CHAPTER 7

ENVIRONMENTAL ASSESSMENT

Chapter 7 Environmental Assessment

7.1 Initial Environmental Examination

7.1.1 Principal Policy

Marine environmental surveys in the vicinity of Beira Port were carried out for Initial Environmental Examination (IEE) under this Study. Investigations including water quality and seabed materials in the wet season and also water quality and benthic macrofauna in two seasons were carried out to clarify seasonal differences.

Through consultations with representatives of the agencies concerned, the necessary environmental information was collected. After examining this information, the environmental impacts expected to be caused by the Project are collectively assessed here.

(1) Environmental Laws of Mozambique

There is no environmental guideline in Mozambique. The Environmental Impact Assessment (EIA) law for Mozambique is under preparation. Therefore, EIA has to be carried out based on the guidelines of Japan International Cooperation Agency (JICA) and Japan's environmental standards or other countries. The Ministry of Coordination for Environmental Actions (MICOA) has been responsible for the environmental management in Mozambique since 1994.

(2) Related International Agreements

Relevant environmental agreements made at several International Conventions are listed below.

- Convention for the Protection of the World Cultural and Nature Heritage
- United Nations Convention on the Law of the Sea
- Convention on International Trade in Endangered Species of Wild Fauna and Flora
- Convention on Biological Diversity
- United Nation Framework Convention on Climate Change
- Montreal Protocol on Substances that Deplete the Ozone Layer

7.1.2 Purpose of IEE

The study for the maintenance and improvement plan of the Access Channel to Beira Port has to analyze the environmental impact. From this perspective, IEE has focused on collecting information and data related to the environmental impact during or after the dredging and dumping works.

7.1.3 Natural Environment

About 75 % of the inhabitants of Mozambique live within 40 km of the coastal region. Beira Port faces the estuary of the Pungue River, which is 372 km long and has a catch basin of 29,500 km^2. It is situated at the vital outlet and a gateway of the Beira Corridor acting as a route for the international cargo transportation to the inland countries.

At the estuary of the Pungue River, the water quality and seabed materials are strongly affected mainly by tidal currents with remarkable variation in the wet summer and the dry winter. Throughout the wet summer and dry winter, land-originated suspended substance is abundant in the estuary and in the vicinity of Beira Port. The sources of water pollution are originated from the discharge of domestic, industrial and agricultural effluents through the Pungue River. In the case of low tidal force and large river discharge, land-originated substances in fresh water occasionally appear to expand to about 20 km offshore.

Crustaceans are the most important resources, emphasizing on shallow-water shrimps which are found along all the Mozambican Coast as well as the Macuti Coast in the vicinity of Beira. The distribution of aquatic animal including these shrimps is directly related to the existence of mangroves in the river estuaries which are regarded as nurseries for fish farming.

(1) Wildlife

Mozambique was considered as one of the African countries with rich fauna potential because of both quantity and diversity of wild species. These fauna species become to be put in different uses in the country, through activities mostly ruled and regulated by the different governing organizations, especially the Provincial Veterinary Services during the colonial period and presently the National Board of Forests and Wildlife, with the aim of appropriate use and protection of fauna resources. Despite such measures, some animal species are subjected through the years to unbridled exploitation, jeopardizing the very existence of the animal communities.

(2) Soil

In Mozambique, there is a wide range of soil types. Among the pedogenetically immature soil, the alluvial soils are those which posses the greatest agricultural potential, covering considerable areas in the extensive Zambezi delta and along the banks of numerous rivers including the Punguo River. The areas covered by alluvial soils include significant layers of hydromorphic and halomorphic soils. Normally such soils are of low production potential for annual crops because of their low fertility, poor water retention and course texture. However, along the coastal strip, the moderate production potential for tree crops, notably cashew and coconut is found.

Lithoidal soils cover large areas of Sofala, Tete, Manica, Gaza, Zambezia, and Maputo. They are poorly developed soils with frequent occurrences of gravel, stones and outcrops of strata on the surface.

(3) Soil Erosion

In Mozambique, soil erosion is a matter of primary concern among the environmental problems which give a damage to the natural basis of agriculture, forestry, wildlife and fishery.

7.1.4 Beach Erosion of Macuti Coast

At first, the influence of the deepening of the Access Channel will be considered. The Access Channel was constructed along the Macuti Channel which had maintained naturally, so that the phenomenon of sand transport system, which have been described in the Chapter 3.5.3, will be scarcely different between before and after the deepening of the Access Channel. A unique difference is the decrease of sand drift crossing beyond the Channel. The volume of sand depositing in the Channel increases with increase of the depth and width of the Channel, so that the volume of sand crossing beyond the Channel decreases at the same time.

The amount of sand drift passing the shoal area in front of the Macuti Beach and reaching the Macuti Channel is nearly equal between before and after the deepening of the Channel. But, the amount of sand drift crossing the Channel and reaching to the Macuti Shoal from the Pelican and Rambler Shoals decreases after the deepening of the Channel. However, most of materials which can cross beyond the Channel are fine sand and silt, because coarse sand deposits in the bottom of the Channel. Fine sand and silt in general do not serve so much for the formation of the beach, which means that the decrease of sand drift crossing the Access Channel would scarcely influence the erosion of the Macuti Coast.

On the other hand, as described in Chapter 6, the dredged materials from the Access Channel are planned to be dumped in the north area of the Channel.

Some part of them is moved toward the Macuti Beach by waves, serving for the formation of the beach. This effect will be very superior to the above mentioned decrease of sand drift crossing beyond the Access Channel from the Pelican and Rambler Shoals. Thus, this maintenance dredging plan of the Access Channel will be effective for the protection of the Macuti Beach, without giving any damage to the stability of the Macuti Beach.

Regarding the countermeasure for the present beach erosion in the Macuti Coast, it is important to prevent alongshore sand transport toward the mouth of the Pungue River. At Present, many concrete groins of relatively short length are installed in the distance of about 5 km along the coast. In addition to the extension of the existing groins, it is recommended to construct a long jetty of some 200 m long at the west end of the Macuti Coast.

In order to prevent sand floating out off-shore-ward from the Beach, it is recommended to make the groins in T-shape by attaching a short breakwater parallel to the coastal line on the tip of each groin. Additionally, it is very useful to supply some part of the dredged sand from the Access Channel directly on the beach.

7.1.5 Bottom Sediment Materials

Representative sampling stations were located around Beira Port and the Macuti Channel in order to conduct the seabed material surveys. The sampling stations are shown in Figure 7.1.5-1.

The results of seabed material survey are summarized in Table 7.1.5-1. Sediments vary over the study area, ranging in consistency from fine mud, through various grades of sand to coarse gravel. According to the distribution of seabed materials, silty sand is predominant upstream of Beira Port and the mixture of mud and sand covers the seabed around the river mouth of the Pungue River. Furthermore, the seabed offshore and at the river mouth are mainly covered by a variety of sands.

The physical characteristics of the sediments has a profound influence on their chemistry and this should be borne in mind when evaluating organic loading and contaminants concentrations. In general, the coarser sediments would be expected to elicit lower readings for the absorption of organs and heavy minerals since they have a lower surface. While, the content of the heavy minerals and organic substance in the muddy sediment which has a large grain surface higher than in the sandy sediment. But this concentration is at the same level as the other coastal sediment of South Africa and also the acceptable base level.

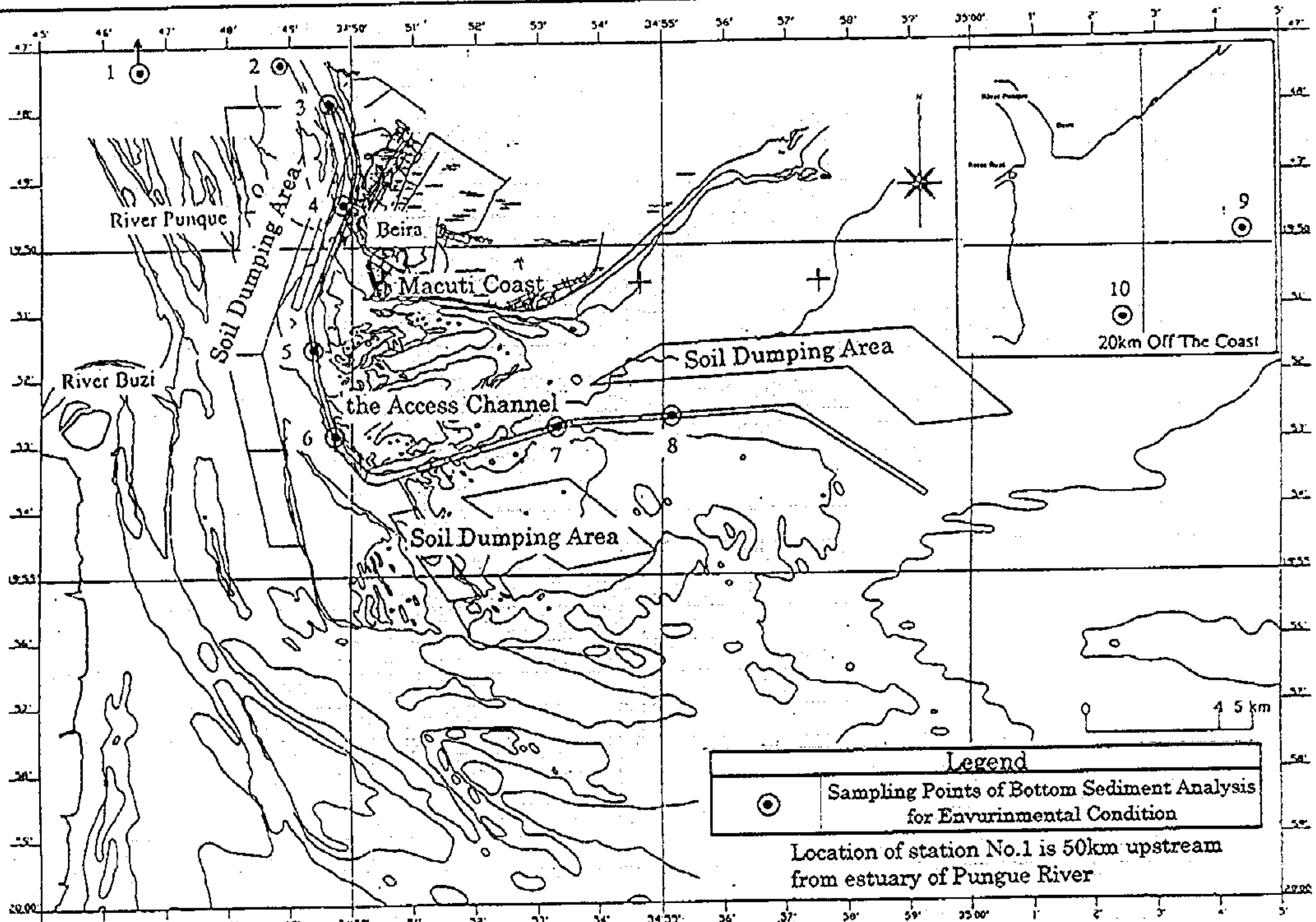

Figure 7.1.5-1 Location of Sampling Stations for Bottom Sediment Analysis

Table 7.1.5-1 Results of Environmental Analysis for Seabed Materials

Station No.	Hydrargyrum(Hg) (mg/g)	Cadmium(Cd) (mg/g)	Lead(Pb) (mg/g)	Arsenic(As) (mg/g)	Copper(Cu) (mg/g)	Zinc(Zn) (mg/g)	Hexavalent Chromium (CrVI) (mg/g)
1	0.000014	0.000100	0.00577	<0.000023	0.00204	0.00817	<0.000100
2	0.000047	<0.000100	0.01090	0.000957	0.01820	0.04100	<0.000100
3	0.000036	<0.000100	0.01810	0.000827	0.03330	0.06590	<0.000100
4	0.000011	<0.000100	0.00156	0.000026	0.00095	0.00204	<0.000100
5	0.000019	<0.000100	0.01290	0.000936	0.02260	0.04620	<0.000100
6	<0.000002	<0.000100	0.00086	<0.000023	0.00038	0.00114	<0.000100
7	0.000033	<0.000100	0.00921	0.000435	0.01600	0.03490	<0.000100
8	0.000011	<0.000100	0.00621	0.000278	0.00860	0.02320	<0.000100
9	0.000010	0.000140	0.00289	<0.000023	0.00400	0.00169	<0.000100
10	0.000028	<0.000100	0.00194	0.000250	0.00134	0.00170	<0.000100

Station No.	Organic Hydrargyrum (mg/kg)	Organic Phosphorus (mg/kg)	Cyanogen (mg/kg)	PCB 1) (mg/kg)	DDT 2) (mg/kg)	BHC 3) (mg/kg)	Ignition Loss (%)
1	<0.00002	<0.00002	<0.00002	<0.00002	Trace	<0.00002	1.23
2	<0.00002	<0.00002	<0.00002	<0.00002	Trace	<0.00002	5.31
3	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	8.40
4	<0.00002	<0.00002	<0.00002	<0.00002	Trace	<0.00002	0.38
5	<0.00002	<0.00002	<0.00002	<0.00002	Trace	<0.00002	6.19
6	<0.00002	<0.00002	<0.00002	<0.00002	Trace	<0.00002	0.21
7	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	5.26
8	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	2.60
9	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	1.91
10	<0.00002	<0.00002	<0.00002	<0.00002	Trace	<0.00002	0.86

1) Polychlorinated biphenyl
2) Dichloro diphenyl trichloroethane
3)Benzene hexa chloride

7.1.6 Water Quality

Water sampling was carried out at the same stations as the sea bed material sampling for environmental analysis as shown in Figure 7.1.5-1.

The results of water quality analysis are shown in Tables 7.1.6-1 to 7.1.6-7.

The investigation of water quality was carried out during spring tide in February and July in 1997. Following parameters were measured.

- Hydraulic parameters: depth, water temperature, salinity, dissolved oxygen, pH
- Water quality: faecal coliforms, turbidity and suspended solids, nutrients, trace metals, organic component.

In the vicinity of Beira, while the Pungue River is in flood in the wet season, the density boundary between fresh water and sea water appeared very clearly. This is the result of the fact that both sea and fresh water mix over whole water column resulting in weak stratification. In contrast, in the dry season when the river flow is smaller, frontal gradient is weak but the stratification is clear.

In the wet season, frontal boundaries strengthen during flood tide and weaken during ebb tide. During the flooding period of the river, the estuarine environment is dominated by fresh water even during the dry season, whereas during the dry season it is dominated by sea water.

(1) Faecal Coliforms

Relatively high faecal coliform counts were recorded during the wet season and these were lower during the dry season. In both seasons, the contamination patterns were basically similar and the contamination was highest in the shallow water area near the city area. High contamination may be attributable to the lower river flow and the discharge from local resident area and their livestock as well as poor sanitary condition.

The results obtained at Station 2 and 6 in the dry season are roughly comparable to levels measured at Durban Harbor (a semi-enclosed water bordering a major city). They are considerably higher than levels generally encountered in the open sea off Durban. Compared with the background provided by the South African Marine Water Guidelines and the respective recommendations for the collection and culture of filter feeders, many of the results obtained near Beira Port indicate significant contamination due to the

Table 7.1.6-1 Results of CTD* Measurements

CTD* Data (River Area)

Station-Season	Temperature(°C)	Salinity(‰)	O2(ml/l)	pH
St 1:Wet	27.2	0.04	4.95	5.85
Dry	21.3	0.09	7.65	6.49

CTD* Data (Low Tide)

Station-Season	Temperature(°C)	Salinity(‰)	O2(ml/l)	pH
St 2:Wet	28.1	0.29	6.81	8.06
Dry	22.1	16.60	5.41	7.81
St 3:Wet	28.3	0.25	3.13	8.14
Dry	22.2	15.90	6.35	8.21
St 4:Wet	29.1	0.33	2.77	8.18
Dry	22.2	7.30	7.10	8.12
St 5:Wet	29.3	0.85	2.73	8.15
Dry	22.2	5.37	7.19	8.26
St 6:Wet	29.3	8.08	3.04	7.77
Dry	22.2	27.40	5.75	8.45
St 7:Wet	29.4	12.80	3.92	7.82
Dry	22.5	28.60	5.81	8.53
St 8:Wet	29.3	15.60	4.12	7.86
Dry	22.8	25.68	6.73	8.60
St 9:Wet	29.8	29.10	4.44	8.08
Dry	23.0	25.36	7.18	8.59
St 10:Wet	29.5	28.00	4.79	8.12
Dry	23.2	27.01	7.76	8.39

CTD* Data (High Tide)

Station-Season	Temperature(°C)	Salinity(‰)	O2(ml/l)	pH
St 2:Wet	29.4	8.98	3.87	7.72
Dry	22.0	25.00	5.86	8.40
St 3:Wet	29.4	10.30	3.65	7.70
Dry	22.1	26.30	5.43	8.46
St 4:Wet	29.6	15.10	3.86	7.82
Dry	22.0	18.50	6.52	8.21
St 5:Wet	29.7	20.10	4.39	7.91
Dry	22.2	27.50	5.80	8.49
St 6:Wet	29.6	21.90	4.70	7.94
Dry	22.3	25.90	6.20	8.53
St 7:Wet	29.8	28.00	4.60	7.98
Dry	22.4	11.20	7.22	8.43
St 8:Wet	29.8	29.10	4.57	7.97
Dry	22.6	29.99	5.90	8.56
St 9:Wet	30.1	30.50	4.65	7.99
Dry	22.8	31.18	6.41	8.07
St 10:Wet	30.1	29.80	4.61	7.96
Dry	22.8	32.75	5.58	8.60

*CTD is abbreviation of Conductivity, Temperature and Depth.

Table 7.1.6-2 Results of Faecal Coliforms Measurements

Station No/ Sample Description	Date	Tide	Faecal coliforms per 100ml	Salinity (‰)
W 1	1997/2/9	non-tidal	226	0
D 1	1997/7/5	non-tidal	500	0
W 2	1997/2/6	Low	1420	0.3
D 2	1997/7/3	Low	74	19.35
W 3	1997/2/6	Low	6000	0.25
D 3	1997/7/3	Low	42	19.57
W 4	1997/2/6	Low	8200	0.33
D 4	1997/7/3	Low	100	21.45
W 5	1997/2/6	Low	3300	0.84
D 5	1997/7/3	Low	500	24.35
W 6	1997/2/6	Low	600	8.08
D 6	1997/7/3	Low	172	28.19
W 7	1997/2/8	Low	76	12.82
D 7	1997/7/3	Low	Nil	31.23
W 8	1997/2/8	Low	64	15.55
D 8	1997/7/3	Low	Nil	32.03
W 9	1997/2/7	Low	200	29.18
D 9	1997/7/4	Low	Nil	33.48
W 10	1997/2/7	Low	530	27.97
D 10	1997/7/4	Low	Nil	33.48
W 2	1997/2/8	High	5000	8.98
D 2	1997/7/2	High	400	24.57
W 3	1997/2/8	High	700	10.35
D 3	1997/7/2	High	1500	26.81
W 4	1997/2/8	High	6000	15.14
D 4	1997/7/2	High	2700	26.81
W 5	1997/2/8	High	58	20.06
D 5	1997/7/2	High	2	29.2
W 6	1997/2/8	High	2100	21.94
D 6	1997/7/2	High	2	30.58
W 7	1997/2/8	High	26	28.01
D 7	1997/7/2	High	2	31.81
W 8	1997/2/8	High	4 060	29.09
D 8	1997/7/2	High	Nil	32.83
W 9	1997/2/7	High	178	30.47
D 9	1997/7/2	High	2	33.04
W 10	1997/2/7	High	122	29.83
D 10	1997/7/2	High	Nil	33.55
Japanese Environmental Standard (River B)			5000	----

(D: July 1997,W: Feb'1997)

Table 7.1.6-3 Results of Turbidity and Suspended Solids Measurements

Station No.	Tide	Turbidity (NTU*)	Total Suspended Solids (mg/ l)
W 1	Non-tidal	19	37
D 1	Non-tidal	210	26
W 2	Low	210	652
D 2	Low	260	1120
W 3	Low	98	294
D 3	Low	270	1020
W 4	Low	150	502
D 4	Low	270	1120
W 5	Low	44	137
D 5	Low	43	115
W 6	Low	88	314
D 6	Low	63	182
W 7	Low	9.5	97
D 7	Low	47	126
W 8	Low	2.7	80
D 8	Low	45	126
W 9	Low	1.7	67
D 9	Low	0.2	57
W 10	Low	1.8	77
D 10	Low	0.7	56
W 2	High	90	271
D 2	High	54	146
W 3	High	27	107
D 3	High	110	300
W 4	High	29	116
D 4	High	79	231
W 5	High	20	95
D 5	High	34	123
W 6	High	5.7	78
D 6	High	11	66
W 7	High	5.3	75
D 7	Low	47	126
W 8	High	2.8	84
D 8	High	4.4	80
W 9	High	1.7	74
D 9	High	0.6	64
W 10	High	1.8	76
D 10	High	0.1	59
Japanese Environmental Standard		(River B)	25

(D: July 1997,W: Feb'1997)

*NTU means Standard Nephelometric Turbidity units

Table 7.1.6-4 Results of Organic Measurements

Station No	Tide	Organic Hg(μg/l)	Organic P(mg/l)	Cyanog-en(mg/l)	PCB (μg/l)	DDT (μg/l)	BHC (μg/l)
W 1	non-tidal	<0.02	0.02	<0.05	<0.02	0<0.02	<0.02
D 1	non-tidal	<0.02	<0.01	<0.05	<0.15	<0.15	<0.15
W 2	Low	<0.02	0.64	<0.05	<0.02	0<0.02	<0.02
D 2	Low	<0.02	0.47	<0.05	<0.15	<0.15	<0.15
W 3	Low	<0.02	0.21	<0.05	<0.02	0<0.02	<0.02
D 3	Low	<0.02	0.07	<0.05	<0.15	<0.15	<0.15
W 4	Low	<0.02	0.43	<0.05	<0.02	0<0.02	<0.02
D 4	Low	<0.02	0.21	<0.05	<0.15	<0.15	<0.15
W 5	Low	<0.02	0.18	<0.05	<0.02	0<0.02	<0.02
D 5	Low	<0.02	0.1	<0.05	<0.15	<0.15	<0.15
W 6	Low	<0.02	0.15	<0.05	<0.02	0<0.02	<0.02
D 6	Low	<0.02	0.06	<0.05	<0.15	<0.15	<0.15
W 7	Low	<0.02	0.14	<0.05	<0.02	0<0.02	<0.02
D 7	Low	<0.02	0.03	<0.05	<0.15	<0.15	<0.15
W 8	Low	<0.02	0.14	<0.05	<0.02	0<0.02	<0.02
D 8	Low	<0.02	<0.01	<0.05	<0.15	<0.15	<0.15
W 9	Low	<0.02	0.01	<0.05	<0.02	0<0.02	<0.02
D 9	Low	<0.02	<0.01	<0.05	<0.10	<0.15	<0.15
W 10	Low	<0.02	0.01	<0.05	<0.02	0<0.02	<0.02
D 10	Low	<0.02	<0.01	<0.05	<0.10	<0.10	<0.15
W 2	High	<0.02	0.17	<0.05	<0.02	0<0.02	<0.02
D 2	High	<0.02	0.15	<0.05	<0.15	<0.15	<0.15
W 3	High	<0.02	0.25	<0.05	<0.02	0<0.02	<0.02
D 3	High	<0.02	<0.01	<0.05	<0.15	<0.15	<0.15
W 4	High	<0.02	0.22	<0.05	<0.02	0<0.02	<0.02
D 4	High	<0.02	<0.01	<0.05	<0.15	<0.15	<0.15
W 5	High	<0.02	0.09	<0.05	<0.02	0<0.02	<0.02
D 5	High	<0.02	<0.01	<0.05	<0.15	<0.15	<0.15
W 6	High	<0.02	0.06	<0.05	<0.02	0<0.02	<0.02
D 6	High	<0.02	<0.01	<0.05	<0.15	<0.15	<0.15
W 7	High	<0.02	0.04	<0.05	<0.02	0<0.02	<0.02
D 7	High	<0.02	<0.01	<0.05	<0.15	<0.15	<0.15
W 8	High	<0.02	0.02	<0.05	<0.02	0<0.02	<0.02
D 8	High	<0.02	<0.01	<0.05	<0.15	<0.15	<0.15
W 9	High	<0.02	0.01	<0.05	<0.02	0<0.02	<0.02
D 9	High	<0.02	0.08	<0.05	<0.15	<0.15	<0.15
W 10	High	<0.02	0.01	<0.05	<0.02	0<0.02	<0.02
D 10	High	<0.02	<0.01	<0.05	<0.15	<0.15	<0.15
Japanese Environmental Standard		not detectable	—	not detectable	not detectable	—	—

(D: July 1997,W: Feb'1997)

Table 7.1.6-5 Results of COD,Total Nitrogen and Total Phosphorus Mesurements

Station No.	Tide	COD(mg/l)	Total Nitrogen (μ g/l)	Total Phosphorus(μ g/l)
D 1	Non-tidal	1.97	322	77
W 1	Non-tidal	4.66	393	29
D 2	Low	3.13	1192	541
W 2	Low	8.01	1120	810
D 3	Low	2.11	589	231
W 3	Low	8.15	1581	681
D 4	Low	2.69	863	363
W 4	Low	8.01	1633	798
D 5	Low	1.38	363	153
W 5	Low	3.35	363	180
D 6	Low	1.38	548	164
W 6	Low	1.67	445	155
D 7	Low	0.58	240	60
W 7	Low	1.75	359	149
D 8	Low	0.58	151	18
W 8	Low	1.53	406	148
D 9	Low	0.8	240	22
W 9	Low	0.15	154	15
D 10	Low	0.67	233	16
W 10	Low	0.44	265	13
D 2	High	1.75	479	205
W 2	High	2.44	329	170
D 3	High	1.24	418	94
W 3	High	3.2	547	257
D 4	High	1.17	205	87
W 4	High	2.26	385	218
D 5	High	1.02	185	68
W 5	High	1.02	244	97
D 6	High	0.8	158	41
W 6	High	0.73	214	60
D 7	High	0.73	185	29
W 7	High	0.44	214	45
D 8	High	0.73	301	22
W 8	High	0.29	180	29
D 9	High	0.8	226	104
W 9	High	0.22	205	9
D 10	High	0.73	240	19
W 10	High	0.22	154	13
Japanese Environmental Standard		3	300	30

(D: July 1997,W: Feb'1997)

Table 7.1.6-6 Results of Trace Metals Measurements (Unfiltered)

Station No.	Tide	Salinity (‰)	Hg	Cd	Pb	As	Cu	Zn	Cr VI
D 1	Non-tidal	0	<0.03	<0.57	<4.00	<0.24	2.6	10.18	<0.6
W 1	Non-tidal	0	<0.02	<0.27	5.52	<0.20	2.7	91.76	18
D 2	Low	19.35	<0.03	0.78	<4.00	1.64	14.88	24.72	<0.6
W 2	Low	0.3	<0.02	0.84	16.42	7	30.42	60.34	42
D 3	Low	19.57	<0.03	<0.57	<4.00	1.84	6.72	1.88	<0.6
W 3	Low	0.25	<0.02	0.8	15.1	5.67	23.14	35.54	40
D 4	Low	21.45	0.04	0.6	<4.00	2.98	10.62	18.5	<0.6
W 4	Low	0.33	<0.02	0.84	16.3	7.57	27.5	53.74	38
D 5	Low	24.35	<0.03	<0.57	<4.00	1.88	3.54	6.04	<0.6
W 5	Low	0.84	<0.02	<0.27	3.52	1.63	3.76	6.84	1
D 6	Low	28.19	0.06	<0.57	<4.00	2.06	8.36	13.1	<0.6
W 6	Low	8.08	<0.02	0.48	5.56	2.17	5.5	12.62	5
D 7	Low	31.23	<0.03	<0.57	<4.00	1.39	1.78	5.44	<0.6
W 7	Low	12.82	<0.02	<0.27	4.5	2.57	3.78	6.74	1
D 8	Low	32.03	<0.03	<0.57	<4.00	1.06	<1.48	3.84	<0.6
W 8	Low	15.55	<0.02	0.32	3.72	2.03	4.42	6.66	1
D 9	Low	33.48	0.08	<0.57	<4.00	1.08	3.22	1.82	<0.6
W 9	Low	29.18	<0.02	<0.27	0.82	0.67	1.94	5.02	<0.58
D10	Low	33.48	<0.03	<0.57	<4.00	0.63	<1.48	<0.57	<0.6
W10	Low	27.97	<0.02	<0.27	4.62	0.67	2.68	8.44	<0.58
D 2	High	24.57	<0.03	<0.57	<4.00	0.92	7.14	19.9	<0.6
W 2	High	8.98	<0.02	0.32	3.92	1.63	4.88	13.8	1
D 3	High	26.81	<0.03	<0.57	<4.00	3.05	2.72	20.6	<0.6
W 3	High	10.35	<0.02	0.62	5.58	2.7	8.66	18.92	5
D 4	High	26.81	<0.03	<0.57	<4.00	1.53	2.68	16.72	<0.6
W 4	High	15.14	<0.02	0.4	6.68	2.3	6.72	11.3	<0.58
D 5	High	29.2	0.03	<0.57	<4.00	1.24	3	14.62	<0.6
W 5	High	20.06	<0.02	0.42	4.06	1.7	4.6	9.46	1
D 6	High	30.58	<0.03	<0.57	<4.00	1.75	<1.48	11.12	<0.6
W 6	High	21.94	<0.02	<0.27	5.62	2.03	2	4.66	<0.58
D 7	High	31.81	<0.03	<0.57	<4.00	0.54	<1.48	5.76	<0.6
W 7	High	28.01	<0.02	<0.27	5.06	1.9	1.58	4.42	<0.58
D 8	High	32.83	<0.03	<0.57	<4.00	1.15	1.54	<0.57	<0.6
W 8	High	29.09	<0.02	<0.27	3.72	0.8	2	8.78	<0.58
D 9	High	33.04	<0.03	<0.57	<4.00	0.92	<1.48	<0.57	<0.6
W 9	High	30.47	<0.02	<0.27	2.84	0.97	1.66	5.78	<0.58
D10	High	33.55	<0.03	<0.57	<4.00	0.75	<1.48	<0.57	<0.6
W10	High	29.83	<0.02	<0.27	2.96	0.67	1.92	41.16	<0.58
Japanese Environmental Standard			0.5	10	10	10	—	—	50
Recommended Limit for S.A.			0.3	4	12	12	5	25	8
Recommended Limit for S.A. River			0.2	3	30	200	5	100	50

Results expressed in μg/l (D: July 1997, W: Feb'1997)

Table 7.1.6-7 Results of Trace Metals Measurements (Filtered)

Station No.	Tide	Salinity(‰)	Cu	Cd	Pb	Zn
D 1	Non-tidal	0	<1.48	<0.57	<4.00	2.28
W 1	Non-tidal	0	1.74	<0.27	8.36	16.08
D 2	Low	19.35	<1.48	<0.57	<4.00	2.64
W 2	Low	0.3	2.2	<0.27	<2.80	16.7
D 3	Low	19.57	<1.48	<0.57	<4.00	1.58
W 3	Low	0.25	2.1	<0.27	<2.80	26.5
D 4	Low	21.45	<1.48	<0.57	<4.00	0.86
W 4	Low	0.33	2.16	<0.27	<2.80	37.42
D 5	Low	24.35	<1.48	<0.57	<4.00	2.64
W 5	Low	0.84	1.06	<0.27	<2.80	11.56
D 6	Low	28.19	<1.48	<0.57	<4.00	<0.57
W 6	Low	8.08	<1.03	<0.27	<2.80	3.6
D 7	Low	31.23	<1.48	<0.57	<4.00	2.44
W 7	Low	12.82	<1.03	<0.27	<2.80	3.56
D 8	Low	32.03	<1.48	<0.57	<4.00	<0.57
W 8	Low	15.55	1.18	<0.27	<2.80	10.7
D 9	Low	33.48	<1.48	<0.57	<4.00	<0.57
W 9	Low	29.18	1.74	<0.27	<2.80	7.64
D10	Low	33.48	<1.48	<0.57	<4.00	0.9
W10	Low	27.97	1.74	<0.27	<2.80	3.94
D 2	High	24.57	<1.48	<0.57	<4.00	3.06
W 2	High	8.98	<1.03	<0.27	<2.80	5.3
D 3	High	26.81	<1.48	<0.57	<4.00	3.76
W 3	High	10.35	1.04	<0.27	<2.80	7.68
D 4	High	26.81	<1.48	<0.57	<4.00	1.22
W 4	High	15.14	<1.03	<0.27	<2.80	8.02
D 5	High	29.2	<1.48	<0.57	<4.00	2.2
W 5	High	20.06	<1.03	<0.27	<2.80	7.76
D 6	High	30.58	<1.48	<0.57	<4.00	1.14
W 6	High	21.94	1.16	<0.27	<2.80	7.1
D 7	High	31.8	<1.48	<0.57	<4.00	1.12
W 7	High	28.01	<1.03	<0.27	<2.80	4.56
D 8	High	32.83	<1.48	<0.57	<4.00	<0.57
W 8	High	29.09	1.36	<0.27	<2.80	6.52
D 9	High	33.04	<1.48	<0.57	<4.00	1.22
W 9	High	30.47	1.26	<0.27	<2.80	5.5
D10	High	33.55	<1.48	<0.57	<4.00	1.5
W10	High	29.83	1.12	<0.27	<2.80	6.76
Japanese Environmental Standard			—	10	10	—
Recommended Limit for S.A. Coastal Waters			5	4	12	25
Recommended Limit for S.A River Waters			5	3	30	100

Results expressed in μ g/l (D:July 1997, W:February 1997) poor sanitary condition which currently is prevailing in the region.

(2) Turbidity and Suspended Solids

Turbidity and suspended solids bear an obvious correlation with one another and may be regarded as key parameters from both an engineering and ecological perspective. The large and dynamic Pungue River is evidently a rich source of suspended material in the Beira region. Some relatively high figures were recorded at low tide in the vicinity of the Port and the Access Channel. It would be reasonable to assume that the strong current generated by large tidal range which are experienced in Beira play a significant role in maintaining suspended material in the water column.

(3) Nutrients Related Measurements

The sea water sampled adjacent to Beira Port and the Access Channel were analyzed for Chemical Oxygen Demand (COD), Total Nitrogen and Total Phosphorus. The results for the dry season appear to be lower than those obtained in the wet season, but the contrast is not very marked. Both surveys showed that samples of the inshore and the channel water were relatively enriched. There are no universal or definitive guidelines for nutrient in the marine environment. It will be recommended that nutrient levels should not cause excessive or nuisance aquatic plant growth or reduce dissolved oxygen concentrations below recommended levels. These conditions were not apparent in Beira and it may be assumed that the observed nutrient levels are within the area's assimilative capacity. However, the trend showing a relatively enriched patch of the inshore water at low tide should be noted.

(4) Trace Metals

Trace metals (mercury, cadmium, lead, arsenic, copper and zinc) taken near Beira Port and the Access Channel were analyzed to establish a baseline of existing conditions. Moreover, partitioning of the water sample in the two phase (particulate and dissolved) was carried out. While usually the total (particulate and dissolved) concentration is used in carrying out assessments, it is sometimes informative to partition the sample into two phases, particularly in situations where there is a high concentration of suspended matter (as was the case of many of the Beira samples).

The results of the two surveys may be assessed by comparison with the recommended limits of South African or Japanese marine waters (those for low saline stations should, of course, be evaluated against the river water criteria).

The results of both surveys are generally low and, in many cases, fell below the detection limits of the instrumentation. However, there are a few noteworthy exceptions. In the wet season, some relatively high values of copper, zinc and hexavalent chrome were recorded at low tide for the stations in front of Beira Port. All samples had low salinity, which suggests that the elevated levels were derived from the Pungue River Catchment and are probably of geological origin. A similar pattern was evident in the dry season but the levels were lower and were confined to fewer stations as might be expected with decreased river flow. In the case of zinc, a single anomalous high result can be probably attributed to the chance inclusion of zinc-rich particles since the filtration produced a much lower result. The results for filtered samples are, with minor exceptions, significantly lower than the unfiltered ones. This demonstrates the role that particulate play in sequestering trace metals.

When analyzed against South African or Japanese criteria, the results reflect relatively pristine conditions.

(5) Organic Materials

Water samples were analyzed for a range of potentially toxic compounds including organic mercury, organic phosphorus, cyanogen, PCB, DDT and BHC, which would indicate contamination from mainly agricultural sources.

The results for both surveys show a very low concentration of all parameters measured by using a higher detection system as the mass spectrometer.

Therefore, contamination of the waters by agricultural chemicals near Beira appears to be negligible at the present time.

7.1.7 Benthic Macrofauna around Dumping Areas

Representative sampling stations were located around the dumping areas in order to conduct Benthos Analysis. The sampling stations are shown in Figure 7.1.7-1.

The benthic macrofaunal community structure provides a good integrated measure of the state of the marine environment.

The survey carried out during the dry season was to assess the benthic macrofauna at five stations which have been designated to receive dredged spoil and at a control site to serve as a long term baseline for comparisons. No rare or endangered species were present. Many of the samples contained very few

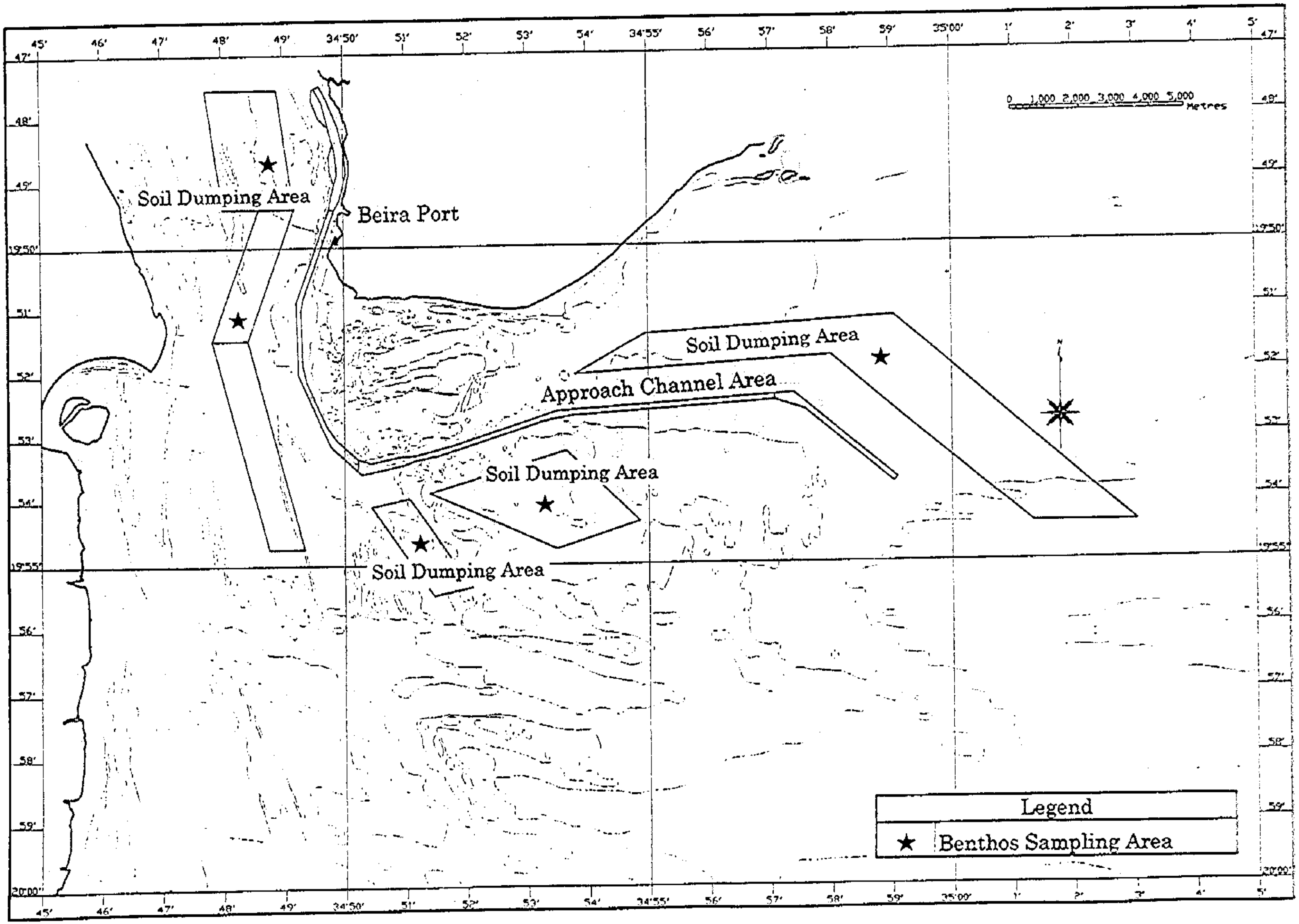

Figure 7.1.7-1 Location of Sampling Stations for Benthos Analysis

species and the population densities, as reflected in the total counts, were generally low. The identities and counts of macrofauna recovered from the samples show wide variations between stations.

From the statistical results, which encompassed the more commonly used indices of community structure such as richness, diversity and evenness, there is a considerable variation between each stations. All these results are suggestive of a difficult and stressed environment. The wide fluctuations in salinity which are often experienced in the area, coupled with strong tidal flows and sediment movement, appear to be the main sources of stress. And high turbidity of the water column probably also plays an important role.

The benthic community data were also explored for trends using the multivariate methods of classification and ordination to be aimed at exploring similarities between stations, or groups of stations, based on their community structure. From these analysis, a division of the stations into two typical groupings (A and B) was observed. Group A contains the station which had finer/muddier sediments, while group B contains the stations with coarser sediments.

As expected, the sediment type is naturally a dominant factor in shaping benthic macrofaunal communities. The higher COD was also associated with the finer sediments. This is also a natural phenomenon and relates to the fact that finer sediments have a greater grain surface area per unit volume for the absorption of organic material.

The benthic community in the vicinity of Beira Port seems to be poorly affected by high COD and wide tidal ranges.

7.1.8 Fishery Resources

In Mozambique, fisheries resources are mostly of marine origin, with most concentration on the banks of Sofala and Boa Paz, especially in the zone of Inhaca island, littoral band, bay and mouths of rivers. The fisheries potential is estimated at 10,000 tons per year, highlighting amongst the captured species crustaceans, pelagic fish, shellfish and others such as cockle, mussel, squids, etc. As compared with production and the national economy, the fisheries sector appears relatively strong.

Income from commercial fishing is mainly from prawns. The fisheries sector may represent about half of the total export earnings with an increasing trend.

The abundance and distribution of fishery resources is largely determined by the ecological variety of the coast. In economic terms, crustaceans are the most important resource giving emphasis on shallow-water shrimps (Penaeus spp. and Metapinaeus spp.), which are found all along Mozambican Coast as well as the Macuti Coast in the vicinity of Beira. In Beira, fishery-types are subsistence fishery, traditional fishery and semi-industrial fishery. The distribution of these shrimps is directly related to the existence of mangroves in the river estuaries which are regarded as nurseries for the young. Recently, illegal cutting has given damages to such mangroves in the vicinity of Beira.

7.1.9 Employment Opportunity

Number of EMODRAGA's employees totaled 213 person in March 1997. Their total wage amounted to 230,839 US$ in 1996. "Rovuma" of existing trailing hopper suction dregder owned by EMODRAGA was operated with 35 crew and their total wage accounted for 32,379 US$. After the introduction of the new dredger, 72 new crew will be necessary for her operation. Their total wage is estimated at about 289,800 US$.

The direct impact of increase of employees can be expected to 33.8 % in term of number of employee and 125.5 % in terms of wages as compared to the present scale. This impact will bring certain positive effects in economic terms to the people in Beira.

7.1.10 Conclusion of IEE

This IEE was carried out as the first known survey on pollution levels in the vicinity of Beira Port. Important elements of IEE are summarized in Table 7.1.10-1.

Apart from some significant faecal contamination, the environment is considered to be relatively pristine. The water quality parameters of all aspects were within acceptable limits. The high tidal range and the seasonal influx of massive quantities of fresh water, principally via the Pungue River, play a dominant role in forming the environmental condition. Macrobenthic communities are found to be poorly developed. This is evidently due to the wide fluctuations in salinity and high tidal flows which are experienced in the area. The data presented here serve as a baseline of the present environmental condition to evaluate the future change.

Table 7.1.10-1 Review of Screening (Port and Harbor)

No.	Environmental Item	Description	Evaluation	Remarks
Social Environment				
1	Waste	Existing of noxious material or heavy mineral in dumping soil / dumping waste oil from dredger	[Y] [N] [?]	No serious contamination in seabed / Waste oils will be inland dispose
Natural Environment				
2	Hydrological Situation	Changes of river discharge and riverbed condition	[Y] [N] [?]	No negative impact by dredging
3	Coastal Zone	Coastal erosion and erosion due to coastal reclamation and changes of marine condition	[Y] [N] [?]	No serious impact by dredging
4	Fauna and Flora	Existing of noxious material or heavy mineral in seabed	[Y] [N] [?]	No serious contamination in seabed
5	Water Pollution	Pollution caused by inflow of silt, sand and effluent from noxious material or heavy metal in seabed	[Y] [N] [?]	No serious contamination in seabed

7.2 Environmental Impact Assessment (EIA)

7.2.1 Principal Policy

The dredging work might give some impact on environment. One effective method of investigating the effect on environment before/during/after dredging work should be introduced. As pointed out previously in Chapter 7.1.1(1), there are no guidelines in Mozambique. Therefore, the Japanese guidelines which comply with the international standards have introduced.

It is concluded to discuss and investigate these guidelines and they will be supplemented by the Study Team if the guidelines lack in some aspects.

The expected environmental issues in dredging works are:

Activity	Consequence to Environment	Impact on Environment
Dredging	Turbidity	Water quality reduction
	Sedimentation	Habitat destruction
	Benthic destruction	Species loss
Ocean dynamism	Tide, wave and current	Coastal erosion

7.2.2 Diffusion of Suspended Solids through Dredging.

The results of the simulation model show that the diffusion of suspended solids caused by dredging is quite negligible. This simulation representing the worst case, in which 6 stations were dredged simultaneously, are shown in Figure 7.2.2-1. According to the figure, the most serious value of turbidity is 1.5 % at 0.02 km^2 on the shoal at 48 hours after the dredging. Likewise, contour lines of 0.1 %, 0.2 % and 0.3 % are spreading out with the strong tidal current.

7.2.3 Beach Erosion of Macuti Coast

As mentioned before, in this Project, some part of sand dumped in the north side of the Access Channel will contribute to nourish the Macuti Beach. Although the volume of this sand is a little, it will be predominant to the decrease of the sand volume passing the Access Channel from the south due to the deepening of the Access Channel. Therefore, this Project does not give any damage to the Macuti Beach from the view point of beach erosion.

7.2.4 Effects of Dredging on Aquatic Life

Effects of turbidity to marine animals living on the seabed will not be serious over the area under consideration.

As regards of fish species, migratory and pelagic fish have some possibility to suffer from a slight shortage of oxygen caused as a result of the turbulence on the seabed. While the crustaceans and shellfish generally are resistant to turbidity.

In the vicinity of the Beira Port, the seabed materials consist of mud and sandy sediment and the turbidity is kept at high levels in the water column. Marine animals, which can live in the low saline and high turbidity water, are predominantly living here. Therefore, the effects of turbidity generated by dredging works to the main marine animals such as the crustaceans and shellfish are expected to be negligible.

7.2.5 Others

(1) Treatment of Waste Oil and Daily Waste Discharged from the Dredger

The waste oil from the dredger shall be dehydrated onboard. Then, treated waste oil shall be burned and treated water shall be dumped off shore.

Daily wet waste in the dredger shall be dehydrated onboard and burned with

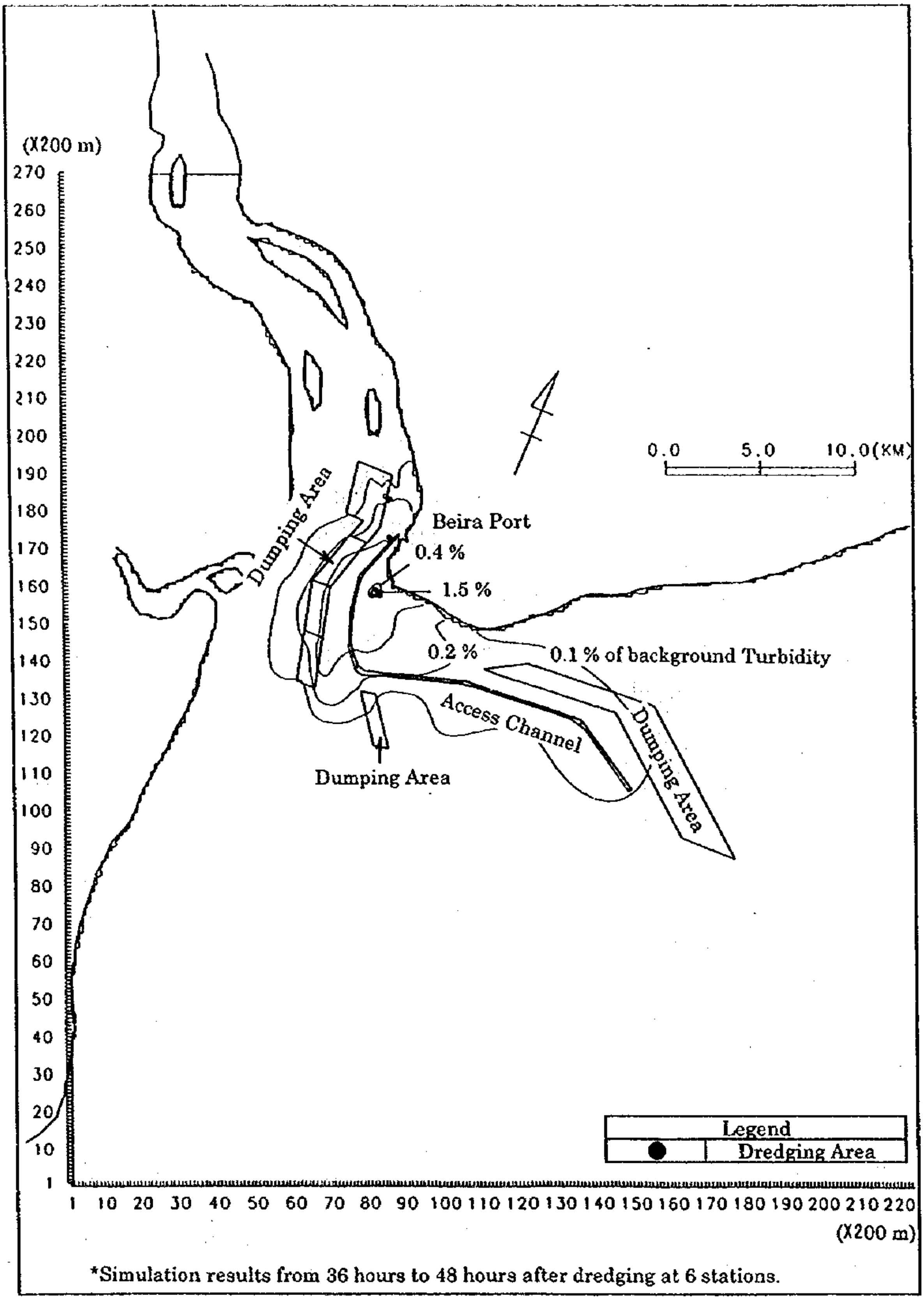

Figure 7.2.2-1 Diffusion Pattern of Suspended Solid

the other dry waste.

Also waste water on the dredger shall be treated properly on board and dumped off shore.

(2) Dissolution of Heavy Metals from Dredged Soil

Since dehydration of sampled seabed materials was not carried out, quantity of soluble metal could not be estimated.

The seabed sediment, in the vicinity of Beira, consists of mainly sand fraction with a small surface. In general, coarser sediments with a smaller grain surface per unit volume absorb less contaminants of heavy metals.

Therefore, it is considered that sandy sediment with a small surface has a small metal-retention capacity. According to the results of these analyses, the most of metal in water column in the Beira region exists in particulate phase and the quantity of soluble metals from the particulate phase is very small. It is also expected that the dissolution rate of heavy metals from suspended materials as a result of dredging operations is very small. The spreading of dissolved metal from suspended materials is mainly brought about by tidal and river flow, but in the vicinity of Beira, the spreading of metal from seabed sediment by dredging operations is relatively not activated, because of the high metal-retention and small metal-dissolution rate of suspended materials of the adjacent area.

7.2.6 Conclusion of EIA

Through the environmental examination described above, it is concluded that the dredging of the Access Channel would not be expected to generate any significant impact on the environment.

CHAPTER 8

ECONOMIC AND FINANCIAL ANALYSIS

Chapter 8 Economic and Financial Analysis

8.1 Economic Analysis

8.1.1 Methodology

The economic internal rate of return (EIRR) based on a cost-benefit analysis is used to appraise the economic feasibility of the Project.

The EIRR is the discount rate which makes the costs and benefits of the Project equal during the project life. It is calculated by using the following formula.

$$\sum_{i=1}^{n} \frac{B_i - C_i}{(1+r)^{i-1}} = 0$$

Where;

n :	Project life
B_i :	Benefits in the i-th year
C_i :	Costs in the i-th year
r :	Discount rate

The project costs and benefits are evaluated in terms of economic prices (shadow prices) converted from market prices by the method of conversion as mentioned in Section 8.1.3.

8.1.2 Prerequisites of Economic Analysis

(1) Base Year

The "Base Year" for the study is set to be 1997 which is defined as the standard year in the estimation of costs and benefits.

(2) Project Life

Project life in the economic analysis is assumed to be 25 years from the durable length of time of the dredger being used by EMODRAGA.

(3) Foreign Exchange Rate

The exchange rate for this analysis is adopted by the same rates as used in the cost estimation shown as follows.

US$ 1.00 = MT 11,300 (Mozambique Meticals)
US$ 1.00 = ¥116.84

(4) Without-case and With-case

The Project is evaluated by means of cost-benefit analysis, comparing the case of achievement of the Project (with-case) with the present case of non-achievement of the Project (without-case) .

Using the discounted cash flow method, the economic internal rate of return (EIRR) will be calculated by means of comparing the benefits with the costs and will be evaluated more deeply by using the sensitivity analysis.

In "without-case", the channel water depth is maintained at 5.0 m, at the same level as in 1997, by dredging the soil volume of 521,991 m^3 per year using an outside contract.

In the base "with-case", a new dredger will be introduced to dredge a soil volume of 2,500,000 m^3 per year under EMODRAGA operation, so that the channel water depth is maintained at 8.0 m which is the same depth as in 1991.

In order to determine whether the Project is feasible against change of the calculation conditions, a sensitivity analysis is made.

8.1.3 Economic Prices

(1) Converting Method of Market Prices to Shadow Prices

For the economic analysis, prices are expressed in shadow prices rather than market prices based on the border price concept. There are various methods to convert the market prices into border prices. In this Project, the border prices (shadow prices) are calculated by eliminating transfer items such as taxes, subsidies, etc.

In general, all the costs and benefits are divided into three categories: labor, tradable goods and non-tradable goods. And labor is further classified into skilled labor and unskilled labor. Regarding skilled labor, the economic price is determined by the conversion factor and the shadow price of unskilled labor is determined by multiplying the nominal wage by the shadow wage rate and the conversion factor for consumption.

The prices of tradable goods are expressed in Cost, Insurance and Freight (CIF) and Free On Board (FOB) value for import goods and export goods, respectively.

These values show the actual border prices. However, as the border prices of non-tradable goods cannot be converted directly, the border prices of the inputs needed to produce the non-tradable goods are considered. After some classification of the non-tradable goods, the shadow prices of a small amount of non-tradable goods are calculated directly by multiplying the market prices by the standard conversion factor.

(2) Transfer Items

Import/export duties, consumption tax, circulation tax, other taxes, subsidies and interests on loans are merely transfer items which do not actually reflect on any consumption of national resources. Therefore, these transfer items should be excluded in the calculation of the costs and benefits of the Project for the economic analysis.

(3) Conversion Factors

Conversion factors for goods and labor are determined as follows :

1) Standard Conversion Factors

The standard conversion factor (SCF) is used to determine the economic prices of certain goods which cannot be directly revalued at border prices. These goods include most non-tradable goods and services. The SCF is expressed by the following equation:

$$SCF = \frac{I + E}{I + D_i + E - D_e} \qquad (8.1.3\text{-}1)$$

where;

I :	Value of Import
E :	Value of Export
D_i :	Value of Import Duties
D_e :	Value of Export Duties

In this study, the average SCF of 0.94 in 1992 to 1996 is adopted according to the past records of trade and customs as shown in Table 8.1.3-1.

2) Conversion Factor for Consumption

This conversion factor is used to convert the market prices of consumption goods into the border prices. The conversion factor for consumption (CFC) is usually calculated in the same manner as the SCF, replacing total imports and exports by those of consumption goods only. In this study, the CFC is adopted as 0.94 of SCF as shown in Table 8.1.3-1.

Table 8.1.3-1 Standard Conversion Factor

(unit : million US$)

	Item	1992	1993	1994	1995	1996	Average
	(I) Import	855.0	954.7	1018.5	727.0	801.5	871.3
	(E) Export	139.3	131.8	149.5	174.3	225.9	164.2
①	I+E	994.3	1,086.5	1,168.0	901.3	1,027.4	1,035.5
	(D_i)Import Duty	69.4	74.8	58.0	65.1	61.8	65.8
	(E_e) Export Duty	0.0	0.0	0.0	0.0	0.0	0.0
②	I+E+Di-Ee	1,063.7	1,161.3	1,226.0	966.4	1,089.2	1,101.3
	SCF (=①÷②)	0.935	0.936	0.953	0.933	0.943	0.940

Source : Bank of Mozambique, Statistical Bulletin, March 1997

3) Conversion Factor for Labor (CFL)

For the purpose of economic analysis, labor costs are measured in terms of their opportunity costs, that is the value of the foregone marginal product from other alternate employment due to the employment of laborers for the Project.

a) Conversion Factor for Skilled Labor

The cost of skilled labor is calculated based on actual market wages, assuming that the market mechanism is functioning properly. However, as these are domestic costs or market costs, they are converted into border prices by multiplying the market wages by the CFC.

Thus, the conversion factor for skilled labor
=(Market wage rate) x (CFC) =1.0 x 0.94 = 0.94 (8.1.3-2)

b) Conversion Factor for Unskilled Labor

As the wages paid to unskilled labor by the Project are usually far the above opportunity cost, these market wages should not be used for the calculation of the economic value of the unskilled labor.

In this study, it is assumed in a simplified manner that the economic cost of unskilled labor is equal to the minimum wage or GDP per capita. Based on the data from EMODRAGA, an average monthly wage for casual workers in 1997 is estimated to be 350,000 MT, and it can be considered as a proper indicator of marginal productivity, that is, the opportunity cost of unskilled labor. Based on government data, the minimum monthly wage of unskilled labor is 271,126 MT and the monthly GDP per capita is 60,345 MT as shown in Tables 8.1.3-2 and 8.1.3-3.

Here, the conversion factor for unskilled labor is calculated by the following formula, adopting the minimum monthly wage as an opportunity cost.

$$\begin{aligned}\text{CFL for Unskilled Labor} &= \text{SCF x (Opportunity Cost / Market Price)}\\ &= 0.94 \text{ x } (271{,}126 / 350{,}000)\\ &= 0.73 \qquad (8.1.3\text{-}3)\end{aligned}$$

Table 8.1.3-2 Casual Labor Cost

(unit : MT)

Item		Cost
Market Wage (monthly)		350,000
Minimum Wage by Law (monthly)		271,126
	GDP per annum	12,600,000 m
	GDP per month	1,050,000 m
	Population (men)	17.4 m
GDP per Capita (monthly)		60,345

Source : Economist Inteligence Unit, Country Report in 1996
EMODRAGA data

Table 8.1.3-3 Shadow Wage Rate

Labor	Conversion Factor	Shadow Wage Rate
Skilled Labor	SCF	0.94
Unskilled Labor	SCF × CF (CF=271,126MT/350,000MT=0.775)	0.73

8.1.4 Costs of the Project

The project costs which consist of investment costs and operation costs must be converted from market prices into economic prices for the economic analysis. Therefore, the Project costs have to be divided into the foreign currency portion and the local currency portion. Further, the local currency portion can be divided into non-tradable goods, skilled labor and unskilled labor. The costs arising from the implementation of this Project are as follows :

(1) Investment Cost

In this Project, a new dredger shown in Table 8.1.4-1 is assumed to be introduced by the foreign currency portion at the end of 1999. As investment costs shown in Table 8.1.4-1 do not include any transfer items such as customs and duties and the foreign exchange rate is a float one, it is not necessary to convert into shadow prices. Therefore, the manufacturing cost of a new dredger in this Project is estimated to be US$ 24,251,000 and the total investment cost including spare parts and mobilization expenses, etc. is estimated at US$ 26,761,000.

Table 8.1.4-1 Investment Cost

(unit : US$)

Item		Foreign Portion
	Manufacturing Cost	24,251,000
	Spare Parts	1,140,000
	Navigation Expenses etc.	1,370,000
Capital Investment Costs		26,761,000

(2) Operation Cost

In order to dredge the soil volume of 2,500,000 m^3, operation costs shown in Table 8.1.4-2 are required every year. The annual operation cost consists of labor costs of crew, provisions of food for local crew onboard, fuel oil costs, lubricating oil costs, maintenance and repairing costs, and other administration costs. As the crew of new dredger consist of 72 skilled persons, the labor cost should be converted into shadow prices (US$ 272,412) by multiplying market prices (US$ 289,800) by the conversion factor (0.94 SCF shown in Table 8.1.3-2). Other costs in shadow prices are calculated in the same manner as the labor cost and the annual operation cost amounts to US$ 2,351,053 in shadow prices, as shown in Table 8.1.4-2.

In the year 2000 to 2004 after the Interim Dredging, the soil volume to be dredged amounts to 3,231,714 m³ for 264 days every year. Therefore, labor costs, provisions for crew onboard and fuel costs in the year 2000 to 2004 are increased to US$ 339,002, US$ 107,205 and US$ 1,064,535, respectively, so that the annual operation cost in the year 2000 to 2004 increase to US$ 2,612,986 in the shadow price as shown in Table 8.1.4-3.

Table 8.1.4-2 Operation Cost

(unit : US$)

Item	Local Portion		
	Market Price	Conversion Factor	Shadow Price
Labor Cost (skilled 72 Persons)	289,800	0.94	272,412
Provisions for Crew Onboard (=9 US$/day×48persos×220days	95,040	0.94	89,338
Fuel Oil Cost (=12,767kg/day×220days×US$280/ton)	786,400	0.94	739,216
Lublicating Oil Cost (=Fuel×0.2)	157,280	0.94	147,843
Maintenance & Repair Cost	500,000	0.94	470,000
Administration Cost	672,600	0.94	632,244
Operation Cost / Year Total	2,501,120		2,351,053

Table 8.1.4-3 Change of Operation Costs (Shadow Price)

(unit : US$)

Year	Dredged Soil Volume	Operation Days	Labor Cost	Provision for Crew Onboard	Fuel Cost	Maintenance & Repair Cost	Administration Cost	Operation Cost(Total)
2000	3,231,714m³	264 days	339,002	107,205	1,064,535	470,000	632,244	2,612,986
2001	3,231,714m³	264 days	339,002	107,205	1,064,535	470,000	632,244	2,612,986
2002	3,231,714m³	264 days	339,002	107,205	1,064,535	470,000	632,244	2,612,986
2003	3,231,714m³	264 days	339,002	107,205	1,064,535	470,000	632,244	2,612,986
2004	3,231,714m³	264 days	339,002	107,205	1,064,535	470,000	632,244	2,612,986
2005	2,500,000m³	220 days	272,412	89,338	887,059	470,000	632,244	2,351,053
2006	2,500,000m³	220 days	272,412	89,338	887,059	470,000	632,244	2,351,053
↓	↓	↓	↓	↓	↓	↓	↓	↓
2024	2,500,000m³	220 days	272,412	89,338	887,059	470,000	632,244	2,351,053

Note : Labor Cost in 2000~2004 = 272,412(1+1/12/30×200%×44) = 339,002 US$
Provisions for Crew Onboard in 2000~2004 = 9 US$/day×48persos×264days ×0.94 = 107,205 US$
Fuel Cost in 2000~2004 = (12,767kg/day×264days×US$280/ton) ×1.2 ×0.94 = 1,064,535 US$

8.1.5 Benefits of the Project

(1) Items of Benefits

The maintenance and improvement of the Access Channel of Beira Port will greatly contribute to the national economy in Mozambique. Considering the "With" and "Without" case, the following items are identified as major benefits of the Project from a viewpoint of the national economy.

1) Saving in ship staying costs
2) Saving in rise in costs of transportation by using other port
3) Saving in costs of transportation by tanker of 50,000 DWT
4) Saving in dredging costs to maintain the channel depth of 5 m
5) Saving in costs of cargo inventory by shortening tide waiting time
6) Improvement of safe navigation for entry and departure
7) Possibility of sailing on schedule for large-scale ships
8) Increase in cargo volume, employment opportunities and incomes.

It is difficult to evaluate all these benefits in monetary terms, and out of the above, items 1), 2), 3) and 4) are considered tangible and the monetary benefits of these items are calculated. The other items are considered intangible.

(2) Calculation of Benefits

In converting the market prices into economic prices, benefits derived from benefit items 1), 2), 3) and 4) are estimated at economic prices.

1) Saving in Ship Staying Costs

The forecast of waiting time for calling ships from 2000 to 2025 by Channel Traffic Simulation is shown by ship type in Table 5.1.3-2.

The waiting time in Table 5.1.3-2 is for both cases of "without-case" (the channel water depth of 5.0 m) and "with-case" (the channel water depth of 8.0 m). The difference between "without-case" and "with-case" is the benefit in which waiting time or the ship staying cost is calculated by multiplying the waiting time by the charterage for each type of ship.

As the charterage by ship type at Beira Port is given in foreign currency at international shipping company rates, the ship staying cost is considered to be expressed in economic price. And the rate belonging to the national economy of Mozambique is assumed to be 50 % of the total benefit.

Table 8.1.5-1 Benefits of Saving in Ship Staying Cost (Channel Water Depth 8.0 m)

(unit : hours, US$)

Year	Waiting Time (hours)		③=①-②	Ship Staying Cost (US$)	
	①Without	② With	Benefit	Total	50%
2000	17,436	3,183	14,253	6,459,596	3,229,798
2002	18,848	3,209	15,639	7,024,346	3,512,173
2007	22,378	3,248	19,130	8,455,808	4,227,904
2012	26,466	3,783	22,683	10,074,986	5,037,493
2017	31,136	4,350	26,786	12,033,062	6,016,531
2022	36,444	4,954	31,490	14,388,950	7,194,475
2025	40,044	5,357	34,687	15,989,506	7,994,753

Note : The Charterage of main ships on Beira Port
(1) Tanker(30,000DWT) = US$ 15,800/day
(2) Container(8,500DWT ; 550TEU) = US$ 6,165/day
Container(14,000DWT ; 1,000TEU) = US$ 8,860/day
(3) Dry Cargo(12,000DWT) = US$ 5,228/day = $ 13.07÷30×12,000
Dry Cargo(20,000DWT) = US$ 5,387/day = $ 8.08÷30×20,000
Source : Lloyd's Shipping Economist, 1997

Table 8.1.5-2 Cost Up by Shifting to Harare-Maputo Route from Harare-Beira

Freight of Container on Railway	(1) Between Harare-Mapu		(2) Between Harare-Beir		(1)-(2) Cost Up /ton	
	Distance	Freight/ton	Distance	Freight/ton	Z$/t	(3) US$/t
① Freight for import	(1,270km)	368.1 Z$/t	(600km)	238.3 Z$/t	129.8	12.5
② Freight for export	(1,270km)	286.2 Z$/t	(600km)	197.5 Z$/t	88.7	8.5

Freight of Container on Railway	(4) Cargo tonnage	(3)×(4) Cost Up	Coversion Factor	Economic Price
① Freight for import	161,000	2,012,500	0.94	1,891,750
② Freight for export	137,000	1,164,500	0.94	1,094,630
Total	298,000	3,177,000	0.94	2,986,380

Note-1 : (4) Cargo tonnage is shown in Table 5.1.1-7

Table 8.1.5-3 Cost up by Using Maputo Port of Zimbabwe Container Cargo in 2002

(unit : US$)

Channel Water Depth (m)	Ratio	(1) Cost Up by using Maputo Port	(1)×50%	Benefit of Saving to cost up (US$)	Rate of Benefit
5.0	100%	2,986,380	1,493,190	0	
6.0	66%	1,971,011	985,505	507,685	34.0%
6.5	50%	1,478,258	739,129	754,061	50.5%
7.0	33%	985,505	492,753	1,000,437	67.0%
8.0	0%	0	0	1,493,190	100.0%
9.0	0%	0	0	1,493,190	100.0%

Note-1 : 50% is the Ratio belonging to Mozambique economy.
Note-2 : The growth rate per annum of cargo tonnage on Limpopo line of Harare-Mapu
2.56 % during 2002-2007 and 3.94 % after 2008 by the forecast of SATCC

Benefits of saving in ship staying cost with the channel water depth of 8 m is shown in Table 8.1.5-1. The detail calculation of benefits in ship staying cost is shown in Table A.5.2-1 of Appendix A-5.

2) Saving in Cost Rise of Transportation by Using the Other Port

The cargo volume for trade goods from Zimbabwe in 2002 reroutable to Harare-Beira route from Harare-Maputo by the improvement of waiting time at Beira Port is estimated at 298,000 tons in Table 5.1.1-7.

As shown in Table 8.1.5-2, the container freight by railway is 368.1 Zimbabwe Dollar (Z$) per ton for import and 286.2 Z$ per ton for export between Harare-Maputo with the distance of 1,270 km. On the other hand, the freight between Harare-Beira for the distance of 600 km is 238.3 Z$ per ton for import and 197.5 Z$ per ton for export. Therefore, by using Maputo Port instead of Beira Port, the transportation costs in the import of goods and the export of goods from Zimbabwe are estimated to rise to 129.8 Z$ (= US$ 12.5) /ton and 88.7 Z$ (= US$ 8.5) /ton, respectively. Then, by multiplying the cost up/ton by the shiftable cargo tonnage, the total cost up amounts to US$ 3,177,000 as the market price, of which the economic price amounts to US$ 2,986,380 by multiplying by the conversion factor 0.94.

As shown in Table 8.1.5-3, the benefit in 2002 amounts to US$ 1,493,190 which is 50 % (the ratio belonging to Mozambique economy) of the difference between the channel water depth of 5.0 m and 8.0 m.

3) Saving in Transportation Costs by 50,000 DWT Tanker

The Beira Port has the oil terminal and the oil pipe line to Zimbabwe. Under the channel water depth of 7.0 m, tankers of 50,000 DWT is not accommodated and tankers of 30,000 DWT with the limitation of maximum loading oil of 25,000 tons are accommodated.

According to the shipping agency of Beira Port, the distance from Aden to Beira is 3,500 km and a voyage tanker of takes 14 days. Then, the cost/ton of oil transportation is calculated as follows :

Staying Cost of the tanker of 30,000 DWT(16,000 US$/day) x
14 days / 25,000 tons
= US$ 8.96 / ton (cost/ton of transportation of oil)

Staying Cost of a tanker of 30,000 DWT is the economic price in the foreign currency.

Under the channel water depth of 8.0 m, a tanker of 50,000 DWT is able to be accommodated and the unit transportation cost becomes less by 15 % than the cost of a 30,000 DWT tanker.

Therefore, saving in unit transportation cost by tanker is calculated as follows :

US$ 8.96 / ton (cost/ton of transportation of oil) x 15 % = US$ 1.344 / ton

Adopting 50 % of the total benefit as the ratio attributing to Mozambique economy, the benefit is calculated as follows :

US$ 1.344 / ton x 50 % = US$ 0.672 / ton
US$ 0.672 / ton x 1,208,300 tons (Oil Cargo in 2002) = US$ 811,978.

4) Saving in Maintenance Dredging Costs of the Channel Depth of 5.0 m

In "without-case" in which no dredger is introduced, dredging costs to maintain the Channel of water depth at 5.0 m are needed for an outside contract.

The unit dredging price by an outside contract is about US$ 3.0/m^3 at the economic price by the foreign currency.

Therefore, saving in dredging costs to maintain the channel of 5 m water depth is calculated as follows :

Soil volume to be dredged per annum 521,991 m^3 x US$ 3.0/m^3
= US$ 1,565,973

8.1.6 Calculation of EIRR and Evaluation

(1) Calculation of EIRR

The EIRR of the Project is calculated as 24.38 % at shadow price. The calculation results of the EIRR are shown in Table 8.1.6-1

From the view point of the national economy, the cost/benefits are discounted by the social discount rate which is commonly set up at a rate higher than the opportunity cost of capital. According to the Staff Appraisal Report by the World Bank in 1994, all projects for trunk roads in Mozambique had the economic rate of return between 17.5 % and 22.9 %, which is in excess of the estimated opportunity cost of capital (12 %).

The EIRR of 24.38 % at the shadow price basis of this Project is much higher than the estimated opportunity cost of capital (12 %) and in excess of EIRR for trunk roads projects.

(2) Sensitivity Analysis

In order to determine whether the Project is feasible against changes of calculation conditions, a sensitivity analysis is made for 7 alternatives.

Base-Case : the channel water depth is maintained at 8.0 m
the Project life is 25 years

Case A : the channel water depth is maintained at 9.0 m
Case B : the channel water depth is maintained at 7.0 m
Case C : the channel water depth is maintained at 6.0 m
Case D : the Investment Cost is 110 % of the Base Case
Case E : the Investment Cost is 90 % of the Base Case
Case F : the Project Life is 20 years
Case G : the Project Life is 30 years

The sensitivity analysis for 3 alternatives of Case A to C is calculated by using the same formula as the base case and the results are summarized in Table 8.1.6-2 and Figure 8.1.6-1. The details of the results of the calculation for 3 alternatives are shown in Appendix A-5.

Table 8.1.6-3 shows the results of the sensitivity analysis for fluctuations of the investment costs and the project life.

(3) Economic Evaluation

As shown in Figure 8.1.6-1, the effect of investment of the new dredger by the Project is very high and the base case is the best in comparison with the other alternate Case A to C.

Further, as shown in Table 8.1.6-3, the EIRR is high in spite of fluctuations of the investment costs and the project life. Therefore, this Project is judged to be feasible from an economic viewpoint.

Table 8.1.6-1 Calculation of EIRR in the Case of Channel Water Depth with 8.0 m (Base Case)

(unit : US$)

Year	Benefit of Saving				(A) Total Benefit	(B) Investment Cost Operation Cost	(A)-(B) Net Benefit
	Ship Staying Cost	Cost up in Transportation	Transportation Cost of Tanker	Dredging Cost to 5m Water Depth			
2000	3,229,798	1,419,577	768,992	1,565,973	6,984,341	29,373,986	-22,389,645
2001	3,370,986	1,455,918	790,193	1,565,973	7,183,070	2,612,986	4,570,084
2002	3,512,173	1,493,190	811,978	1,565,973	7,383,314	2,612,986	4,770,328
2003	3,691,454	1,531,416	834,364	1,565,973	7,623,207	2,612,986	5,010,221
2004	3,879,887	1,570,620	857,366	1,565,973	7,873,847	2,612,986	5,260,861
2005	4,077,939	1,610,828	881,003	1,565,973	8,135,743	2,351,053	5,784,690
2006	4,286,101	1,652,065	905,292	1,565,973	8,409,430	2,351,053	6,058,377
2007	4,227,904	1,694,358	930,250	1,565,973	8,418,485	2,351,053	6,067,432
2008	4,426,482	1,761,116	964,385	1,565,973	8,717,956	2,351,053	6,366,903
2009	4,634,387	1,830,503	999,773	1,565,973	9,030,636	2,351,053	6,679,583
2010	4,852,057	1,902,625	1,036,459	1,565,973	9,357,114	2,351,053	7,006,061
2011	4,852,057	1,902,625	1,036,459	1,565,973	9,357,114	2,351,053	7,006,061
2012	4,852,057	1,902,625	1,036,459	1,565,973	9,357,114	2,351,053	7,006,061
2013	4,852,057	1,902,625	1,036,459	1,565,973	9,357,114	2,351,053	7,006,061
2014	4,852,057	1,902,625	1,036,459	1,565,973	9,357,114	2,351,053	7,006,061
2015	4,852,057	1,902,625	1,036,459	1,565,973	9,357,114	2,351,053	7,006,061
2016	4,852,057	1,902,625	1,036,459	1,565,973	9,357,114	2,351,053	7,006,061
2017	4,852,057	1,902,625	1,036,459	1,565,973	9,357,114	2,351,053	7,006,061
2018	4,852,057	1,902,625	1,036,459	1,565,973	9,357,114	2,351,053	7,006,061
2019	4,852,057	1,902,625	1,036,459	1,565,973	9,357,114	2,351,053	7,006,061
2020	4,852,057	1,902,625	1,036,459	1,565,973	9,357,114	2,351,053	7,006,061
2021	4,852,057	1,902,625	1,036,459	1,565,973	9,357,114	2,351,053	7,006,061
2022	4,852,057	1,902,625	1,036,459	1,565,973	9,357,114	2,351,053	7,006,061
2023	4,852,057	1,902,625	1,036,459	1,565,973	9,357,114	2,351,053	7,006,061
2024	4,852,057	1,902,625	1,036,459	1,565,973	9,357,114	2,351,053	7,006,061
Total	112,117,964	44,558,971	24,290,478	39,149,325	220,116,738	EIRR=	24.38%

Note : Handling capacity per annum of container is maximam in 2010

Table 8.1.6-2 EIRR by Sensitivity Analysis of Channel Water Depth

(unit : US$)

Case	Channel Water Depth (m)	EIRR (%)	Maintenance Dredging Volume (m³)	Cost of the Project Investment Cost	Operation Cost	Total Benefits
Case C	6.0 m	21.55%	725,493	18,700,000	1,758,780	141,147,755
Case B	7.0 m	22.52%	1,698,509	22,400,000	2,105,580	178,171,717
Base Case	8.0 m	24.38%	2,500,000	26,761,000	2,351,053	220,116,734
Case A	9.0 m	21.97%	3,482,786	29,300,000	2,473,015	221,396,648

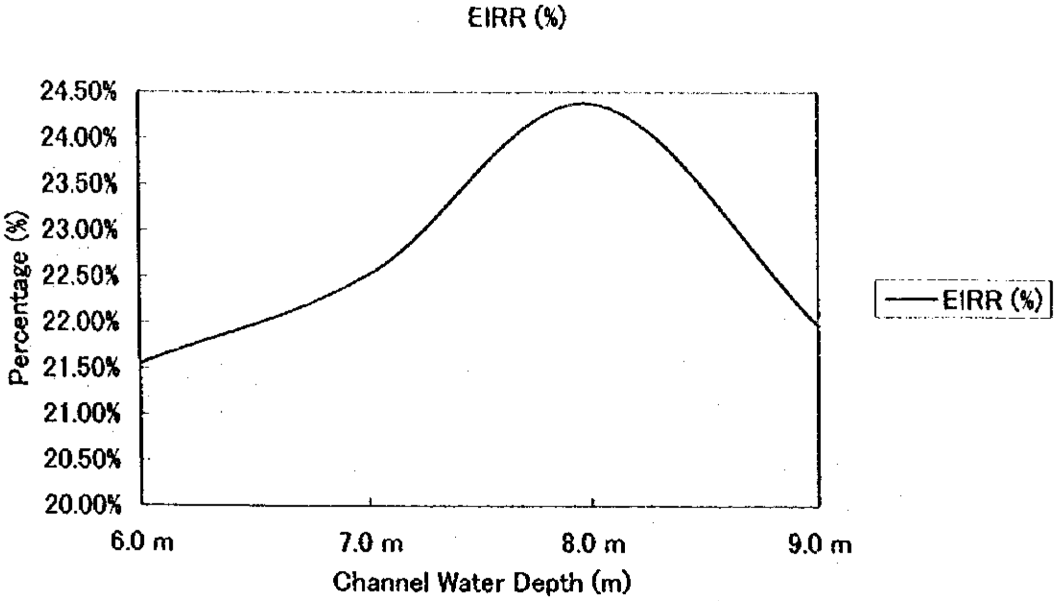

Figure 8.1.6-1 Economic Internal Rate of Return (EIRR) by Channel Water Depth

Table 8.1.6-3 EIRR by Sensitivity Analysis of Investment Cost and Project Life

Case D	Investment Cost × 1.1	EIRR= 21.97%
Case E	Investment Cost × 0.9	EIRR= 27.37%
Case F	Project Life 20 Years	EIRR= 24.06%
Case G	Project Life 30 Years	EIRR= 24.48%

8.2 Financial Analysis

8.2.1 Methodology

In the Economic Analysis of the previous Section, the economic feasibility of the investment is analyzed from the view points of the national economy.

The financial feasibility of the Project is evaluated by means of a financial internal rate of return (FIRR) based on a cost-benefit analysis in the same way as the economic analysis and the financial soundness of the EMODRAGA is studied by financial statements.

(1) Discount Cash Flow Analysis

This study aims at analyzing the profitability of the Project itself, seeking the financial internal rate of return (FIRR) by the Discount Cash Flow Method. The FIRR is a discount rate which makes the net present value of the cash flow (income - cost) equal to zero.

(2) Analysis of Financial Statements

In order to find out whether EMODRAGA can maintain soundness of financial affairs with the execution of the Project, estimated Financial Statements (Income and Expenditure, Source and Application of Funds and Balance Sheet) are prepared for the period from the year 2000, when the accounts for EMODRAGA are settled by using the new dredger, to the year 2024, when the Project life is to be completed, in order to analyze incomes expenditures, conditions of raising fund and financial status.

8.2.2 Discount Cash Flow Analysis

(1) FIRR

The costs and benefits used for the analysis are evaluated in terms of market prices. Costs of the Project include the capital investment and the operation costs, while the benefits increase by the incomes and decrease by the operation costs.

92.6 % of the income of EMODRAGA in 1996 was provided by CFM, based on the agreement between EMODRAGA and CFM. As the objective of this Project is the maintenance and improvement of the Access Channel, the income of this Project is assumed to be paid by the Port Department of CFM-C.

The factors in order to decide the income of this Project are as follows:

1) In order to keep the profit of EMODRAGA, the ratio of the continuing profit by dredging volume of 2,500,000 m^3 has to gain more than 10 %.

2) In order to reduce the payment from the Port Department of CFM-C, the expenses to dredge a volume of 2,500,000 m^3 has to be less than 2.0 US$/$m^3$ or to be less than 20 % of the continuing profit of the Port Department of CFM-C.

3) During the period that the dredging is not executed due to repair of dredger and other reasons, the income equivalent to the fixed cost of EMODRAGA should be assured.

The total cost of EMODRAGA consists of the fixed cost (labor costs, maintenance and repair costs, administration costs and depreciation) and the variable cost (fuel, lubricant oil, etc.) in proportion to the dredging volume. Under the assumption that this total cost is paid by CFM-C with the continuing profit of 10 %, the annual income of EMODRAGA is calculated as shown in Table 8.2.2-2. Thus, on and after 2005, the income of EMODRAGA comes to US$ 3,851,000. Dividing this value by the dredging volume of 2,500,000 m^3, the unit price of dredging volume comes to 1.54 US$/$m^3$. Also, in 2007, the US$ 3,851,000 corresponds to about 14 % of the continuing profit of CFM-C. This percentage is obtained by dividing that value by US$ 26,777,000 of continuing profit in 2007 as shown in Table 8.2.4-1. Such percentage decreases year by year due to the increase of cargo volume handled at Beira Port.

The FIRR becomes 2.28 % which falls between 2 % and 3 %, the same level as the interest rate on foreign loans, as shown in Table 8.2.2-3.

(2) Sensitivity Analysis

Table 8.2.2-4 shows the results of the sensitivity analysis for fluctuations of the income and investment costs.

8.2.3 Analysis of Financial Statement

(1) Premises

1) The project life is assumed to be 25 years from 2000 to 2024.
2) The depreciation is calculated by straight line method with the service life

Table 8.2.2-1 Investment and Operation Cost for Costs/Benefits

(unit : US$)

Year	Dredged Soil Volume	Operation Days	Labor Cost	Provision for Crew Onboard	Fuel Cost	Maintenance & Repair Cost	Administration Cost	Operation Cost(Total)	Investment Cost	Total Costs
2000	3,231,714m^3	264 days	360,640	114,048	1,132,484	500,000	672,600	2,779,772	26,761,000	29,540,772
2001	3,231,714m^3	264 days	360,640	114,048	1,132,484	500,000	672,600	2,779,772		2,779,772
2002	3,231,714m^3	264 days	360,640	114,048	1,132,484	500,000	672,600	2,779,772		2,779,772
2003	3,231,714m^3	264 days	360,640	114,048	1,132,484	500,000	672,600	2,779,772		2,779,772
2004	3,231,714m^3	264 days	360,640	114,048	1,132,484	500,000	672,600	2,779,772		2,779,772
2005	2,500,000m^3	220 days	289,800	95,040	943,680	500,000	672,600	2,501,120		2,501,120
2006	2,500,000m^3	220 days	289,800	95,040	943,680	500,000	672,600	2,501,120		2,501,120
↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
2024	2,500,000m^3	220 days	289,800	95,040	943,680	500,000	672,600	2,501,120		2,501,120

Note : Labor Cost in 2000~2004 = 289,800(1+1/12/30×200%×44) = 360,640 US$

Provisions for Crew Onboard in 2000~2004 = 9 US$/day×48 persos×264days = 114,048 US$

Fuel Cost in 2000~2004 = (12,767 kg/day×264days×US$280/ton) × 1.2 = 1,132,484 US$

Table 8.2.2-2 Income for Costs/Benefits

(unit : US$)

Year	Dredged Soil Volume	Variable Income (US$ 0.57/m³)	Fixed Cost	Total Income
2000	3,231,714	1,842,077	2,425,796	4,267,873
2001	3,231,714	1,842,077	2,425,796	4,267,873
2002	3,231,714	1,842,077	2,425,796	4,267,873
2003	3,231,714	1,842,077	2,425,796	4,267,873
2004	3,231,714	1,842,077	2,425,796	4,267,873
2005	2,500,000	1,425,000	2,425,796	3,850,796
2006	2,500,000	1,425,000	2,425,796	3,850,796
↓	↓	↓	↓	↓
2024	2,500,000	1,425,000	2,425,796	3,850,796
Note : Fixed Cost= Labor Cost +Maintenance & Repair Cost +Administration Cost +Depreciation = US$ 2,425,796				

Table 8.2.2-3 Calculation of FIRR (unit : US$)

Year	Income	Cost	Net Profit
2000	4,267,873	29,540,772	-25,272,899
2001	4,267,873	2,779,772	1,488,101
2002	4,267,873	2,779,772	1,488,101
2003	4,267,873	2,779,772	1,488,101
2004	4,267,873	2,779,772	1,488,101
2005	3,850,796	2,501,120	1,349,676
2006	3,850,796	2,501,120	1,349,676
2007	3,850,796	2,501,120	1,349,676
2008	3,850,796	2,501,120	1,349,676
2009	3,850,796	2,501,120	1,349,676
2010	3,850,796	2,501,120	1,349,676
2011	3,850,796	2,501,120	1,349,676
2012	3,850,796	2,501,120	1,349,676
2013	3,850,796	2,501,120	1,349,676
2014	3,850,796	2,501,120	1,349,676
2015	3,850,796	2,501,120	1,349,676
2016	3,850,796	2,501,120	1,349,676
2017	3,850,796	2,501,120	1,349,676
2018	3,850,796	2,501,120	1,349,676
2019	3,850,796	2,501,120	1,349,676
2020	3,850,796	2,501,120	1,349,676
2021	3,850,796	2,501,120	1,349,676
2022	3,850,796	2,501,120	1,349,676
2023	3,850,796	2,501,120	1,349,676
2024	3,850,796	2,501,120	1,349,676
		FIRR=	2.28%

Table 8.2.2-4 FIRR by Sensitivity Analysis

Case A	Investment Cost × 1.1	FIRR= 1.38%
Case B	Investment Cost × 0.9	FIRR= 3.32%
Case C	Income per annum × 1.05	FIRR= 3.74%
Case D	Income per annum × 0.95	FIRR= 0.85%

of 25 years and the residual value of new dredger is assumed to be 10 %. Annual depreciation cost = 26,761,000x0.9/25 = US$ 963,396.

3) The rate of income tax is assumed to be 50 % of the continuing profit.
4) The exchange rate was US$ 1 = 10,785 MT in 1995, 11,230 MT in 1996 and 11,300 MT after 1997. The summarized financial statements are shown in units of US$.
5) The new dredger in this Project is assumed to be granted in the capital account of EMODRAGA as the investment from the Government of Mozambique.
6) In this Project, it is assumed that there is no loan and there is no loan repayment.

(2) Financial Statement

The financial soundness of EMODRAGA in this Project is evaluated by estimated financial statements (income statement, source and application of funds and balance sheet) prepared for the period from 2000 to 2024.

Profit and Loss (P/L or income and expenditure statement), balance sheet (B/S) and statement of source and application of funds are analyzed as shown in Tables 8.2.3-1, 8.2.3-2 and 8.2.3-3, respectively.

At the end of the project life, the Project will gain current assets estimated at US$ 29,254,462 which can recover the initial investment of US$ 26,761,000 and can obtain the new funds of US$ 5,174,562. Therefore, this Project is considered to be feasible enough in spite of the low level of FIRR.

8.2.4 Financial Management

(1) Budget of CFM-C for Operation and Maintenance Cost of the Project

Table 8.2.4-1 shows the trend of P/L of the Port Section of CFM-C during the year 2000 to 2024 and the source of funds to pay the operation and maintenance costs of this Project in the case of gaining marginal profits under certain fixed costs.

The rate of expenses required for new dredging works (revenues for EMODRAGA of this Project) against the source of fund for CFM-C, out of which the operation and maintenance costs can be paid for, will decrease from 19.7 % in 2000 to 9.8 % in 2024 as a result of increased cargo volume of Beira Port.

Table 8.2.3-1 Profit and Loss (Income and Expenditure) Statement

(unit : US$)

Fiscal Year	2000	2001	2002	2003	2004	2005	2006
(A) Revenue	4,267,873	4,267,873	4,267,873	4,267,873	4,267,873	3,850,796	3,850,796
(B) Expenses	2,779,772	2,779,772	2,779,772	2,779,772	2,779,772	2,501,120	2,501,120
(C) Depreciation	963,396	963,396	963,396	963,396	963,396	963,396	963,396
(A-B-C) Profit & Loss	524,705	524,705	524,705	524,705	524,705	386,280	386,280
Net Profit after Income Tax	262,353	262,353	262,353	262,353	262,353	193,140	193,140
Accmulated Profit & Loss	262,353	524,705	787,058	1,049,410	1,311,763	1,504,903	1,698,043

Fiscal Year	2007	2008	2009	2010	2011	2012	2013
(A) Revenue	3,850,796	3,850,796	3,850,796	3,850,796	3,850,796	3,850,796	3,850,796
(B) Expenses	2,501,120	2,501,120	2,501,120	2,501,120	2,501,120	2,501,120	2,501,120
(C) Depreciation	963,396	963,396	963,396	963,396	963,396	963,396	963,396
(A-B-C) Profit & Loss	386,280	386,280	386,280	386,280	386,280	386,280	386,280
Net Profit after Income Tax	193,140	193,140	193,140	193,140	193,140	193,140	193,140
Accmulated Profit & Loss	1,891,183	2,084,323	2,277,463	2,470,603	2,663,743	2,856,883	3,050,023

Fiscal Year	2014	2015	2016	2017	2018	2019	2020
(A) Revenue	3,850,796	3,850,796	3,850,796	3,850,796	3,850,796	3,850,796	3,850,796
(B) Expenses	2,501,120	2,501,120	2,501,120	2,501,120	2,501,120	2,501,120	2,501,120
(C) Depreciation	963,396	963,396	963,396	963,396	963,396	963,396	963,396
(A-B-C) Profit & Loss	386,280	386,280	386,280	386,280	386,280	386,280	386,280
Net Profit after Income Tax	193,140	193,140	193,140	193,140	193,140	193,140	193,140
Accmulated Profit & Loss	3,243,163	3,436,303	3,629,443	3,822,583	4,015,723	4,208,863	4,402,003

Fiscal Year	2021	2022	2023	2024	Ratio
(A) Revenue	3,850,796	3,850,796	3,850,796	3,850,796	100%
(B) Expenses	2,501,120	2,501,120	2,501,120	2,501,120	65%
(C) Depreciation	963,396	963,396	963,396	963,396	25%
(A-B-C) Profit & Loss	386,280	386,280	386,280	386,280	10%
Net Profit after Income Tax	193,140	193,140	193,140	193,140	5%
Accmulated Profit & Loss	4,595,143	4,788,283	4,981,423	5,174,563	134%

Table 8.2.3-2 Balance Sheet at the End of Fiscal Year

(unit : US$)

Fiscal Year	2000	2001	2002	2003	2004	2005	2006
Current Assets	1,225,749	2,451,497	3,677,246	4,902,994	6,128,743	7,285,279	8,441,815
Fixed Assets	25,797,604	24,834,208	23,870,812	22,907,416	21,944,020	20,980,624	20,017,228
(A) Assets	27,023,353	27,285,705	27,548,058	27,810,410	28,072,763	28,265,903	28,459,043
(B) Liability	0	0	0	0	0	0	0
(C) Capital	26,761,000	26,761,000	26,761,000	26,761,000	26,761,000	26,761,000	26,761,000
(A-B-C) Surplus	262,353	524,705	787,058	1,049,410	1,311,763	1,504,903	1,698,043

Fiscal Year	2007	2008	2009	2010	2011	2012	2013
Current Assets	9,598,351	10,754,887	11,911,423	13,067,959	14,224,495	15,381,031	16,537,567
Fixed Assets	19,053,832	18,090,436	17,127,040	16,163,644	15,200,248	14,236,852	13,273,456
(A) Assets	28,652,183	28,845,323	29,038,463	29,231,603	29,424,743	29,617,883	29,811,023
(B) Liability	0	0	0	0	0	0	0
(C) Capital	26,761,000	26,761,000	26,761,000	26,761,000	26,761,000	26,761,000	26,761,000
(A-B-C) Surplus	1,891,183	2,084,323	2,277,463	2,470,603	2,663,743	2,856,883	3,050,023

Fiscal Year	2014	2015	2016	2017	2018	2019	2020
Current Assets	17,694,103	18,850,639	20,007,175	21,163,711	22,320,247	23,476,783	24,633,319
Fixed Assets	12,310,060	11,346,664	10,383,268	9,419,872	8,456,476	7,493,080	6,529,684
(A) Assets	30,004,163	30,197,303	30,390,443	30,583,583	30,776,723	30,969,863	31,163,003
(B) Liability	0	0	0	0	0	0	0
(C) Capital	26,761,000	26,761,000	26,761,000	26,761,000	26,761,000	26,761,000	26,761,000
(A-B-C) Surplus	3,243,163	3,436,303	3,629,443	3,822,583	4,015,723	4,208,863	4,402,003

Fiscal Year	2021	2022	2023	2024	Ratio
Current Assets	25,789,855	26,946,391	28,102,927	29,259,462	92%
Fixed Assets	5,566,288	4,602,892	3,639,496	2,676,100	8%
(A) Assets	31,356,143	31,549,283	31,742,423	31,935,562	100%
(B) Liability	0	0	0	0	
(C) Capital	26,761,000	26,761,000	26,761,000	26,761,000	84%
(A-B-C) Surplus	4,595,143	4,788,283	4,981,423	5,174,562	16%

Table 8.2.3-3 Statement of Source and Application of Funds

(unit : US$)

Fiscal Year	2000	2001	2002	2003	2004	2005	2006
Net Profit after Tax etc.	262,353	262,353	262,353	262,353	262,353	193,140	193,140
Depreciation	963,396	963,396	963,396	963,396	963,396	963,396	963,396
Capital	26,761,000	0	0	0	0	0	0
(A) Source of Funds	27,986,749	1,225,749	1,225,749	1,225,749	1,225,749	1,156,536	1,156,536
Initial Investment	26,761,000	0	0	0	0	0	0
Repayment of Loan	0	0	0	0	0	0	0
(B) Application of Funds	26,761,000	0	0	0	0	0	0
(A-B) Increased Current Asset	1,225,749	1,225,749	1,225,749	1,225,749	1,225,749	1,156,536	1,156,536

Fiscal Year	2007	2008	2009	2010	2011	2012	2013
Net Profit after Tax etc.	193,140	193,140	193,140	193,140	193,140	193,140	193,140
Depreciation	963,396	963,396	963,396	963,396	963,396	963,396	963,396
Capital	0	0	0	0	0	0	0
(A) Source of Funds	1,156,536	1,156,536	1,156,536	1,156,536	1,156,536	1,156,536	1,156,536
Initial Investment	0	0	0	0	0	0	0
Repayment of Loan	0	0	0	0	0	0	0
(B) Application of Funds	0	0	0	0	0	0	0
(A-B) Increased Current Asset	1,156,536	1,156,536	1,156,536	1,156,536	1,156,536	1,156,536	1,156,536

Fiscal Year	2014	2015	2016	2017	2018	2019	2020
Net Profit after Tax etc.	193,140	193,140	193,140	193,140	193,140	193,140	193,140
Depreciation	963,396	963,396	963,396	963,396	963,396	963,396	963,396
Capital	0	0	0	0	0	0	0
(A) Source of Funds	1,156,536	1,156,536	1,156,536	1,156,536	1,156,536	1,156,536	1,156,536
Initial Investment	0	0	0	0	0	0	0
Repayment of Loan	0	0	0	0	0	0	0
(B) Application of Funds	0	0	0	0	0	0	0
(A-B) Increased Current Asset	1,156,536	1,156,536	1,156,536	1,156,536	1,156,536	1,156,536	1,156,536

Fiscal Year	2021	2022	2023	2024	Ratio
Net Profit after Tax etc.	193,140	193,140	193,140	193,140	17%
Depreciation	963,396	963,396	963,396	963,396	83%
Capital	0	0	0	0	
(A) Source of Funds	1,156,536	1,156,536	1,156,536	1,156,536	100%
Initial Investment	0	0	0	0	
Repayment of Loan	0	0	0	0	
(B) Application of Funds	0	0	0	0	
(A-B) Increased Current Asset	1,156,536	1,156,536	1,156,536	1,156,536	100%

Generally, the profit of enterprises is to be divided as follows :

1) 1/3 : the source for rise in the labor cost and other expenses for next year
2) 1/3 : the source for the short-term operational funds as dredging cost or maintenance cost, etc. in the next year
3) 1/3 : the source of the long-term investment in the future.

As the maintenance dredging of Beira Port is assumed to increase cargo volume significantly, the rate of ②/① in Table 8.2.4-1 is considered to be acceptable. From the view point of EMODRAGA as a whole, the projection to increase the net current assets by this Project is shown in Table 8.2.4-2. The net current assets of more than US$ 1,750,000 per annum is estimated to be accumulated by EMODRAGA.

(2) Raising of the Port Charge

In case that the cargo volume of Beira Port will not increase against the demand forecast of SATTC, the raising of the Port Charge has to be considered.

Based on the data of shipping tariff of Beira Port as shown in Table 8.2.4-3, the ratio of navigation aid by INAHINA is about 40 %. As the improvement of the Access Channel improves the safety of channel navigation to the Port, some part of the tariff shall be allocated to EMODRAGA as a dredging cost.

In case that a transportation time of a Zimbabwe container cargo becomes shortened, the cargo owners will gain the profit of US$ 12.5 /ton for import and of US$ 8.5 /ton for export as shown in Table 8.1.5-2. If these profits are absorbed to raise the port charge of container cargo, the increase of tariff amounts to US$ 6,312,626 in 2000 which corresponds to 148 % of the new revenue for EMODRAGA in this Project.

Total benefit of saving in ship staying sost in the case of channel water depth of 8.0 m through the execution of this Project is estimated at US$ 112,117,960 for 25 years as shown in Table 8.1.6-1. In 2007, benefit of saving in ship staying sost is estimated at US$ 4,227,904 and this benefit per ship of tanker with shipping tariffs from US$ 10,000 to 14,000 amounts to US$ 25,506 as shown in Table 8.2.4-4.

These benefits mentioned above will justify the raising of port charges by CFM-C.

Table 8.2.4-1 Operation and Maintenance Cost for the New Dredger of EMODRAGA

(unit : 1000 US$,metric tons)	Port Section of CFM		Cargo Volume, Revenue and Expenses on Demand Forecast						
	1995	1996	2000	2002	2007	2012	2017	2022	2024
Container Cargo	238,120	279,530	637,981	670,673	768,809	861,000	861,000	861,000	861,000
General Cargo (included Cabotage)	1,123,180	1,234,070	1,266,717	1,395,427	1,584,541	1,889,742	2,254,195	2,689,487	2,886,460
Oil Cargo	1,126,900	1,089,700	1,167,398	1,208,300	1,384,300	1,657,618	1,984,900	2,376,801	2,554,433
Cargo Volume of Beira Port(tons)	2,488,200	2,603,300	3,072,096	3,274,400	3,737,650	4,408,360	5,100,095	5,927,288	6,301,893
Container Terminal	7,554	12,652	24,243	25,486	29,215	32,718	32,718	32,718	32,718
General Cargo Terminal	8,040	8,855	9,500	10,466	11,884	14,173	16,906	20,171	21,648
Oil Terminal	3,043	3,160	3,385	3,504	4,014	4,807	5,756	6,393	7,408
Maritime Service etc.	454	444	538	573	654	771	893	1,037	1,103
(A) Operational Revenue	19,091	25,111	37,667	40,028	45,767	52,470	56,273	60,819	62,877
(B) Direct (Variable) Expenses (32.27% in 1996)	5,183	8,103	12,155	12,917	14,769	16,932	18,159	19,626	20,290
(C)=(B)×0.0808 (Expense Rate to EMODRAGA)		655	982	1,044	1,193	1,368	1,467	1,586	1,639
(D) Expenses to EMODRAGA fixed in 1996	334	655	655	655	655	655	655	655	655
(E)=(C)-(D)		0	327	389	538	713	812	931	984
(A-B) Marginal Profit (67.73% in 1996)	13,908	17,008	25,512	27,111	30,998	35,538	38,114	41,193	42,587
F. Fixed Expenses (=Depreciation + Interest)	4,395	4,221	4,221	4,221	4,221	4,221	4,221	4,221	4,221
(G=A-B-F) Continuing Profit	9,513	12,787	21,291	22,890	26,777	31,317	33,893	36,972	38,366
①=(E+G) Source of Fund to Pay for ②			21,618	23,279	27,316	32,030	34,705	37,903	39,350
②=Payment to EMODRAGA for New Dredger			4,268	4,268	3,851	3,851	3,851	3,851	3,851
Rate(%) of ②/①			19.7%	18.3%	14.1%	12.0%	11.1%	10.2%	9.8%

Source : CFM-C

Table 8.2.4-2 Net Current Assets of EMODRAGA by this Project

(unit : 1000 US$)	1995	1996	2000	2002	2007	2012	2017	2022	2024
Revenues of all EMODRAGA in 1996	1,502	2,349	2,349	2,349	2,349	2,349	2,349	2,349	2,349
Revenues of this Project			4,268	4,268	3,851	3,851	3,851	3,851	3,851
(A) Total Revenues	1,502	2,349	6,617	6,617	6,200	6,200	6,200	6,200	6,200
Expenses of all EMODRAGA in 1996	1,700	1,726	1,726	1,726	1,726	1,726	1,726	1,726	1,726
Expenses of this Project (included depreciation)			3,743	3,743	3,465	3,465	3,465	3,465	3,465
(B) Total Expenses	1,700	1,726	5,470	5,470	5,191	5,191	5,191	5,191	5,191
{(A)-(B)}×50% Net Profit	-99	311	574	574	505	505	505	505	505
(C) Depreciation	425	289	1,252	1,252	1,252	1,252	1,252	1,252	1,252
{(A)-(B)}×50%+(C) Increase in Net Current Assets		600	1,826	1,826	1,757	1,757	1,757	1,757	1,757
(Accumulated net) Current Assets of this Project			1,226	3,677	9,598	15,381	21,164	26,946	29,260

Source : EMODRAGA, Annual Report

Table 8.2.4-3 The Data of Shipping Tariff at Beira Port

(unit : US$)

Name of Ship	Respect v.20	Respect v.21	Respect v.22	Respect v.23	Karibu
Navigation days	3 days	3 days	4 days	4 days	5 days
Tonnages	27,914	32,600	23,979	32,128	32,895
Navigation aid(INAHINA)	4,747.47	4,747.47	4,747.47	4,747.47	5,589.57
Entrance	500.00	500.00	500.00	500.00	500.00
Pilotage	832.14	832.14	832.14	832.14	912.34
Mooring/unmoor	100.00	100.00	100.00	100.00	100.00
Tugboats	1,952.14	2,928.21	2,702.14	3,678.12	3,782.34
Launch Hire	210.00	210.00	240.00	180.00	270.00
Berth Occupancy	2,034.63	2,034.63	2,712.84	2,712.84	3,194.04
Sub-total	10,376.38	11,352.45	11,834.59	12,750.57	14,348.29

Source : MANICA, Ship's Agency, on July 31 in 1997.

Table 8.2.4-4 Benefits of Saving in Ship Staying Cost per Ship by Type

(Unit : US$, Number of Ships)

Year	2000	2002	2007
(1)Saving in Ship Staying Cost	731,284	821,295	1,004,712
(2)Number of Ships' Call	334	350	403
(1)/(2) of Container	2,189	2,347	2,493
(1)Saving in Ship Staying Cost	845,417	949,349	1,207,227
(2)Number of Ships' Call	113	114	141
(1)/(2) of Dry Cargo	7,482	8,328	8,562
(1)Saving in Ship Staying Cost	1,651,826	1,740,363	2,014,944
(2)Number of Ships' Call	62	69	79
(1)/(2) of Tanker	26,642	25,223	25,506
(1)Saving in Ship Staying Cost	1,271	1,167	1,021
(2)Number of Ships' Call	48	53	58
(1)/(2) of Cabotage	26	22	18
(1)Saving in Ship Staying Cost	3,229,798	3,512,174	4,227,904
(2)Number of Ships' Call	557	586	681
(1)/(2) in Total	5,799	5,993	6,208