APPENDIX

APPENDIX

APPENDIX -1 Members of the Basic Design Study Team

(1) Basic Design Study Team

Name	Duty	Present Position
Mr. M. Nagano	Leader, Port Planning	Supervisory officer on Environmental Technology, 3rd Port Construction Bureau, Ministry of Transport
Mr. T. Amano	Port Operation and Management	Deputy Director of Engineering Department I, The overseas Coastal Area Development Institute of Japan
Mr. H. Shiono	Coordination	Grant Aid Planning and Survey Department, JICA
Dr. I. Ishiguro	Structural Planning	Nippon Tetrapod Co., Ltd.
Mr. K. Igari	Structural Design	do
Mr. F. Ichino	Natural Conditions	do
Mr. S. Ishikawa	Cost Estimation	do

(2) Draft Final Report Explanation Team

Name	Duty	Present Position
Mr. M. Nagano	Leader	Supervisory officer on Environmental Technology, 3rd Port Construction Bureau, Ministry of Transport
Mr. Y. Yamada	Coordination	Procurment Department, JICA
Dr. K. Ishiguro	Structural Planning	Nippon Tetrapod Co., Ltd.
Mr. K. Igari	Structural Design	do

APPENDIX -2 Minutes of Discussions (April 7, 1988)

MINUTES OF DISCUSSIONS

FOR

THE PROJECT ON THE DEVELOPMENT

OF

APIA PORT

IN

WESTERN SAMOA

In response to the request of the Government of Western Samoa, the Government of Japan had decided to conduct a basic design study on the project of developing Apia Port and entrusted the study to the Japan International Cooperation Agency (JICA). JICA sent to Western Samoa the Basic Design Study Team headed by Mr Masataka Nagano, Senior Adviser, the 3rd District Port Construction Bureau, Ministry of Transport from March 28 through April 24, 1988..

The Team had series of discussions on the Project with the officials concerned of the Government of Western Samoa headed by Hon Toeolesulusulu Siueva Toalepaialii, Minister of Transport, and conducted field survey in Apia Port.

As the results of the studies, both parties agreed to recommend to their respective Governments the major points of understanding reached between them, as attached herewith, to be examined towards the realization of the Project.

Dated: April 7, 1988

Mr Masataka NAGANO
Leader, Japanese Basic
Design Study Team
Japan International
Cooperation Agency (JICA)

Hon Toeolesulusulu Siueva
TOALEPAIALII
Minister of Transport
Western Samoa

ATTACHMENT

1. OBJECTIVE OF THE PROJECT

The objective of the Project is the development of Apia Port by Aid of Japanese Grant System in response to the request of Western Samoa Government.

2. EXECUTIVE BODY

The executing organisation for the Project is the Ministry of Transport (MOT) of Western Samoa, which is responsible for the establishment of a port management body for proper and effective operation and maintenance of all port facilities in Western Samoa including those provided under the Japanese Grant Aid.

3. SITE OF THE PROJECT

The site of the Project is located in Apia Port area as illustrated in Annex I.

4. REQUESTS BY THE GOVERNMENT OF WESTERN SAMOA

The Japanese Basic Design Study Team will convey the requests on the Project from the Government of Western Samoa as listed in Annex II to the Government of Japan, so that the latter will take necessary measures within the scope of the Japanese Economic Cooperation Grant System.

5. MEASURES TO BE UNDERTAKEN BY THE GOVERNMENT OF WESTERN SAMOA

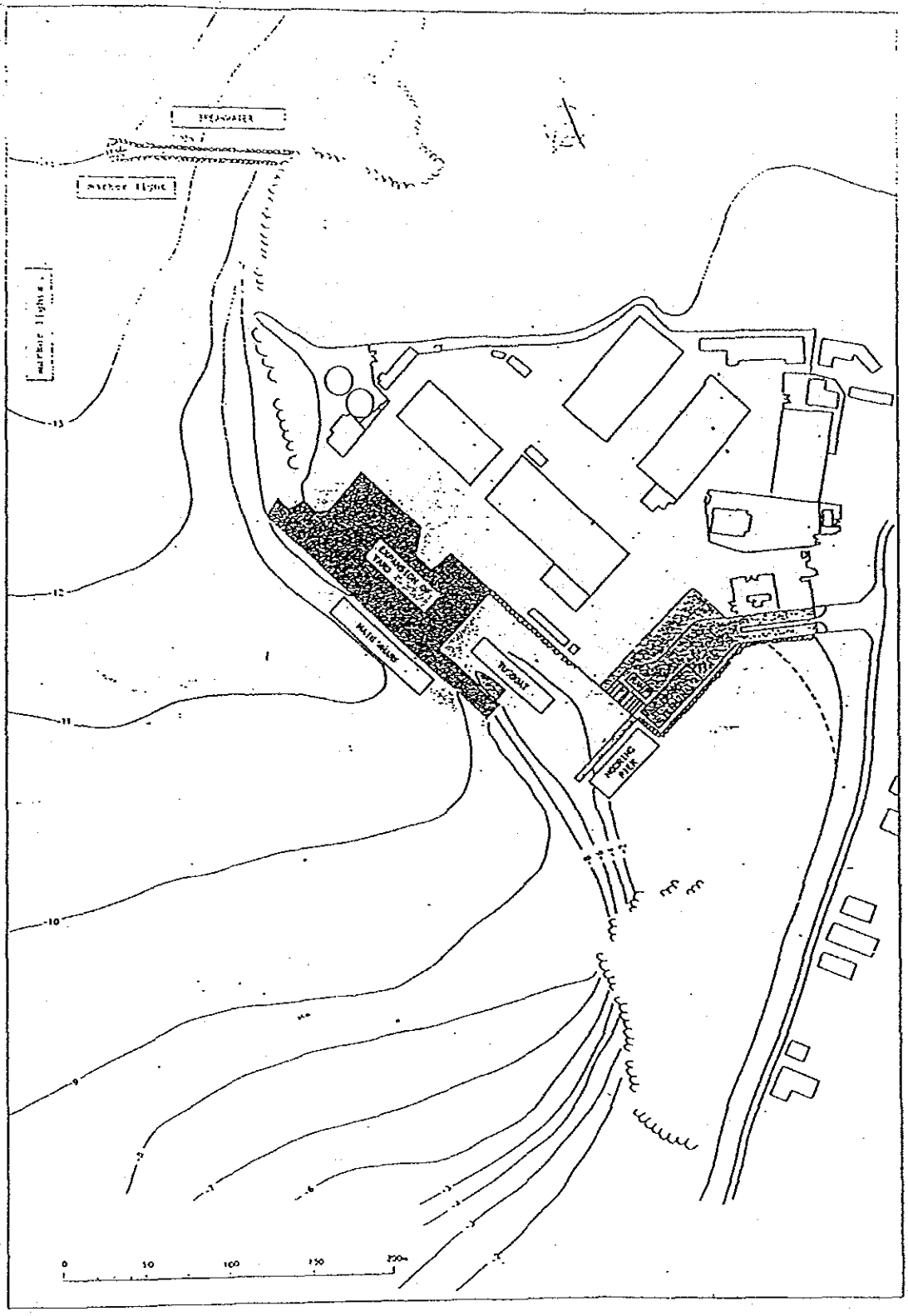
The Government of Western Samoa will undertake the necessary measures listed in Annex III.

6. SYSTEM OF JAPANESE GRANT AID

The Government of Western Samoa has understanding that the Japanese Grant Aid System for implementation of the Project is to be proceeded by use of Japanese consulting firm and Japanese construction firms.

Japanese side has understanding that as much as possible subcontracts be awarded to Western Samoa companies and that the use of local resources be maximized.

ANNEX I. SITE OF PROJECT



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ANNEX II

Items of the Project are as listed below in priority order:-

1. A tugboat (with engine horse power of more than 1100HP with auxilliary apparatus)

2. Repair of the main wharf and expansion of the container yard

3. Upgrading of ferry terminal (terminal building, wharf of minimum depth to suit draft of the new tugboat)

4. Breakwater (100m length with marker light)

5. Marker lights (on the tanker mooring bouys)

6. Vehicles (3-ton trucks, pickups, landcruisers)

7. Small computer system (accounting & statistic purposes)

ANNEX III

Necessary measures to be undertaken by the Government of Western Samoa are as follows:-

1. To secure land site necessary for the execution of the Project and provide work space for construction including stock yard for materials and equipments.

2. To secure sea area necessary for the construction of the marine facilities.

3. To provide utilities such as electricity, water supply, drainage and sewage, telephone and other incidental facilities at the Project site.

4. To exempt tax and duty, promoting customs clearance at ports of disembarkation in Western Samoa on the materials and equipments for the Project.

5. To exempt corporation tax and income tax on Japanese nationalities to work for the Project.

6. To issue entry visas and working permits to those who enter into Western Samoa and stay for the Project.

7. To facilitate stable supply of local materials such as concrete aggregate and rubble stones for the Project.

8. To bear necessary expenses for undertakings of Western Samoa side.

APPENDIX -3 Minutes of Discussions (June 30, 1988)

MINUTES OF DISCUSSIONS
ON
THE BASIC DESIGN STUDY
OF
THE DEVELOPMENT OF APIA PORT PROJECT
IN
WESTERN SAMOA

In response to the request of the Government of Western Samoa for Grant Aid for the Development Project of Apia Port (hereinafter referred to as "The Project"), The Government of Japan decided to conduct a basic design study on the Project and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent the basic design study team headed by Mr..MASATAKA NAGANO, Supervisory Officer on Environmental Technology, the Third Port and Harbour Bureau, Ministry of Transport, from March 28 through April 24, 1988.

As a result of the study JICA prepared a draft report and dispatched a team headed by Mr. MASATAKA NAGANO, to explain and discuss it from June 27 through to 30,1988.

Both parties had a series of discussions on the draft report and agreed to recommend to their respective Governments that the major points of understanding reached between them, attached herewith, should be examined towards the realization of the Project.

Apia June 30 1988

Mr. MASATAKA NAGANO
Leader
Basic Design Study Team
Japan International
Cooperation Agency (JICA)

Honourable JACK O. NEIZLER
Minister of Transport
Western Samoa

Attch:

ATTACHMENT

1. The Western Samoa side agreed in principle on the basic design proposed in the Draft Final Report (with minor alterations, which will be incorporated in the Final Report).

2. The Government of Western Samoa will take necessary measures inclusive of preparation of budget for development and operating cost upon the execution of the Grant Aid to the Project by the Government of Japan.

3. The Final Report (10 copies in English) will be submitted to the Western Samoa side by the end of August 1988.

4. The Government of Western Samoa will take necessary measures for proper and effective operation and maintenance of the facilities and equipments provided by "the Project".

5. The Western Samoa-side requested that the three vehicles referred to in phase 2 be included in phase 1.

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APPENDIX -4 Schedule of the Study Team (Basic Design)

( ): Local Time of W.S.

No.	Date (1988)	Activities
1	Mar. 28 Mon. (27 Sun.)	. Team Leader: Mr. Nagano, Mr. Amano, Mr. Shiono, Mr. Igari, Mr. Ishikawa and Mr. Ichino departed Tokyo for Auckland.
2	29 Tue. (28 Mon.)	. Team Leader: Mr. Nagano and Mr. Shiono made an on-the-spot inspection of Wellington Port. . Mr. Amano, Mr. Igari, Mr. Ishikawa and Mr. Ichino made an on-the-spot inspection of Auckland Port.
3	30 We. (29 Tue.)	. Team Leader: Mr. Nagano and Mr. Shiono visited the Embassy of Japan in NZ. . Mr. Amano, Mr. Igari and Mr. Ishikawa made data collection of construction situations in New Zealand. . Mr. Shiono made data collection of natural condition. . Team Leader: Mr. Nagano, Mr. Amano, Mr. Shiono, Mr. Igari, Mr. Ishikawa and Mr. Ichino departed Auckland and arrived at Apia.
4	31 Tur. (30 Wed.)	. Team Leader: Mr. Nagano, Mr. Amano, Mr. Shiono, Mr. Igari, Mr. Ishikawa and Mr. Ichino visited JICA Office and paid courtesy visit to MOF and MOT. . Held an official meeting with officials concerned and explained the Inception Report of the Basic Design Study and the Japanese Grant Aid System.
5	Apr. 1 Fri. (31 Tur.)	. Made an on-the-spot inspection of Apia Port. . Prepared for field survey.
6	2 Sat. (1 Fri.)	. Made on on-the-spot inspection of Mulifanua Port and Faleolo Air port. . Prepared for field survey. . Visited quarry site. . Dr. Ishiguro departed Tokyo.
7	3 Sun. (2 Sat.)	. Held an internal meeting with the study team members. . Prepared for field survey.
8	4 Mon. (3 Sun.)	. Classified collected data. . Dr. Ishiguro arrived Apia.

No.	Date (1988)	Activities
9	Apr. 5 Tue. (4 Mon.)	. Held an internal meeting with the study team members. . Prepared for field survey.
10	6 Wed. (5 Tue.)	. Held an official meeting with the officials concerned. . Prepared for field survey. . Made data collection of construction conditions.
11	7 Tur. (6 Wed.)	. Discussed the contents of the Minutes of Discussions. . Prepared for field survey. . Made data collection of construction conditions.
12	8 Fri. (7 Tur.)	. The Minutes of Discussions on the project was signed. . Prepared for field survey. . Team Leader: Mr. Nagano, Mr. Amano and Mr. Shiono visited MOT and JICA office.
13	9 Sat. (8 Fri.)	. Team Leader: Mr. Nagano and Mr. Shiono departed Apia for Wellington. . Started BH-4 boring started. . Made data collection of construction conditions, management and operation of Apia Port.
14	10 Sun. (9 Sat.)	. Survey for construction yard and quarry site. . Continued BH-4 boring test.
15	11 Mon. (10 Sun.)	. Classified collected data and continued BH-4 boring.
16	12 Tue. (11 Mon.)	. Team Leader: Mr. Nagano and Mr. Shiono visited the Embassy of Japan in New Zealand and explained the Minutes of Discussions. . Continued BH-4 boring and started BH-1 boring test. . Visited ACP, WSSC and local firms.
17	13 Wed. (12 Tue.)	. Team Leader: Mr. Nagano and Mr. Shiono arrived at Tokyo. . Continued BH-4 and BH-1 boring test and sounding survey. . Visited PWD, MOBIL and Airport Authority.
18	14 Tur. (13 Wed.)	. Finished BH-4 boring test and started BH-3 & BH-2 boring test. . Visited PWD, Lands & Survey and Agriculture.
19	15 Fri. (14 Fur.)	. Continued BH-2 boring and started BH-6 boring test. . Executed each sounding survey.

No.	Date (1988)	Activities
20	Apr. 16 Sat. (15 Fri.)	. Visited MOT. . Mr. Amano, Dr. Ishiguro, Mr. Igari and Mr. Ishikawa departed Apia for Sydney. . Continued BH-2 and BH-6 boring.
21	17 Sun. (16 Sat.)	. Mr. Amano, Dr. Ishiguro, Mr. Igari and Mr. Ishikawa arrived at Tokyo. . Continued BH-6 boring test.
22	18 Mon. (17 Sun.)	. Continued BH-3 boring test.
23	19 Tue. (18 Mon.)	. Continued BH-3 boring test.
24	20 Wed. (19 Tue.)	. Continued BH-3 boring test.
25	21 Tur. (20 Wed.)	. Started BH-5 boring test.
26	22 Fri. (21 Tur.)	. Continued BH-5 boring test.
27	23 Sat. (22 Fri.)	. Mr. Ichino departed Apia.
28	24 Sun. (23 Sat.)	. Mr. Ichino arrived Tokyo.

APPENDIX -5 Schedule of the Study Team (Draft Report)

( ) : Local Time of W.S.

No	Date (1988)	Acivities
1	Jun. 25 Sat. (24 Fri.)	Team Leader : Mr. Nagano, Mr. Yamada, Dr Ishiguro and K.Igari departed Tokyo for Sydney.
2	26 Sun. (25 Sat.)	The Team members made an on-the-spot inspection Sydney Port. The Study Team departed Sydney for Apia.
3	27 Mon. (26 Sun.)	The Study Team arrived at Apia.
4	28 Tue. (27 Mon.)	The Team members visited JICA office and paid courtesy visit to MOT. Held an internal meeting with the Team members.
5	29 Wed. (28 Tue.)	Held an official meeting with the officials concerned. Presented and explained the draft final report of the Basic Design Study.
6	30 Thu. (29 Wed.)	Discused the contents of the draft final report and the Minutes of Discussions with the officials concerned. Made an on-the-spot inspedtion of Apia Port.
7	Jul. 1 Fri. (30 Thu.)	The Minutes of Discussions on the Project was signed.
8	2 Sat. (1 Fri.)	The Study Team departed Apia for Sydney.
9	3 Sun. (2 Sat.)	Team Leader : Mr. Nagao and Mr. Yamada departed Sydney to Wellington. Dr. Ishiguro and Mr. Igari departed Sydney.

10	4 Mon. (3 Sun.)	Team Leader : Mr. Nagano and Mr. Yamada visited the Embassy of Japan in New Zealand and explained the Minutes of Discussions. Dr. Ishiguro and Mr. Igari arrived at Tokyo.
11	5 Tue. (4 Mon.)	Team Leader : Mr. Nagano and Mr. Yamada arrived at Tokyo.

APPENDIX-6 List of Interviewed Personnel

(1) Western Samoa Government Officials Concerned

Hon. Toeolesulusulu Siueva Toalepaialii	Minister of Transport
Hon. Jack Netzler	Minister of Transport
Mr. Toomata Lotu Uele	Acting Secretary, Ministry of Transport
Mr. Nofo Vaaelua	Asst. Secretary, Marine & Shipping Div., Ministry of Transport
Mr. Mose Sua	Deputy Secretary, Ministry of Foreign Affairs
Ms. Noumea Simi	Officer, Ministry of Foreign Affairs
Mr. Epa Tuioti	Deputy Financial Secretary, Treasury Department
Ms. Susana Faasau	Senior Finance Officer, Treasury Department
Mr. Falari Chan Tung	Deputy Director, Economic Development Department
Ms. Lusia Sefo	Chief Planning Officer, Economic Development Department
Mr. Noel Hawkins	Chief Civil Engineer, Public Works Department

Mr. Ishikuki Punivalu	Civil Engineer, Public Works Department
Mr. Ray Bancroft	General Manager, Western Samoa Shipping Corporation

(2) Japanese Embassy in New Zealand

Mr. Seiichi Omori	Ambassador
Mr. Kenji Shimizu	First Secretary

(3) JICA Office in Western Samoa

Mr. Kyosuke Takaoka	Resident Representative

APPENDIX- 7 Data of Natural Conditions

Table - 1 Number of Rain Days per Month

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1971	30	24	26	23	14	16	11	17	21	24	20	25	251
1972	24	24	19	24	13	13	11	11	21	18	15	21	214
1973	21	23	21	19	14	14	17	20	25	26	28	28	256
1974	25	24	25	22	15	18	16	7	15	19	21	20	256
1975	26	19	22	19	22	20	16	14	24	25	16	27	227
1976	27	23	23	19	17	17	25	10	4	13	21	21	251
1977	19	21	23	15	15	11	9	8	9	15	20	17	220
1978	30	18	28	17	19	15	4	17	12	22	24	22	182
1979	25	24	20	17	17	20	13	8	13	18	12	19	228
1980	24	19	25	17	18	18	13	18	26	24	19	18	239
1981	22	21	24	-	-	-	10	18	18	22	22	26	183
1982	27	24	25	12	15	9	12	18	9	11	14	8	184
1983	19	13	16	11	15	12	8	6	12	17	11	24	164
1984	21	22	25	21	14	14	10	13	12	14	14	24	204
1985	22	27	22	23	18	18	13	18	10	13	15	18	217
1986	22	17	22	28	19	14	18	9	19	14	11	22	215.
1987	22	-	-	-	-	-	-	-	-	-	-	-	-
Mean	24	21	23	19	14	14	13	13	15	18	17	21	218

Source: Apia Meteorological Office

Table - 2 Total Monthly Rainfall

(mm)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1977	366.9	261.9	454.9	61.9	97.9	85.6	59.4	44.1	57.1	132.7	149.5	134.0	1,905.9
1978	959.7	197.1	640.9	100.5	141.6	125.7	130.0	267.7	70.1	281.6	513.3	412.9	3,841.1
1979	209.3	270.4	332.0	100.3	244.3	119.9	208.7	51.7	236.2	348.9	247.8	391.6	2,761.1
1980	372.2	310.2	464.4	302.7	216.1	161.2	162.4	161.9	593.1	488.0	208.8	180.1	3,621.1
1981	259.3	361.3	634.9	-	-	-	67.5	75.2	198.6	350.3	438.2	596.6	2,981.9
1982	481.1	947.1	132.6	33.9	289.3	51.5	71.6	276.3	63.1	100.9	125.4	63.1	2,635.9
1983	228.5	141.1	256.5	130.9	75.8	113.8	14.5	105.2	23.6	82.6	202.4	573.7	1,948.6
1984	274.1	260.2	277.0	131.0	59.4	301.2	90.5	158.3	191.5	159.2	674.0	619.9	3,196.3
1985	440.1	379.1	354.8	240.4	288.6	141.7	96.6	84.5	71.3	86.4	65.8	145.4	2,394.7
1986	489.1	162.6	349.8	249.9	288.2	158.3	149.2	75.2	202.2	155.7	125.5	460.6	2,866.3
1987	508.8	-	-	-	-	-	-	-	-	-	-	-	-
Mean	417.2	329.1	389.8	150.2	189.0	139.8	105.0	130.0	170.7	218.6	275.1	357.8	2,872.3

Source: Apia Meteorological Office

Table - 3 Annual Occurrence Frequency of Wind Speed and Direction - Period 1951 - 1970

Speed in Knots	N	NE	E	SE	S	SW	W	NW	Total
0 - 2									37.942
3 - 13	2.158	3.480	19.230	12.265	6.262	2.029	1.882	1.620	48.926
14 - 27	0.359	0.576	10.775	0.758	0.040	0.019	0.152	0.402	13.080
28 - 40	0.010	-	0.017	-	-	-	0.007	0.012	0.046
40 -	-	-	-	-	-	-	-	0.005	0.005
Total	2.527	4.056	30.022	13.023	6.302	2.048	2.041	2.039	100.000

Source: Apia Meteorological Office

Table - 4 Annual Occurrence Frequency of Winf Direction at Apia 1951 - 1970

(%)

Month	N	NE	E	SE	S	SW	W	NW	CALM
Jan.	0.55	0.51	1.63	0.75	0.63	0.31	0.34	0.34	3.40
Feb.	0.43	0.35	1.32	0.60	0.55	0.31	0.42	0.46	2.95
Mar.	0.51	0.42	1.44	0.73	0.50	0.21	0.38	0.37	3.96
Apr.	0.15	0.31	1.67	0.82	0.31	0.15	0.17	0.23	4.38
May	0.09	0.28	2.47	1.15	0.40	0.07	0.04	0.05	3.99
June	0.05	0.19	3.28	1.34	0.44	0.05	0.05	0.02	2.76
July	0.04	0.20	3.21	1.67	0.69	0.11	0.04	0.04	2.56
Aug.	0.07	0.30	3.49	1.59	0.60	0.21	0.03	0.04	2.22
Sep.	0.03	0.30	3.56	1.34	0.37	0.07	0.03	0.02	2.54
Oct.	0.12	0.36	3.35	1.18	0.55	0.15	0.08	0.06	2.72
Nov.	0.21	0.40	2.60	0.95	0.54	0.13	0.17	0.15	3.12
Dec.	0.30	0.44	2.02	0.82	0.72	0.27	0.30	0.26	3.35
Total	2.55	4.06	30.04	13.07	6.30	2.04	2.05	2.05	37.95

Source : Apia Meteorological Office

Table - 5 Record of Hurricanes

Year	Month	Mean Wind Velocity (m/sec)	Time (hrs)	Wind Direction	Max Wind Velocity (m/sec)
1831 - 1888	Storm: Only basic records, no data for wind direction and velocity				
1889	3	30	24 (Same wind direction 8 hrs)	W - S -SE	-
1923	3	25	12	NE - NW	-
1926	1	30	2	NSE - S	-
1930	12	20	-	N	-
1946	12	23.6	-	-	-
1952	1	19.4	3	-	-
1957	12	14.4	24	ESE	38
1958	3	15	1	ENE	24
1959	2	9.8	24	N	21
1960	1	19	5	NW	26
1961	3	11.8	72	NW	26
1963	3	15	14	NW	21
1964	1	5	24	NE	19
1965	3	4.5	24	E	18
1966	1	30	9	S	41
1967	12	10.5	24	NE	21
1968	2	28.3	1.25	NW	39
1969	1	10.3	24	NNE	21.5
1970	2	11.5	24	NNE	22.5
1972	1	10.5	24	NE	26
1974	1	10.5	24	NNE	19
1975	1	9	48	SSE	26

Source: Apia Meteorological Office

APPENDIX-8 Soil Survey Report

Contents

1. Objective of the site investigation

The objective of the site investigation was to obtain the necessary data on subsoil conditions and sea depth for the basic design of the project. The area to be covered by the investigation was the site of the breakwater structure, reclamation, ferry boat terminal and planned its mooring dolphin.

2. Scope of work completed

The bathymetric survey and soil investigation were carried out at each described above in such a manner as below:

(1) Breakwater structure site

Bathymetric survey : Area surveyed was 150 x 150 sp. meters depth measured at the grid of 30 x 20 sq. meters by sonic sounding equipment

Boring : 2 Nos. of Jet Boring were completed up to 10 meter depth below seabed. Substituted S.P.T was completed at 3 meter interval.

Results of the above are exhibited in the location map (Fig. 1), jet boring log (Fig. 2), respectively.

(2) Reclamation site for container handling and storage

Bathymetric survey : Reserved pool behind of wharf was surveyed at the grid of 10 x 10 sq. meters.

Boring : 2 Nos. of rotary borings with S.P.T and undisturbed sampling were carried out to the depth of 25 meters and 15 meters below seabed respectively. Borehole log is exhibited in the BH log. (Fig. 3)

(3) Ferry boat terminal & mooring dolphin site

Bathymetric survey : As survey results being available (completed in 1964), sea depth was referred from the chart.

Boring : 2 Nos. of rotary borings with S.P.T and undisturbed sampling were carried out to the depth of 25 meters and 15 meters below seabed respectively. Borehole log is exhibited in the Fig. 4

(4) Laboratory soil test

5 Nos. of undisturbed samples and 7 Nos. of disturbed samples were tested according to the requirement of the foundation of the structural design. The laboratory soil test schedule is shown in the table below (Table-1).

Table 1 Schedule of Laboratry Soil Test

Boring / depth	Sieve	Gs	LL/PL	U.C.	Cc
BH-4 6.00m	o	o	o		
BH-4 5.00m	o	o	o	o	o
BH-4 10.00m	o	o	o	o	o
BH-5 7.00m	o	o	o	o	o
BH-5 10.00m	o	o	o	o	o
BH-5 15.00m	o	o	o		
BH-6 11.50m	o	o	o		
BH-6 6.50m	o	o	o		
Soro Soro Beach Sand	o	o			
Coral Sand	o	o			
Crushed Sund	o	o			

Table 2 Test Data Summary - Foundation Material

SHEET____ OF____

PROJECT Apia Port Development R/D, West Samoa - LOCATION ____ BORING NO. ____ CHECKED BY ____

SAMPLE NO.	DEPTH IN METER	NATURAL WATER CONTENT w %	SPECIFIC GRAVITY G_s	WET DENSITY γ_t (g/cm³)	INITIAL VOID RATIO e	DEGREE OF SAT S_r %	MECHANICAL ANALYSIS: GRAVEL %	SAND %	FINES %	D_{10} %	COEFF. OF UNIFORM.	COEFF. OF CURVAT.	ATTERBERG LIMITS: LIQUID LIMIT w_L %	PLASTIC LIMIT w_P %	PLAST. INDEX I_P	CLASSIFICATION U.S.C.S.	SHEAR TEST: UNCONFINED COMPRESSION q_u kg/cm²	E_{50} kg/cm²	S_t	T_x or D_s: C kg/cm²	φ DEG.	TYPE TEST	CONSOLIDATION: P_c kg/cm²	C_c	REMARKS
BH-4	5.00 6.00	53.9	2.930	1.668	1.703	92.7	3.5	27.0	69.5	-	-	-	58.9	25.2	33.7	CH	0.181	2.5	-				0.33	0.41	
																	0.196	3.2							
BH-4	6.00 7.00	49.4	2.903	1.741	1.492	96.1	9.0	43.5	47.5	0.0017	70.6	6.7	NP	NP	-	SM	0.168	5.3	-				0.60	0.37	
																	0.155	3.0							
BH-4	8.00 9.00	54.0	2.975	1.749	1.619	99.2	0.0	13.5	86.5	-	-	-	51.3	24.1	27.2	CH	0.893	27.1	-				0.54	0.41	
																	0.510	12.4							
BH-4	10.00 11.00	57.4	2.976	1.702	1.753	97.4	0.0	8.0	92.0	-	-	-	59.5	25.0	34.5	CH	1.110	46.3	-				1.45	0.60	
																	0.983	39.3							
BH-5	7.00 8.00	52.4	2.929	1.743	1.560	98.4	2.5	37.0	60.5	-	-	-	53.7	25.4	28.3	CH	0.403	10.6	-				0.62	0.48	
																	0.479	13.7							
BH-5	10.00 10.30	55.8	2.968				4.0	42.0	54.0	-	-	-	55.3	25.8	29.5	CH									
BH-5	15.00 15.30	56.3	2.982				2.0	42.0	56.0	0.0031	25.8	2.0	NP	NP	-	M									
BH-6	6.50 6.80	53.0	2.916				6.5	39.0	54.5	0.0018	50.0	4.2	NP	NP	-	M									
BH-6	11.50 11.80	54.9	2.973				9.5	41.5	49.0	0.0026	50.0	2.8	NP	NP	-	M									
Soro Beach Sand	Soro Sand	-	3.305	-	-	-	0.0	90.5	9.5	0.080	2.4	1.7	N.P		-	S-M									
Coral Sand		-	2.919	-	-	-	42.0	48.0	10.0	0.070	31.4	1.4	N.P		-	S-M									
Crushed Sand		-	3.107	-	-	-	31.5	55.0	13.5	0.040	40.0	2.8	N.P		-	SM									

NOTES U.S.C.S.—Unified Soil Classification System

q_u —Uncont. Compr. Strength
E_{50} —Mean Modulus of Deformation
S_t —Sensitivity Ratio

Tc— Triaxial Compression
Ds— Direct Shear
C — Cohesion
φ — Friction Angle

UU — Unconsolidated Undrained
CU — Consolidated Undrained
CD — Consolidated Drained

P_c — Preconsolidation Pressure
C_c — Compression Index

3. Subsoil profile

(1) Breakwater site

The breakwater construction site is located along the foot of the east reef at the gate of Apia Bay. The subsoil is mainly composed of grey to dark grey, very fine sand with a trace to some calcareous silt. The density increases with depth. No suspended silt is observed on the sea bed.

(2) Reclamation site for container handling and storage site

The constitution of the subsoil at the site is composed of suspended silt on top of the seabed, dark grey, silty sand with a little sand and a few thin layers composed of coral fragments up to the depth of 22.30 meters. Coral and cemented sand beneath the suspended silt, classified in the same group of layers as on the existing reef, overlies the sandy silt around the half way in the reserved pool behind the wharf, as it was dredged out in the course of wharf construction. The thickness of the layer is changeable depending on the location from 0.5 meter to 2.5 meters. The other horizon of coral and cemented sand overlies the basement basalt in places. Black, a weathered and decayed basalt underlies over the site at the depth of 24.00 meters below the seabed. The basalt is confirmed to be a reliable supporting layer for pilings. The subsoil cross section is exhibited in Fig. 5, 6. The mechanical and physical properties of the sandy silt layer are described in the next clause.

(3) Ferry boat terminal and mooring dolphin site

The composition of the subsoil at the site is similar to the reclamation site. The mechanical and physical properties of the subsoil are consequently judged to be the same features as those of the layer appearing in the reclamation site. The subsoil cross section is exhibited in Fig. 7.

4. The mechanical and physical properties of the each layer

(1) Coral and cemented sand layer (Cap rock)

- Unified soil classification system : GP & cemented sand
- N. value : 25 - 50
- Unconfined compression strength : Not more than 100 kg/cm^2 at the core of the cemented sand.

(2) Sandy silt layer

- Unified soil classification system : CL-ML & SM-SC
- N. value : 0 - 19
- Spesific Gravity : 2.90 - 2.98
- Density : 1.67 - 1.75 g/cc
- Cohesive strength with depth : Cu = 0.47 Z (Z 1.0 in meter)
- Consolidation index : 0.37 - 0.60
- Coefficient of consolidation : 1.5 - 3.0×10^3 (cm^2/day)
- Coefficient of volume compressibility : 4.4 - 6.4×10^{-2} (cm^2/kg)

Each laboratory soil test result is summarized in the test data summary sheet. (Table - 2)

(3) Basement basalt layer

According to the soil investigation done in 1987, the compressive strength of the basalt core is reported to be 300 kg/cm^2 and more. Though a fresh basalt is very hard with a compressive strength over 2,000 kg/cm^2, the top layer of the basement basalt over the site is weathered and decayed to a 1 to 2 meter thickness with numerous fissures as well as bouldered mass. This layer is classified in to "Salavi Volcavics" groups in the geological age of Penultimate Glaciation or Last Interglacial, to early Last Glaciation.

5. Discussions of the foundation of structures

(1) Piling foundation

Piling foundation would be recommended for the structure of the extention of the wharf and mooring dolphin. The subsoil conditions at both sites are summarized in the following manner:

- Seabed to 3.00 m — Suspended silt $N = 0$
- 3.00 m to 16.00 m — Soft, sandy silt $\bar{N} = 5$
- 16.00 m to 23.00 m — Soft to stiff sandy silt and medium dense silty sand $\bar{N} = 13$
- Below 23.00 m — Weathered basalt $N > 50$

Long term bearing capacity of a pile, after taking 3 as a safety factor, is given as the following formula:

$$Q = 1/3\ [40\ N \cdot AP + 1/5\ Ns \cdot As + 1/2\ Nc \cdot Ac]$$

Where Q (ton) : Long-term bearing capacity of a pile

N, Ns & Nc : N value of the bearing point, of the granular material and of the cohesive material respectively.

Ap (m^2) : Bottom area of the piles

As & Ac (m^2) : Area of the perimeter of the pile in the granular material and in the cohesive material respectively.

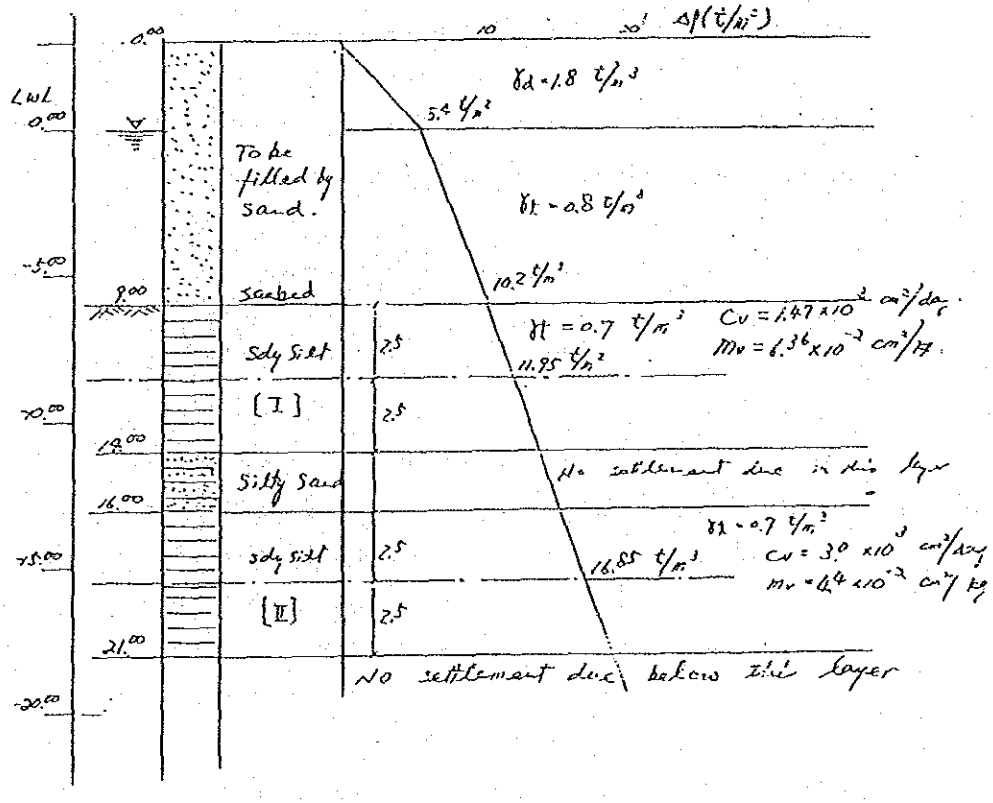
Long term bearing capacity of a pile is obtained below as per the pile diameter:

Long term bearing capacity of pile	Pile diameter (mm)
130 (t/pile)	500
180 (t/pile)	600
250 (t/pile)	700
330 (t/pile)	800

Compensation (reduction) due to jointing of a pile shall be considered depending on the number of piles to be jointed at site.

(2) Settlement

A certain settlement if anticipated due to the reclamation at the reserved pool behind the wharf, which is to be extended to the container handling yard. Schematic subsoil constitution and soil mechanical parameter at the reclamation site are shown as below:



The formula to obtain the consolidation settlement and time required to achieve 95% of it is given as below:

$$S = mv \cdot H \cdot \Delta p$$

$$t = \frac{H \quad Tv}{Cv}$$

Where, S : Settlement

C : Coefficient of consolidation (cm^2/day)

H : Thickness of layer due consolidation (cm)

Δp : Pressure increase (kg/cm^2)

Tv : Total settlement (cm)

mv : Coefficient of volume compressibility (cm^2/kg)

Tv : Time function corresponding to the consolidation performance

a) Calculation of settlement

From the schematic subsoil condition for settlement calculation in Fig. 10, the following calculations proceed:

Layer I (Seabed to 5.00 m)

$S1 = 6.4 \times 10^{-2} (cm^2/kg) \times 500 \text{ cm} \times 1.2 \text{ kg/cm}^2$

$= 38.4$ cm

Layer II (7.0 - 12.0 m)

$S2 = 4.4 \times 10^{-2} \times 500 \times 1.7$

$= 37.4$ cm

Total settlement due = Layer I + Layer II

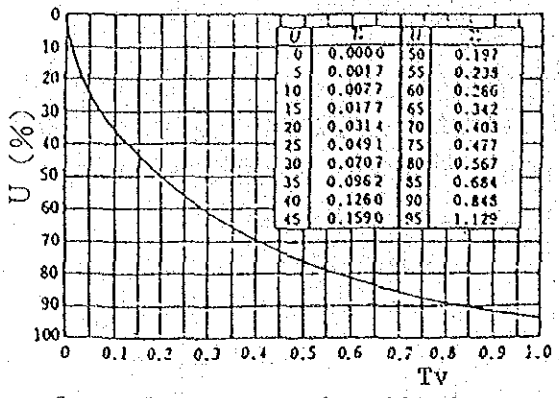
$= 75.8$ cm

b) Time required to reach 95% of consolidation settlement.

$$\text{Layer I, } t1 = \frac{(500)^2 \times Tv}{1.47 \times 10^3 \text{ cm}^2/\text{day}}$$

$$\text{Layer II, } t2 = \frac{(500)^2 \times Tv}{3.0 \times 10^3 \text{cm}^2/\text{day}}$$

Time function (Tv) corresponding to the consolidation performance is given as in the table below.



U	Tv	U	Tv
0	0.0000	50	0.197
5	0.0017	55	0.238
10	0.0077	60	0.286
15	0.0177	65	0.342
20	0.0314	70	0.403
25	0.0491	75	0.477
30	0.0707	80	0.567
35	0.0962	85	0.684
40	0.1260	90	0.848
45	0.1590	95	1.129

Therefore, Layer I, t1 = 192 days

Layer II, t2 = 94 days

As the settlement proceeds at each layer simultaneously, it takes 200 days to complete 95% of the settlement. The settlement due in the backfill sand above the seabed only occurres immediately at the stage of the construction, which is considered as instant settlement.

c) Bearing capacity

Ultimate subsoil bearing capacity below the seabed for the shallow founded rock mound is modified from Terzhagi's formula of soil bearing capacity for shallow foundation.

$$= \alpha \cdot C \cdot Nc + \gamma \cdot Z \cdot Nq + \beta \cdot \gamma \cdot B \cdot N_\gamma \ (t/m^2) \quad (1)$$

As for cohesive soil, angle of internal friction (ϕ) is measured to $\phi = 0^\circ$. Hence the bearing capacity factors, Nc = 5.7, Nq = 1.0 and $N\gamma = 0$ are obtained from the standard graph respectively.

Substitute the above to formula (1), then formula (1) is shown as, $= 5.7\alpha \cdot C + \gamma \cdot Z$ (2)

The consistency of subsoil at the site is soft, and partial failure may take place instead of total failure for the rock mound.

Then, cohesion C is replaced to 2/3 Cu,

Formula (2) is shown as, $q' = 3.8\alpha \cdot Cu + \gamma \cdot Z$ (3)

The shape factor α is adopted to 1, while Cu = 0.47 z based on the depth and cohesion relation (Fig. 8), then the ultimate subsoil bearing capacity for the rock mound is shown

$q' = 1.79Z + \gamma \cdot Z$, when, $Z > 1.0$ m (4)

While, the design load of the mound rock is given as below:

Unit weight of rock in the water : $\gamma = 1.3$ t/m^3

Effective void ratio of mound rock: $e = 0.3$

Contact pressure of rock mound : $p = 1.3 \times 0.3 \times 2/3 \times h$

(h: height of mound)

Bearing capacity at the depth of 3.00 meters below the seabed is = 7.47 t/m^2

Contact pressure of rock mound with the top elevation 6.00m LWL and 3.00 meters into seabed is P = 2.34 t/m^2.

Then, safety factor $Fs = q'/p = 3.19 > 3$

Therefore, the stability of the proposed rock mound would be safe to in the event of the partial failure or allowable bearing capacity of the subsoil would be permissible to the designed pressure of the rock mound.

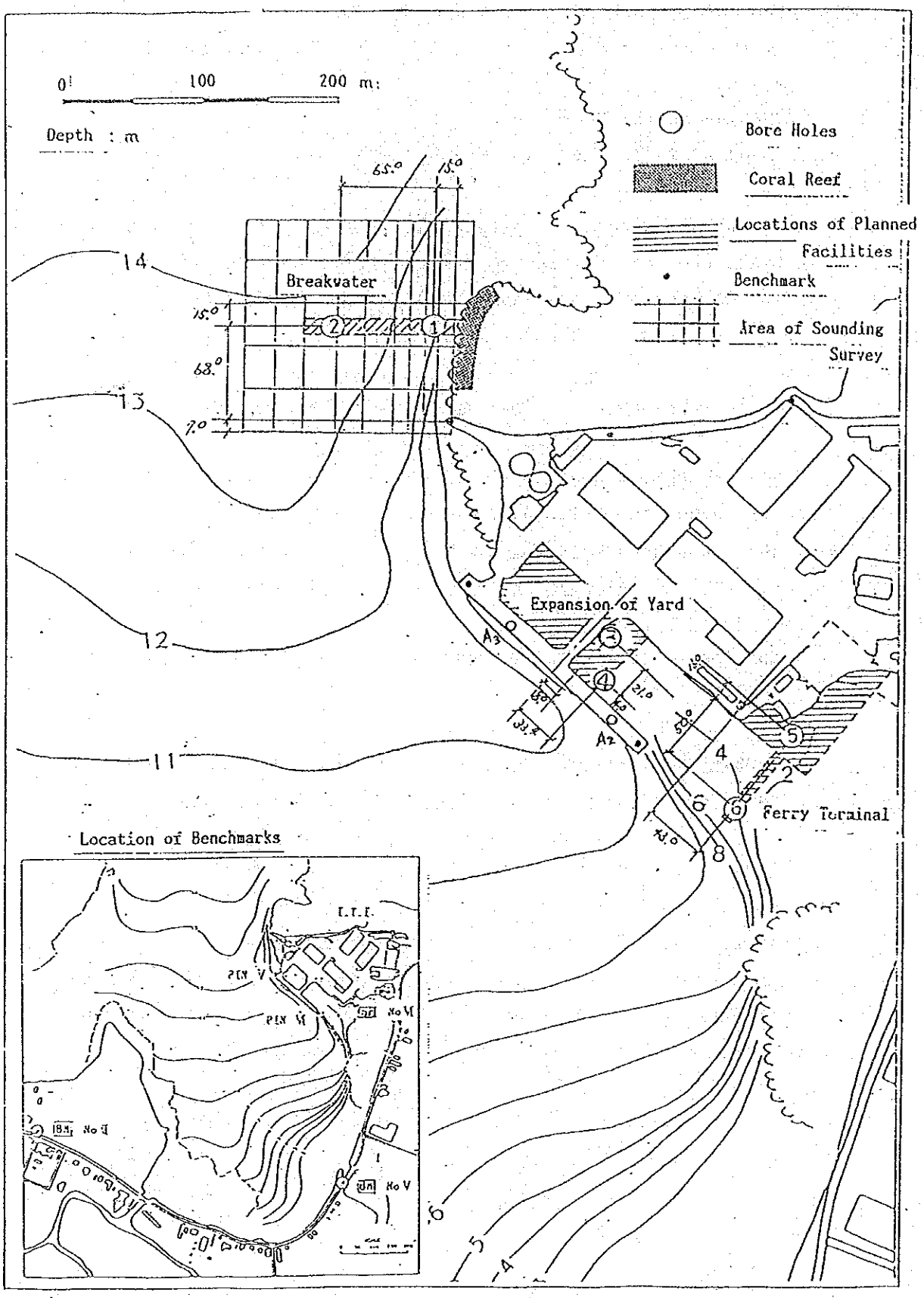


Fig. 1 Location of Natural Condition Survey

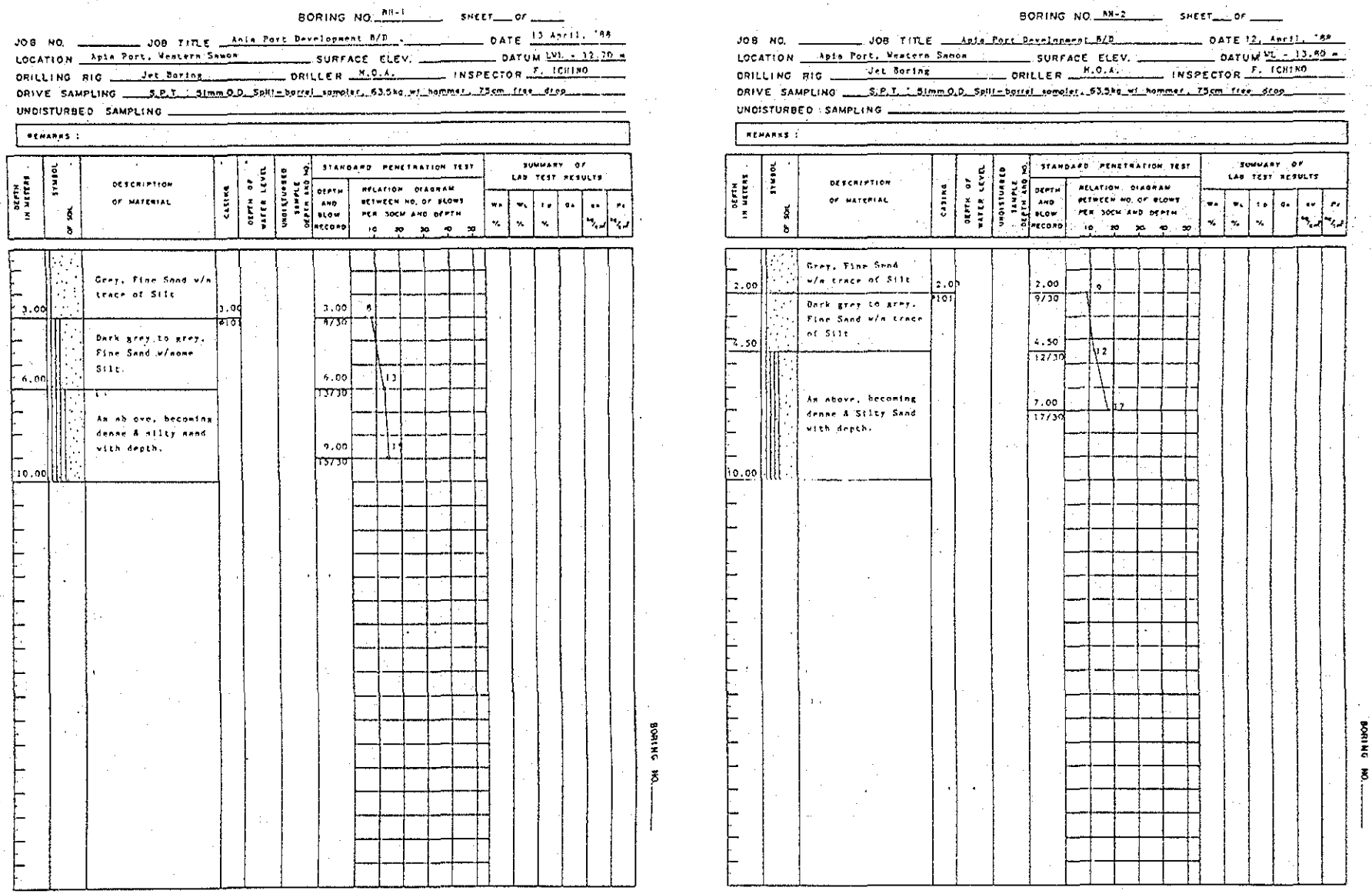


Fig. 2 Subsurface Exploration Record (BH-1 & BH-2)

BORING NO. BH-3 SHEET OF

JOB NO. JOB TITLE Apia Port Development B/D DATE 12 - 14 April '88
LOCATION Apia Port, Western Samoa SURFACE ELEV. DATUM LWL - 2.40 m
DRILLING RIG ER - 50 DRILLER M.O.A. INSPECTOR F. ICHINO
DRIVE SAMPLING S.P.T. : 51mm O.D. Split-barrel sampler, 63.5kg wt hammer, 75cm free drop
UNDISTURBED SAMPLING TWS : 75 mm I.D. liner - 1.00 m
REMARKS :

DEPTH IN METERS	SYMBOL OF SOIL	DESCRIPTION OF MATERIAL	CASING	DEPTH OF WATER LEVEL	UNDISTURBED SAMPLE DEPTH AND NO.	STANDARD PENETRATION TEST: DEPTH AND BLOW RECORD	STANDARD PENETRATION TEST: RELATION DIAGRAM BETWEEN NO. OF BLOWS PER 30CM AND DEPTH (10 20 30 40 50)	SUMMARY OF LAB TEST RESULTS: Wn %	WL %	Ip %	Gs	γd t/m³	Pc kg/cm²
1.00		Suspended Silt											
		Coral & Cemented Sand.	2.00 φ101			2.00 30/30							
3.20						5.00 3/30							
		Dark grey, Silty Sand w/a trace to some Silt.			6.00 TWS-1								
						10.00 4/30							
15.00						15.00 9/30							

BORING NO. BH-4 SHEET OF

JOB NO. JOB TITLE Apia Port Development B/D DATE 8 - 11 April '88
LOCATION Apia Port, Western Samoa SURFACE ELEV. DATUM LWL - 2.20 m
DRILLING RIG ER - 50 DRILLER M.O.A. INSPECTOR F. ICHINO
DRIVE SAMPLING S.P.T. : 51mm O.D. Split-barrel sampler, 63.5kg wt hammer, 75cm free drop
UNDISTURBED SAMPLING T.W.S. 75 mm I.D.
REMARKS :

DEPTH IN METERS	SYMBOL OF SOIL	DESCRIPTION OF MATERIAL	CASING	DEPTH OF WATER LEVEL	UNDISTURBED SAMPLE DEPTH AND NO.	STANDARD PENETRATION TEST: DEPTH AND BLOW RECORD	STANDARD PENETRATION TEST: RELATION DIAGRAM BETWEEN NO. OF BLOWS PER 30CM AND DEPTH (10 20 30 40 50)	SUMMARY OF LAB TEST RESULTS: Wn %	WL %	Ip %	Qu	γd t/m³	Pc kg/cm²
0.70		Suspended Silt											
		Dark grey, Sandy Silt w/a little to some Fine Sand. 3.30 to 3.50, Coral fragments	4.00 φ101			4.00 2/30							
5.00		Dark grey, Silty Sand 6.00 to 6.20, Shelly coarse sand.			5.00 TWS-1 6.00 TWS-2	5.00 7/30 6.00 5/30							
7.00		Dark grey, Sandy Silt w/a little sand 9.00 - 9.10, Coral fragments.			8.00 TWS-3	7.00 3/30 9.00 3/30							
9.50													
10.00		Grey, Sandy Silt			10.00 TWS-4	11.00 4/30 12.00 7/30 13.00 3/30 14.00 8/30 15.00 8/30 16.00 12/30 17.00 10/30 18.00 12/30 19.00 12/30 20.00 13/30 21.00 17/30 22.00 19/30 23.00 50/8							
22.00		Dark grey, Sandy Silt w/a trace of Sand, becoming homogeneous silt and dense with depth.											
22.1		Grey, Sandy Silt											
23.5		Coral fragments & Shells.											
25.00		Black, Weathered basalt & Pebbles.											

Fig. 3 Subsurface Exploration Record (BH-3 & BH-4)

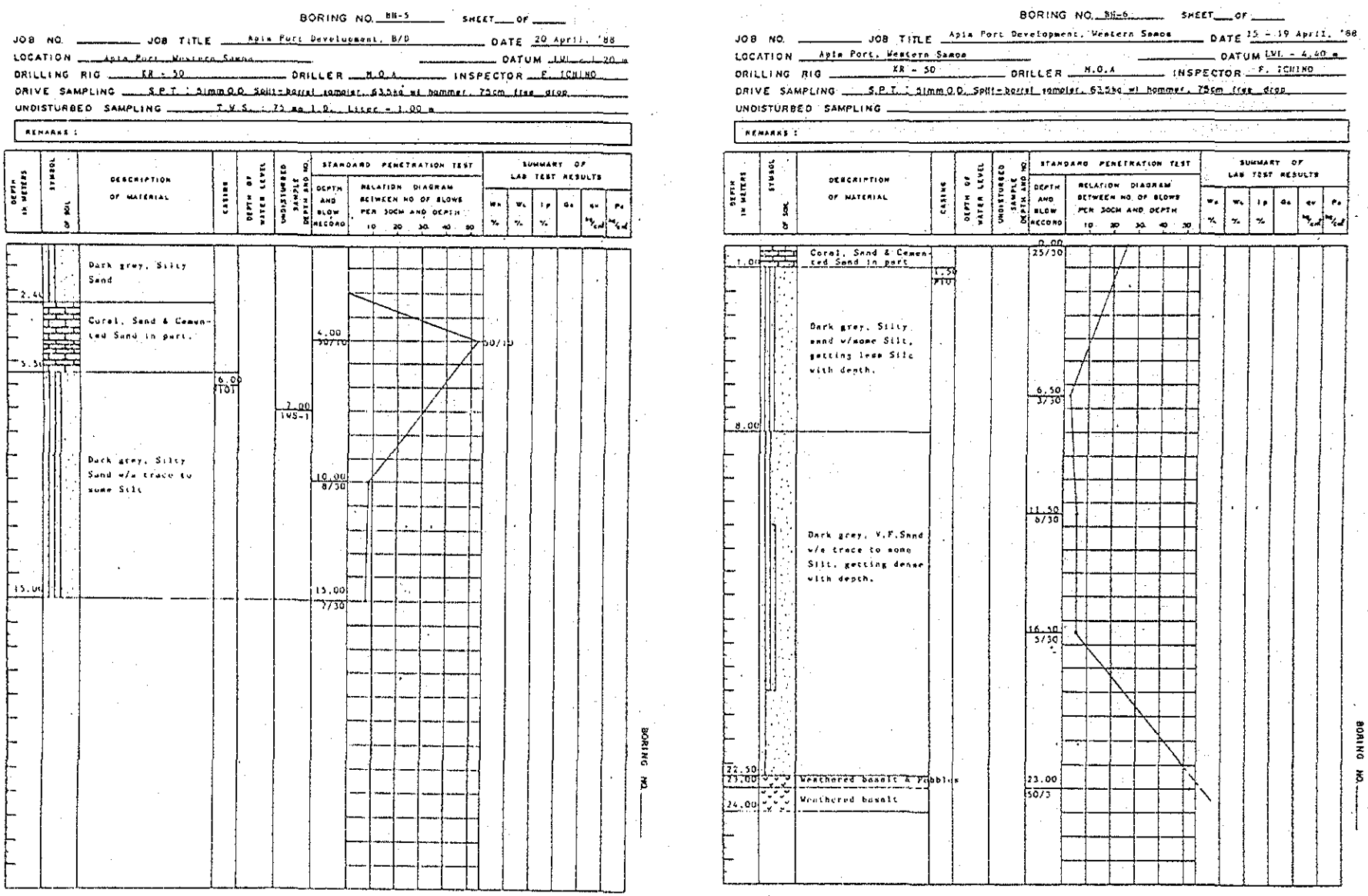


Fig. 4 Subsurface Exploration Record (BH-5 & BH-6)

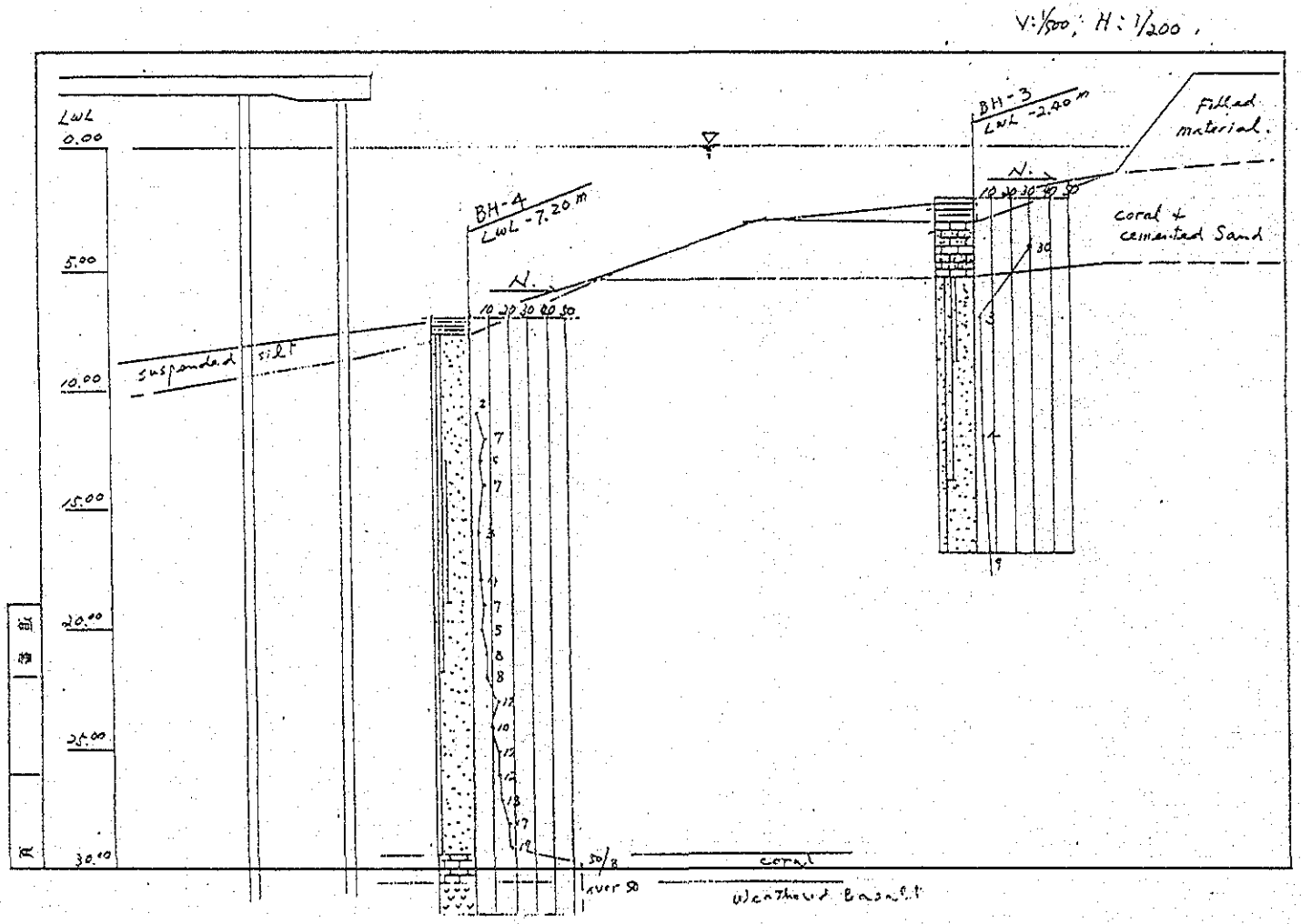


Fig. 5 Subsoil Profile (BH-3 + BH-4)

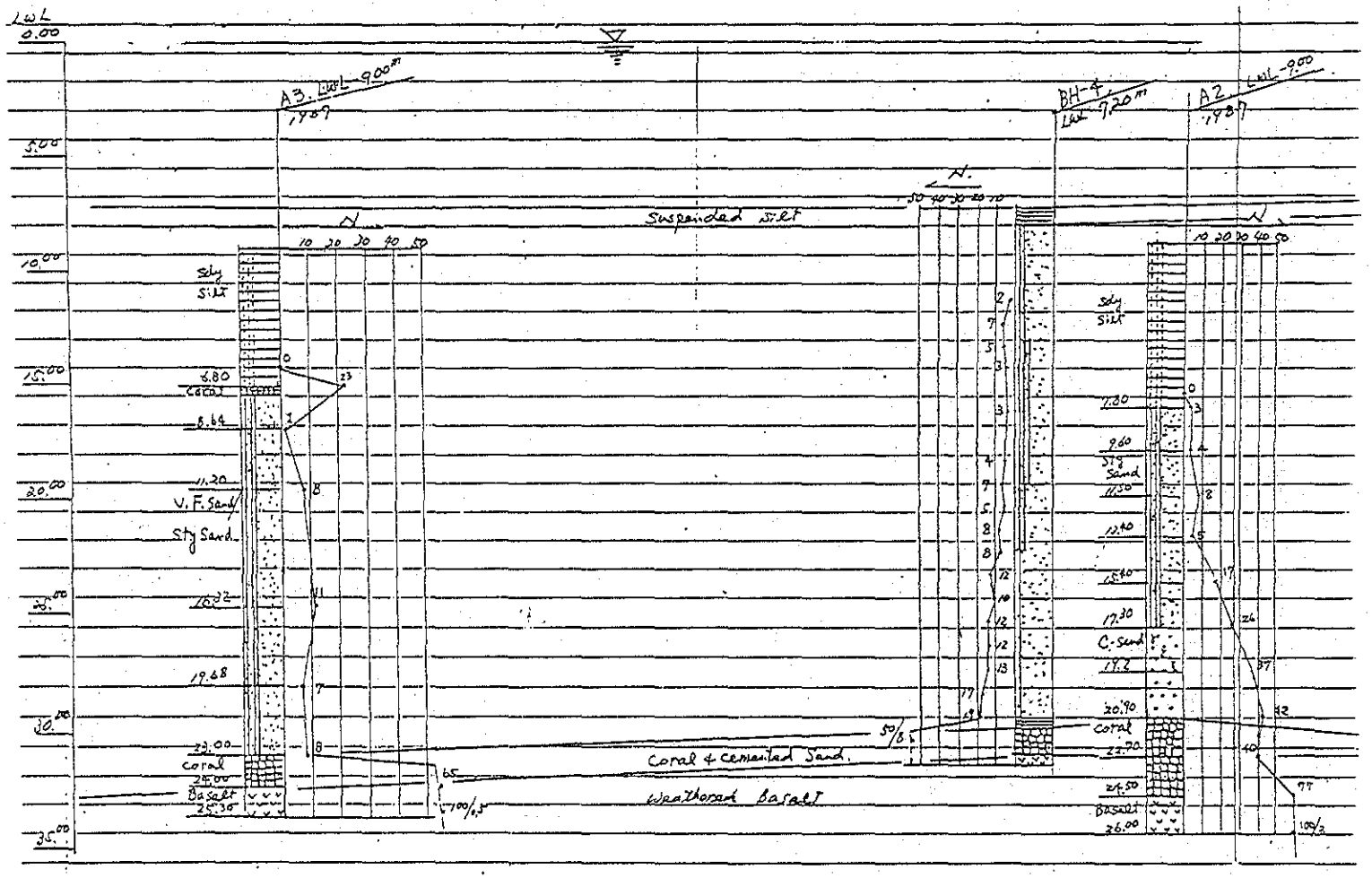


Fig. 6 Subsoil Profile (BH-4, A2, A3)

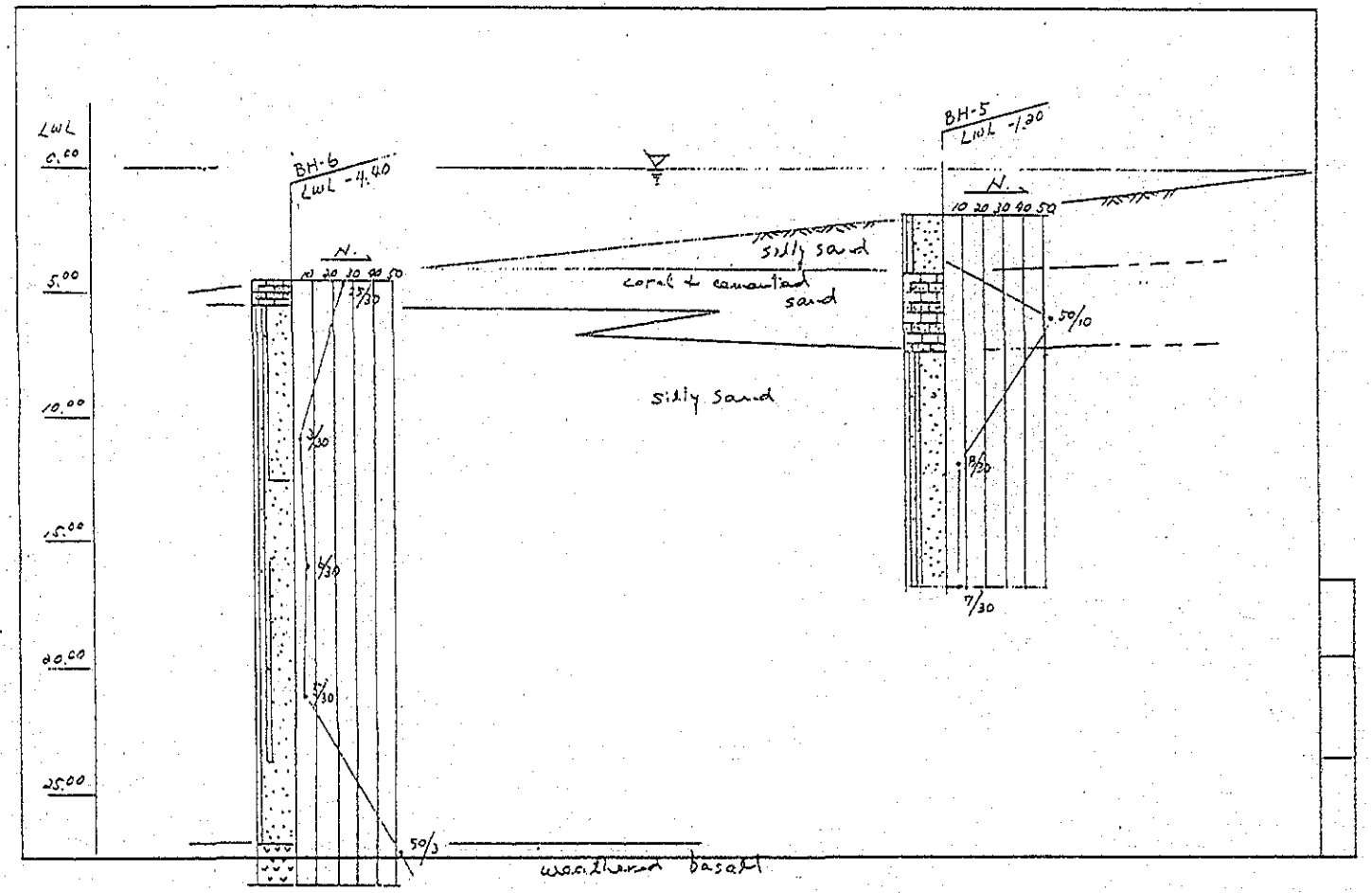


Fig. 7 Subsoil Profile (BH-5 + BH-6)

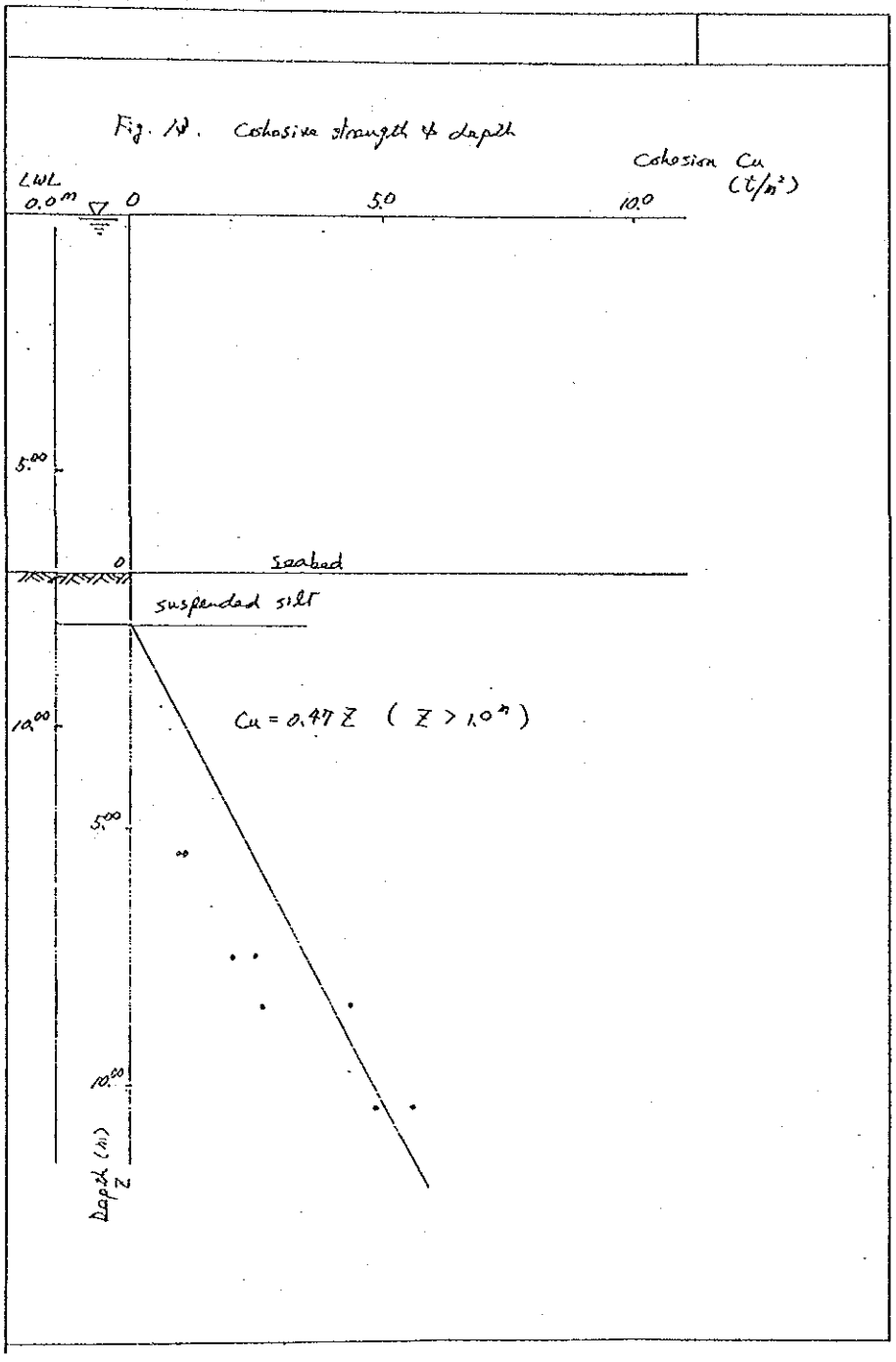


Fig. 8 Depth and Cohesion Relation

APPENDIX -9 Loads on Ferry Dolphin

(1) Tractive Force to the Bollard

The tractive force is determined on the technical standard for port and harbour facilities in Japan.

For the size of ship as 500 to 1000 GT the tractive force to the bollard is 25 T.

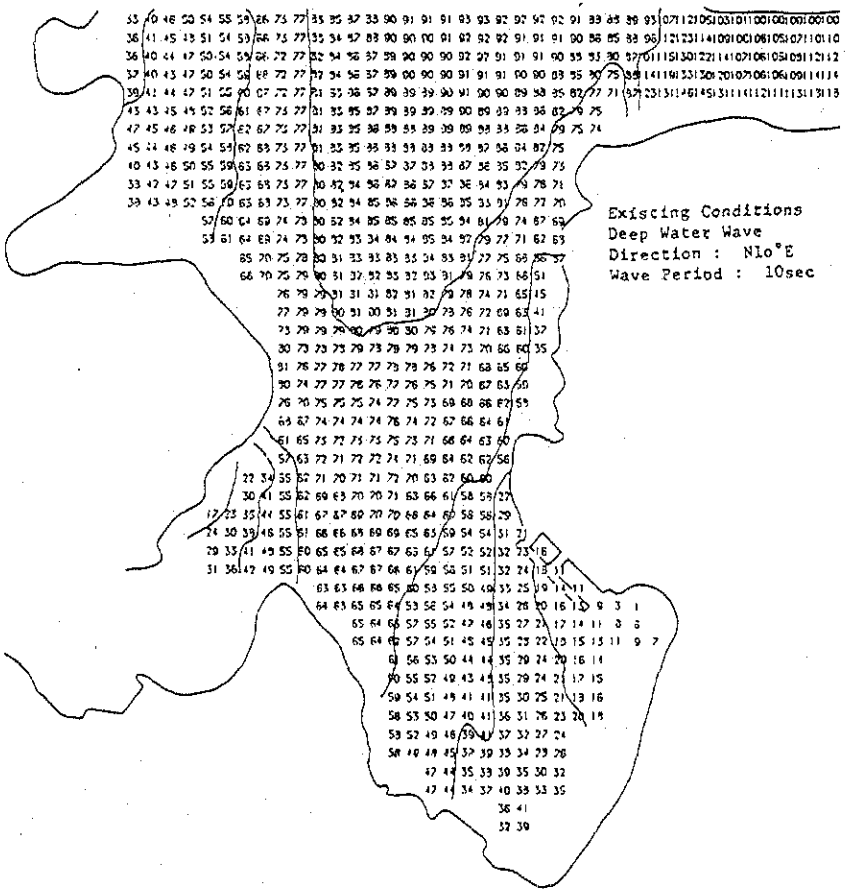
(2) Berthing Energy

The effective berthing energy of a ship is calculated by the following equation.

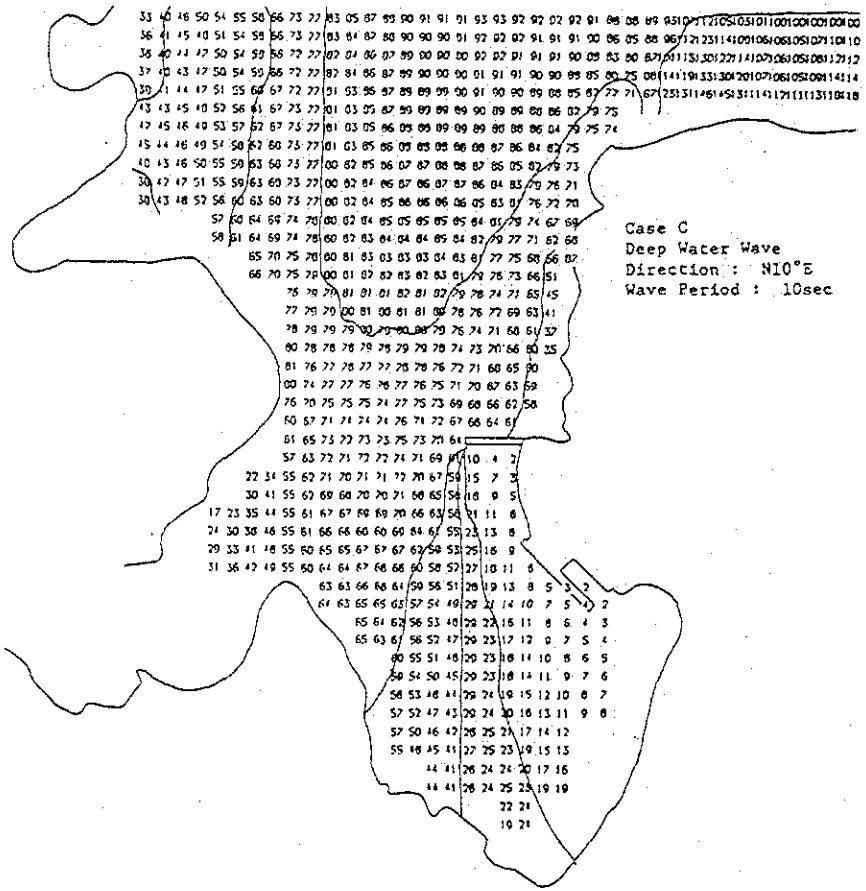
$$E = \frac{WV^2}{2g} \cdot \frac{1}{1+(L/R)} \quad \cdots\cdots\cdots\cdots\cdots(1)$$

where E : Effective berthing energy of ship (t.m)
g : Acceleration of gravity, g=9.8 m/sec^2
W : Virtual weight of ship (t)
V : Berthing velocity of ship (m/s)
L : Length from the point of contact to the center of gravity of the ship as measured parallel to the wharf (m)
R : Radius of gyration about the virtical axis through the center of gravity of the ship in a horizontal plane (m)

In case of the size of ship 1000 DW and V=15 m/sec, the effective berthing force is 1.2 t.m from the equation (1).



Wave Height Ratio (Existing Conditions)



Wave Height Ratio (Case C)

APPENDIX-11 Bollard Pull of Tugboat

1. Design Conditions

(1) Size of vessel	:	10,000 GT (General Cargo)
(2) Towing speed	:	5 kt (calm water)
		* Assumed that if a tugboat can tow this vessel at 5 kt it is enough to assist the berthing of the vessel.
(3) Wind speed	:	10 m/s direction: 30 degres

2. Vessel

. Dead weight tonnage	:	15,000 DWT
. Displacement volume	:	19,662 m^3
. Cb	:	0.63
. Length (Lpp)	:	162 m
. Breadth	:	21.7 m
. Draft	:	9.1 m

* Based on the Technical Standards for port and harbour facilities in Japan.

3. Tractive Force

(1) Water Force

1) Friction Force (RF)

$V = 5kts = 2.572$ m/s

$Fn = 2.572 / \sqrt{L.g} = 0.065$

$RF = 1.025 \times \lambda \times S \times 2.572^{1.825}$

$= 0.1392 + 0.258/(2.68 + 162) = 0.1408$

$S = 162 \times 21.7 \times (1.22 \times 9.1/21.7 + 0.46) \times (0.63 + 0.765)$

$= 4764.8$

$RF = 1.025 \times 0.1408 \times 4764.8 \times 5.607$

$= 3885.7$Kg

RF = 5783.6Kg (with the adhesion of sea shell : x 1.5)

2) Added Force (RW)

$Rw = 1/2 \times 104.5 \times 19662^{2/3} \times 2.572^2 \times 0.0018$

$= 453.4$Kg

3) Tatal Water Force

$RM = RF' + RW = 6237.0Kg$

(2) Wind Forde

$RA = 1/2 \ Ca \cdot \rho \ (A \cos^2 \theta + B \sin^2 \theta) \ v^2$

$Ca = 1.33$

$\rho = 0.123 Kgs^2/m^2$

$\theta = 30^\circ$

$A = 30m^2$

$B = 1705.9m^2$

$V = 10$ m/s

$Ra = 0.5 \times 1.33 \times 0.123 \times 444.5 \times 10^2$

$= 3676.7Kg$

(3) Total Force

$RM + RA = 9913.7Kg$

4. Tugboat

. Gross tonnage	:	130 GT (184.45 GRT)
. Displacement volume	:	318 m^3
. Length (Lpp)	:	24.0 m
. Breadth	:	8.3 m
. Draft	:	2.6 m

5. Resisting Force of Tugboat (RT)

$RT = 500$ kg

* It is need to take some allowance due to be large Froud Number for the tugboat.

6. Total Towing Force (R)

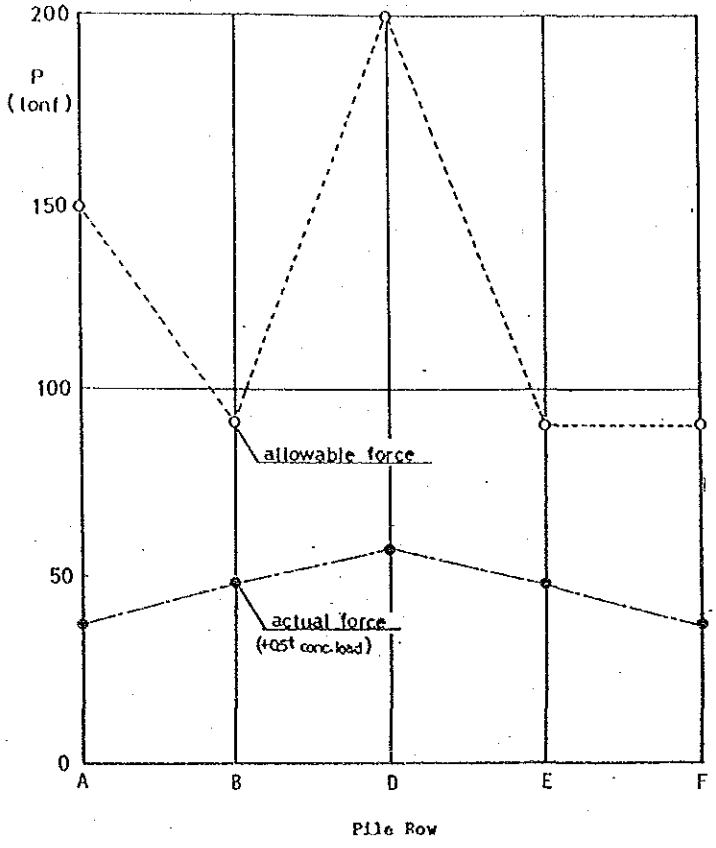
$R = RM + RA + RT = 10.4$ t

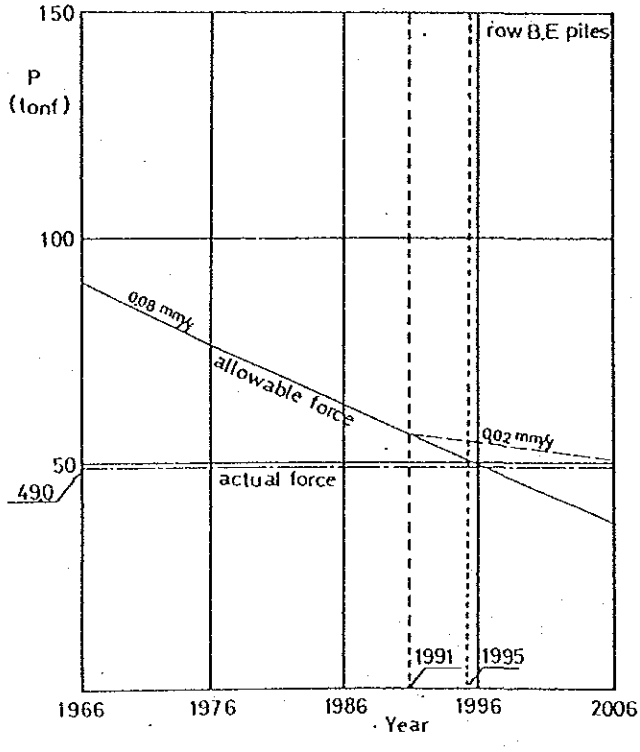
7. Bollard Pull (Tb)

$Tb = R/\tau$ τ: Ratio of the decrease at towing (0.75)

$= 10.4/0.75 \fallingdotseq 14.0$ ton

APPENDIX-12 Remaining Serviceable Life of Main Wharf





APPENDIX-13 Drawing of Basic Design

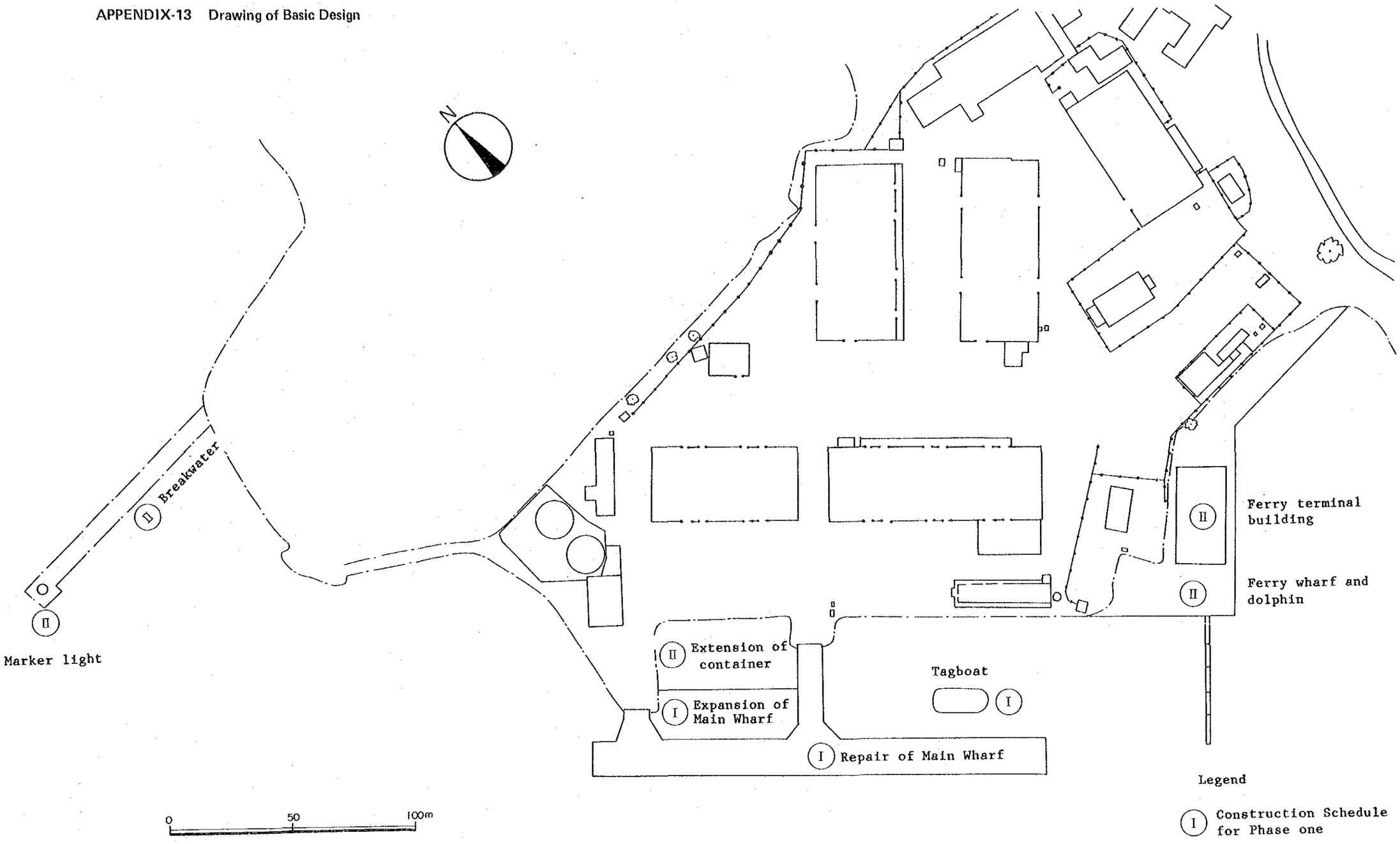
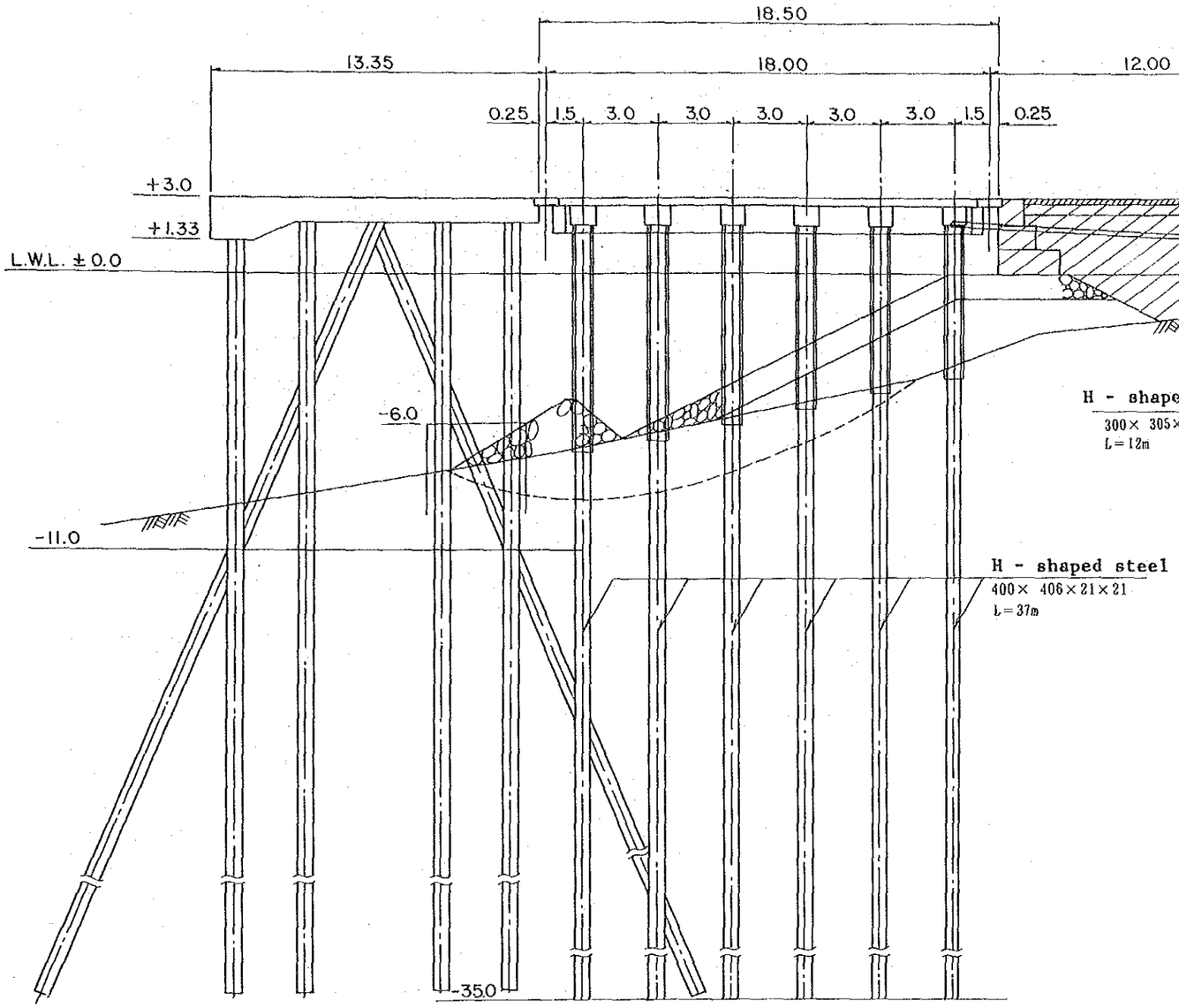
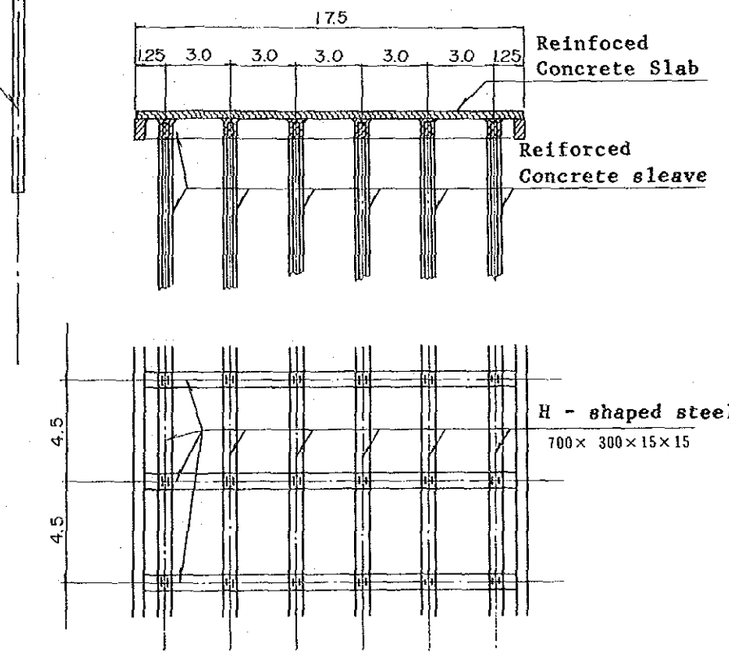


Fig. 1 Layout of Maintenance Facilities



(1) Cross Section of Extended Pier



(2) Supperstructure
of Extended Pier

Fig. 2 Expansion of the Main Wharf

APPENDIX-14 Port Revenue

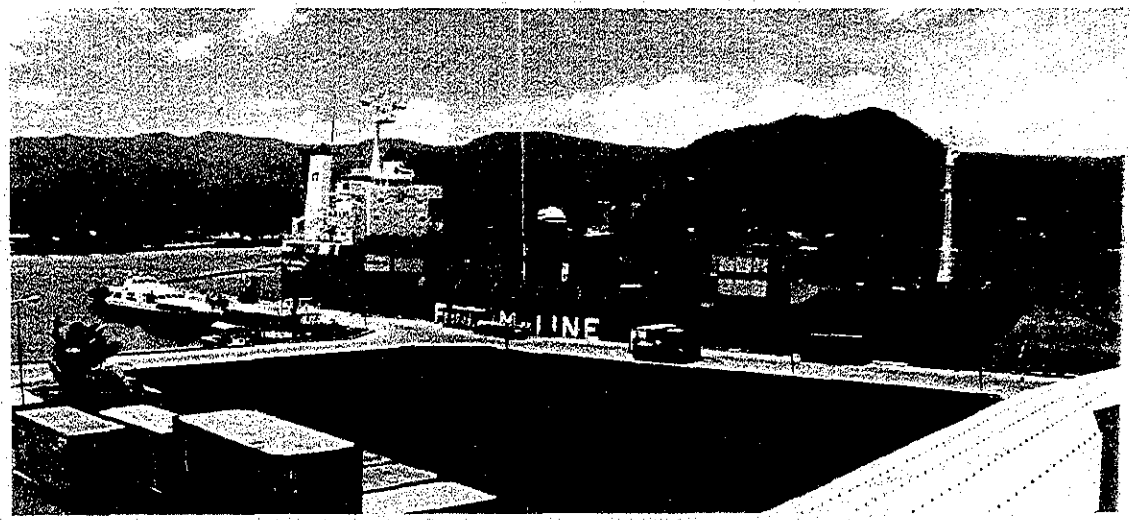
	1985	1986	1987	1991
*Light Dues and Pilotage	120	120	110	106
*Port Dues	75	100	75	79
*Wharfage	240	288	280	371
*Strage of Cargo	240	560	510	558
*Strage of Container	30	10	10	17
*Berthage and Dockage	24	70	70	59
*Levies	174	168	135	140
*Miscellaneous	90	55	70	128
Total	993	1,363	1,260	1,458

Note : 1) Revenue for last 3 years is the amounts of central government budget.

2) Revenues for 1991 is estimated with the present port tariff.

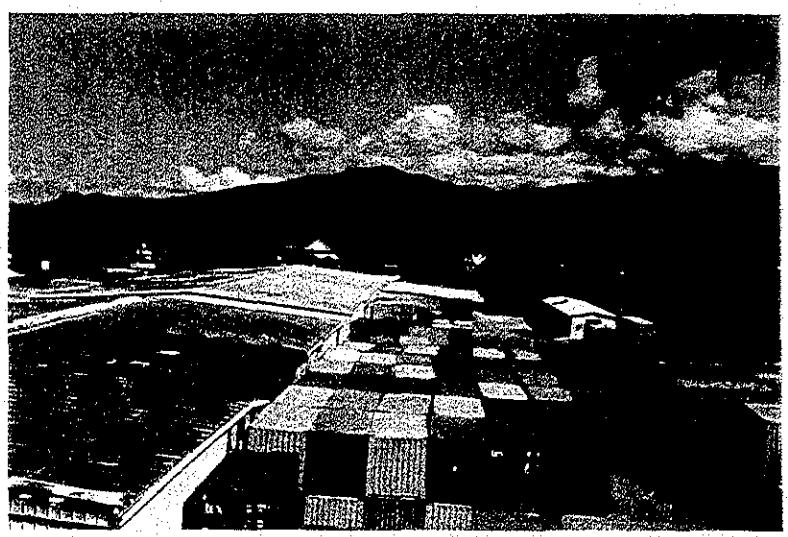
APPENDIX-15 Photographs

Overall View of the Project Site

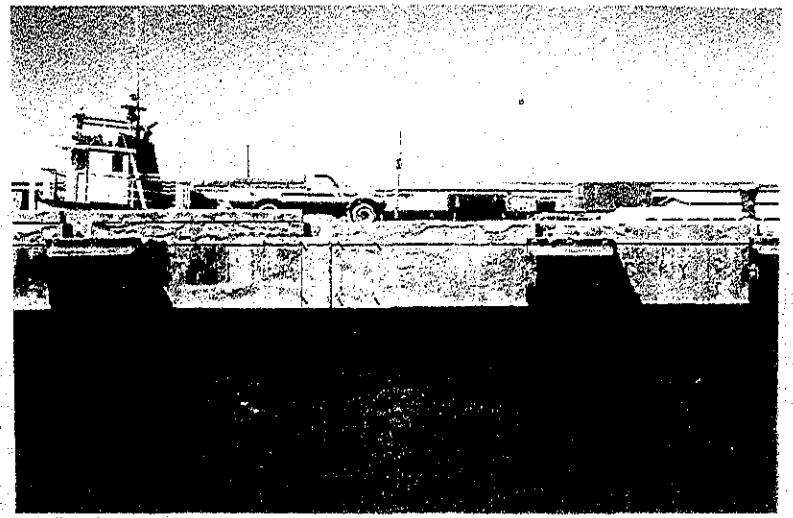


Sea Area behind the Main Wharf

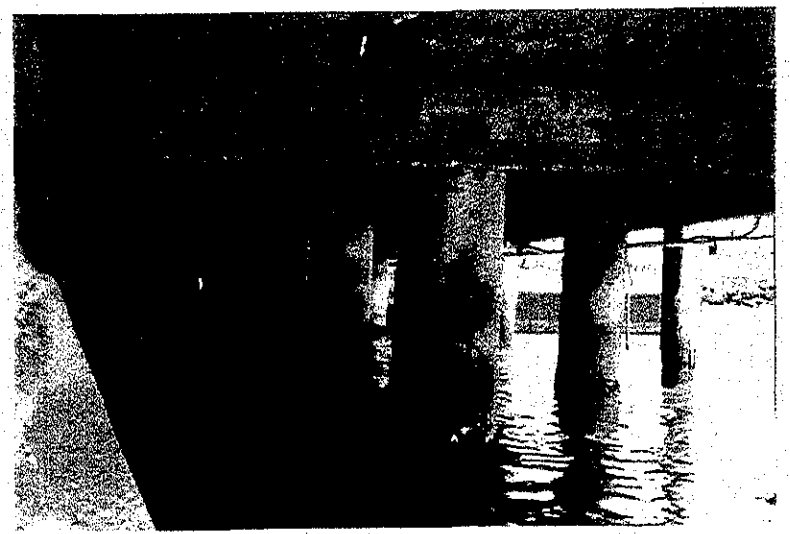
Main Wharf and North Access Bridge



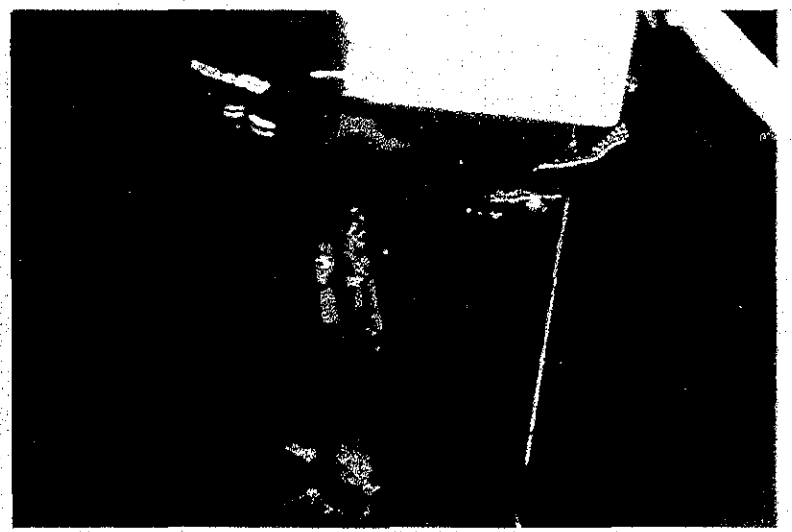
Container Yard and Shed No. 2



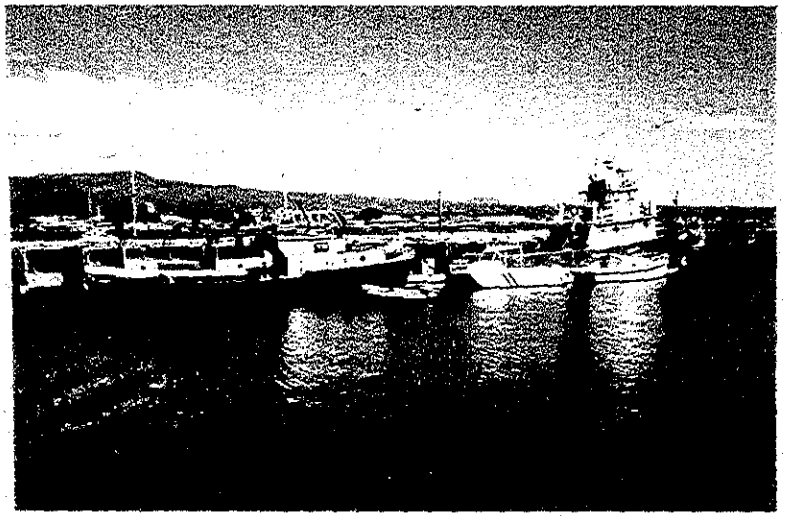
Fender and Curbing



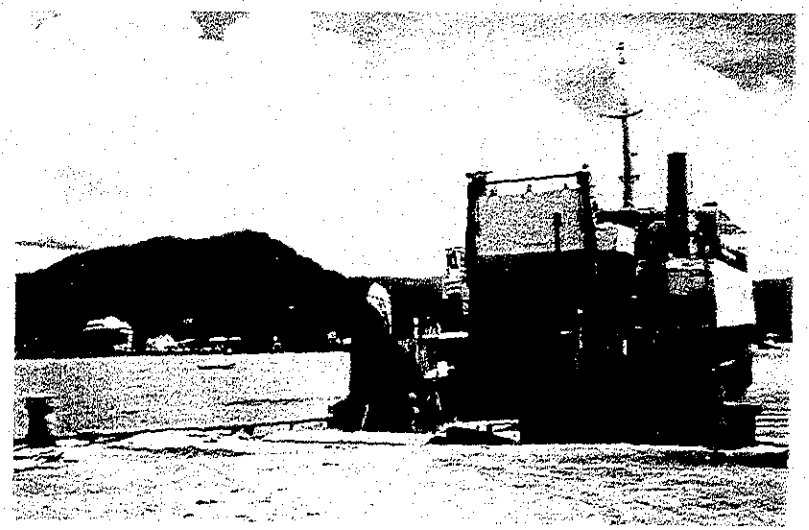
Pilings of the Main Wharf (above water)



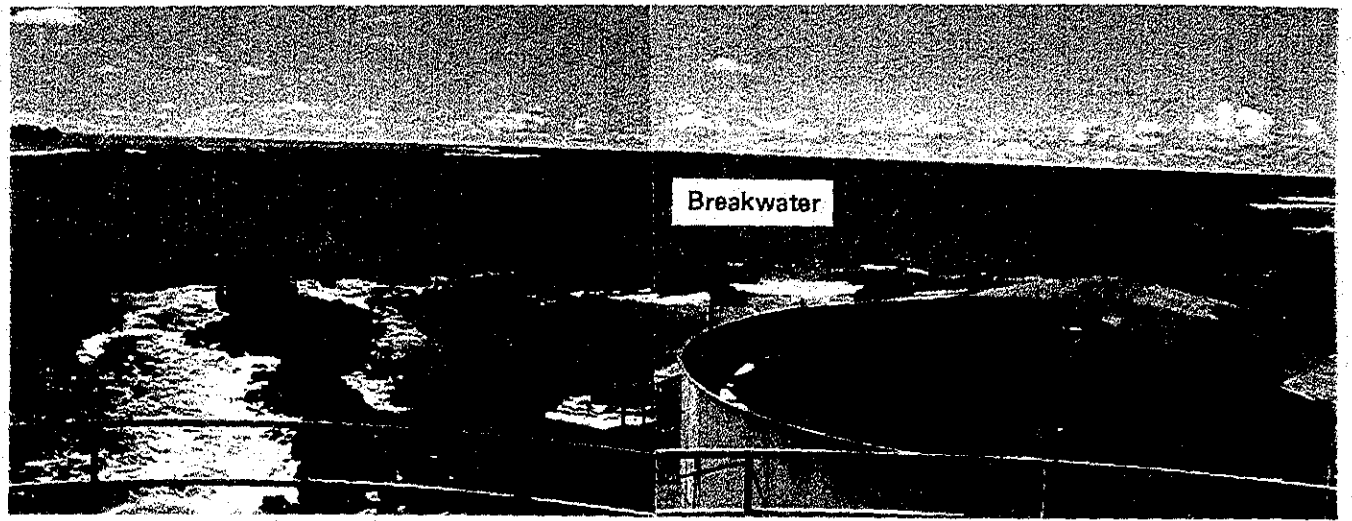
Damaged Concrete Sleave (under water)



Basin for Small Vessels



Existing Ferry Wharf



Construction Site of New Breakwater