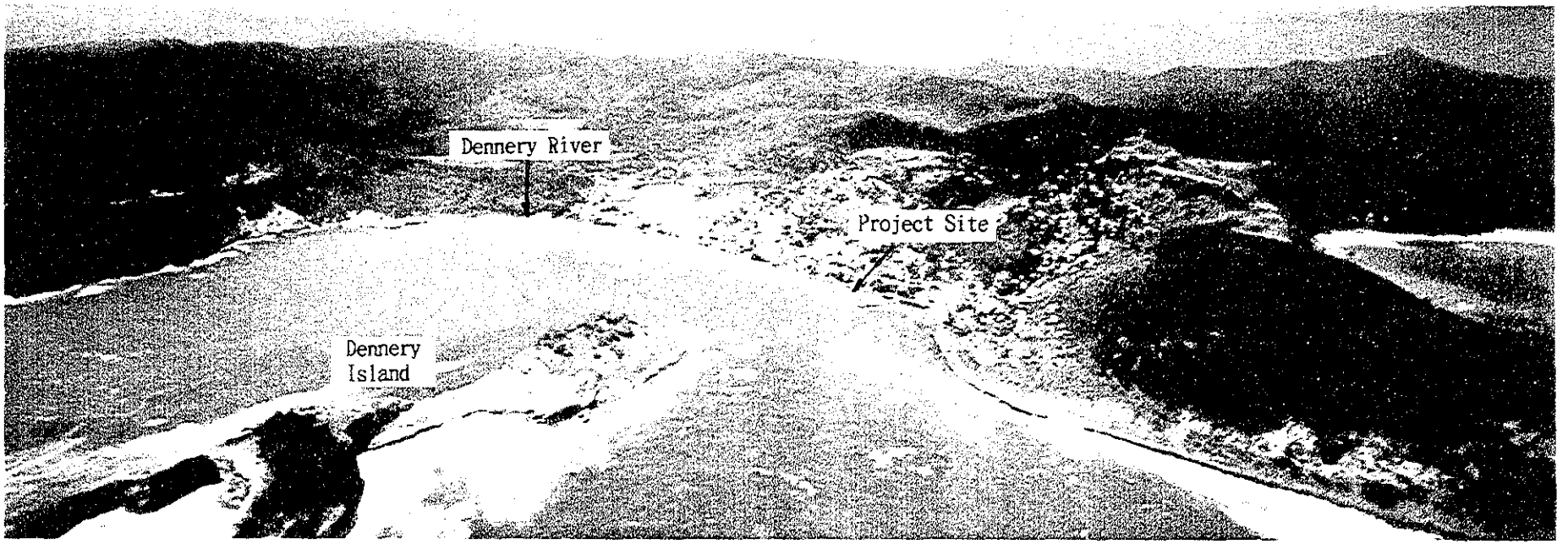

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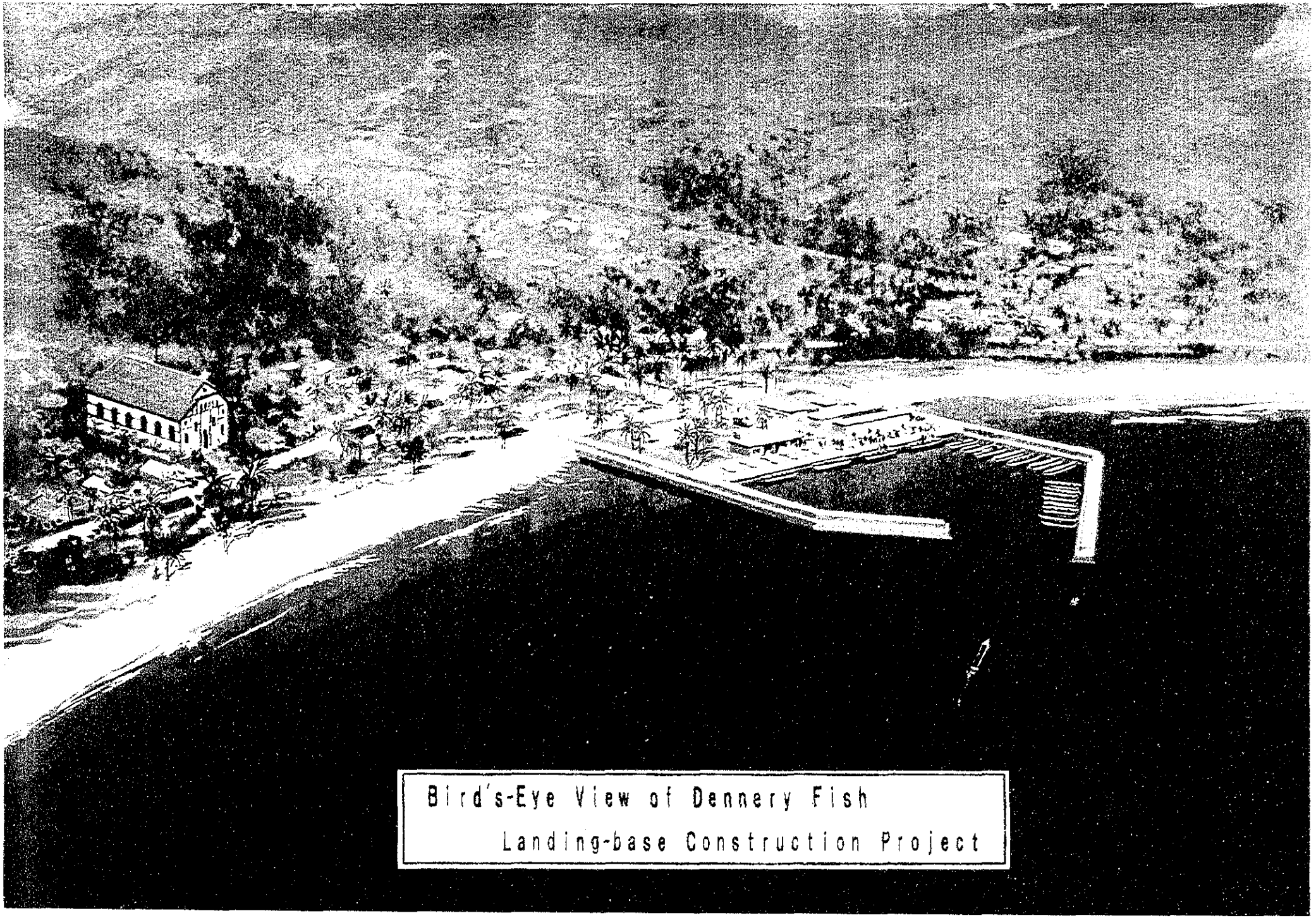

Bird's-Eye View of Dennery Fish
Landing-base Construction Project

SUMMARY

SUMMARY

The island of St. Lucia lies in the Windward Islands group in the Caribbean Sea between Martinique and St. Vincent. The island's economy is based on agriculture with banana as its most important export crop of which St. Lucia is the largest exporter in the Windward Islands. The other major crops are coconuts and cocoa. Considerable efforts are being made to diversify agricultural production and to reduce the substantial bill for food imports. Although the agricultural sector accounts for 30 % of export earnings, the National Development Plan attaches its major emphasis to the promotion of tourism and the manufacturing sector, the building of infrastructure, the development of human resources, and the increase of its competitive position in the world market.

The fishing industry supplies the nation with low-cost protein for its diet and provides employment opportunities to the fishing communities and these means to earn cash income. The Fishery Development Policy of the Government of St. Lucia aims at covering the foreign trade deficit with increasing the fish catch by the local fishermen in the coastal areas, and to decrease the import of fish into the islands.

Fishery resources for St. Lucia has been left undeveloped since fishing is solely limited to the small-scale coastal fishing ports with traditional canoes. Since its dependence in 1979, St. Lucia has relied mainly upon the Canadian International Development Agency (CIDA) to improve the fisheries development.

Japan has been requested by the Government of St. Lucia to provide assistance and has performed Grant Aids projects in 1988 and 1989 to put in order the coastal fishing to replace the wood canoes with fiber reinforced plastic (FRP) fishing boats in activities that will not duplicate with the efforts of CIDA, together with the supply of new fishing gear, and rehabilitate fishing by reconstructing the Castries Fish Market Facilities.

The Government of St. Lucia has requested for a Grant Aid project as a part of the fisheries development project for the construction of the largest fisheries base of Dennery Fish Landing-Base on the east coast of the island.

The Government of Japan, based on the request from the Government of St. Lucia, has decided to perform a Basic Design Study, and sent to St. Lucia a Basic Design Team of the Japan International Cooperation Agency (JICA) from 29 August to 25 September 1992, which team held discussions with the related agencies of St. Lucia, confirmed the authenticity of the

request and the background, and performed the necessary investigations and collected data for the study. After the team returned to Japan, further studies were made and a draft report was prepared and for the explanation and discussion of it, a mission was sent to St. Lucia from November 15 to November 26, 1992.

Investigation has revealed that there are twelve principal fish landing places in St. Lucia with approximately 450 fishing boats which have an annual catch of some 500 tons, but due to the wood canoe fishing boats which can engage in only a day's catch and cannot increase their catch through the use of new fishing methods or improved fishing gear, due to the inadequate fishing infrastructures such as the port facilities that efficient landing of fish cannot be performed; that the Government has banned the cutting of the Gomiei Tree which is the principal material to make the canoe, the fishermen are requesting changeover to the FRP fishing boats; and due to the lack of cold storage facilities that a part of the landed fish is being thrown away during the peak seasons when there is more fish than can be sold.

Also, the following has been disclosed, that the proposed site at Dennery is close to the fishing grounds and the fishermen have a strong desire to catch the fish, and this is reflected in the annual catch of 100 to 150 tons with 32 fishing boats (25 % of the total fish catch) which is the largest catch of approximately 4.5 tons per boat, but due to the lack of modern fishing port facilities, the fish is landed directly on the beach, and since Dennery Beach is exposed directly to the rough waves of the open seas the fishermen are required to work under hazardous conditions, and the opportunity of the fishermen to put out to sea is limited under these conditions.

In order to resolve these problems and to develop the small scale fishing industry at Dennery, it will be mandatory to change the fishing boats to the FRP type and to introduce new fishing infrastructures and new fishing methods, and to build a mooring facility for the FRP fishing boats, and to provide a base for suitable distribution facilities for the increased fish catch resulting from the improved fishing methods. In concrete terms, this means to provide a fishing port with calm waters where the fish is presently being landed on the beach, and to construct cold storage facilities for the landed fish, and to provide a fish distribution base which will result in increased catch of fish and lead to the promotion of new fishing methods for the fishermen, and the use of Dennery Fishing Port Facilities as the operating base for the FRP fishing boats.

The coastline at Dennery consists of approximately 800 m of sandy beach, where there are form fish landing basis, and there is a small tombolo formed by being in the lee of Dennery Island. North of the tombolo there is a stone jetty about 50 m long on the coast. The coastline is approximately 100 m in length between the jetty and the tombolo where there is a sandy

beach which is narrow compared to other areas, and the waves reach the private houses along the coast for which shore protection facilities are provided by armor stones. The Dennery River is at the south end of the coastline, and the river mouth opens to the south. The Ravine Troual Eau River is at the north end of the coastline.

Wind studies indicate that the predominant winds at Dennery coastline is from the ENE. The prominent waves are also from this direction. The coastal current was checked by float tracking and indicated that the currents are also from the north. From results of the observations the maximum velocity is 27 cm/sec in front of the proposed fishing port area which is not fast, and there will no problems for the fishing boats to navigate. There are two rise and fall of tides per day at Dennery Bay, and from the field observations the largest tidal range was 55 cm. The surface soil layers at the proposed fishing port site is a sandy layer 3 - 9 m, under which there is a clayey layer with a N-value of 3 - 9. From the results of the sounding survey, the 3 m depth of the navigation route of the proposed fishing port is guaranteed, and it was confirmed that there will be ample depth to navigate the objective fishing boats.

Investigation of the conditions at the above Dennery Beach and the natural conditions indicate that the four fish landing places on the 800 m long beach will be adequate for the construction of the port facilities, since this area will not be subject to the direct waves of the open sea being in the lea of Dennery Island, therefore, it was determined that the site to the south of the existing stone jetty at the north side of Dennery would be most suitable to construct the fishing port facilities. The fishing port facilities to be constructed will consist of breakwaters to maintain calm waters for the small FRP fishing boats, a quay for landing caught fish, mooring facilities for fishing boats, and building facilities for the administration of the fishing port operation.

In checking the contents requested by the Government of St. Lucia, from the results of the field investigations and the studies in Japan, the following scope of work is considered to be in order for the Grant-Aid facilities and equipment:

Type of Facility	General Specification	Remarks
1. Fishing Port Facility & Related facilities	Breakwater: (North L = 110 m, South L = 40 m) Landing Wharf (Depth: 2 m, Length: 70 m) Revetment (North Side: L = 45 m, South Side: L = 45 m) Land Reclamation (4,050 m²) Main Bldg. (9 m x 20 m, Ice Making Mach. 2 ton, Ice Strg, Office, Refrd. Strg., Fish Handling Rm, Retail Sales Stands) Workshop (6 m x 10 m) Fishing Gear Strg. (40 Boats 4 m x 20 m, 2 Bldgs.) Toilet Facilities (4 m x 8 m) Pavement Water Supply, Electricity, Telephones	Steel Sheet Pile type Reinf. Conc. & Conc. Blk. Asph. Pvmt.
2. Fishing Boats	FRP Fishing Boats: 18 each (Martinique Type, w/75 HP Eng.)	
3. Fishing Gear	Tuna Long Line Fishing Gear, Bottom Fishing Gear, Trolling Pole and Line, Stick held dip net, Payao Equipment, Navigation Equipment and Audio Equipment	
4. Vehicles	Refrg. Transport: (2 ton): 1 Ea Pickup Truck (Dbl Cab): 1 Ea	

The land property for the Access Road is a private property, and it will be necessary for the Government of St. Lucia to procure this property by the time construction work will be commenced.

After exchange of official documents by the Governments of St. Lucia and Japan, the consultant's contract will be signed, and it will require 3 months to prepare the documents for the Design and Tendering. After the contractor's tenders are evaluated and the contract awarded, the construction works will be commenced. This project will be performed in one stage, and the construction works is expected to take approximately 11 months to complete.

The Executing Agency will be the Fisheries Bureau, which is under the supervision of the Ministry of Agriculture, Fisheries & Lands. The completed facilities will be operated and maintained by the Fisheries Bureau, Fisheries Cooperative, and the St. Lucia Fish Cooperative. There will be officers of the Fisheries Bureau assigned to Dennery to administer and operate the facilities on a permanent basis. The necessary annual expenses for the operation and maintenance of the facilities are estimated at EC$50,000, but it is estimated that the sales of ice alone can be more than adequate to make up this amount.

With the completion of the project, there will be a safe mooring berth provided for the FRP Fishing Boats and a landing wharf for the fish catch, and efficient fishing operations can be performed which will contribute to the fisheries development at Dennery. With the ice making facility and refrigerated fish transport facilities, the freshness of the fish will be guaranteed, these will contribute to change the fishing to a more modern method, together with the new fishing methods made possible by the new fishing gear.

The completion of the landing-base facilities as a Grant Aid project will have a deep significance, and its early implementation is highly expected.

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CHAPTER 1

Introduction

CHAPTER 1 INTRODUCTION

The Country of St. Lucia is an island located in the East Caribbean Sea of the Smaller Antilles, and the fishing industries supplies low cost protein to the people of the island, and provides employment to the people engaged in the fishing community, and is an importance source of income. The fishing industry was developed in the latter part of 1970 with assistance provided by the Canadian International Development Agency (CIDA).

Fishing in St. Lucia is performed by use of the traditional Caribbean canoes, and fishing is conducted on a very small scale, with the result that the fishing resources are not effectively utilized. On the other hand, the fishing activities are concentrated during the period of January to June every year, and fish facilities tend to run short during the period when the fish catch is at its peak, since there are problems of sales and distribution of the fish.

CIDA has made studies and analysis of the fisheries development problem, and has made recommendations to solve this problem, and introduced technologies to develop the untapped resources, realignment of the distribution of the fish caught, and to provide assistance for the fishing industries, together with the introduction of training and organization of the fishing industry as a priority development item, and these development plans are being implemented by CIDA at its center.

Especially, CIDA has implemented the rehabilitation of the fishing port of the capital city of Castries in 1984, and has cooperated in the training of personnel. Japan has responded to a request from the Government of St. Lucia, and in parallel with the development plan, it has offered to furnish fiber reinforced plastic (FRP) boats as a replacement for the wood canoes in order to realign the infrastructure to increase the small scale coastal fishing in a manner so as not to duplicate the efforts of CIDA, together with the improvement of the fishing tackle accessories, and has provided Grant-Aid for the construction of facilities for the fishing center for the capital city of Castries.

The Government of St. Lucia has requested a Grant Aid to construct the facilities of the fishing port at Denney on the east coast of the island as a part of the plan to refurbish the coastal fishing.

The purpose of this study is to understand the contents and the background of the "Denney Fishing Port Development Project" submitted by the Government of St. Lucia, to check the socio-economic effects of the project, and to justify the project as a Grant Aid issue, and to determine whether the required facilities and equipment have been selected.

The Government of Japan, at the request of the Government of St. Lucia, has decided to implement the basic design for the project, and the Japan International Cooperation Agency (JICA) dispatched a Study Team headed by Mr. Yukio Tsubota, Deputy Section Chief, Construction Section of the Fishing Ports Division of the Fisheries Agency to St. Lucia from 29 August 1992 to 25 September 1992, which exchanged the minutes of the discussion while field investigations were studies and data were collected.

After the team returned to Japan, further studies were made and a draft report was prepared and for the explanation and discussion of it, a mission headed by Mr. Yukio Tsubota, Deputy Section Chief, Fishing Ports Construction Division of the Fisheries Agency was sent to St. Lucia from November 15 to November 26, 1992.

A list of the members of the Study Team, the Study Schedule, the members of the Counterpart Team, and Minutes of Discussions are attached in the Appendix to this report.

The basic design team, with the cooperation of the Government officials of St. Lucia, performed the study for the following items:

(1) Investigated the background of the project, and the contents of the represented project.
(2) Investigated other preceding projects related with this project.
(3) Studied the contents of the project, and held discussions to determine their propriety.
(4) Studied the effects of the implementation of the project, and investigated their impacts.
(5) Investigated the maintenance, operation and management systems available in St. Lucia.
(6) Investigated the natural conditions at the project site (sea levels, currents soils conditions, ground survey of terrain).
(7) Investigated construction capabilities.
(8) Collected data related to the project.

Based on the results of the above, the JICA Team performed studies in Japan for the contents of the project, the scope of the work items, construction period, construction costs, project justification, and prepared a Draft Final Report which was submitted to Government of St. Lucia by a team headed by Mr. Yukio Tsubota, Fishing Ports Construction Division of the Fisheries Agency.

CHAPTER 2

Background of the Project

CHAPTER 2 BACKGROUND OF THE PROJECT

2.1 Description of St. Lucia

(1) The Location:

The Country of Saint Lucia is located in the Windward Islands in the West Indies in the Caribbean Sea, at latitude 13°43' to 14°05'N and longitude 60°53' to 61°05'W, with an area of 616 km^2 (22 km in the north-south direction, 44 km east-west), and is an island formed by volcanic activities, the west coast faces the Caribbean Sea, and the east coast faces the Atlantic Ocean.

(2) The Population:

The population was 151,000 (1990 census) with a growth of 2.0 %. The population of the capital city of Castries had a population of 57,300, Micoud 15,900, Vieux Fort 14,600, Gros Islet 13,500, Dennery 12,800, with the remainder of 37,000 living in Soufriere, Anse La Raye, Laborie, Canaries, and Choiseul.

(3) The Topography:

The northern part of the island consists of comparatively flat hills, the central part is hilly with Mt. Gimini (959 m), with the peaks of the Grand Piton (798 m), and Petit Piton (736 m) on the west coast. The south side of the island consists of flat alluvial plains and the Moule-a-Chigue Peninsula lies at the southern tip (222 m). There are rain forests in the hilly country and there are many pockets of sandy beaches on the coasts. The total length of the coastline is 158 km.

(4) Climate:

The climate is of the tropical trade winds, and there is a breeze that predominates throughout the year with an average velocity of 5 - 8 m/sec. The temperature is from 24° to 27°C year around with very little change throughout the year, but the dry season is from January to June, and rainy season is from July to December. The mountain areas have heavy rainfall from 3,500 mm to 3,800 mm annually, and the coast areas have little rain with an average of 1,200 mm. The average yearly rainfall in the Dennery coastal area has an average of 1,700 mm.

The hurricane season is from June to November, and the most severe hurricane in this century was the Allen Hurricane which hit the island in August 1980.

(5) Constitution and Government:

Under the 1979 constitution St. Lucia proclaimed its independence from a colony of Britain and became a parliamentary democracy which the queen of England is the titular head of state represented by a governor general. The national legislature consists of an appointed senate and an elected House of Assembly, both with a normal term of five years, subject to dissolution. The present cabinet was established in April 1992 with the Rt. Hon. John Compton as the Prime Minister, and the present party in power is the United Workers Party.

(6) The Economy:

The GDP of St. Lucia (GDP using 1977 as the base year), increased from EC$219 million in 1985 to EC$274 million in 1990, and the economy is growing at a smooth pace. The economic growth from 1985 to 1990 was 2.1 % - 6.8 %. The growth in GDP can be attributed to the growth in agriculture, which consists principally of bananas, coconuts and cocoa. Almost all the bananas produced are exported to the U.K., and the total quantity of 73,700 tons in 1985 increased to 131,700 tons in 1990. This amount was 61 % of the total bananas exported from St. Lucia (worth EC$199 million) and is an important export item.

The breakdown of the GDP items by activity is very high for Government services and agricultural items and was 17.8 % and 17.1 % respectively in 1989. Next in line is commerce at 13.9 %.

The imports are much larger than the exports, and the deficit in 1990 was EC$388 million (exports were EC$324 million, imports ECS732 million in 1990). Trade with Japan was imports EC$45 million, exports EC$0.22 million in 1990. Prices are quite stable, and the rate of inflation in 1990 was 4.37 %.

2.2 Outline of the Fishing Industry

2.2.1 The Fishing Industry in St. Lucia

(1) The Fishing Resources and the Fish Catch Volumes

The fishing resource in St. Lucia can be generally classified into the following two classes:

a. Deep Sea Bass, Red Sea Bream, Lobsters, Clamshells, Sea Bottom Fish and Reef Fish that live on the continental shelf.

b. Spanish Mackerel, Dorado, Flying Fish, Yellowfin tuna, and other surface fish.

According to a CIDA Report for 1984, the continental shelf of St. Lucia is 5,500 ha and the fishing resources is estimated to be 1,000 to 2,000 tons yearly for an average of 1,500 tons of fish yield can be realized.

The Fisheries Management Unit (FMU) performed a survey of the fish catch of the various areas by a hired personnel. The results are given in Table 2-2-1.

Table 2-2-1 The Total Fish Catch in St. Lucia

Year	Total Catch Recorded, ton	Adjusted Catch, ton
1978	1,438	1,900
1979	1,368	1,800
1980	1,120	1,400
1981	906	1,200
1982	935	1,200
1983	1,071	1,400

Source: A Fishery Development Plan for St. Lucia, 1984 - 1991

Since there could be areas where the investigators could not reach, the Fisheries Ministry has assumed that the figures reported are 70 % of the total for the country, and adjusted the figures by adding another column.

A comparison of the fish catch in the 6 years after 1978, and 6 years after 1985 indicate that the quantities have decreased by one-half. This is due to:

a. Pollution of the environment due to concentration of people to the cities or to the industrialization of the cities.

b. Damaging of the reef by illegal fishing using dynamite to catch fish.

c. Overfishing of certain species especially lobsters and conch type mollusks.

d. The adverse effects of drilling for oil, or the changes in the methods for obtaining statistics, or changes in currents which have caused herds of fish to move, there are many reasons which have not been made clear.

From the results of fish resources and fish catch given in Tables 2-2-1, it seems that the fish catch could increase if the pollution of the environment could be improved, and the average amount of fish caught after 1985 was 470 tons. Table 2-2-2 gives the fish catch by species.

Table 2-2-2 The Fish Catch by Species for St. Lucia (ton)

Year	Tuna	Dolphin	Kingfish	Flying Fish	Blackfish	Others	Total
1985	83.0	136.0	62.0	119.2	6.0	195.8	602.0
1986	75.0	77.0	36.0	87.7	7.0	149.3	432.0
1987	75.0	61.0	29.0	67.2	4.0	94.8	331.0
1988	133.3	102.4	31.6	84.0	3.9	58.8	414.0
1989	111.7	76.8	21.3	91.3	45.2	103.9	450.2
1990	142.0	98.0	27.0	117.0	57.0	132.0	573.0

Source: Data from Fisheries Bureau

(2) The Number of Fishing Boats and the Catch in the Fish Unloading Areas:

There are 12 main fish unloading areas (fish landing beaches) in St. Lucia, and there are a total 456 fishing boats in the country. The areas, the number of fishing boats, and the fish catch are given in Tables 2-2-3 and 2-2-4. The fishing boats are mainly Caribbean canoes of wood, and there are already 56 FRP fishing boats. The length of the canoe and FRP boat is all less than 8 meters long, and it is of the day's trip type. The fish catch by area, by type for 1991 are given in Table 2-2-5.

Table 2-2-3 Type of Fishing Boat by Area, St. Lucia (1991)

Area	Canoe	FRP	Total
Anse-La-Raye	31	3	34
Canaries	25	4	29
Castries	57	18	75
Choisuel	48	0	48
Dennery	30	2	32
Esperence	9	2	11
Laborie	32	8	40
Marisule	6	1	7
Micoud	11	1	12
Praslin	6	2	8
River Doree	12	0	12
Savannes	6	1	7
Soufriere	70	0	70
Vieux Fort	57	14	71
Total	400	56	456

Source: Data from Fisheries Bureau

Table 2-2-4 Fish Catch by Area for St. Lucia (ton)

Area	1984	1985	1986	1987	1988
Anse-La-Raye	18	33	33	2	4
Canaries	7	6	6	6	12
Castries	56	83	77	67	57
Choisuel	80	92	53	23	21
Dennery	142	134	105	89	133
Gros Islet	24	18	5	6	6
Laborie	39	20	21	13	22
Micoud	14	29	13	11	4
Praslin	15	25	4	4	5
Soufriere	31	42	42	21	17
Vieux Fort	112	120	73	89	133
Total	608	602	432	331	414

Source: Data from Fisheries Bureau

Table 2-2-5 Fish Catch by Area by Species, 1991 (Pound)

Area	Flying Fish	Dolphin	King Fish	Tunas	Snappers	Others	Total
Bannanes	315	0	0	2,001	1,293	18,172	21,781
Castries	16,955	0	68	49,186	13,688	24,214	104,089
Choisuel	9,400	13,003	2,596	45,750	7,052	10,970	88,771
Dennery	5,300	114,217	46,191	107,685	5,037	37,730	316,160
Gross-Islet	860	839	1,218	4,347	1,696	66,546	75,506
Laborie	0	162	0	0	0	2,116	2,278
Micoud	320	4,314	1,776	4,008	3	2,508	12,929
Praslin	3,270	3,270	1,650	1,049	0	560	9,799
Savannes	0	37,869	5,552	1,650	0	33,156	78,227
Soufriere	23,541	21,427	3,072	62,478	1,920	227,854	340,292
Vieux Fort	0	96,054	24,729	49,964	3,116	18,601	192,464
Total	59,961	291,155	86,852	328,118	33,783	442,427	1,242,296

Source: Data from Fisheries Bureau

2.2.2 The Fishing Industry at Dennery

(1) The Fish Catch and the Fishing Method

The fish catch at Dennery is in the range of 100 - 150 tons yearly as can be seen from Table 2-2-4. In 1991, the catch recorded was 146 tons (322,265 pounds) . The monthly catch at Dennery (See Table 2-2-6) started in November and lasted until June of the following year for 8 months, and peak months was the 6 months from January to June.

The fishing method was by drag net and surface nets. The crew consists of the captain and a crew of 2 for a total of 3 per boat, and they have on board gill nets, drag nets and spears consisting of three types of fishing gear. The method used will depend on the fishing area, and the most appropriate gear will be selected. In the slack season, when the surface fishing goes slack, the deep sea fish will be fished to try for the sea bottom fish. Some boats will take only the bottom gill net.

In the peak season, except when it rains, fishing is performed daily, and on the average fishing is performed for more than 25 days per month. Even in the slack season, fishing is performed 10 to 15 days out of the month. The fishing boats go out between the hours of 6:00 to 8:00 am, and depending on the catch they return to port between 2:00 to 8:00 pm.

The fishing areas are generally to the east of the island (Atlantic Ocean side) and extend from the north to south, and extend out form Dennery Port from 2 miles to 75 miles.

Table 2-2-6 Monthly Catch at Dennery by Species (Pound) (1991)

Month	Flying Fish	Dolphin	Tuna	King Fish	Snapper	Turtle	Others	Total
Jan.	16	8,248	21,182	3,917	-	25	3,870	37,258
Feb.	2,520	7,408	3,761	2,567	69	30	8,950	25,305
Mar.	100	27,410	12,073	9,076	4	-	263	48,926
Apr.	50	32,544	4,374	10,612	30	-	588	48,198
May	200	14,664	6,897	8,933	73	-	1,243	32,010
Jun.	450	12,659	6,048	1,635	-	-	2,325	23,117
Jul.	306	2,979	6,637	1,414	212	-	4,300	15,848
Aug.	-	1,047	1,157	323	2,053	-	6,187	10,767
Sep.	-	643	5,489	1,785	897	-	3,260	12,074
Oct.	-	567	3,802	93	958	-	3,678	9,098
Nov.	-	3,894	15,393	3,269	311	80	1,402	24,349
Dec.	1,680	2,216	20,474	2,567	430	-	7,950	35,315
Total	5,322	114,279	107,285	46,191	5,037	135	44,016	332,265

Source: Data from Fisheries Bureau

(2) The Fishing Boats and the Number of Fishermen

The coast line at Dennery is approximately 800 m long, and the fish unloading area is divided into 4 blocks, the number of fishing boats is 32, and the number of fishermen is 96. The number of fishing boats and the fishermen are given in Table 2-2-7.

Table 2-2-7 The Fishing Boats and Fishermen at Dennery Fishing Unloading Area

Fish Unloading Area	Fishing Boat	Fishermen
Over the Bridge Landing Place	16	48
Kupa Landing Place	2	6
Vanjari Landing Place	4	12
Bottom Tom Landing Place	10	30
Total	32	96

Source: From hearing conducted with fishermen. (1991 Sep.)

According to the Fisheries Law of St. Lucia, boats without fishing permit are not allowed to catch fish within the territorial waters or economic or inland waters of St. Lucia. In order to obtain a fishing permit, the fishing boat must be registered and the boat owner must have a I.D. Card issued to him. The registration of fishing boats have been completed, but the issue of I.D. Cards are expected to be completed after the end of this year. The number of fishing boats given in Table 2-2-7 are correct for the Dennery Fish Landing, but the number of fishermen are the number of association members, and do give the correct number of fishermen in Dennery area. As stated before, the boat owners must have a I.D. Card issued, but there is no restriction for the crew and there are as many of none association members as there are association members, and it can be assumed that the number of fishermen are about 200 in all. There are no statistics for the ratio of permanent fishermen to the part-time fishermen, but according to the fishermen, the permanent fishermen could be about 70 - 80 %, and the part-time fishermen 20 - 30 %.

(3) The Income of the Fishermen

The total fish catch in the Dennery area according to the data is less than 150 tons for the year and is less than 5 tons per boat which is a very low figure. However, the method of data collection which forms the basis for the data are not reported daily, and is reported by an investigator assigned to each area who reports in periodically after checking the fish catch of each boat at the time of fish unloading.

It is assumed that actual fish catch is much more than the figures given in the table, but in using the data given in Table 2-2-6 for the 3 peak months, the income of the fishermen can be assumed to be about EC$730.

(4) The Distribution of Fish and the Fish Cost

Price control is practiced in St. Lucia. For the cost of fish there is a maximum retail cost by fish specie and a maximum wholesale cost established in 1980 but is not presently used. At the present time there is a new cost system being studied by the Government, and there is a fish unit cost that is being used which is announced by the Fish Marketing Corp. Complex in Castries temporarily every two months.

The fish landed from the fishing boats are sold to the local consumers, middlemen and the complex. In the peak season 10 - 15 % is sold to the local consumers and the rest is distributed to the Middlemen and the complex. Their take differs from time to time. The buying price by the complex will not change for two months, but the middlemen have their own system and they purchase the fish at a price higher than the complex price or at a lower price each time. The fishermen sell to the highest buyer and so the price is not fixed.

There are about 10 middlemen at Castries and some of them come to Dennery every day. The price established by the complex is fixed for the fish species, but the middlemen buy their fish at a unit price by the pound for their purchase. The unit price for the fish differs by the amount of fish catch and the season, and the price at the time of this investigation (first part of September 1992) the price for Red Snapper was the highest fish at EC$5.50 per pound. The middlemen bid for a price of EC$6.00 per pound at this time. The retail price is fixed by adding EC$0.50 per pound to the complex price, and it is forbidden to sell higher than this price.

(5) The Fishermen's Cooperative

The number of fishermen belonging to the Dennery Regional Fishery Association as given in Table 2-2-7 is 96. The breakdown of this figure is 32 boat owners and 64 fishermen. Of the fishermen there are many former boat owners who have become lay fishermen due to superannuation of their boats and selected to stay with the association.

The cooperative is managed by operating fund paid up by the members (shares), and the cost of the share which was EC$5.00 at the time of issue is now EC$150.00. The cooperative is not very active, but some of the activities are as follows:

1. Sales of oil on credit (sales by cash to non-members).
2. Gasoline at EC$0.66/gallon is paid back to the fishermen every 3 months.
3. Provides assistance in purchase of tax-free items to association members.

(6) National Development Projects

At the present time National Development Projects are being planned by the Government of St. Lucia and there is none to be made known, the national economy is being planned according to the guideline planned by the World Bank for St. Lucia. This guideline gives the following items for the economic development of the country:

1) to expand tourism and expand industries and to break away from the banana mono-culture.
2) to rehabilitate the infrastructure facilities to activate national enterprises.
3) to curb labor costs and to strengthen the national economy.
4) to develop personal skills.

The guideline gives as the strategy for the fisheries development to increase the fish catch by the local fishermen and to reduce the imported fish to reduce the trade deficit. The practical objectives for this is to improve the fishing gear and the fishing methods and to train the fishermen.

(7) Fisheries Development Plans

The development of the fisheries for St. Lucia are based on the "Fisheries Development Projects (1984 - 1991)" and provided with aid.

In order to improve the fisheries industry of St. Lucia, CIDA has in their report pointed out problems and made the following recommendations:

1. To adopt techniques for catching deep sea fish. For this they will make demonstrations and perform training.

2. Furnish the necessary equipment on the boats.

   a. to furnish navigational aids, canoe lamps, warehouses, repair facilities, fueling stations, ice supply stations, facilities for the consumers, and the sales outlets.

   b. to provide facilities for large storage and relay of the fish at Vieux Fort and Dennery as a part of the Castries Fisheries Complex.

3. To form and strengthen cooperatives and train the core staff to operate the facilities.

4. To improve the techniques and productivity, and in order to train and raise their techniques and knowledge and train them overseas.

5. To request the economic and technical support from foreign organizations for the implementation of this project.

The development of the fisheries development is being performed with the assistance from CIDA and Japanese projects including the dispatch of the JICA experts for the guidance of new fishing methods and demonstrations, however, the Vieux Fort and Dennery Fishing Ports which are a part and supporting the Castries Fishing Complex are not developed. The Government of St. Lucia has made a request to the Japanese Government for assistance to develop the construction of the Dennery Fishing Port.

2.3 Outline of the Request

The contents of the request for assistance from the Government of St. Lucia is for the construction of a fish landing-base at Dennery based on the economic development and fisheries developments described in the above, but not to duplicate the CIDA plans, and to cover the following items:

(1) Provide infrastructure facilities and related facilities for a fishing port.
(2) Furnish FRP type fishing boats.
(3) Provide fishing gear for mordernizing fishing.
(4) Furnish vehicles for the transport of fish and the operation of the port facilities.

CHAPTER 3

Outline of the Project

CHAPTER 3 OUTLINE OF THE PROJECT

3.1 Objective

The fishing at Dennery is performed by Caribbean type wood canoes as described hereinbefore, and they are of the day operation type where the fishing area are close by, and the catch is the largest in St. Lucia due to the strong desire of the fishermen to get more fish.

Dennery Port faces the Atlantic Ocean, and compared to the other ports facing the Caribbean Sea, it is exposed to the waves of the open sea. However, since Dennery Port lacks such infrastructures as breakwaters to protect it from the strong waves, the boats cannot put out to sea and are losing their chance to catch the fish.

Dennery Port has the potential to supply fish to the capital city of Castries, together with the future role to become the source of supply for Vieux Fort, due to the lack of port infrastructures such as breakwaters, it is in a position where it is missing out to catch more fish and promote the development of fishing.

In order to solve these problems, the Government of St. Lucia has requested the Government of Japan to provide assistance for the construction of facilities for a safe and calm fish landing-base facilities at Dennery.

The purpose of this project is to construct a safe fish landing-base facility at Dennery and to increase the catch at the port and promote fishing to increase its capability to supply fish to the capital city of Castries and also to become the source of supply to Vieux Fort where a fish processing center is being planned.

3.2 Study and Examination of the Request

The contents of the terms of agreement with the Government of St. Lucia is as described in paragraph 2.4, and consists of, (1) providing of infrastructure facilities related to fishing, (2) to furnish FRP type fishing boats, (3) provide fishing gear for development of new fishing methods; and (4) providing of vehicles for transporting of fish and for use in the operations of the port administration.

(1) Fishing Infrastructure Facilities and Related Facilities

The coastline at Dennery consists of approximately 800 meters of sandy beach, which is divided into four fish landing sections, and there is no modern infrastructure facilities required to support fishing industries.

Dennery faces the Atlantic Ocean, and the coastline is constantly directly exposed to the waves of the open seas. For this reason, even in the peak fishing season when the waves are high, the chances to put out to sea are less than the ports on the Caribbean Sea side.

The fishing area are close to Dennery, and the desire to catch fish is strong and as shown in Table 3-2-1, the catch per boat is 4.5 tons which is the highest compared to other ports.

Construction of fishing infrastructures and a port with quiet waters, will increase the chance to put out to sea when the waves are rough, together with the new FRP fishing boats, and the introduction of new fishing technique all require that the new facilities are mandatory.

The construction of the new facilities are in step with the economic development policy of the Government of "Reconstruction of Infrastructures to Support the Private Business Activities" and will contribute to the improvement of the national welfare and economic development.

The two FRP fishing boats are moored in the outer waters and would be provided with a mooring place within the harbor when the landing-base facilities are built, and would provide for an effective landing place and provisioning of the fishing boats. (See Appendix-6 for the handling of the increased FRP boats)

The Dennery Fishing Port infrastructures and related facilities required are generally as follows:

1. Breakwaters for a quiet port facility.
2. Quaywalls for fish landing, positioning of fishing boats and rest (depth of water - 2.0 m).
3. Establish a administration office for the smooth operation of the fishing operations and administration.
4. Provide ice making and refrigerated storage facilities to maintain the freshness of the fish catch.

5. Establish a retail shop for sales of the fish to local consumers.
6. Provide a storehouse to keep the fishing gear and other related accessories.
7. Provide a building to repair the fishing gear.
8. Construct toilet facilities to maintain the environment of the port clean.
9. Provide surface pavement for the inside of the port complex.
10. Provide water supply, electricity and telephone facilities.
11. Provide a site for the construction of fuel oil storage and dispensing facilities.

Table 3-2-1 Annual Fish Catch Per Boat by Area (1991)

Area	Number of Boats	Fish Catch (ton)	Catch Per Boat (ton)
Castries	75	47	0.6
Choisuel	48	40	0.8
Dennery	32	143	4.5
Laborie s	40	1	4.0
Micoud	12	6	0.5
Praslin	8	4	0.5
Soufriere	70	154	2.2
Vieus Fort	71	87	1.2

Source: Consultant's Estimate

(2) FRP Type Fishing Boats:

The existing fishing boats are mainly wood Caribbean type canoes. The number of FRP type fishing boats of which there were only 14 in 1980 have now increased to 56 (see Table 2-2-3). This can be attributed to the ban on cutting down the Goimi Tree to preserve the environment, the slowness of the wood canoes and the extra time required to return to port, and the short life of the wood canoes of 4 to 5 years.

The advantages of the FRP boats compared to the wood canoes are their high speed for the same number of horsepower, stability and steerability, large carrying capacity, and their long life. For these reasons, the range of operation can be extended, and the actual fishing time at the fishing ground can be lengthened, with the result that more fish can be caught.

There are two FRP fishing boats in use at the Dennery (See Appendix-6 for the increased FRP boats), and about 20 fishermen have stated that they would like to change to FRP boats from their wood canoes. In view of the future changes that

could take place with the fishing boats in St. Lucia and new fishing methods being proposed, it will be essential to introduce the FRP type of fishing boats to St. Lucia.

The supply of 18 FRP fishing boats requested will have their mooring places when the fishing port facilities have been completed, and will contribute greatly to the modernizing of fishing at Dennery and the development of the fisheries, and to the increase of their catch of fish.

It is recommended that the type of FRP boats to be furnished to have the same type of boat bottom as the V-bottom Martinique in order to ride out the rough waves of the Atlantic Ocean to carry on the fishing. This is the type of boat presently being used by the local fishermen and will provide a smooth transition from the wood canoes.

(3) Fishing Gear for the New Fishing Methods:

It is expected that with the provision of the facilities for the fishing port and the introduction of the FRP fishing boats, that a big improvements in the fishing techniques will be made. At the present time there are JICA fishing experts dispatched to St. Lucia to train the local fishermen in the improvements in the fishing gear and fishing methods by actual training by demonstrations.

Since the experts were recently sent over, the results of their training are awaited. The training by demonstration and the development of new fishing methods are considered equally as important as the construction of fishing port facilities, supply of fishing gear, and the supply of the FRP fishing boats.

(4) Vehicles for Transport of Fish and Port Administration:

The fish landed at Dennery are purchased by the local consumers, the middlemen, and the Castries Complex. There are 2 refrigerated vehicles owned by the Castries Complex for the transportation of fish from Dennery to the capital city of Castries. The freshness of the fish can be expected to be lost being exposed to the hot sun after a day's operation by the fishing boats. The distance from Dennery to Castries is 30 km and takes about 40 minutes, and a refrigerated vehicle is mandatory to maintain the freshness of the fish during their transportation.

On the other hand, with the completion of the fish landing-base facilities, there will be an administration provided to which there will be permanently assigned personnel from the Fishing Ports Administration Office and it will become

necessary to provide a vehicle for fishing port administrative and management purposes.

3.3 Project Description

3.3.1 Executing Organization and the Management System

The Execution Agency for the Dennery Fishing Port Construction Project will be the Fisheries Department of the Ministry of Agriculture and Lands. Fig. 3-3-3 gives the organization chart of the Ministry. Fig. 3-3-2 gives the organization of the Fisheries Facilities Management Organization.

After completion of the Dennery Fishing Port, the management will be taken over by the National Development Corporation, and the actual management will be handled by the sub-offices in charge of the facilities (see Table 3-3-1, Management Organizations for the Management of Fishing Ports Facilities).

Table 3-3-1 Operating Organizations for Dennery Fish Landing-Base Facilities

	Description of Facility	Managing Organization
1.	Breakwaters, Quays, and Other Fishing Port Infrastructures	Fisheries Bureau
2.	Fishing Gear Storehouse, Workstation, Fueling Facilities	Fisheries Cooperative
3.	Main Building (Ice Plant, Refrigerated Storehouse, Fish Wholesales Area)	FMC (St. Lucia Fish Marketing Corp.)
4.	Toilets	Local Government and Ministry of Health
5.	FRP Boat	Fishermen in Dennery
6.	Fishing Gear	Fisheries Bureau
7.	Vehicles	Fisheries Bureau and FMC

Fig. 3-3-1 Organization Structure of Ministry of Agriculture, Forestry, Lands and Fisheries

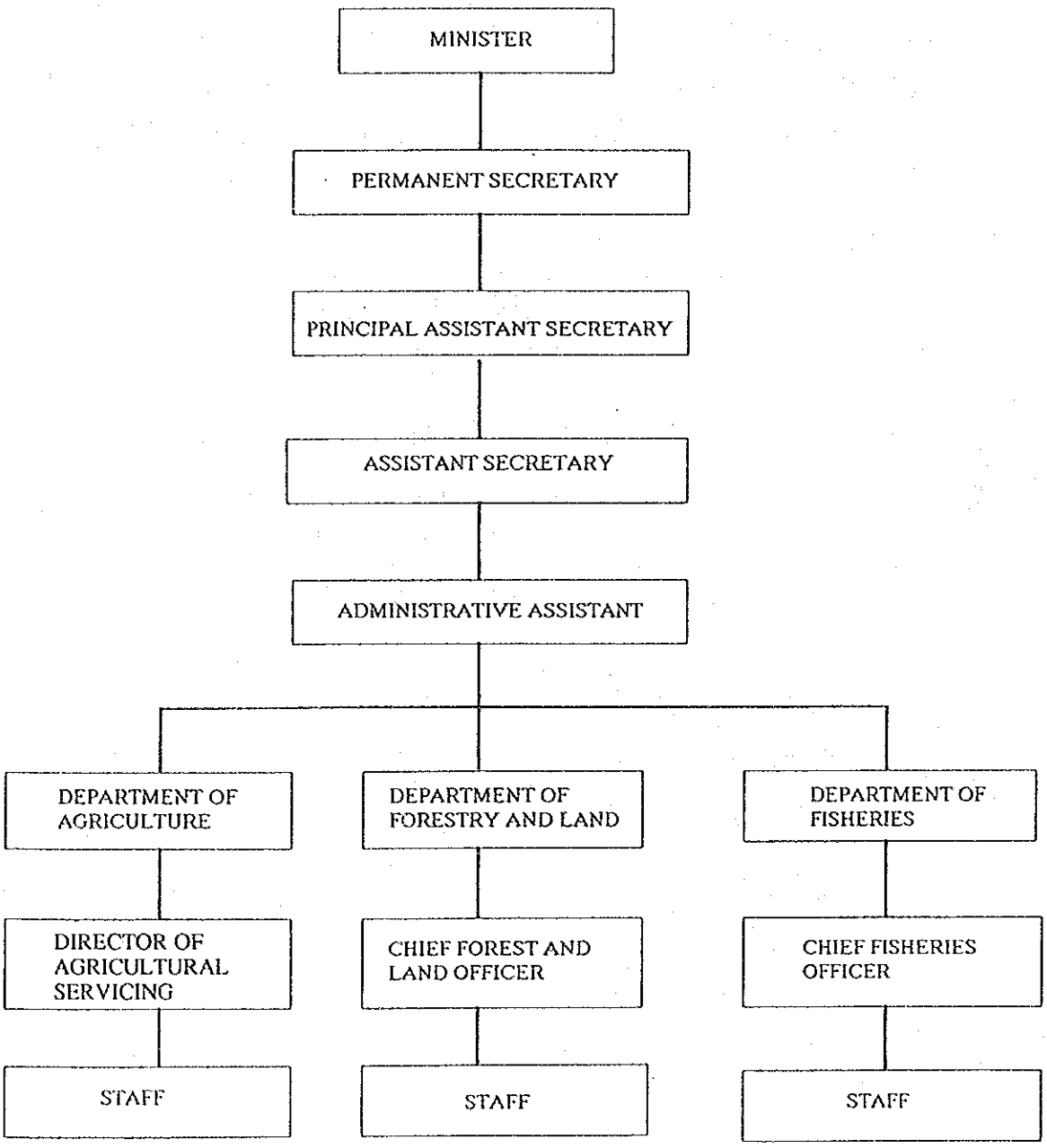
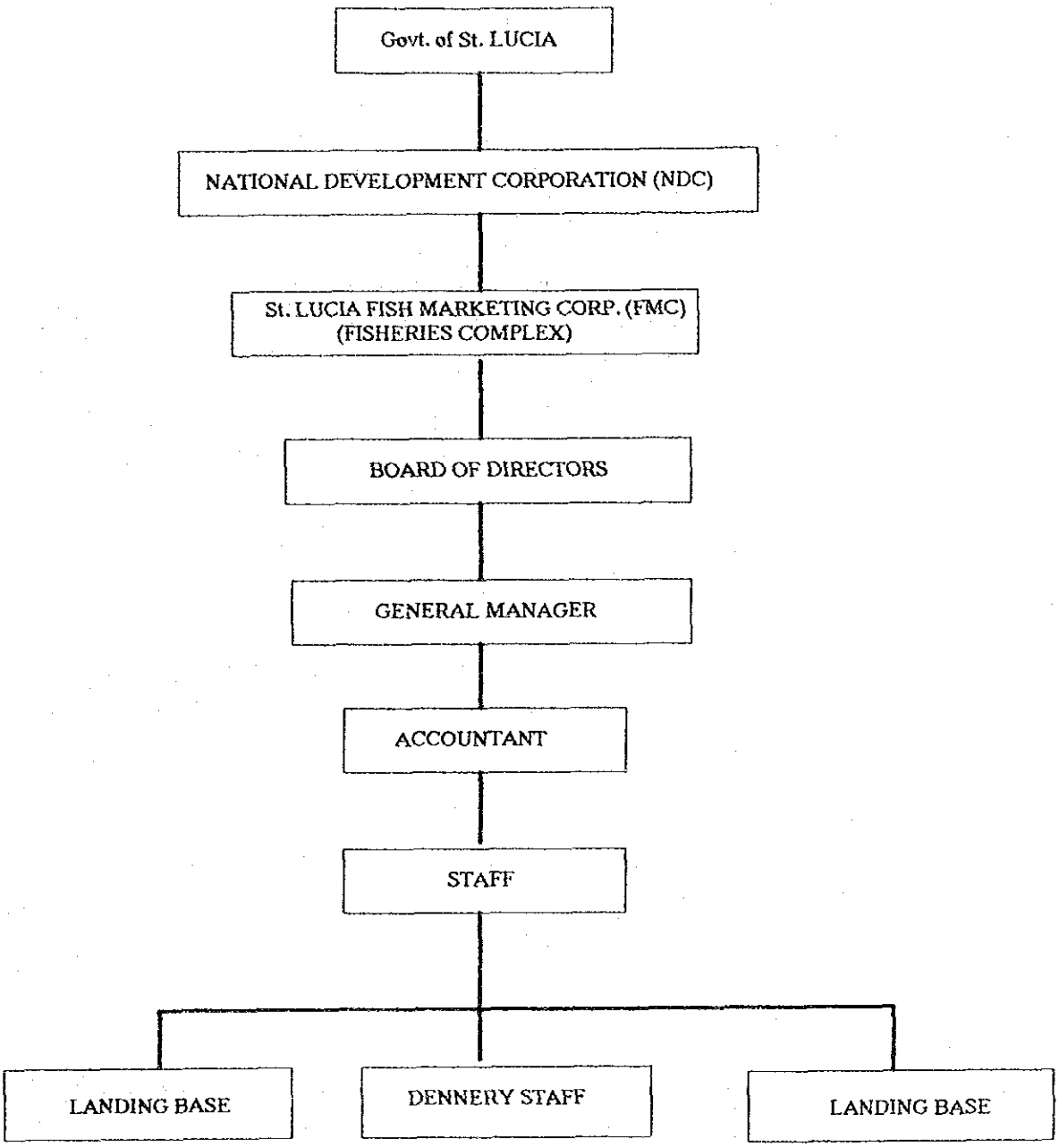


Fig. 3-3-2 Operation Organization for Dennery Fishing Port



3.3.2 Location of Project Site and Conditions

(1) Location of the Project:

The location of the project site of the Dennery Fishing Port Construction is the seashore side of the Dennery Village. The Dennery Village is located in the east central part of St. Lucia, and is approximately 30 km away from the capital city of Castries and it takes about 40 minutes by car. Dennery has an area of 1,700,000 m^2, with a population of 12,875 (1990), one half of which is engaged in agriculture and the other half in fishing.

(2) Industries:

The coastline in the Dennery area due to its geographical location thrived in the past for the export of sugar which has declined and is now engaged in the business of obtaining animal protein and has changed to coastal fishing. There are farm lands behind the coastline where banana, sweet potato and other farm produce are grown. 50 % of the population is engaged in agriculture, 30 % is engaged in fishing, and 10 % are engaged in the industries.

(3) Condition of the Seashore:

St. Lucia lies within the hurricane belt and consequently suffers frequent devastations of its crops and infrastructure. Hurricane Allen, in August 1980, caused damage across the island caused major damage to the breakwater structure at the north side of the river mouth.

The seashore at Dennery is a pocket beach shaped coastline approximately 800 meter long, and part of it is formed by the Dennery Island in the front, and there is a small tombolo behind the island. On the north end of the tombolo there is a jetty some 50 meters long with 500 kg to 2 ton stones, and the south side of the jetty there is a sandy beach.

Between the stone jetty and the tombolo the coast for some 100 m long is narrower than at other coast lines, and extends behind the houses that are constructed down to the coast line and there are stone walls to prevent further erosion by the sea.

There are two rivers flowing into the bay, and the mouth of the Dennery River flows towards the south, and the delta area is a wetland. The east side of the

Dennery Island and the coast line on both the north and south ends of the Dennery Beach are heavily eroded by the action of the sea wave.

3.3.3 Outline of Facilities and Equipment

Table 3-3-2 gives a description of the proposed facilities for the Dennery fishing port project.

Table 3-3-2 Proposed Facilities to be Constructed for the Dennery Fish Landing-Base and the Materials and Equipment to be Supplied

Type of Facility	General Specification	Remarks
1. Fishing Port Facility & Related facilities	Breakwater: (North L = 110 m, South L = 40 m)	
	Landing Wharf (Depth: 2 m, Length: 70 m)	Steel Sheet Pile type
	Revetment (North Side: L = 45 m, South Side: L = 45 m)	
	Land Reclamation (4,050 m²)	
	Main Bldg. (9 m x 20 m, Ice Making Mach. 2 ton, Ice Strg, Office, Refrd. Strg., Fish Handling Rm, Retail Sales Stands)	Reinf. Conc. & Conc. Blk.
	Workshop (6 m x 10 m)	
	Fishing Gear Strg. (40 Boats 4 m x 20 m, 2 Bldgs.)	
	Toilet Facilities (4 m x 8 m)	
	Pavement	Asph. Pvmt.
	Water Supply, Electricity, Telephones	
2. Fishing Boats	FRP Fishing Boats: 18 each (Martinique Type, w/75 HP Eng.)	
3. Fishing Gear	See Separate List	
4. Vehicles	Refrg. Transport: (2 ton): 1 Ea	
	Pickup Truck (Dbl Cab): 1 Ea	

3.3.4 Maintenance Operation and Plan

(1) Cost for Maintenance and Administration:

After completion of the Dennery Fishing Port Facilities, the maintenance and administration will be as described in Table 3-3-1 be performed by the Fisheries Bureau, Fishing Coop. and the FMC (St. Lucia Fish Marketing Corp.). When the Dennery Fishing Port Facilities are completed, there will be 1 or 2 Bureau personnel dispatched by the Fisheries Bureau. The additional costs for maintenance and administration, personnel, electric power, water charges, can be considered, and be estimated as follows:

Personnel:	2 Bureau Officers, EC$48,000. per annum. (EC$2,000 x 2 x 12 = EC$48,000.)
Electricity:	Main cost will be for 150 ton of ice making. Electricity to make 150 ton of ice is EC$2,000. (150 x 90 kwh/ton x 0.15/kwh = EC$2,000.)
Water Charges:	Main cost will be for 150 ton of ice. 200 ton/yr for water is approx. EC$400. (200 x 7.78/3.8 = EC$410.)

(2) Income from Operation of Fishing Port:

The operations of the facilities already constructed are operated by taking in the following charges:

Fishing Gear Storehouse:	EC$10.00 per month
Rental for Fish Sales Area:	EC$2.00 per use, or EC$ 30.00 per month
Rental Charge for Workshop:	Free of charge
Cost of Ice:	EC$0.30/pound

The income expected to be gained from operation of the fishing port is currently being estimated and cannot yet be disclosed, but a rough estimate can be made from the existing charges as follows for fishing gear storehouse, sales area, and ice:

Income from fishing gear storehouse: The yearly income from rental to 40 owners are EC$4,800.
(40 x 10 x 12 = EC$4,800.)

Rental from Sales Area: The yearly income from rental for 8 wholesales areas will be EC$2,800. (8 x 30 x 2 = EC$2,800.)

Income from Sales of Ice: The yearly income from sales of 150 tons of ice will be EC$99,000. (10 x 0.3 x 2,200 = EC$99,000.)

The sum of the above adds to a total of EC$106,600.

(3) Evaluation of the Maintenance and Administration Costs:

From the trial balance sheet for this project indicates that the incomes exceed the expenses, and the maintenance and administrative expenses can be defrayed from this income. So the operation of the Dennery Fishing Port will not become an added expense item to the Fisheries Bureau and the Fisheries Complex, and the project is considered feasible.

CHAPTER 4

Basic Design

CHAPTER 4 BASIC DESIGN

4.1 Design Policy

In order to implement the design for the Dennery Fish Landing-Base Project Basic Design, the background of the Project described in Chapter 2, and the contents of the Project described in Chapter 3 will be considered, and the following design policy will be adopted:

(1) To make the entire project scope of a suitable size.

(2) To take into consideration the natural conditions at the project site.

(3) To adopt the type of structure, materials and construction meeting with the conditions of the construction site.

(4) Since there is fishing activities going on at the coastline, the design and construction methods must not obstruct the fish unloading operations and other fishing activities.

In other words, the above policies will be performed in the following shape and form in performing the design:

(1) To Make the Entire Project Scope of a Suitable Size:

a. To provide a fish landing wharf of suitable size for FRP fishing boats to land their catch, and also provide a lay-by wharf.

b. The proposed fish landing wharf will consider the operation of the existing wood canoes.

c. The contents of the proposed facilities shall be of a scope within the requirements of a Grant-Aid project, while also being within the requirements of the Government of St. Lucia.

d. The proposed facilities will be satisfactory for the future fisheries development in St. Lucia, and increase of fish catch at Dennery and the introduction of new fishing methods with the contents and size required, with a low cost for maintenance and administration of the facilities.

(2) To Take into Consideration the Natural Conditions at the Project Site:

a. To gain a thorough knowledge of the topology, currents, tides, and the soils of the project site, and reflect this information into the design of the facilities.

b. The proposed fishing port site faces the high waves of the Atlantic Ocean where the waves of the open sea directly attack the coast, and wave analysis, littoral effects will be thoroughly investigated, and the facilities should be designed so as not be affected by these forces.

(3) To Design Facilities with Structural, Materials and Construction Methods Best Suited for the Construction Site:

a. The structures shall be of simple design, and shall be easy to maintain and administer with the methods available in St. Lucia.

b. The materials and construction methods selected shall be those available in St. Lucia, and the methods shall be possible to perform.

(4) Thoroughly Consider the Fishing Boats and Fishing Activities:

a. The construction schedule shall take into consideration that the construction operations will not conflict with the peak fishing season operations.

b. To prepare the design and construction to keep the work required in the open sea to a minimum.

The basic design will keep in mind the above design policies and executed.

4.2 Study and Examination on Criteria

4.2.1 Climate

(1) Rainfall:

The annual rainfall for the Dennery area in 1991 was 1,876.3 mm, and from February to May is the dry season, and June to January is the rainy season. Table 4-2-1 is a record of the rainfall in the Dennery area.

(2) Temperature:

The mean temperature in the Dennery area is 29.0 °C, with very little variations between seasons. Table 4-2-1 also gives a record of the monthly average temperature.

Table 4-2-1 The Weather in the Dennery Area

Month (1991)	Rainfall	Maximum Temperature	Average Temperature	Minimum Temperature	Humidity
Jan.	142.6 (mm)	27.8 (°C)	25.3 (°C)	22.7 (°C)	73 (%)
Feb.	64.5	27.8	25.0	22.1	78
Mar.	93.1	28.1	25.2	22.3	72
Apr.	71.0	28.3	26.0	23.6	75
May	84.3	29.5	26.9	24.3	72
Jun.	163.2	29.7	26.7	23.6	72
Jul.	114.9	29.5	26.2	22.9	76
Aug.	126.2	30.3	26.2	22.1	76
Sep.	189.6	30.2	26.0	21.8	73
Oct.	149.6	29.9	26.2	22.5	72
Nov.	565.0	29.4	26.0	22.5	81
Dec.	112.3	27.9	24.2	20.4	73

Source: Union Weather Station

(3) Winds:

There is no wind data available for the Dennery area. According to records taken at Vieux Fort Airport which is approximately 45 km to the south, the prevailing winds are from the east throughout the year (ENE-E-ESE, 70° to 110° clockwise from the North), and the average wind speed is 9 to 16 kn. Table 4-2-2 is a record of the wind data.

Table 4-2-2 Mean Wind Speeds

Month	Mean Wind Velocity (1978 - 88)	
Jan.	9 - 15 (kn)	4.8 - 7.7 (m/sec)
Feb.	11 - 16	5.7 - 8.2
Mar.	10 - 14	5.1 - 7.2
Apr.	10 - 14	5.1 - 7.2
May	9 - 14	4.6 - 7.2
Jun.	13 - 16	6.7 - 8.2
Jul.	11 - 15	5.7 - 7.7
Aug.	10 - 15	5.1 - 7.7
Sep.	8 - 12	4.1 - 6.2
Oct.	9 - 12	4.6 - 6.2
Nov.	9 - 13	4.6 - 6.7
Dec.	10 - 15	5.1 - 7.7

Source: Vieux Fort Airport Data

(4) Daylight Hours:

There is no record of Daylight Hours for Dennery. Data from the Vieux Fort Airport have recorded for 1990, the daylight hours of 8 - 9.5 (hour/day). Table 4-2-3 gives the recorded data.

Table 4-2-3 Daylight Hours (1991)

	Maximum Daylight Hours	Average Daylight Hours
Jan.	10.8 (hr)	8.7 (hr.)
Feb.	11.1	8.9
Mar.	11.1	8.9
Apr.	11.8	8.4
May	11.9	9.0
Jun.	11.2	8.3
Jul.	11.9	9.3
Aug.	11.7	8.3
Sep.	11.4	9.4
Oct.	11.0	7.0
Nov.	10.9	8.9
Dec.	10.7	9.5

Source: Data from Viuex Fort Airport Weather Station

4.2.2 Wave

(1) Offshore Wave Conditions

The estimate of waves and the determination of the design wave will be the most important element in the construction of the Dennery Fish Landing-Base Port facilities. The data for the outer wave factors will be taken from existing data available. This study will be made by referring to information taken from Sailing Directions for the North Atlantic Ocean, 1988 by the Defence Mapping Agency, Hydrographic/ Topographic Center.

a. The Yearly Offshore Wave Factors:

The data divides the North Atlantic Ocean area into 50 areas, and the data for winds, waves and other information is given. The information for the East Side of the Caribbean Sea (No. 44) gives the wave data in the percentage for each season by the rank of the wave. In the calculations to be performed in this analysis, the value of the individual wave height is required, and the information for each rank of wave will be determined. The basic data information will be multiplied by the disturbance percentage to obtain the conversion, the sum of the values for the seasons will be considered the value for the year. The results of the analysis are given in Table 4-2-4, and the prevailing wave in Eastern Sector of the Caribbean Sea is a wave height of 1 to 2 meters with a period of 7 seconds.

Table 4-2-4 Yearly Wave Data (Frequent)

Period (sec)	0 - 6	6 - 7	8 - 9	10 - 11	12 - 13	13 -	Unknown	Total
Wave Height								
0 - 0.1 m	116	10	4	5	-	-	44	179
1 - 2.0 m	230	254	93	22	12	3	61	675
2 - 3.0 m	21	127	94	17	15	6	21	301
3 - 4.0 m	9	10	12	7	1	3	3	45
4 - 5.5 m	-	2	4	1	1	-	3	11
Total	376	403	207	52	29	12	132	1,211

Source: Consultant's Estimate

b. Statistic Wave Height:

On the basis of the wave height data during 25 years, the recurring wave height for a period of 10 - 50 years is assumed in Table 4-2-5.

Table 4-2-5 Probable Wave Height

Recurring Period	Percentage Not Exceeding	Variation to Normalize	Probable Wave Height
10 yr	0.95763	2.51123	4.817 → 4.8 m
20 yr	0.97881	2.94283	5.135 → 5.1
30 yr	0.98588	3.18798	5.316 → 5.3
40 yr	0.98941	3.35909	5.443 → 5.4
50 yr	0.99153	3.49031	5.539 → 5.5

Source: Consultant's Estimate

On the basis of the data given in Table 4-2-4, assuming that relationship of Wave Height (H), Period (S) could be given by a relation of $H = A \cdot S + B$, the results are given in Table 4-2-6.

Table 4-2-6 Probable Wave Height and Period

Recurring Wave Height	Wave Height	Wave Period
10 Yr	4.8 m	11.0 sec
20 Yr	5.1 m	11.5 sec
30 Yr	5.3 m	11.8 sec
40 Yr	5.4 m	11.9 sec
50 Yr	5.5 m	12.1 sec

Coefficient A = 1.50189, B = 3.79606

Therefore, the offshore wave factors have been determined as Wave Height H_O = 5.5 m, and Period T_O = 12.0 sec, and of the waves that come from the 3 directions of ENE-E-ESE, and the wave that the predominant wave that penetrates after breaking on shallow sea bottom will be considered to be the most damaging wave on structures.

(2) The Change in Wave Height in Shallow Sea Bottoms

The changes in wave height in shallow sea bottoms have been studied by making a comparison with a refractive wave pattern based on the offshore wave factors given in the above. The investigation was prepared for the waves that penetrate Dennery Bay from the 3 directions of ENE-E-ESE. The results indicate that the maximum high wave will occur in the area near the mouth of the bay where the depth for 10 - 11 m (on the outside of Dennery Island) will be the highest for the wave for outer waves from East direction, defraction coefficient k_r = 0.9 - 0.95, shallow sea bottom waves in the range N85.0°E to S87.0°E, and perpendicular to the coast line. The wave dissipation will be the largest in the lee of Dennery Island where the depth is -3.0 m, it is recommended that the this site be selected for the fishing port.

(3) Selection of the Design Wave:

The design wave will be selected on the basis of wave height variations in shallow sea bottoms, and the waves from the north will be distributed 1 - 2 m when the waves are high, there can be waves penetrating directing along the deep navigation channels due to the sea bottom profile. The design wave selected for the design of structures, will be the limited waves to be for the design on the safe side as follows:

At the head of the breakwater:	H = 3.3 m, T = 12 sec.
At the root of the north breakwater:	H = 2.9 m, T = 12 sec.
At the south breakwater:	H = 2.8 m, T = 12 sec.

4.2.3 Water Level

(1) The Period of Observation and the Location:

There are no records of any tidal observations performed for Dennery Bay. So a Tide Measuring Instrument from Japan was installed at a place with quiet waters near the proposed project site. The period of measurement was from 4th to 19th September 1992 for a period of 15 days continuous.

(2) Results of Measurement:

The results indicated that there were 2 double day tides in this area (2 high tides and 2 low tides and that there was very little variation, and the tides occurred regularly). Fig. 4-2-1 gives the results and the analysis.

Also, the sum of the Four Major Tidal Components, the height of the Standard Surface from the Average Surface (Z_0) is 34.3 cm. The Four Major Tidal Components are as follows:

Principal Lunar Semidiurnal Component	(M_2)	:	0.152 m
Principal Solar Semidiurnal Component	(S_2)	:	0.063 m
Principal Lunar Diurnal Component	(O_1)	:	0.066 m
Luni-Solar Diurnal Component	(K_1)	:	0.062 m.

The sum Four Major Tidal Components is as follows:

$$M_2 + S_2 + O_1 + K_1 = 0.152 + 0.063 + 0.066 + 0.062 = 0.343 \text{ m.}$$

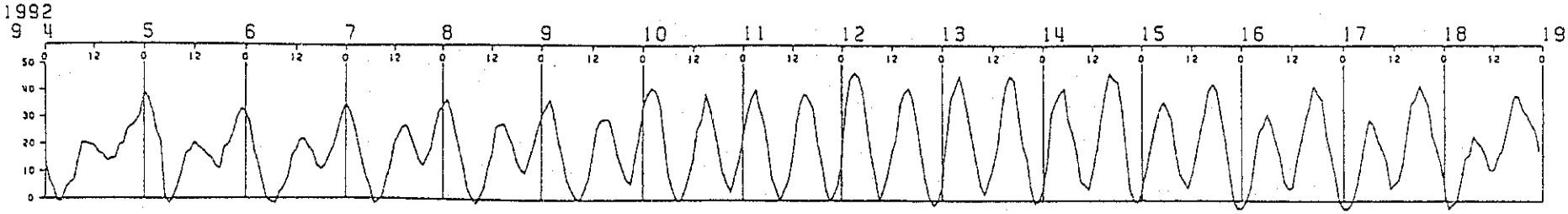
(4) Selection of Design Water Level:

The measured results will be analyzed to obtain the Four Major Tidal Components, and the required water level will be selected for the design, but the water level will have seasonal and secular variations which must be taken into consideration. For this reason, the data available at Viuex Fort and Castries Ports, the British Admiralty Charts for Castries will be used as reference materials.

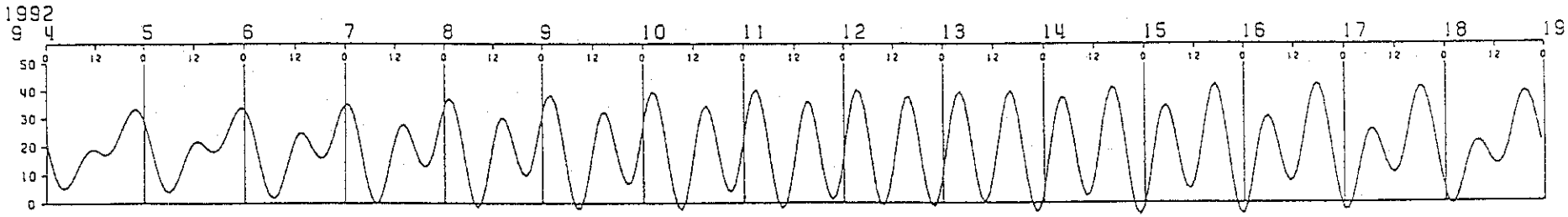
Table 4-2-7 gives the comparison of investigation results and existing data, which gives the Standard Water Level as 47 cm lower than the Average Water Level, and the Low Water Level at Dennery is 34 cm higher than the value given by the Four Major Tidal Components, and is assumed to be approximately 35 - 45 cm lower than the average water level.

The average water level obtained from the observed data was 20 cm higher than the Temporary Standard Level (0). The Low Water Level at the site, in using the Z_0 as 45 cm, 25 cm lower than the Temporary Water Level at the site. Also, the High Water Level measured at the site was 21.4 cm higher than the Temporary Standard Level (55.8 - 34.4 cm = 21.4 cm). For this reason, the following design levels have been selected:

H.W.L.	(High Water Level)	+ 0.70 m
M.W.L.	(Mean Water Level)	+ 0.45 m
L.W.L.	(Low Water Level)	± 0.00 m



(1) Observed Tide



(2) Estimated Tide by Four Major Tidal Components

Fig. 4-2-1 THE RESULTS OF TIDAL OBSERVATION

Table 4-2-7 Observed Water Level and Existing Water Levels

	Observed Water Level	British Admlty Data Castries	U.S. Data Castries	U.S. Data Viuex Fort
H.W.L.	0.56 m	-	-	-
M.H.W.L.	-	0.55 m	0.52 m	0.58 m
M.W.L.	0.34 m	0.47 m	-	-
M.L.W.L.	-	0.30 m	-	-
L.W.L.	0.00 m	0.00 m	0.00 m	0.00 m

4.2.4 Current

The current observations were conducted by the 2 methods of 25 hour continuous observation at fixed points and float observations.

(1) Observation of Current at Fixed Points:

A 25-hour continuous observation at a fixed point was conducted with a Current Meter (Model DCM-2). The observation was conducted at a period of flood tide to measure the maximum current from 14:00 hours of 8th September to 14:00 hours of 9th September 1992.

The maximum current measured was 27 cm/sec., and the direction was 245° from North. The relation of direction and velocity was dominated by the constant current flow, and there was very little signs of turbulence.

(2) Observations by Float Tracking:

There is a small sandy beach in front of the project site, and it is assumed that there are currents flowing the coast, and another out to sea from Dennery Island. In order to obtain a two-dimensional horizontal flow pattern, 2 floats each were cast simultaneously at 2 points north of the island, and 2 at a point south of the island. Also, in order to investigate a velocity pattern perpendicular to the shoreline and within the harbor, floats were cast at 4 places on the surface (-1.0 m), and at intermediate depths (-2.0 m) at 4 places, for a total of 8 places.

The results indicated that currents in Dennery Bay are greatly influenced by the waves from the north much stronger than the waves from the south.

4.2.5 Beach, Sea Bottom Profiles and Littoral Drift

(1) Establishment of Monuments and Bench Marks:

There are no detailed survey data available for the proposed Dennery Fishing Port area. Also, there are no base lines nor bench marks for the proposed site, so a temporary Bench Mark (Z_O') and 5 supplementary points were established and a ground survey was performed.

(2) Ground Topographic Survey:

Using the temporary bench marks, a ground topographic survey was made with a plane table survey in order to obtain a layout of the dwellings within the proposed Fishing Port site. Fig. 4-2-2 is the result of the survey.

(3) Survey of the Sea Bottom Profile:

There is no data available for the bottom profile nor any existing detailed depth information for the area.

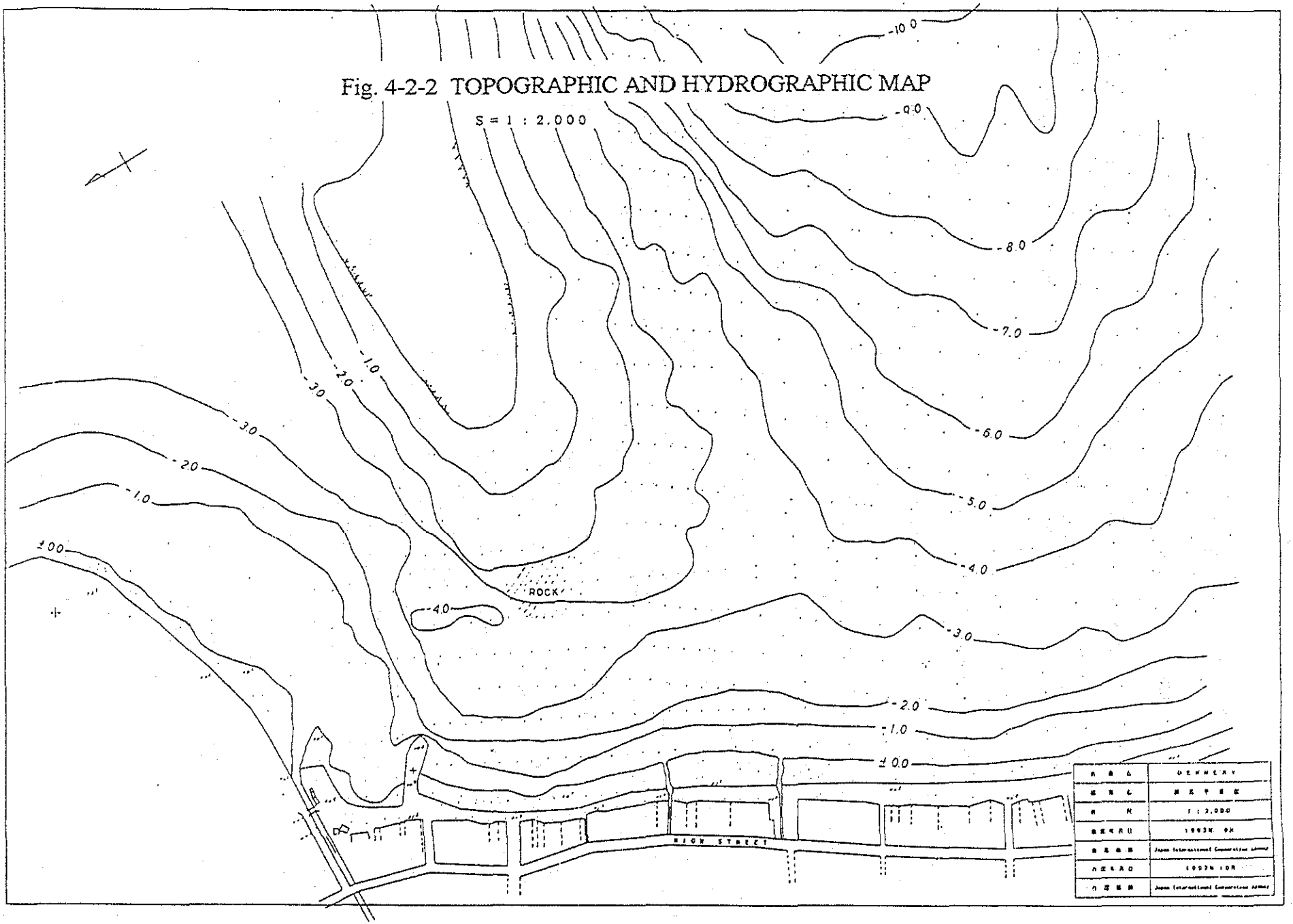
Where the water was comparatively shallow, the sea bottom profile was surveyed by the survey crew, and for the deeper areas the survey was performed with a sonar sounding equipment. The depth sounding operation offshore was performed from a guiding point on land. The measuring point location was fixed with two transits on land.

As there was a rock outcropping near the mouth of the bay and near the proposed breakwater site, a diver was sent down to measure the depth and investigate the bottom conditions. Fig. 4-2-2 gives the results of the survey.

(4) Investigation of Littoral Drift:

In order to analyze littoral drift, representative sand samples of the beach sand (13 samples) were taken near the proposed fishing port site, and grain size analysis and specific gravity tests were made. The grain size analysis and specific gravity tests were made at the Ministry of Communications, Works & Transport Materials Laboratory.

Fig. 4-2-2 TOPOGRAPHIC AND HYDROGRAPHIC MAP



The sand found in the north side of Dennery beach (Sample No. 2, 3) have a diameter of 5 - 15 cm, and are actually small stones. The reason for this is probably due to the fact that the site where the sand samples were taken are severely pounded by the rough waves from the north. At the south side of Dennery Island (Samples No. 9 - 8 - 7) on the same slope, the diameter has a tendency to grow larger towards the outer sea. This can be attributed to a relative change in the sea bottom, and there are few sand bars or troughs in the intermediate area which indicates the peculiarity of the sea bottom. The grain size analysis of the sand taken along the shoreline (Samples No. 11 - 13) showed comparatively little change in the grain size. Table 4-2-8 gives the test results.

Table 4-2-8 Grain Size Analysis and Specific Gravity of Beach Sand

Sample Number	Location Sample Taken	Depth of Water	Grain Dia. (D50)	Specific Gravity
1.	North Breakwater	-4 m to -5 m	Ø0.55 mm	-
2.	North Inside Bay	-2 m to -3 m	Ø5 - 10 cm	-
3.	250 m from Beach Center	-1 m to -0.5 m	Ø10 - 15 cm	-
4.	100 m from Beach Center	-2 m to -3 m	Ø0.15 mm	-
5.	250 m from South Beach	-4 m to -5 m	Ø0.35 mm	-
6.	130 m from South Beach	-2 m to -1.5 m	Ø0.8 mm	-
7.	320 m from South Beach	-4 m to -5 m	Ø0.7 mm	-
8.	150 m from South Beach	-2 m to -3 m	Ø0.4 mm	-
9.	Near P3 Beach	±0.00 m	Ø0.25 mm	-
10.	130 m from River Mouth	-2 m to -3 m	Ø0.3 mm	-
11.	250 m South of Stone Jetty	±0.00 m	Ø0.28 mm	2.69 kg/m^3
12.	100 m South of Stone Jetty	±0.00 m	Ø0.28 mm	2.49 kg/m^3
13.	On Beach, Root of Stone Jetty	±0.00 m	Ø0.22 mm	2.24 kg/m^3

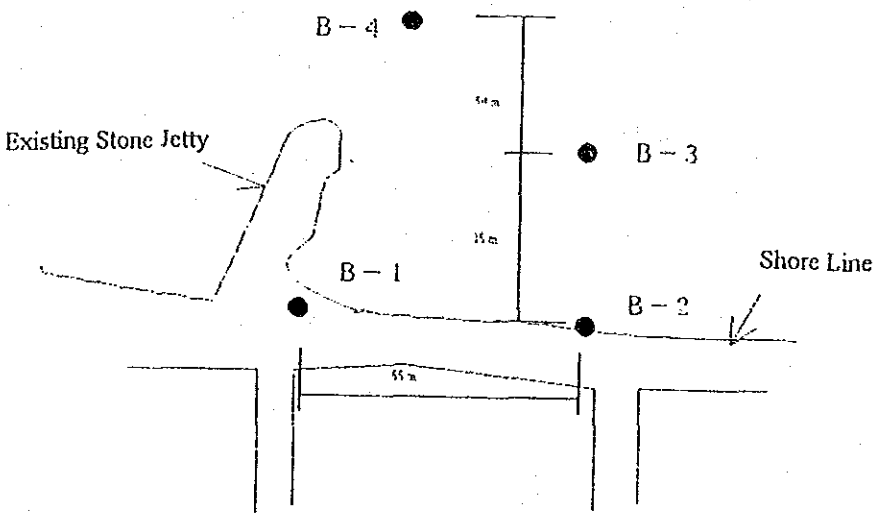
4.2.6 Soils

(1) Investigation Sites:

The only structure on the Dennery coastline is Stone Jetty of 50 m in length on the north of the beach, and there is no soil information available. In order to obtain the soils data for the proposed Fish Landing-Base project in the area leeward of Dennery Island, where the waves were comparatively quiet, 2 holes were drilled on the beach, and 2 holes offshore, for a total of 4 holes. Of the 4, the offshore hole

(B-4) was drilled to confirm the upper soils condition. Fig. 4-2-3 gives the locations of the holes.

Fig. 4-2-3 Location of Soils Investigation



The soil logs are given in Fig. 4-2-4. A general description of each hole is described in the following, and the soils condition in the Dennery beach are sandy for the upper 3 - 9 m strata below which there is layer of clay with a blowcount (N) of 3 to 9.

Bore Hole No. B-1

Bore Hole No. B-1 was drilled at the root of the existing south of the Stone Jetty. Ground elevation was +0.60 m. At a depth of -3 m, there was a layer with a N-value of between 10 to 30, and at a depth of -8.7 m there was a layer of dense fine sand with a N-value of about 20. The sandy layer contained seashells, pea gravel and peat. Below this there was a layer of clayey silt with a N-value of 3 to 9 containing seashells, peat, and decomposed vegetation at a depth of -15 m. At a depth of -15 m, the peat layer turned dense.

Bore Hole No. B-2

Hole No. B-2 is 55 m south of Hole No. B-1, with a ground elevation of +0.45 m. Compared with B-1, the upper sandy layer is thin at 3.1 m, and the N-value exceeded 30 in some of the sandy layers. Under this layer there was a clayey silt layer with a N-value of 3 to 5, containing seashells and decomposed vegetation.

Bore Hole No. B-3

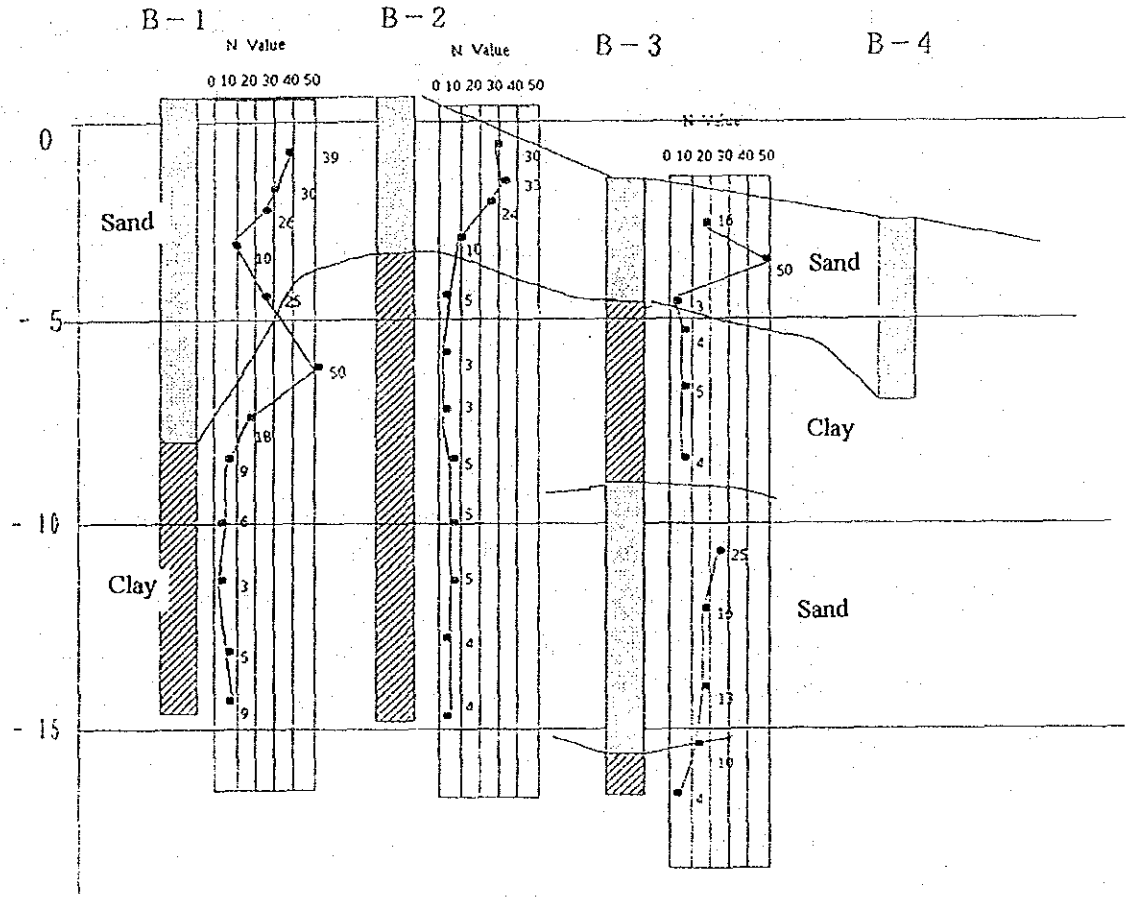
Hole No. B-3 is 35 m out to the sea from Hole No. B-2, and the ground elevation is -1.8 m. The upper layers at this contain seashells, and sandy layers with pea gravel, but there are layers with a high N-value. This layer is thick at 3.0 m. Under this layer is similar to Hole No. B-1 with N-values of 3 to 5, containing seashells, clayey silt with decomposed vegetation continuing to -7.7 m. At a depth of -8.0 m it was assumed that there would be silt similar to the other holes, and an undisturbed penetration sample was tried the soils changed to a sandy silt and a sample could not be obtained. This sandy silt layer had a N-value of about 15 and contained seashells, decomposed vegetation to a depth of -14 m. Also, at a depth of -15 m, there was a layer of silty clay containing seashells and decomposed vegetation.

As seen in the above 3 holes, the thickness of the upper sandy layer varied from a thick layer of 8.7 m to a thin layer of 3.0 m and had a wide variation. At the proposed north breakwater site the water depth was about -2 m, and it will be necessary for the stone mound of breakwater construction to have a layer of sand to withstand the weight of sacrificial stones, and so it was decided to confirm the thickness of the sandy layer by drilling an added hole No. B-4. Since this boring was to confirm the layer of sand, the rod was driven with a 140 pound hammer.

Hole No. B-4

Hole No. B-4 is 85 m away toward the sea, and the ground elevation is approximately -2.8 m. It required many blows to make the rod penetrate the upper layer. At a depth of 4.5 m the rod refused to penetrate any further. It is assumed that the layer of sand is a mixture of sand with pea gravel. From this it was assumed that upper sandy layer was 4.5 m thick, and under this the soils was a layer of dense sand.

Fig. 4-2-4 Soils Log



(3) Selection of Soils Conditions:

From the results of the soils log, the soils conditions to be used for the design of the wharf and breakwater are selected as follows:

Fig. 4-2-5 Soils Conditions

-1.5 to -3.5 m

Sandy Layer

Layer Thickness	:	3 m
N-value	:	16 - 50

-4.5 m

Clayey Layer

Layer Thickness	:	5 m
N-value	:	3 - 5

-9.0 m

Sandy Layer

N-value	:	13 - 25

-15.0 m

Clayey Layer

N-value	:	4

4.2.7 Summary of Design Conditions

From the above natural field conditions and design analysis performed in Japan, the following design conditions have been determined for the design of the Dennery Fishing Port project:

(1) Climate:

Temperature	:	27.8 °C - 30.3 °C (Year round)
Humidity	:	72 % - 81 %
Prevailing Wind	:	ENE-E-ESE (70° - 110° clockwise from North)
Wind Velocity	:	17 - 21 m/sec.

(2) Sea Conditions:

Design Water Level	:	H.W.L. +0.70 m M.W.L. +0.35 m L.W.L. ±0.00 m
Residual Water Level	:	When drainage is good: L.W.L. + 2/3 (H.W.L. - L.W.L.) = +0.47 m When drainage is not good: L.W.L. + 1/3 (H.W.L. - L.W.L) = +0.23 m
Direction of Design Wave	:	ENE-E-ESE
Design Wave	:	H_O = 5.50 m, use Limit Wave Height (H = 0.78 h) for Wave in Front of Breakwater (Probable Wave 30 - 50 Years)
Wave Period	:	T_O = 12.00 sec
Design Current	:	0.27 m/sec.

(3) Seismic Force:

The Windward Island including St. Lucia in the Caribbean Tectonic Plate, and have a record of earthquakes. The record of these earthquakes are recorded at the Earthquake Center at Trinidad and Tobago. It has been recommended to use a Design Horizontal Coefficient of 0.1 for St. Lucia. The design earthquake coefficient of 0.1 will be used for the design of the facilities for the Fishing Port accordingly.

(4) Soils Conditions:

The soils conditions for the design soils conditions will be as given in Fig. 4-2-5.

(5) Various Load Factors:

Tonnage of Fishing Vessels	:	3 (GT) Type
Draft of Fishing Vessel	:	1.5 m
Berthing Speed of Fishing Vessels	:	0.5 m/sec
Traction of Fishing Vessels	:	1 t/base
Spacing of Vessel Mooring	:	5.0 m
Load Factor (Normal)	:	1.0 t
Load Factor (Earthquake)	:	0.5 t.

(6) Materials:

The materials and their unit weight will be as follows:

Description	Weight per Unit Volume (t/m^3)
Structural Steel	7.85
Cast Iron	7.25
Reinforced Concrete	2.45
Concrete	2.3
Cement Mortar	2.2
Lumber	0.8
Fill Stone, Internal	
Friction Angle, $\varnothing 30° \cdot \gamma =$	1.8 (in air)
Ditto, $\varnothing 15° \cdot \gamma =$	1.0 (in air)
Asphalt Pavement	2.3
Stone	2.6
Aggregates (wet, in air)	1.8
Aggregates (saturated, in air)	2.0
Sea Water	1.03

(7) Friction Coefficient (μ):

Precast Concrete and Stone Boulder	$\mu = 0.6$
Precast Concrete and Rock Outcropping	$\mu = 0.5$
Precast Concrete and Precast Concrete	$\mu = 0.5$
Cellular Block and Stone Boulder	$\mu = 0.7$
Cast-in-place Concrete and Rock Outcropping	$\mu = 0.8$
Stone Boulder and Stone Boulder	$\mu = 0.8$

(8) Safety Factors:

1)	Against Slippage	Minimum 1.2
2)	Against Falling	Minimum 1.2
3)	Against Allowable Edge Pressure	40 - 50 t/m^2
4)	Against Eccentric Loads	Minimum 1.0
5)	Against Foundation Reaction	Minimum 2.5
6)	Against Linear Slippage	Minimum 1.2
7)	Against Circular Slippage	Minimum 1.3

9) Allowable Stresses:

Allowable Stress, Sheet Piling (SY30)	Bending Stress, 1,800 (kg/cm2)
	Bending Comp., 1,800 (kg/cm2)
	Shear Stress, 1,000 (kg/cm2)
Allowable Stress, Tie Rod (SS41)	Shear Stress, 4,100 (kg/cm2)
	Yield Strength,
	Less than 40 mm, 960 kg/cm2 (Normal Condition)
	1,440 kg/cm2 (Earthquake)
	More than 40 mm, 880 kg/cm2 (Normal Condition)
	1,320 kg/cm2 (Earthquake)

4.3 Basic Plan

4.3.1 Site and Layout Plan

The study for the alternate sites for the Fish Landing-Base of a shoreline with a total length of approximately 800 meters at Dennery divided into 4 sites can be considered. A comparison of the four sites is given in Table 4-3-1.

1. Construct the fish landing-base at the northernmost end of the shoreline. (Scheme A)

2. Construct the fish landing-base between the stone jetty and the tombolo. (Scheme B)

3. Construct the fish landing-base on the tombolo. (Scheme C)

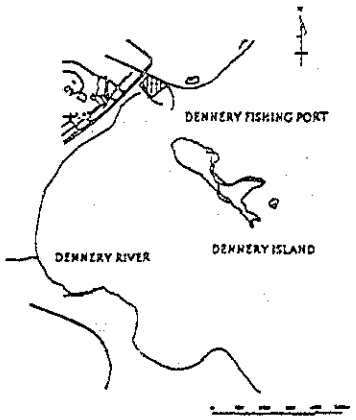
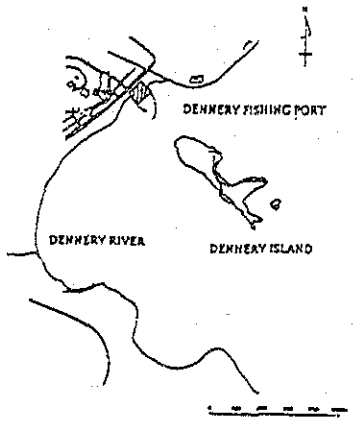
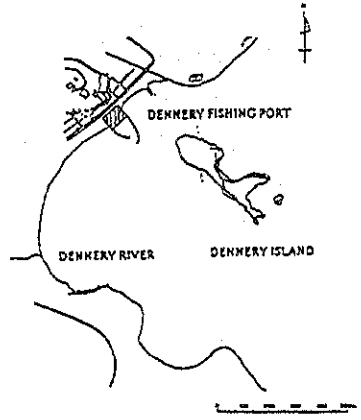
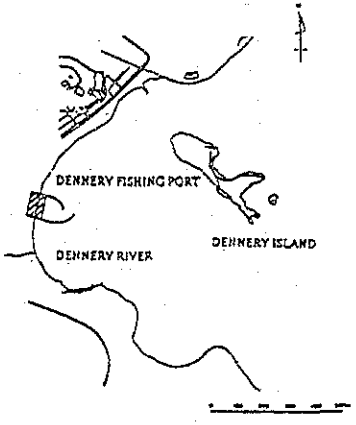
4. Construct the fish landing-base between the tombolo and the Dennery River. (Scheme D)

The coastline at Dennery faces the Atlantic Ocean and the force of the outer sea waves act directly on the breakwater constructed at the outer protection facilities of the fishing port. The prevailing winds at the port are from the north in the range of 70 - 110°, and the prevailing waves are also from this direction.

For this reason in Schemes A and D, the port is located away from the leeward side of Dennery Island, and compared with the other Schemes, the waves acting on the breakwater are larger, which will require a higher construction cost for the breakwater. Also, due to the closeness to the Lavine Trou River and the Dennery River the sites would not be satisfactory due to the silt transport from the rivers.

On the other hand, Schemes B and C are on the leeward side of the Dennery Island, and are protected from the high waves from the open sea, and from the results of the wave analysis are in the most tranquil part of the coastline. From this point, it will be easy to maintain the navigation aids for safe navigation routes, with space for future expansion of the port facilities, ease of construction of access roads, possible siltation of the port and obstruction to the fishing activities during the construction period, it is therefore adjudged that Scheme B is better suited for the fish landing-base than the other Schemes.

Table 4-3-1 Comparison of the Proposed Fishing Port Sites

	Scheme A	Scheme B	Scheme C	Scheme D
Plan View				
Characteristics	Plan to construct fishing port facilities at the northernmost end of an Dennery coastline. 1. The off-shore area of the proposed area is shallow, and requires more dredging of the sea bottom to provide mooring for the fishing boats compared to other Scheme.	Plan to utilize existing stone jetty. 1. No dredging required for mooring of fishing boats. 2. The coastline is subject to wave erosion, and there are stones placed to prevent further erosion. 3. The port construction will arrest further erosion of the coastline. 4. It will be easier to maintain land for the access road than other Schemes. 5. There will be little effects from direct waves from the outer sea.	Plan to construct fishing port on the tombolo. 1. Will not be affected from waves of the outer sea due to being leeward of Dennery Island. 2. Dredging will be required to provide mooring for fishing boats. 3. Since the site is on the tombolo at the mouth of the river, there can be problems of siltation in the future.	Plan to construct the fishing port between the tombolo and Dennery River. 1. There will be silt from the Dennery River there is a possibility of siltation occurring in the future at the mouth of the river. 2. There will be waves from the outer sea due to the proposed site being on the leeward side of the island.

4.3.2 Scope of Works

(1) Infrastructure Facilities for the Fish Landing-Base and Other Related Facilities:

1) Estimate of Fishing Boats Using Facilities and Their Numbers

There are at present 32 fishing boats at Dennery of which 2 are of the FRP type. With the supply of 18 more FRP boats under the project, there are two cases that can be considered for the Dennery area on the basis of the increase of fishing boats (See Appendix-6 for the handling of increased FRP boats).

a. If the present number of fishing boats are retained, the total number will be increased to 50 boats.

Canoe 30 + FRP Boats 20 = 50 Boats

b. If the present Canoes are replaced by FRP boats newly introduced, the total number will be 32 boats.

Canoe 12 + FRP Boats 20 = 32 Boats.

The number of fishing boats at Dennery will be a maximum of 50 boats, and a minimum of 32, but to be practical, the average of the two of 41 will be considered. The reason for this is that out of the 18 FRP Boats, 9 will be considered as additional, and 9 will be considered as replacements, and the planned number of fishing boats will be assumed as follows:

Canoe 21 + FRP Boats 20 = 41 Boats.

The type and dimensions of the fishing boats will be as follows based on measurements taken of the existing boats at the site:

Average canoe dimensions: 6.5 m lg x 1.8 m wd.

Average FRP Boat dimensions: 7.2 m lg x 2.0 m wd.

2) Required Length of Lay-by Wharf

The two FRP fishing boats at Dennery are tied up off-shore since there is no mooring facility available at the present time (September 1992). After completion of the fishing port facilities, the canoes can be beached on the shore as at present and idle, but the FRP boats will have to be provided with

Lay-by wharf within the port. For this reason a Lay-by wharf will have to be provided for the FRP boats as follows (See Appendix-6 for the measures to cope with the increased FRP boats):

The FRP boats will be assumed to moor in the lengthwise pattern, assuming 20 FRP boats, the required length of the Lay-by wharf will be 60 m.

Required wharf Length: 2.0 m x 1.5 x 20 boats = 60 m.

Required Width in the water area: 7.2 m x 2.1 = 15 m.

3) Required Length for the Fish landing Wharf:

The proposed fish landing wharf will be planned for use by both canoes and FRP boats. From the results of investigation at the site, the time required to land fish is assumed to be 20 minutes per boat, including the time to land and depart. Fish landing usually takes place from 14:00 to 18:00 hours, and on the average about 10 boats can discharge their catch, but allowing for peak seasons, double this amount or 20 boats could enter to discharge their catch.

a. Rate of Turnover of the Wharf:

Number of Turnovers per Hour: 1 Hour ÷ 20 min = 3

b. Number of Fishing Boats Making Use per Hour:

Assuming that canoes and FRP boats will require the same time, the number of canoes using the wharf will be 3.3 and FRP boats will be 3.3 utilizing the wharf simultaneously.

Canoes 10 each ÷ 3 = 3.3 boats

FRP Boats 10 each ÷ 3 = 3.3 boats.

c. Extending Length of Fish Landing Wharf:

Required length of the fish landing wharf will be 52 meters, assuming a spare length of 0.15 L per boat.

Canoes :	6.5 m x 1.15 x 3.3	= 25 m
FRP Boat:	7.2 m x 1.15 x 3.3	= 27 m
Required Extension		= 52 m

4) Main Building:

The main building will be planned to house the ice making facilities, ice storage roomes, fish storage room, fish handling space, retail fish stand areas, and administrative spaces.

a. Ice Making Facilities:

(i) Ice Making Capacity:

The ice making capacity and storage facilities are calculated from the Monthly Fish Catch (1991), in Table 2-2-6, and the maximum monthly catch of approximately 49,000 pounds.

In making studies of the methods used to obtain statistical data, it is assumed that the actual amount of fish caught exceeds the data reported. For this reason, the average daily catch of fish is assumed at approximately 1,960 pounds (1 ton) daily.

49,000 lb x 1.2 ÷ 30 dy = 1,960 lb/d ÷ 1 tn/dy

In consideration of the daily variations in the catch (fishermen's report that at peak season some boats catch in excess of 1,000 lb), the maximum daily catch is assumed to be double that reported of 2 tons.

Therefore the amount of ice usage per boat (due to the closeness of the fishing area, the catch will be assumed at 1/2) will be 1 ton, and the amounts to be used at the retail market and for transport (transport time to the capital city Castries is short and will be 1/2 the same as for the boats) will be 1 ton, for a total of 2 tons per day will be used for the calculations.

(ii) Ice Storage Facilities:

The ice storage facilities will be adequate for 2 tons of ice per day. The effective space requirement will be 6 m^3, considering the void ratio of plate ice.

The ice storage space will be assumed for 2 m x 3 m = 6 m^2. The effective stack height will be 6 m^3 ÷ 6 m^2 = 1 m.

Assuming a clear space of 1 meter to the ceiling, the clear height to the ceiling will be 2 meters.

Therefore the size of ice storage facilities is as follows:

2 m width x 3 m length x 2 m height

b. Insulated Cabinet for Fish Storage

The storage of fresh fish will be a mixture of ice and the fish in a container the so-called icing storage method, and the storage by mechanical means (refrigerated equipment) has a tendency to cause the fish to dry out and is not considered a good method. Also, where there is no special technician available for proper maintenance of machinery, it will be better that mechanical refrigeration methods not be used.

Therefore, the fish storage facility for this project will not be provided with refrigeration means but will be an insulated cabinet. The capacity will be for a maximum of 2 tons as described before. The storage will be by ice in the ratio of 0.5 ton of ice for 1 ton of fresh fish, and the required size of the facility will be as follows.

The average specific gravity of fish is 0.8 and ice is 0.5 so the storage space for the cold storage space will be 4.5 m^3.

Space Requirement: 2 tn ÷ 0.8 tn/m^3 +
1 tn ÷ 0.5 tn/m^3 = 4.5 m^3

When storing fresh fish, the height of stacking is usually less than 1 meter, and so the floor space will be 4.5 m^2, but since there will be working space required, a space of 6 m^2 will be assumed.

Floor Space: 4.5 m^3 ÷ 1 m + Work Space = 6.0 m^2.

Therefore, the space for the insulated cabinet will be the same as for the ice storage facility.

Therefore, the internal dimensions for the ice storage facility will be 2 m wide, 3 m depth, 2 m high.

c. Fish Retail Stands:

15 % of the daily fish catch at Dennery is sold to the local consumers. The average daily amount of fish sold to the retail stands is 7.3 kg of the catch per boat.

Max. Catch 2 tn/dy ÷ 41 boats x 15 % = 7.3 kg.

From results of investigations conducted by hearing, the time of retail sales is 30 minutes each time. The return of fishing boats is the 4 hours from 14:00 to 18:00 hours, and the retail stands will be able to open 8 times per day. But the return of the boats will concentrate during this time and actually be 5 times, and there are 8 stands.

Retail Stands: 41 $^{\text{Boats}}$ ÷ 5 = 8 $^{\text{Stands}}$.

d. Office Space:

With the completion of the fishing port, there will be 1 or 2 administrators dispatched from the Fisheries Bureau to administer and manage the facilities. Office space will be required for these officers, and the space requirement will be 5 m^2 per person, and office space will be planned for 10 m^2.

5) Fishing Gear Repair Shop (Workshop):

The repair of fishing nets require a large space and on clear days, the work is usually performed outdoors. The Workshop will not be provided to repair the many fishing nets simultaneously, but to repair fishing gear, and the Workshop space will be provided mainly to make minor repairs.

Therefore, space will be provided for the fishermen to make repairs while in the sitting position for which space of 3 m^2 per person will be provided. It is assumed that all the fishermen would not be there at the same time, so the workshop will be planned for one-half of the 20 FRP Boats. For this number the workshop space required will be 60 m^2.

Required Space: 3.0 m^2 x 20 = 60 m^2.

6) Fishing Gear Storehouse:

There is an existing Fishing Gear Storehouse behind the Dennery Fish Landing Place commensurate with the number of fishing boats. After the Fishing Port is completed, the FRP Boats will be moored within the port. The fishing gear will placed in safekeeping in the Storehouse at the time of fish landing and the gasoline will placed in portable tanks and kept in the Storehouse. The Storehouse will be required for the storage of the fishing gear and gasoline.

The Storehouse for the fishing gear will be the same size as the present one with a space of 2 m x 2 m per boat. It will be desirable to provide the same number of storage space as the fishing gear, but due to structural layout of the building, it will have to provide an even number of bays, and for the arrangement of buildings, it would be better to provide 2 Storehouses, one for 20 fishing boats. Therefore, for a planned number of 41 boats, 40 storage spaces will be planned. The required size of each Storehouse will be 4 m x 20 m.

7) Toilet Facilities

There are 2 existing toilet facilities provided at the Dennery Beach with toilets and showers, and the toilet facilities planned for the project will be a similar type, but only one will be provided.

8) Fueling Facilities

According to information from the Fishermen's Coop, the minimum amount of fuel dispensed per day at the peak fishing season was 1,000 gallons, and the underground storage tank is a minimum of 1,000 gal x 2 each.

The underground tank and fuel dispensing stand, and related facilities will be provided under a special contract with the Taxaco Oil Co. (checked and confirmed in the field), and so only the site will be provided under this project.

(2) FRP Fishing Boats:

In accordance with the request from the Fisheries Bureau, there will be 18 FRP Fishing Boats with V-bottom of the Martinique type (24 footers). In order to make it a standard practice to keep the caught fish refrigerated with ice, there will be an insulated hold provided in the center of the boat. The insulated hold will be approximately 2 m wide, with spacing of 1 m of the bulkheads, and a depth of 0.5 m. The internal volume of the refrigerated hold will be approximately 0.8 m^3, and this will be adequate to store an average of one day's catch in the peak season.

This may not be enough capacity to handle any extraordinary fish catch of 1,000 pounds, but enlargement of the insulated hold would require sacrificing of other space of the boat, so only one insulated hold will be provided.

(3) Fishing Gear:

There are JICA experts dispatched to St. Lucia to assist in developing new fishing methods, and train the fishermen by a training-demonstration program. Since they were sent over recently, the fruits of their efforts will have to awaited, but one fact has been pointed out by them which is the lack of adequate fishing gear to perform their training by demonstration. For this reason, the items requested by the St. Lucia Government for fishing gear will be furnished for this training demonstration. (see Appendix 5 for the detailed gear list)

(4) Vehicles:

There will be one transport vehicle to haul the fish from Dennery to Castries, and the 2 ton capacity will be adequate for the intended use, including the ice required during the transport. When the catch is large, the extra fish can be kept in the refrigerated storage facility at Dennery and several trips could be made as required. Therefore, the refrigerated transport vehicle of 2 ton capacity will be provided. For the administrative vehicle, there will be one pick-up truck (double cab) provided.

4.3.3 Layout of the Facilities

A general layout plan of the facilities described hereinbefore has been prepared as shown by Fig. 4-3-1.

(1) Location of the Wharf Face Line:

According to the results of the depth survey, if there will be no dredging of the navigation channel, the maximum depth of the navigation channels of -3.0 m can be maintained by this project. Therefore, the maximum depth of -2.5 m can be maintained, and from the specifications of the fishing boats using the facilities, the wharf face lines have been located so that a depth of -2.0 m can be guaranteed without any dredging.

The crest of the wharf will be planned for an elevation of +1.5 m based on the results of a tide analysis and the type of the boats. The width of the apron has been decided for 6.0 m as only small boats will be used, and travel will be by vehicles. The junction of the north breakwater and the fish landing wharf will be used for mooring idle boats, for which the wharf has been extended, so with the required length for fish landing and lengthwise mooring of the boats, a total length of 70 m (52 m + 15 m = 67 m ≒ 70 m) has been considered.

(2) Extension of the Breakwater:

It has been planned to extend the north breakwater by 110 m, and the south breakwater by 40 m taking into consideration the results of the littoral analysis, the areas required for operating and mooring of the fishing boats (turning basin: 3L, mooring area: 2.1L, fish landing area: 1.5B).

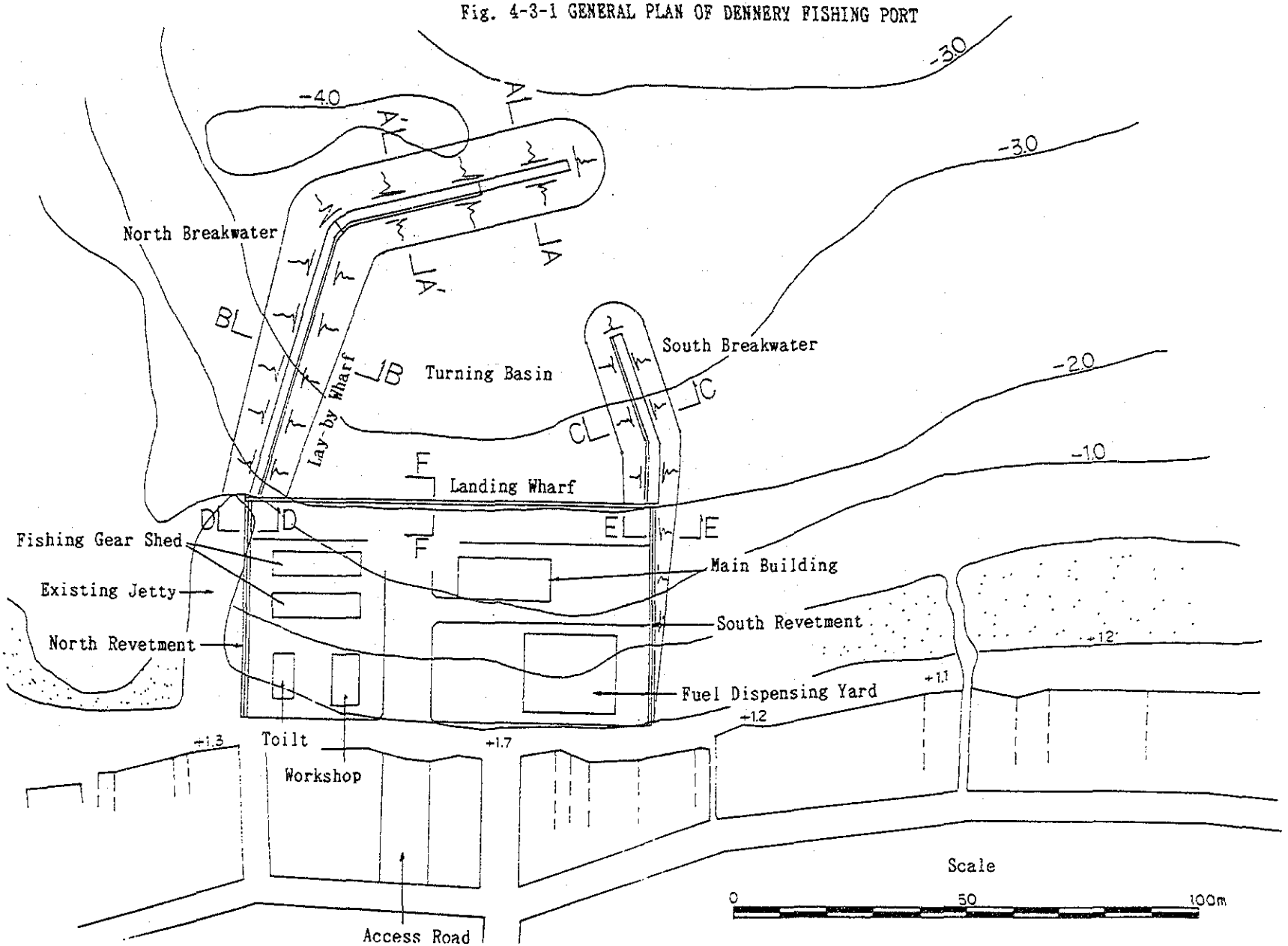
(3) Building Layout:

The arrangement of buildings within the fishing port area has been decided based on the fishermen's movement flows, flow of the landed fish, location of the fish landing wharf, and the location of the access road as follows:

1) The Main Building has been located in the center of the port facilities adjacent to the fish landing wharf since it houses the ice making facilities, ice storage and the retail sales area.

2) The Fishing Gear Storehouse has been located near the Lay-by wharf at the north reclaimed land for easy transport of the fishing gear. Two Storehouse each with storage space for 20 storage spaces have been provided.

Fig. 4-3-1 GENERAL PLAN OF DENNERY FISHING PORT



3) The Toilet and Fishing Gear Workshop have been located behind the Fishing Gear Storehouses.

4) The Fuel Storage and Dispensing Facilities have been located behind the Main Building to be able to supply fuel and ease of access.

(4) Access Road:

There are two access roads from the National Road to the Fishing Port site, but they are only 4.0 m wide and narrow. For this reason the open lot (private land) in the center has been proposed to be used for a 10.0 m wide access road.

The land proposed for the Access Road is a private property but the local Government has given its basic agreement to procure the land by the time of commencement of the project. If the land cannot be procured within the time, there is no choice but to use the existing road.

The surfacing of the road will be asphalt pavement.

4.3.4 Structural Design

(1) The Wharf:

The wharf will be the most important of the fishing port structures. In order to select the most suitable type, comparative designs has been prepared. Refer to Table 4-3-2 for the alternative designs. From the soils conditions at the project site, the type that will permit a comparatively simple and rapid construction and that will not require any excavation will be the wharf with sheet piling for its constructibility, low cost and comparative long life, and this type has been selected. The typical cross section of the wharf is given in Fig. 4-3-2.

(2) Breakwaters:

Dennery is constantly washed by the waves of the open seas. The breakwaters will be an important infrastructure to maintain a safe and calm waters for a fishing port. In order to select a breakwater the alternative designs shown in Table 4-3-3 were provided to compare different types of breakwaters. The type of breakwater selected will be a simple structure which can be constructed with local materials and can be constructed from the land side and not require heavy construction equipment, and be simple to construct with low maintenance costs. The stone

mound type of breakwater has been selected for the breakwater which meets these requirements.

At the junction of the breakwater with the wharf at the north breakwater, there will be a Lay-by wharf as shown in Fig. 4-3-3 where concrete blocks will be provided for the mooring of the fishing boats. The wharf will be extended the required 60 m for the Lay-by wharf. A standard cross section for the north end of the breakwater is given in Figs. 4-3-4 and 4-3-5. Fig. 4-3-6 gives a standard cross section of the south breakwater.

(3) Revetment:

Revetment facilities will be constructed to protect the reclaimed land. The fairing into the existing ground, and connection to the breakwater will consist of local stone materials which will make the facility easy to maintain. Fig. 4-3-7 gives the standard cross section for the facility.

(4) Main Building:

The Main Building will house the ice making facilities, ice storage, refrigerated storage, fish processing, fish retail sales, and office space. The structural system will be planned for a reinforced concrete structure which will require little maintenance and operations cost. The flake ice equipment will be installed on top of the ice storage facility which will be of structural steel framing. The finish of the Fish Retail Stands will be ceramic tile. The ice storage and refrigerated facilities will be constructed with prefabricated insulated panels. The floor slabs will be of concrete. The necessary utilities of electric power and lighting, water supply and drainage systems will be provided. Fig. 4-3-8 gives the general structural details of the Main Building.

(5) Fishing Gear Storage:

The Storehouse will be used to store Fishing Gear. There will be 2 Storehouse, each for storing fishing gear for 20 boats each. The buildings will be constructed with concrete block walls with cement mortar finish, concrete floor slabs and reinforced concrete roof slab. Shelving will be provided within each room for storage of small items. A general plan of the storehouse is given in Fig. 4-3-9. There will be no building utilities of electricity nor water provided.

(6) Workshop:

This Workshop will be provided for the repair of fishing gear. The building will consist of a concrete floor slab, support columns, and a reinforced concrete roof slab, and there will be no exterior enclosing building walls. The support columns will be structural steel with an exterior concrete finish. There will be a hanger provided for hanging of nets provided between the columns on the east and west side of the building. A general plan is given in Fig. 4-3-10. Electric lighting will be provided.

(7) Toilets Facilities:

The Toilet will be constructed of concrete block walls finished with cement mortar with concrete floor slab, and a reinforced concrete roof slab. A general plan is given in Fig. 4-3-10. There will be a septic tank with a leaching well to treat the effluent from the toilet drainage system. See Fig. 4-3-11 for general layout.

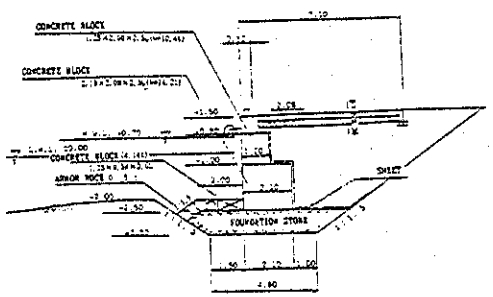
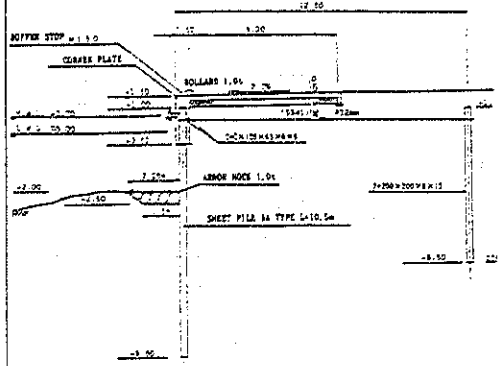
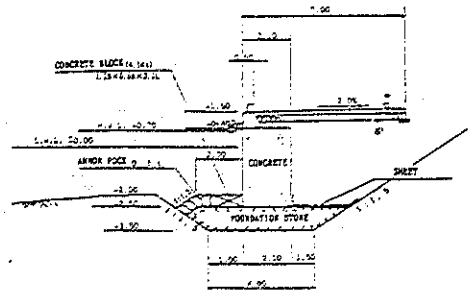
(8) Paving Plan:

From the soils study, it is expected that there will be subsidence of the grounds and so asphalt pavement will be provided for easy maintenance. See Fig. 4-3-12 for a General Plan for site paving. The center road in the center of the fishing complex will be 10.0 m wide, the same as the Access Road. Other roads will be of the same width as the Apron and 6.0 m wide.

(9) Electric Power, Water Supply and Telephone Plan:

The Electric Power, Water Supply and Telephones will be provided for the Fishing Complex, using conduit pipes, water distribution pipes, and wiring systems installed along the roadway, and connected to the existing utilities systems. There will be one telephone provided in the Main Building. See Fig. 4-3-13 for a utilities plan.

Table 4-3-2 COMPARISON TABLE FOR PROPOSED STRUCTURE

ITEMS \ STRUCTURE			BLOCK TYPE	STEEL SHEET PILE TYPE	GRAVITY TYPE
OUTLINE OF STRUCTURE					
FEATURE	MERIT		EASY IN QUALITY CONTROL OF CONCRETE EASY IN MANUFACTURING FACILITIES	RATHER EASY IN CONSTRUCTION FACILITIES NOT REQUIRED EXCAVATION MAY EASILY COPE WITH LARGE VESSEL IN THE FUTURE	STABILITY AGAINST WAVE FORCE BE RATHER FIRM
	DEMERIT		INCREASED IN UNDERWATER WORK(i.e EXCAVATION,RUBBLE MOUND AND PLACING BLOCK etc.) REQUIRED LARGE BLOCK YARD REQUIRED HEAVY MARINE PLANT	REQIRED TO COPE WITH RUST	REQUIRED ACCURACUY IN UNDERWATER WORK NOT EASY IN CONTROL OF CONCRETE PLACING
APPROX. QUANTITY	CONCRETE (m^3)	BLOCK	648 m^3	NIL	54 m^3
		INSITU Concrete	44 m^3	109 m^3	668 m^3
		TOTAL	692 m^3	109 m^3	722 m^3
	STONE (m^3)	FOUNDATION STONE	720 m^3	NIL	702 m^3
		ARMOR ROCK	117 m^3	110 m^3	176 m^2
		TOTAL	837 m^3	110 m^3	878 m^3
	OTHERS	STEEL	NIL	165 TON	NIL
		BOLLARD	19 NOS	19 NOS	19 NOS
ROUGH EWSTIMATE COST ONLY DIRECT COST (MILLION)			¥ 56.0 MILLION	¥ 40.0 MILLION	¥ 42.0 MILLION
CONSTRUCTION PERIOD (MONTH)			5 MONTH	4 MONTH	4 MONTH
EVARUATION			×	○	△