THE MINISTRY OF FINANCE
THE REPUBLIC OF GHANA

NO. 1

BASIC DESIGN STUDY REPORT
ON
THE PROJECT FOR THE CONSTRUCTION OF
SEKONDI FISHING PORT
IN
THE REPUBLIC OF GHANA

DECEMBER, 1996

JAPAN INTERNATIONAL COOPERATION AGENCY
TETRA CO., LTD.

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PREFACE

In response to a request from the Government of the Republic of Ghana the Government of Japan decided to conduct a basic design study on the Project for the Construction of Sekondi Fishing Port and entrusted the study to the Japan International Cooperation Agency (JICA).

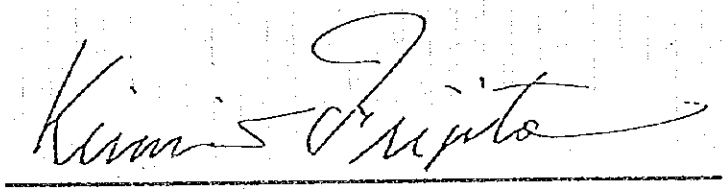
JICA sent to Ghana a study team from March 16 to April 23, 1996 and from July 13 to August 16, 1996.

The team held discussions with the officials concerned of the Government of Ghana, 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 Ghana in order to discuss a draft basic design, and as this result, the present report was finalized.

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

I wish to express my sincere appreciation to the officials concerned of the Government of the Republic of Ghana for their close cooperation extended to the teams.

December, 1996



Kimio Fujita
President
Japan International Cooperation Agency

December, 1996

Letter of Transmittal

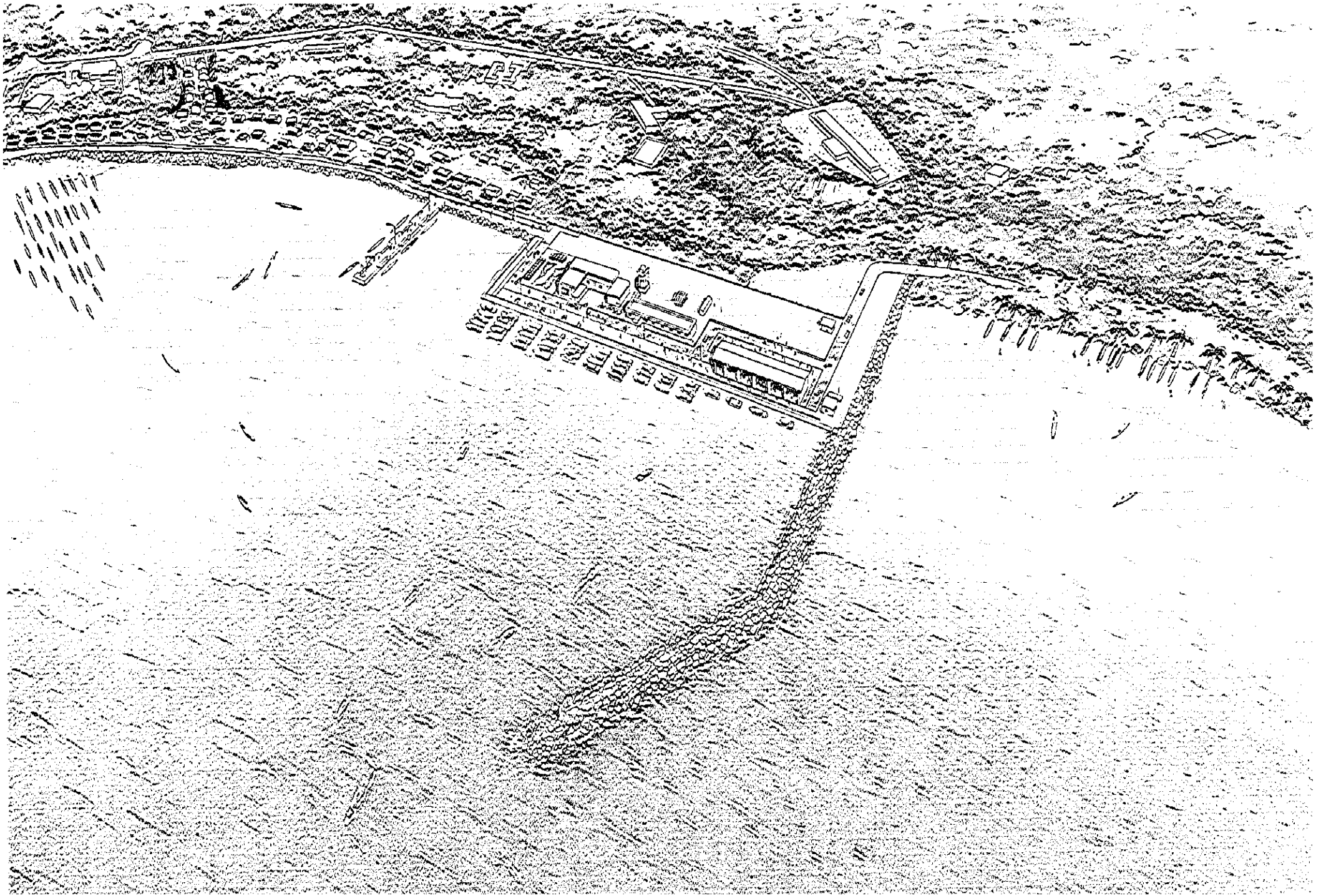
We are pleased to submit to you the basic design study report on the Project for the Construction of Sekondi Fishing Port in the Republic of Ghana.

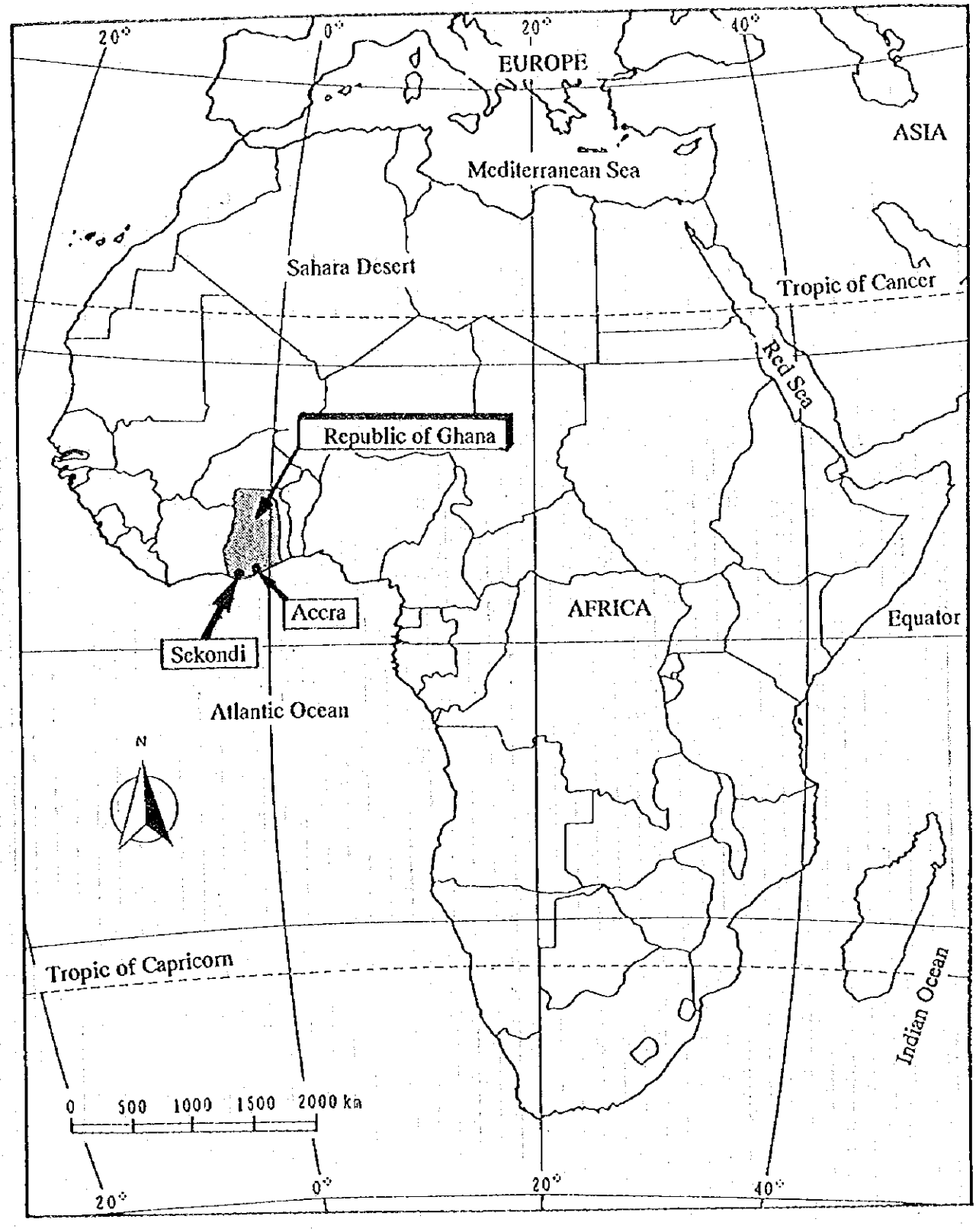
This study was conducted by TETRA Co., Ltd., under a contract to JICA, during the period from March 11, 1996 to January 27,1997. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Ghana and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

Finally, we hope that this report will contribute to further promotion of the project.

Very truly yours,

Koichi Igari
Project manager,
Basic design study team on
The Project for the Construction of
Sekondi Fishing Port
TETRA Co., Ltd.

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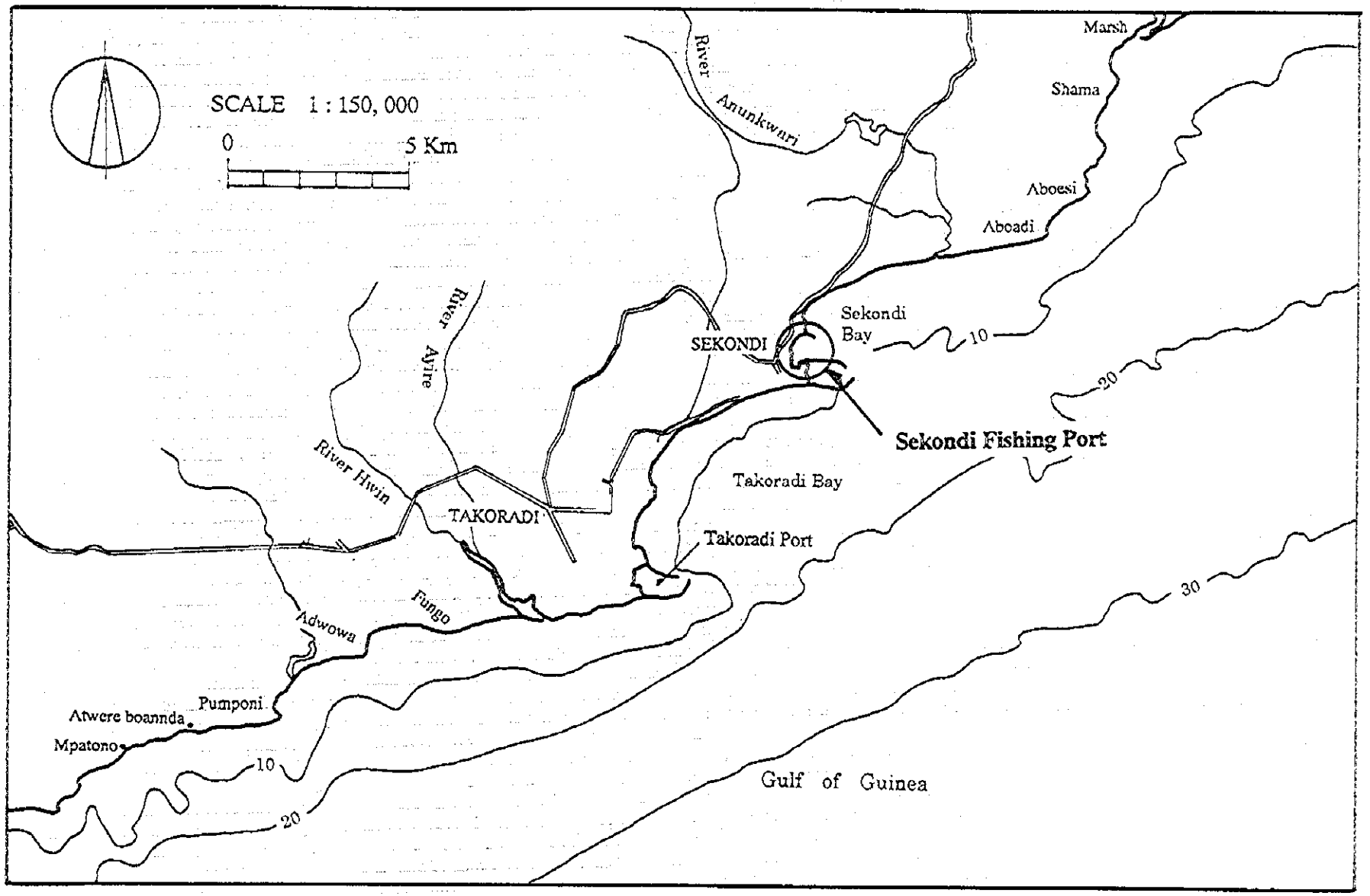
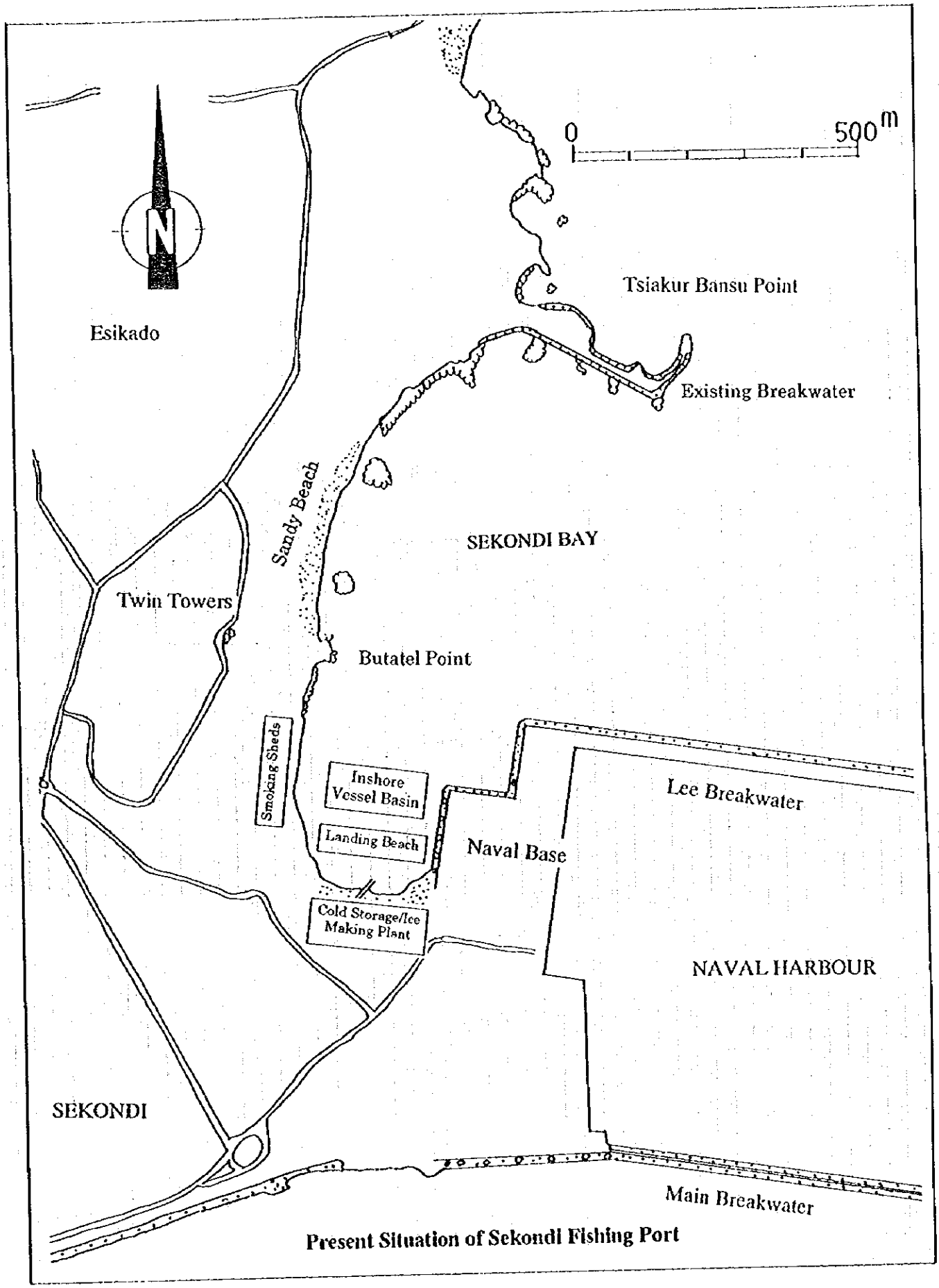


Location of Sekondi Fishing Port



Present Situation of Sekondi Fishing Port

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Abbreviations

GDP	Gross Domestic Product
US$	United States Dollar
NDPF	National Development Policy Framework
PAS	Public Administration System
EEZ	Exclusive Economic Zone
IMF	International Monetary Fund
ERP	Economic Recovery Programme
GPHA	Ghana Ports and Harbours Authority
M/T	Metric Ton
SFC	State Fishing Corporation
FAO	Food and Agriculture Organization of the United Nations
RC	Reinforced Concrete
EIA	Environmental Impact Assessment

CHAPTER 1

BACKGROUND OF THE PROJECT

CHAPTER 1 BACKGROUND OF THE PROJECT

Ghana is situated at the central part of West Africa and faces the Gulf of Guinea to the south, Togo to the east, Burkina Faso to the north and Cote D'Ivoire to the west. The country has the area of 238,537 km², about 2/3 of that of Japan. According to the World Bank Statistics, population was about 16.26 million in 1993, the average increase in the 80s being 3.4%. The ratio of urban population including that of Accra, the capital, to the total is as high as about 32%.

The continental shelf in the seas of Ghana accounts for about 21,000 km². Although the offshore distance is generally narrow, it offers a fishing ground rich in small pelagic fishes such as sardines and large pelagic fishes such as bonito and tuna seeking after the small fishes, as seasonal upwelling generates at places where the warm currents such as the Guinea Current and the cold currents such as the South Equatorial Current and the Canary Current cross each other. The fishing industry successfully operates in much the same way as Senegal, producing about 380,000 tons annual catch. Though the fishing industry accounts for 1.5% of GDP, the Government of Ghana regards the fishing industry as a source of animal proteins, employment opportunities and means for earning foreign currency. The number of fishermen about 100,000. The country is largely dependent on fishes landed in the country for its animal protein supply. The annual fish per capita consumption is 23.6 kg, about 1.7 times of the world average of 13.5 kg. In 1993, the country exported 24,000 tons of marine products such as refrigerated/frozen bonito and tuna to such destinations as nearby Abidjan. Export of fishes is an important source of foreign currency earnings in recent years, and contributes to the national economy.

Fishery in Ghana can be categorized into five sectors; inshore fishery in the continental shelf, pelagic fishery by trawlers, bonito/tuna fishery by purse seine and pole/line fishing, traditional canoe fishery, and fresh water fishery. The major force in fishery is fishermen from fishing villages dotted along the coast line who are engaged in hand line fishing, gill net and purse seine fishing. They have about 8,000 boats and their catch accounts for about 70% of the entire volume. In recent years, the annual catch has reached a plateau as shown by the records for 1990 (366,000 tons) and for 1993 (382,000 tons). Further promotion is desired for achieving the expansion of marine products. Serious problems faced by marine fishery include poor quality of fish catches due to underdeveloped landing facilities, fish handling sheds, ice making plants, etc. in all the fishing ports except Tema.

Fishery activities in Ghana have centered around Tema Fishing Port with Accra, the capital, and Tema City in the hinterland. As the Port was crowded and lacked adequate

facilities, the Government of Japan carried out Tema Inner Fishing Harbour Rehabilitation Project(1988 -1989) and Tema Outer Fishing Harbour Rehabilitation Project (1992 -1994) for expansion and improvement of Tema Fishing Port based on the feasibility study by the World Bank. Both Outer Fishing Harbour and Inner Fishing Harbour, which had been improved previously, contributed not only to improving the efficiency of fishing and landing operations but also to invigorating distribution of marine products from the fishing port and other commercial activities, thus achieving major economic effects. On the other hand, the Western region has no landing facilities to speak of.

Sekondi Fishing Port located at about 250 km west of Accra is a major fishing port for the Western Region. The Port has been using comparatively calm waters formed behind the Naval Base's breakwater. It enjoys the advantage of being close to the fishing grounds. However, there are no landing facilities where inshore vessels can directly berth, and no related infrastructure such as oil and water supplies and ice making facilities is established. Currently, fish catches are landed by hand-rowing canoes making trips between vessels anchored in the basin and the canoe landing beach. Compared to the improved Tema Fishing Port, landing of the catch in Sekondi requires a lot of time, hindering work efficiency and deteriorating fish freshness. Shallow depth of the basin often inflicts damages to vessels, incurring much repair expenses and lowering fishermen's income.

In view of the present situation and problems as discussed above, the Government of Ghana requested a grant aid scheme for developing Sekondi Fishing Port, as the key point in the Western Region, and for promoting fishery in the area as outlined below:

[Contents of the Request]

(1) Basic Facilities
- 1) Breakwater structured with rubble and rip-rap rocks : 130 m long, 5 m wide
- 2) Shore protection structured with rubble and rip-rap rocks : 150 m long
- 3) Slipway : 45 m long
- 4) Landing wharf structured with concrete block : -3.5 m deep, 110 m long
- 5) Lay-by wharf structured with concrete block : -2.0 m deep, 120 m long
- 6) Dredging and reclamation works

(2) Functional Facilities
- 1) Ice making plant complete with ice storage unit : 10 ton/day
- 2) Cold storage unit : -25 ℃
- 3) Water supply system with water tank : 10 ton
- 4) Electrical / Mechanical works
- 5) Administration building : 120 m²
- 6) Construction and Pavement works for access road and area interior the site

CHAPTER 2

CONTENTS OF THE PROJECT

CHAPTER 2 CONTENTS OF THE PROJECT

2-1 Objectives of the Project

Under the national development policy of "Ghana Vision 2020", the Government of Ghana is currently promoting measures for five key issues; development of human resources, economic growth, regional development, urban development and socioeconomic environment. "Intermediate Development Plan for Agriculture (1991 - 2000)" cites the following targets for the marine industry.

* Increase fish catch for people's diet
* Increase employment opportunities in marine industry and promote diversification of economic structure in rural areas
* Promote sustainable development in ocean and fresh water fisheries

As this project is a part of fishery production development in Western Region of Ghana, it optimally serves these policies for fishery.

The Government of Ghana proposed construction of a modern fishing port in order to solve the following present problems faced by the country.

* Inefficient fishery operations due to lack of adequate fishing port facilities
* Damages to inshore vessels caused by insufficient depth of the basin and consequent limitations on increasing the size of boats
* Impact on environment such as deterioration of water quality

As the result of discussions with the survey team, the Government of Ghana finally requested a grant aid assistance for Sekondi Fishing Port Construction Project to the Government of Japan as described below.

[Items requested]

(1) Basic facilities

1) Breakwater
2) Wharves for inshore vessels
3) Canoe jetty
4) Roads in and around the fishing port
5) Pavement within the fishing port area

(2) **Functional facilities**

1) Ice making plant
2) Cold storage unit
3) Fish handling shed
4) Administration building
5) Water supply system
6) Fire fighting system and sea water pumps
7) Security and tower lighting
8) Toilets and sewage facilities
9) Fish market

2-2 Basic Concept of the Project

Basic direction and concept of the plan decided for Sekondi in "Intermediate Development Plan for Agriculture (1991 - 2000)" were carefully studied, and the subsequent changes and results of new surveys were taken into consideration in drafting this plan and selecting the layout, structure and scope of the facilities proposed. The Sekondi Fishing Port Project is the third in series of grant aids for improvement of fishing ports offered by the Japanese Government after rehabilitation of the inner fishing harbour and the outer fishing harbour in Tema Fishing Port. Following completion in 1995, Tema Fishing Port is being most effectively utilized and the project was highly appreciated by the Government of Ghana. The Government of Ghana places the highest priority to Sekondi Fishing Port after Tema in its plan for improving fishing ports, and proposes to develop Sekondi Fishing Port as the nucleus for fishing in Western Region.

Sekondi Fishing Port Construction Project is formulated taking into account the following points.

* Improvements consistent with purposes of Fishery Development Plan
* Improving efficiency in fishing operation and increasing fish catch
* Improving safety of inshore vessels
* Preserving freshness of fish catch and stabilizing fish prices
* Preventing water contamination in the fishing port
* Preventing siltation of basin by littoral drift
* Establishing adequate management/operation system
* Layout plan taking into account the existing facilities such as fish smoking sheds
* Needs, effectiveness and priority for each of the facilities in the port and their optimum scopes

Sekondi Fishing Port serves about 50 inshore vessels and about 300 canoes. When implemented, this project will greatly improve efficiency of landing/preparation of inshore vessels and safety of vessels, and contribute to promotion of marine industry in the Western Region. In preparing the plan, local landing and distribution systems which are quite different from those of Japan were carefully considered by referring to Tema Fishing Port, and an optimum plan as a Japan's grant aid scheme was drawn.

2-2-1 Examination on Requested Facilities

(1) Selection of Project Site

As shown in Figure-2.2.1, two sites were presented for consultation with the Government of Ghana; the site 1 was in front of the existing breakwater in the rocky reef zone in the north of Sekondi Bay which was suggested by the Government of Ghana, and the site 2 in the reef zone in the center of Sekondi Bay which was chosen as a result of the first field survey. As shown in Table-2.2.1 which compares the sites, choice of the site 2 was agreed as it is accessible from the smoking sheds, enables continuing of the existing marketing channel and presents no problems in coordination with the Naval Base. The site 1 was judged inadequate because of possible hindrance of fishing operations by the effect of waves and extra cost involved of removal of two wrecked ships in the area.

Based on the result of examination, the site 2 was chosen as the project site. As for application procedure for environmental assessment regarding disappearance of the existing sandy beach which may be caused by the choice of the site 2 and partial moving of the smoking sheds which may be absorbed into the new port, assurances of cooperation from the Ministry of Transport and Communications have been given.

(2) Examination on Content of Request

Although there are no problems in formulating this project and in the request from the Government of Ghana, there were additional requests from the Government at the time of the second field survey. The results of consultation with the Government regarding additions and changes to the request and of the survey are described below.

1) Canoe Jetty

The initial plan was to improve the fishing port for use mainly by inshore vessels. However, the second field survey revealed that large canoes were catching expensive fishes in addition to the species caught by inshore vessels.

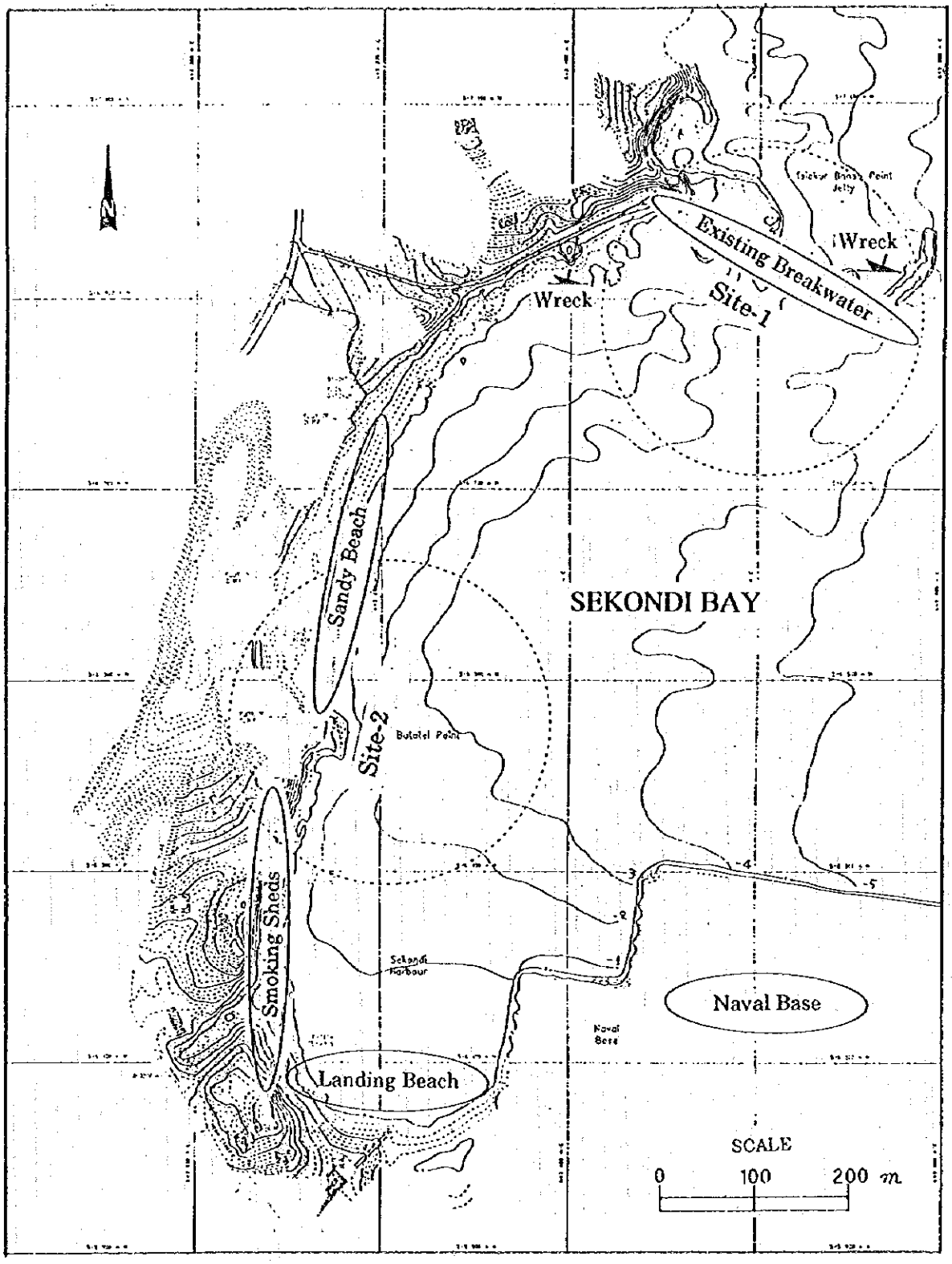


Figure-2.2.1 Project Site

Table-2.2.1 Comparison of Project Site

Items	Site-1: in front of existing breakwater	Rated	Site-2: in front of rocky reef (Butatel Point)	Rated	Remarks
1. Securing area	-Administration of naval facilities such as existing breakwater should be transferred, requiring coordination with concerned offices. -Access to fishing port by vehicles can be secured easily. -Two wrecked ships must be evacuated.	X	-A part of smoking sheds must be removed, necessitating compensation such as alternative site for the sheds and replacement of the smoking platforms. -Access to fishing port from north or south by vehicles is not easy.	O	Securing the site for the project is responsibility of Ghanaian Government.
2. Convenience	-Landing wharf and smoking sheds will be located far from each other, causing inconveniences. Using of fishing port becomes difficult. -Sandy beach in the bay will remain intact.	X	-Landing wharf will be located near smoking sheds, and the fishing port as a whole will more compact, thus improving efficiency. -A part of sandy beach in the bay will disappear.	O	
3. Functionality	-Breakwater will have to be a big one in order to preserve calmness in the basin against waves from outer sea. -The site is subject to strong SW wind and the impact of waves generated inside the port throughout the year.	X	-A breakwater of relatively small scope is sufficient since the calmness inside the port is preserved. -Impacts wind and waves generated in the port are relatively small.	O	
4. Work conditions	-Construction of wharves will be influenced by waves. -Breakwater can be constructed with the end-on method from land side. -Dredging of hard rocks will be rather small in scope.	O	-Construction of wharves will be relatively free of impacts of waves. -Breakwater can be constructed with the end-on method from land side. -Dredging of hard rocks will be rather big in scope.	O	
5. Cost	1.00	O	1.00	O	
6. Management	-Management of fishing port will be easy as it can be separated completely from canoe landing beach and basin	O	-Management of the fishing port will be somewhat complicated as the port will be adjacent to the canoe basin, and the inshore vessels and large canoes will both be using the navigation channel and the port mouth..	X	
Overall evaluation	-The site is not suitable for the project because of difficulties in coordination with Naval Base, in fishing operation under the impact of strong wind and waves generating in the port and of wrecked ships	X	-The site is suitable for the project because of good access from the smoking sheds which will continue the existing distribution system, and because there will be no problems in coordination with Naval Base.	O	

Note: O is suitable, X is not suitable

Use of the new port by large canoes was considered essential in moving middlewomen to the new port and invigorating it. The Government of Ghana mentioned that while it was possible to charge inshore vessels for the use of the port, they could not do so with large canoes against the year standing practice even if both vessels and canoes were to use the same new wharf. As this may cause difficulties in port management, addition of a jetty for large canoes was requested to land their catch in the new port.

2) Fish Handling Shed

Since the need for preventing deterioration of freshness of catch under the scorching sun was recognized, positive examination was decided. The study team suggested to place the shed immediately behind the fish landing wharf, and the Government of Ghana showed understanding of this proposal.

3) Slipway

There had been a request for a slipway for repair of inshore vessels, and the study team asked if it was really necessary. As it was possible for the inshore vessels based in Sekondi to use the shipyard facility in the neighboring Takoradi Port, a request was made for an open storage yard in the candidate site for the slipway.

Table-2.2.2 shows the summary of overall evaluation of the priority for various facilities which are to be improved by this project as determined in view of solutions for various problems, the current degree of demand for each facility, economy and safety of the facilities. It was decided that the cold storage unit and fish market included in the request by the Government of Ghana did not need urgent improvement, and that these facilities would not be included in the project. Only the land would be secured for future development.

a) It was pointed out that the cold storage unit would not be economically advantageous since little profit was expected from operation, and that since the season for pelagic fishes for which the plant is intended is as short as three months, the year-round operation of the plant cannot be expected.

b) As the fish catch offered for auction in the fish handling shed would be taken over by middlewomen and sold directly to smoking sheds, etc., the catch offered for general retail would be very small in amount, and the catch sold fresh was as little as 20% of the entire catch according to the result of origin and distribution survey.

Table-2.2.2 Priority Evaluation

Requested Items		Resolve the present bottlenecks	Demand	Economic benefit	Upgrade safety	Total evaluation
(1)Basic facilities						
	(a)Breakwater	◎	◎	◎	◎	◎
	(b)Wharves for inshore vessels	◎	◎	◎	◎	◎
	(c)Canoe jetty	○	◎	○	◎	◎
	(d)Road in and around the fishing port	◎	◎	◎	◎	◎
	(e)Pavement within the fishing port area	◎	◎	○	◎	◎
(2)Functional facilities						
	(a)Ice making plant	◎	◎	◎	◎	◎
	(b)Cold storage unit	○	○	△	○	△
	(c)Fish handling shed	◎	◎	◎	◎	◎
	(d)Administration building	◎	◎	○	○	◎
	(e)Water supply system	◎	◎	◎	◎	◎
	(f)Fire fighting system and sea water pumps	○	◎	○	◎	◎
	(g)Security and tower lighting	○	◎	○	◎	◎
	(h)Toilets and sewage facilities	◎	◎	◎	◎	◎
	(i)Fish market	△	○	○	○	△

Note: Each facilities are ranked ◎, ○, and △ with ◎ as the highest rank and △ as the lowest rank.

2-2-2 Basic Direction of Development Plan

(1) Fishing Port Plan

In formulating the present project, following problems currently faced by Sekondi Fishing Port must be solved first.

* Inefficient fishery operations due to lack of adequate fishing port facilities
* Damages to inshore vessels caused by insufficient depth of the basin and consequent limitations on increasing the size of boats
* Impact on environment such as deterioration of water quality

The layout plan for the facilities is proposed by considering the smoking sheds adjacent to the approved project site 2 and the sandy beach. The layout of the navigation channel is proposed by considering the safety of navigation and preservation of water quality in the port. As for future management and operation of Sekondi Fishing Port, an optimum system is proposed by considering the organization, the fee system and the management cost.

(2) Use of Existing Fishing Port

When this project will be completed, the existing canoe landing beach in Sekondi will be offered for use by canoes, but inshore vessels will not be allowed to use it as a rule.

2-3 Existing Condition of Sekondi Fishing Port

2-3-1 Fishing Activities

(1) Fish Catch

The fish production in Ghana for 1984 - 1993 are presented in Table-2.3.1. The catch for 1993 consisted of approximately 320,000 tons from marine fishing and approximately 50,000 tons from inland fishing which consists mainly of fish culture. Of marine fishing, canoe fishery accounts for about 260,000 tons and inshore fishery about 5,000 tons. In recent years, the annual catch has reached a plateau as shown by the records for 1990 (366,000 tons) and for 1993 (382,000 tons).

Tables-2.3.2 and 2.3.4 respectively show fish catch of inshore vessels by port (1993), the monthly fish catch of inshore vessels (1986-1995), and the fish catch by species (1993).

Table-2.3.2 shows that the fish catch by inshore vessels at Sekondi was approximately 1,500 tons in 1993, second largest (about 30%) after Tema (2,000 tons) in the country. As for the monthly catch, those for July and August were greater than in any other months, accounting for about 50% of the annual catch.

Table-2.3.3 shows that the fish catch at Sekondi during the past 10 years fluctuated between about 1,000 tons and 3,000 tons, and that for July, 1993 was the largest at about 715 tons in the past three years (1993-1995).

Table-2.3.4 shows that Round Sardines account for about 60% of the annual catch, mainly in the three months between June and August, followed by L. H. Herrings which account for about 15% and Burrito white horsehead about 10%.

Table-2.3.5 shows the catch by canoe for Shama-Ahanta East district including Sekondi Port. It is about 17,000 tons per year, about 80% of which is by the purse seine fishing, and the catch is greater for June to September.

Table-2.3.1 Fish Production in Ghana (1984-1993)

Unit: M/T

Year	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
1. Canoes	171,233	159,899	190,196	261,451	244,042	220,877	242,020	215,847	307,931	257,237
2. Inshore Vessels										
a. Purse Seiners	6,260	9,956	10,117	5,003	1,880	8,622	6,470	5,557	9,404	3,747
b. Trawlers	8,443	8,022	11,776	9,928	5,533	4,034	2,779	1,798	1,364	1,483
Sub-Total (Ins. Vessels)	14,703	17,978	21,893	14,931	7,413	12,656	9,249	7,355	10,768	5,230
3. Industrial Vessels	16,429	21,932	22,344	20,171	16,042	23,073	26,558	27,892	20,933	18,323
4. Shrimp Vessels						380	725	784	386	1,548
5. Tuna Vessels	29,143	34,406	34,719	33,465	35,433	32,294	40,802	37,794	30,776	36,856
6. Total	231,508	234,215	269,152	330,018	302,930	289,280	319,354	289,672	370,794	319,194
7. Tuna Transhipped	25,133	24,337	24,568	26,290	29,571	21,543	28,253	24,938	17,717	21,145
8. Tuna Sold Locally	5,815	10,069	10,151	7,175	5,861	10,751	12,549	12,855	13,058	15,710
9. Fish Exported	1,811	1,818	11,910			3,710	4,961	5,227	4,696	3,283
10. Fish Imported		1,000	496			23,448	22,698	26,576	34,274	36,983
11. Shrimps Exported						193	186	147	133	99
12. Inland Waters	41,000	43,000	53,000	55,000	57,630	57,660	58,000	57,000	56,000	52,000
13. Domestic Consumption	247,369	252,060	286,170	358,728	330,988	344,562	365,927	342,151	438,135	382,101

Source: Fisheries Department

Table-2.3.2 Fish Catch of Inshore Vessels by Port (1993)

Unit: M/T

MONTH	TEMA	APAM	MUMFORD	ELMINA	SEKONDI	AXIM	TOTAL	% CONTR.
JAN	99.7	12.8	35.7	50.0	74.0	0.0	272.2	5.3
FEB	80.7	6.1	16.5	24.8	35.0	0.0	163.1	3.2
MAR	160.3	4.0	12.8	11.2	44.4	0.0	232.7	4.6
APR	72.2	5.8	0.2	8.4	25.2	0.0	111.8	2.2
MAY	30.2	0.0	7.0	20.4	35.2	0.0	92.8	1.8
JUN	109.6	10.5	13.9	45.5	151.2	0.0	330.7	6.5
JUL	118.0	22.4	218.2	225.6	714.9	0.0	1,299.1	25.5
AUG	957.0	7.5	187.2	65.0	178.3	4.1	1,399.1	27.4
SEP	155.8	6.8	26.1	66.0	85.4	0.0	340.1	6.7
OCT	92.3	21.6	229.7	45.4	107.4	0.0	496.4	9.7
NOV	67.7	0.0	5.6	16.3	69.1	0.0	158.7	3.1
DEC	111.3	10.6	20.0	39.7	20.0	0.0	201.6	4.0
TOTAL	2,054.8	108.1	772.9	618.3	1,540.1	4.1	5,098.3	100.0
%CONTR.	40.3	2.1	15.2	12.1	30.2	0.1	100.0	

Source: Fisheries Department

Table-2.3.3 Monthly Fish Catch of Inshore Vessels (1986-1995)

Sekondi Fishing Port — Unit: M/T

Month	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	AVE.
JAN	219.2	86.0	60.8	106.1	341.4	94.2	53.2	74.0	87.1	82.3	120.4
FEB	55.9	86.9	33.8	89.6	199.2	67.9	N/A	35.0	82.3	109.9	84.5
MAR	258.6	117.2	66.2	124.4	110.6	54.8	43.2	44.4	134.4	N/A	106.0
APR	219.9	60.6	50.3	107.5	21.7	29.1	51.7	25.2	104.8	69.1	74.0
MAY	187.5	71.8	93.5	67.8	42.8	41.6	34.8	35.2	91.6	101.5	76.8
JUN	97.9	94.0	80.3	40.9	60.6	21.7	48.7	151.2	67.4	98.6	76.1
JUL	637.4	231.1	116.0	184.1	220.9	43.2	249.2	714.9	111.7	199.3	270.8
AUG	473.1	191.7	69.9	230.4	263.0	612.6	227.2	178.3	121.7	92.0	246.0
SEP	121.0	74.0	114.5	151.2	224.2	151.3	108.4	85.4	141.6	147.9	132.0
OCT	235.8	445.9	156.4	229.2	38.2	443.9	68.0	107.4	149.3	81.9	195.6
NOV	225.8	466.6	337.6	191.3	130.8	69.9	35.8	69.1	152.3	105.2	178.4
DEC	186.8	121.0	135.4	293.2	69.0	58.9	22.8	143.7	131.3	145.4	130.8
TOTAL	2,919	2,047	1,315	1,816	1,722	1,689	943	1,664	1,376	1,233	1,672
AVE.	243.2	170.6	109.6	151.3	143.5	140.8	85.7	138.7	114.6	112.1	140.9

Source: Fisheries Department

Table-2.3.4 Fish Catch of Inshore Vessels by Species (1993)

Sekondi Fishing Port

Unit: M/T

Species	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Total	%
Red Pandora	1.5	0.0	0.0	0.2	1.6	3.2	0.0	0.0	0.0	0.2	0.0	0.0	6.7	0.4
Cassava	20.8	7.1	13.3	4.4	5.7	0.8	0.0	0.0	16.2	22.2	14.0	15.0	119.5	7.1
Red Mullet	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.9	0.0	0.0	1.1	0.1
Burrito	10.6	4.7	2.3	7.0	10.5	5.5	0.0	0.0	26.3	29.4	12.5	55.3	164.1	9.8
Burro	1.5	0.0	1.4	0.2	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	3.2	0.2
Chub Mackrel	0.0	0.0	0.0	0.0	0.0	5.2	5.4	0.9	0.0	0.0	0.0	0.0	11.5	0.7
Bumper	3.4	1.5	1.6	0.0	0.7	0.0	0.0	1.2	0.0	0.1	0.0	0.4	8.9	0.5
Moonfish	0.9	0.0	0.3	0.9	2.6	0.1	0.0	0.0	0.0	0.0	0.1	0.6	5.5	0.3
Threadfin	2.0	1.7	1.6	1.0	1.2	0.1	0.0	0.0	0.3	0.8	0.6	13.5	22.8	1.4
Round Sardine	0.0	0.0	0.0	0.0	0.0	130.1	704.8	179.7	0.0	0.0	0.0	0.0	1,014.6	60.6
Flat Sardine	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.1	3.1	0.2
L. H. Herrin	31.0	16.3	21.0	11.2	11.4	3.6	0.0	0.0	33.7	41.5	30.6	54.0	254.3	15.2
Shad	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	0.1	0.0	1.4	0.1
Yellowfin Tuna	0.0	0.0	0.0	0.0	0.0	0.0	4.4	0.0	0.0	0.0	0.0	0.0	4.4	0.3
Ribbon Fish	0.8	3.1	0.0	0.0	0.0	0.0	0.0	0.0	0.2	1.0	4.2	0.0	9.3	0.6
Shrimps	0.5	0.2	0.5	0.2	0.5	0.6	0.0	0.0	16.4	9.4	6.8	1.2	36.3	2.2
Cuttlefish	0.3	0.5	2.3	0.0	0.3	0.2	0.0	0.0	0.0	0.0	0.0	0.2	3.8	0.2
Others	0.7	0.0	0.0	0.1	0.4	1.7	0.2	0.6	0.2	0.6	0.1	0.4	5.0	0.3
Total	74.0	35.1	44.3	25.2	35.1	151.2	714.8	182.4	93.3	107.4	69.0	143.7	1,675.5	100.0
%	4.4	2.1	2.6	1.5	2.1	9.0	42.7	10.9	5.6	6.4	4.1	8.6	100.0	

Source: Fisheries Department

Table-2.3.5 Fish Catch by Canoe for Shama-Ahanta East District (1993)

SHAMA-AHANTA EAST (including Sekondi Fishing Port) Unit: M/T

MONTH	Purse Seine	Beach Seine	Set Net	Line	Gill Net	TOTAL	% CONTR.
JAN	929.0	43.1	153.4	55.8	12.7	1,194.0	6.9
FEB	402.6	61.4	47.2	49.8	329.2	890.2	5.2
MAR	1,214.5	57.8	92.7	64.1	260.1	1,689.2	9.8
APR	435.8	29.9	65.9	67.5	135.0	734.1	4.3
MAY	319.0	35.7	28.1	91.4	110.2	584.4	3.4
JUN	1,839.6	43.5	24.6	32.7	34.2	1,974.6	11.5
JUL	2,760.2	47.3	35.0	49.7	42.8	2,935.0	17.1
AUG	2,968.0	45.7	30.4	15.2	113.3	3,172.6	18.5
SEP	1,711.8	30.8	37.5	18.9	81.7	1,880.7	10.9
OCT	465.2	53.1	81.9	43.6	39.2	683.0	4.0
NOV	237.2	44.2	128.6	75.1	57.1	542.2	3.2
DEC	636.3	56.5	136.3	31.6	54.9	915.6	5.3
TOTAL	13,919.2	549.0	861.6	595.4	1,270.4	17,195.6	100.0
%CONTR.	80.9	3.2	5.0	3.5	7.4	100.0	

Source: Fisheries Department

(2) Number of Inshore Vessels and Fishermen

The number of inshore vessels using Sekondi Fishing Port, categorized by the place of registration, are given in Table-2.3.6. All vessels operating from Sekondi are registered in Takoradi where the Western Regional Office of the Fisheries Department is located. Table-2.3.7 shows the number of inshore vessels by boat lengths. The inshore vessels using the Sekondi Fishing Port are about 8 m to 15 m in length and made of wood. The largest is a trawler with the length 16.8 m and the maximum draft of 1.8 m. Large number of vessels are with engine power of about 100 HP.

Table-2.3.8 shows the number of canoes in Sekondi broken down by the fishing methods. Of 300 canoes, 81 are equipped with outboard engine. The canoes are divided broadly into outboard engine powered (13 to 20 m length) and traditional ones without engine (5 to 8 m length). Table-2.3.9 shows the number of fishermen at Sekondi; of 2,690 in total, 1,600 work on inshore vessels and 1,090 on canoes.

The canoe census is conducted every three years. According to Table-2.3.10, the number of canoe fishermen in Ghana was about 96,400 and decreased by 10 % from 1989 to 1992. At present, they are expected to be about 100,000.

Table-2.3.6 Number Inshore Vessels Using Sekondi Fishing Port (1996)

	Takoradi	Elmina	Mumford	Central	Tema	Total
No. of Vessels	58	14	7	30	1	110

Source: Fisheries Department

Table-2.3.7 Number of Inshore Vessels by Boot Lengths (1996)

	25ft - 32ft (7.6 - 9.7m)	33ft - 49ft (10 - 14.9m)	50ft ~ 69ft (15.2 - 21m)	Total
No. of Vessels	38	71	1	110

Source: Fisheries Department

Table-2.3.8 Number of Canoes by Gear (1992)

	Purse Seine	Line	Shrimp Net	Gill Net & Others	Non-mech. Canoes	Total Canoes	Mechanized Canoes
No. of Canoes	22	22	17	44	195	300	81

Source: Fisheries Department

Table-2.3.9 Number of Fishermen (1992)

Inshore Vessels	Canoes	Total
1,600	1,090	2,690

Source: Fisheries Department

Table-2.3.10 Movement of Canoe Fishermen in Ghana (1986-1992)

Year	1986	1989	1992
No. of Fishermen	104,700 (1.00)	91,400 (0.87)	96,400 (0.92)
No. of Canoes	8,214	8,052	8,688

Source: Fisheries Department

(3) Fishing Gear and Fishing Method

The inshore vessels operating from Sekondi Fishing Port are small sized boats. Steel and FRP boats are classified as large sized boats, and all operate from Tema Fishing Port.

1) Inshore Vessels

All the vessels operate as purse seiners during the peak season. They carry no machinery such as winches, and the 15-member crew throw nets by hand. This means that they cannot operate purse seiners during the stormy weather. The purse seine is 10 m in length and 40 m in depth.

Except during the peak season, vessels are engaged in trawling along the coast. The trawling net is 60 m long from the wing to the cot end, and uses a very small otter board. The vessel trawls the net from the stern. The rope is attached to the bit at the bow and the towing time is 1.5 hours.

2) Canoes

a) Large Sized Canoes

Canoes are engaged in purse seine during the peak season similar to inshore vessels, and in gill netting in other seasons.

b) Medium Sized Canoes

They pack ice in the ice boxes and operate for four days in long-lining, line fishing and gill netting.

c) Small Sized Canoes

They engage in line fishing, beach seine, and set-netting.

3) Fish Species

a)	Purse Seine	: sardine, bumper, mackerel, flat sardine
b)	Trawler	: shrimp, cassava, cuttlefish, sole, red pandora, burrito
c)	Canoe, Large	: sardine, bumper, mackerel, flat sardine
	Medium	: sardine, bumper, mackerel, flat sardine, red pandora, grouper
	Small	: snapper, dolphin fish, red pandora, grouper

(4) Inshore Vessels Operations and Port Arrival/Departure Pattern

Table-2.3.11 shows the operation of inshore vessels during the past five years (actual number). The small number of operation from April to June (many vessels do not operate during these months) is because vessels are docked for repair and inspection of the hull and engine in preparation for the peak season. The figure indicates that about 60 to 70 vessels are operating throughout the year where as about 10 to 25 vessels are not operating.

The arrival/departure pattern of inshore vessels and canoes with outboard engine was studied during the second field survey (July 18 to August 7, 1996) and the typical pattern is presented in Figure-2.3.1. All inshore vessels operated as purse seine on July 20, 1996, their departure times were concentrated between 15:00 hours and 16:00 hours and arrival times were concentrated between 08:00 hours and 09:00 hours. Fish landing work is carried out for three hours in the morning and preparation work for departure is carried out for three hours in the afternoon. Arrival of the canoes, on the other hand, dispersed between 08:00 hours and 15:00 hours on July 24, 1996, and the peak of departure times were both in the morning and the afternoon.

Table-2.3.11 Operation of Inshore Vessels (Actual Number)

Unit: Number of Vessels

MONTH	1991			1992			1993			1994			1995			AVERAGE		
	WORK	NOT	TOTAL	WORK	NOT	TOTAL	WORK	NOT	TOTAL	WORK	NOT	TOTAL	WORK	NOT	TOTAL	WORK	NOT	TOTAL
JAN	58	18	76	50	19	69	55	16	71	75	12	87	50	12	62	57.6	15.4	73.0
FEB	57	18	75	45	22	67	59	15	74	67	16	83	69	8	77	59.4	15.8	75.2
MAR	60	32	92	48	22	70	53	13	66	44	15	59	72	9	81	55.4	18.2	73.6
APR	51	25	76	55	25	80	38	10	48	68	25	93	57	10	67	53.8	19.0	72.8
MAY	39	38	77	41	23	64	49	11	60	62	24	86	57	12	69	49.6	21.6	71.2
JUN	35	34	69	33	23	56	70	14	84	52	20	72	70	11	81	52.0	20.4	72.4
JUL	62	25	87	52	13	65	114	13	127	75	13	88	90	6	96	78.6	14.0	92.6
AUG	58	24	82	75	14	89	114	8	122	49	10	59	45	5	50	68.2	12.2	80.4
SEP	76	21	97	78	10	88	87	8	95	77	5	82	50	5	55	73.6	9.8	83.4
OCT	53	18	71	90	10	100	72	14	86	107	11	118	76	4	80	79.6	11.4	91.0
NOV	79	18	97	51	16	67	78	13	91	73	19	92	74	6	80	71.0	14.4	85.4
DEC	69	21	90	63	14	77	78	14	92	65	14	79	76	8	84	70.2	14.2	84.4
AVE.	58.1	24.3	82.4	56.8	17.6	74.3	72.3	12.4	84.7	67.8	15.3	83.2	65.5	8.0	73.5	64.1	15.5	79.6

Source : Fisheries Department

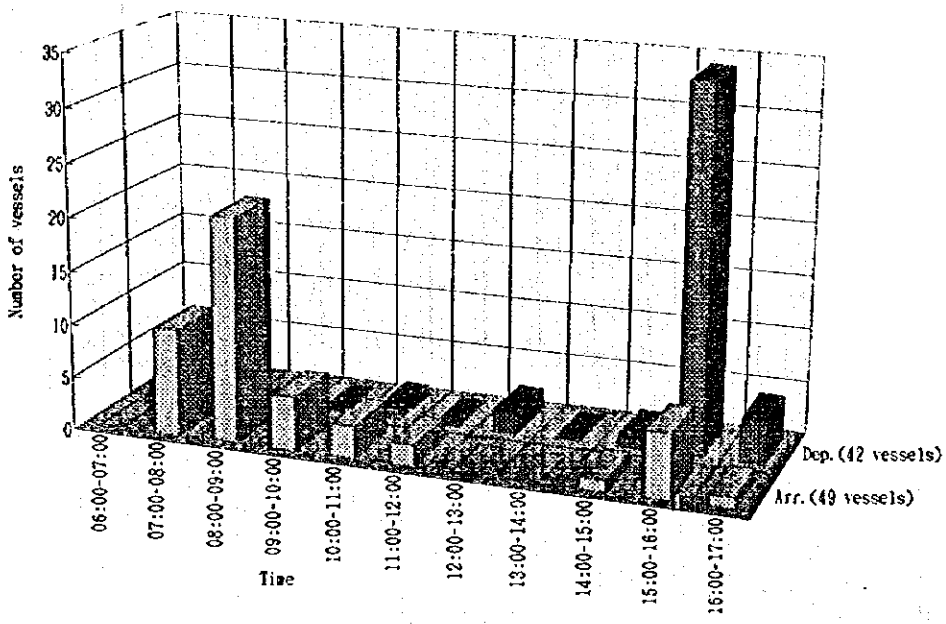


Figure-2.3.1(1) Arrival / Departure Pattern of Inshore Vessels (July 20, 1996)

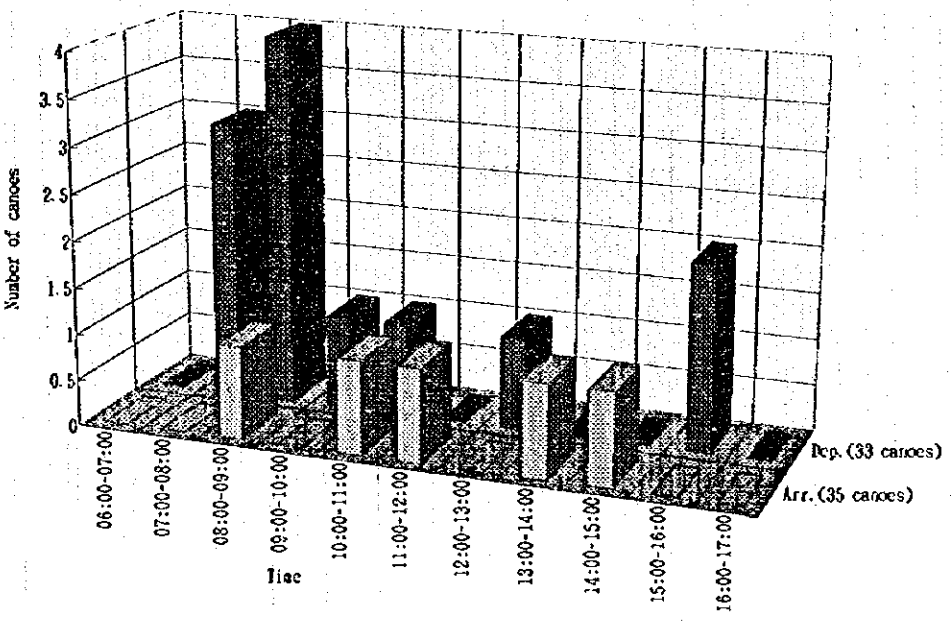


Figure-2.3.1(2) Arrival / Departure Pattern of Canoes (July 24, 1996)

(5) Distribution of Fishing Grounds

The distribution of fishing grounds in Ghana are illustrated in Figure-2.3.2. The country faces the Gulf of Guinea, has the coast line extending for about 560 km, and the continental shelf extending down to the depth of 200 m which is most prominently developed between Sekondi and Elmina. This portion is 50 nautical miles in width and 21,000 km^2 in area.

Upwelling generates in the deep layer of the south equatorial current at the time slightly lagging behind the rainy season of May through September, encouraging generation of planktons. Sardines which feed on planktons come into the area, followed by large pelagic fishes such as bonito and tuna, thereby creating an abundant fishing ground. Along with Senegal, Ghana is therefore considered the biggest fishing industrial country in West Africa. The peak season for pelagic fishes occurs between November and January and between June and August.

To the east of Axim Coast, the coastal area extending for 10 nautical miles to the offshore of Winneba provides a fishing ground for small and medium sized canoes and coastal trawlers, but the area is full of reefs and rough sediments on the bottom. Since these vessels have no fishing equipment and are operated by men, posing many restrictions, the limiting depth for inshore vessels to engage in trawling is 30 m,

During the peak season, the area with 40 - 60 m depth becomes a fishing ground for pelagic fishes such as sardines, bumper, mackerels and herrings. The continental shelf off Sekondi is the primary ground, but it shifts as the fishes migrate. The continental shelf near estuaries of rivers serves as the fishing ground for tiger and white prawns, the peak season being from October to November. Line fishing, beach seine, and set net fishing are also being employed in various parts of the country.

The fishing grounds in this area categorized by the fishing methods are listed below.

a) Purse Seiners (Inshore Vessels/Large Canoes)

These boats operate throughout the year chasing fish schools from the area at 10 nautical miles off the coast of Axim with 40 m depth to that at 10 nautical miles off the coast of Winneba with 60 m depth, but mostly in the sea off Sekondi. When there are less pelagic fishes, the inshore vessels operate as trawlers and large canoes as gill netters.

b) Trawlers (Inshore Vessels)

These vessels operate along Axim coast at 7 - 8 nautical miles off Winneba up to the depth of 30 m. Small canoes also operate in this area, increasing congestion of fishing boats.

c) **Others**

Other methods include line fishing, bottom long line, gill net (for large and medium sized canoes), beach seine, set net, etc. operate in the coastal area.

d) **Offshore Fishing**

About 60 purse seiners and trawlers of more than 50 GT of Tema Fishing Port are operating off Sekondi.

e) **Bonito/Tuna Fishing**

In addition to about 30 boats engaged in bonito/tuna fishing, 17 prawn trawlers are operating from Tema Fishing Port in the fishing grounds near estuaries of rivers.

(6) Efficiency of Landing Operations

In Sekondi Fishing Port, the inner bay adjacent to the Naval Base is used as the basin by canoes and inshore vessels, and their catch is landed on the sandy beach.

As there are no wharves, fish catches are transferred to small rowing canoes from the vessels, and landed on the sandy beach directly from the canoes. The landing operation efficiency is accordingly very poor, and fish loses freshness very quickly as they are exposed to intense heat of the sun directly.

As a result of the field survey an average time of 2 hours and 20 minutes is spent per vessel in landing during the purse seine operation, and 1 hour and 10 minutes in the trawling, reducing the market value of fish significantly.

The speed of landing operation measured from trawler using fish boxes at Tema, and found that it took an hour to handle 100 boxes.

(7) Origin and Distribution Survey of Fish Catch

Origin and distribution survey was conducted at Sekondi for 17 days from July 19 to August 7, 1996. The results are presented in Table-2.3.12.

According to the table, about 73% of the catch is sent to neighboring areas of Sekondi and Takoradi, and 27% to the inland areas. About 15% is smoked (4.3% for Sekondi/Takoradi + 10.8% for inland and other areas = 15.1%), about 50% is fried (34.4% for Sekondi/Takoradi + 16.8% for inland and other areas = 50.4%), and about 22% is sold fresh (21.4% for Sekondi/Takoradi + 0.3% for inland and other areas = 21.7%). Fish caught by trawlers are usually fried, while a large quantity of sardines caught by purse seine are smoked and transported to inland.

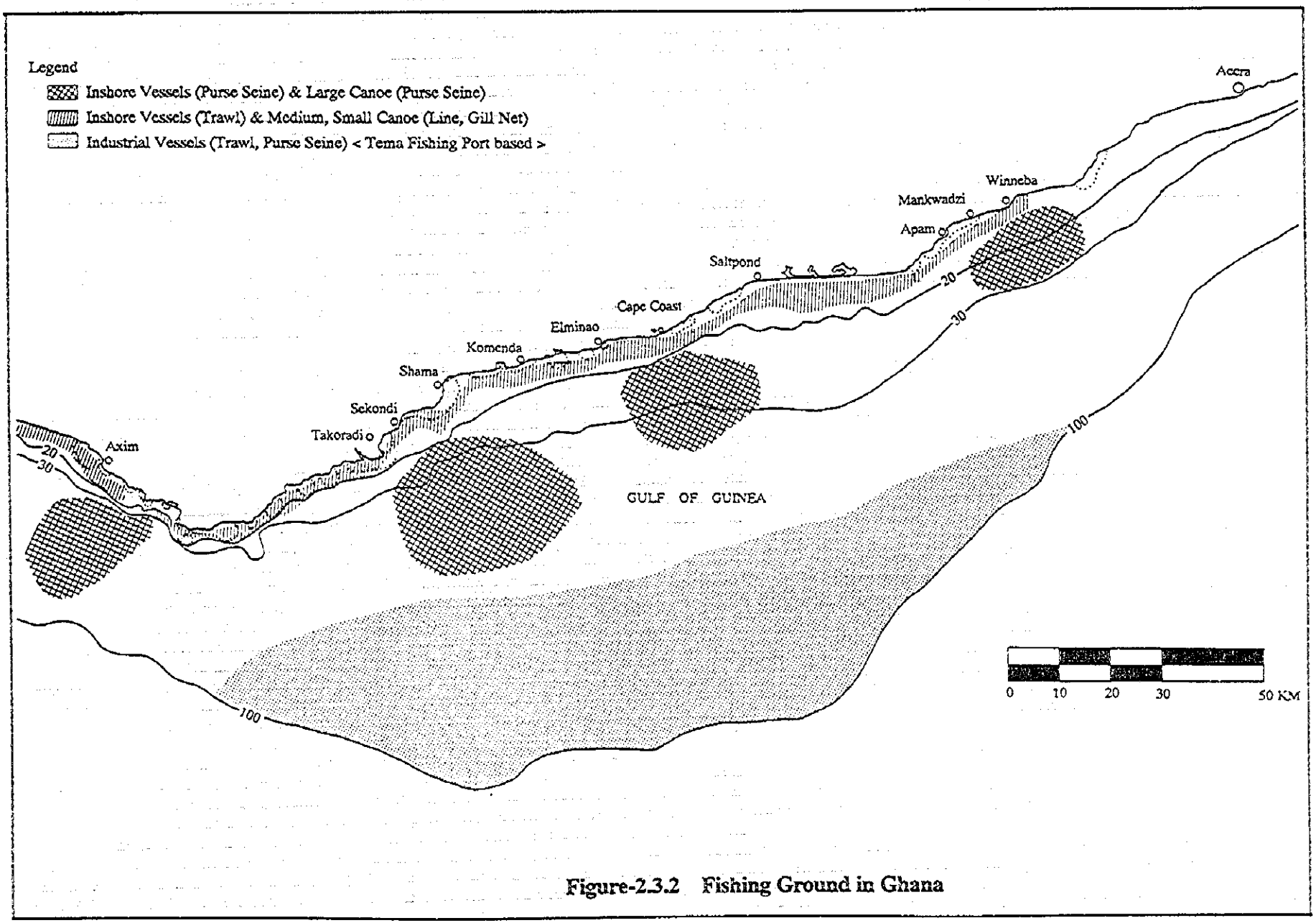


Figure-2.3.2 Fishing Ground in Ghana

Table-2.3.12 Fish Volume Brought Out by Destination and Type of Processing
(Duration: July 19 to August 7,1996)

Date	No. of Sample Vessel		Fish Volume for Sampling (kg)	Fish Volume Brought Out by Destination (kg)										Remarks
	Purse Sine	Trawl		Sekondi . Takoradi					Inland & Others					
				Smoke	Fry	Fresh	Others	Total	Smoke	Fry	Fresh	Others	Total	
19-Jul	3	0	124	31	20	20	0	71	10	43	0	0	53	Some Catch of Round Sardine
20-Jul	8	0	663	112	60	200	0	372	121	150	20	0	291	ditto
21-Jul	6	1	379	60	120	75	0	255	30	63	0	31	124	ditto
22-Jul	6	5	1,129	280	455	115	30	880	30	175	0	44	249	ditto
24-Jul	4	6	2,070	430	610	340	0	1,380	510	180	0	0	690	ditto
25-Jul	2	9	1,535	150	730	80	215	1,175	40	320	0	0	360	ditto
26-Jul	0	11	1,858	0	1,024	204	135	1,363	0	475	0	20	495	
27-Jul	0	11	1,568	0	909	258	328	1,495	0	73	0	0	73	
28-Jul	0	9	1,337	0	595	362	300	1,257	0	80	0	0	80	
29-Jul	0	8	996	0	496	40	380	916	30	50	0	0	80	
31-Jul	0	8	1,302	0	622	175	260	1,057	0	245	0	0	245	
1-Aug	0	11	2,201	30	1,023	675	238	1,966	0	235	0	0	235	
2-Aug	0	10	2,071	25	1,092	579	355	2,051	0	20	0	0	20	
3-Aug	0	8	1,689	0	384	835	255	1,474	100	115	0	0	215	
4-Aug	0	8	1,433	0	390	993	20	1,403	0	30	0	0	30	
5-Aug	0	11	1,780	30	501	506	483	1,520	55	205	0	0	260	
7-Aug	7	1	4,360	0	90	210	300	600	1,940	1,770	50	0	3,760	Large Catch of Round Sardine
TOTAL			26,495	1,148	9,121	5,667	3,299	19,235	2,866	4,229	70	95	7,260	
%			100.0%	4.3%	34.4%	21.4%	12.5%	72.6%	10.8%	16.0%	0.3%	0.4%	27.4%	

(8) Fishermen's Associations

Fishermen's Associations in Sekondi Fishing Port are listed below.

1) Inshore Fisheries Association (Sekondi and Takoradi Branches)

Officers	:	Chairman, 1; President, 1; Directors, 3; Accountant, 1; Total,6
Membership	:	Owners of inshore vessels, 92
Number of vessels	:	110
Fees	:	6,000 cedis/vessel/year
Activities	:	Members are entitled to purchase fuel at prices lower than the market value with coupons issued by the association. They can purchase gas oil for 1,800 cedis/gallon where as usual price is 2,500 cedis/gallon. The difference is paid by the Government. The association is not concerned with construction of inshore vessels or purchase of fishing gear.

2) Canoe Fishermen's Association

Officers	:	Chairman, 1; President, 1; Directors, 3; Total,5
Membership	:	Owners of canoes, 200
Number of boats	:	Large sized canoes, 67; medium sized, 40; small sized, 13; Total, 120
Fees	:	20,000 cedis/canoe/year
Activities	:	Like Inshore Fisheries Association, members are entitled to purchase fuel with coupons issued by the association. The association is also not concerned with construction of canoes or purchase of fishing gear.

3) Fish Smokers' Association, Sekondi Branch

Officers	:	Chairman, 1; President, 1; Directors, 1 Accountant, 1; General Affairs, 1; Total,5
Membership	:	Women only, 65
Fees	:	6,000 cedis/person/year
Activities	:	Joint transportation of products to inland area

4) Middlewomen

In Sekondi, all the middlemen are women, but they are not organized into cooperative, They operate as individuals, and charge commissions of 1,000 cedis per 1 crate (31 kg). Crate means an aluminum bowl.

(9) Distribution · Consumption

Figure-2.3.3 shows the marketing channel for fisheries products landed at Sekondi Fishing Port and Figure-2.3.4 for the hinterland.

Landing operations are carried out mostly by small rowing canoes on the landing beach of fishing villages except in Tema Fishing Port where there are wharves. Inshore vessels arriving at Sekondi are anchored at 100 to 200 m off the beach, transfer the catch to small transport canoes, which in turn land them on the beach. Middlewomen auction for fishes that are still on the canoe, and pay cash.

As there are no storage facilities such as cold storage, processors (small cottage industry) who own smoking platforms smoke pelagic fishes and transport them by bus or rail to inland cities such as Kumasi, Obuasi and Tarkwa. Table-2.3.13 shows the population of Sekondi, Takoradi and inland cities which make up the hinterland for Sekondi Fishing Port.

Fresh fish are placed in ice boxes or bags by middlewomen and sold to wholesalers in these cities.

Shrimps landed by inshore vessels and expensive fishes such as red pandora and grouper landed by line fishing canoes are offered for auction and sold by middlewomen to hotels and restaurants in Takoradi and to wholesalers in Accra.

Pelagic fishes (sardine, bumper, mackerel, herring) are bid on the beach and bought by middlewomen, who in turn transport them to a smoking shed (raw fish processing capacity, 1,500 tons/year) standing next to the landing beach. In this area, there are 65 women processors who have organized a cooperative and are jointly engaged in smoking business. The products are transported to inland cities such as Kumasi.

Middlewomen sell other pelagic fishes to retailers, who sell them on roadside stalls as fresh or fried.

The interview survey revealed following auction prices at Sekondi beach.

Bottom fish, Shrimp	:	900 - 1,000	cedis/kg
Sole	:	1,000 - 1,200	cedis/kg
Cassava	:	800 - 1,600	cedis/kg
Burrito	:	800	cedis/kg
Ray	:	600	cedis/kg
Cuttle fish	:	500	cedis/kg
Sardine	:	800	cedis/kg
Mackerel	:	1,000	cedis/kg

Red pandora caught by medium sized canoes are sold to wholesalers of Accra for 30,000 cedis per fish (about 15 kg).

Table-2.3.13 Population of Hinterland of Sekondi Fishing Port (1984 Census)

City	Population (x 1,000)
Sekondi - Takoradi	178
Tarkwa	44
Obuasi	67
Kumasi	490

Source: 1984 Census

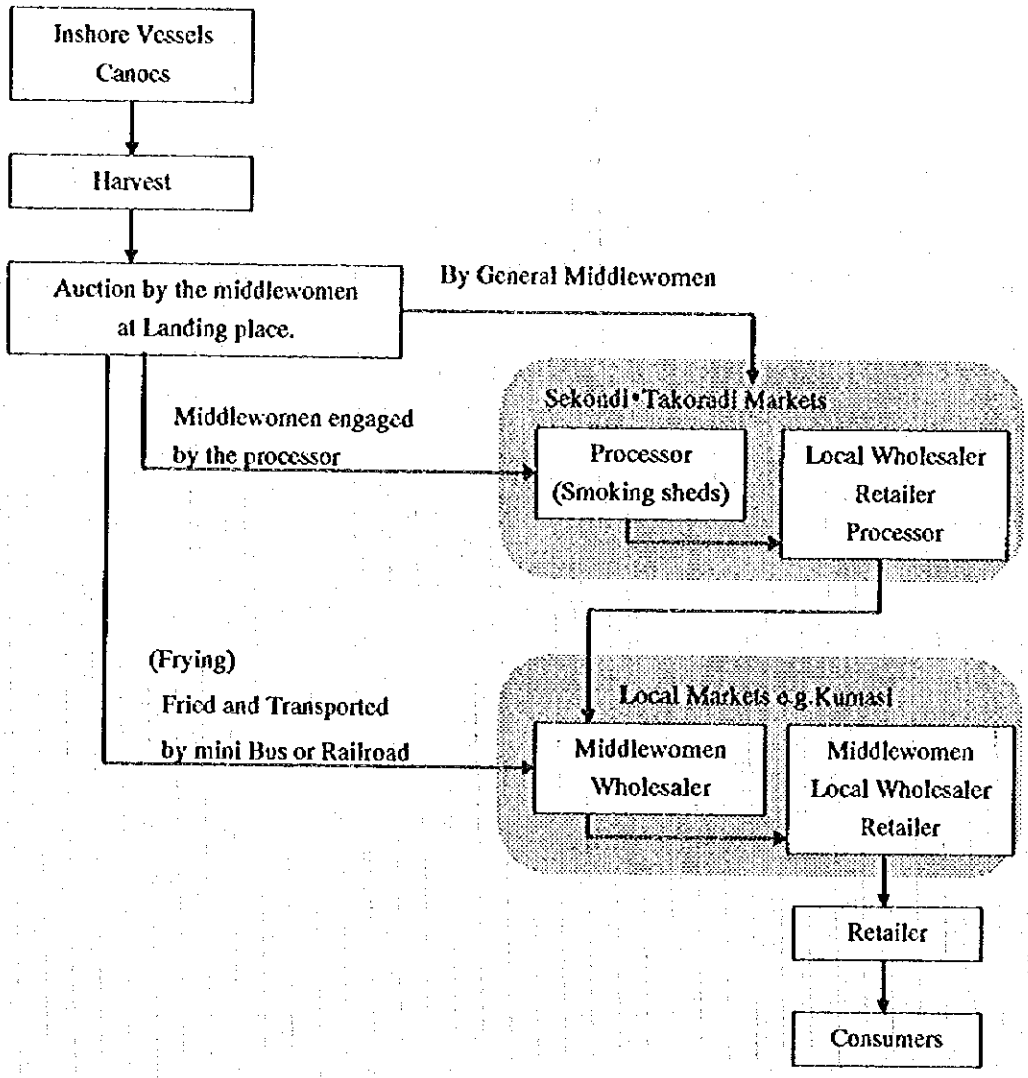


Figure-2.3.3 Marketing Channel for Fisheries Products

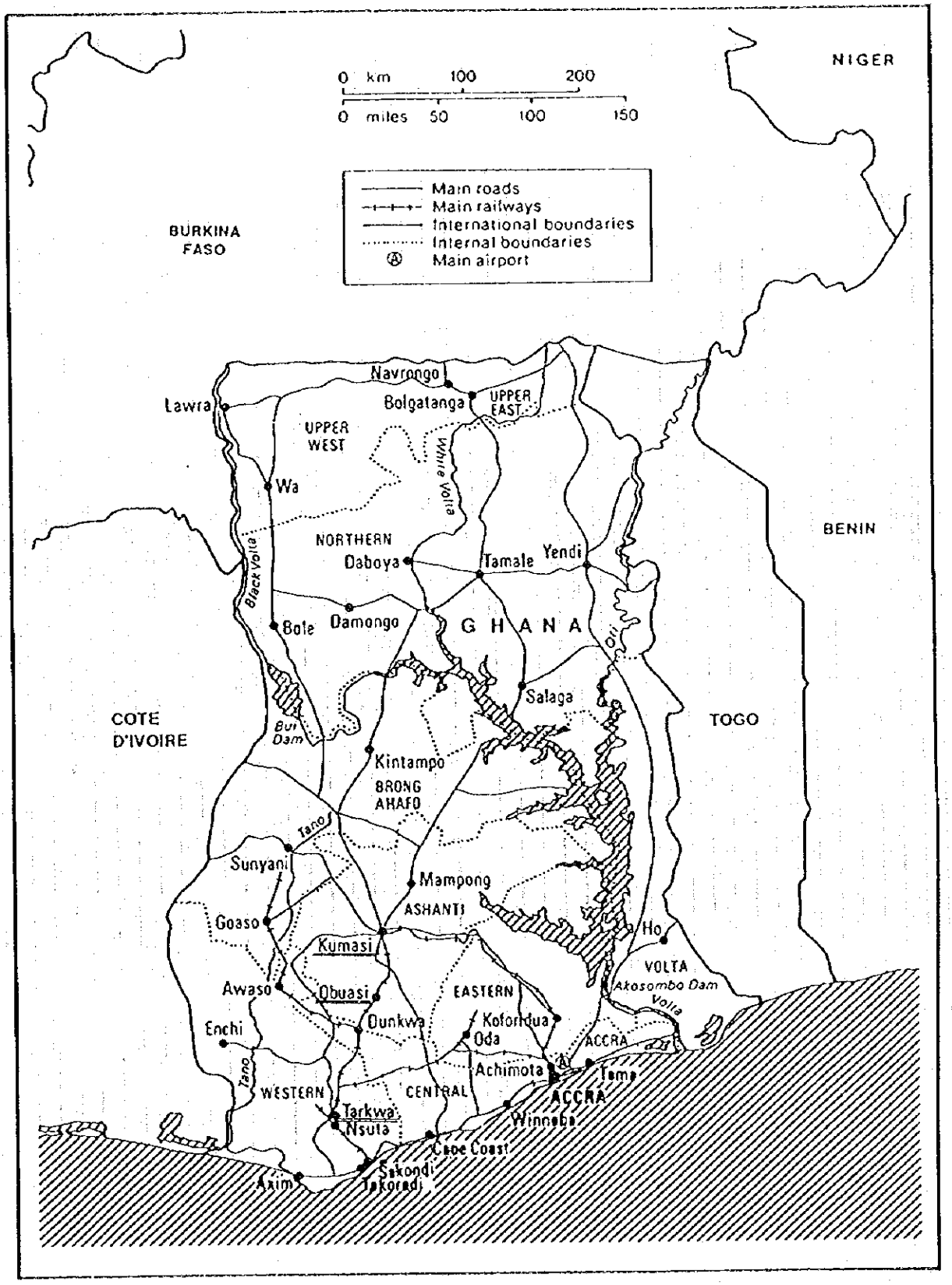


Figure-2.3.4 Hinterland of Sekondi Fishing Port

(10) Result of Interview Survey

In the second field survey, an interview survey was conducted between July 17 and 23 with 20 owners of 22 inshore vessels in the office of Inshore Fisheries Association at Sekondi. Table-2.3.14 shows the result and its summary is described below.

a) Inshore vessels are about 8 years old and their average horse power of about 88 HP. They carry no fishing machinery, and operate entirely with man power. This limits the operating area to the waters near the coast.

b) A vessel has an average of 14 men as its crew.

c) Average annual repair cost is 4 million cedis; the repair is necessitated because the shallow depth in the basin causes damage to the bottom and congestion of vessels damages to the boat sides.

d) As for the hours of arrival/departure for vessels, trawlers depart between 02:00 hours and 04:00 hours and return back between 15:00 hours and 16:00 hours of the same day. Purse seiners vessels depart between 14:00 hours and 18:00 hours and return back between 07:00 hours and 09:00 hours of the following day.

e) Vessels anchor in the basin and transfer the catch to small canoes for transporting to the beach. It takes 76 minutes for a trawler from arrival time at the port to the time of sold out of catch, and 155 minutes for purse seiner, lowering the freshness and quality of fishes tremendously.

f) All the interviewed boat owners indicated that they would shift to the new wharf from the canoe landing beach currently being used if a new wharf will be built at Sekondi Fishing Port.

Table-2.3.14 Result Of Interview Survey

Registered Number	Year Built	L×B×D feet	HP	No. of Crew	Annual Repair Cost Cedi	Arrival/Departure Time				Landing Time		Shift to New Wharf
						Trawl		Purse Seine		Trawl	Purse Seine	
–	1988 (8)	35×9×6	92	15	2.500.000	0400	1600	1500	1000	60	120	Intend to shift
TF-465	1983 (13)	35×8×6	65	15	2.500.000	0400	1600	1500	1000	60	180	〃
MF-30	1988 (8)	32×8×5	74	14	2.300.000	0400	1500	1400	0900	180	240	〃
TF-199	1981 (15)	–	155	15	10.000.000	0200	1600	1400	1000	60	120	〃
TF-519	1982 (14)	38×10×6	42	8	–	0400	1600	1500	1000	60	180	〃
CRF-121	1986 (10)	37×11×6	120	15	2.000.000	0400	1600	1500	1000	60	180	〃
TF-373	1991 (5)	35×9×6	95	16	4.000.000	0300	1500	1800	0700	20	120	〃
TF-364	1995 (1)	32×8×5	74	15	720.000	0300	1600	1600	0900	60	180	〃
EL-10	1983 (13)	35×9×6	95	16	2.760.000	0300	1600	1600	0900	120	180	〃
MF-22	1987 (9)	35×9×6	125	17	6.000.000	0300	1600	1500	0600	60	120	〃
CRF-79	1991 (5)	35×9×6	95	17	–	0200	1600	1600	0900	45	180	〃
EL-7	1993 (3)	32×8×6	45	13	2.000.000	0300	1500	1500	0700	60	120	〃
TF-210	1985 (11)	40×12×7	95	17	950.000	0300	1500	1600	0900	60	180	〃
CRF-106	1988 (8)	35×9×6	65	16	3.000.000	0200	1500	1500	0800	60	120	〃
CRF-116	1996 (0)	30×7×5	45	10	8.400.000	0300	1900	1600	0900	45	120	〃
TF-242	1988 (8)	35×9×7	98	15	–	0400	1500	1800	0600	60	120	〃
TF-61	1980 (16)	35×9×6	65	14	6.000.000	0300	1500	1600	0900	180	240	〃
CRF-61	1996 (0)	38×11×7	105	15	6.000.000	0300	1500	1600	0900	180	240	〃
CRF-117	1988 (8)	32×8×6	65	15	6.000.000	0300	1400	1400	0900	120	180	〃
TF-505	1991 (5)	30×7×5	–	10	1.400.000	0400	1500	1500	0700	45	120	〃
TF-65	1991 (5)	35×8×6	105	12	3.000.000	0300	1500	1400	0600	60	120	〃
EL-51	1991 (5)	35×9×6	98	15	–	0300	1500	1500	0200	20	60	〃
Ave.	7.7yr	34.7×9×5.9	87.5	14.3	3.860.000					76min	155min	

2-3-2 Related Facilities

(1) Ice Making Facilities

1) Current Condition of Ice Making Plant

Sekondi Fishing Port has a flake ice making plant built in 1973 by the government fund. Since State Fishing Corporation (SFC) has stopped its operation in 1988, no ice is available to fishermen.

The reason for stopping the operation is that the installed ice making machine was for making flake ice, requiring more sophisticated handling and maintenance than other systems (plate or block ice). Engineers were not capable of repairing the damaged motor and could not obtain spare parts because of the limited fund, and abandoned the repair.

In the beginning, one of the two ice making machine was broken down, and while they were trying to obtain spare parts for the first one, the second one also broke down. They repaired one of the systems by taking parts from the other and continued operation for a while. But both machine broke down completely in 1988.

Ice making machine were manufactured in 1967 and are quite obsolete. Since necessary parts are difficult to obtain and the systems have been left unrepaired for eight years and it would be difficult to repair them for operation.

2) Ice Supply

Ice from two ice making plants located in Takoradi City are supplying ice to the fishermen in Sekondi. One was built in 1958 by SFC and produces block ice. Their machinery is obsolete and most inefficient. The other is a privately owned company (ANSA Cold Store Ltd.) and has been supplying ice to fishermen and general public since its operation was started in 1989. At the time of the survey, a new cold storage was being built next to the ice making plant.

Ice is being sold at 1,700 - 1,800 cedis/block ice.

3) Use of Ice

Inshore vessels have not been using ice since the plant of SFC was broken down. Canoes engaged in net fishing do not use ice, but those engaged in line fishing use block ice which keeps longer than flake ice.

In Tema Fishing Port, a major fishing port of Ghana, inshore vessels and canoes use ice supplied from ice making plants in the port and nearby area. The inshore vessels use flake ice and crushed ice made from block ice. Canoes use block ice as in Sekondi Port.

In Sekondi, fishermen hardly use ice while they auction, transport or sell fish on the beach.

Dimensions of Ice Making Machine

a) Sekondi State Fishing Corporation

Year when constructed	:	1973
Manufacturer	:	Sabro (Sweden)
Year when manufactured	:	1967
Shape of ice	:	Flaked
Type of freezer	:	Water cooled, open type
Coolant	:	Ammonia
Production capacity	:	3 tons/day x 2 units
Year when operation ceased	:	1988

b) Takoradi State Fishing Corporation

Year when constructed	:	1958
Manufacturer	:	Sabro (Sweden)
Year when manufactured	:	1955
Shape of ice	:	Block
Type of freezer	:	Water cooled, open type
Coolant	:	Ammonia
Catalyst	:	Calcium chloride
Dimensions of ice can	:	240 x 1550 x 1100 mm , 25kg/block
Production capacity	:	7.5 ton/day

c) ANSA COLD STORE LTD. (private company)

Year when constructed	:	1989
Manufacturer	:	Sabro (Sweden)
Shape of ice	:	Block
Coolant	:	Ammonia
Catalyst	:	Calcium chloride
Dimensions of ice can	:	240 x 1600 x 1100 mm, 25kg/block
Production capacity	:	12.5 ton/day

(2) Cold Storage

1) Current Condition of Cold Storage at Sekondi

A cold storage was constructed with the government fund in 1973 in Sekondi. SFC had been responsible for its operation until 1994, when it ceased operation.

The freezer ceased operation because of a defective design (it is a large cold storage and yet has no partitions inside) and because of sub-standard techniques which had caused damage to the slider section of the freezer. Just like the ice making machine, it proved impossible to obtain spare parts and the repair could not be completed.

There were originally four freezer units (one for the ice making machine). As it was impossible to obtain spare parts for repair, they used the parts from one of the units to operate the remaining units, thus decreasing overall capacity of the cold storage. Gradually, other units also broke and finally all four stopped functioning two years ago.

Since the freezers were made as early as in 1967, it is difficult to obtain spare parts. Evaporators, condensers and piping systems are left without proper maintenance, damaged greatly, and the ceiling has fallen. Restoration and operation of the system is believed impossible.

There is no cold storage in Sekondi except that mentioned above.

Dimensions of the Cold Storage

Year when constructed	:	1973
Country of manufacture	:	Sweden
Type of freezer	:	Water cooled, open type
Coolant	:	Ammonia
Method of cooling	:	Forced air circulation system
Storage temperature	:	-30℃
Heat insulation thickness	:	100 mm
Storage capacity	:	1500 tons (nominal), (Outer dimension; 30Lx22Wx5.5H m)
Heat insulation doors	:	Two (no partitions)

2) Cold Storage in Takoradi City

In addition to the cold storage in the ice making plant of SFC, there are seven privately owned cold storage in Takoradi City. Fishing Corporation's storage employs the secondary coolant of the ice making machine, but was not in use at the time of the survey. All the other private storages were used for keeping frozen fish. One used a remodeled refrigerating container.

3) Use of Cold Storage

All the privately owned cold storage in Sekondi were used for keeping frozen fish at Tema until they were sold to retailers. They were not used for fresh fish landed at Sekondi by the inshore vessels.

4) Method of Storage

When the cold storage in Sekondi was in operation, fishermen, middlewomen and many other unspecified people could use it by renting fish boxes. The fee was 800 cedis per week per box. The box was about 47 x 61 x 21 cm and carries between 25 kg and 30 kg. On a 90 x 120 cm pallet, 100 boxes could be placed for storage in the cold storage. Although the effective length of the cold storage was as large as 5 m, no forklift was used and boxes were piled by hand. The storage efficiency was therefore extremely poor.

This method is being followed in Tema Fishing Port where 600 - 800 cedis are charged for keeping one box of fresh or frozen fish.

5) Typical Dimensions of Cold Storage owned by Private Company

Typical dimensions of privately owned cold storage are shown below.

a) NYAME YIE COLD STORE LTD.

Year when built	:	1986
Inside capacity	:	25 tons
Inside temperature	:	-25℃
Freezer	:	closed type
Coolant	:	R-12

b) HANNAH NEWMAN COLD STORE

Year when built	:	1981
Inside capacity	:	45 tons
Inside temperature	:	-15℃
Freezer	:	closed type
Coolant	:	R-12

c) FRIOGHA LTD

Year when built	:	1992
Inside capacity	:	40 ft container x 2
Inside temperature	:	-20℃

(3) Fuel Supply Facility

1) Current Conditions of Fuel Supply

When those engaged in fishery buy fuel for their vessels in Ghana, they are given preferential prices than the general retail prices based on the government subsidy.

There are facilities operated by four private companies near Sekondi Fishing Port from which fishermen directly buy fuel for inshore vessels and canoes calling at the port.

Fuel price 1 gallon = 4.5 liter

a) For fishing boat : 1,800 cedis/gallon (diesel oil)
b) For general public : 2,500 cedis/gallon (diesel oil)
c) For outboard engine : 1,850 cedis/gallon (mixed oil 30 : 1)
d) For automobile : 3,000 cedis/gallon (gasoline)

2) Fuel Supply Conditions

Fishermen purchasing oil for their inshore vessels must present coupons issued by the association if they wish to be benefited from the preferential lower price. They purchase fuel with the coupon and transport fuel in 1.5 gallon plastic tanks by a small canoe to the vessel anchored front of the beach.

Canoe fishermen buy fuel with 500 cedis coupon and transport it in plastic tanks to the canoe.

3) Capacity of Fuel Supply Facility

Fuel tanks (underground) have the following capacity.

Tank capacity

a) SHELL : 3,000 gallon (for inshore vessel)
b) TOTAL : 3,000 gallon (ditto)
c) ELF : 3,000 gallon (ditto)
d) GOIL : 3,000 gallon (ditto)
e) GOIL : 3,000 gallon (for canoe)

(4) Water Supply Facility

1) Current Conditions of Water Supply Facility

There is just one privately owned store selling water. The store meets all the demands of inshore vessels and canoes as well as of middlewomen and fishery-related people.

When the ice making plant of SFC was operating, water used to be supplied from a water tank for the plant. Now that the plant is not in operation, no water is available.

2) Conditions of Water Supply

There is a piped water system in the port of which faucet is controlled by the individual who owns the store and sells water to fishermen in plastic tanks. Fishermen buy water in plastic tank, take it to their canoes as in the case of fuel. As preparation for departure and departure occur almost simultaneously for all the vessels, long cues are formed in front of the water supply store, and some vessels must wait for a long time before they can depart. If the owner is not in the store, water is not available.

Price of drinking water is 200 cedis for 15 gallons.

(5) Electricity

1) Supply Conditions

Electricity is supplied by Electricity Corporation of Ghana, Electro Volta House. In Sekondi City, electricity is transmitted from a station in Volta Lake to the main station located outside the city, and then to substations in the city and transformed there before it reaches factories and homes.

In Sekondi Fishing Port, there is a substation adjacent to the fishing village as a boat building yard used to acquire large amount of power for their machinery.

2) Current Conditions of Power Supply

Wires between substations and various facilities or transformers in the city are buried underground. Transformers are not placed on the poles but kept on the ground inside a building. Transmission is poor condition; voltage fluctuates largely and transmission failure occurs often.

As Ghana gets its electricity from hydraulic power stations, if there is shortage of rain during the rainy season and the level of water in Volta Lake lowers, the power generating capacity lowers, and the power supply is controlled to control consumption.

3) **Outline of Power Supply**

Transmission voltage	:	11,000 v
Secondary voltage	:	415 v (for motor)
		240 v (home use)
Frequency	:	50 hz

(6) Sewage System (Current Conditions at Fishing Port)

There is no toilet for use by fishermen, middlewomen and others engaged in fishery related work in the port. People relieve themselves in vacant lots or near the seawall, thus creating most unhygienic conditions.

There are no systems for collection, incineration or recovery of fish wastes, discarded fishing gear, garbage or wastes. They are all dumped into the sea, contaminating the water.

(7) Offices (Current Conditions)

GPHA has no port administration office in the Sekondi Fishing Port. There are, however, independent offices of the Inshore Fisheries Association, the Canoe Fishermen's Association, and Fisheries Department. No joint activities such as exchange of information on fishery or consultations on port management are being carried out.

These offices have the following areas

Inshore Fisheries Association	:	76 m^2 (four rooms)
Canoe Fishermen's Association	:	16 m^2 (one room)
Fisheries Department	:	21 m^2 (two rooms)

(8) Fish Handling Shed

1) **Current Conditions**

There is no building in Sekondi Fishing Port which is used for fish handling except one roofed shed about 60 meters away from the shoreline which was used for such purpose in the past. The old shed is currently used as a waiting room for middlemen and a place for selling daily provisions and foodstuff.

Because the transaction takes place in the canoe, fish is exposed directly to the sun, and as no ice is used except for some line fish, their freshness deteriorates considerably.

2) **Dimensions of the Shed**

Area : 5.5 x 18.0 m
Height : 3.4 m (the sea side), 2.5 m (the land side)
Width : 2.2 m

(9) Boat Yard

The existing slipway on the canoe landing beach at Sekondi is obsolete. Simple repairs are being made by landing boats on the west side of the landing beach.

There is a workshop owned by the Fisheries Department in the north of Takoradi Port where private companies offer repair services. There are 14 engineers and technicians stationed at the workshop who are engaged in supervision of repair and education of fishermen.

2-4 Basic Design

2-4-1 Design Concept

Design concepts are shown below.

a) In the layout plan for the outer port facilities of the fishing port, special care will be taken to minimize the effect of waves in Sekondi Bay area where the project site is situated.
b) The project site is exposed to the southerly winds throughout the year, and care should be taken to protect landing operations, etc. from storms.
c) As Ghana has earthquakes, a seismic design should be employed.
d) Facilities for public or common use (lavatories) adapted to local customs and habits should be designed.
e) By giving full consideration to the natural conditions and construction situation, local construction materials and labor will be utilized as much as possible.
f) The grade for architectural design shall be set by referring to local execution examples.
g) As Ghana has no design standards for port structures, the design shall basically follow Japanese standards.

2-4-2 Natural Conditions

(1) Climatic Condition

The climate in Ghana is a tropical one and is under the influence of the northeastern trade wind called Mahataan from the Sahara Dessert and monsoons or southwestern trade wind from the sea in the south. The rainy season is from April to October and the dry season is from November to March. Tropical cyclones often generate near Cape Verde Islands located far west of Ghana, but they do not affect Ghana.

Observation data of Takoradi Meteorological Observatory, the location of weather observation closest to Sekondi, are used as the climatic conditions for the project site.

1) Temperature

Table-2.4.1 shows monthly average of maximum and minimum temperature during the past 30 years. The table shows that the maximum temperature is about 31℃ between February and May, the minimum temperature is about 22℃ between July and September, and the mean diurnal range is about 7℃. The annual range for the maximum and the minimum temperatures are about 5℃ and 3℃, respectively. The seasonal change of temperature is rather small throughout the year.

Table-2.4.1 Monthly Average of Maximum and Minimum Temperature (℃: 1961 -1990)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Ave.
Max.	30.8	31.3	31.5	31.3	30.6	29.0	27.9	26.4	27.9	29.1	30.4	30.6	29.7
Min.	22.2	23.2	23.5	23.8	23.5	23.1	22.4	22.0	22.2	22.5	22.8	22.5	22.8
Ave.	26.6	27.3	27.5	27.5	27.0	26.1	25.1	24.7	25.1	25.8	26.6	26.5	26.3

Source: Takoradi Meteorological Observatory

2) Rainfall

Table-2.4.2 shows the monthly average of rainfall during the past 30 years. The annual rainfall is about 1,200 mm, less than that of Tokyo's 1,400 mm. The rainfall concentrates from May to July during the three months, accounting for almost half of the annual rainfall.

Table-2.4.2 Monthly Average of Rainfall (mm: 1961-1990)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Total
Rain.	23.1	33.6	67.2	97.0	209.4	311.1	123.8	64.7	69.8	97.9	69.0	29.1	1,196

Source: Takoradi Meteorological Observatory

3) Relative Humidity

Table-2.4.3 shows the monthly average of relative humidity observed at 6:00 hours and 15:00 hours during the past 30 years. The average relative humidity at 6:00 hours and 15:00 hours is 97% and 78%, respectively and the monthly change are small.

Table-2.4.3 Monthly Average of Relative Humidity (%: 1961-1990)

Time	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Ave.
6:00	97	97	96	96	96	95	96	97	97	97	96	97	96.4
15:00	74	75	74	75	78	82	82	83	82	80	76	75	78.0

Source: Takoradi Meteorological Observatory

4) Wind Direction and Speed

Table-2.4.4 shows the monthly average of wind direction and speed during the past 20 years. The frequency of wind occurrence by direction and speed and the wind rose taken from the hourly observation data (location of observation: Latitude 4° 53'N, Longitude 1° 46'W, Altitude 9 m) are presented in Appendix-7. As shown in the Table-2.4.4, the predominant wind direction is southerly(S) to southwesterly(SW) throughout the year. The monthly average of wind speed is almost constant and, which is between 3 and 4 knots. It is apparent that the southerly(S) to southwesterly(SW) winds predominate at about 44% and about 95% of the wind is less than 10 knots in speed.

The wind roses at every three hours are presented in Appendix-7. The Figures show that between 0:00 hours and 9:00 hours the northwesterly(NW) to westerly(W) land breeze blows, at about 9:00 hours the southwesterly(SW) to southerly(S) sea wind begins to blow, and at about 15:00 hours the wind speed reaches the maximum and then decreases from about 18:00 hours.

Table-2.4.4 Monthly Average of Wind Direction and Speed

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Ave.
Dir.	S	S	SW	SW	S	S	SW	SW	SW	SW	S	S	SW
Speed	2.9	3.8	4.3	3.6	3.1	3.6	3.9	4.3	4.4	4.4	3.2	2.4	3.7

Source: Takoradi Meteorological Observatory

(2) Sea Condition

1) Tide

Tide observation was conducted for 20 consecutive days from March 28 to April 16 by installing a pressure type tide gauge in Takoradi Port, about 8 km away from Sekondi Fishing Port. Tides were observed simultaneously in Sekondi Bay and Takoradi Port using auxiliary gauge. The results of observation and analysis are presented in Appendix-7.

The Tide Level Chart in Sekondi is shown in Figure-2.4.1.

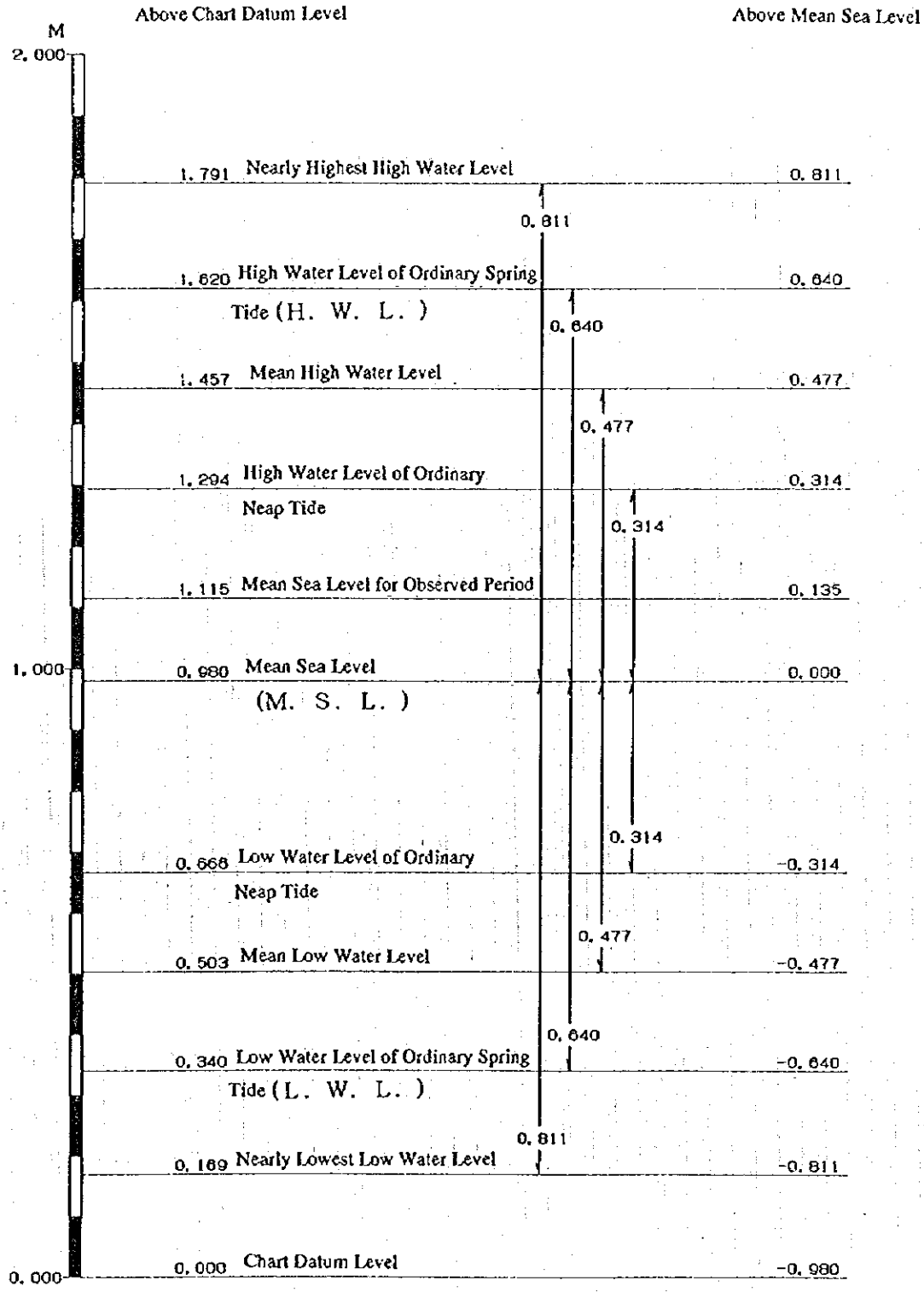


Figure-2.4.1 Tide Level Chart in Sekondi

2) Waves

a) Offshore Wave Characteristics

Since there is no wave observation station near Sekondi Bay or Takoradi Port, no wave observation data are available. We therefore obtained the data for Sekondi hindcast offshore waves by taking from U.S. Navy's Global Spectral Ocean Wave Model database. The frequency of occurrence of offshore waves by height and direction, wave rose of offshore waves in Sekondi and monthly wave rose of offshore waves are shown in Appendix-7.

According to these data, southerly(S) to south-southeasterly(SSE) waves predominate at about 93%; the waves 1 meter or less in height account for 24%, and those between 1 and 2 meters 68%. As for the monthly wave direction, southerly(S) to south-southeasterly(SSE) waves predominate throughout the year and the waves higher than 2 meters account for 8% and occur more frequently between June and September.

b) Offshore Design Waves

By statistically processing the above offshore wave data, Weibull distribution was obtained and the non-exceedance probability of the waves calculated. The wind speed, wave height and period for each return period were calculated. As the wave model data was available only for 5 years, that for ocean going vessels for 5 years was added to extend the period to 10 years. Table-2.4.5 shows the offshore wave dimensions broken down by the return periods. The wave with a return period of 30 years was applied in design for fishing port facilities and the dimensions of the offshore design waves are shown in Table-2.4.6. South-southeasterly(SSE) and southeasterly(SE) offshore waves were included in the table as they are less likely to be shielded by the Naval Base breakwater and more likely to reach Sekondi Bay although they occur less frequencies.

Table-2.4.5 Dimensions of Offshore Waves by Return Periods

Return Period (year)	Wind Speed (Knots)	Wave Height H1/3(m)	Period T1/3(sec)
1	25	3.0	9.8
10	28	3.5	11.5
25	29	3.6	11.9
50	30	3.8	12.6
100	31	3.9	12.9

Table-2.4.6 Dimensions of Offshore Design Waves

Offshore Wave Direction		S	SSE	SE
Wave Height	Ho (m)	3.7	3.7	3.7
Period	To (sec)	12	12	12
Wave Length	Lo (m)	225	225	225
Wave Steepness	Ho/Lo	0.016	0.016	0.016

c) Waves in Sekondi Bay

Offshore waves reach the Sekondi Bay after being deformed by diffraction by the Naval Base breakwater and by refraction due to the sea bottom topography. The equivalent deepwater wave height at the mouth of Sekondi Bay was calculated by computing wave deformation using energy balance equation. By considering breaker deformations by water depth, the height of waves reaching the shore was obtained. The results of wave deformation calculation are presented in Appendix-7.

The result of analysis of the calmness by the incident waves at the mouth of Sekondi Bay is also presented in Appendix-7. Based on the offshore design waves, the wave height in Sekondi Bay is about 1.2 m near the existing breakwater, about 0.5 m in front of the sandy beach, and about 0.25 m in front of the canoe landing beach.

3) Currents

Current direction and speed were observed for 25 consecutive hours (day and night) from April 16 to 18 (Spring tide) in the first field survey and from July 30 to August 1 (Spring Tide) in the second field survey by installing electromagnetic current meter at two locations (A and B) in the Sekondi Bay. Table-2.4.7 shows the maximum current speed at the time of flood and ebb tides. The results of current observation are presented in Appendix-7.

The table shows that the speed of the current is 1.8 - 4.9 cm/sec during flood tide and 1.8 - 4.0 cm/sec during ebb tide. Accordingly, the speed by the current is slow in the bay.

Current observations using floats were conducted on July 30 (ebb tide) and 31 (flood tide) during the second field survey. The tracks of floats are presented in Appendix-7. The tracks of floats indicate that the flow from the inner bay to the existing breakwater on the north predominates at both ebb tide and flood tide.

Table-2.4.7 Maximum Current Speed at Spring Tide

Tide	Location	First	Second
Flood	A	3.0 cm/sec	1.8 cm/sec
	B	3.1 cm/sec	4.9 cm/sec
Ebb	A	2.3 cm/sec	1.8 cm/sec
	B	4.0 cm/sec	3.1 cm/sec

Duration of the First Survey : April 16 to April 18, 1996

Duration of the Second Survey: July 30 to August 1, 1996

(3) Topography

Topographical and sounding survey was conducted in respect of the land and the sea bottom to understand the topography in the vicinity of Sekondi Bay. The results are shown in Figures-2.4.2 and 2.4.3, respectively.

Sekondi Bay can be roughly divided into the rocky reef area in the vicinity of the existing breakwater (Tsiakur Bansu Point), the rocky reef in the center (Butatel Point) and the sandy beach just north of it, and the canoe landing beach in the inner basin in the south. The topography of each area is outlined as follows.

1) Northern Area: Existing Breakwater

a) Land

The existing breakwater extends to the northwesterly-southeasterly direction in the rocky reefs (Tsiakur Bansu Point) area comprising of sandstone and is 300 m long, 20 to 50 m wide and elevation is +4.0 m. It is a rubble mound breakwater covered by armor stones weighing 2 to 4 tons each.

b) Sea Bottom

The depth near the breakwater is 0.0 to -2.0 m at the base and -5.0 m at the head. As the area includes the rocky reef, the sea bottom undulation is excessive with the bottom slope of 1/30 to 1/100.

2) Center Area: Rocky Reef and Sandy Beach

a) Land

Sandy beach (length ; 300 m, width ; 30 to 50 m, elevation ; +3.0 m) lies to the north of rocky reef (Butatel Point). There is a coconut grove on the land which is between the beach and cliffs of 10 m height.

b) Sea Bottom

The water depth in front of the sandy beach is -1.0 m to -3.0 m, the bottom slope 1/30 to 1/200, and it becomes relatively gradual toward the offshore from the point at -3.0 m. Although the area is sandy beach, there are occasionally shoals comprising of sandstone in the sea bottom.

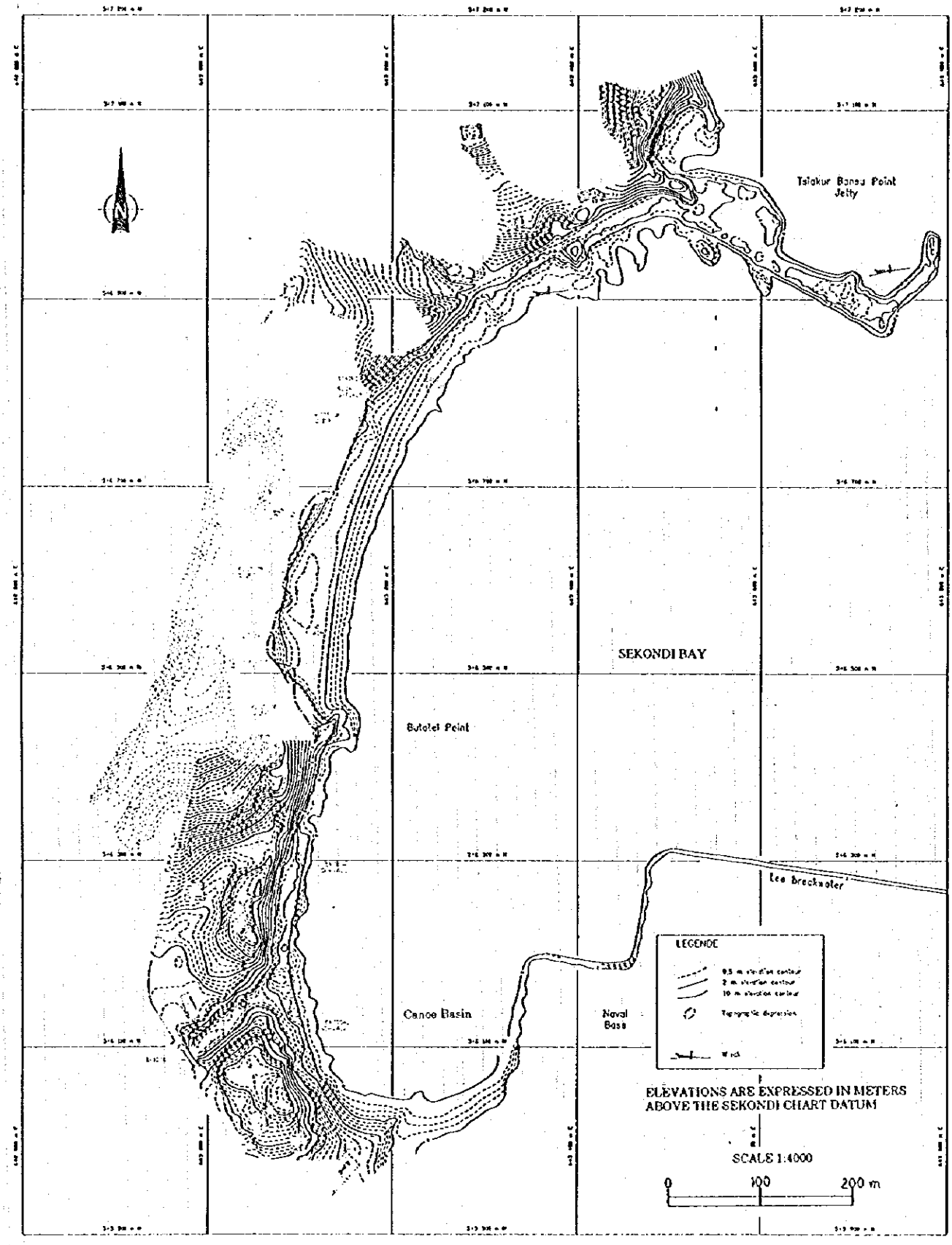


Figure-2.4.2 Topographic Map in Sekondi Bay

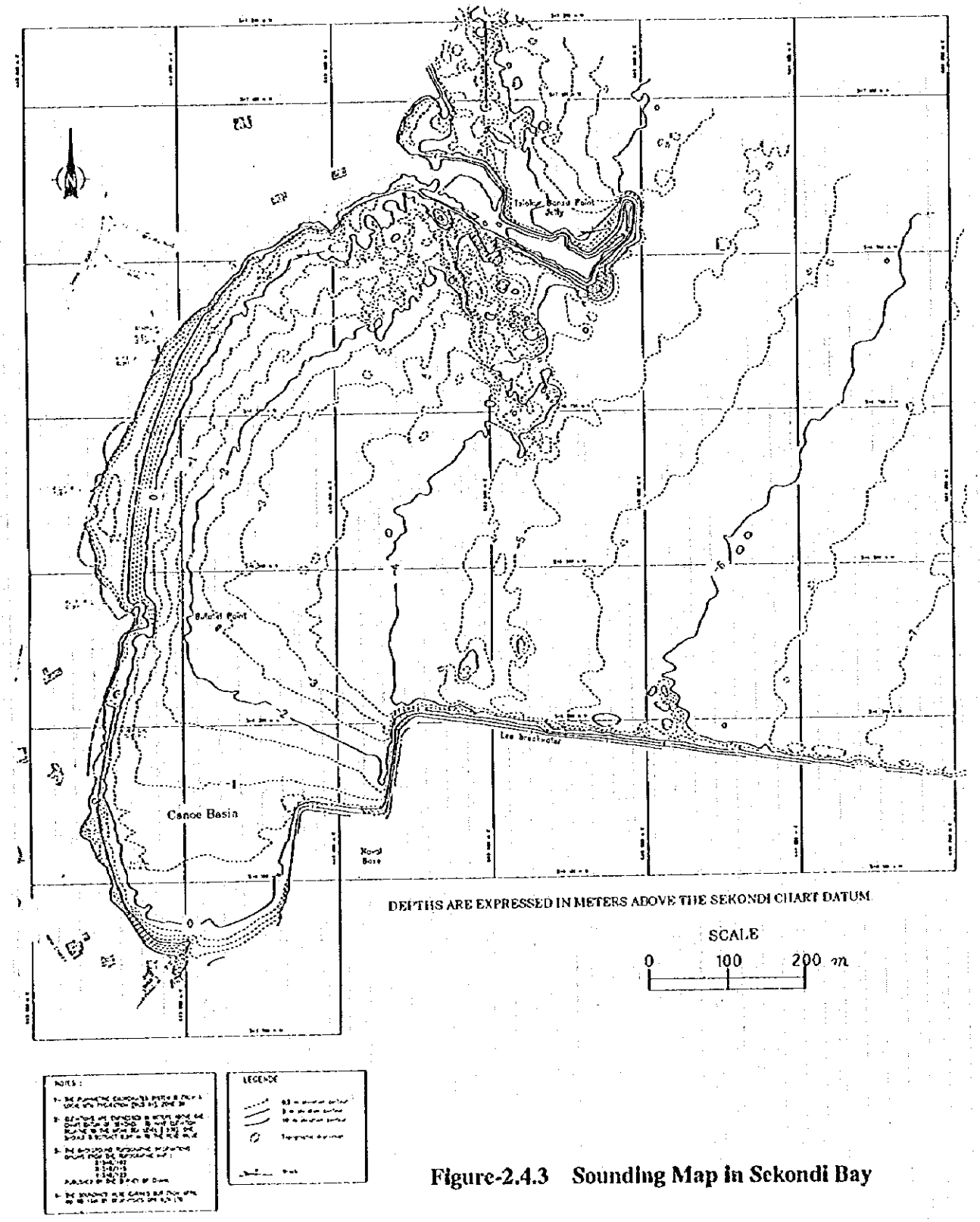


Figure-2.4.3 Sounding Map in Sekondi Bay

3) Inner Basin in the South : Canoe Landing Beach

a) Land

The canoe landing beach is a pocket beach which is 200 m long, 80 m wide and the elevation is +2.0 m. A vertical seawall stands to the west and the rubble slope of the Naval Base to the east.

b) Sea Bottom

The water depth in front of the beach is 0.0 to -1.0 m and the bottom slope is relatively gradual at 1/150.

(4) Soil Conditions

The soil investigation was conducted by one land boring and eight marine borings at two sites near the existing breakwater and near the rocky reef (Butatel Point) in the center of the bay. The boring points, the boring logs, the thickness of overburden and the soil laboratory test results are presented in Appendix-7. Soil conditions near the breakwater and near the rocky reef in the center of the bay are characterized as follows.

1) Near the Existing Breakwater

* The sea bottom is weathered sandstone, but there are hardly any sandy overburden on the surface layer.
* The result of land boring shows that rocky boulders are used for the breakwater.
* The unconfined compression strength of weathered sandstone is about 100 kg/cm^2.

2) Near the Rocky Reef at the Bay Center

* The soil foundation near the sandy beach is weathered sandstone and covered by 0 to 0.3 m silty sand overburden.
* In front of the vertical seawall (the fish smoking sheds are in the back) to the south of the rocky reef, there is a 1.5 to 1.8 m layer of sand of 7 to 15 N-value and gravely sand.

(5) Littoral Drift

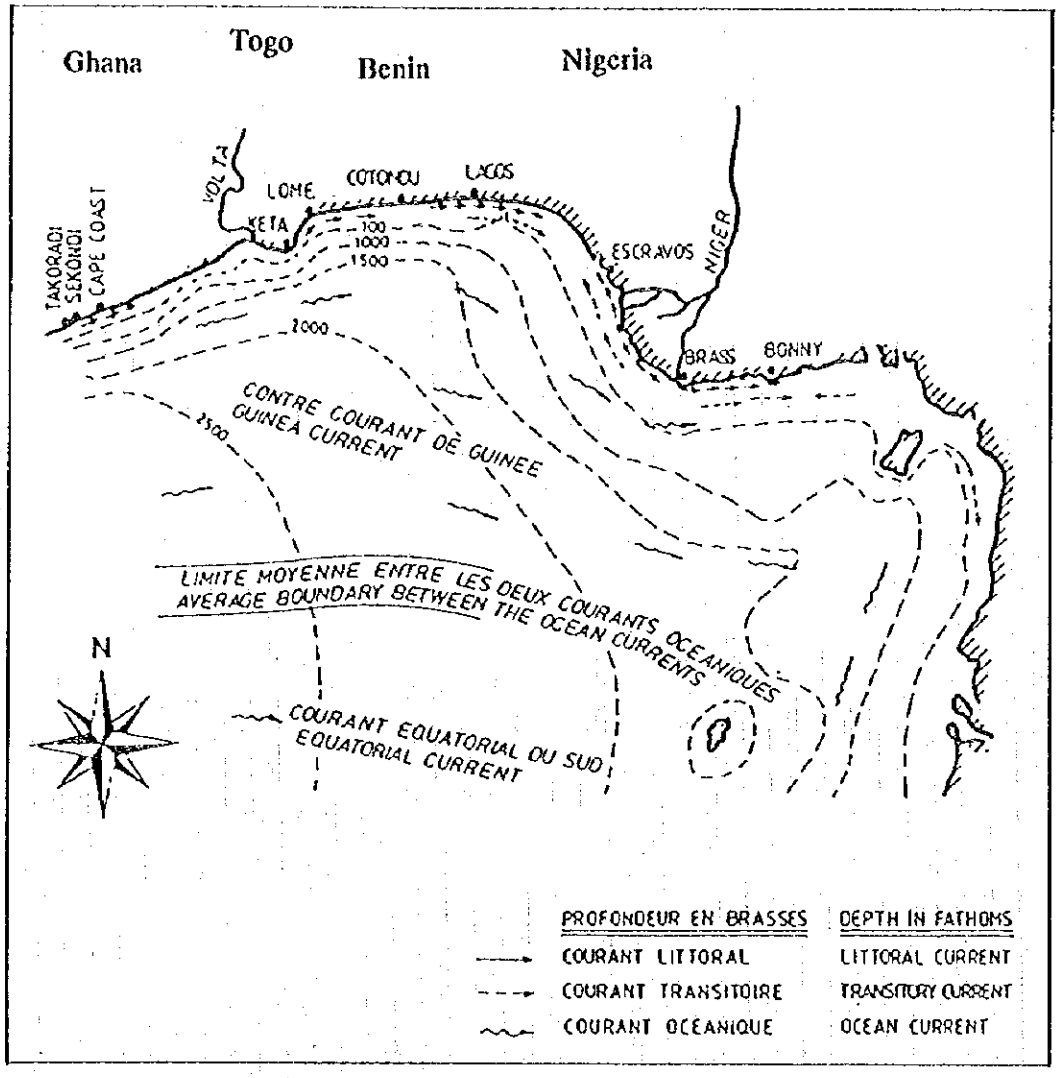
1) Littoral Drift along the Coast of Guinea Gulf

The coastal sea facing the Guinea Gulf in West Africa has the accretion tendency in the western area near the border of Ivory Coast and Cape Three Points in Ghana and the erosion tendency in the eastern area toward the Niger River Delta. Figures-2.4.4 and 2.4.5 show the pattern of surface current including the ocean current in the Guinea Gulf and the littoral transport along the coast of Ghana.

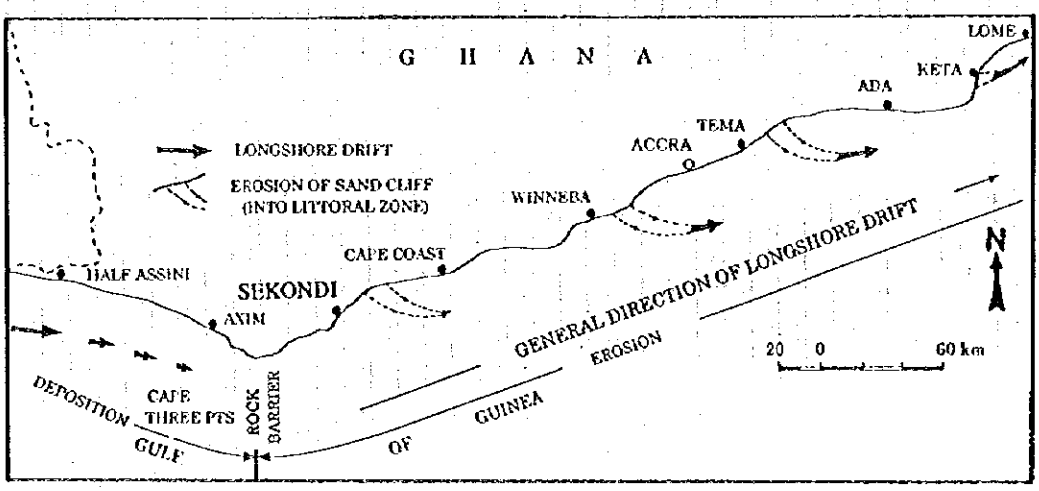
Sekondi area on the coast of Ghana is estimated to have considerably less eastward littoral drift because of the following reasons.

* There is hardly any sand supply from the west side of Cape Three Points.
* There is only a small sand supply from the rivers to the west coast of Sekondi.
* There is also a small sand supply by eroding of the cliffs on the west coast of Sekondi because of stable rocks.

There is little littoral drift along the coast is demonstrated by the fact that hardly any sand accretes on the western side of Takoradi Port or Sekondi Naval Base. In a relatively small area such as the creek surrounded by capes and breakwaters, sandy beaches are formed to thereby cause serious problems by littoral drift, as in the case of Elmina Fishing Port where the port mouth has been closed.



Figure–2.4.4 Pattern of Surface Current



Figure–2.4.5 Littoral Transport along the Coast of Ghana

2) Littoral Drift in Sekondi Bay

The coastal investigation and the analysis of the seabed materials sampling were conducted twice in Sekondi Bay. The first sampling was conducted in April, 1996 in calm sea season and the second was in August in rough sea season. The bay is shielded from the ocean waves by the Naval Base breakwater, and the coastline is bow shaped and extends for about 1 km. Figure-2.4.6 shows the characteristics of the coast of Sekondi Bay. The sampling points and the analysis result of seabed materials are presented in Appendix-7.

There were no notable changes in the shoreline in Sekondi Bay according to our interview survey. Outside the bay, however, there are observed erosion of the shoreline in the west of the Naval Base and accretion of the sandy beach (Nyiasia) in the north of the existing breakwater.

a) First Survey

The results of survey suggest that the area near the existing breakwater is not a source of littoral drift supply since it is rocky reefs despite its being under the influence of waves, and that there are no erosion or accretion. Similar tendency is observed at the center of the bay as fine grain seabed materials are transported and deposited in the canoe landing beach where the effect of waves is negligible. The result of the interview survey, however, suggests that both erosion in the sandy beach and accretion in the canoe landing beach are insignificant and that the amount of littoral drift is limited.

b) Second Survey

There were observed more effects of waves in the second survey as compared to the first survey. This corresponds to the wave characteristics of Sekondi that waves are high in June through September. The result of shoreline survey shows, however, no significant changes in the shoreline, suggesting that influence of waves on the bathymetry is minimal.

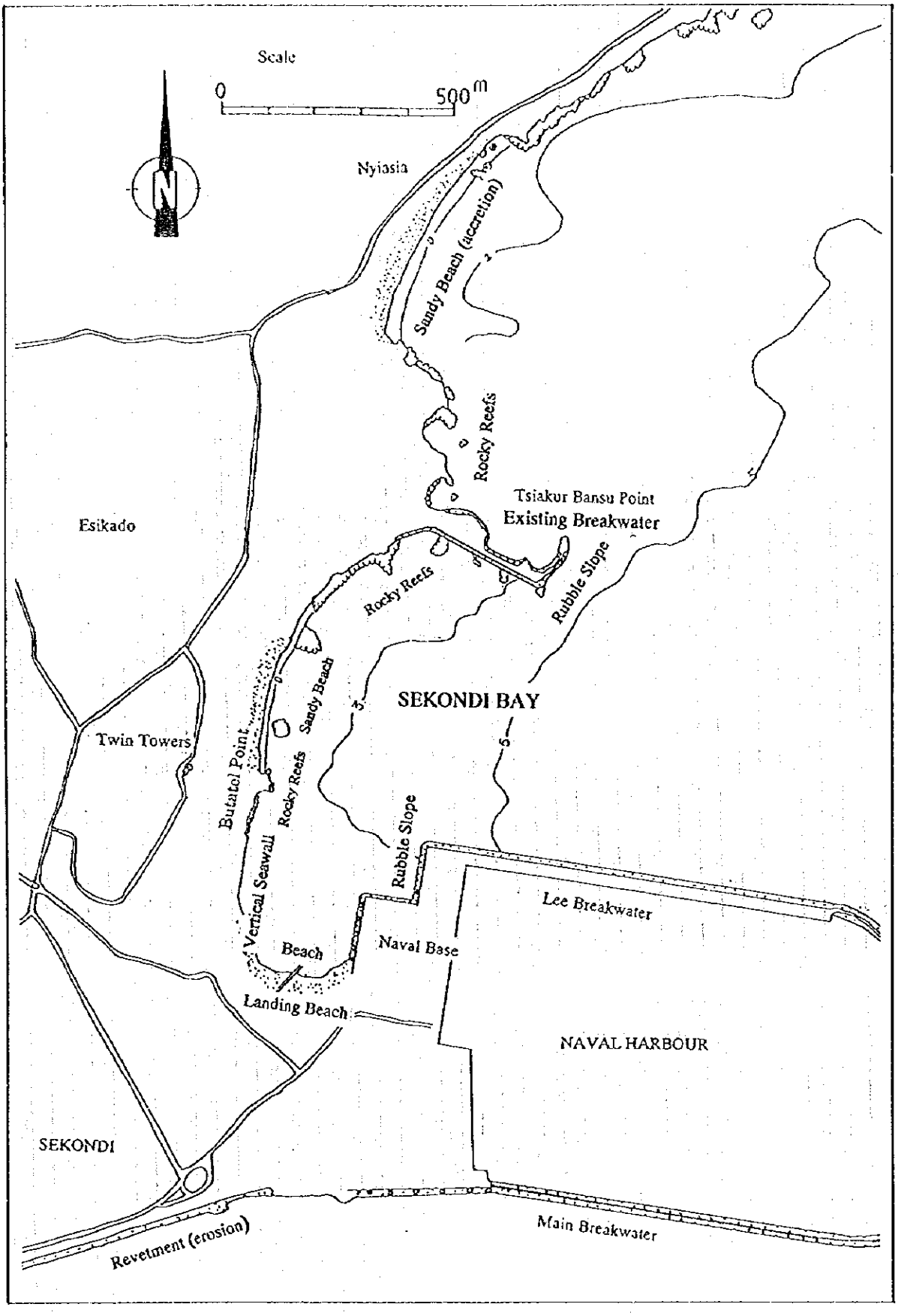


Figure-2.4.6 Characteristics of the Coast of Sekondi Bay

2-4-3 Layout Plan

The reef at the center of Sekondi Bay, the site 2, was chosen for the project as it was ascertained that accessibility from the smoking sheds was excellent, that the existing marketing channel could be continued, and that coordination with the Naval Base would present no problems.

The site 2 has the following restrictions.

* Canoe landing beach and smoking sheds should be left intact
* Natural beach extending in the north of the reef should be left intact
* There is a steep cliff right behind the reef, barring its use
* There is a seawall for the Naval Base on the sea side of the reef area, limiting the area for use

(1) Layout of Basic Facilities

Basic structure comprising the breakwater and the wharves is designed according to the following design concept.

1) Breakwater

Breakwater will be located on the north side in order to maintain calmness within the port against the waves in the eastern direction. To minimize topographical changes of the natural sandy beach at the center of Sekondi Bay, an offshore type will not be built.

2) Wharf

The landing wharf and the lay-by wharf will be arranged linearly from south to north in parallel to the coast line in order to minimize rocking of the inshore vessels moored at the wharf due to strong south wind prevailing over their center lines. This layout will allow the following.

* At the landing wharf, the inshore vessels can be moored in parallel to the direction of strong winds, minimizing rolling and facilitating landing operations.
* At the lay-by wharf, parallel mooring is possible allowing more number of inshore vessels per unit length to be moored.

The seaside position of the wharf face line will be at the depth of -2 m in order to minimize dredging, particularly rocky reef dredging.

3) Layout Plan

Figure-2.4.7 shows a layout plan for basic facilities. The wharf for inshore vessels will start at the north end of seawall for the existing smoking sheds and extend toward north for the prescribed length, thus enabling a linear layout and leaving the major portion of natural beach.

The canoe jetty will be located nearer the canoe landing beach by about 60 m from the south end of the wharf, and the jetty and the wharf will be connected by a walkway.

(2) Layout of Functional Facilities

Layout of the functional facilities on the land is decided by fully considering the flow of fish and the flow of facility management. Figure-2.4.8 shows the functional facilities and the flow of fish catch. The flow of fish caught by inshore vessels and large canoes is explained as below.

* Fish catches landed on the wharf are transported to the fish handling shed.
* Fish is offered for auction in the shed and purchased by middlewomen.
* Middlewomen process most of fish either by frying or smoking, and sell the remainder fresh.
* Fried or smoked fish is sold to retailers and then to consumers.

1) Fish Handling Shed

The shed will be built right behind the landing wharf for efficient fish landing and preserving their freshness.

2) Ice Making Plant: Ice Making Machine and Ice Storage

The ice making plant shall be located near the center of the lay-by wharf in order to facilitate smooth supply of ice to inshore vessels and large canoes.

3) Administration Office

The office will house GPHA, the Fisheries Department and Inshore Fisheries Association. In order to optimization of the function of these organizations, the office will be located at the center of the land area close to major facilities including the wharves, the fish handling shed, the ice making plant.

Figure-2.4.9 shows the layout of the functional facilities.

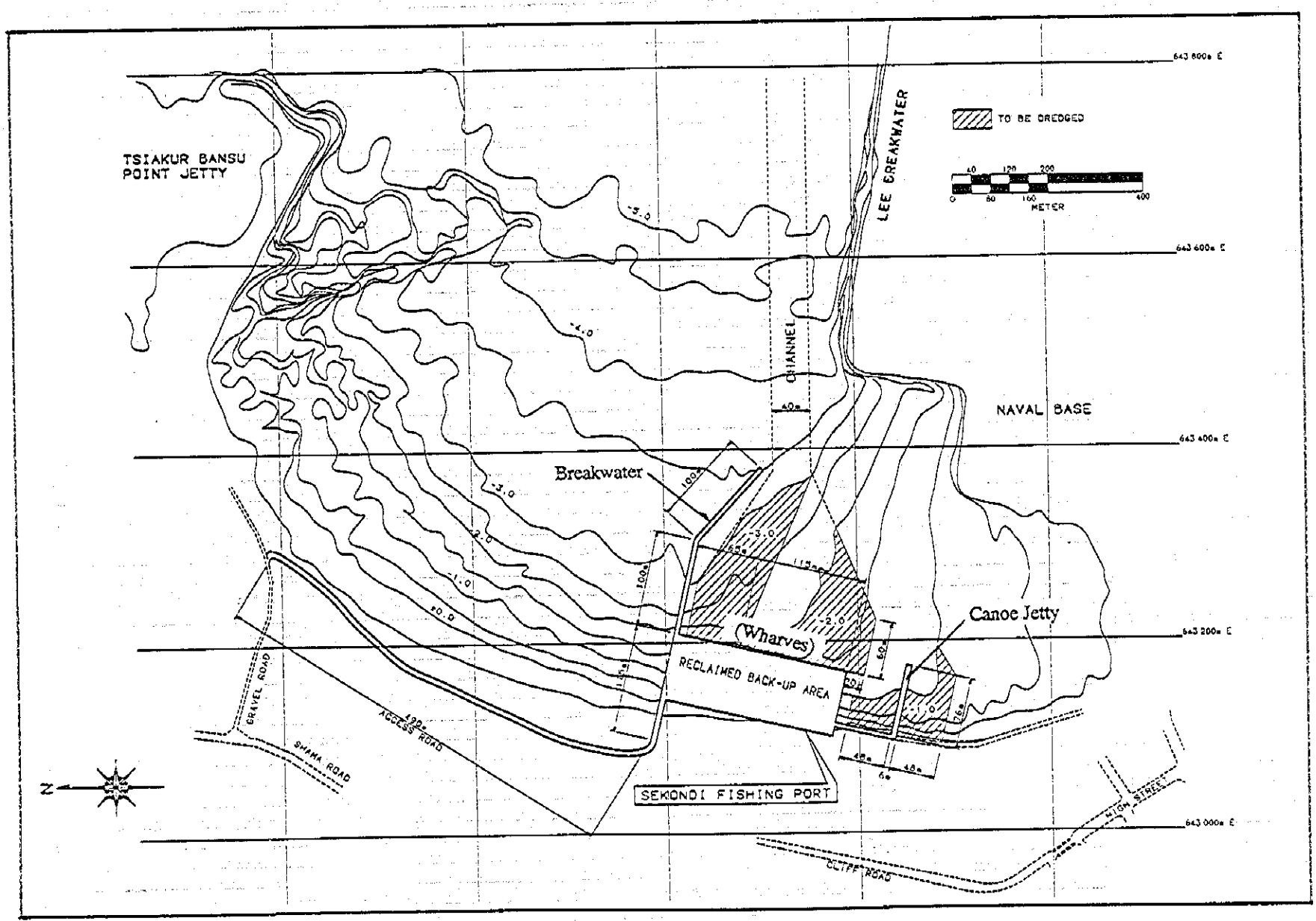


Figure-2.4.7 Layout Plan for Basic Facilities

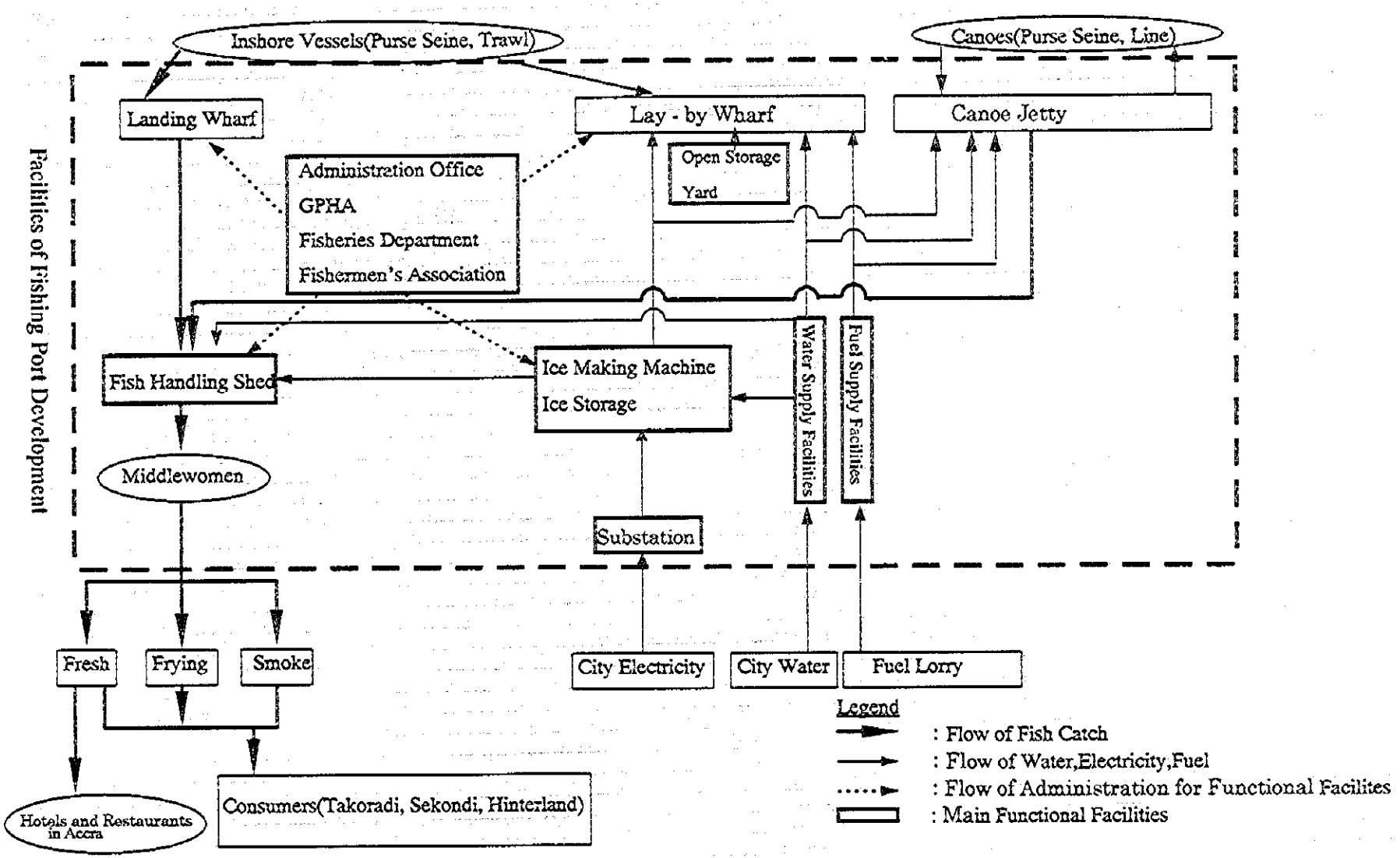


Figure-2.4.8 Fishing Facilities and Flow of Fish Catch

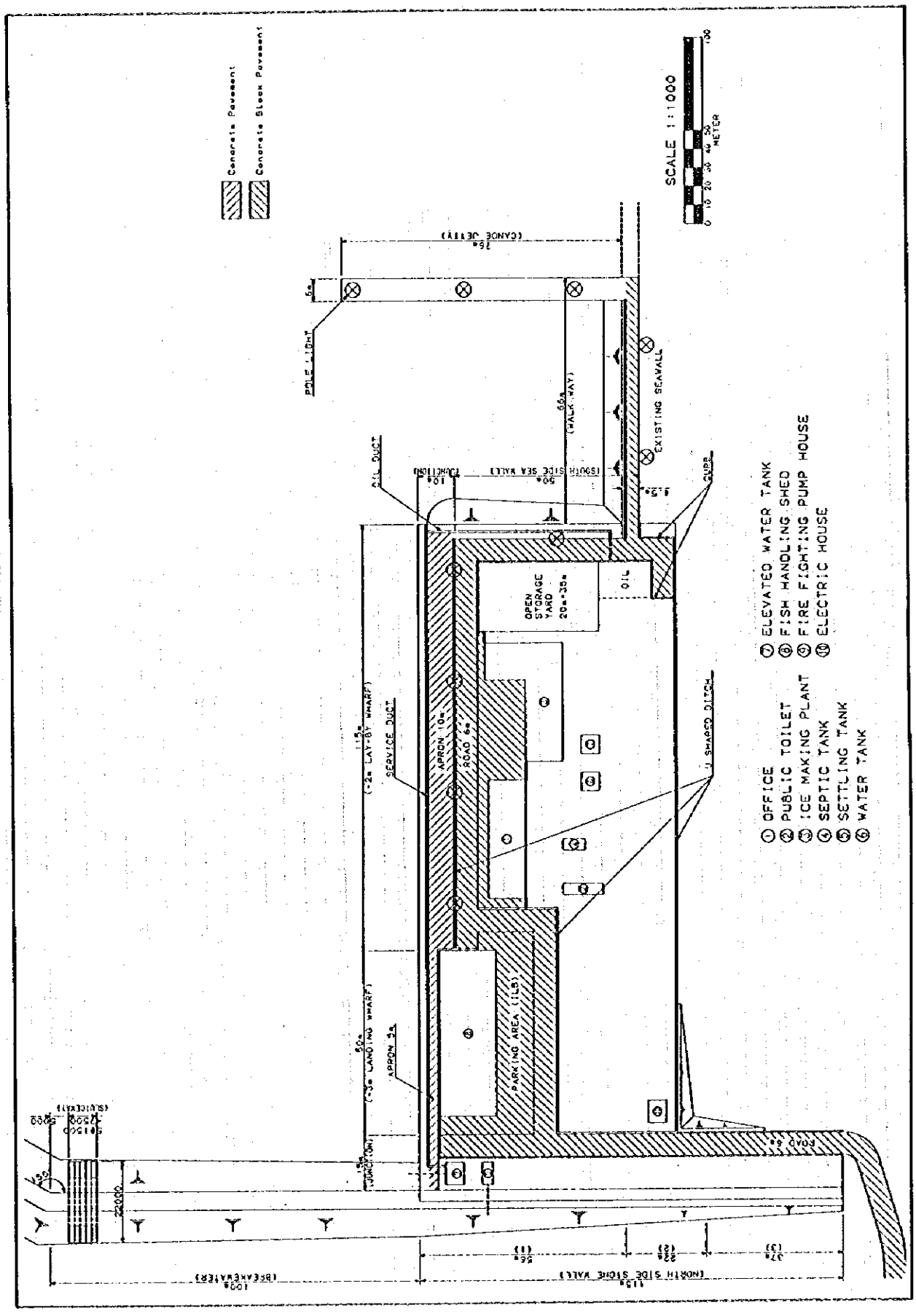


Figure-2.4.9 Layout of the Functional Facilities

(3) Calmness of the Basin

Based on the result of the calmness analysis with and without breakwater when attacked by the waves with a return period of 30 years, the use of lay-by wharf was studied (see Figures-2.4.10). It was expected that without a breakwater the waves would be higher than the critical wave height for the lay-by and the landing wharves (0.4 - 0.5 m). With a breakwater, the wave height will be below the critical wave height.

(4) Wharves

There will be provided an apron of 5 m width for the landing wharf, and one of 10 m width for the lay-by wharf in order to facilitate landing and preparations. A 2-lane, 6 m wide road will be built behind the apron. There will be secured a land of about 40 m width behind the road for building the ice making plant, fish handling shed, office and open storage yard.

Length of the landing wharf is estimated using the amount landed in a day (standard day) and the number of vessels using the port for landing obtained based on the record for the past three years (1993 - 1995), and that for the lay-by wharf estimated using the number of boats per day obtained by a similar method. The design length of the wharf is based on the standard day during the peak season. The use of the port during lean season was also studied. The records on the amount landed in a day and the number of vessels using the port for landing are presented in Appendix-6.

1) Fish Catch and Number of Vessels Using the Port on a Standard Day

a) Table-2.4.9 and Figure-2.4.11, based on the Table-2.4.8 (monthly fish catch of inshore vessels) show the top three months of monthly fish catches broken down by the year and the monthly means.

b) The number of vessels using the port per day and the fish catch are calculated for each year from 1993 to 1995.

c) The standard day is chosen from a month of the year with the second largest catch, since the catch for July at 715 tons is extraordinary compared to other months.

d) As for the standard day, top five days with large daily catches are chosen in the month with the second largest catch, and the number of vessels using the port on these days, the catch per day, the catch per vessel, and the mean number of inshore vessels using the port for the period of five days are calculated. The result is shown in Table-2.4.10.

c) Table-2.4.10 shows that for three years from 1993 to 1995 the average number of vessels using the port is 46, and average catch per day 12.5 tons (284 kg per vessels).

2) Standard Fish Catch and Number of Vessels Using the Port during the Lean Season

a) The standard day for the lean season is chosen from a month with the least catch in 1993 - 1994. Since the daily data for April, 1995 is not available, the year 1995 is not included in the calculation.

b) The fish catch, etc. on a standard day is estimated using the same method as for the peak season. Table-2.4.11 shows the result.

c) The average number of vessels using the port for the two years of 1993 and 1994 was 27 and the average catch per day 3.0 tons (112 kg per vessel).

3) Number of Berths Required for the Wharf

Length of the landing wharf is calculated by the following formula.

$$\text{Length} = \Sigma \quad \frac{N}{\gamma} L$$

where L : berth length = vessel length + allowance

N : number of vessels using the port on a standard day

γ : number of berth rotation = $\frac{\text{hours for landing}}{\text{landing hours per vessel}}$

As for the lay-by wharf, assuming that a 10 m long inshore vessel has 2.5 m breadth (B) and needs 0.5 B allowance, the wharf length per vessel should be about 4 m. If 4 vessels are on abreast berthing, there is no merit for lengthwise berthing. Therefore, it is assumed that there will be 5 abreast berthing, length of 11.5 m per berth is required.

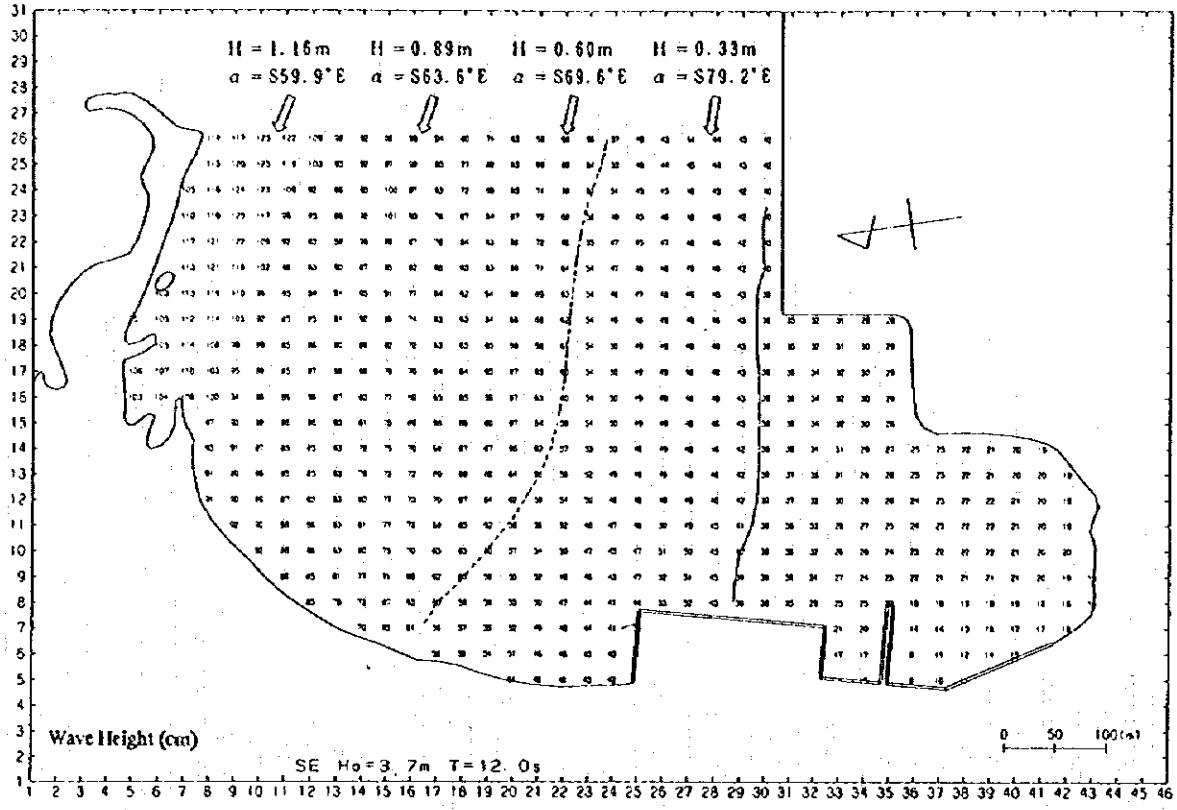


Figure-2.4.10(1) Calmness without Breakwater by the Waves with a Return Period of 30 Years

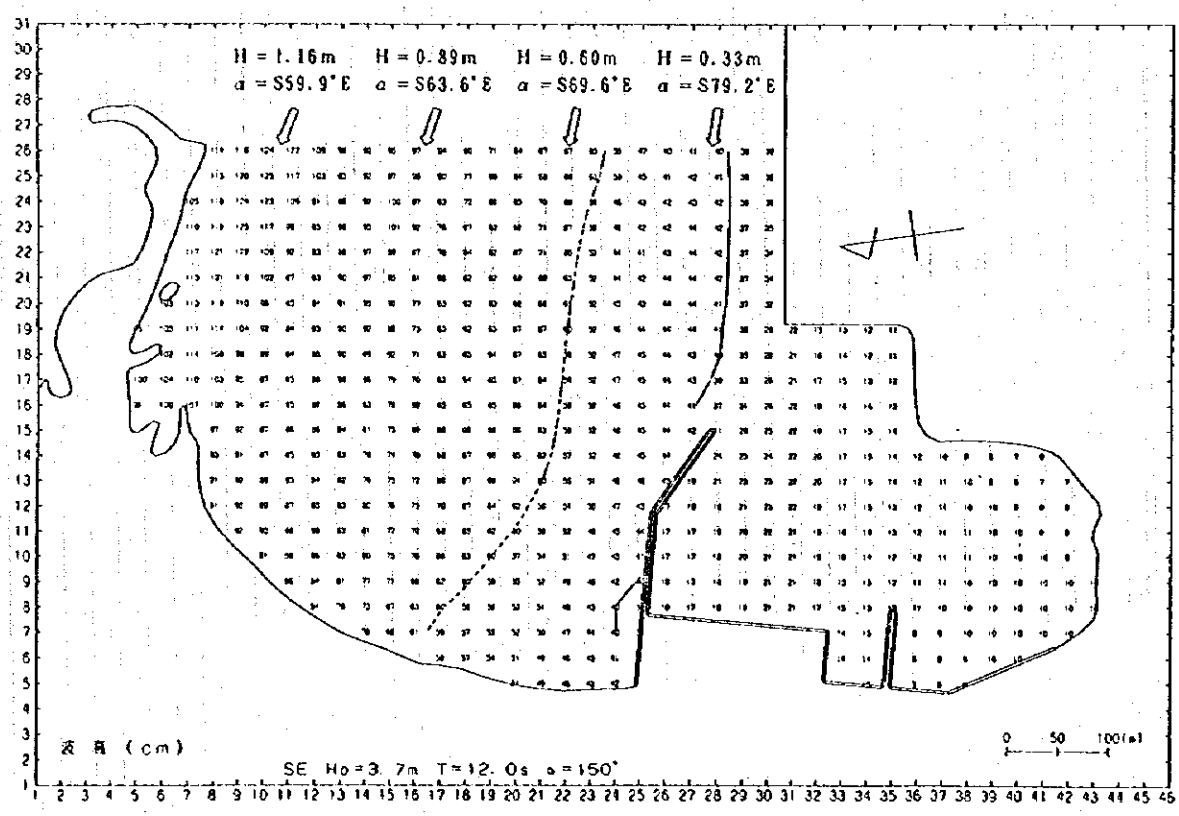


Figure-2.4.10(2) Calmness with Breakwater by the Waves with a Return Period of 30 Years

Table-2.4.8 Top Three Months of Monthly Fish Catch

Sekondi Fishing Port

Unit : M/T

Month	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	Ave.
Jan	219.2	86.0	60.8	106.1	① 341.4	94.2	53.2	74.0	87.1	82.3	120.4
Feb	⑫ 55.9	86.9	⑫ 33.8	89.6	199.2	67.9	N/A	35.0	82.3	109.9	84.5
Mar	③ 258.6	117.2	66.2	124.4	110.6	54.8	43.2	44.4	134.4	N/A	106.0
Apr	219.9	⑫ 60.6	50.3	107.5	⑫ 21.7	29.1	51.7	⑫ **25.2**	104.8	⑫ 69.1	74.0
May	187.5	71.8	93.5	67.8	42.8	41.6	34.8	35.2	91.6	101.5	76.8
Jun	97.9	94.0	80.3	⑫ 40.9	60.6	⑫ 21.7	48.7	③ 151.2	⑫ **67.4**	98.6	76.1
Jul	① 637.4	③ 231.1	116.0	184.1	220.9	43.2	① 249.2	① 714.9	111.7	① 199.3	270.8
Aug	② 473.1	191.7	69.9	② 230.4	② 263.0	① 612.6	② 227.2	② **178.3**	121.7	92.0	246.0
Sep	121.0	74.0	114.5	151.2	③ 224.2	③ 151.3	③ 108.4	85.4	③ 141.6	② **147.9**	132.0
Oct	235.8	② 445.9	② 156.4	③ 229.2	38.2	② 443.9	68.0	107.4	② **149.3**	81.9	195.6
Nov	225.8	① 466.6	① 337.6	191.3	130.8	69.9	35.8	69.1	① 152.3	105.2	178.4
Dec	186.8	121.0	③ 135.4	① 293.2	69.0	58.9	⑫ 22.8	143.7	131.3	③ 145.4	130.8
Total	2,919	2,047	1,315	1,816	1,722	1,689	943	1,664	1,376	1,233	1,672
Ave.	243.2	170.6	109.6	151.3	143.5	140.8	85.7	138.7	114.6	112.1	140.9

Peak Season : ① ; 1st. ② ; 2nd. ③ ; 3rd
Lean Season : ⑫ ; 12th

Source: Fisheries Department

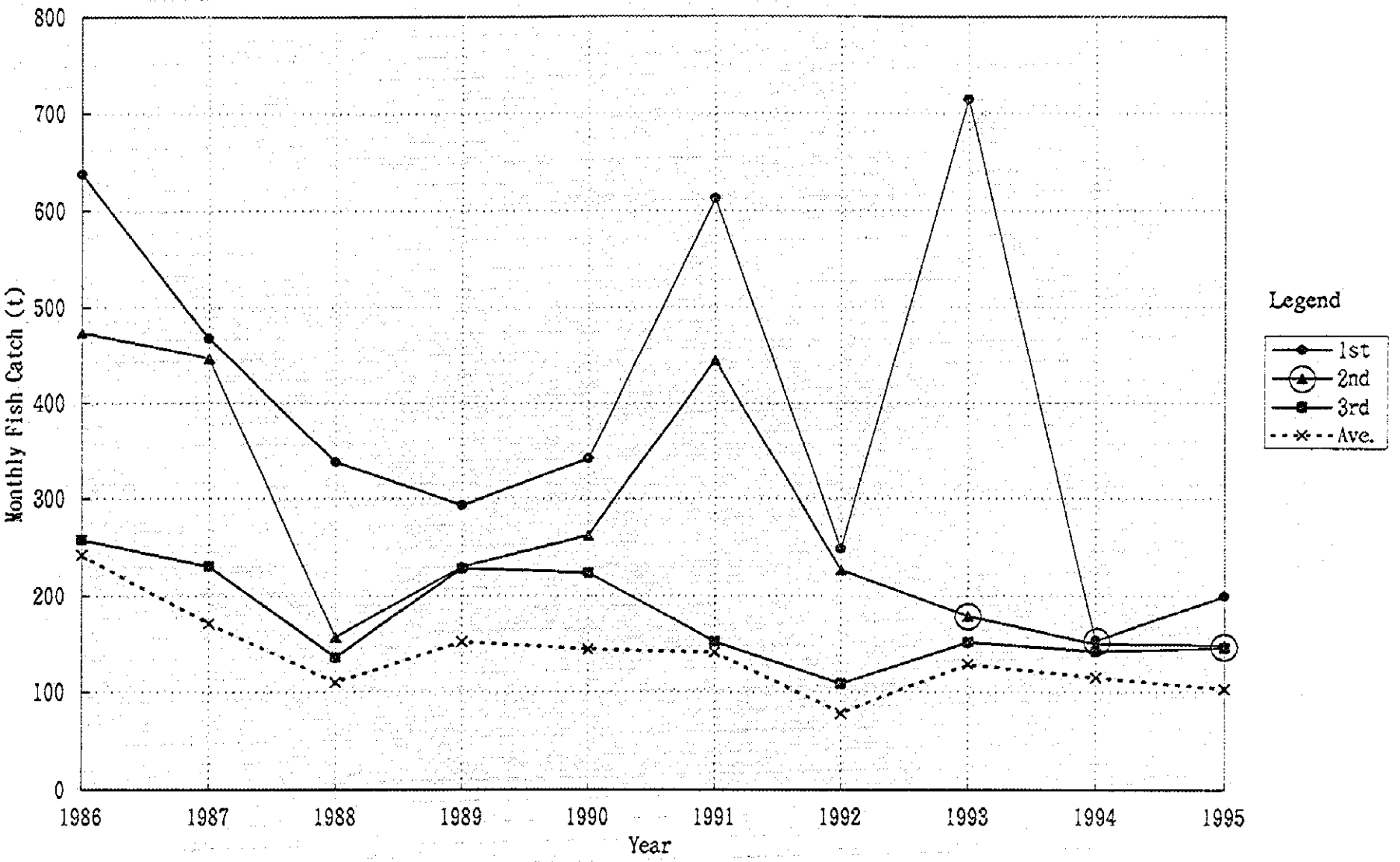


Figure-2.4.11 Top Three Months of Monthly Fish Catch

Table-2.4.9 Top Three Months of Monthly Fish Catch by the Year & Monthly Average(1986-1995)

Unit : M/T

Year	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	Ave.
1st	637.4	466.6	337.6	293.2	341.4	612.6	249.2	714.9	152.3	199.3	400.5
2nd	473.1	445.9	156.4	230.4	263	443.9	227.2	178.3	149.3	147.9	271.5
3rd	258.6	231.1	135.4	229.2	224.2	151.3	108.4	151.2	141.6	145.4	177.6
Ave.	243.2	170.6	109.6	151.3	143.5	140.8	78.6	128.3	114.6	102.8	138.3

Source: Fisheries Department

Table-2.4.10 Number of Vessels In-coming per Day & Fish Catch for Standard Day in Peak Season (Inshore Vessels)

Year	Month	Monthly Fish Catch(t)	No. of In-coming Vessels per Day	Fish Catch per Day (t/day)	Fish Catch per Vessel (kg/vessel)	Ave. No. of Vessels Using Port per Day
1993	Aug	178.3	43	20.9	493	52
1994	Oct	149.3	48	9.1	190	51
1995	Sep	147.9	46	7.6	168	48
Ave.		158.5	45.7	12.5	284	50.3

Source: Fisheries Department

Table-2.4.11 Number of Vessels In-coming per Day & Fish Catch for Standard Day in Lean Season (Inshore Vessels)

Year	Month	Monthly Fish Catch(t)	No. of In-coming Vessels per Day	Fish Catch per Day (t/day)	Fish Catch per Vessel (kg/vessel)	Ave. No. of Vessels Using Port per Day
1993	Apr	25.2	26	2.0	77	27
1994	Jun	67.4	27	3.9	146	28
Ave.		46.3	26.5	3.0	112	27.5

Source: Fisheries Department

a) Tables-2.4.12 and 2.4.13 show the required berth lengths for the wharf during the peak and lean seasons.
b) Tables show that 4 berths for the landing wharf and 10 for the lay-by wharf are required during the peak season, and 2 berths for the landing wharf and 6 berths for the lay-by wharf during the lean season. This indicates that if 4 berths for the landing wharf and 10 berths for the lay-by wharf were to be built under this project, the landing wharf will be used for 7 rotations (27 vessels/4 berths) even during the lean season and that the lay-by wharf will be used on 3 abreast berthing (28 vessels/10 berths).

4) Length of Wharf

a) Table-2.4.14 shows the length for the wharves for the peak season, and those data for the lean season are for the reference.
b) The design length is 50 m for the landing wharf and 115 m for the lay-by wharf.

(5) Canoe Jetty

Canoe jetty is used for both large and medium sized canoes engaged in purse seine and hand line fishing for landing their catch and for preparation. The number of canoes is calculated similarly as for the inshore vessels. Table-2.4.15 shows the result of calculation, except that the result for the purse seine canoes is obtained by averaging catches on the day they did have catches and that for hand liners (canoes) by averaging all the data. This is because only the data for July, 1996 is available.

a) The number of canoes using the wharf on a standard day is 13 for purse seine canoes and 6 for hand liners, the total being 19 canoes.
b) As 13 of 19 canoes are large sized and engaged in purse seine fishing, the length is assumed to be 20 m. The length of remaining 6 canoes is 17 m.
c) As in the case of the inshore vessels, when the berthing allowance on both sides of the canoe is set at 15% of the canoe length, the length (L) per berth is 23 m (=20 x 1.15).
d) Canoes will be berthed to the jetty on 3 abreast by considering that they will be engaged both in landing catches and preparation, and the number of berths required will be 6 (= 19/3).

Table-2.4.12 Required Number of Berths for Landing Wharf

(1) Peak Season

Fish Catch) (t)	No. of In-coming Vessels	Fish Catch per Vessel (kg)	Fish Box per Vessel	Landing Time (Hour)	Berthing Time (Hour)	No. of Rotation of Berth	Required No. of Berth
12.5	46	284	10	0.1	0.17	11	4

(2) Lean Season

Fish Catch) (t)	No. of In-coming Vessels	Fish Catch per Vessel (kg)	Fish Box per Vessel	Landing Time (Hour)	Berthing Time (Hour)	No. of Rotation of Berth	Required No. of Berth
3.0	27	112	4	0.04	0.17	14	2

Table-2.4.13 Required Number of Berths for Lay-by Wharf

(1) Peak Season

No. of Vessels	Berthing Abreast	Required No. of Berth
51	5	10

(2) Lean Season

No. of Vessels	Berthing Abreast	Required No. of Berth
27	5	6

Table-2.4.14 Required Length of Berths

(1) Peak Season

Type of Wharf	Required No. of Berth	Berth Length	Required Length	Planned Length
Landing Wharf	4	11.5m	46m	50m
Lay-by Wharf	10	11.5m	115m	115m

(2) Lean Season

Type of Wharf	Required No. of Berth	Berth Length	Required Length
Landing Wharf	2	11.5m	23m
Lay-by Wharf	6	11.5m	69m

e) The length of canoe jetty shall be 76 m including the approach in order to allow three 20 m long canoes to berth on both sides. There will be built a 6 m approach at the landward end of jetty to protect the rubble mound slope of the walkway.

f) The jetty length therefore will be set as below.

Jetty length = 3 x length of berth + allowance + approach

= 3 x 23 m + 1 m + 6 m

= 76 m

As for the lean season, the number of canoes using the jetty on a standard day is 7 for large sized canoes and 6 for medium sized canoes, the total being 13 canoes.

a) The number of large sized canoes engaged in purse seine fishing will be decreased similar to the case of inshore vessels; calling canoes 8 (=13×27/46), fish catch 349 kg per canoe, using canoes 7 (=13×27/51), and

b) The number of medium sized canoes engaged in line fishing is 6 as same in the peak season,

Therefore, these canoes will be berthed to the both sides of the jetty on 3 abreast and 2 abreast in the lean season,

Table-2.4.15 Number of Canoes In-coming per Day & Fish Catch for Standard Day in Peak Season (Canoes)

Year	Month	Fish Method	No. of In-coming Vessels per Day	Fish Catch per Day (t/day)	Fish Catch per Vessel (kg/vessel)	Ave. No. of Vessels Using Port per Day
1996	Jul	Trawl	13	11.9	885	13
		Line	6	3.4	556	6

Source: Fisheries Department