5.10.7 Depreciation Costs

The annual depreciation costs of port facilities and equipment are calculated by the straight line method based on their service lives.
Residual values after all depreciations are estimated as zero. At the end of the project life, fixed assets are assumed to be sold at their residual values.

5.10.8 Fund Raising

Eighty percent of initial investment costs is assumed to be raised by foreign fund and conditions are assumed as follow;

Soft loan
Loan period: 30 years
Grace period: 10 years
Interest rate: 2.6 %
(Note) These conditions are quoted from those of the OECF(Japan)

The remaining initial investment costs are assumed to be raised by government fund.

5.10.9 Appraisal of the Project

The calculation of the FIRR is examined to clarify the viability of the project.

(1) Result of the FIRR calculation

The result of the FIRR calculation is - 4.1 %, as shown in Table 5-10-13. Judging from the this analysis, the project is not regarded as financially feasible. This means that the existing tariff should be raised or more government funds should be employed in the investment costs to secure the viability of the project.

5.10.10 Comparison of Alternative of FIRR.

(1) Alternative cases

The following analysis is aimed to clarify the financially feasible rate of government fund.

Table 5-10-13 FIRR Calculation

Base Case G.Fund: 20% Tariff: Exsiting Unit:milion FMG

	Year	Revenues			Cost			Revenue-Cost	Net Present Value		
		Operating Revenues	Subsidy (G. Fund)	Total	Investment	Expense	Total		Revenues	Cost	Difference
1	1994	0	607	607	3,036	0	3,036	-2,429	607	3,036	-2,429
2	1995	0	3,068	3,068	15,340	0	15,340	-12,272	3,199	15,993	-12,795
3	1996	0	4,045	4,045	20,224	0	20,224	-16,179	4,397	21,983	-17,586
4	1997	0	1,808	1,808	9,040	0	9,040	-7,232	2,049	10,245	-8,196
5	1998	499	231	730	1,155	477	1,632	-902	863	1,928	-1,066
6	1999	510		510		477	477	33	628	588	41
7	2000	519		519		477	477	42	667	613	54
8	2001	530		530		477	477	53	710	639	71
9	2002	541		541		477	477	64	755	666	89
10	2003	551		551		477	477	74	802	694	108
11	2004	566		566		477	477	89	859	724	135
12	2005	566		566		477	477	89	895	755	141
13	2006	566		566		477	477	89	934	787	147
14	2007	566		566		477	477	89	973	820	153
15	2008	566		566		477	477	89	1,015	855	160
16	2009	566		566		477	477	89	1,058	892	166
17	2010	566		566		477	477	89	1,103	930	173
18	2011	566		566		477	477	89	1,150	969	181
19	2012	566		566		477	477	89	1,199	1,011	189
20	2013	566	61	627	304	477	781	-154	1,385	1,725	-340
21	2014	566		566		477	477	89	1,303	1,098	205
22	2015	566		566		477	477	89	1,359	1,145	214
23	2016	566		566		477	477	89	1,417	1,194	223
24	2017	566		566		477	477	89	1,477	1,245	232
25	2018	566	1,053	1,619	5,263	477	5,740	-4,121	4,405	15,618	-11,213
26	2019	566		566		477	477	89	1,606	1,353	252
27	2020	566		566		477	477	89	1,674	1,411	263
28	2021	566		566		477	477	89	1,745	1,471	274
29	2022	566		566		477	477	89	1,820	1,533	286
30	2023	566		566	-14,789	477	-14,312	14,878	1,897	-47,970	49,868
	Total	14,470	10,873	25,343	39,573	12,402	51,975	-26,632	43,950	43,950	-0

FIRR= -4.1%

Table 5-10-14 Alternative Case of FIRR Calculation (1)

Case	Government Fund	Soft Loan	FIRR	Ave. Interest Rate
Case A	90 %	10 %	4.9 %	0.26 %
Case B	80 %	20 %	1.9 %	0.52 %
Case C	70 %	30 %	0.1 %	0.78 %

※ Operating Revenue and Cost are equal to base case

Analyzing the results of the FIRR calculation, Case A and Case B are feasible as the FIRR exceeds the average interest rate. Case C, however, is not feasible, which means that the level of government funds should be set over 80 % to ensure the viability of the project.

In the following analysis, operating revenues are raised based on section 5.8.3; entering the port charge and wharfage charge are 2 times the existing tariffs level. In this case, government fund is set at 70 %, a level which proved to be not feasible in Case C.
The result of the FIRR calculation is shown in Table 5-10-15.

Table 5-10-15 Alternative Case of FIRR Calcuation (2)

Case	Government Fund	Soft Loan	FIRR	Ave. Interest Rate
Case D	70 %	30 %	0.8 %	0.78 %

* Entering the port charge and Wharfage charge : Base case × 2
Costs are equal to Base case

In this case, FIRR is nearly equal to the average interest rate, so it is difficult to ensure financial feasibility.

(2) Financial soundness of the port management body

Case B is the minimum FIRR in which the average interest rate is exceeded (Case D is nearly equal), so Case B is appraised from the viewpoint of financial soundness of the port management body. The projected financial statement for the short-term projects and financial indicators, working ratio, operating ratio, rate of return on net fixed assets and debt service coverage ratio are shown in Table 5-10-16.

1) Profitability

The rate of return on net fixed assets is less than the average interest rate of the fund (See Figure 5-10-1). It is presumed that there will be a problem with profitability of the project.

2) Loan repayment capacity

The debt service coverage ratios are less than 1 (See Figure 5-10-2.). It is presumed that there will be difficulty in repaying the long-term loans using the annual operating revenues.

3) Operational efficiency

Both the operating ratios and the working ratios are not at favorable levels (See Figure 5-10-3, 5-10-4). It is presumed that there will be a problem with the operational efficiency of the organization and the efficiency of the routine operations.

5.10.11 Consideration of the Result

According to the economic analysis, this project is valuable as a national development scheme. So it is desirable to implement the project as soon as possible.

However, judging from the result of the FIRR calculation, it is very difficult to ensure the financial feasibility of the project.
The main reason is that investment costs are much greater than operating revenues, but it is impossible to further trim the project costs.
To increase operating revenues, the port tariff level needs to be reconsidered, but it has a ceiling because port activities must be competitive with neighboring ports and alternative transportation.

In this case, subsidy from government or finance from foreign countries is introduced in general. But from the result of the FIRR calculation, the project is not viable, even if the subsidy is 70 %. Further, subsidy from government is not expected because financial resources are limited in Madagascar. It is often possible to get economic aid from foreign countries, but it is unlikely that they will shoulder all investment costs of the Short-Term Plan. While it is desirable to ensure completion of the entire Short-Term Plan, it may be worth examining the possibility of going ahead with part of the short-term plan in the process of the Short-Term Plan.

A technical examination of the above is shown later in 5.12 Urgent Improvement Plan.

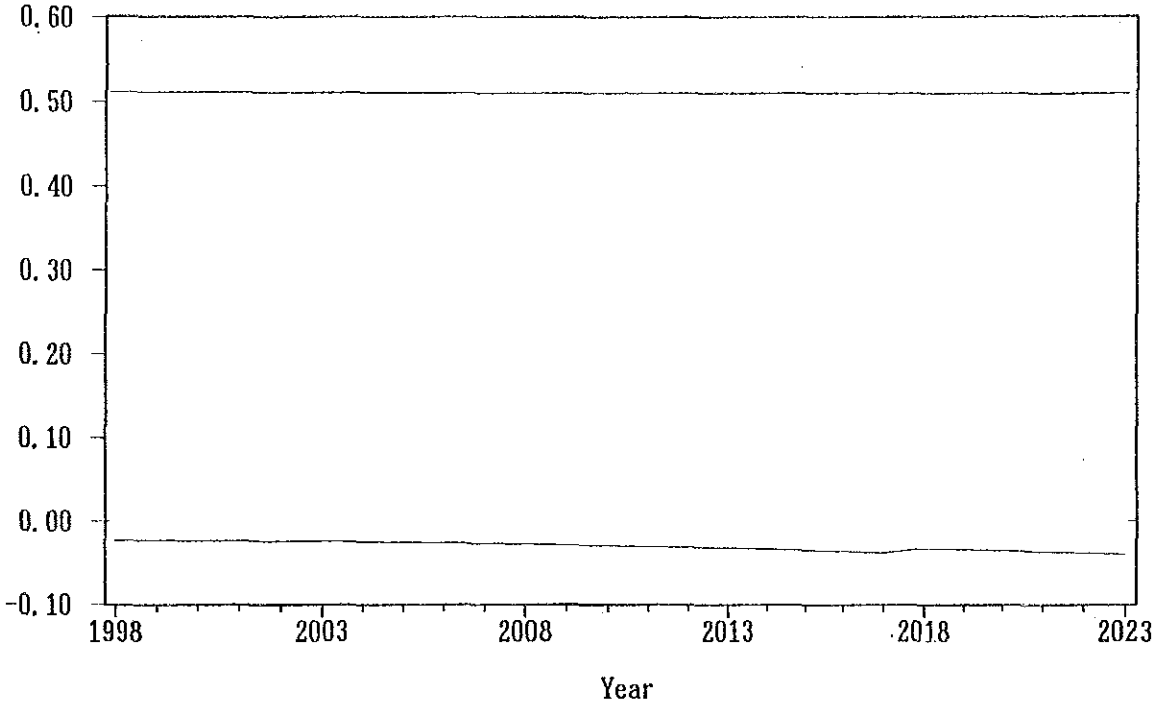


Fig. 5-10-1 Rate of Return on Net Fixed Assets

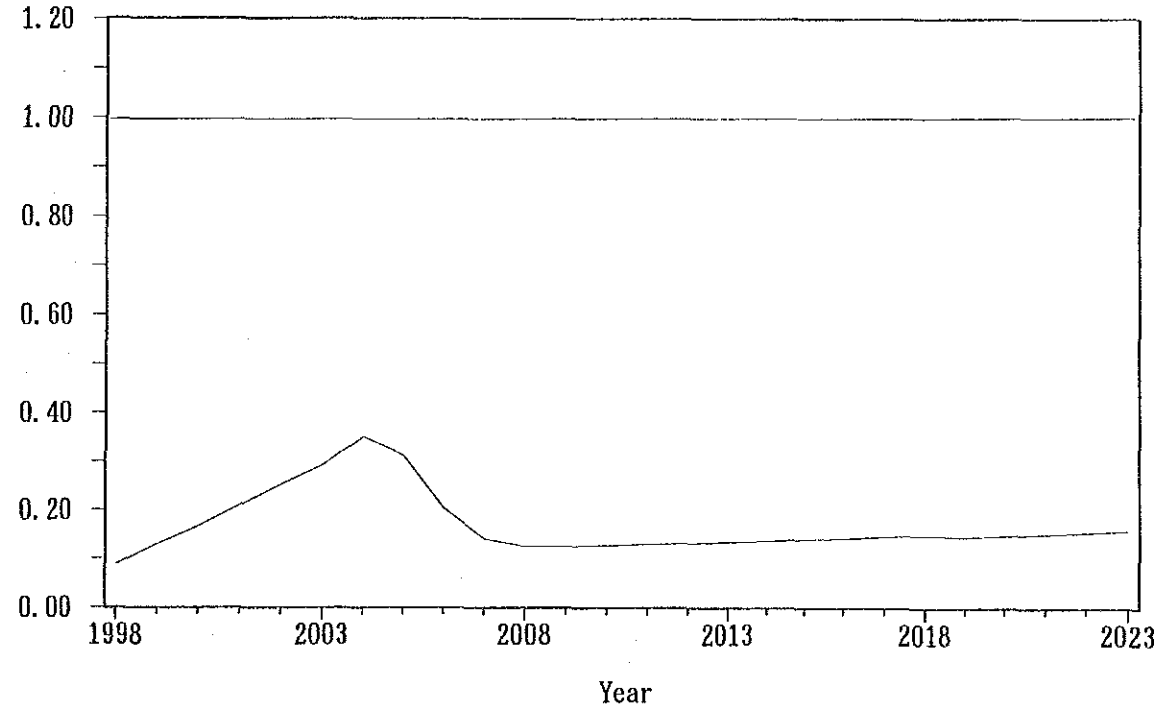


Fig. 5-10-2 Debt Service Coverage Ratio

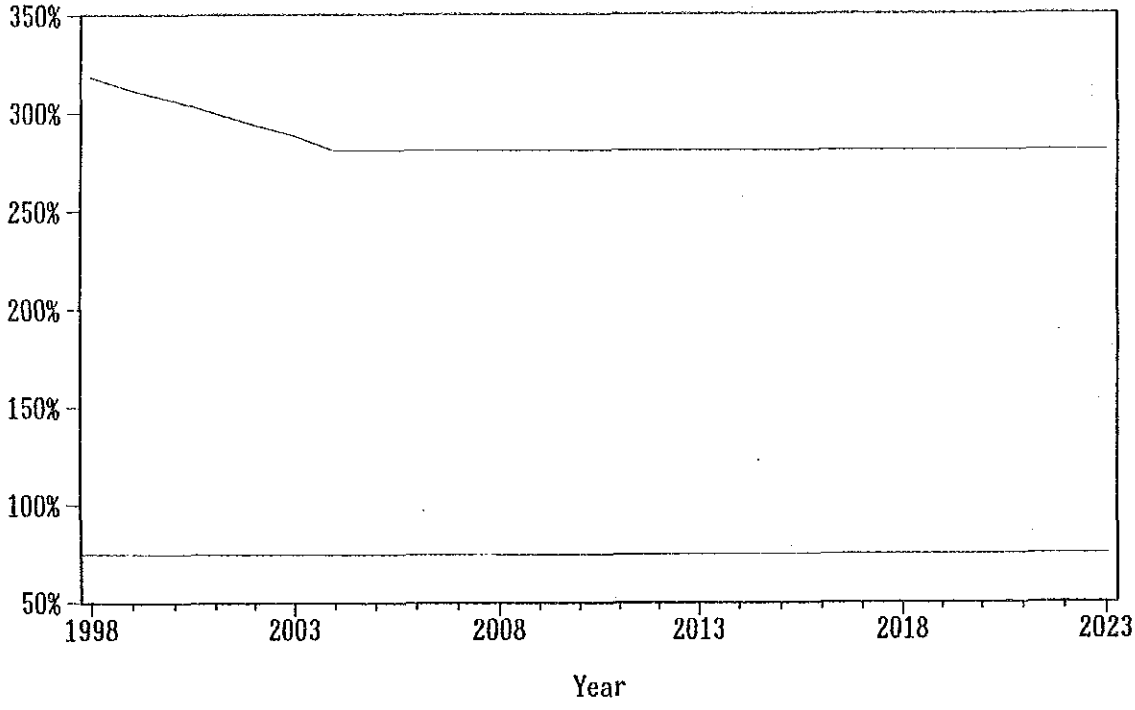


Fig. 5-10-3 Operating Ratio

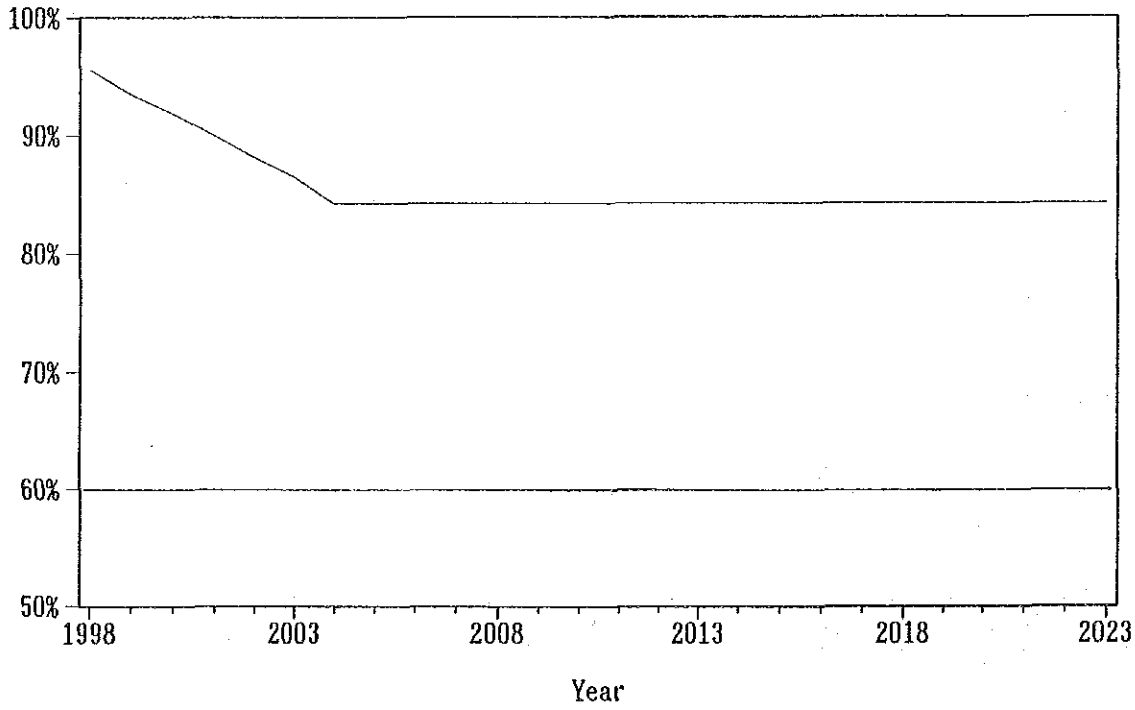


Fig. 5-10-4 Working Ratio

Table 5-10-16 Projected Financial Statements

PROFIT AND LOSS STATEMENT (UNIT: Million FMG)

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Operating Revenue	0	0	0	0	499	510	519	530	541	551	566	566	566	566	566	566	566	566	566	566	566	566	566	566	566	566	566	566	566	566
Operating Expenses	0	0	0	0	1,589	1,589	1,589	1,589	1,589	1,589	1,589	1,589	1,589	1,589	1,589	1,589	1,589	1,589	1,589	1,589	1,589	1,589	1,589	1,589	1,589	1,589	1,589	1,589	1,589	1,589
Personnel	0	0	0	0	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
Maintenance and repair	0	0	0	0	437	437	437	437	437	437	437	437	437	437	437	437	437	437	437	437	437	437	437	437	437	437	437	437	437	437
Administration	0	0	0	0	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
Depreciation costs	0	0	0	0	1,112	1,112	1,112	1,112	1,112	1,112	1,112	1,112	1,112	1,112	1,112	1,112	1,112	1,112	1,112	1,112	1,112	1,112	1,112	1,112	1,112	1,112	1,112	1,112	1,112	1,112
Net Operating Income	0	0	0	0	-1,090	-1,079	-1,070	-1,059	-1,048	-1,038	-1,023	-1,023	-1,023	-1,023	-1,023	-1,023	-1,023	-1,023	-1,023	-1,023	-1,023	-1,023	-1,023	-1,023	-1,023	-1,023	-1,023	-1,023	-1,023	-1,023
Non-operating Revenues	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Interest on deposit	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non-operating Expenses	0	16	98	218	297	345	392	444	503	568	643	726	825	958	1,136	1,352	1,602	1,890	2,221	2,601	3,040	3,543	4,121	4,787	5,552	6,459	7,475	8,644	9,987	11,533
Interest on long-term loans	0	16	96	201	248	254	254	254	254	254	254	254	253	248	238	226	213	200	188	175	164	151	139	126	113	128	115	102	90	77
Interest on short-term loans	0	0	2	17	50	91	138	190	249	315	389	472	572	710	898	1,127	1,389	1,690	2,033	2,426	2,876	3,392	3,983	4,661	5,439	6,331	7,360	8,541	9,898	11,456
Net Income Before Tax	0	-16	-98	-218	-1,387	-1,424	-1,462	-1,503	-1,551	-1,606	-1,666	-1,749	-1,848	-1,981	-2,159	-2,375	-2,625	-2,913	-3,244	-3,624	-4,063	-4,566	-5,144	-5,810	-6,575	-7,482	-8,498	-9,667	-11,010	-12,556
Income Tax	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Income After Tax	0	-16	-98	-218	-1,387	-1,424	-1,462	-1,503	-1,551	-1,606	-1,666	-1,749	-1,848	-1,981	-2,159	-2,375	-2,625	-2,913	-3,244	-3,624	-4,063	-4,566	-5,144	-5,810	-6,575	-7,482	-8,498	-9,667	-11,010	-12,556
(Contribution To the Government)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Income After Contribution	0	-16	-98	-218	-1,387	-1,424	-1,462	-1,503	-1,551	-1,606	-1,666	-1,749	-1,848	-1,981	-2,159	-2,375	-2,625	-2,913	-3,244	-3,624	-4,063	-4,566	-5,144	-5,810	-6,575	-7,482	-8,498	-9,667	-11,010	-12,556
Retained Earnings		-16	-114	-331	-1,719	-3,143	-4,604	-6,107	-7,658	-9,264	-10,930	-12,678	-14,526	-16,507	-18,667	-21,042	-23,667	-26,580	-29,824	-33,448	-37,510	-42,076	-47,221	-53,030	-59,605	-67,088	-75,586	-85,253	-96,263	-108,819

CASH FLOW STATEMENT (Unit: Million FMG)

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Cash Beginning		0	-16	-114	-331	-607	-919	-1,268	-1,659	-2,098	-2,592	-3,146	-3,813	-4,732	-5,987	-7,511	-9,262	-11,264	-13,553	-16,172	-19,172	-22,611	-26,552	-31,073	-36,259	-42,209	-49,068	-56,942	-65,984	-76,371
Cash Inflow (excluding G. Funds)	607	3,068	4,045	1,808	253	33	42	53	64	74	89	89	89	89	89	89	89	89	89	150	89	89	89	89	1,142	89	89	89	89	89
Net operating income	0	0	0	0	-1,090	-1,079	-1,070	-1,059	-1,048	-1,038	-1,023	-1,023	-1,023	-1,023	-1,023	-1,023	-1,023	-1,023	-1,023	-1,023	-1,023	-1,023	-1,023	-1,023	-1,023	-1,023	-1,023	-1,023	-1,023	-1,023
Depreciation costs	0	0	0	0	1,112	1,112	1,112	1,112	1,112	1,112	1,112	1,112	1,112	1,112	1,112	1,112	1,112	1,112	1,112	1,112	1,112	1,112	1,112	1,112	1,112	1,112	1,112	1,112	1,112	1,112
Long-term loans	607	3,068	4,045	1,808	231	0	0	0	0	0	0	0	0	0	0	0	0	0	0	61	0	0	0	0	1,053	0	0	0	0	0
Interest on deposits	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cash Outflow (excluding G. Funds)	607	3,084	4,143	2,026	528	345	392	444	503	568	643	758	1,009	1,344	1,613	1,840	2,090	2,378	2,709	3,150	3,528	4,031	4,609	5,275	7,092	8,947	7,963	9,132	10,475	12,021
Investment	607	3,068	4,045	1,808	231	0	0	0	0	0	0	0	0	0	0	0	0	0	0	61	0	0	0	0	1,053	0	0	0	0	0
Repayment for long-term loans	0	0	0	0	0	0	0	0	0	0	0	30	184	386	476	488	488	488	488	488	488	488	488	488	488	488	488	488	488	488
Interest on long-term loans	0	16	96	201	248	254	254	254	254	254	254	254	253	248	238	226	213	200	188	175	164	151	139	126	113	128	115	102	90	77
Income Tax	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(Contribution to the Government)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Interest on short-term loans	0	0	2	17	50	91	138	190	249	315	389	472	572	710	898	1,127	1,389	1,690	2,033	2,426	2,876	3,392	3,983	4,661	5,439	6,331	7,360	8,541	9,898	11,456
Cash Inflow - Cash Outflow	0	-16	-98	-218	-275	-312	-350	-391	-439	-494	-554	-687	-920	-1,255	-1,524	-1,751	-2,001	-2,289	-2,620	-3,000	-3,439	-3,942	-4,520	-5,186	-5,951	-6,858	-7,874	-9,043	-10,386	-11,932
Cash Ending	0	-16	-114	-331	-607	-919	-1,268	-1,659	-2,098	-2,592	-3,146	-3,813	-4,732	-5,987	-7,511	-9,262	-11,264	-13,553	-16,172	-19,172	-22,611	-26,552	-31,073	-36,259	-42,209	-49,068	-56,942	-65,984	-76,371	-88,303
Cash excess	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cash shortage	0	-16	-114	-331	-607	-919	-1,268	-1,659	-2,098	-2,592	-3,146	-3,813	-4,732	-5,987	-7,511	-9,262	-11,264	-13,553	-16,172	-19,172	-22,611	-26,552	-31,073	-36,259	-42,209	-49,068	-56,942	-65,984	-76,371	-88,303

BALANCE SHEET (UNIT: Million Rp.)

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
(Assets)																														
Current Assets	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cash & Deposit	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fixed Assets	3,036	18,376	38,600	47,640	47,683	46,571	45,459	44,347	43,235	42,123	41,011	39,899	38,787	37,675	36,563	35,451	34,339	33,227	32,115	31,307	30,195	29,083	27,971	26,859	31,010	29,898	28,786	27,674	26,562	25,450
Construction costs	3,036	18,376	38,600	47,640	48,795	48,795	48,795	48,795	48,795	48,795	48,795	48,795	48,795	48,795	48,795	48,795	48,795	48,795	48,795	49,099	49,099	49,099	49,099	49,099	54,362	54,362	54,362	54,362	54,362	54,362
Accumulated depreciation		0	0	0	1,112	2,224	3,336	4,448	5,560	6,672	7,784	8,896	10,008	11,120	12,232	13,344	14,456	15,568	16,680	17,792	18,904	20,016	21,128	22,240	23,352	24,464	25,576	26,688	27,800	28,912
Net fixed assets	3,036	18,376	38,600	47,640	47,683	46,571	45,459	44,347	43,235	42,123	41,011	39,899	38,787	37,675	36,563	35,451	34,339	33,227	32,115	31,307	30,195	29,083	27,971	26,859	31,010	29,898	28,786	27,674	26,562	25,450
Total Assets	3,036	18,376	38,600	47,640	47,683	46,571	45,459	44,347	43,235	42,123	41,011	39,899	38,787	37,675	36,563	35,451	34,339	33,227	32,115	31,307	30,195	29,083	27,971	26,859	31,010	29,898	28,786	27,674	26,562	25,450
(Liabilities and capital)																														
Liabilities	607	3,691	7,834	9,859	10,356	10,678	11,027	11,418	11,857	12,351	12,905	13,541	14,277	15,146	16,194	17,457	18,970	20,771	22,903	25,476	28,426	31,880	35,912	40,610	47,126	53,496	60,882	69,437	79,335	90,779
Current Liabilities (short-term lo	0	16	114	331	607	919	1,268	1,659	2,098	2,592	3,146	3,813	4,732	5,987	7,511	9,262	11,264	13,553	16,172	19,172	22,611	26,552	31,073	36,259	42,209	49,068	56,942	65,984	76,371	88,303
Fixed Liabilities (Long-term loan)	607	3,675	7,720	9,528	9,759	9,759	9,759	9,759	9,759	9,759	9,759	9,729	9,545	9,159	8,682	8,195	7,707	7,219	6,731	6,304	5,816	5,328	4,840	4,352	4,916	4,428	3,940	3,453	2,965	2,477
Capital	2,429	14,685	30,766	37,781	37,317	35,893	34,432	32,929	31,378	29,772	28,106	26,358	24,510	22,529	20,369	17,994	15,369	12,456	9,212	5,831	1,769	-2,797	-7,941	-13,751	-16,116	-23,598	-32,096	-41,763	-52,773	-65,329
Investment In Kind By Gov. Funds	2,429	14,701	30,880	38,112	39,036	39,036	39,036	39,036	39,036	39,036	39,036	39,036	39,036	39,036	39,036	39,036	39,036	39,036	39,036	39,279	39,279	39,279	39,279	39,279	43,490	43,490	43,490	43,490	43,490	43,490
Net Income After Tax and Cont.	0	-16	-98	-218	-1,387	-1,424	-1,462	-1,503	-1,551	-1,606	-1,666	-1,749	-1,848	-1,981	-2,159	-2,375	-2,625	-2,913	-3,244	-3,624	-4,063	-4,566	-5,144	-5,810	-6,575	-7,482	-8,498	-9,667	-11,010	-12,556
Retained Earnings	0	-16	-114	-331	-1,719	-3,143	-4,604	-6,107	-7,658	-9,264	-10,930	-12,678	-14,526	-16,507	-18,667	-21,042	-23,667	-26,580	-29,824	-33,448	-37,510	-42,076	-47,221	-53,030	-59,605	-67,088	-75,586	-85,253	-96,263	-108,819
Total Liabilities and capital	3,036	18,376	38,600	47,640	47,683	46,571	45,459	44,347	43,235	42,123	41,011	39,899	38,787	37,675	36,563	35,451	34,339	33,227	32,115	31,307	30,195	29,083	27,971	26,859	31,010	29,898	28,786	27,674	26,562	25,450

5.11 Environmental Impact Analysis

5.11.1 Basic Concept

It is very important to consider both the environment and development when making a port plan. In the formulation of the Master Plan, the Plan has been examined from the environmental point of view by means of scoping. This is referred to as the Initial Environmental Examination (IEE). As a result, some likely environmental impacts have been pointed out.

After additional surveys and discussions with relevant people such as DTM's director and the hospital's manager, it can be confidently said that the Master Plan will not cause any environmental problem. However, a more detailed examination is necessary. So, a further environmental impact assessment, what is called, an Environmental Impact Analysis (EIA) will be implemented.

As indicated in section 4.11, the most significant environmental impact factor is water pollution by operation of the tuna canning factory and the second is noise by operation of construction machines. However, some other factors will likely have an environmental impact as well. Therefore, EIA is being conducted for all factors pointed out in section 4.11.

5.11.2 Noise and Vibration Generated by Construction Works

Noise and vibration is a public nuisance associated with construction works. They are generated simultaneously. In this section, noise is singled out and the impact is examined, because noise usually affects a larger area than vibration.

Many construction crafts, floating construction plants or machines will be used; details will be decided when construction works step forward to the implementation stage. In this stage, according to the study, the major sources of noise to be considered and power levels are as follows:

Table 5-11-1 Construction Equipment

Machine	Power Level
Road roller	68-72 dB(A)
Back-hoe	80-85 dB(A)
Bulldozer	83 dB(A)
Concrete mixer	83 dB(A)
Grab bucket dredger	112 dB(A)
Pile driving barge	100-130 dB(A)

Among these machines, pile driving barge's power level is the highest and grab bucket dredger's is the second. This means that the most considerable noise will be generated at the time of piling and dredging. Naturally, the noise level declines with distance from the source. As to the relationship between noise level and distance, some studies have been made and a formula has been proposed. Using it, the noise level by piling can be calculated and results are shown as follows:

Table 5-11-2 Noise Level from Source

Distance	Noise Level
100 m	82 dB(A)
200 m	75 dB(A)
300 m	72 dB(A)
500 m	68 dB(A)
1,000 m	62 dB(A)
3,000 m	52 dB(A)

Another surveys indicates typical noise levels as follows in Table 5-11-3:

Table 5-11-3 Typical Noise Level

Noise Level dB(A)	Situation
110-	klaxon at 2m, riveting
100-	under a railway bridge
90-	inside a noisy factory
80-	inside a train, bell of telephone
70-	inside a noisy office
60-	usual conversation, inside a quiet car
50-	inside a quiet office
40-	inside a library, midnight in town
30-	whispering voice, midnight in suburban area
20-	rustling level

There is a hospital (HOPITAL PRINCIPAL D'ANTSIRANANA) about 1,000 m away from the project site on the plateau. As the above tables show, the noise level at the hospital is 60-70 dB(A), which corresponds to that inside a quiet car, in other words, that of a residence in the urban area.

By similar calculation, it is observed that the noise level is 50-60 dB(A) when a dredger is working and it is nearly equivalent to that inside ordinary offices.

According to the discussion, it was confirmed that the manager of the hospital recognizes that the noise at such a level will not bring about any problem.

Consequently, the impact by noise can be regarded as minor.

5.11.3 Change in Economic Activities Caused by Employment of Laborers during Construction Phase

During the construction related to the project, there will be a rise in employment opportunity for local workers. Table 5-6-1(2), 5-7-1, 5-7-2(1)and (2) show the local portion related to the construction. Some workers, for example, directors, will come from other

areas but many workers, namely, skilled and unskilled labors will be employed from the hinterland.

From a rough estimation, during the total construction period, about five hundred people in the district will be employed. On top of that, as shown in Table 5-6-2, a lot of materials will be supplied from the region and relevant companies and people will earn revenue and wages. This extra income will contribute to the local economy.

The total number of workers, including consultants, who will come from other areas is approximately 500. They will stay at hotels in Antsiranana, buy daily goods, eat in restaurant etc. The effect should not be overlooked.

On the negative side, in large and long-time construction projects, there is sometimes some influence on the population distribution and the cultural environment in and around the project site by the inflow of people associated with the construction works. However, judging from the scale of this construction, it is considered negligible.

5.11.4 Air Pollution by Calling Vessels

In 1990, the total staying time by calling vessels was estimated at about 1,690 (vessel*days), possibly the longest time to date. At the stage of operation after completion of the project, it is estimated to decrease to about 1,600, or by 5 % because higher cargo handling efficiency and shorter staying time in the port is expected in the operation phase, even though cargo volume will increase.

Air pollution has never occurred in this region. One of the major reasons is that this area is blessed with good natural conditions. As an example, the visible distance is over 10 km on fine days. Dominant wind direction at the project site is from east-south-east to south-east. On the other hand, the central city is located on the windward side.

Therefore, it is safe to say that air pollution by calling vessels will not cause a serious problem as at present.

5.11.5 Water Pollution by Calling Vessels

With the decrease in staying time of vessels, generated water pollutant load which poured into the sea will also decrease.

According to the survey, water quality in the Diego-Suarez Bay is excellent excluding the place right near the outlet of drainage of the tuna canning factory. The

survey shows that COD (chemical oxygen demand) at observation points was under one ppm(mg/l). In Japan, water quality in terms of COD is desired to be under two ppm even at very clear sea areas. Consequently, it is judged that water pollution by calling vessels will be negligible.

The only concern about water pollution is drainage from the tuna canning factory. This subject will be examined in detail later.

Bilge has to be treated properly, following the relevant laws and regulations. In the port of Antsiranana, there are no disposal facilities nor will there be in the near future. Therefore, it is recommended that DTM strongly instruct shipping companies on their responsibility so as to deal it with by themselves.

5.11.6 Wastes Generated by Calling Vessels

Referring to the study by the Japan Association for Preventing Marine Accidents, the garbage volume generated by calling vessels can be calculated. As a result, the yearly amount is about 215 kl, 150 tons in volume, weight, respectively. Taking into account that calling vessels for refuge or rest account for over 40 % of the total in terms of staying time (vessels*days), the above values must be overestimated. Moreover, as mentioned before, the total staying time at the future port operation is forecasted to decrease compared with the present operation.

In principle, wastes generated by vessels should be treated by those vessels. Wastes from calling vessels do not currently cause any trouble, so that it is expected that wastes will be treated properly in future, too. However, it is better that the administration such as the local government or the port management body, or authorities or companies related to port activities help and cooperate to establish an appropriate waste treatment plan.

5.11.7 Economic Effect Caused by Employment for Cargo Handling and Storage in Operation

According to the interview, at present, CMDM employs about 30 regular labors and 700 irregular skilled and unskilled labors at the busiest period.

It is forecasted that the cargo volume excluding oil products will increase by over 70 % in the operation phase of the Short-Term Development Plan. Additional employees will be required to handle the increase in cargo volume, that is, simply speaking, about 20 and 500 people will regularly and irregularly be employed. That may be a slight overestimation but at least several hundred labors will be needed at the highest time. Moreover, people to take charge of management, accounting, and technicians to maintain facilities and equipment are required.

5.11.8 Noise and Vibration Generated by Road Traffic in Operation

With the increase of cargo handling, road traffic volume will increase. It is forecast that traffic volume into or out of the port in the operation phase will reach about 20 vehicles per hour in terms of 5 tonnage loaded truck. That is rather low and the increase of traffic volume is only several vehicles compared with the present situation.

Considering the present situation of road traffic, the proposed project will not bring about a serious problem of noise and vibration.

However, there are a lot of holes or cracks in the existing roads, so that slight vibration may reach neighboring houses or buildings when large vehicles pass through. So, it is recommended that rehabilitation works or traffic control such as speed control be done.

5.11.9 Traffic Jam or Accident Associated with Transportation of Cargoes in Operation

As explained above, road traffic volume is quite small and will continue to be so in the near future. Therefore, traffic congestion will not become a problem.

However, the roads are winding and the width of almost all of them is narrow. Such conditions are conducive to traffic jams or accidents. Therefore, it is thought effective to introduce speed control in the urban area and around the port.

5.11.10 Water Pollution and Bottom Contamination Generated by Factories Effluent in Operation

At present, the tuna canning factory is operating just behind the port and the drainage is affecting water quality in the sea. It is said that they are going to build another factory; other than that, no other new factories are planned. Therefore, the impact cannot be neglected and the influence must be examined. The impact of human activities in the urban area, livestock effluent and tourism activities on the city will be analyzed. The details are as follows.

(1) Calculation method of pollutant load

As already mentioned, the originated pollutant sources consist of those related to human activities, industrial activities, livestock effluent and tourism activities. The indicator of water quality is COD.

The discharged pollutant load is calculated by each origin of pollutant as follows:

Discharged pollutant load = (Volume by each origin of pollutant)*(Unit loading)

Table 5-11-4 Sources of Pollution

classification	origin of pollutant
Human waste	raw sewage, common municipal drainage
Industrial waste	tuna canning factory
Livestock effluent	cattle, pig
Tourism activities	tourists

The attained pollutant load which flows into the sea is calculated as follows:

Attained pollutant load = (Discharged pollutant load)*(1-Removal rate)*(Rate of attainment)

(2) Calculation case

These cases are calculated, taking into account the following conditions:

Present situation (year:1992) (one case)
Future situation (year:1998) in case of non-treatment and treatment for waste water (two cases)

Future unit loading is assumed the same as the present.

Table 5-11-5 Calculation Cases of Pollutant Load

case	year	human waste	industrial waste	livestock effluent	tourism activities
1	1992	current population	current drainage and its COD concentration	current number of cattle and pig	current number of tourists
2	1998	future population	estimated drainage in the future based on the industrial expansion plan	same as the above	same as the above
3	1998	same as the above	estimated drainage in the future taking account of countermeasures	same as the above	same as the above

(3) Results of calculation

Following the above method, the calculation results of attained pollutant load are shown in Tables 5-11-6, 7 and 8. They are 5.3 tons/day, 12.5 tons/day and 2.8 tons/day for case 1, 2 and 3, respectively. A countermeasure in case 3 is an active sludge process.

By numerical analysis, the diffusion of the above attained pollutant load into the sea area was calculated. Based on the surveyed currents, nine calculation cases are shown in Table 5-11-9:

Table 5-11-6 Current Pollutant Load

		frame	unit loading	generated pollutant load (kg/day)	removal rate	discharged pollutant load (kg/day)	rate of attainment	attained pollutant load (kg/day)
		A	B	C=A*B	D	E=C*(1-D)	F	G=E*F
Population		56419	10g/(day*person)	564	0	564	0.5	282
Canning factory		585cu.m/day	8500g/cu.m	4972.5	0	4972.5	1	4972.5
Livestock	cattle	4200	530g/head	2226	0	2226	0.01	22.2
	pig	365	130g/head	47	0	47	0.01	0.5
Tourist		10person/day	8.5g/(day*person)	0.0085	0	0.085	0.5	0.04
Total								5277.2

Table 5-11-7 Future Pollutant Load without Countermeasures

		frame	unit loading	generated pollutant load (kg/day)	removal rate	discharged pollutant load (kg/day)	rate of attainment	attained pollutant load (kg/day)
		A	B	C=A*B	D	E=C*(1-D)	F	G=E*F
Population		68000	10g/(day*person)	680	0	680	0.5	340
Canning factory		1433cu.m/day	8500g/cu.m	12180.5	0	12180.5	1	12180.5
Livestock	cattle	4200	530g/head	2226	0	2226	0.01	22.2
	pig	365	130g/head	47	0	47	0.01	0.5
Tourist		10person/day	8.5g/(day*person)	0.0085	0	0.085	0.5	0.04
Total								12543.2

Table 5-11-8 Future Pollutant Load with Countermeasures

		frame	unit loading	generated pollutant load (kg/day)	removal rate	discharged pollutant load (kg/day)	rate of attainment	attained pollutant load (kg/day)
		A	B	C=A*B	D	E=C*(1-D)	F	G=E*F
Population		68000	10g/(day*person)	680	0	680	0.5	340
Canning factory		1433cu.m/day	8500g/cu.m	12180.5	0.8	2436.1	1	2436.1
Livestock	cattle	4200	530g/head	2226	0	2226	0.01	22.2
	pig	365	130g/head	47	0	47	0.01	0.5
Tourist		10person/day	8.5g/(day*person)	0.0085	0	0.085	0.5	0.04
Total								2798.8

Table 5-11-9 Calculation Cases of Diffusion

case	1	2	3	4	5	6	7	8	9
pollutant load(COD)(kg/day)	5,277	5,277	5,277	12,543	12,543	12,543	2,799	2,799	2,799
current velocity(cm/s)	13	25	40	13	25	40	13	25	40

The results are shown in Figure 5-11-1 to 5-11-9. They indicate that at present, high value of COD is restricted right near the outlet of the drainage of tuna canning factory, but when pollutant load increases in future, the contour of two mg/l (COD) spreads out. However, its range is limited to alongside the quay.

Consequently, it can be said that it will not affect seriously other activities in the port. However, the drainage from the tuna canning factory needs to be treated properly. It is suggested that, as a means of treatment, a settling pond is not sufficient. Rather, an active sludge process would be more effective.

5.11.11 Offensive Odor Generated by Factories in Operation

There is a possibility that odors will be generated when materials are carried into the factory from the port area. However, as mentioned before, this area is blessed with good natural conditions (the urban area is on the windward side) and in addition, generally speaking, odor by tuna is not so intense.

Therefore, there is no need to be nervous about an odor problem.

5.11.12 Treatment of Wastes Generated by Operation of Industrial Activities

A lot of wastes are generated in the process of producing food stuffs. Japanese statistics reveal that about 40 kg of sludge and about 100 kg of solid wastes are generated per production in terms of one million yen on average. It cannot be precisely determined if the same will be true in Madagascar. However, a considerable amount of wastes will be generated, in particular, as a result of doubling production capacity.

Basically, the canning factory must deal with the disposal by itself. It is expected that the local government or the port management body will instruct and help the factory and thus it will not cause a serious problem.

5.11.13 Employment Effect by Operation of New Tuna Canning Factory

In the near future, the tuna canning factory is going to double its production. At present, the number of employees is about 650. The factory's plan is closely connected to the Short-Term Development Plan. This means that the implementation of the project has a rather large employment effect.

5.11.14 Conclusion

Considering comprehensively everything mentioned above, the implementation of the project in the Short-Term Development Plan will not cause any problem for the environment. One thing that must be given attention is the drainage from the tuna canning factory. The implementation of the plan to double the production brings about positive impacts such as employment effect as well as a negative impact (water contamination). It is already the leading company and the major user of the port and this situation will continue. Therefore, it is expected that it will make efforts to reduce the unfavorable impact on water quality.

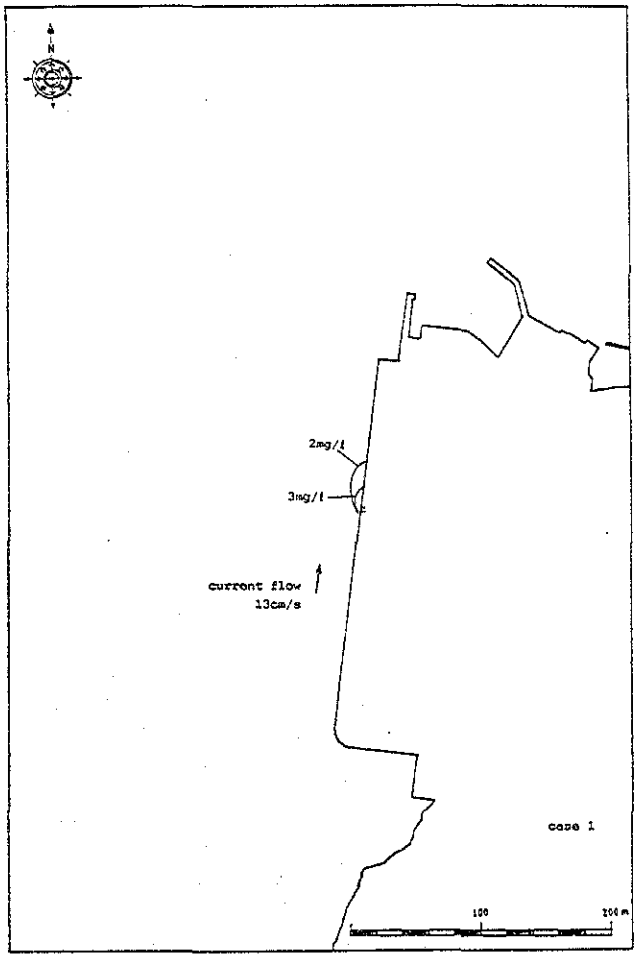


Figure 5-11-1 Distribution of Water Quality Indicated with COD
- Case 1 -

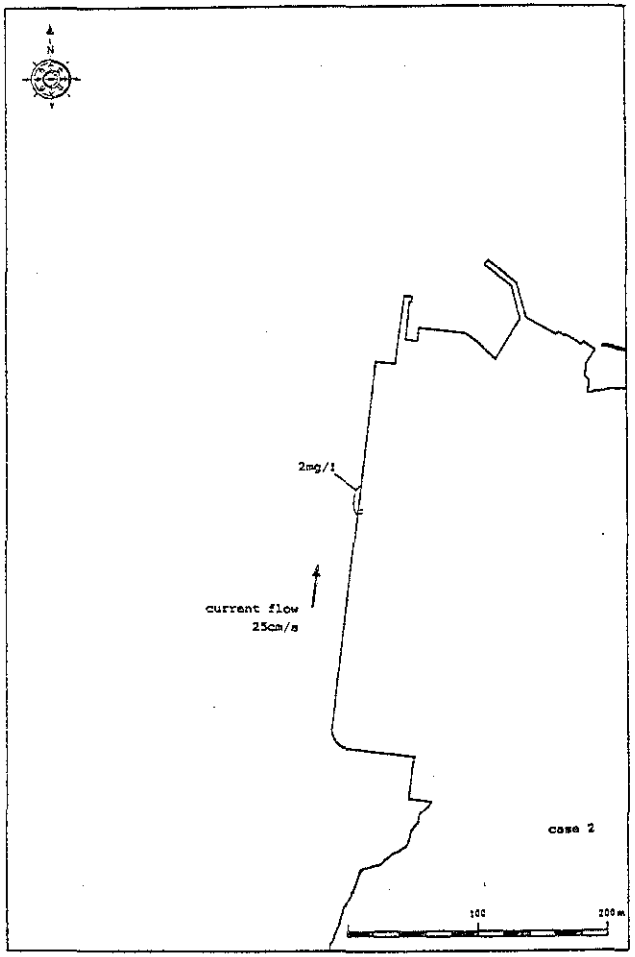


Figure 5-11-2 Distribution of Water Quality Indicated with COD
- Case 2 -

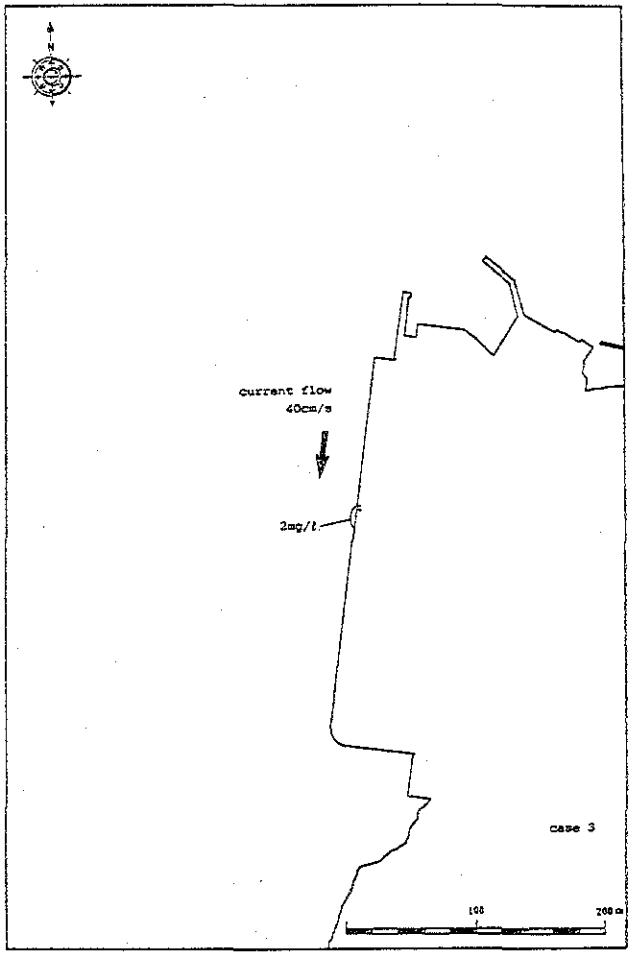


Figure 5-11-3 Distribution of Water Quality Indicated with COD
- Case 3 -

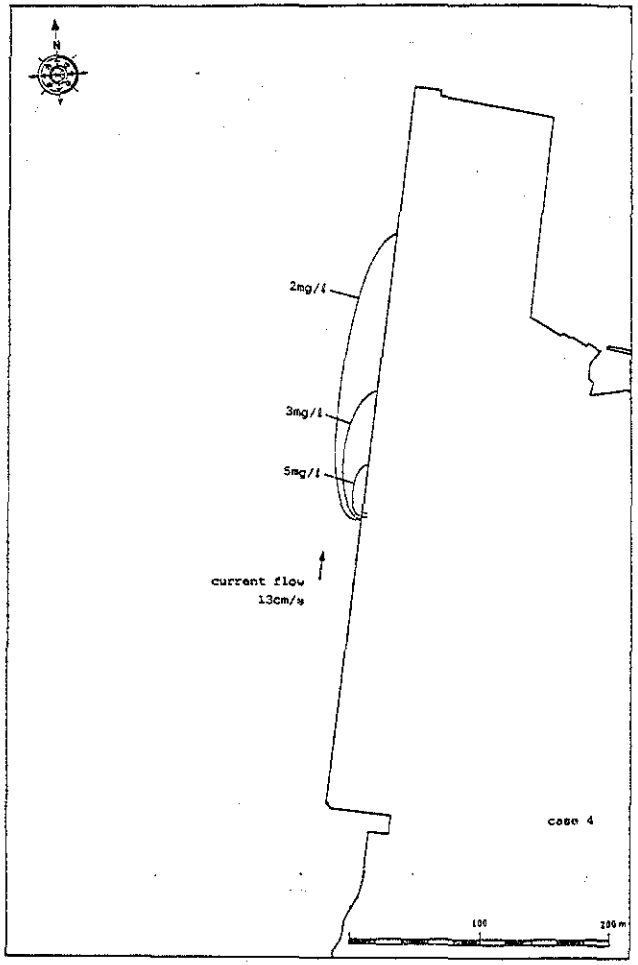


Figure 5-11-4 Predicted Distribution of Water Quality Indicated with COD (Without Countermeasures) - Case 4 -

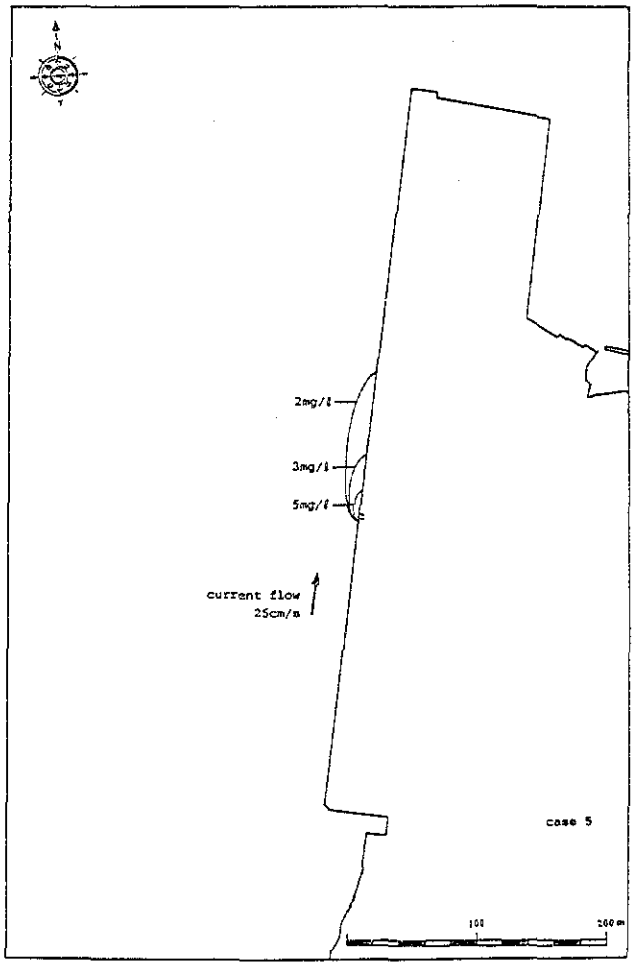


Figure 5-11-5 Predicted Distribution of Water Quality Indicated with COD (Without Countermeasures) - Case 5 -

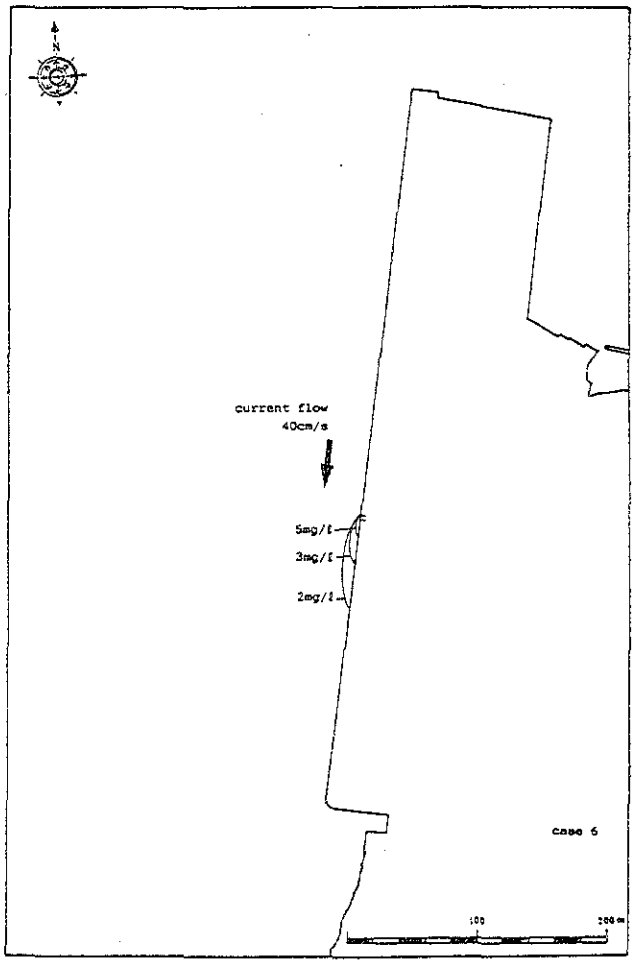


Figure 5-11-6 Predicted Distribution of Water Quality Indicated with COD (Without Countermeasures) - Case 6 -

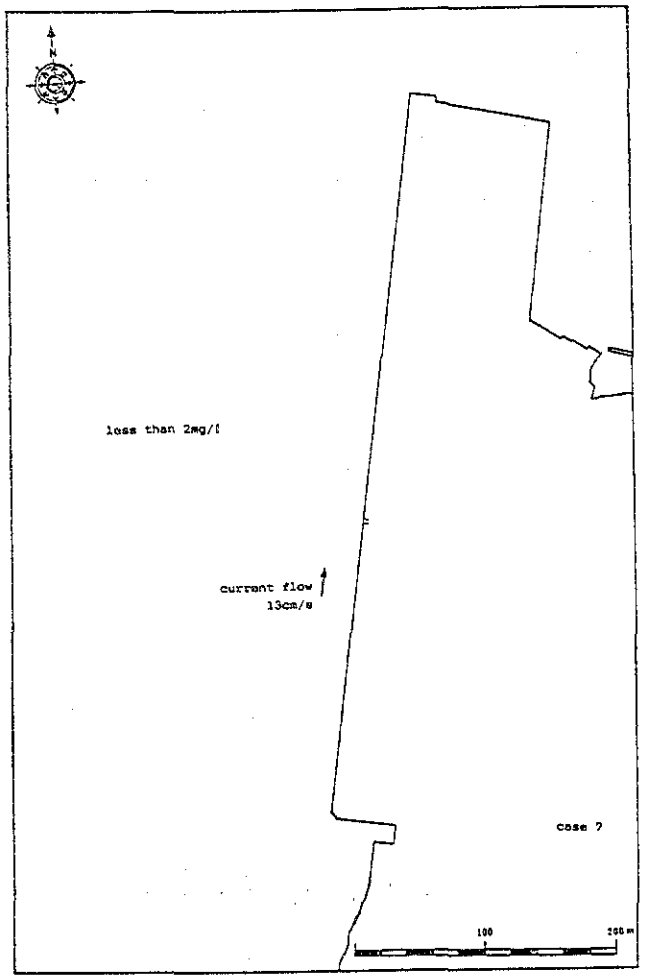


Figure 5-11-7 Predicted Distribution of Water Quality Indicated with COD (With Activated Sludge Process as a Countermeasures) - Case 7 -

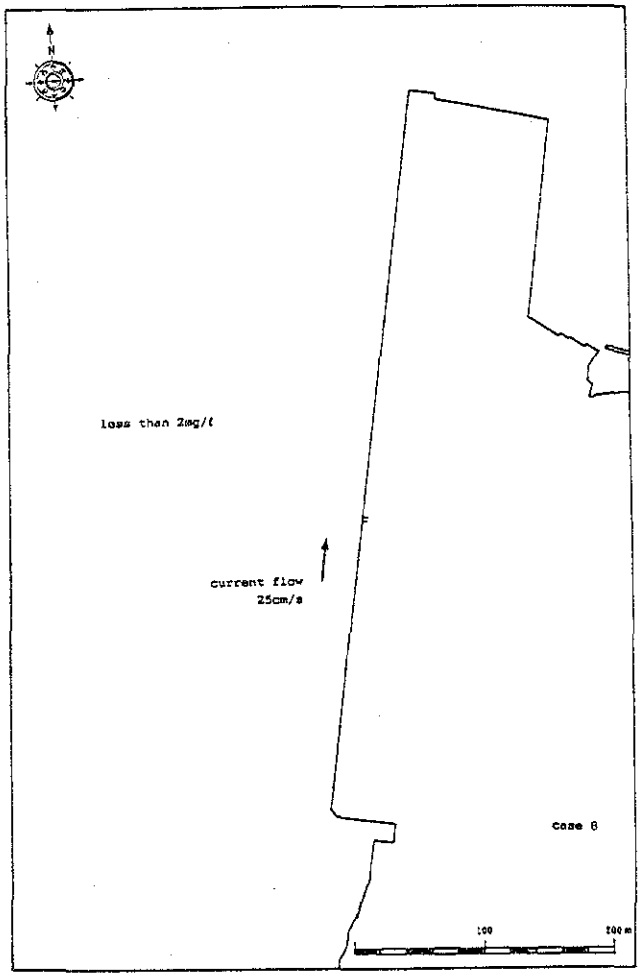


Figure 5-11-8 Predicted Distribution of Water Quality Indicated with COD (With Activated Sludge Process as a Countermeasures) - Case 8 -

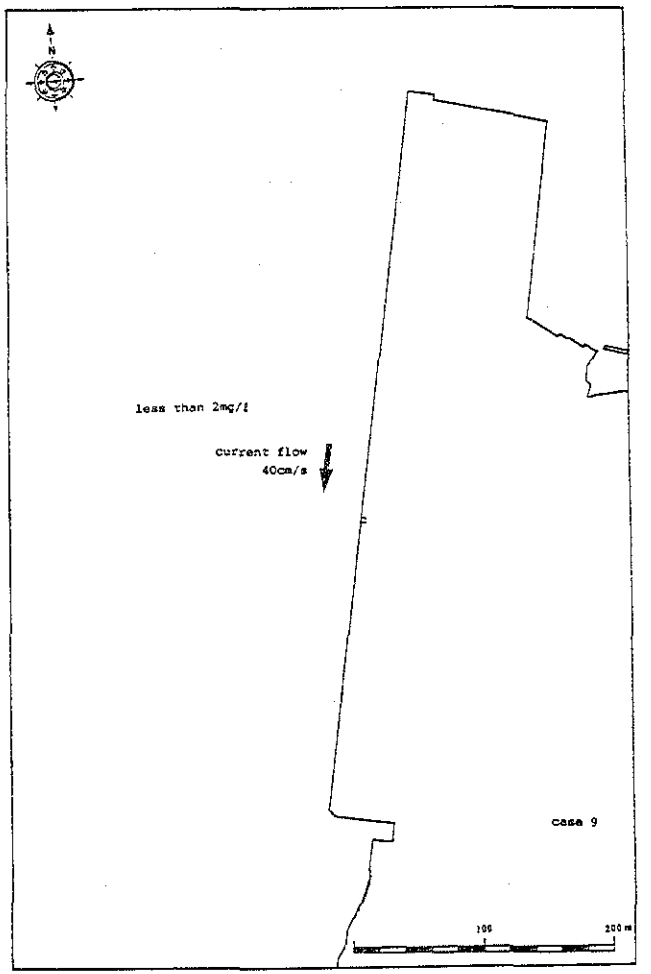


Figure 5-11-9 Predicted Distribution of Water Quality Indicated with COD (With Activated Sludge Process as a Countermeasures) - Case 9 -

5.12 Urgent Improvement Plan

As mentioned in the financial analysis, the Madagascar government is faced with heavy financial constraints. In order to implement the Plan, it must be financed by foreign countries or international assistance aid. However, it is doubtful the total necessary funds can be attained. If the funds cannot be raised, the situation arises in which only some parts of the Plan can be implemented. Under such a scenario, the level of port services world not be as high as it could be if the entire Plan were to be completed. Clearly then, every effort should be made to secure the required funds. At the very least, enough budget to rehabilitate or improve superannuated or deteriorated facilities should be secured.

From the above point of view, the urgent improvement plan is examined. It will be the first step in the implementation of the whole Short-Term Development Plan and the basic concept should be as follows:

- Rehabilitation works should be completed.

- Consideration should be given to minimizing the influence to port activities as much as possible during rehabilitation works.

The proposed urgent improvement plan is shown in Figure 5-12-1. The main contents and characteristics of the urgent improvement plan are as follows:

- The length of quay extension is 120 m, the same as the existing "Old Quay" which corresponds to the length necessary to accommodate a fishery cargo vessel with freezers.

- In this plan, 10,000 DWT class vessels cannot be accommodated in full load unless the quay were to be extended by an additional 50m.

- Judging from the record of calling vessels in 1990, it is estimated that about 54% of ocean-going cargo vessels, 83% of coastal cargo vessels and almost all fishery boats can be accommodated at the extended quay.

- The berth occupancy ratio in the urgent improvement plan becomes greater than in the Short-Term Development Plan in case that the forecasted cargo volume is handled. Namely, the ratio in the urgent improvement plan is over 50% in 1994, 64% in 1998, whereas it is about 50% in 1998 in the Short-Term Development Plan. The maximum berth occupancy for three berths recommended by UNCTAD is 55%, which means that some congestion would unavoidable in 1998 when the ratio will

be 64%.

- Rehabilitation works will not cause major problems for accommodating vessels, when those works start from the end of the "Old Quay" coming after the construction work of the extension.

- The construction cost of public portion including corresponding consultant fee is estimated at about 16.9 million US dollars, about 64% of the total construction cost for the Short-Term Development Plan.

- However, additional construction cost so as to implement the remaining parts of the whole Short-Term Development Plan is estimated at about 14.5 million US dollars, so that the total construction cost results in an increase of about 5.2 million US dollars, if the stage construction works are scheduled.

- The extension of the quay will be completed within two years from the commencement of construction works.

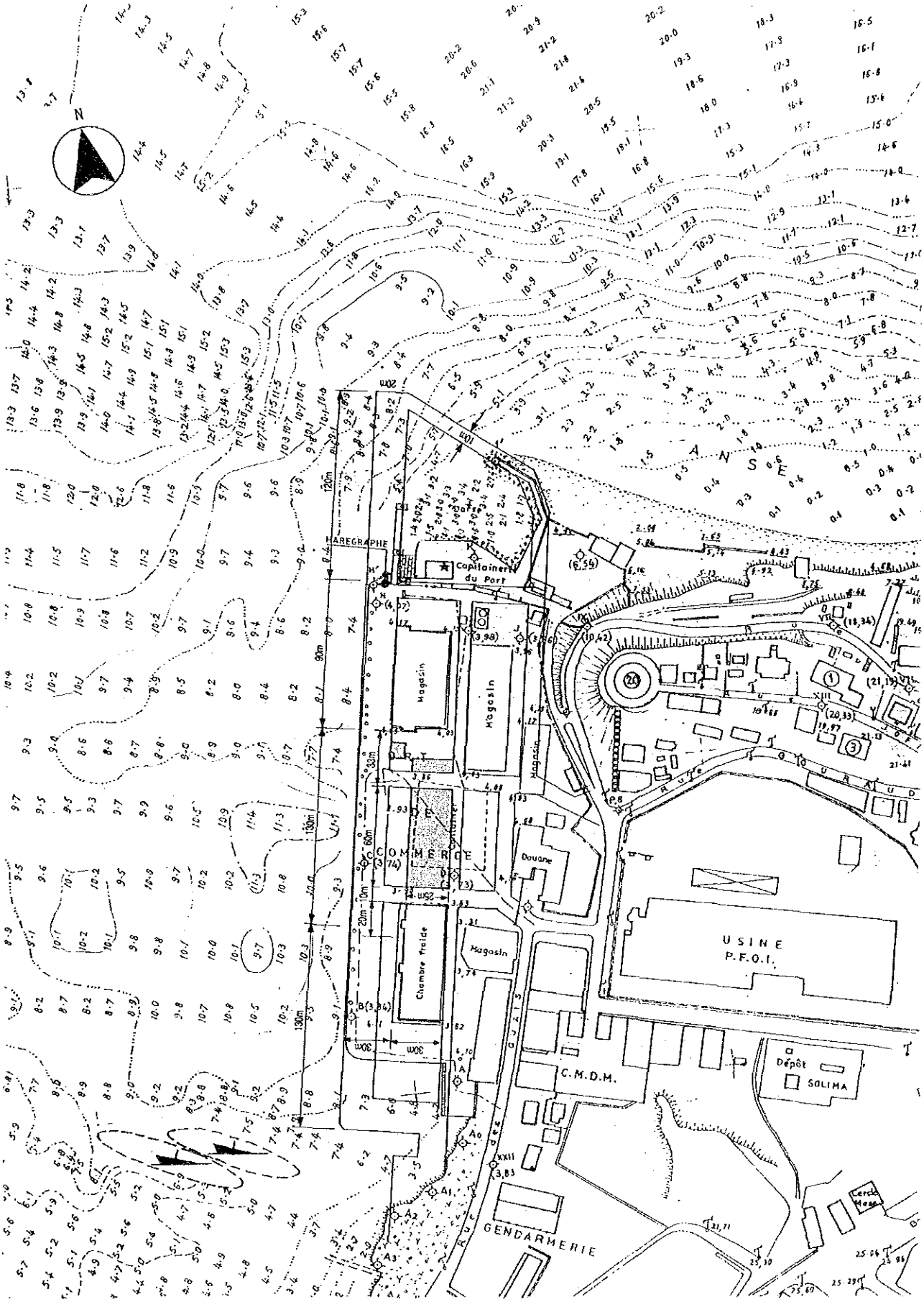


Figure 5-12-1 The Proposed Urgent Improvement Plan

APPENDICES

A-1.5 Socioeconomic Activities

1. Credit for structural adjustment program by World Bank

1) Industrial sectors

Date : March 1985

Amount : 40.20 million SDR

Objective : The realization of structural reform to improve efficiency and productivity

2) Public sectors

Date : July 1988

Amount : 92.50 million SDR

Measures : a) creation of a public expenditure program with careful monitoring
b) liberalization of exports
c) rationalization of public sector enterprises
d) improvement of liquidity and effectiveness of the barking system
e) privatization or liquidation of public enterprises

2. Instruction by IMF

1) Measures for structural adjustment

Date : August 1987 - August 1990

Contents : a) Substantial depreciation of FMG
b) liberalization of import system
c) raising of production cost of principle agricultural products
d) gradual elimination of price control

Remark : Due to unsatisfactory results, the above program was canceled in May 1989 at the request of the Madagascar government

2) Measures for promotion of structural adjustment

Date : May 1989 - May 1992

Contents : a) reformation of fiscal policy
b) reformation of investment code
c) restructuring of banking system
d) creation of free trade zone

Table A-1-8-1 Result of Activities of SECREN

SOCIETE D'ETUDES, DE CONSTRUCTION
ET DE REPARATION NAVALES (SECREN)
- ANTSIRANANA -
SERVICE CONTROLE DE GESTION

CHIFFRE D'AFFAIRES SECREN

		UNITE	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
CA en FMG	- NATIONAUX	M. FMG	565	578	931	1.004	1.702	1.843	1.929	1.836	3.671	2.725
	- THONIERS	M. FMG		138	872	1.642	3.579	5.691	6.054	6.655	3.892	2.910
	- AUTRES ETRANG	M. FMG	172		53	165	189	1.004	2.159	6.231	3.177	6.206
	- C.N.	M. FMG	49	170	259	53	96	184	497	703	266	0
	- DIV.	M. FMG	274	143	161	405	521	793	648	1.211	633	365
			1.060	1.029	2.276	3.269	6.087	9.515	11.287	16.636	11.639	12.206
NBRE DE NAVIRES	-NATION.-PECHE		22	25	30	38	44	39	38	36	39	33
	-MILIT.		8	7	3	6	5	4	3	2	2	0
	-AUTRES		12	9	9	9	10	5	9	10	11	8
	-ETRANG.-TH FRA			4	16	10	11	14	13	10	7	10
	-TH ESP				2	5	5	7	6	7	8	2
	-AUTRES		2			2	2	3	6	4	4	2
			44	45	60	70	77	72	75	69	71	55

Table A-1-8-2 Regional Development Orientation (West of Faritany Antsiranana-1/2)

Blocking Factors	Development Factors	Objective and Actions	Projects to be Promoted
• Low productivity of agricultural products and particularly food crops • Non profitable farm gate prices • Ever-increasing input costs • Lack of storage regulations • Monopoly and guaranteed income in some collecting and supply channels • Difficulty in obtaining agricultural loans • Weak leadership and inconsistent objectives • Fluctuating international prices of exports • Superannuation of the irrigation networks and stagnation of managed areas • Generally deficient communication routes combined with a high transport cost • Weakness of farmers' organization in collecting information and defending their interests	• Great diversity of crops and implementarily among the sub-zone • Availability of plain that can be managed(20,000 ha) • Available funds connected with the trade of income-generating products • Possibility to export zebus from Vohémar • Promising projects either at a cruising speed like Soavoanio or at a launching phase like the Antalaha oil palm trees • Same experience of NGO in fishery and profession training • Existence of towns(of more than 20,000 inhabitants); Vohémar, Sambava, Antalaha as solvent outlets for the farmers' products • Existence as regards vanilla of association of products and processors capable of better organizing the profession	• Short term program of rehabilitation of the most vital communication routes in connecting with high productive potential areas • Enforcement of a coherent cost/price policy which ensures a minimum income to farmers • Reform of the trade network and control of middlemen's abuse • Urging the organization within the Association of defence and promotion of farmers(ADPE) • Decentralization of the agricultural credit and easing of credit grant terms • Control the problem of international price fluctuation of a stabilization policy • Initiate important rural development and environment protection works which will release at the same time a supplementary income as a support to the farmers	* Management of the plains of: • Antenina, Antanamangakitro, Ambendrnana in the Fivondronana of Andapa • Anjana, Ankorena, Anipanga in the Fivondronana of Sambava • Ambalajombilana in the Fivondronana of Vohémar • Valambanina, Ifaho VF, Ambinanifaho VF, Isahana VF of a global area of 3,600 ha and a management total cost of 611 billion FMG • Installation of a rice-processing factory at the Biblical school of Soavinandriana • Rehabilitation of the windmills for the supplying of troughs • Construction of an artificial insemination center
• Poor definition of the functions of the various urban centers. Potential conflict between Antalaha and Sambava over the fundamental role of the zone • Weakness if not absence of suitable port developments for Sambava and Antalaha, the 2 largest centers for shipping and receiving goods • Quasi-absence of industrial units apart from Soavoanio which has launched a small coconut oil extraction plant • Inadequacy of urban community means and technical services to structure the cities does not make them play their training pole role • Lack of social leader ship in training and promotion particularly for young people that are more and more rejected by the educational system without any prospect	• Existence of 2 urban centers of sub-regional dimensions; Antalaha(pop.48,000) and Sambava(pop.30,000) and the latter has experienced a consistent demographic dynamism(+5.4% per year) • Support to towns through a secular trade experience related to the income-generating crops and the zebu export in Vohémar • Productive diversity of the agricultural hinterland which has resulted in a continuity of trade and services in the cities • A good air link with Sambava on whose airport a B727 can land • Existence promotional projects such as the "alcohol project" of Antalaha which can contribute to the energization of the region	• Definition of an urban development planning for the zone which allows a frame of organization and the assembling of the different city functions • Development of important facilities, parti-cularly ports to sustain the commercial and fishery functions of the cities • Rehabilitation of service networks to accompany urbanization dynamics which is most noticeable in Sambava • Strengthen public and private organizations involved in social aid and solidarity • Repair of public service equipment, particularly those of health and primary education sectors • Strengthening of the decentralized community means and technical services as they go along with development	

Table A-1-8-3 Regional Development Orientation (West of Faritany Antsiranana-2/2)

Blocking Factors	Development Factors	Objective and Actions	Projects to be Promoted
* Precariousness of the people's living conditions: • Decrease of 3% per year in the total number of students • An average of 10 schools per year close down • Increase of morbidity for all kinds of disease • Hygiene and water problems for 80% of the population • Malnutrition; perceptible when certain kinds of diseases develop • Precariousness of socio-collective means particularly those of public health • Medicine shortage	* A strong aspiration to better social living conditions: • Providing the youth of the population with the prospect of social mobility, particularly at the level of urban growth of Diego and Nosy-Be • Social leadership at the decentralized community level with a view to reducing social difficulties • Presence of NGOs which attempt to compensate for the inadequacy of the public service	* Rehabilitate the socio-collective public service and the social network of solidarity: • Restore State's capacity to intervene in the social field • Specifically, ensure minimum service in health and basic education • Restore human and material capacities of the decentralized communities for social matters • Energize the basic human network of social solidarity • Introduce new association approaches of the social and the productive for the process durability	* Social projects targeted to strata with most precarious conditions: • Provision of medicine for the whole Fivondronana for one year; these provisions should be given to NGO to ensure good distribution • Improvement of drinking water supply at Miadana, Mahazandry, Ambanoro, Mangirankirano, Betsiaka, Matsabory-Ilaidama, Anivorano-Nord, Sakaramy as well as the digging of 18 wells in the Fivondronana of Ambanja • Rehabilitation of health centers in Ambanja; the city of Diego, Ambilobe, Sirama • Rehabilitation of educational centers in Hell-Vill and Ambilobe • Setting up of a village community pharmacies in Diego II • Setting up of a nutritional recuperation center for about 360 children/year in Diego I
* Advanced degradation of the road transport network and the telephone communication network: • Difficult connection between the whole Faritany and its spatial neighborhood, particularly near Mahajanga • Difficult connection between Diego, the regional capital and the Faritany territory • Difficult connection from East to West between the two halves of the province • Disastrous consequences on the hemmed-in position of peripheral zones, on the product distribution and on the supply of the population in public service	* A strong dynamism of port and air transport activity: • Control up to 10 to 15% of the national air and sea transport by the West-Antsiranana planning zone • Strong participation through this in the Malagasy effort towards export(30% of the national volume) • Existence of a commercial tradition and an opening to foreign countries • Predisposition of the region to tourism	* Global system balance of flow and exchange for the internal link and the road network: • Rehabilitation of the North-South(RN 6) road trunk connecting the city of Diego to Faritany of Mahajanga • Rehabilitation of the East-West(RN 5a) trunk • Operating road information service antenna in contact with settlement and production zones • Establish an intervention team for road maintenance and good service	* First road transport difficulty-freeing related projects: • A 22 km track at Ambahivahibe • A 12 km road on the trunk Ambanja-Ankatafa • Rehabilitation of a road of 8 km on the trunk Ambanja-Analavory-Antsatsaka • Rerepairment of a road of 12 km on the trunk Ambalavelona-Ambalahonka-Ambiky • Rehabilitation of the link road Ambalafary-Anjiaboky(8 km) • Development of the trunk Ambaliho-Nosy Faly(8 km)

Table A-1-8-4 Regional Development Orientation (East of Faritany Antsiranana-1/3)

Blocking Factors	Development Factors	Objective and Actions	Projects to be Promoted
* Problems in communication facilities • Acute problems in telephone connections • Quasi-absence of telex connections		* Rehabilitation of communication facilities: • Rehabilitate telephone network • Make the region have access to the higher service of telex and other modern means of communication which are necessary for project development	• Rehabilitation of the link road Antsiratsika-Ambohitrandriana • Repairment of the Namakia bridge • Rehabilitation of the Beramanja-Analavana road • Remaking of 2 tracks; Beramanja-Anaborano(25 km) and Siranonkova-Madiromiarina(8 km) • Rehabilitation of the roads... Bemanondrobe(6 km) Andrianakonko-Mahazandribe(6km) Andrianakongo-Mahazandry(5 km)
* Weakness of productivity and agricultural food production: • Poor rice crop yield zone despite its potential • Low average yield in rice-farming; about 1.2 ton • Limited rice-field area(70,000 ha) in relation to the population's needs • Extensive animal breeding; 300,000 heads for more than 400,000 ha of pasture • Increase of input cost and low monetary surplus per hectare(about 60,000 FMG for rice) • Strong pressure on land due to shortage of arable land(average arable land; 3 ha per farm)	* Realizing existing potential of agricultural areas and improvement of agricultural methods: • Only 200,000 ha are now cultivated from a potential estimated at 1,000,000 ha, 400,000 of which stand as pastures for animal breeding • As for irrigable areas, only half of the potential of 10,000 ha is irrigated • There are some reserves of fertile land which can be cultivated through leadership and rural extension	* Implement a development strategy for the productive potential in agriculture: • Defend against potential calamities; tavy(slash-burn), bushfires, erosion... • Start a hydro-agricultural management process on the rice-farming plains in the rich basins of the Mahavavy and the Sambirano • Urge cashew-growing which is easily adapted to the region's ecological conditions and yields a nut with a high commercial value • Implement a cattle-breeding intensification policy through fodder-growing and enclosure layout • Improve agricultural methods, particularly in respect to the seasons	* Management of some plains as a start for the potential development process: • Rehabilitation of the hydro-agricultural network of Andrianakonko(200 ha) • Rehabilitation of the hydro-agricultural network of Ampasindava(50 ha) • Plain management of Navetsy • Plain management of Mahabe(50 ha) • Plain management of Andrahibo(50 ha) • Plain management of Masovariaka(100 ha) • Construction of 2 irrigation canals in Amparihy and Ambahivahibe • Rehabilitation of a "husking" plant and an irrigation canal in Sadjoavato • Remaking of an Ampamakia polder(50 ha) • Hydro-agricultural rehabilitation of the Ankinaka plain • Hydro-agricultural management of 3 plains in the Fivondronana of Ambilobe

Table A-1-8-5 Regional Development Orientation (East of Faritany Antsiranana-2/3)

Blocking Factors	Development Factors	Objective and Actions	Projects to be Promoted
• Only 20% of the road network can be managed under normal and cost standard conditions • Some problems exist in the current road network in terms of connections between the city of Diego and the rest of the Faritny, the eastern half of the province with the western half, and the whole region with the rest of the country • The low road traffic(3.5% of the national volume) reinforces Antsiranana's reliance on exports to generate income and in the long run this will have a detrimental effect on natural economy • The other networks of service(drinking water, electricity, telephone) suffer from the same inadequacy as that of the road network and thereby constitute a serious stumbling block for the region	• Existence of a know-how in huge public works and development capable of-if materials become available-rehabilitating the network and organize its permanent maintenance • Existence of some social credit for non-free services on condition that rates reflect real costs • Existence of a productive potential capable of justifying the economic profitableness of road, hydraulic electrical... infrastructures to be developed and rehabilitated • Existence of an urban network(of 8 towns of more than 15,000 inhabitants over an area of 44,000 km²) which account for the existence network as regards space	• Drawing up of a sub-regional road development planning to work as an organizational frame with the national road and priority layout planning on the regional and local scale • Implementation of a common service of road maintenance for the different Fivondronana of the zone which could be organized as association of communes • Intensive intervention on the matter of drinking water in view of its consequences on health due to the inadequacy of the service • Electrification planning of urban centers and rural networks • Rehabilitation of the telephone communication network as main support to the new projects development and promotional activities	* Rehabilitation of: • 6 road links in the Fivondronana of Andapa • 3 bridges in the Fivondronana of Andapa • 3 road links in the Fivondronana of Sambava • of a pole ferry-boat in the Fivondronana of Sambava • of a port(Tanambo-Doana) in Sambava • 4 links in the Fivondronana of Vohémar • 3 links in the Fivondronana of Antalaha
• Unfavorable tendencies are seen in the educational system; the total number of pupils is decreasing, schools are closing down, more incidents of students repeating grades are observed, and the dropout rate has risen sharply while enrolment rate has fallen under 50% • A healthcare system near collapse, only covering 20% of the needs in medicine and care • Growing morbidity connected to under nourishment, lack of drinking water, hygiene problems in areas without proper Sanitation facilities • Lack of a professional trainning policy which can help increase opportunities of integrating young victims of the failing educational system • Absence of a social solidarity program, of a program aiming at helping the most deprived and protecting children	• Existence of medical personnel(377 agents) hardened by the difficulties and capable of progressively improving their medical service performances should practical means be made available to them • The same applies to the "educational" leadership where the number of teachers and administrative personnel is over 1,700, which means an important human potential though still insufficient as far as needs are concerned • The existance of actions of social solidity which demands to be coordinated and above all reinforced to assure their continuity in the time as well as in the territorial space	• Implement a program that is necessarily national and can stop in a first phase the unfavorable change in the basic social services and in a second phase start to straightten out the situation whose effects can become worse and be so for a long time if no forceful intervention is made • Favor at the local and regional scale the action of solidity by making participate by effort those who profit the most by the effects of the "libéralisation" and by the first results of the growth	• Building of 6 drinking water conveyance in the Fivondronana of Andapa • Donation of medicaments to the 4 Fivondronana of the zone • Contribution to the arrangement of the Fivondronana and Firaisana premises in Andapa • Rehabilitation of a SAFF and the high school of Andapa • Rehabilitation of health centers in Sambava • Rehabilitation of 2 SFF in Sambava • Support to the community in Sambava • 1 laying on water in the Fivondronana of Vohémar • Food production project • Rehabilitation of Vohémar HS • Laying on water in 11 Fokotany in Antalaha • Rehabilitation of the public school administration premises • Lodgings for the saint Jean private school pupils • Animation and production projects for young people and women in Antalaha • Rehabilitation of the equipment of the Fivondronana premises in Antalaha

Table A-1-8-6 Regional Development Orientation (East of Faritany Antsiranana-3/3)

Blocking Factors	Development Factors	Objective and Actions	Projects to be Promoted
• Interference of the scope of activities between decentralized communities who are supposed to have the "decisionmaking power" on the regional scale on one hand and the decentralized technical services which depend on ministries on the other hand • Lack of a drawing-up and follow-up frame of a regional development strategy • Inadequacy of the decentralized community means with nominal budgets • Weakness of the local associative movement which could have played the development partner role • Multiplicity of operators without obligation of coordination and without referring to a hierarchy of the objectives	• Existence of a regional "consciousness" and a will of the elites to review the structures and modernize the production and service apparatus • Existence of some experience in regional and local administration even if the means are inadequate and the prerogatives not always specified • The regional representation of the Ministry of the Planning in the absence of other executives, can promote a coherent approach to regional development	• Elaboration on the regional and sub-regional scale of a strategy of territory and socio-economic development articulated to the national strategy • Setting-up of a institutional frame on the regional(or sub-regional) scale in charge of the follow-up of this strategy implementation • Substantially improve the means of intervention of decentralized communities • Support the emergence of an associative and representative movement that is capable of setting itself up as a genuine development partner and arousing the population's concern to the general problems of the region • Favor the sectorial decentralization policies particularly those related to credits and in the long run the emergence of a regional credit capable of taking responsibility for the specific conditions of project promotion	

Table A-1-8-7 EPZ of Philipines

Table Cacite EPZ Performance

	1987	1988	1989	1992
Number of Firms Operating	1	4	14	90
Average Employment	99	323	3294	20204
Salaries and Wages (P000)	876	6017	43497	711316
Local Sales (P000)			1364	
Local Purchases (P000)		277	4418	
Exports (US$000)	739	3021	15306	251855
Imports (US$000)	712	2843	11631	232668
Trade Balance (US$000)	27	178	3675	19187

SOurce: EPZA

Table *Features of the Operating Companies by PSIC code* (As of Aug., 1991)

PSIC Code	Number of Company	(%)	Average Employment per Firms (Persons)	Average Area (m2) per Firms	Total Employment (Persons)	(%)	Total Land Area Occupied (m2)	(%)
312	1	1.7		5,000	0	0.0	5,000	1.1
321	3	5.2	142	8,333	425	3.3	25,000	5.4
322	23	39.7	216	4,689	4,317	33.6	107,836	23.3
331	1	1.7		5,000	0	0.0	5,000	1.1
341	2	3.4	98	4,002	195	1.5	8,003	1.7
355	1	1.7	2034	31,077	2,034	15.8	31,077	6.7
356	1	1.7		5,000	0	0.0	5,000	1.1
369	1	1.7		5,000	0	0.0	5,000	1.1
371	1	1.7	7	10,000	7	0.1	10,000	2.2
372	1	1.7	40	10,000	40	0.3	10,000	2.2
381	5	8.6	113	10,000	565	4.4	50,000	10.8
382	2	3.4	293	11,642	586	4.6	23,284	5.0
383	8	13.8	580	18,725	4,062	31.6	131,076	28.4
384	1	1.7	26	5,000	26	0.2	5,000	1.1
385	1	1.7	39	3,003	39	0.3	3,003	0.6
390	6	10.3	113	6,331	564	4.4	37,984	8.2
	58	100.0	308	8,110	12,860	100.0	462,263	100.0

Source: EPZA.

Note: PSIC (Phipipine Standand Industrial Classification)

312 Food
321 Textiles
331 Wood & Wood Product
332 Furniture & Fixtures
341 Paper & Paper Produ
351 Industrial Chemical
355 Rubber Products
356 Plastic Products
369 *Non-metalic Mineral* Products
371 Iron & Steel Basic Products
372 Non-ferrous Metal Products
381 Fabricated Metal Products
382 Mashinery except electrical
383 Electrical Mashinery
384 Transport Equipment
385 Other Equipment & Infrastructure
390 Other Manufacturing Industries

A-2.2 Cargo Traffic and Facilities

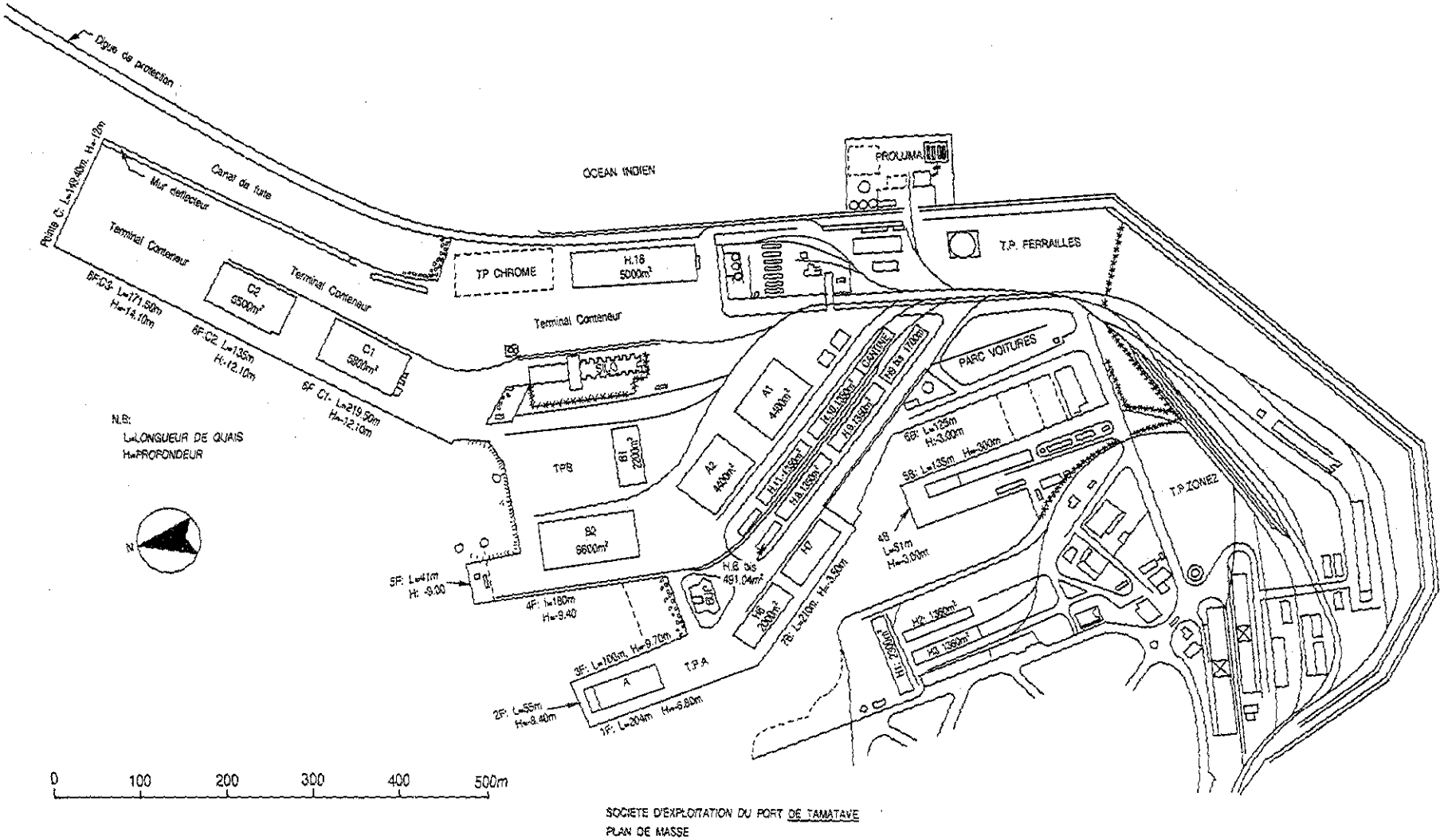


Figure A-2-2-1 Ground Plan of the port of Toamasina

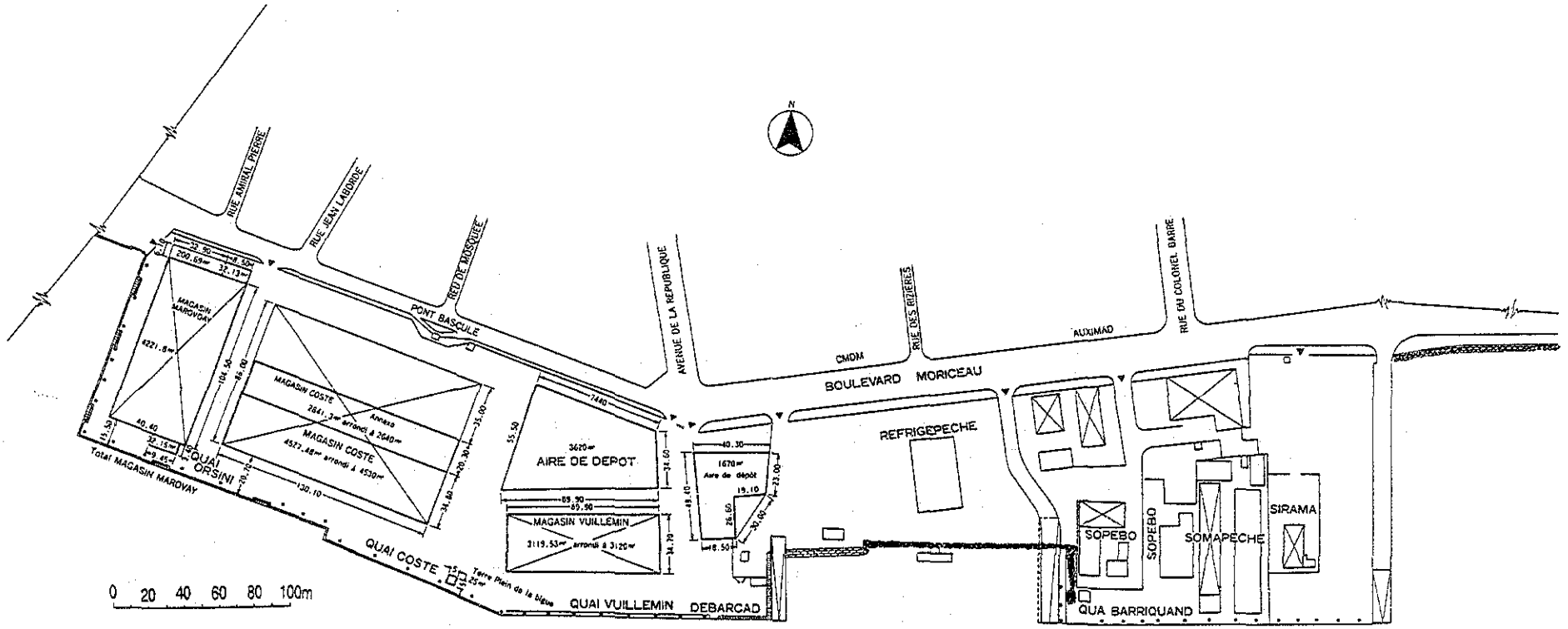


Figure A-2-2-2 Ground Plan of the port of Mahajanga

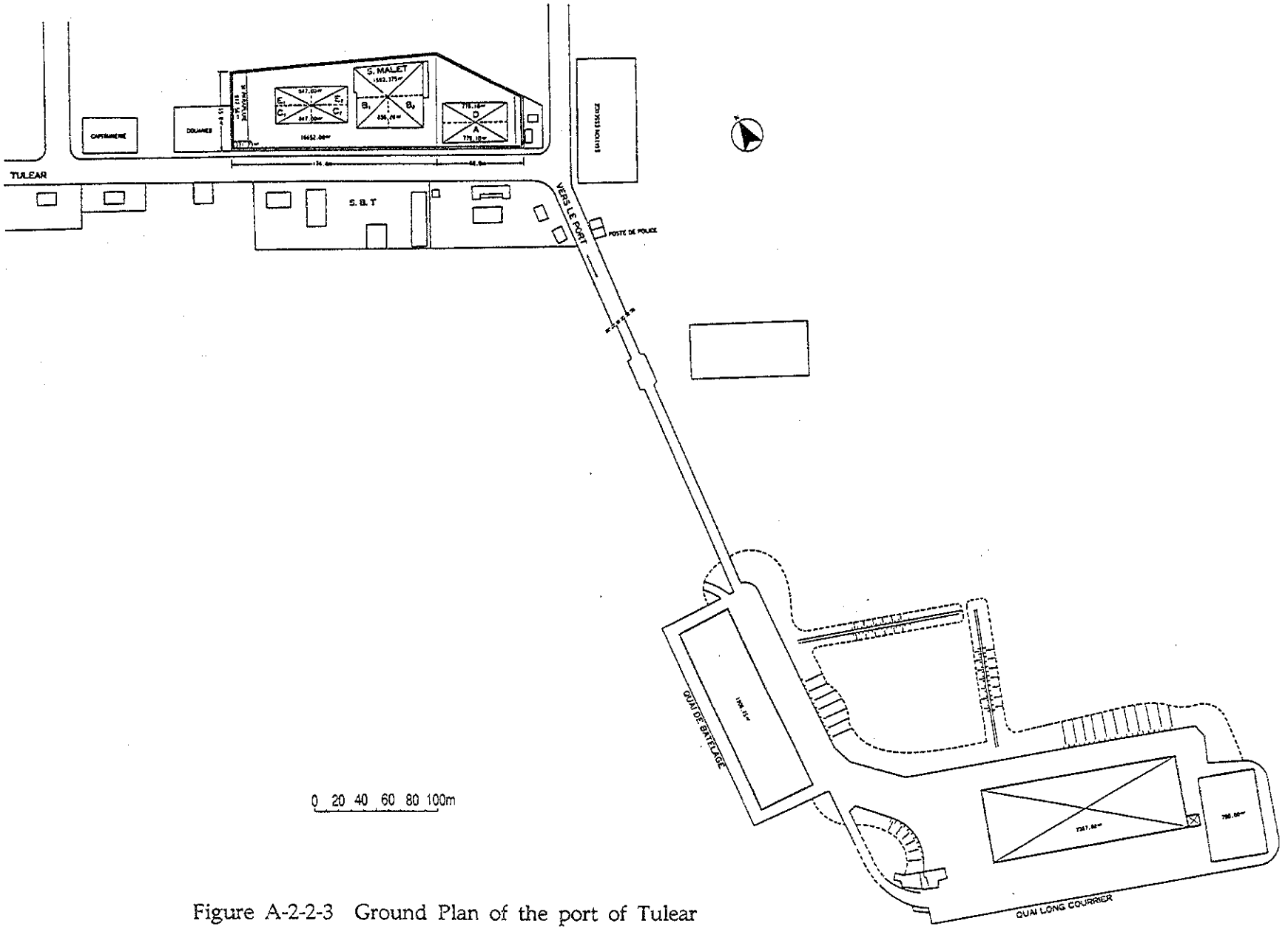


Figure A-2-2-3 Ground Plan of the port of Tulear

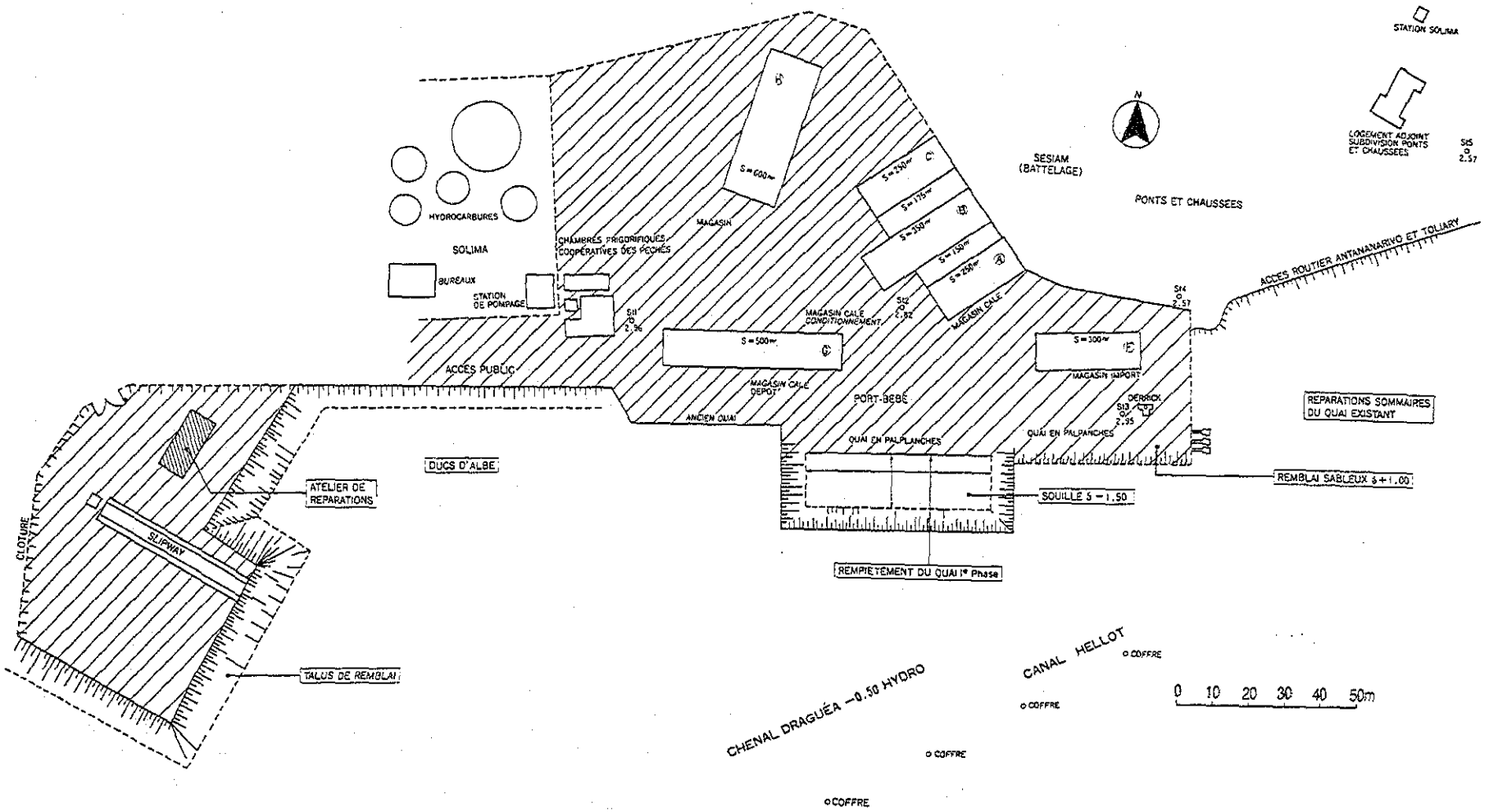


Figure A-2-2-4 Ground Plan of the port of Morondava

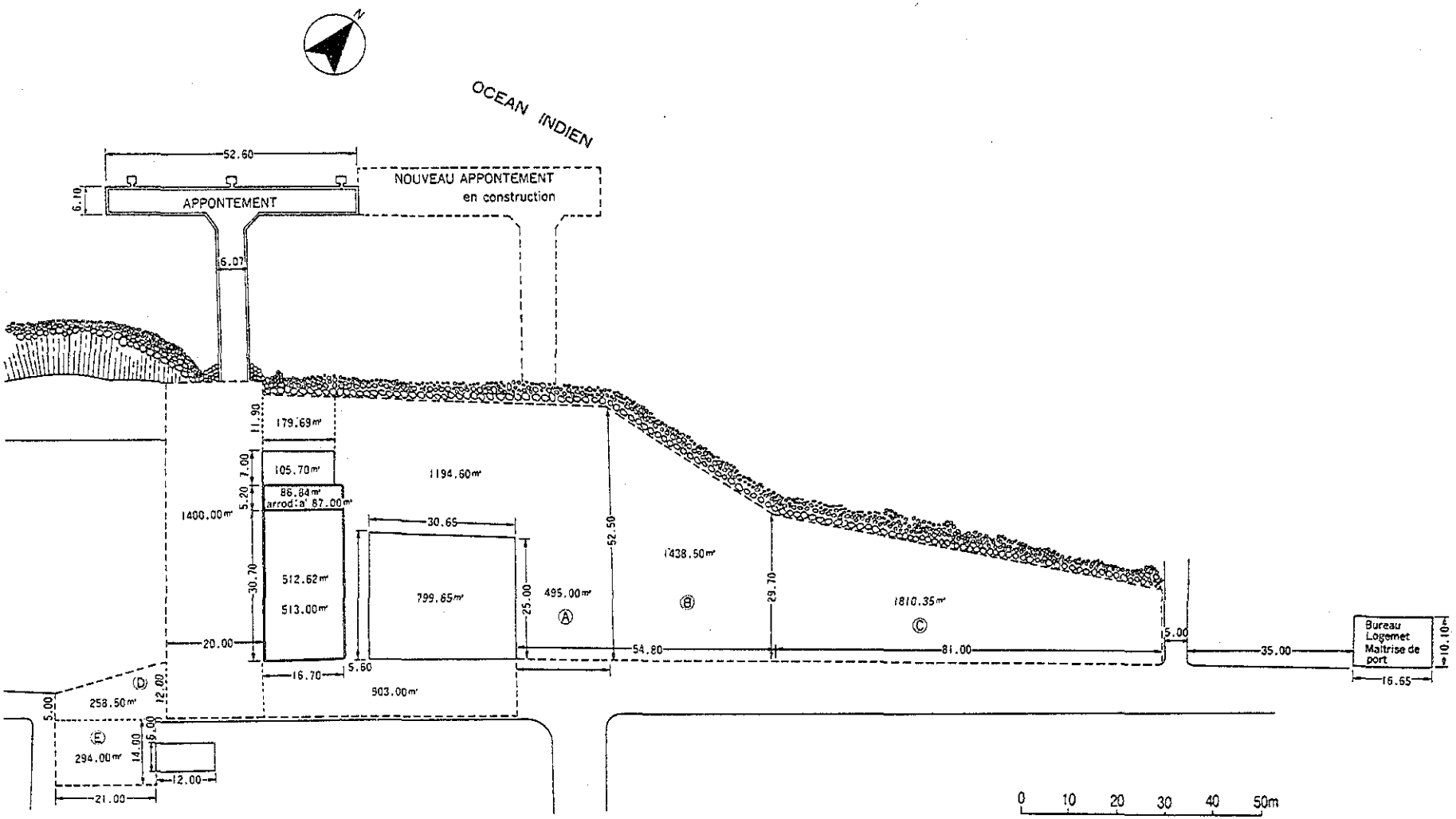


Figure A-2-2-5 Ground Plan of the port of Vohemar

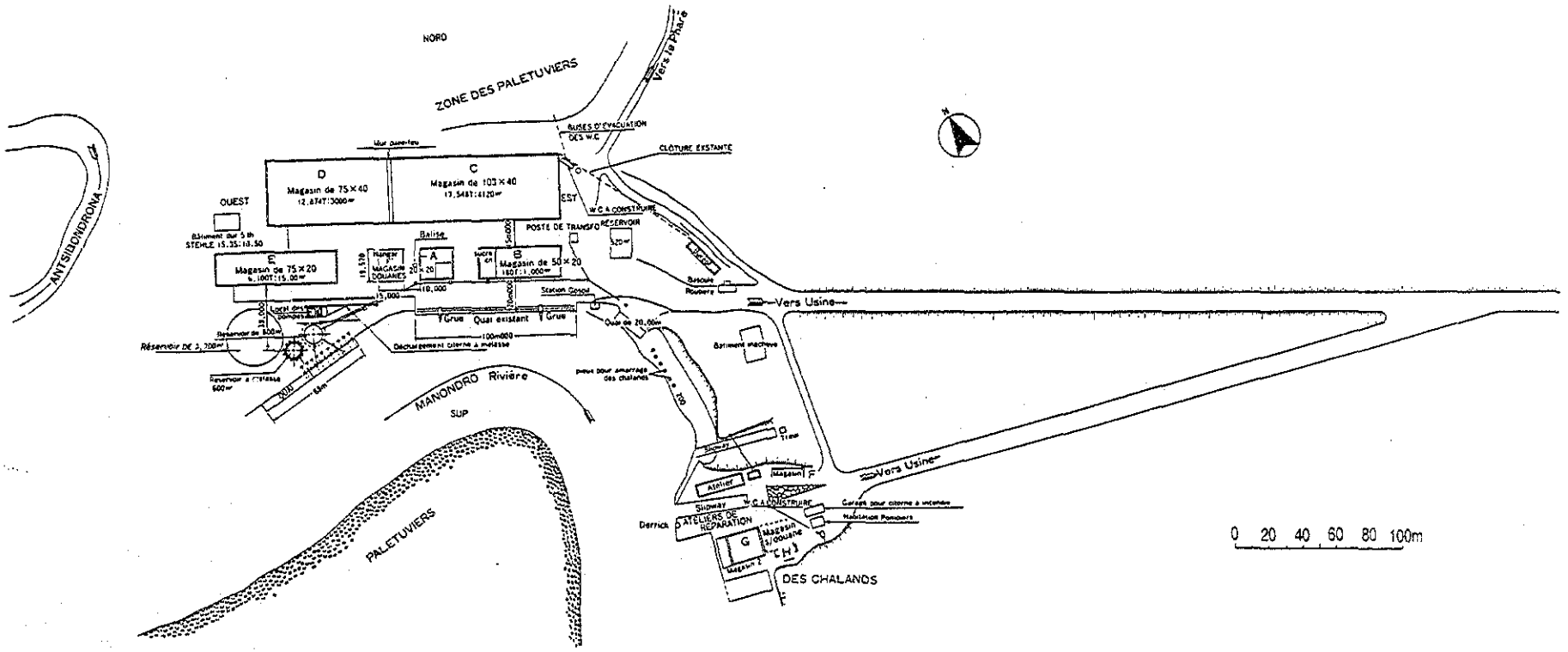


Figure A-2-2-6 Ground Plan of the port of Saintlouis

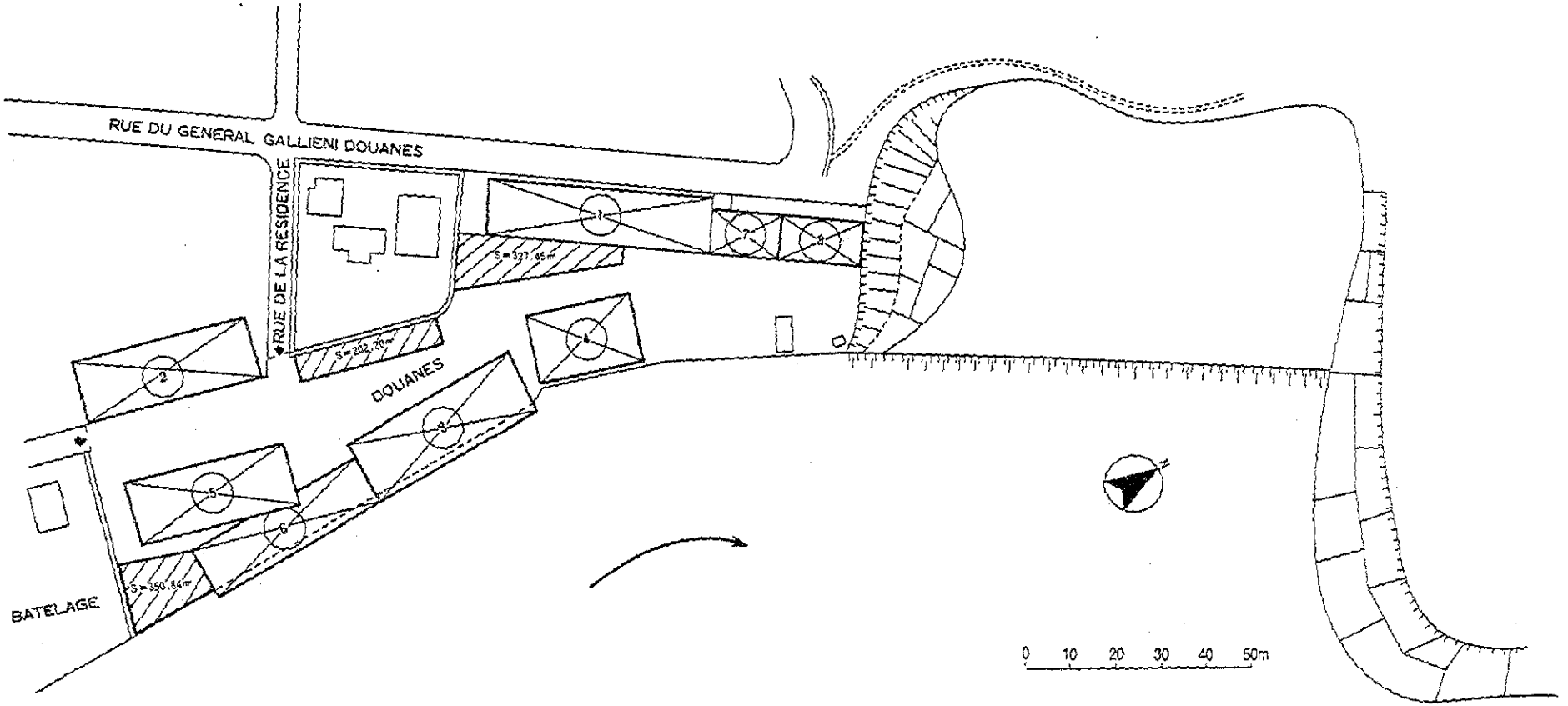


Figure A-2-2-7 Ground Plan of the port of Mananjary

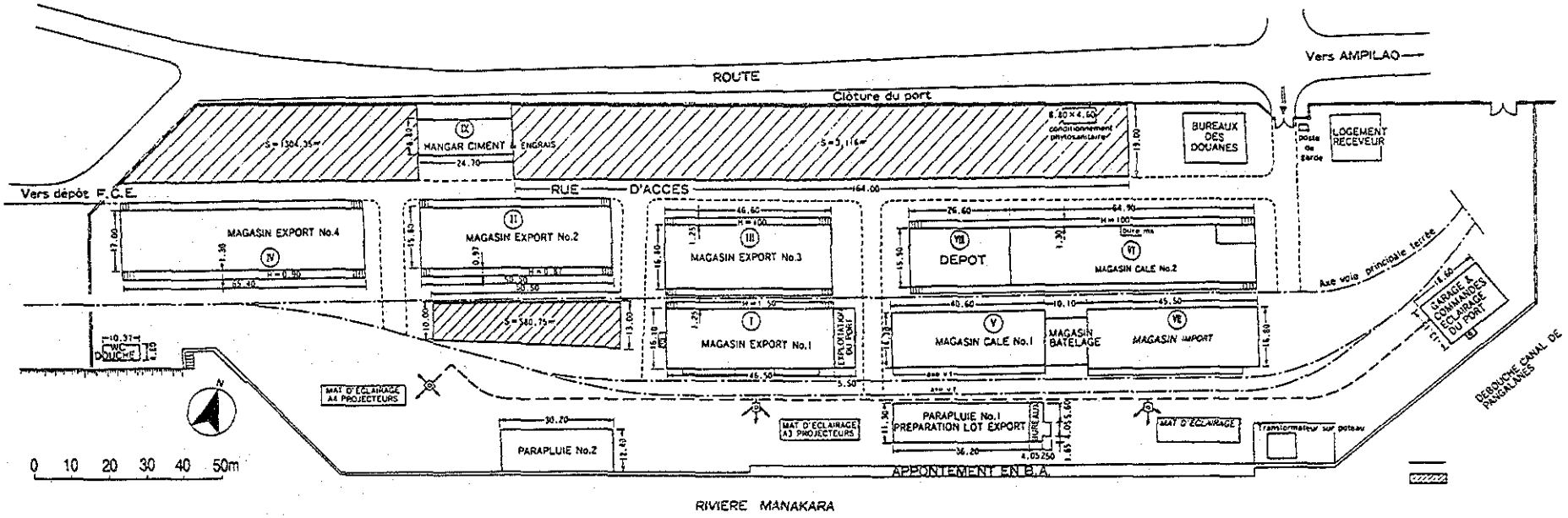


Figure A-2-2-8 Ground Plan of the port of Manakara

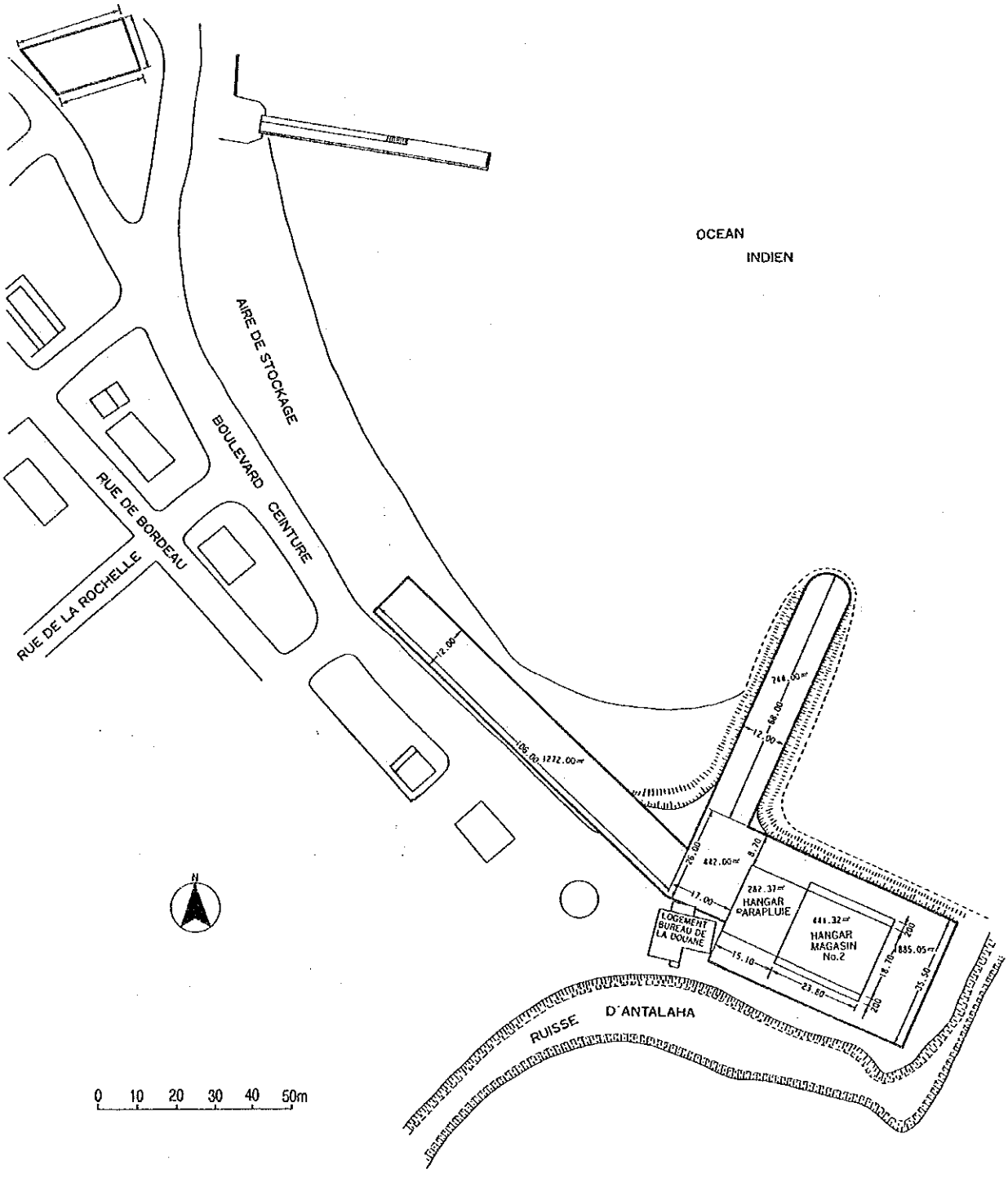


Figure A-2-2-9 Ground Plan of the port of Antalaha

A-3.2 Natural Conditions

A-3.2.1 Wave Computation

(1) Wave Computation on Ordinary Surface Wind Condition

Waves reaching the port of Antsiranana under normal condition are mostly generated by surface winds inside of the bay of Diego-Suarez. And the influence of ocean waves invading from the mouth of the bay is negligibly small, that is to say the height of waves reaching the port of Antsiranana decays only 5 % of that of waves at the mouth as proved in the following paragraph 3) of (2). Also, since the wind region, that is the Bay, is relatively small and the fetch, that is the distance of wind blowing, is not more than 10 km, it is not necessary to consider the effect of attenuation due to the change of duration and direction of winds. Therefore, the waves reaching the Port can be directly computed by means of S.M.B method using wind data of Table 3-2-2 presented in preceding subsection 3-2-2, provided that those wind speeds are multiplied by 1.5 for the adoption to this wave computation for the following reasons:

- Wind records have been made at the airport of Antsiranana 10 km away from the Port, and generally the conversion factor of from 1.2 to 1.5 is adopted for this case,

- Wind records have been made hourly and ten minutes averages have been taken and

- In the case that the duration of wind blowing is short, actual wind speed on sea possibly exceeds the average wind speed.

Effective fetch required to apply the S.M.B method, which is the average distance of each fetch divided every 5° in range from + 45° to - 45° with the center being zero "0", can be obtained by using following Saville Formula:

$$F_{eff} = \frac{\Sigma\ Fi \cdot COS^2\ \theta i}{\Sigma\ COS\ \theta i}$$

where,

Feff: Effective fetch

Fi: Fetch of component direction

θ_i: Component direction

An example of calculating the effective fetch for the case of ENE is illustrated in Figure A-3-2-1.

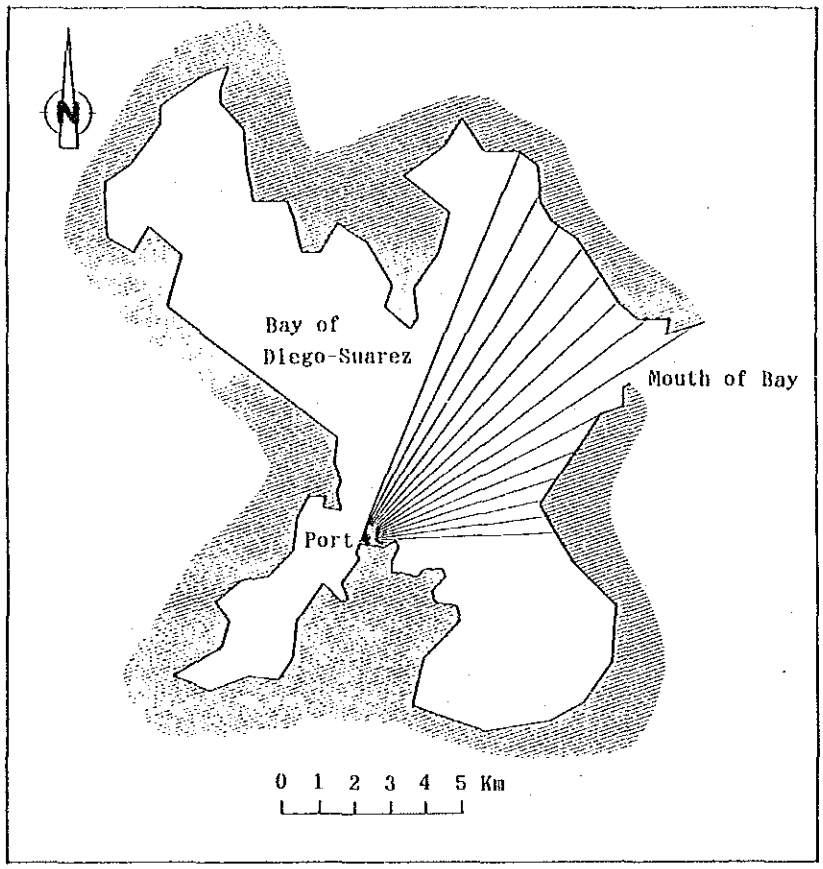


Figure A-3-2-1 Illustrated Example of Calculation of Fetch (Direction ENE)

Table A-3-2-1 shows effective fetches for each direction.

Table A-3-2-1 Effective Fetch (km)

Direction	N	NNE	NE	ENE	E	ESE	SE	SSE
Feff	5.8	7.5	7.6	5.9	3.3	1.4	0.3	0.2
Direction	S	SSW	SW	WSW	W	WNW	NW	NNW
Feff	0.7	1.7	2.5	2.6	2.2	1.5	2.1	3.5

Consequently, the frequencies of occurrence of waves on ordinary surface wind condition are obtained as shown in Table 3-2-7 of subsection 3-2-3.

(2) Wave Computation on Extraordinary Wind Condition

Waves under extraordinary wind condition in Antsiranana are brought by cyclones generated in the Indian Ocean. Here the wave dimensions will be obtained by computing such cyclones as described in the following flow chart:

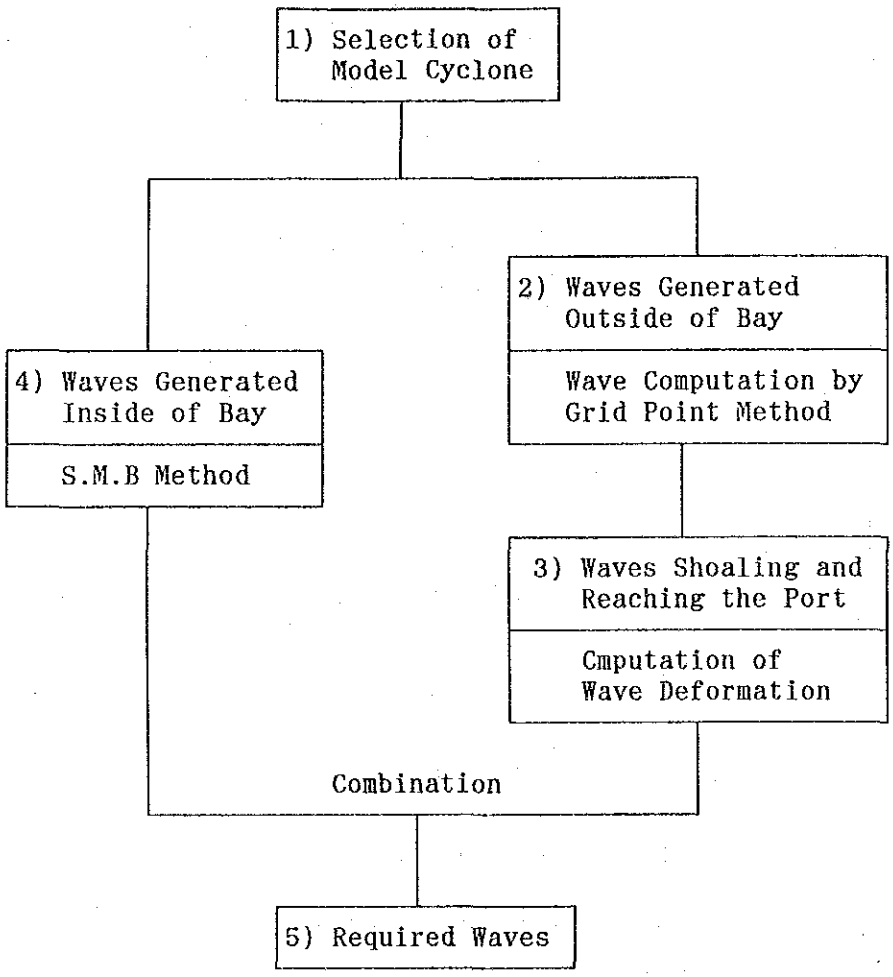


Figure A-3-2-2 Flow Chart of Wave Computation

1) Selection of Model Cyclone

Table A-3-2-2 is a list of cyclones that attacked Antsiranana from 1979 to 1990. Among those cyclones, three large-sized cyclones having the instantaneous maximum wind speed of over 250 km/h (70 m/s), namely, cyclone "ANDRY", "KAMISY" and "BENEDICTE" will be discussed here. But since there are no data on the central pressure and the track for those cyclones, some assumptions on those data have been made by adjusting the simulated wind speeds to the actually recorded ones. From the above assumptions, it was found that two cyclones, "ANDRY" and "KAMISY", had similar properties, and thus both cyclones will be called "B type" and the cyclone "BENEDICTE" "A type" for the sake of convenience.

2) Wave Computation by Grid Point Method

Figure A-3-2-3 shows the area for wave computation where the interval of grid point is set at 30 km. Figure A-3-2-4 shows the computed hourly changes of winds inside of the bay by type A. From the Figure, the maximum wind speed is found to be 25 m/s, which is nearly the same as that indicated in the weather map(See Figure A-3-2-5). Figure A-3-2-6 shows the computed hourly changes of waves at the mouth of the bay by type A and B, where the maximum height of wave is found to be 5.0 m for the case of A type and 4.3 m for B type. And the periods and directions of both waves have nearly the same value, that is 8 seconds in period and North-North-East in direction. Since type A is found to be bigger than type B from the above results, the cyclone "BENEDICTE" (type A) will be adopted as the final model cyclone. Figure A-3-2-7 shows the computed plane of distribution of wave dimensions of type A.

3) Computation of Wave Deformations

The above computed waves of type A will decay due to the influences of wave refraction and diffraction caused by water depth, sea bottom shape and so on. Here the wave dimensions reaching the port of Antsiranana will be obtained by applying the above computed wave dimensions to energy equilibrium equation that includes the effect of wave irregularity. The wave conditions of computation are shown in Table A-3-2-3. As for the direction of incident waves, the most influential direction is conjectured to be North-North-East but three other directions, NE, ENE and E, will also be included with the consideration of topographical conditions.

Table A-3-2-2 List of Cyclones that have Attacked the Port of Antsiranana (1979 to 1990)

Period	Name	Zone	Max. Wind Speed	Date of Passage
1979 - 1980	D.T BERENICE	ANTALAHA	19 km/h	16/12/79
1980 - 1981	D.T BETTINA	ANTSIRANANA	90 km/h	29/11/80
1981 - 1982	C.T BENEDICTE	ANTSIRANANA	252 km/h	19/12 to 20/12/81
		VOHEMAR	65 km/h	ditto
	D.T JUSTINE	VOHEMAR	104 km/h	18/03/82
		SAMBAVA	86 km/h	ditto
		ANTALAHA	76 km/h	ditto
		ANTSIRANANA	97 km/h	ditto
1982 - 1983	D.T ARILISY	ANTSIRANANA	79 km/h	01/11/82
		VOHEMAR	52 km/h	31/10/82
		ANTALAHA	40 km/h	ditto
	C.T BEMANY	ANTALAHA	54 km/h	03/12/82
1983 - 1984	C.T ANDRY	ANTSIRANANA	>250 km/h	10/12/83
	C.T KAMISY	ANTSIRANANA	>250 km/h	U.K
		SAMBAVA	U.K	U.K
		VOHEMAR	60 km/h	U.K
1984 - 1985	D.T ANETY	ANTSIRANANA	22 km/h	20/11/84
		VOHEMAR	43 km/h	ditto
		SAMBAVA	50 km/h	ditto
		ANTALAHA	50 km/h	ditto
1985 - 1986	C.T COSTA	ANTSIRANANA	54 km/h	07/01 to 12/01/86
		VOHEMAR	28 km/h	ditto
		SAMBAVA	36 km/h	ditto
		ANTALAHA	36 km/h	ditto
1987 - 1988	C.T CALIDERA	SAMBAVA	37 km/h	13/01/88
		VOHEMAR	32 km/h	ditto
	C.T FILAO	ANTSIRANANA	58 km/h	24/02/88
		SAMBAVA	U.K	ditto
		ANTALAHA	43 km/h	ditto
		ANDAPA	14 km/h	ditto
	D.T HELY	ANTSIRANANA	40 km/h	20/03/88
		SAMBAVA	U.K	ditto

Note: D.T: Tropical Depression (Wind Speed, 20 to 60 km/h)
C.T: Tropical Cyclone (Wind Speed, 119 to 168 km/h)
U.K: Unknown

Table A-3-2-3 Wave Conditions of Computation

Wave Direction	NNE, NE, ENE, E
Wave Period	8.0 seconds
Spreading Parameter	10

The computed results are as shown in Figures A-3-2-8-(1) to A-3-2-8-(3) for the wave direction of NNE, Figures A-3-2-9-(1) to A-3-2-9-(3) for the wave direction of NE, Figures A-3-2-10-(1) to A-3-2-10-(3) for the wave direction of ENE and Figures A-3-2-11-(1) to A-3-2-11-(3) for the wave direction of E. Figures (1) of A-3-2-8 to A-3-2-11 show distributions of rate of wave height against the wave height, 100 %, outside of the bay by cyclone, which indicate that the wave height at the port is 5 %. Figures (2) of A-3-2-8 to A-3-2-11 show distributions of coefficient of wave refraction against a 100 % of waves outside of the bay by cyclone, which indicate that the coefficient at the port is 5 %. Figures (3) of A-3-2-8 to A-3-2-11 show distributions of wave direction, which indicate that the wave direction at the port is NNE regardless of direction of incident waves. To summarize, the rate of wave height at the port decays 5 % of wave height outside of the bay that has been computed in preceding paragraph 2) regardless of the direction of incident waves. This is probably because the mouth of the bay is remarkably narrow compared with the width of the bay inside so that the waves decay rapidly at the mouth and expand radially.

From the above results, the wave height at the port can be calculated to be 25 cm by multiplying 5.0 meters of wave height at the mouth by 0.05 of the rate of wave height computed above(i.e. 5.0 meters X 0.05 = 0.25 meters).

4) Computation of Waves Generated Inside of the Bay

Using the S.M.B method, the computation of waves generated inside of the bay for the case of type A was performed under the following conditions:

- Maximum wind speed: 25 m/s
- Fetch: 7.6 km (the longest fetch, NNE)

As a result, the wave dimensions are 1.58 meters in height and 3.9 seconds in period.

5) Combination of Waves

Consequently, the wave during extraordinary wind condition can be obtained to be 1.6 meters in height by combining both waves computed above, in which the following formula is applied.

$$H_t = \sqrt{H_1^2 + H_2^2}$$

where,

H_t: Height of combined wave

H_1: Height of wave reaching the Port which was generated outside of the bay

H_2: Height of wave generated inside of the Bay

Since the wave period is largely influenced by wind waves generated inside of the bay and the energy of waves generated outside of the bay has decayed as explained before, the wave period of wind waves generated inside of the Bay, that is 3.9 seconds, will be adopted.

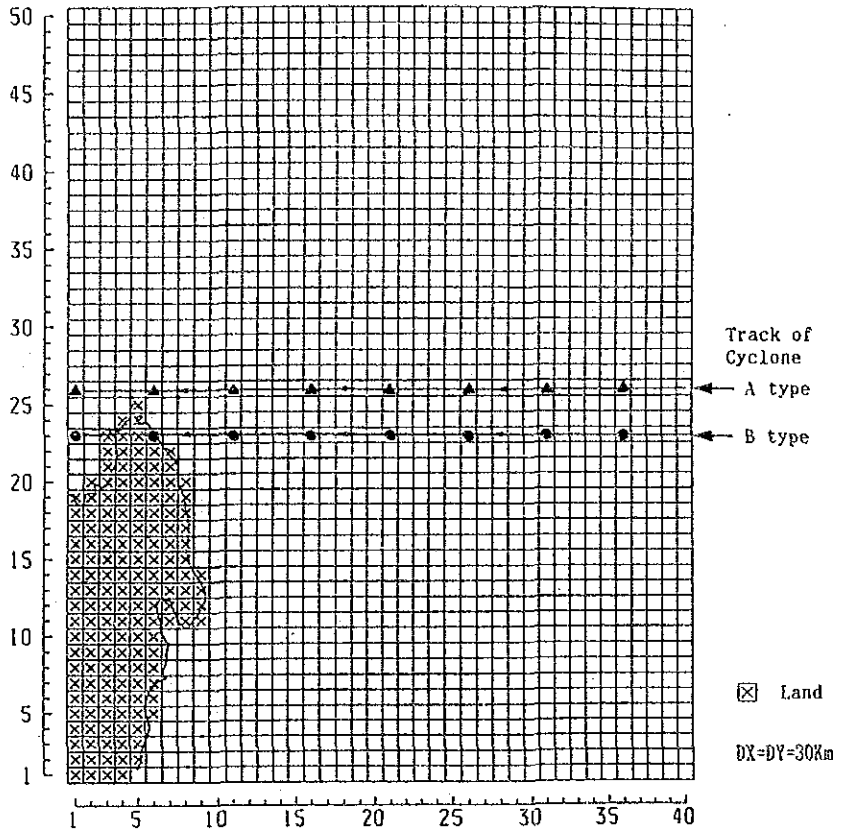


Figure A-3-2-3 Area for Wave Computation

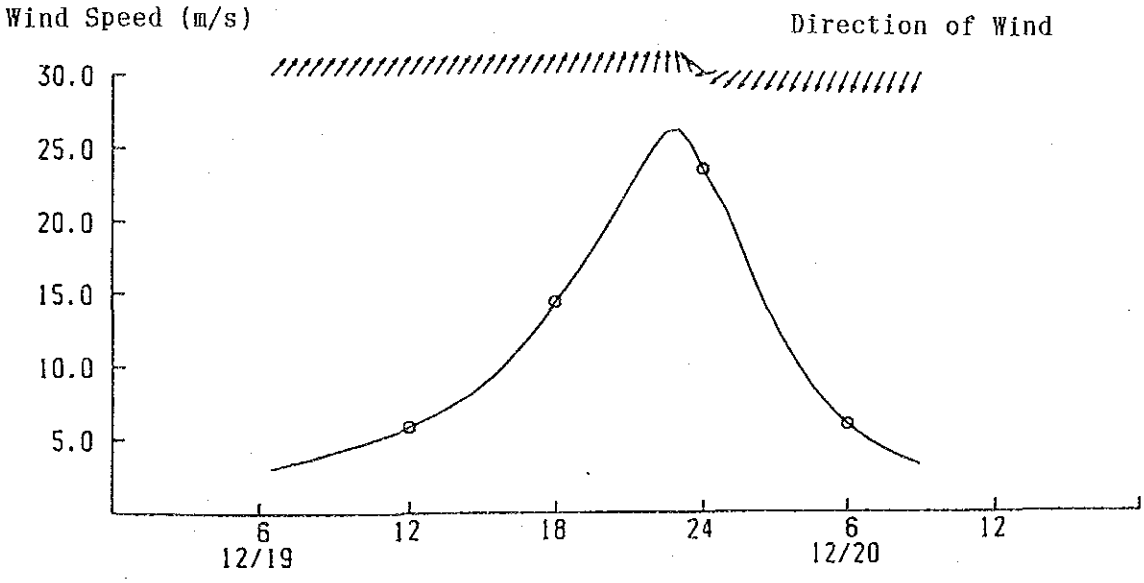


Figure A-3-2-4 Hourly Changes of Winds
(Type A: "BENEDICTE")

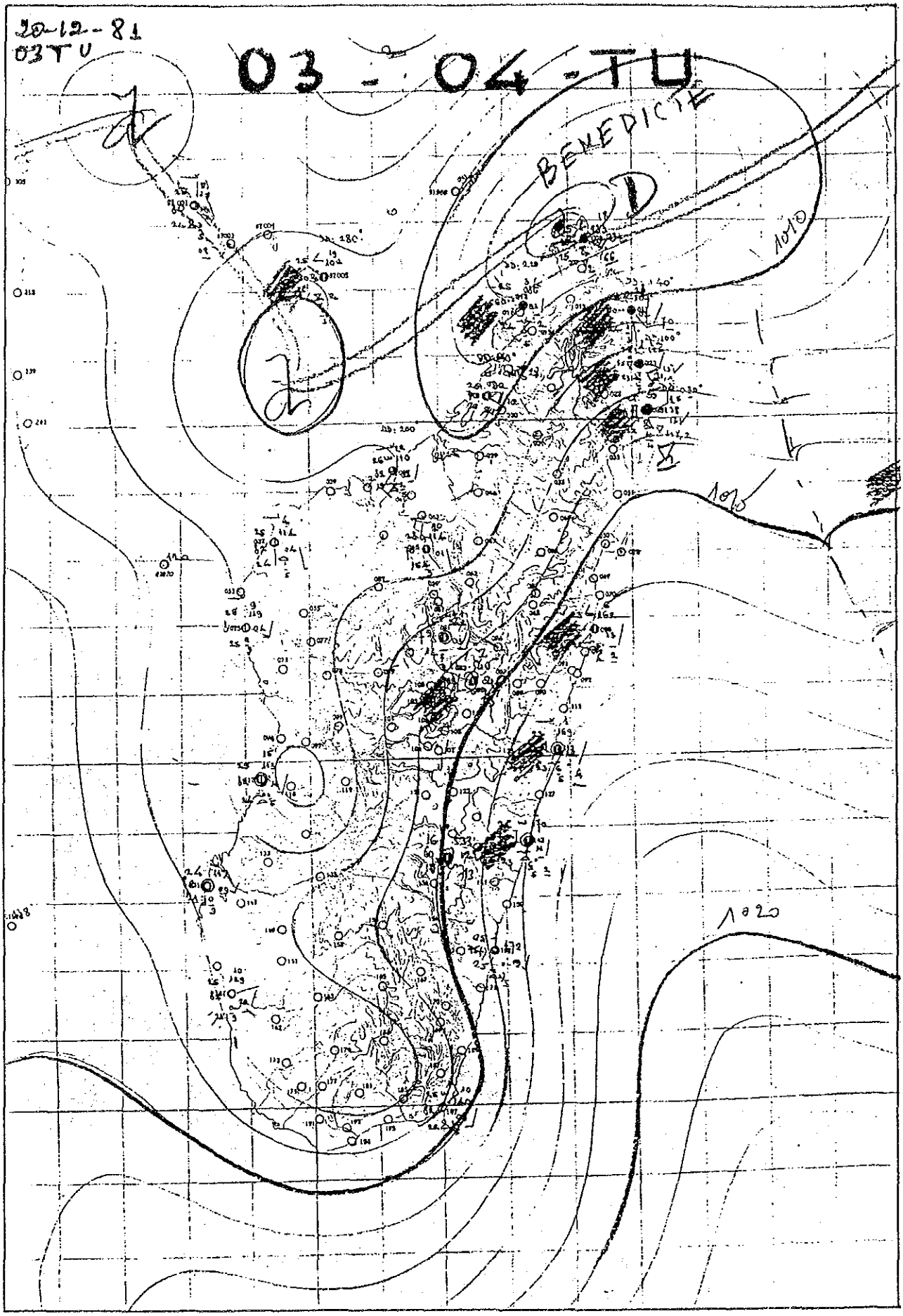
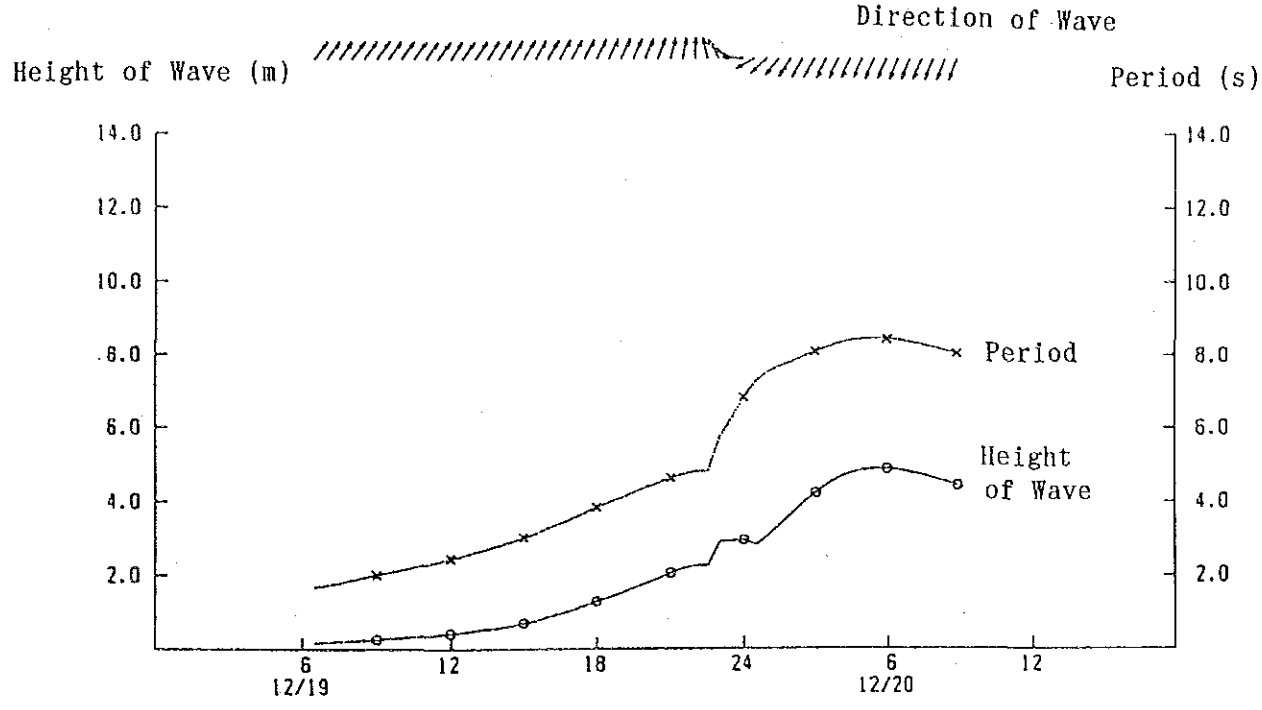
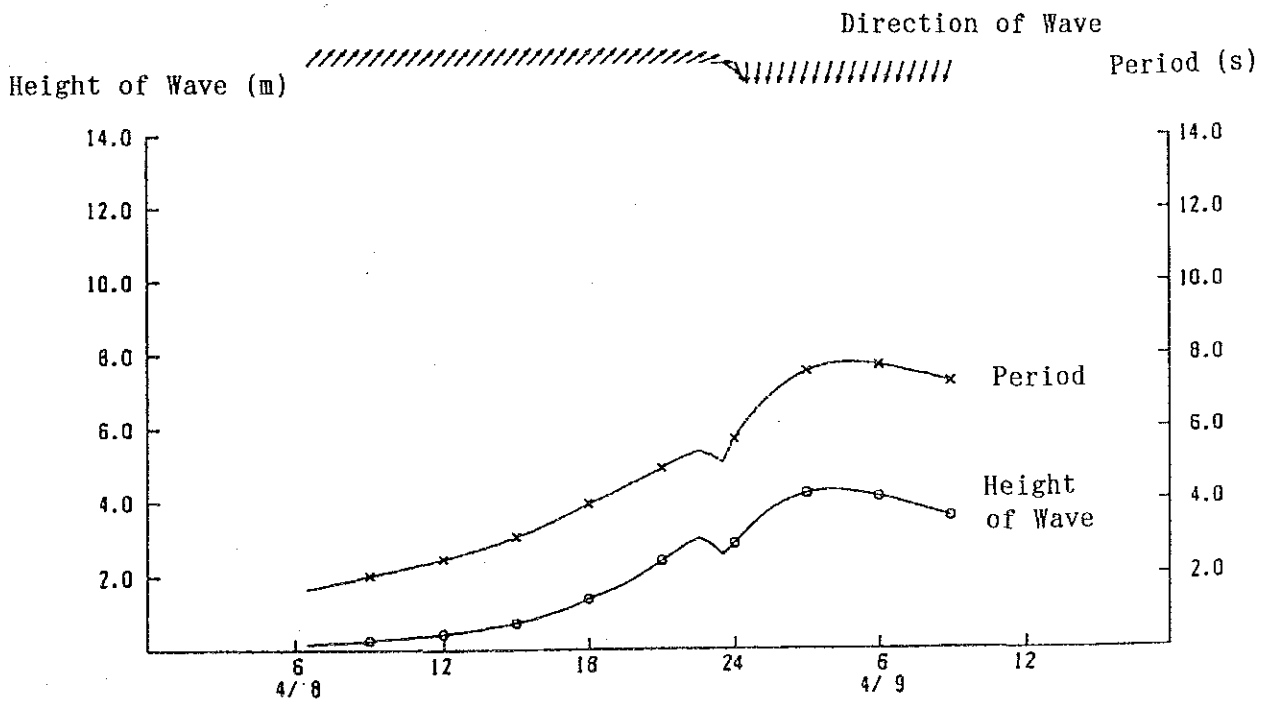


Figure A-3-2-5 Weather Map (BENEDICTE, 20th/Dec./1981)



(A type: BENEDICTE)



(B type: ANDRY, KAMISY)

Figure A-3-2-6 Hourly Changes of Waves at the Mouth

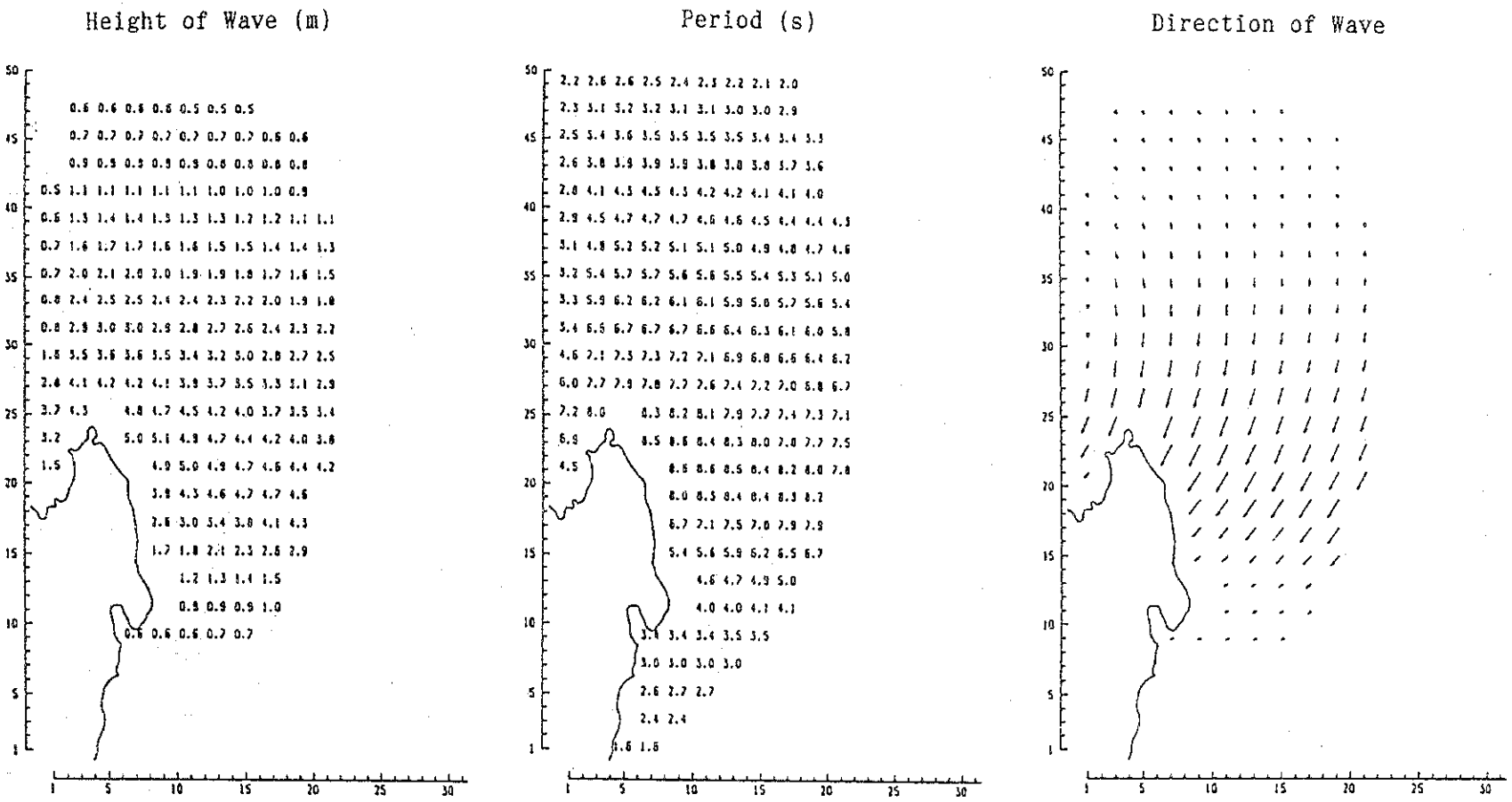


Figure A-3-2-7 Plane of Distribution of Wave Dimension
(Type A, BENEDICTE)

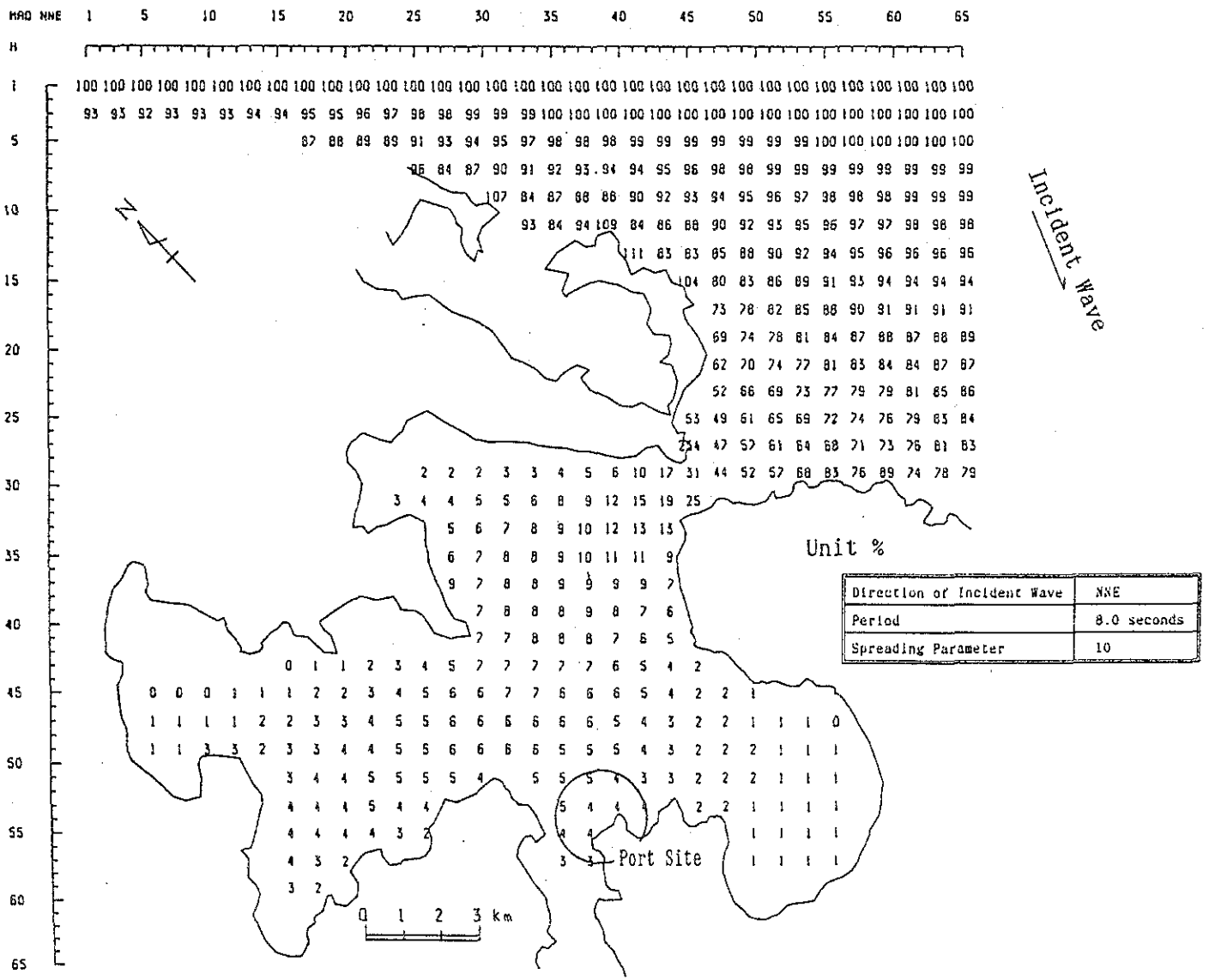


Figure A-3-2-8-(1) Plane of Distribution of Rate of Wave Height
(Direction of Incident Waves: NNE)

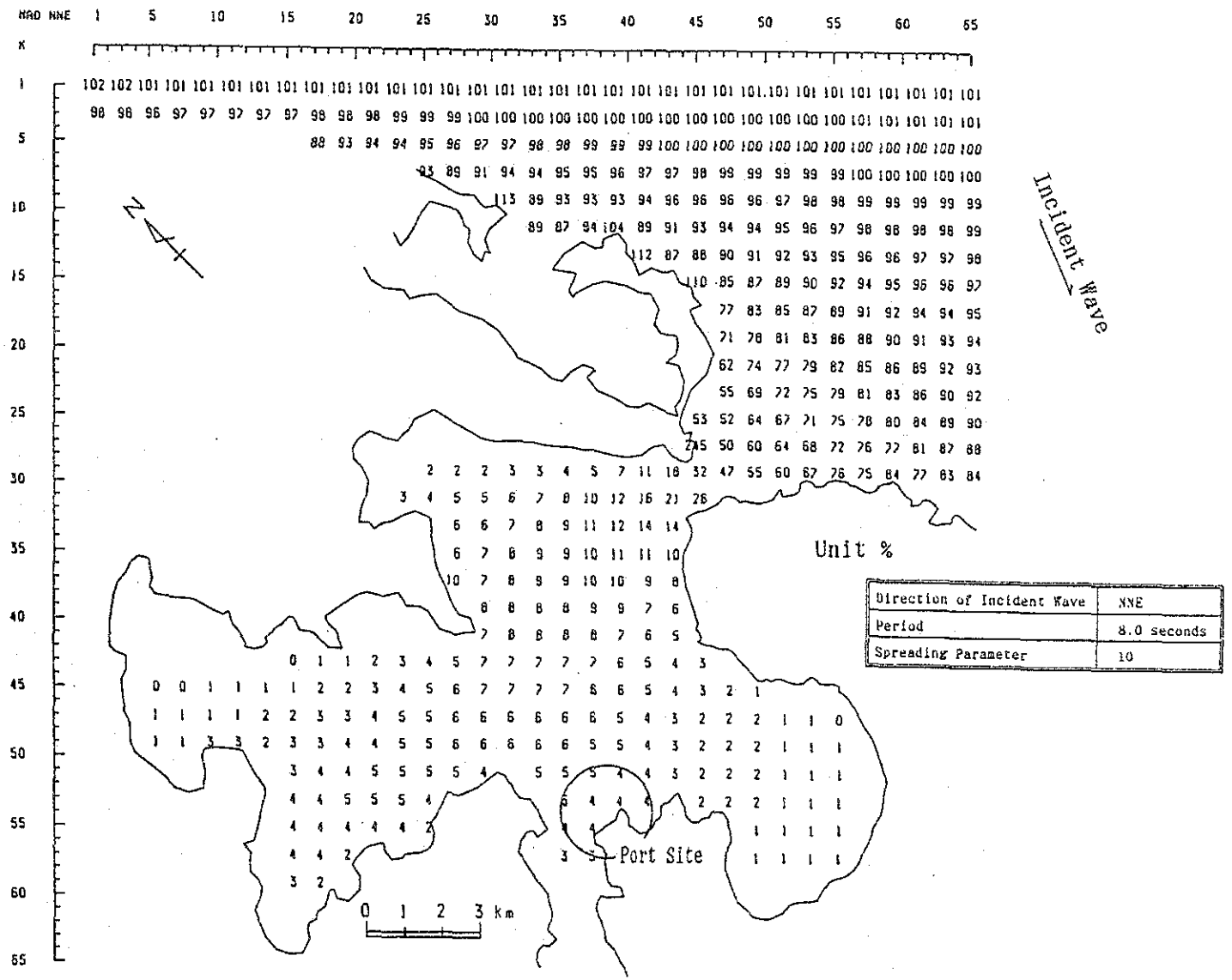


Figure A-3-2-8-(2) Plane of Distribution of Coefficient of Wave Refraction
(Direction of Incident Waves: NNE)

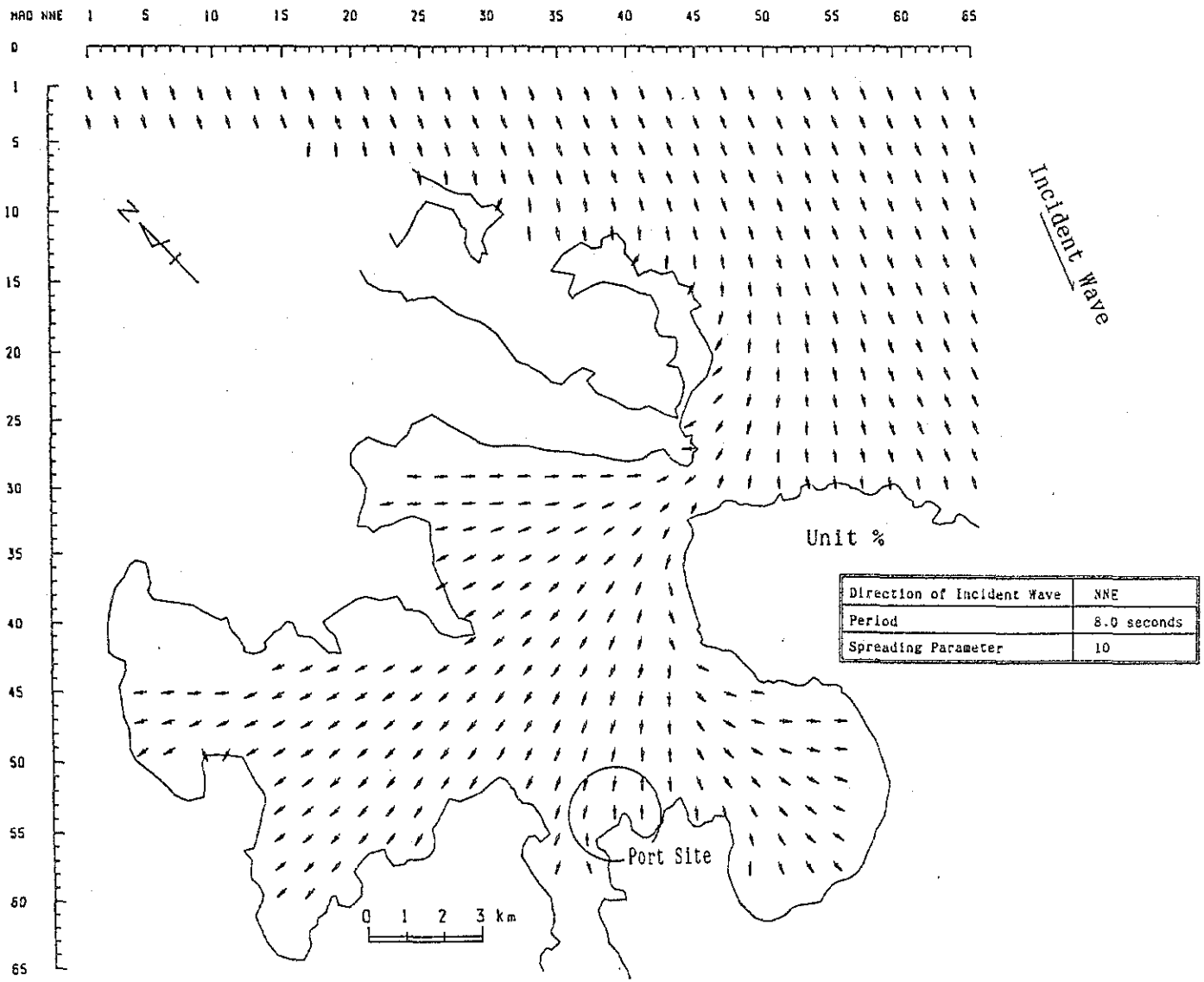


Figure A-3-2-8-(3) Plane of Distribution of Wave Direction
(Direction of Incident Waves: NNE)

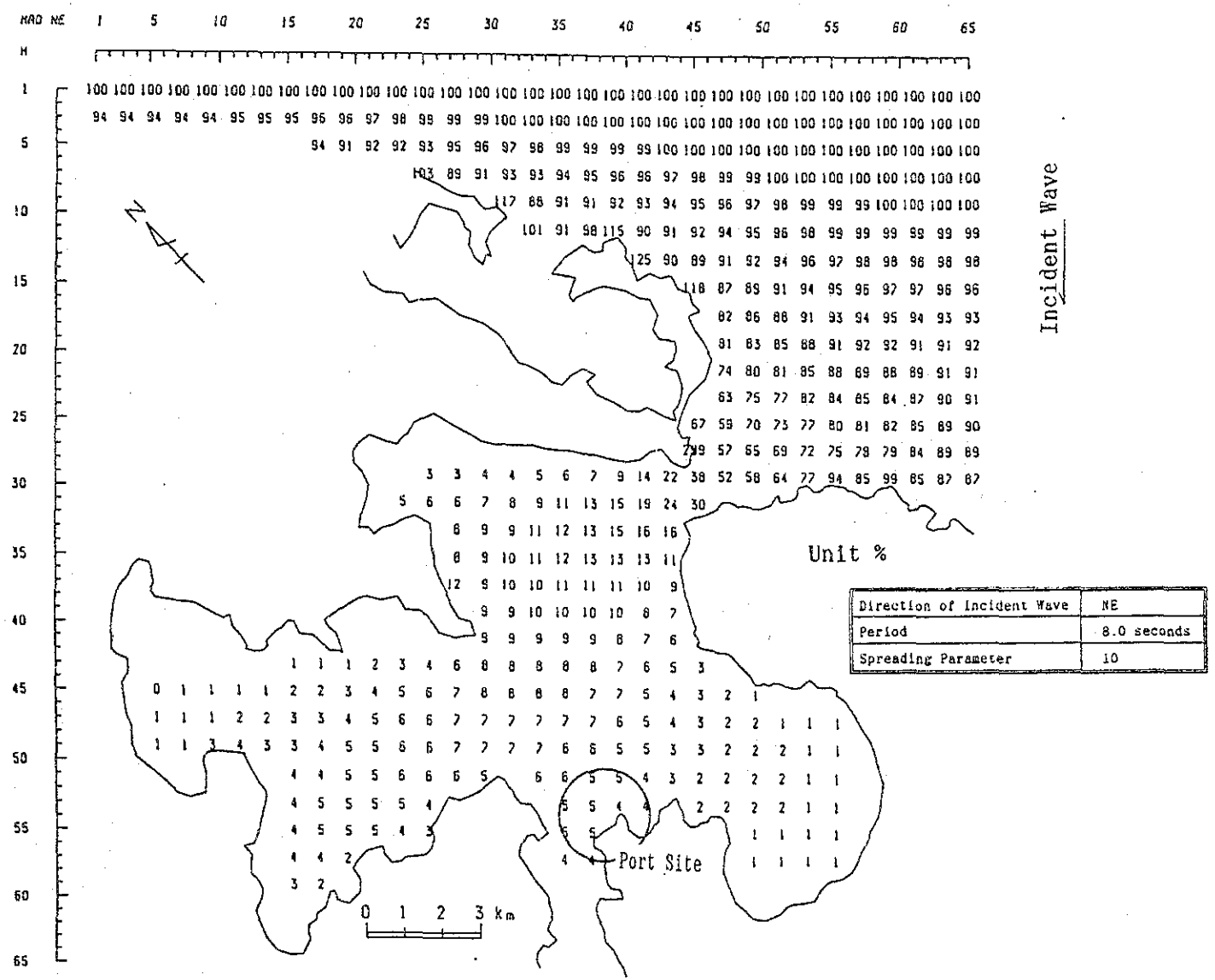


Figure A-3-2-9-(1) Plane of Distribution of Rate of Wave Height
(Direction of Incident Waves: NE)

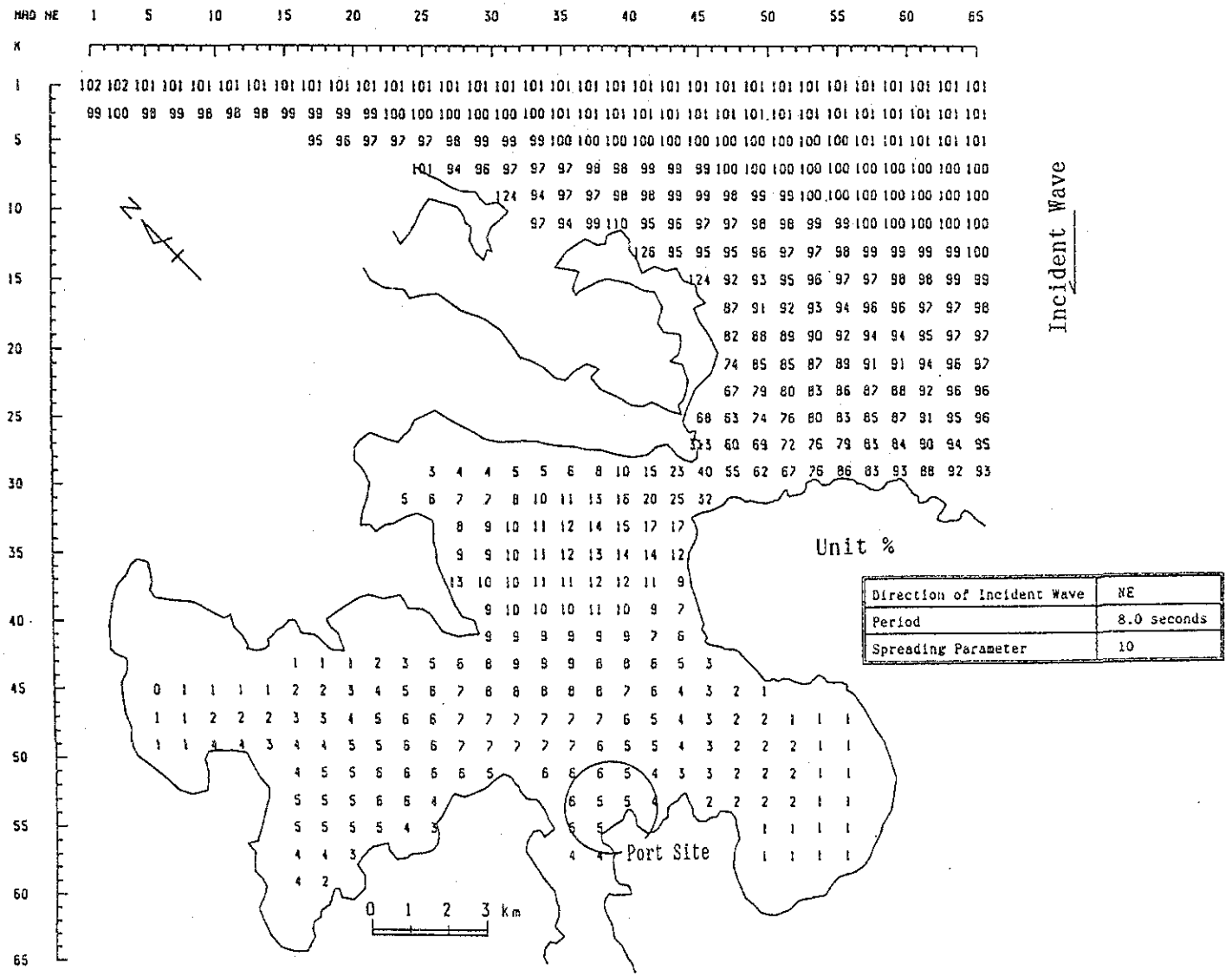


Figure A-3-2-9-(2) Plane of Distribution of Coefficient of Wave Refraction
(Direction of Incident Waves: NE)

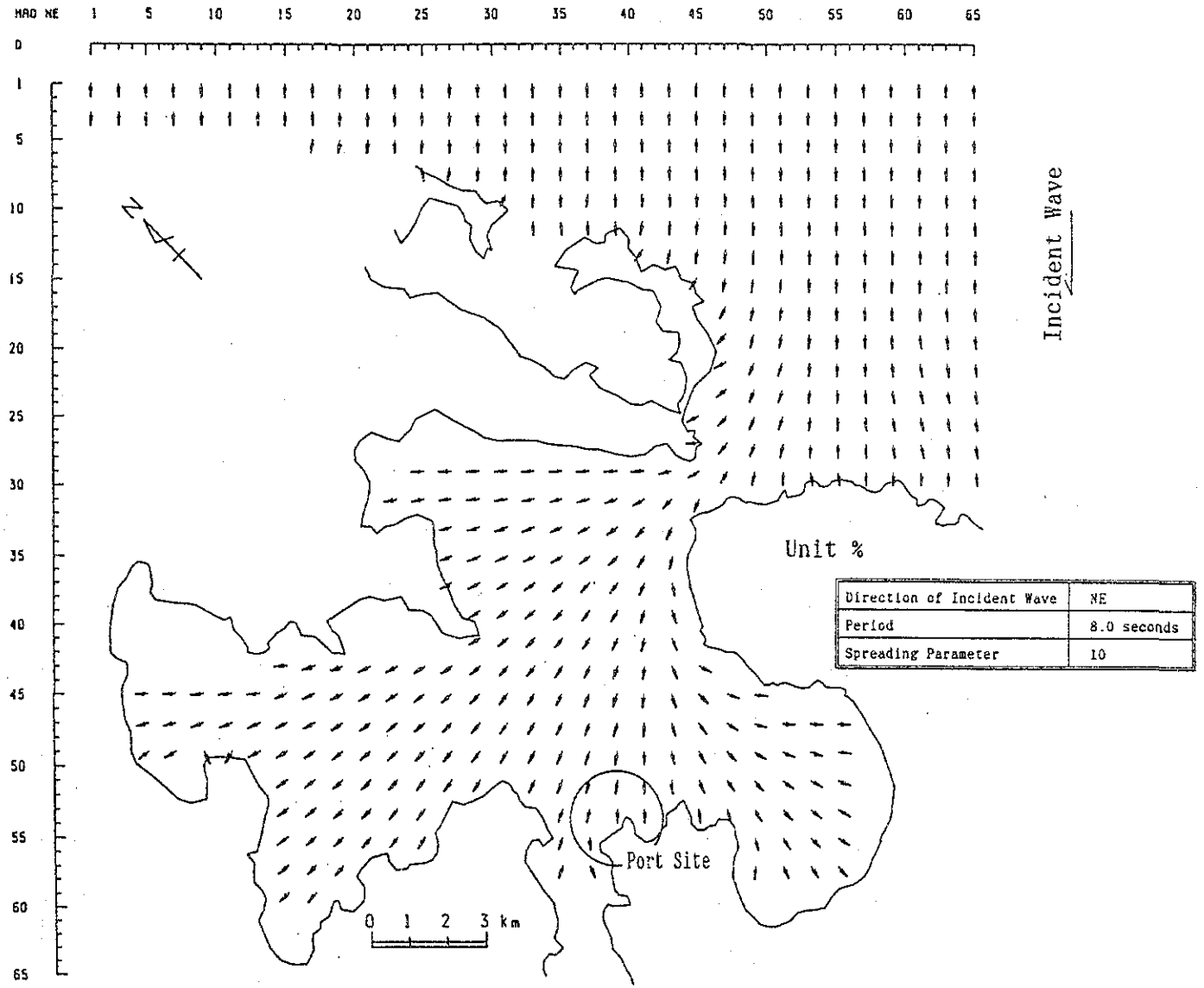


Figure A-3-2-9-(3) Plane of Distribution of Wave Direction
(Direction of Incident Waves: NE)

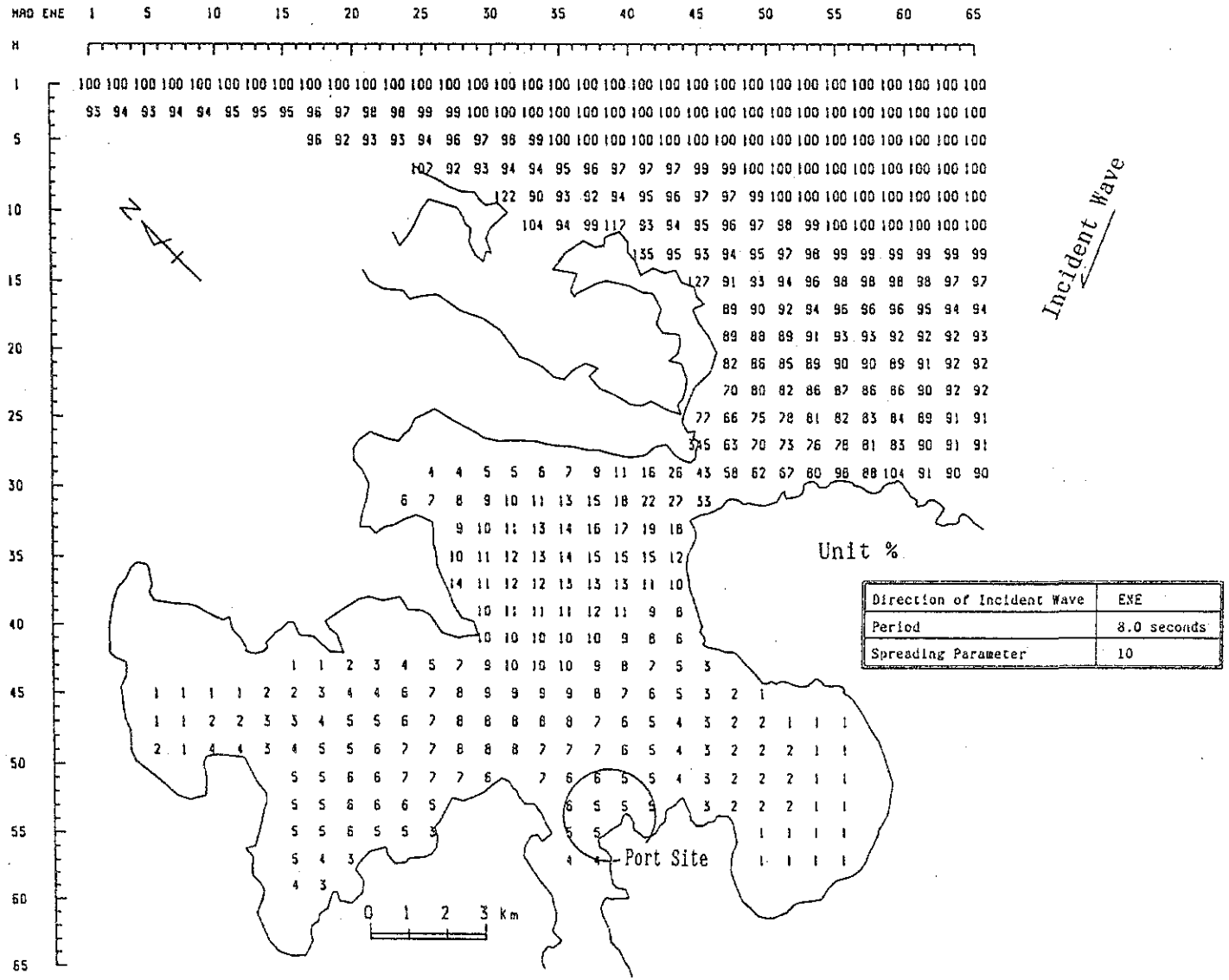


Figure A-3-2-10-(1) Plane of Distribution of Rate of Wave Height
(Direction of Incident Waves: ENE)

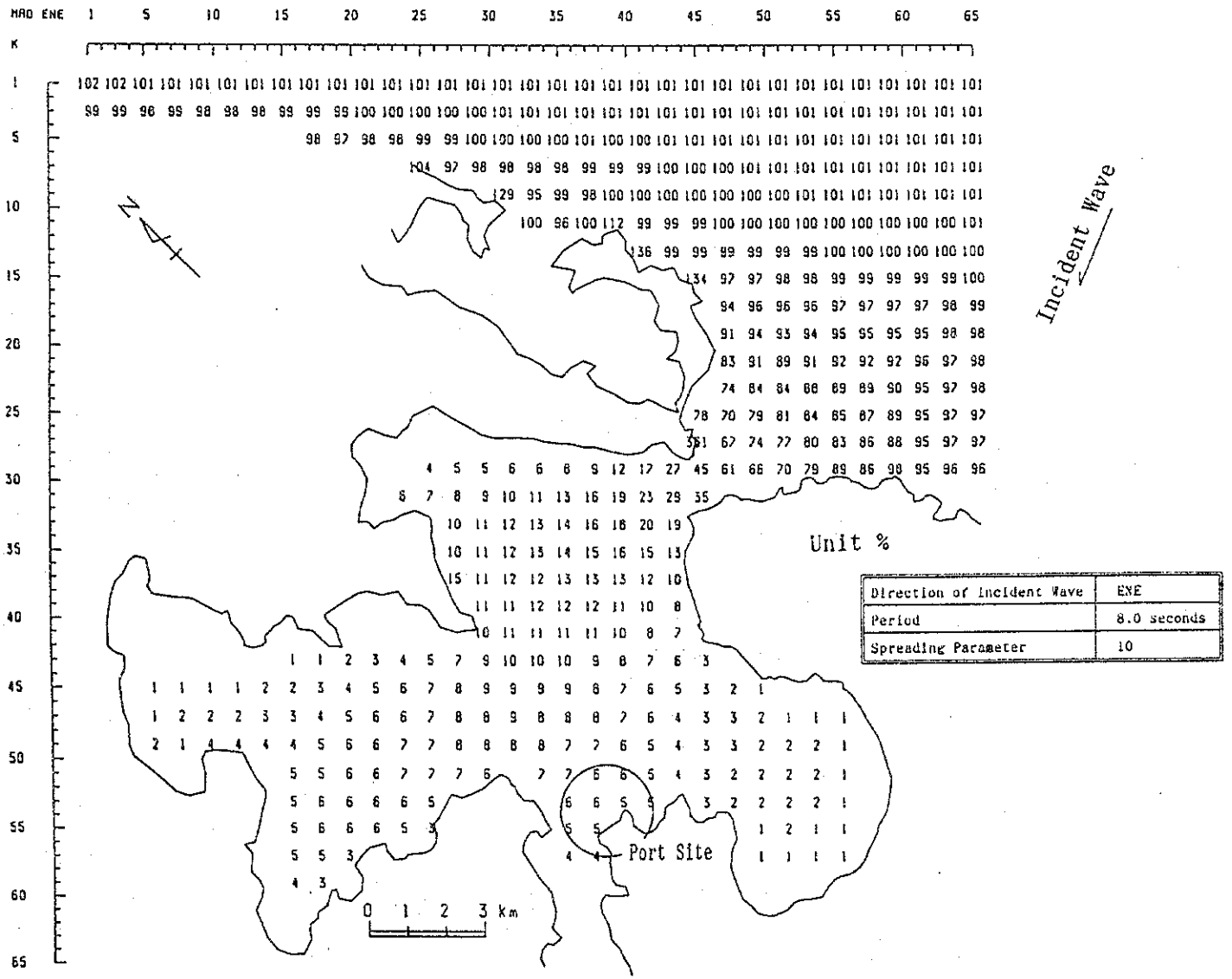


Figure A-3-2-10-(2) Plane of Distribution of Coefficient of Wave Refraction
(Direction of Incident Waves: ENE)

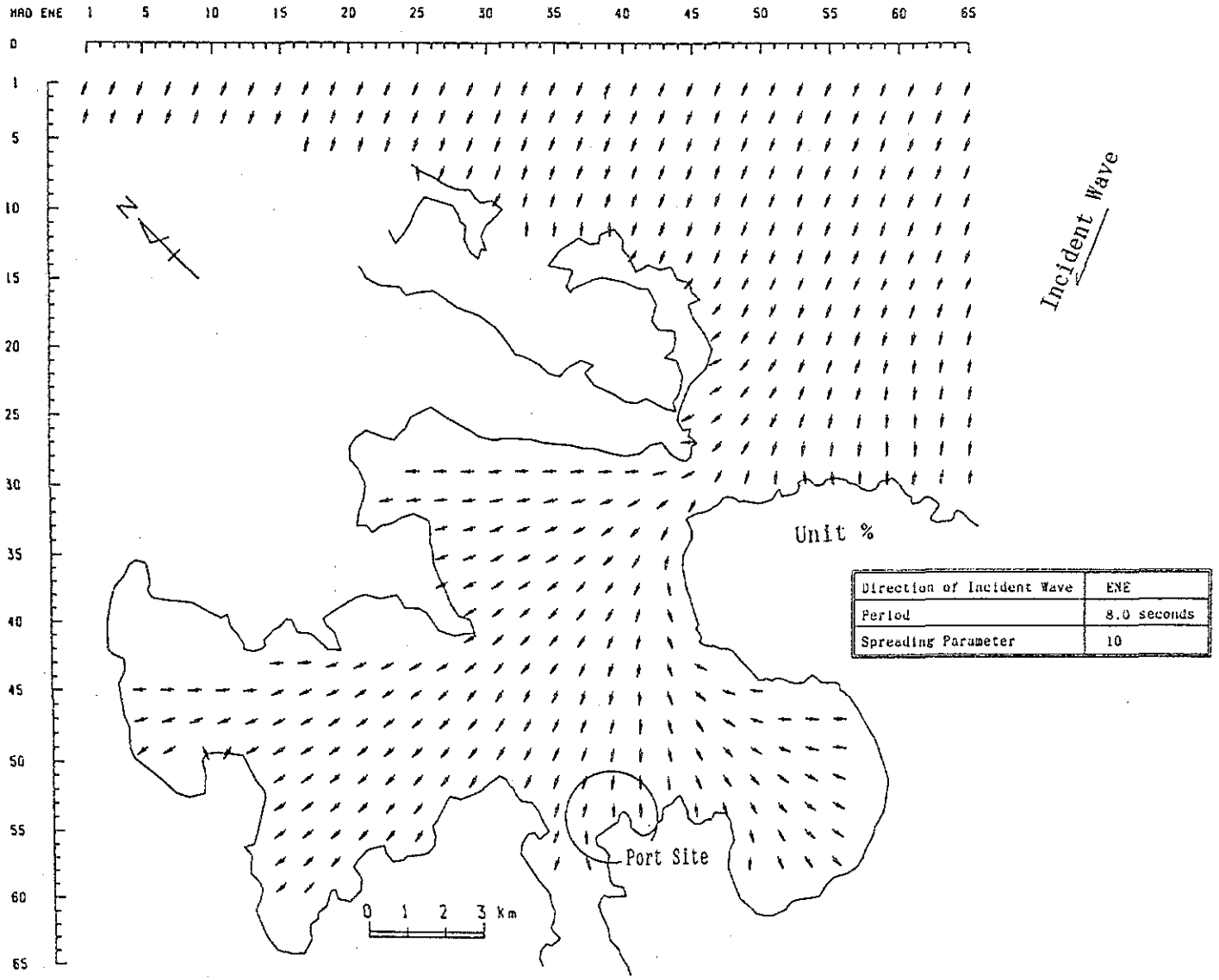


Figure A-3-2-10-(3) Plane of Distribution of Wave Direction
(Direction of Incident Waves: ENE)

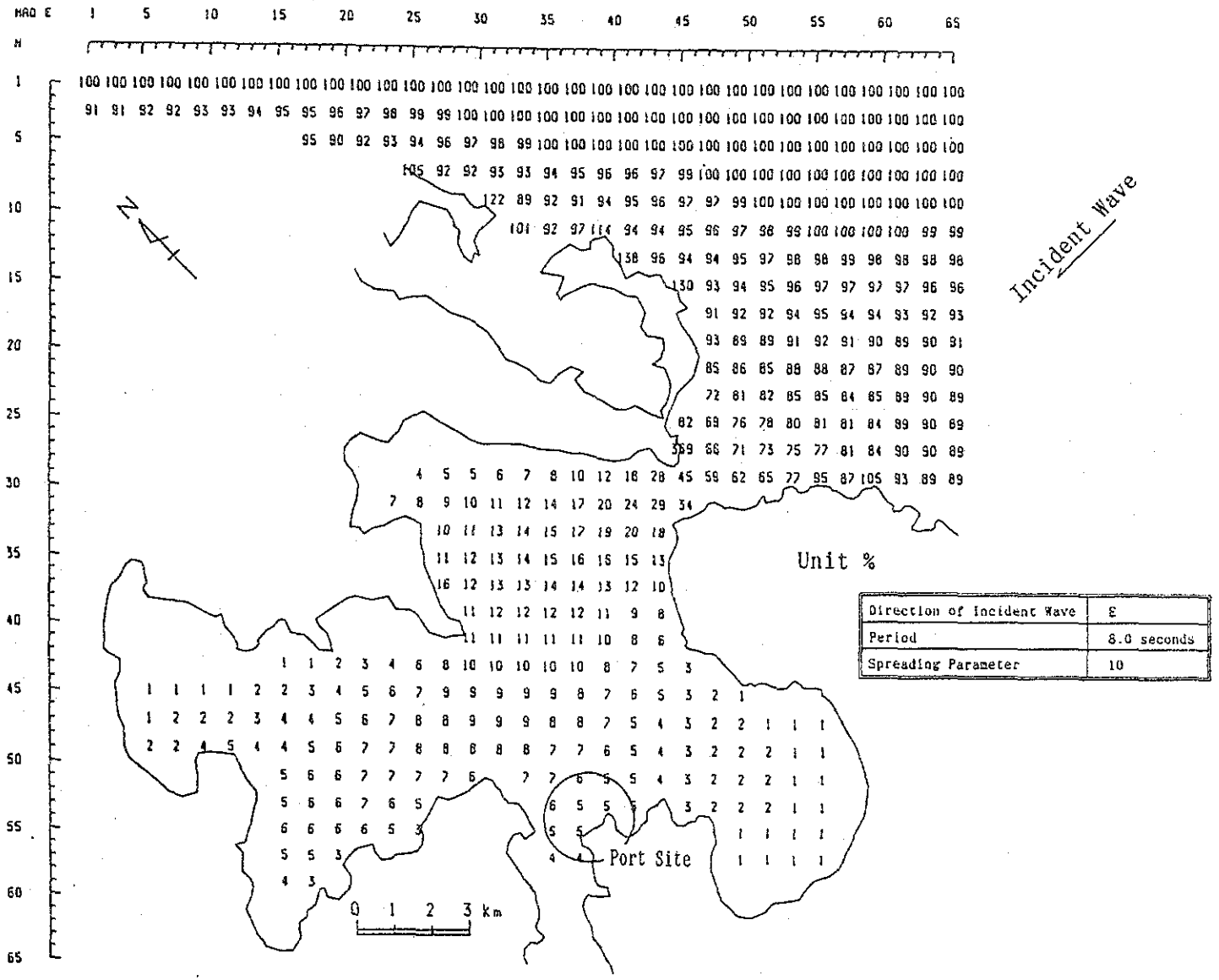


Figure A-3-2-11-(1) Plane of Distribution of Rate of Wave Height
(Direction of Incident Waves: E)

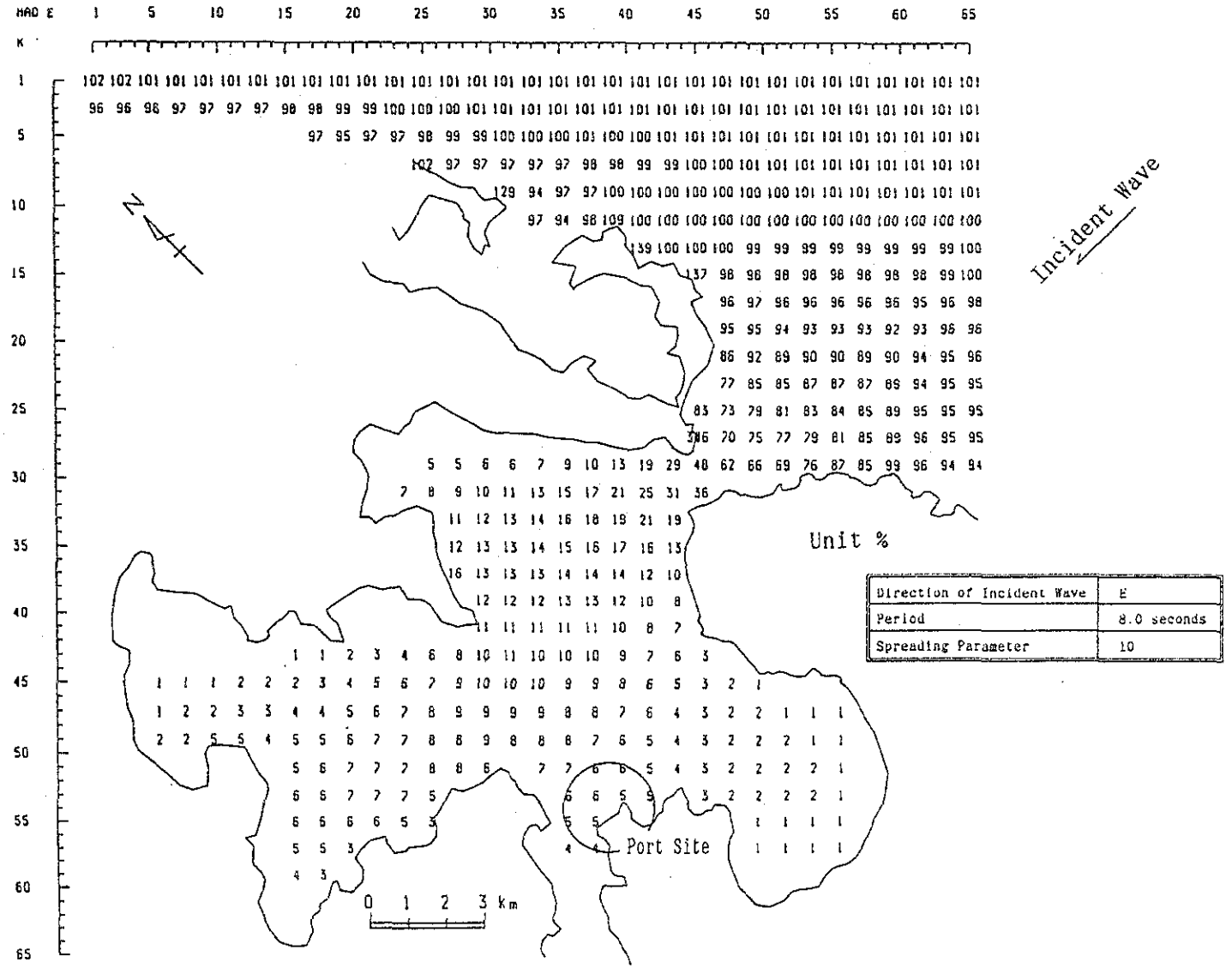


Figure A-3-2-11-(2) Plane of Distribution of Coefficient of Wave Refraction
(Direction of Incident Waves: E)

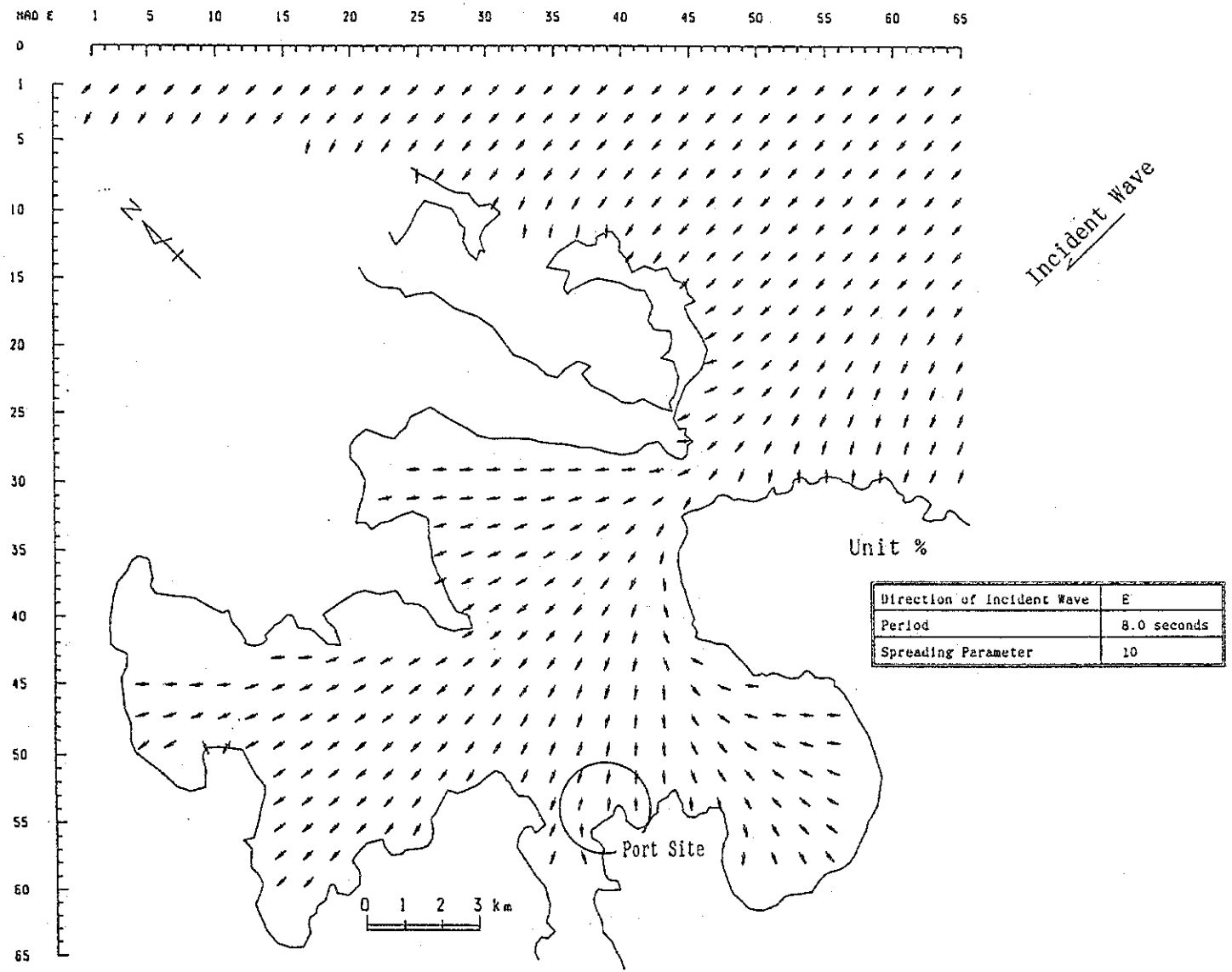


Figure A-3-2-11-(3) Plane of Distribution of Wave Direction
(Direction of Incident Waves: E)

A-3.2.2 Boring Data

Detailed soil profiles and the results of laboratory tests of recovered soil samples are presented in this subsection.

BACHY

SOCIETE MALGACHE DE SONDAGES INJECTIONS FORAGES

LALANA RAVONINAHITRINIARIVO
ANTANANARIVO

TELEPHONE N° 409.34
TELEX 22.307 . B.P. 186

Client : NIPPON TETRAPOD Co, LTD

MR : 719 ANTSIRANANA

Sondage n° S C 1

Beginning : 25-09-93 End : 30-09-93

Notes	Casing	Diamèters	Soils or rocks description	% Core	Thickness	Cross section	Depth	Height*
Depth of tide at low water : 10.40 m							0,00	
			Grey silt		4.50		4,50	
			Grey soft clay with remains of shells		2,00		6,50	
SPT à 6.50 N=1	LS ϕ 158	Soupape ϕ 140		Samples				
PEI 8,00 – 8,50								
SPT à 8,50 N=1								
PEI 10,00 – 10,50								
SPT à 10,50 N=1	10,50	10,50	Grey plastic clay with remains of shells					
PEI 12,00 – 12,50								
SPT à 12,50 N=2								
PEI 14,00 – 14,50	LS ϕ 140	ϕ 116 Soupape						
SPT à 14,50 N=2			Peat clay with shells and gravels of basalt		8,60		15,10	
PEI 15,80 – 16,30			Boulders of basalt	100 %	0,20		15,30	
SPT à 16,30 N=20			Grey plastic clay with gravels of basalt		0,30		15,60	
SPT à 18,00 N=38	17,50	17,50		100 %	1,90		17,50	
				89 %	0,50		18,00	
SPT à 20,00 N=50		K2 116 K2 96 rower	More or less yellowish grey chalky marl		2,00		20,00	
SPT à 22,00 N=60				68 %	2,00		22,00	
SPT à 24,00 N=80				100 %	1,25		23,25	
				55 %	0,75		24,00	
		25,00			1,00		25,00	

* Height from NGM

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SOCIETE MALGACHE DE SONDAGES INJECTIONS FORAGES

LALANA RAVONINAHITRINIARIVO
ANTANANARIVO

TELEPHONE 22.800.34
TELEX 22.307 . B.P. 186

Client : NIPPON TETRAPOD Co, LTD

MR : 719 ANTSIRANANA

Sondage n° SC 2

Beginning : 01-10-93 End : 04-10-93

Notes	Casing	Diameters	Soils or rocks description	% Core	Thickness	Cross section	Depth	Height*
Depth of tide at low water = 10,10 m							0.00	
PEI 2,50 – 3,00	ϕ 168	Soupape ϕ 140	Blackish silt	Samples	2,20		2,20	
PEI 4,50 – 5,00			Grey soft clay		2,30		4,50	
SPT à 5,00 N=0								
PEI 6,50 – 7,00			Yellowish gray plastic clay with remains of shells and detritus		2,50		7,00	
SPT à 7,00 N=0								
PEI 8,00 – 8,45								
PEI 10,00 – 10,50					3,00		10,00	
SPT à 10,50 N=36	10,00	10,00 K2 46	Yellowish gray chalky marl, more or less soft	80%	2,00		12,00	
SPT à 12,00 N=69		12,00 K2 116	More or less yellowish grey chalky marl	80%	2,00		14,00	
SPT à 14,00 N=51				100%	0,85		14,85	
SPT à 16,00 N=125		14,85		100%	1,15		16,00	
SPT à 18,00 Refus			More or less compact grey chalky marl					
SPT à 20,00 Refus		K2 96		80%				
SPT à 22,00 Refus								
SPT à 24,00 Refus		25,00			9,00		25,00	

* Height from NGM

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SOCIETE MALGACHE DE SONDAGES INJECTIONS FORAGES

LALANA RAVONINAHITRINIARIVO
ANTANANARIVO

TELEPHONE N° 200 34
TELEX 22.307 - BP 186

Client : NIPPON TETRAPOD Co, LTD

MR : 719 ANTSIRANANA

Sondage n° SC3

Beginning : 12-10-93 End : 14-10-93

Notes	Casing	Diameters	Soils or rocks description	% Core	Thickness	Cross section	Depth	Height*
Depth of tide at low water = 10,90 m							0,00	
PEI 3,50 – 4,00 SPT à 4,00 N= 3			Silty sand and remains of shells and detritus		0,80		0,80	
PEI 5,50 – 6,00 SPT à 6,00 N=2	LS ϕ 168		Clayey sand and remains of shells and chalky marl		4,20		5,00	
PEI 8,00 – 8,50 SPT à 8,50 N=4	LS ϕ 140		Sand with shells and detritus of chalky marl and cobbles	Samples	6,80		11,80	
PEI 9,50 – 10,00 SPT à 10,00 N=16			Boulders and gravels of basalt (5 - 10 cm)		1,60		13,40	
PEI 10,50 – 11,00	12,50	K2 146 Rower	Compact yellowish grey chalky marl	80%	6,40		19,80	
SPT à 13,80 N=41								
SPT à 15,80 N=46		15,80						
SPT à 17,80 N=76		K2 116 Rower		90%	5,20		25,00	
SPT à 19,80 N=%								
SPT à 22,80 Refus								
SPT à 25,00 Refus		25,00						

* Height from NGM

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SOCIETE MALGACHE DE SONDAGES INJECTIONS FORAGES

LALANA RAVONINAHITRINIARIVO
ANTANANARIVO

TELEPHONE 22 209 34
TELEX 22 307 BP 188

Client : NIPPON TETRAPOD Co, LTD

MR : 719 ANTSIRANANA

Sondage n° SC 4

Beginning 08-10-93 End 11-10-93

Notes	Casing	Diameters	Soils or rocks description	% Core	Thickness	Cross section	Depth	Height*
Depth of tide at low water = 10,10 m							0.00	
PBI 1,00 – 1,50		Soupape ϕ 140	Grey plastic clay	Samples	1,20		1,20	
PBI 2,00 – 2,50			Grey sandy plastic clay		2,60		3,80	
PBI 3,00 – 3,50								
SPT à 3,50 N:1			Fine grains clayey sand with gravels and boulders of basalt		1,40		5,20	
PBI 4,50 – 5,00	LS ϕ 168	5,30	Gravels and boulders of basalt (10 - 20 cm)		2,30		7,50	
SPT à 7,50 N:15								
PBI 9,00 – 9,50			Yellowish grey chalky marl friable	45%	2,00		9,50	
SPT à 9,50 N:16	9,50							
SPT à 11,50 N:34	LS ϕ 140	K2 146 Rowar	Yellowish grey chalky marl very friable	30%	2,00		11,50	
			Yellowish grey chalky marl friable	54%	1,30		12,80	
SPT à 13,50 N:36	13,50	13,50	Grey chalky marl, more or less compact	100 %	0,70		13,50	
			Compact grey chalky marl	90 %	2,00		15,50	
SPT à 15,50 N:52								
SPT à 17,50 N:62				90%	2,00		17,50	
SPT à 19,50 N:72		K2 116 Rowar	More or less compact chalky marl	85 %	2,00		19,50	
SPT à 21,50 N:85								
SPT à 23,50 Refus				80%				
		25,00			5,50		25,00	

* Height From NGM

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SOCIETE MALGACHE DE
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LALANA RAVONINAHITRINIARIVO
ANTANANARIVO

TELEPHONE DP 208.34
TELEX 22.307 . B.P. 180

Client : NIPPON TETRAPOD CO, LTD

MR : 719 ANTSIRANANA

Sondage n° SC5

Beginning 18-10-93 End 21-10-93

Notes	Casing	Diameters	Soils or rocks description	% Core	Thickness	Cross section	Depth	Height*
Depth of tide at low water = 8,90 m							0,00	
PEI 1,00 – 1,50		Soupape	Remains of shells and corals with soft clay	Samples	1,60		1,80	
PEI 2,20 – 2,70			Sandy soft clay		2,00		3,80	
SPT à 3,00 N=1								
PEI 4,80 – 5,30		3,80	Bluish grey soft chalky marl	100 %	1,00			
SPT à 5,30 N=18				40%				
PEI 6,80 – 7,30					2,00		7,20	
SPT à 7,30 N=33				100 %	0,40			
SPT à 8,80 N=22	LS ϕ 168	K2 146 Rover	Decomposed sandy rock, with gravels of basalt	Samples	4,10		11,30	
SPT à 10,80 N=30			Gravels of basalt (5 - 8 cm)		1,40		12,70	
SPT à 12,70 N=49	12,70		More or less compact grey chalky marl	72 %	2,00		14,70	
SPT à 15,30 N=59			Gravels of basalt		0,70		15,40	
SPT à 17,40 N=68		15,70	More or less compact chalky marl	80%	2,00			
SPT à 19,40 Refus		K2 116		95%	2,00			
SPT à 21,00 Refus				100 %	5,60		25,00	
		25,00						

* Height from NGM

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SOCIETE MALGACHE DE SONDAGES INJECTIONS FORAGES

LALANA RAVONINAHITRINIARIVO
ANTANANARIVO

TELEPHONE NR 200 34
TELEX 22.307 BP 186

Client : NIPPON TETRAPOD CO, LTD

MR : 719 ANTSIRANANA

Sondage n° SC 6

Beginning : 10-11-93 End : 12-11-93

Notes	Casing	Diamèt	Soils or rocks description	% Core	Thickness	Cross section	Depth	Height*
Depth of hide at low water = 5,60 m							0,00	
PEI 0,75 / 1,25	LS ϕ 160	soupape ϕ 114	Sand with remains of corals and shells	Samples	1,80		1,80	
PEI 1,80 / 2,30		1,80	Gravels of basalt (5 - 10 cm)		1,75		3,55	
PEI 3,00 / 3,50				100%	0,45		4,00	
SPT à 4,00 N = 39	4,00		Yellowish grey chalky marl, more or less compact	95 %	2,00		6,00	
PEI 4,50 / 5,00								
SPT à 6,00 N = 76			More or less compact chalky marl	80%	2,00		8,00	
SPT à 8,00 N = 50				73%	1,30		9,30	
SPT à 10,00 Refus			Compact chalky marl	100%	0,70		10,00	
SPT à 14,00 Refus			More or less compact chalky marl	82%	1,40		11,40	
SPT à 14,00 Refus			Compact grey chalky marl	100%	0,60		12,00	
SPT à 16,00 Refus			More or less compact chalky marl	87%	2,00		14,00	
SPT à 18,00 Refus		C D K2 116 Rawor	Compact grey chalky marl	100%	11,00		25,00	
SPT à 20,00 Refus								
SPT à 22,00 Refus		25,00						

* Height from NGM

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SOCIETE MALGACHE DE
SONDAGES INJECTIONS FORAGES

LALANA RAVONINAHITRINIARIVO
ANTANANARIVO

TELEPHONE HP 200.34
TELEX 22.367 - BP 184

Client : NIPPON TETRAPOD Co, LTD

MR : 719 ANTSIRANANA

Sondage n° SC7

Beginning 13-11-93 End 16-11-93

Notes		Casing	Diamèters	Soils or rocks description	% Core	Thickness	Cross section	Depth	Height
Depth of tide at low water = 7.30 m								0,00	
PBI 1,00 / 1,50			Seepage ϕ 114	Sand with remains of corals and shells	Samples	3,80		3,80	
PBI 2,60 / 3,10				Grey clay with remains of shells		0,85		4,65	
PBI 3,80 / 4,30				Blackish scoria sand with gravels		2,65		7,30	
SPT à 4,30 N=22									
PBI 7,30 / 7,80		15 ϕ 140							
SPT à 7,80 N=79				Soft yellowish grey chalky marl	66%	0,75		8,05	
SPT à 9,00 N=95		8,00		Compact grey chalky marl	100%	0,95		9,00	
SPT à 11,00 Refus				Compact grey chalky marl with soft layer	82%	2,00		11,00	
SPT à 13,00 Refus				More or less compact grey chalky marl	80%	2,00		13,00	
SPT à 15,00 Refus			CD K2 116 Rowor	Compact grey chalky marl	100%	2,00		15,00	
SPT à 16,50 Refus									
SPT à 18,00 Refus									
SPT à 20,00 Refus									
SPT à 22,00 Refus									
			25,00					25,00	

* Height from NGM

BACHY

SOCIETE MALGACHE DE SONDAGES INJECTIONS FORAGES

ANTANANARIVO

Client : NIPPON TETRAPOD Co, LTD

MR : 719 ANTSIRANANA

Sondage n° SC 8

Beginning 18-11-93 End 20-11-93

Notes	Casing	Diamètres	Soils or rocks description	% Core	Thickness	Gross section	Depth	Height*
Depth of tide at low water = 7,30 m							0,00	
PBI 1,10 / 1,60		Soupape ø 114	Sand with remains of corals and shells	Samples	4,00		4,00	
PBI 2,80 / 3,30								
PBI 4,00 / 4,50								
SPT à 4,50 N = 1								
SPT à 6,00 N = 1			Grey clay with remains of shells		2,40		6,40	
PBI 7,50 / 8,00			Grey peaty clay		0,70		7,10	
SPT à 8,00 N = 63	8,00		Soft yellowish grey chalky marl		0,40		7,50	
SPT à 9,50 N = 72			Soft to compact yellowish grey chalky marl	47%	2,00		9,50	
SPT à 11,50 Refus			More or less compact yellowish grey chalky marl	85%	2,00		11,50	
SPT à 13,50 Refus				82%	2,00		13,50	
SPT à 15,50 Refus				93%	2,00		15,50	
SPT à 17,50 N = 58			More or less compact chalky marl with soft layers	80%	2,00		17,50	
SPT à 20,00 Refus				82%	2,00		19,50	
SPT à 23,00 Refus		C.D K2 116 Rewor	Compact grey chalky marl	100%	5,50		25,00	
		25,00						

* Height from NGM

TABLEAU DE RESULTATS DES ESSAIS DE LABORATOIRE

ETUDE GEOTECHNIQUE
CHANTIER : ANTSIRANANA - NORD MR 719

Dossier n° 93.54.46
Annexe n° I
Tableau n° 01

N° SONDAGE			SC1 B	SC1 M	SC1 H	SC1 B	SC1 M	SC1 H	SC1 B	SC2 B
PROFONDEURS (m)			8.00 / 8.50	8.00 / 8.50	8.00 / 8.50	12.00 / 12.50	12.00 / 12.50	12.00 / 12.50	15.80 / 16.30	8.00 / 8.30
NATURE APPARENTE DES SOLS ECHANTILLONNES			Argile molle grise + coquilles	Argile molle grise + coquilles	Argile molle grise	Argile molle grise + g. g. coquilles	Argile molle grise + g. g. coquilles	Argile molle grise + g. g. coquilles	Argile grise avec cailloux	Argile molle grise
CARACT. D'ETAT	γ (kN/m3)		16.3	16.0	16.0	18.0	18.0	18.1	20.3	16.8
	W (%)		64.7	68.2	66.6	44.0	45.0	45.3	33.5	57.1
	γd (kN/m3)		9.9	9.5	9.6	12.5	12.4	12.4	15.2	10.7
	Sr (%)		100	99	99	100	100	100	100	100
	γs (kN/m3)		27.3	27.3	27.3	27.4	27.4	27.4	27.4	27.3
IDENTIFICATION	Granulo-Sédimento % de passant à	2 mm	99			99			95	100
		0.40 mm	99			99			91	100
		80 µ	93			92			84	83
		20 µ	71			64			61	61
		2 µ	39			38			40	40
	Ld'Atterberg	WL (%)	73			51			53	60
		WP (%)	36			25			27	30
		IP (%)	37			26			26	30
CLASSIFICAT° LPC			Lt			At			At	At
COMPRESSIBILITE	G'c (kPa)		50	46		34 ± Remanié	50		*	38 ± Remanié
	Cc		0,570	0.595		0.342	0,372		*	0.414
	Cg								*	
CISAILLEMENT BOITE TRIAXIAL	R.C (kPa)		18,8	19.7	13,6	32,1	35,3	26,1	*	11,8
	φuu (°)									
	C' (kPa)									
	φ' (°)									
AUTRE									* [illegible]	

LABO MADAGASCAR

TABLEAU DE RESULTATS DES ESSAIS DE LABORATOIRE

ETUDE GEOTECHNIQUE

CHANTIER : ANTSIRANANA - NORD MR 719

Dossier n° 93.SL.46

Annexe n° I

Tableau n° 02

N° SONDAGE		SC2 M.	SC2 H	SC2 B	SC2 M	SC2 H	SC3 B	SC3 M	SC3 H
PROFONDEURS (m)		8.00 / 8.50	8.00 / 8.50	10.00 / 10.50	10.00 / 10.50	10.00 / 10.50	3.50 / 4.00	3.50 / 4.00	3.50 / 4.00
NATURE APPARENTE DES SOLS ECHANTILLONNES		Argile molle grise	Argile molle grise	Marne argileuse grise	Marne argileuse grise	Marne argileuse grise	Sable argileux non verdâtre + Nodules	Sable argileux non verdâtre + Nod.	Sable argileux non verdâtre + Nodules
CARACT. D'ETAT	γ (kN/m3)	16,9	16,8	19.7	*	20,3	20,2	20,6	21,0
	W (%)	57,1	57,7	27.0	*	26,8	23,3	21,5	20,4
	γd (kN/m3)	10,7	10,6	15,5	*	16,0	16,4	16,9	17,4
	Sr (%)	100	100	100		100	94	94	96
	γs (kN/m3)	27,3	27,3	26,6		26,6	27,6	27,6	27,6
IDENTIFICATION	Granulo-Sédimento % de passant à 2 mm			100			83		
	0,40 mm			98			57		
	80 µ			99			24		
	20 µ			81			11		
	2 µ			52			5		
	L. d'Atterberg WL (%)			59			31		
	Wp (%)			30			22		
	IP (%)			29			9		
CLASSIFICAT° LPC				At			SA		
COMPRESSIBILITE	G'c (kPa)			160	*		40		
	Cc			0,095	*		0,117		
	Cg				*				
CISAILLEMENT BOITE TRIAXIAL	R.C (kPa)	15,2	8,9	371,5	*	217,6	26,6	20.3	18,3
	φuu (°)								
	C' (kPa)								
	φ' (°)								
AUTRE				[illegible]	* essai irréalisable				

LRTPC MADAGASCAR

TABLEAU DE RESULTATS DES ESSAIS DE LABORATOIRE

ETUDE GEOTECHNIQUE
CHANTIER : ANTSIRANANA – NORD PR719

Dossier n° 93SL46
Annexe n° I
Tableau n° 03

N° SONDAGE			Sc3 B	Sc3 M	Sc3 H	Sc4 B	Sc4 M	Sc4 H	Sc5 B	Sc5 M
PROFONDEURS (m)			8.00 / 8.50	8.00 / 8.50	8.00 / 8.50	3.00 / 3.50	3.00 / 3.50	3.00 / 3.50	4,80 / 5.30	4,80 / 5.30
NATURE APPARENTE DES SOLS ECHANTILLONNES			Sable argileux mou verdâtre + Nodules	Sable argileux mou verdâtre + Nodules	Sable argileux mou verdâtre + Nodules	Sable argileux verdâtre	Sable argileux verdâtre	Sable argileux verdâtre	Argile marneuse grise	Argile marneuse grise
CARACT. D'ETAT	γ (kN/m3)		20,0	19.9	19.9	20,3	20,6	19.6	18.9	19,0
	W (%)		25,6	26.4	26,0	33,2	30.3	29.8	33,7	32,9
	γd (kN/m3)		15,9	15.7	15,8	15,2	15,8	15.1	14,1	14,3
	Sr (%)		96	94	96	100	100	100	99	100
	γs (kN/m3)		27,5	27.5	27,5	27,3	27,3	27,3	27,0	27,0
IDENTIFICATION	Granulo-Sédimento % de passant à	2 mm	94			100			99	
		0,40 mm	74			85			98	
		80 µ	49			42			96	
		20 µ	41			30			87	
		2 µ	27			20			70	
	L.d'Atterberg	WL (%)	34			33			59	
		WP (%)	22			23			31	
		IP (%)	12			10			28	
CLASSIFICAT° LPC			SA			SA			Lt	
COMPRESSIBILITE	G'c (kPa)		50	46		56	60			
	Cc		0,112	0,106		0,132	0,114			
	Cg									
CISAILLEMENT BOITE TRIAXIAL	R.C (kPa)		28,1	19.9	14,6	25,4	24.7	23.7	87,5	77,2
	φuu (°)									
	C' (kPa)									
	φ' (°)									
AUTRE										

LNTPB MADAGASCAR

TABLEAU DE RESULTATS DES ESSAIS DE LABORATOIRE

ETUDE GEOTECHNIQUE
CHANTIER : ANTSIRANANA - NORD MR 719

Dossier n° 93.51.46
Annexe n° I
Tableau n° 04

N° SONDAGE		Sc 5 H	Sc 5 B	Sc 5 M	Sc 5 H				
PROFONDEURS (m)		4.80 / 5.30	6.80 / 7.30	6.80 / 7.30	6.80 / 7.30	———	———	———	———
NATURE APPARENTE DES SOLS ECHANTILLONNES		Argile marneuse grise	Argile marneuse grise	Argile marneuse grise	Argile marneuse grise				
CARACT. D'ETAT	γ (kN/m3)	18,9	17,5	18,1	18,0				
	W (%)	35,6	45,2	44,0	47,0				
	γd(kN/m3)	13,9	12,0	12,5	12,2				
	Sr (%)	100	96.	100	100				
	γs(kN/m3)	27,0	27,4	27,4	27,4				
IDENTIFICATION	Granulo-Sédimento % de passant à 2 mm		100						
	Granulo-Sédimento % de passant à 0,40 mm		99						
	Granulo-Sédimento % de passant à 80 µ		98						
	Granulo-Sédimento % de passant à 20 µ		90						
	Granulo-Sédimento % de passant à 2 µ		75						
	Ld'Atterberg WL (%)		80						
	Ld'Atterberg Wp (%)		39						
	Ld'Atterberg IP (%)		41						
CLASSIFICATION LPC			Lt						
COMPRESSIBILITE	G'c(kPa)								
	Cc								
	Cg								
CISAILLEMENT BOITE TRIAXIAL	R.C(kPa)	66,7	70,7	65,9	57,3				
	φuu (°)								
	C' (kPa)								
	φ'(°)								
AUTRE									

TABLEAU DE RESULTATS DES ESSAIS DE LABORATOIRE

LRPD MADAGASCAR

Dossier n°.....
Annexe n°.....
Tableau n° 01

ETUDE GEOTECHNIQUE
CHANTIER : MR 719 ANTSIRANANA - NORD

N° SONDAGE		SC7 B	SC7 M	SC7 H	SC7 B	SC7 M	SC7 H	SC8 B	SC8 M
PROFONDEURS (m)		3.80 / 4.30	3.80 / 4.30	3.80 / 4.30	7.30 / 7.80	7.30 / 7.80	7.30 / 7.80	1.00 / 1.50	1.00 / 1.50
NATURE APPARENTE DES SOLS ECHANTILLONNES		Argile molle grise + coques	Argile molle grise + coques	Argile molle grise + coques	Argile molle grise	Argile molle grise	Argile molle grise	Argile plastique grise	Argile plastique grise
CARACT. D'ETAT	γ (kN/m3)	19.7	19.9	19,6	18.8	18.6	18,8	17,7	17,8
	W (%)	31,1	32,0	29,3	36,4	36.4	36,0	46,9	45,9
	γd (kN/m3)	15,0	15,1	15,1	13,8	13,6	13,8	12,0	12,2
	Sr (%)	100			100			100	
	γs (kN/m3)	27.9			27,0			27,0	
IDENTIFICATION	Granulo-Sédimento % de passant à 2 mm	93			92			100	
	Granulo-Sédimento % de passant à 0,40 mm	76			83			99	
	Granulo-Sédimento % de passant à 80 µ	40			71			98	
	Granulo-Sédimento % de passant à 20 µ	24			57			88	
	Granulo-Sédimento % de passant à 2 µ	11			38			54	
	L. d'Atterberg WL (%)	43			69			50	
	L. d'Atterberg WP (%)	22			34			26	
	L. d'Atterberg IP (%)	21			35			24	
CLASSIFICAT° LPC		SA			Lt			Ap/At	
COMPRESSIBILITE	G'c (kPa)	28			140			34	
	Cc	0,218			0,210			0,374	
	Cg	± Remanié							
CISAILLEMENT BOITE TRIAXIAL	Cuu (kPa)								
	φuu (°)								
	R.C (kPa)	24,0	22,9	21,8	66,3	57,1	41,2	14,4	13,9
AUTRE									

LABO MADAGASCAR

TABLEAU DE RESULTATS DES ESSAIS DE LABORATOIRE

ETUDE GEOTECHNIQUE

CHANTIER : M719 ANTSIRANANA - NORD

Dossier n°.....

Annexe n°.....

Tableau n°.02.....

N° SONDAGE		SC8 H	SC8 B	SC8 M	SC8 H				
PROFONDEURS (m)		1.00 / 1.50	7.50 / 8.00	7.50 / 8.00	7.50 / 8.00	—	—	—	—
NATURE APPARENTE DES SOLS ECHANTILLONNES		Argile plastique grise	Argile marneuse grise	Argile marneuse grise	Argile marneuse grise				
CARACT. D'ETAT	γ (kN/m3)	17,5	21,1	21,7	20,7				
	W (%)	47,4	16,0	15,2	17,1				
	γd(kN/m3)	11,9	18,2	18,8	17,7				
	Sr (%)		88						
	γs(kN/m3)		27,2						
IDENTIFICATION	Granulo-Sédimento % de passant à 2 mm		100						
	Granulo-Sédimento % de passant à 0,40 mm		99						
	Granulo-Sédimento % de passant à 80 µ		98						
	Granulo-Sédimento % de passant à 20 µ		87						
	Granulo-Sédimento % de passant à 2 µ		54						
	L.d'Atterberg WL (%)		43						
	L.d'Atterberg WP (%)		22						
	L.d'Atterberg IP (%)		21						
CLASSIFICAT° LPC			Ap						
COMPRESSIBILITE	G'c(kPa)			100					
	Cc			0,103					
	Cg								
CISAILLEMENT BOITE TRIAXIAL	Cuu(kPa)								
	φuu (°)								
	R-C(kPa)	13,4	122,0	124,2	107,5				
AUTRE									

A-3.3 Port Facilities

A-3.3.1 Criteria for Judgement of Deterioration

Table A-3-3-1 Criteria for Judgement of Degree of Deterioration of Members

Item	Corrosion of the reinforcing bar	Cracking of the concrete	Spalling of the cover concrete
Degree	Visual inspection		
0	Not observed	Not observed	Not observed
1	Small patches of dotted rusts are observed on the concrete surface	A few cracks are observed on the concrete surface	Not observed
2	A few rust strains are observed on the concrete surface	Some cracks are observed on the concrete surface	A few swellings (expansions) are observed on the concrete surface
3	Many rust strains are observed on the concrete surface	Many cracks are observed on the concrete surface	A few spallings are observed on the concrete surface
4		Many wide cracks (more than 2mm in width) are observed on the concrete surface	Many spallings are observed on the concrete surface
5			Heavy spallings are observed on the concrete surface

Table A-3-3-2 Criteria for Judgement of Degree of Deterioration

Degree	Visual inspection.
0	Steel is not corroded.
1	Only the surface of the steel is corroded partially.
2	Only the surface of the steel is corroded generally, or some deficits are observed on the steel.
3	Many deficits are observed on the steel.
4	Heavy deficits are observed on the steel.
5	

Table A-3-3-3 Judgement for Necessity of Repair

Degree of Deterioration	0	1	2	3	4	5
Necessity of Repair	Not necessary			Need to repair		
			(execute repair depends on situation)			(execute reinforcement depends on situation)

A-3.3.2 Compression Test for Concrete Core Sample

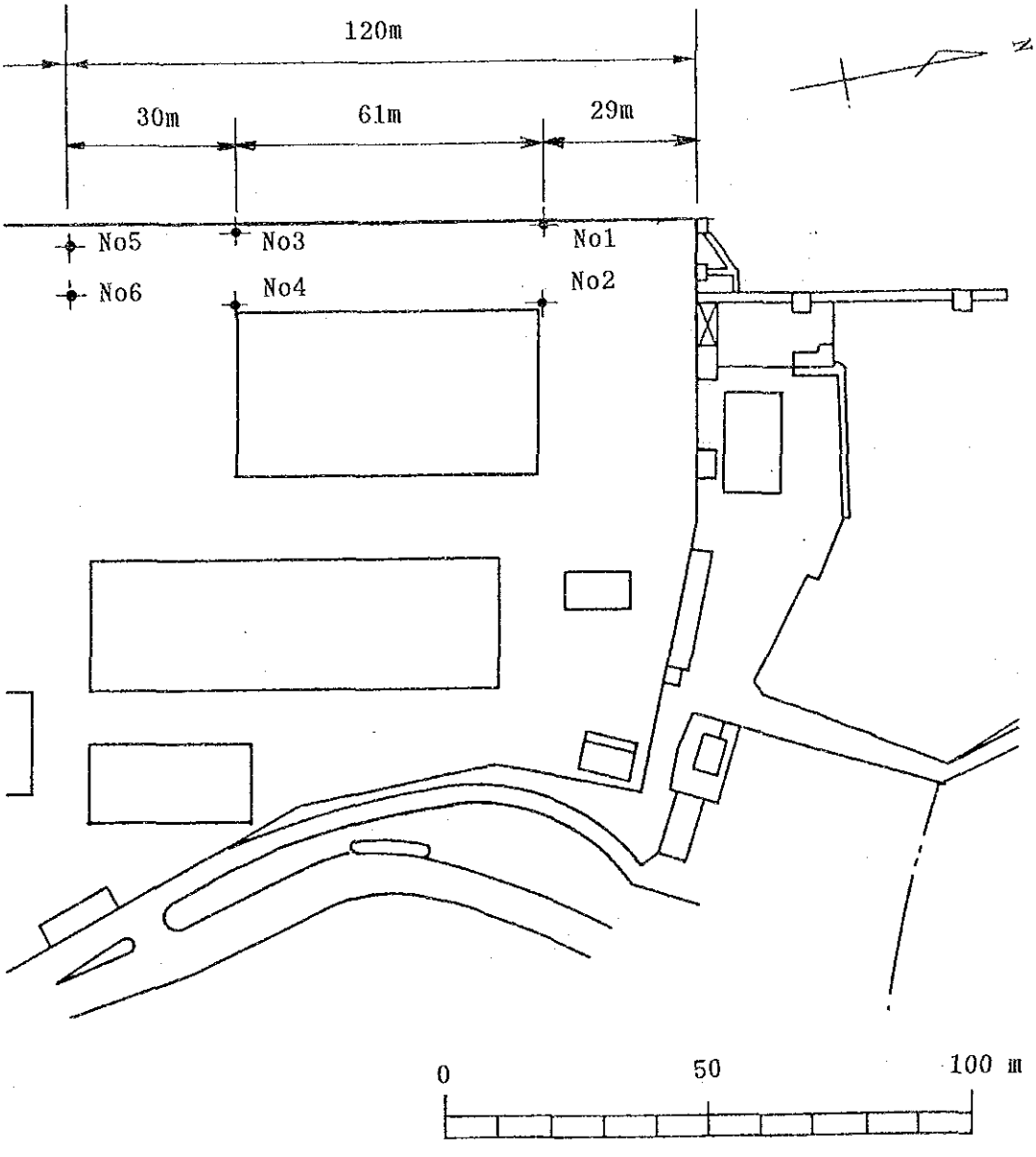


Figure A-3-3-1 Location of Core Sampling

Table A-3-3-4 Results of Simple Compression Test

Location No	Sample	Dimension (cm)		Unit Weight (tf/m^3)	Compressive Strength (kgf/cm^2)
		Diameter	Height		
No 1	1	11.5	11.8	2.43	324*
	2	11.5	11.3	2.53	304*
	3	11.5	11.6	2.66	265*
No 2	1	11.5	11.4	2.31	265*
	2	11.5	11.7	2.26	225
No 3	1	11.5	11.6	2.66	320*
	2	11.5	11.6	2.65	312
No 4	1	11.5	11.5	2.31	278
	2	11.5	11.5	2.30	320
	3	11.5	11.6	2.27	285
No 5	1	11.5	11.7	2.62	280*
No 6	1	11.5	11.6	2.22	246
	2	11.5	11.6	2.30	285

Note : Asterisk(*) means presence of reinforcing bar.

A-3.6 Calling Vessels

Excerpts from calling vessel data of the Port Office are shown. Date which is unreliable or unavailable is denoted by the bar line.

Table A-3-6-1 Calling Vessel Data by the Port Office

MOIS D'AVRIL 1990

NUMERO	CONSIGNATAIRE	ARRIVEE	PROVENANCE	DEPART	DESTINATION	J.BRUTE (Tx)	L.H.TOUT (m)	NOMS NAVIRES
90/70	AUXIMAD	01/4/90 10h30	SECREN	10/4/90 17h15	Vohimar	587.01	52.40	VATSY 2
90/71	SCAC	01/4/90 13h05	Toamasina	02/4/90 08h25	Arabia Golf	18,211.00	176.05	LIA
90/72	AUXIMAD	01/4/90 13h35	Toamasina	01/4/90 19h30	Mahajanga	1,103.10	77.02	VATSY 4
90/73	SAMA	02/4/90 06h30	Mahajanga	04/4/90 03h00	Mahajanga	175.31	25.02	ASGARI
90/74	TM. VALLY MA.	02/4/90 12h15	Nosy Be	04/4/90 03h10	Mahajanga	[illegible]	27.97	SAINT LOUIS
90/75	AUXIMAD	04/4/90 07h40	Nosy Be	04/4/90 16h15	Toamasina	11,530.00	158.00	TOAMASINA
90/76	AUXIMAD	04/4/90 07h40	Nosy Be	05/4/90 10h00	SECREN	171.12	33.00	JACQUES ORSINI
90/77	SOLIMA	04/4/90 12h00	Toamasina	06/4/90 05h00	Nosy Be	4,205.00	108.00	TSIMIRORO
90/78	AUXIMAD	06/4/90 08h20	Mayotte	10/4/90 7h30	Haute Mer	760.49	58.20	GOMBESSA
90/79	AUXIMAD	08/4/90 10h00	SECREN	10/4/90 20h30	Vohimar	429.00	47.99	KINGA
90/80	AUXIMAD	10/4/90 7h00	Seychelles	21/4/90 16h30	Haute Mer	1,475.00	77.30	ALBACORA 14
90/81	AUXIMAD	10/4/90 10h45	Haute Mer	21/4/90 16h30	Haute Mer	1,344.88	78.75	ALBACORA 6
90/82	AUXIMAD	10/4/90 14h15	Haute Mer	23/4/90 05h30	Haute Mer	1,498.93	77.30	ALBACORA ONCE
90/83	AUXIMAD	11/4/90 10h30	Singapore	18/4/90 07h30	Bangkok	1,782.38	83.15	TANYO 1
90/84	AUXIMAD	11/4/90 15h00	SECREN	[illegible]	Mahajanga	171.12	33.00	JACQUES ORSINI
90/85	AUXIMAD	12/4/90 10h15	Haute Mer	24/4/90 05h00	Haute Mer	1,475.00	77.30	ALBACORA 12
90/86	AUXIMAD	12/4/90 20h10	Haute Mer	24/4/90 06h00	Haute Mer	760.49	58.20	GOMBESSA
90/87	AUXIMAD	13/4/90 08h45	Djeddah	02/5/90 17h10	Bangkok	4,731.00	11.50	VICTORIA REEFER
90/88	AUXIMAD	14/4/90 07h45	Haute Mer	15/4/90 16h00	Haute Mer	131.12	23.00	MARIO DE FATIMA
90/89	AUXIMAD	14/4/90 22h10	Seychelles	23/4/90 06h10	Haute Mer	1,365.11	78.75	EUZKADI ALAI
90/90	AUXIMAD	14/4/90 22h15	Seychelles	20/4/90 17h30	Haute Mer	988.15	52.00	ATERPE ALAI
90/91	AUXIMAD	15/4/90 06h30	Seychelles	24/4/90 17h30	Porto Rico	1,479.77	96.05	PACIFIC QUEEN
90/92	AUXIMAD	15/4/90 07h30	Haute Mer	18/4/90 16h30	Haute Mer	833.00	63.30	TXORI EDER
90/93	AUXIMAD	16/4/90 06h30	Haute Mer	27/4/90 18h30	Haute Mer	1,351.69	66.00	MONTE FRISA 7
90/94	AUXIMAD	16/4/90 16h30	Antalaha	19/4/90 15h30	Antsohihy	429.00	47.99	KINGA
90/95	AUXIMAD	17/4/90 08h00	Haute Mer	25/4/90 6h00	Haute Mer	1,300.00	72.20	KAI ALAI
90/96	AUXIMAD	14/4/90 18h15	Victoria	23/4/90 16h15	Italie	67.84	68.00	FADH
90/97	TRANS 7	18/4/90 23h12	La Reunion	18/4/90 19h15	Nosy Be	3,704.40	110.00	BARBARA D
90/98	AUXIMAD	19/4/90 07h20	Haute Mer	27/4/90 17h00	Haute Mer	2,107.00	67.97	JUAN RAMON E.
90/99	ALY MAMAD	19/4/90 23h30	Mitsamudu	23/4/90 23h00	Vohimar	317.48	50.45	SOALALA
90/100	AUXIMAD	20/4/90 07h00	Mitsamudu	20/4/90 09h00	SECREN	456.34	51.60	YLANG YLANG
90/101	AUXIMAD	19/4/90 13h00	Mahi	27/4/90 16h30	Bangkok	1,656.16	81.68	DELPHINUS
90/102	SOLIMA	[illegible]	Toamasina	[illegible]	Nosy Be	4,205.00	108.00	TSIMIRORO
90/103	AUXIMAD	21/4/90 09h10	Haute Mer	21/4/90 14h30	Haute Mer	1,132.73	71.50	BAYOTA
90/104	AUXIMAD	21/4/90 11h06	Hodeidah (Ymen)	14/5/90 17h00	Espagne	1,948.40	89.76	PRASLIN REEFER
90/105	SOLIMA	22/4/90 17h15	Las Palmas	04/5/90 05h10	Haute Mer	557.68	55.00	INTERTUNA UNO
90/106	AUXIMAD	24/4/90 (	[illegible]pagne	12/5/90 14h00	Espagne	1,220.06	87.75	ILARGIA
90/107	AUXIMAD	24/4/90 08h00	Haute Mer	02/5/90 17h20	Haute Mer	851.19	68.00	LA BOUGAINVILLE
90/108	AUXIMAD	25/4/90 06h30	Haute Mer	03/5/90 06h30	Haute Mer	1,475.36	60.00	ALBACORA 16
90/109	AUXIMAD	25/4/90 08h00	Seychelles	26/5/90 08h30	SECREN	1,200.28	70.50	READRUC
90/110	AUXIMAD	25/4/90 10h18	Djeddah	25/4/90 14h48	SECREN	2,058.00	95.50	
90/111	AUXIMAD	26/4/90 06h30	Haute Mer	04/5/90 05h10	Haute Mer	1,475.38	68.00	

MOIS DE MAI 1990

NUMERO	CONSIGNATAIRE	ARRIVEE	PROVENANCE	DEPART	DESTINATION	J.BRUTE (Tx)	L.H.TOUT (m)	NOMS NAVIRES
90/120	AUXIMAD	01/5/90 06h30	Haute Mer	06/5/90 20h15	Haute Mer	855.00	63.00	CHRISTOPHE
90/121	AUXIMAD	01/5/90 09h30	Haute Mer	10/5/90 11h45	Haute Mer	851.19	59.06	P.JOINVILLE
90/122	AUXIMAD	01/5/90 10h45	Cleuta (Esp.)	05/5/90 14h00	Victoria (Sey.)	1,386.60	92.00	ALBACORA FRISA
90/123	AUXIMAD	01/5/90 07h00	Haute Mer	10/5/90 09h30	Haute Mer	607.93	51.00	GEVREDO
90/124	AUXIMAD	02/5/90 07h00	Haute Mer	06/5/90 12h30	Haute Mer	833.90	63.30	TXORI-URD
90/125	AUXIMAD	[illegible]	Haute Mer	08/5/90 14h00	Haute Mer	1,308.49	73.80	ALMADABRA
90/126	SOLIMA	03/5/90 15h00	SECREN	05/5/90 10h20	SECREN	2,734.00	100.00	BEMOLANGA
90/127	ALI MAMADE	04/5/90 20h00	Mahajanga	10/5/90 23h00	Vohimar	317.98	50.45	SOALALA
90/128	SOLIMA	06/5/90 08h30	SECREN	[illegible]	Toamasina	2,734.00	100.00	BEMOLANGA
90/129	AUXIMAD	06/5/90 09h00	Haute Mer	15/5/90 10h04	SECREN	1,332.91	69.48	TXORI-ZURI
90/130	AUXIMAD	06/5/90 14h34	Singapore	07/5/90 17h30	Zone ico. Pche	424.00	42.85	YAH YOW 8
90/131	AUXIMAD	06/5/90 15h00	Haute Mer	14/5/90 14h00	Haute Mer	1,146.50	69.00	TREVIGNON II
90/132	AUXIMAD	07/5/90 04h30	Mahajanga	11/5/90 23h10	Mahajanga	182.00	35.00	WUBBINA
90/133	AUXIMAD	07/5/90 06h30	Haute Mer	10/5/90 05h30	Haute Mer	1,475.00	77.30	ALBACORA 14
90/134	AUXIMAD	07/5/90 07h30	Haute Mer	08/5/90 14h30	SECREN	988.15	52.00	ATERPE ALAI
90/135	AUXIMAD	07/5/90 07h30	Haute Mer	14/5/90 07h30	Haute Mer	773.00	55.00	ARMEN
90/136	MSC	07/5/90 10h00	La Reunion	08/5/90 16h00	Durban	9,192.14	155.73	ROSA'S
90/137	AUXIMAD	07/5/90 13h10	Haute Mer	10/5/90 17h30	SECREN	1,146.50	70.50	H. DE KERNANDEC
90/138	AUXIMAD	07/5/90 15h10	Haute Mer	16/5/90 17h10	Haute Mer	1,146.50	70.50	TRESCAO
90/139	AUXIMAD	09/5/90 07h00	Haute Mer	17/5/90 05h15	Mahi (Sey.)	760.49	58.20	GOMBESSA
90/140	AUXIMAD	09/5/90 07h00	Haute Mer	13/5/90 06h00	Haute Mer	1,365.11	78.75	EUZKADI ALAI
90/141	SOLIMA	10/5/90 06h00	Toamasina	11/5/90 06h30	Nosy Be	4,205.00	[illegible]	TSIMIRORO
90/142	AUXIMAD	08/5/90 11h20	Mahajanga	10/5/90 17h15	Moroni (Comores)	433.46	47.00	V. DE NIGUMACHO
90/143	AUXIMAD	10/5/90 17h45	SECREN	11/5/90 12h30	Haute Mer	1,146.50	69.00	ROSPICO
90/144	AUXIMAD	10/5/90 20h10	Maroantsetra	[illegible]	[illegible]	[illegible]	58.00	HASIKIN 18
90/145	AUXIMAD	12/5/90 14h45	Mayotte	19/5/90 05h10	Vohimar	429.00	47.99	KINGA
90/146	AUXIMAD	12/5/90 19h10	Haute Mer	21/5/90 13h15	Haute Mer	1,809.50	67.50	IZARO
90/147	AUXIMAD	13/5/90 06h00	Port Victoria	31/5/90 06h30	Porto-Rico	2,869.00	96.95	PACIFIC MARCHIOI
90/148	AUXIMAD	13/5/90 06h00	SECREN	15/5/90 10h10	Moroni (Comores)	456.34	51.00	YLANG YLANG
90/149	SOLIMA	14/5/90 10h45	Maurice	15/5/90 18h40	Toamasina	2,734.00	100.00	BEMOLANGA
90/150	AUXIMAD	14/5/90 15h10	Toamasina	21/5/90 10h30	Vohimar	1,438.60	72.54	VATSY
90/151	AUXIMAD	16/5/90 07h30	Mahajanga	18/5/90 06h00	Toamasina	3,297.16	97.52	ONIBE
90/152	AUXIMAD	16/5/90 08h30	Toamasina	21/5/90 05h30	Port St Louis	139.63	73.37	V. DE MANAKARA
90/153	AUXIMAD	16/5/90 13h30	Haute Mer	21/5/90 06h00	SECREN	1,132.73	71.50	BAYOTA
90/154	SCAC	[illegible]	Fort Dauphin	[illegible]	Fort Dauphin	491.59	72.05	ILDERIM 6
90/155	AUXIMAD	19/5/90 10h45	Haute Mer	22/5/90 06h30	Vohimar	429.00	47.99	KINGA
90/156	AUXIMAD	18/5/90 13h00	SECREN	19/5/90 10h00	Haute Mer	1,146.50	70.50	H.NERLANDERS
90/157	AUXIMAD	05/5/90 09h00	Toamasina	06/5/90 06h30	Port St Louis	1,103.10	77.02	VATSY 4
90/158	AUXIMAD	19/5/90 15h00	SECREN	23/5/90 06h00	Haute Mer	988.15	52.00	ATERPE ALAI
90/159	AUXIMAD	20/5/90 19h30	Haute Mer	23/5/90 06h00	Haute Mer	1,682.00	84.21	MONTELAPE
90/160	HASIKIN	21/5/90 12h15	Taowan	24/5/90 11h00	Haute Mer	413.24	[illegible]	YUH YOW 2
90/161	SCAC	22/5/90 16h00	Moroni	24/5/90 06h00	Toamasina	98.68	[illegible]	ISLE FERRY

A-4.4 Demand Forecast

The results of demand forecast in the case of low economic growth are shown in the following tables and figures.

Table A-4-4-1 Result of GDP Forecast in 1990 Price

(UNIT:BILLION FMG,%)

YEAR		AGRICULT		INDUSTRY		SERVICE		TOTAL	
		PRICE	SHARE	PRICE	SHARE	PRICE	SHARE	PRICE	SHARE
1992	Price	1383	33.6	577	14.0	2155	52.4	4115	100
2010	Case 1								
	Price	2581	28.0	1833	19.9	4793	52.1	9207	100
	Ave growth rate	3.5		6.6		4.5		4.6	
	Case 2								
	Price	2234	31.9	1103	15.7	3669	52.4	7006	100
	Ave growth rate	2.7		3.7		3.0		3.0	

Table A-4-4-2 Results of Cargo Volume Forecast (1)

(UNIT:TON)

YEAR		Case1(A)	Case2(B)	(A)-(B)
FOREIGN	EXPORT	89100	78600	10500
	IMPORT	86800	70700	16100
	TOTAL	175900	149300	26600
DOMESTIC	LOAD	60000	54700	5300
	UNLOAD	87300	78900	8400
	TOTAL	147300	133600	13700
TRANSHIP		164000	148300	15700
TOTAL	LOAD	149100	133300	15800
	UNLOAD	174100	149600	24500
	TRANSHIP	164000	148300	15700
	TOTAL	487200	431200	56000

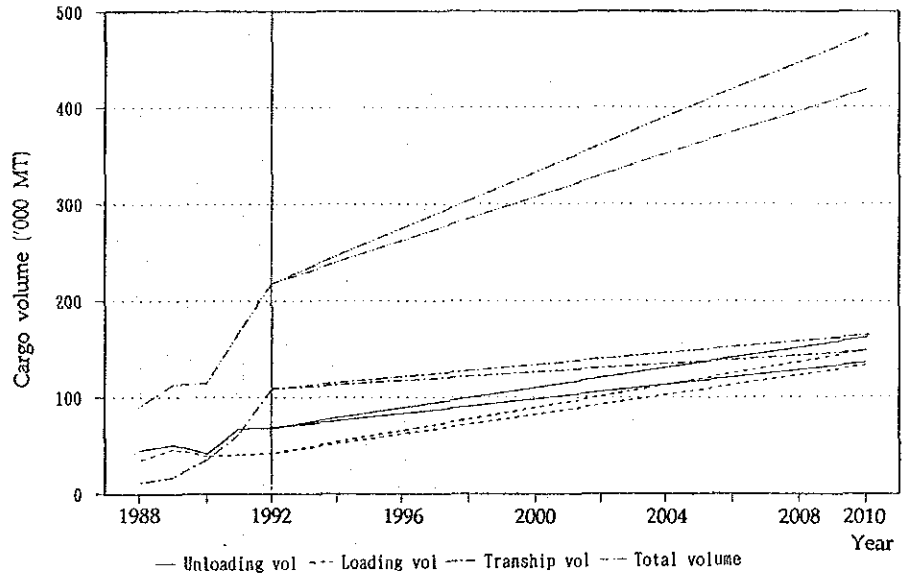


Figure A-4-4-1 Results of Cargo Volume Forecast (1)

Table A-4-4-3 Results of Cargo Volume Forecast (2)

(UNIT:TON)

YEAR		Case1(A)	Case2(B)	(A)-(B)
LOAD	FOREIGN	89100	78600	10500
	TUNA-related	15200	15200	0
	SALTS	25600	25600	0
	PETROLEUM	0	0	0
	OTHERS	48300	37800	10500
	DOMESTIC	60000	54700	5300
	TUNA-related	0	0	0
	SALTS	29900	29900	0
	PETROLEUM	12200	10400	1800
	OTHERS	17900	14400	3500
	TOTAL	149100	133300	15800
	TUNA-related	15200	15200	0
	SALTS	55500	55500	0
	PETROLEUM	12200	10400	1800
	OTHERS	66200	52200	14000
UNLOAD	FOREIGN	86800	70700	16100
	TUNA-related	8000	8000	0
	SALTS	0	0	0
	PETROLEUM	48700	41600	7100
	OTHERS	30100	21100	9000
	DOMESTIC	87300	78900	8400
	TUNA-related	37000	37000	0
	SALTS	0	0	0
	PETROLEUM	19100	15900	3200
	OTHERS	31200	26000	5200
	TOTAL	174100	149600	24500
	TUNA-related	45000	45000	0
	SALTS	0	0	0
	PETROLEUM	67800	57500	10300
	OTHERS	61300	47100	14200
TRANSHIP	TOTAL	164000	148300	15700
	TUNA	52000	52000	0
	PETROLEUM	112000	96300	15700
TOTAL	FOREIGN	175900	149300	26600
	TUNA-related	23200	23200	0
	SALTS	25600	25600	0
	PETROLEUM	48700	41600	7100
	OTHERS	78400	58900	19500
	DOMESTIC	147300	133600	13700
	TUNA-related	37000	37000	0
	SALTS	29900	29900	0
	PETROLEUM	31300	26300	5000
	OTHERS	49100	40400	8700
	TRANSHIP	164000	148300	15700
	TUNA	52000	52000	0
	PETROLEUM	112000	96300	15700
	TOTAL	487200	431200	56000
	TUNA-related	112200	112200	0
	SALTS	55500	55500	0
	PETROLEUM	192000	164200	27800
	OTHERS	127500	99300	28200

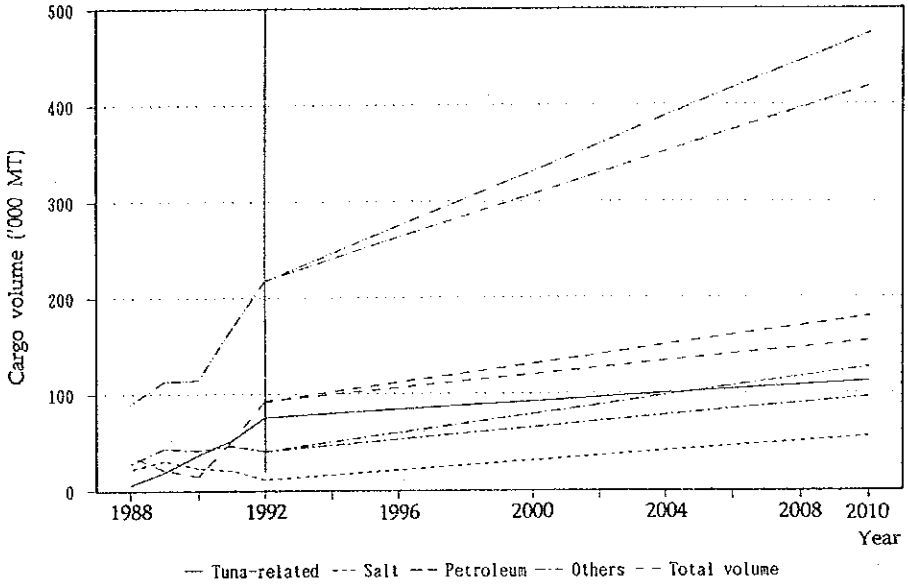


Figure A-4-4-2 Results of Cargo Volume Forecast (2)

Table A-4-4-4 Results of Forecast in Loading General Cargo

(Unit:ton)

	Case1(A)	Case2(B)	(A)-(B)
Foreign cargo	141,100	130,600	10,500
Tuna(tranship)	52,000	52,000	0
Salts	25,600	25,600	0
Rice	0	0	0
Flour	0	0	0
Cement	0	0	0
Fertilizer	0	0	0
Canned food	15,200	15,200	0
Others	48,300	37,800	10,500
Domestic cargo	47,800	44,300	3,500
Tuna(tranship)	0	0	0
Salts	29,900	29,900	0
Rice	1,500	1,500	0
Flour	2,200	2,200	0
Cement	400	300	100
Fertilizer	1,700	1,000	700
Canned food	0	0	0
Others	12,100	9,400	2,700
Total	188,900	174,900	14,000
tuna(tranship)	52,000	52,000	0
Salts	55,500	55,500	0
Rice	1,500	1,500	0
Flour	2,200	2,200	0
Cement	400	300	100
Fertilizer	1,700	1,000	700
Canned food	15,200	15,200	0
Others	60,400	47,200	13,200

Table A-4-4-5 Results of Forecast in Unloading General Cargo

(Unit:ton)

	Case1(A)	Case2(B)	(A)-(B)
Foreign cargo	38,100	29,100	9,000
Rice	0	0	0
Flour	0	0	0
Tuna-related	8,000	8,000	0
Cement	6,200	4,600	1,600
Coffee	0	0	0
Fertilizer	1,900	1,200	700
Animal & Vegetable oil	1,100	700	400
Metal products	1,100	1,100	0
Others	19,800	13,500	6,300
Domestic cargo	120,200	115,000	5,200
Rice	4,600	4,600	0
Flour	7,200	7,200	0
Tuna-related	89,000	89,000	0
Cement	4,100	3,000	1,100
Coffee	1,600	1,600	0
Fertilizer	0	0	0
Animal & Vegetable oil	200	200	0
Metal products	300	300	0
Others	13,200	9,100	4,100
Total	158,300	144,100	14,200
(TRANSHIP)	52000	52000	0
Rice	4,600	4,600	0
Flour	7,200	7,200	0
Tuna-related	97,000	97,000	0
(TRANSHIP)	52000	52000	0
Cement	10,300	7,600	2,700
Coffee	1,600	1,600	0
Fertilizer	1,900	1,200	700
Animal & Vegetable oil	1,300	900	400
Metal products	1,400	1,400	0
Others	33,000	22,600	10,400

A-5.5 Structural Design

A-5.5.1 Reconstruction Works of the Old Quay (1972)

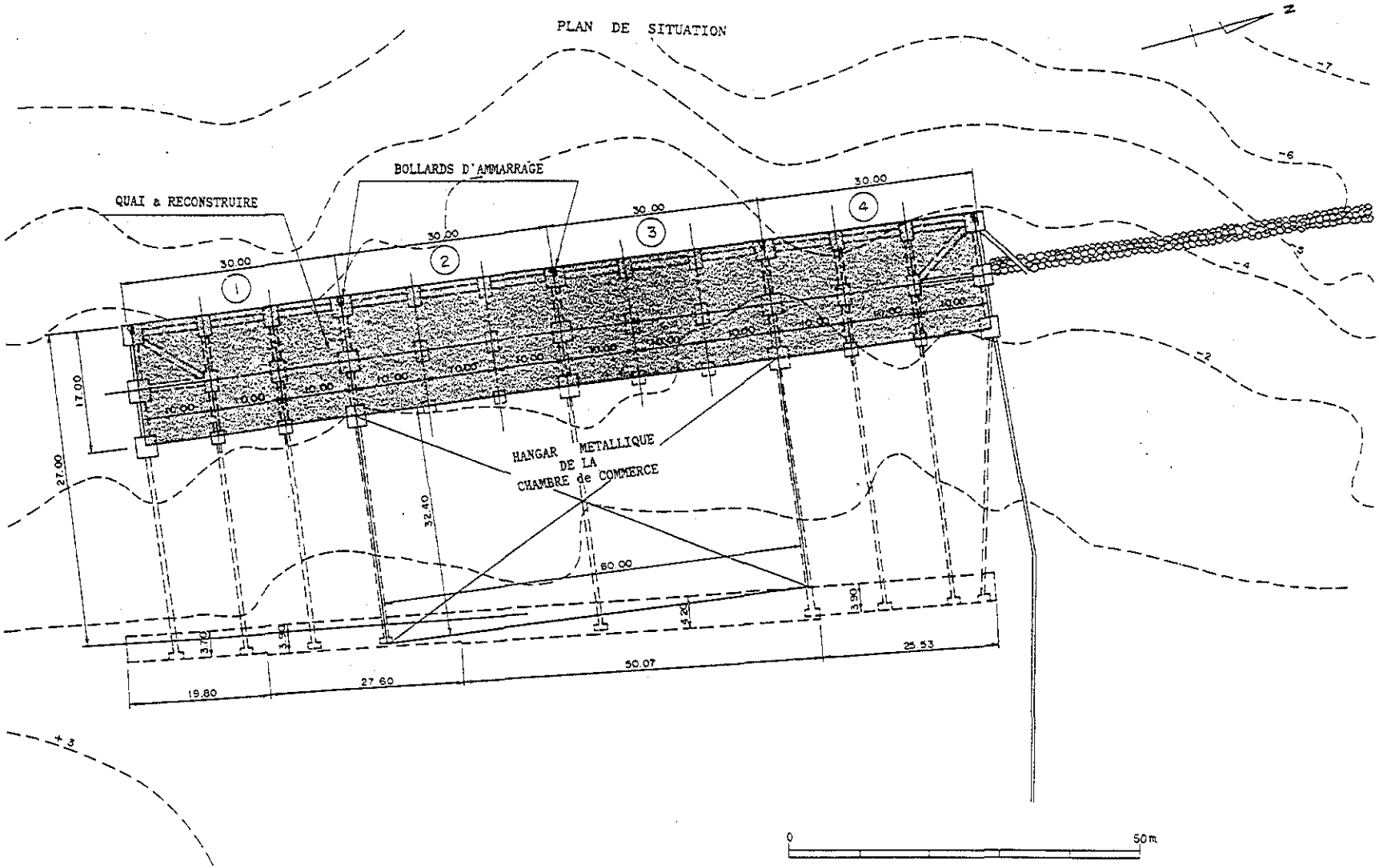


Figure A-5-5-1 General Plan

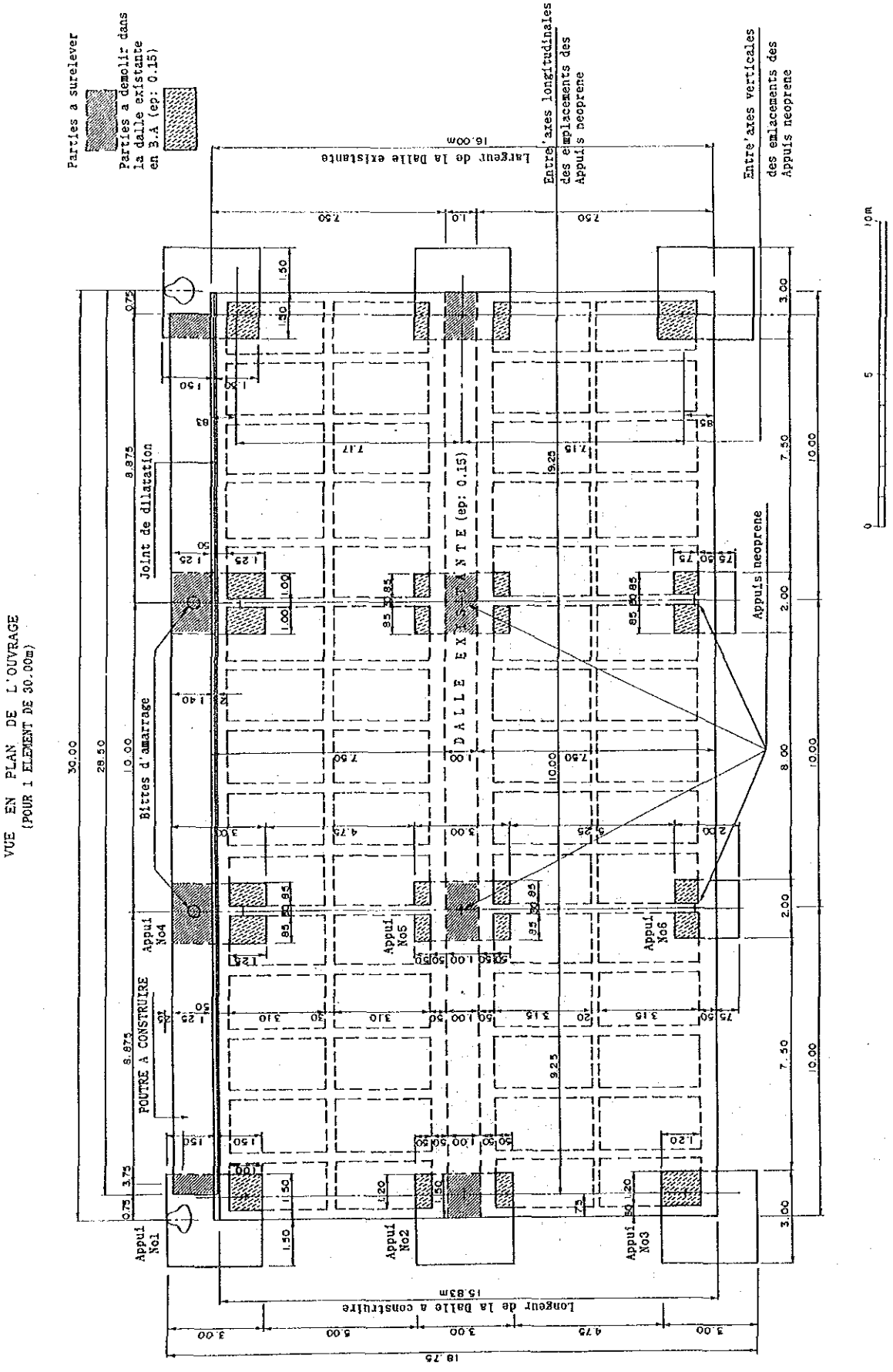
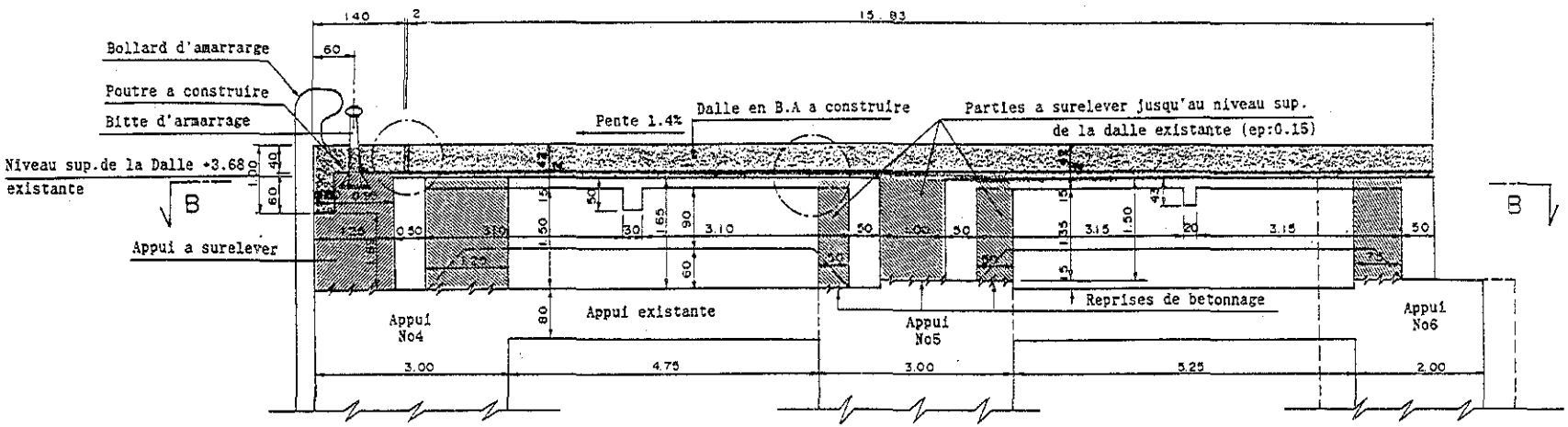


Figure A-5-5-2 View of Structure

COUPE TRANSVERSALE A-A DE L'OUVRAGE



PLAN-COUPE B-B DE L'OUVRAGE EXISTANT

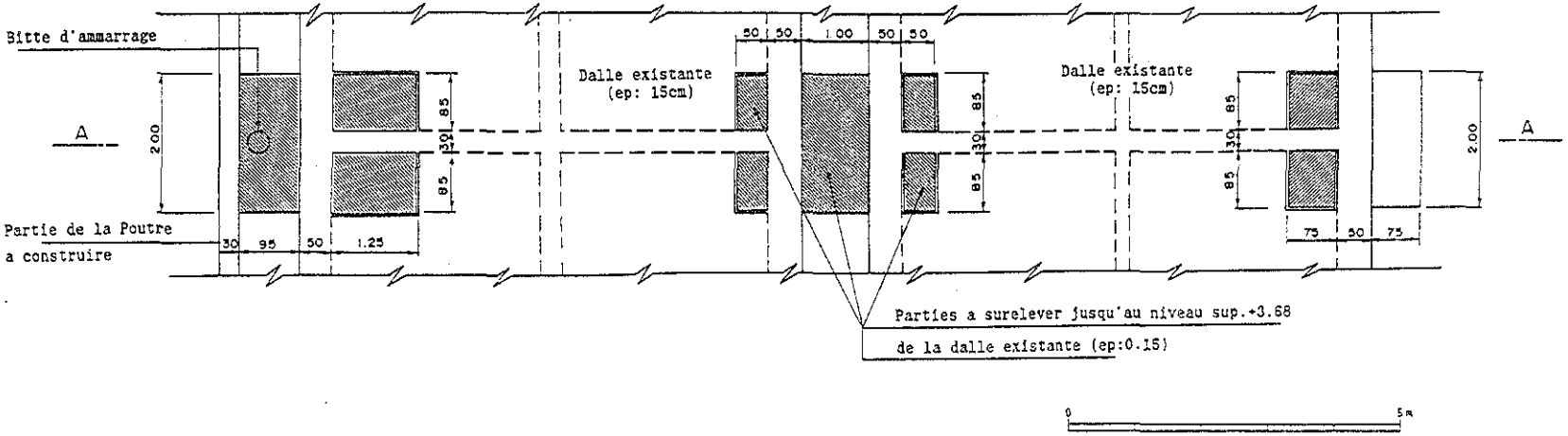
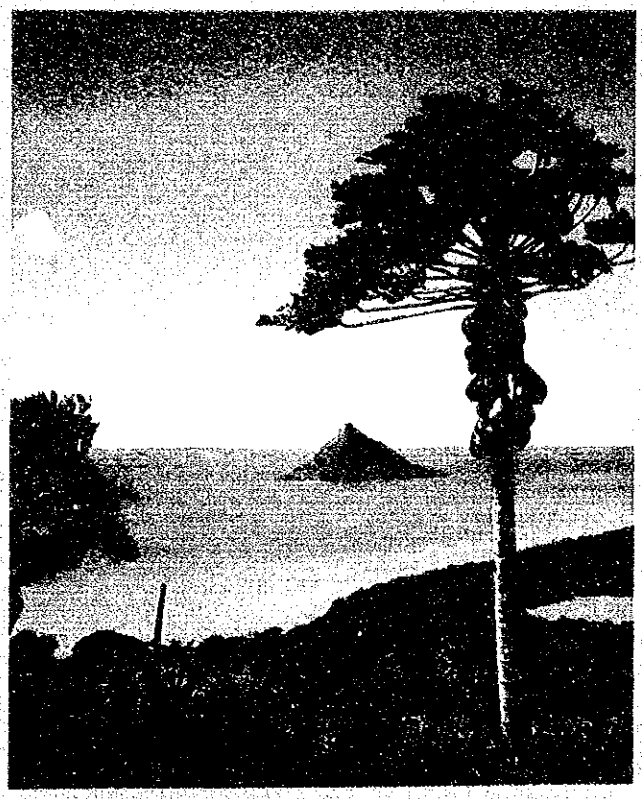


Figure A-5-5-3 Slab and Front Wall



JICA