CHAPTER 9

IMPLEMENTATION PLAN

Chapter 9 Implementation Plan

9.1 Manufacturing of the Dredger

9.1.1 Scope of Works

As a dredger is a working vessel employed for the special purpose of dredging works, special skills are required not only for the design of the dredger but also for ship construction works.

To construct the dredger, the strict control procedures for quality assurance and for keeping the construction schedule are essential.

In compliance with these requirements, the construction of the dredger should be planned to be carried out by a reliable shipbuilder who has sufficient skill and experience in building dredgers and similar types of working vessels as well as engineering capability.

When the construction work of the recommended dredger is executed, the scope of works of the shipbuilder and consultant, and the owner may be as follows.

(1) Scope of Works of the Consultant

To carry out the consulting services from a detailed design of the planned dredger, assistance on tendering work and supervision of the construction works on the dredger at a shipyard.

(2) Scope of Works of the Shipbuilder

1) To undertake the construction of the dredger, procurement of material, machinery, equipment and spare parts and required tests and trials in a shipyard.

2) To assist in training of crew on operation technique of the dredger and on handling the dredging equipment.

3) To transport the dredger to Beira Port after completion.

(3) Scope of Works of the Owner

1) To obtain all authorization and permissions required in Mozambique for the implementation of the ship procurement and take delivery of the

dredger.

2) To obtain the provisional nationality certificate and necessary documents for the transportation of the dredger to Mozambique.

3) To secure the quay for safe mooring of the dredger

4) To prepare and execute all the necessary procedures to accept the dredger without delay into Beira Port, to import the dredger and its equipment and to register it in Mozambique.

9.1.2 Manufacturing Schedule of the Dredger

For the construction of the dredger, approximately 20 months are required after contracting the shipbuilding project. And a further approximately 3 months will be necessary for the transportation to Beira Port in Mozambique and for delivery. The expected implementation schedule is shown in Figure 9.1.1-1.

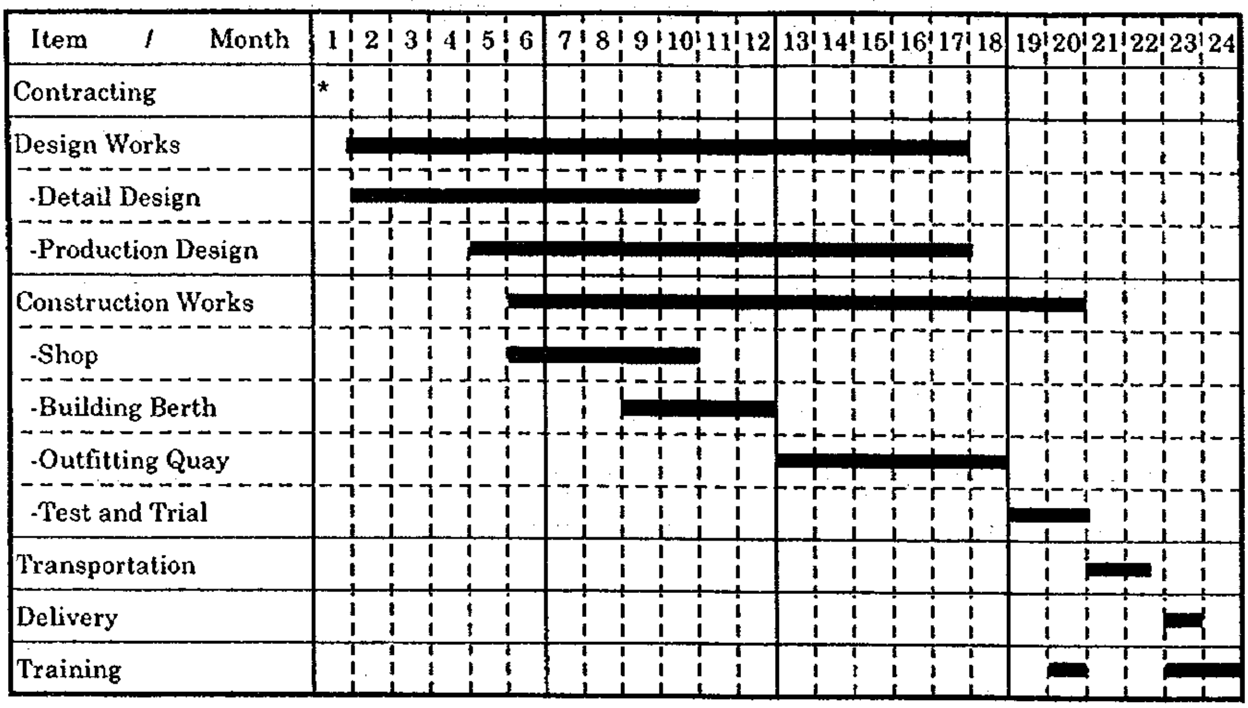


Figure 9.1.1-1 Expected Implementation Schedule of the Dredger

9.1.3 Raising Funds

According to the Study, a new dredger is concluded to be necessary to maintain and improve the Access Channel of Beira Port. And introduction of a new dredger has been evaluated to be financially sound in terms of FIRR. The required funding shall be raised from foreign sources at a low interest rate or on a grant basis.

9.2 Dredging Operation and Management

9.2.1 Management of Dredger and Relevant Equipment

(1) Dredger

Regular maintenance and repair in addition to daily inspection are most important for a trailer suction hopper dredger, not only in terms of dredging part but also in terms of sailing part.

Additionally, the water in the channel is muddy in some portion and the dredger is often compelled to stop operations due to troubles in the cooling system which uses muddy sea water. In the worst case, the main engine suddenly stops and the dredger is grounded. Careful attention should be paid to this problem.

Measuring devices such as water flow, soil concentration and draft meters in a dredger are sensitive and annual maintenance by the staff of the manufacturer will be necessary.

(2) Survey Equipment

A survey boat in good condition is necessary to make sounding surveys on the bathymetric condition of the channel and the dredging performance in which a complete array of survey equipment including a data processor is installed. This equipment should be protected from high levels of humidity.

(3) Navigation Aids

For safe navigation of ships in the Channel, the following steps are to be undertaken at appropriate intervals.

1) Regular Maintenance of Navigation Aids
   a) Check-up of the conditions and functions of the navigation aids on-site, and, if necessary, repair them.
   b) Replacement of consumables such as batteries, lamps and anchor chains.
   c) Overhaul of equipment on land including the above items.

2) Accident Prevention
   a) Patrol of the channel area
   b) Issue of regulations, manuals and charts.
   c) Up-to-date information on the current condition of navigation aids.

3) Remedy of Accidents
   1) Preparation of procedures in the event of accidents.
   2) Notice of information concerning accidents and navigational aids.
   3) Repair and restoration of navigation aids.

9.2.2 Operation and Management

Regarding the operation and management of maintenance dredging, the following points are recommended in order to make the maintenance dredging more effective.

1) To support and upgrade communications between the relevant organizations.
2) To strengthen the operation and management system in EMODRAGA.
3) To continue training personnel.

(1) Supporting and Upgrading Communications

Supporting and upgrading communications between the relevant organizations should be taken into consideration as follows.

1) To secure the maintenance dredging budget
2) To fulfill each body's responsibility in the maintenance dredging

Regarding the general concept of the maintenance dredging budget, it has basically been decided by negotiation between CFM and EMODRAGA. There was some difference in past revenues of EMODRAGA defrayed by CFM-C. An enough budget allocated for the maintenance dredging shall be secured to keep the Channel at the required condition.

The navigation channels should be kept safe through continuous maintenance dredging from the viewpoint not only of the national economy but also of the economy of the hinterland countries. It is necessary to upgrade communications by increasing cooperation and coordination between the relevant organizations. Reliable communications will enable confirmation of the fulfillment of each body's responsibility for maintenance dredging.

(2) Operation and Management System

Strengthening the operation and management systems of EMODRAGA should take the following points into consideration.

1) Monitoring System for Dredging Operation

Smooth execution of dredging operation requires the collection of correct information such as site conditions, material conditions and working conditions as well as records of dredging operations. Therefore, establishment of a system to monitor dredging operations is necessary. A monitoring system will enable a coordinated analysis of revenues and expenditures of EMODRAGA.

2) Maintenance and Repair Program

A schedule of regular maintenance docking and repair of the dredger has been arranged by EMODRAGA. However, it is sometimes not carried out or it is delayed due to lack of funds.

The maintenance and repair program should be established according to the regulations and maintenance planning. As well, the execution of regular maintenance and repair of the dredger is not only beneficial in terms of effective dredging operations but will also help lengthen the dredger's life-span.

3) Procurement of Spare Parts and Materials

The delay in procurement of spare parts and materials is due to lack of funds, a long decision making process and other reasons.

It is necessary to proceed with an intentional purchase scheme based on the analyzed consumption of spare parts and materials as soon as possible. A skilled expert is required to deal with effective procurement procedures.

(3) Training of Personnel

As mentioned in the previous section, the training program is aimed at establishing a systematic dredging operation, from the drawing up of the dredging program based on an appropriate monitoring system, priority of demand and budgeting constraints to how to execute the maintenance dredging for the highest productivity level. To this end, the training of personnel in all the relevant dredging authorities is required.

CHAPTER 10

CONCLUSION AND RECOMMENDATION

Chapter 10 Conclusion and Recommendation

10.1 Conclusion

Present Situation and Problems of Beira Port

Mozambique is situated in the east coast of Southern Africa. In 1995, the population was 17.4 million and the GNP per capita was about US$ 90. Nacala Port in the northern part, Beira Port in the central part and Maputo Port in the southern part are the major ports in Mozambique.

Beira Port is located at the estuary of the Punque River and has container and general cargo berths of 1,632 m in total length and an oil berth. Beira Port is playing an important role as a gateway of sea transport not only for Mozambique but also for inland countries such as Zimbabwe, Malawi, etc. through railways, roads and oil pipe lines. The total cargo handled at Beira Port was about 2.6 million ton in 1996, of which about 80 % were transit cargoes to and from the inland countries, and is estimated to increase double to 5 million ton after 20 years.

Port facilities has a enough capacity for the future increase of cargo, but the shoaling due to the sedimentation in the Access Channel is so severe that is a bottleneck for the navigation of a large ships such as tankers and bulk-carriers. This is a serious factor to impede the sound development of Beira Port. The tidal range in Beira Port is very large and is beyond 6 m, so that large ships pass the Access Channel taking advantage of the high tide.

In 1990, the Access Channel of 28 km in length was dredged to 8 m deep below CDL taking the 30,000 DWT tanker and general cargo ship as the design ship under a grant aid by the Netherlands. Thereafter, its maintenance dredging scarcely has been executed, so that at present the shallowest water depth reaches until about CDL -5 m. Therefore, large ships are compelled to do uneconomical transportation due to a long tide waiting and a decrease of ship draft by partially loaded cargo. In 1990, the average tide waiting hour of large ships more than 5 m in draft was recorded as 30 hours.

The maintenance dredging at all ports in Mozambique is being executed by EMODRAGA under the budget of CFM. EMODRAGA has one grab dredger in Beira Port, but it is obsolescent and engages only in dredging the mooring basin in front of the berth. The trailing suction hopper dredger "Rovuma", which operates mainly at Maputo Port, is also obsolescent and has not remaining a capacity to dredge the Access Channel in Beira Port besides Maputo Port.

Maintenance Dredging Volume of the Access Channel

The channel traffic simulation based on the forecast cargoes has made clear that the tide waiting time of ships is significantly very high for the cases of 5 and 6 m in channel depth and that it is within the permissible limit for the case of 8 m. That is, the average tide waiting time becomes to more or less 5 hours per ship for the case of 8 m channel depth.

Based on the sedimentation characteristics and its volume obtained from field observations, analysis of sounding maps and past data, and computer simulation, the average annual maintenance dredging volume for the case of 8 m has been estimated at 2,500,000 m^3. However, the actual maintenance volume for each year seems to vary more or less 50 % owing to the fluctuation of river flows and cyclones attacking Beira Port.

Countermeasure of Improvement and Maintenance of the Access Channel

The introduction of a trailing suction hopper dredger with hopper capacity of 2,000 m^3 is judged to be the most appropriate and optimal option for the purpose of restoring and maintaining the Access Channel to 8 m deep. Its construction cost is estimated at US$ 25 million and the operation cost is approximately US$ 3.4 million. The dredging fleet formation of two dredgers with hopper capacity of 1,000 m^3 can be considered as an alternative. However, it is not recommended due to higher capital and running cost, though it has such advantages as the possibility of phased purchase and introduction, and the higher operation efficiency in the low tide by its shallower draft.

The concepts of the recommendable dredger are as follows

Hopper capacity	2,000 m^3
Length overall	83.0 m
Breadth mould	15.0 m
Fully loaded draft	5.5 m
Running speed under full load	10.2 knots

Environmental Evaluation

In environmental examination, there was not found any injurious substances complying to the level of the international standards in the quality of water and bottom sediments. Also, it is concluded that this Project would not be expected to generate any significant damaging impact on the environment.

Economic and Financial Evaluation

The economic internal rate of return (EIRR) of this Project has been calculated to be 24.38 % at the shadow price, so that this Project is expected to generate a enough high economic effect to Mozambique. On the financial management, the operation cost is paid from the revenue increase of CFM by the ship cargoes increase, so that this Project is also judged to be sound and appropriate from the view point of finance.

From the above mentioned, through consideration of important role of Beira Port for the sea transport of Mozambique and neighboring inland countries, the urgent implementation of the maintenance and improvement of the Access Channel to Beira Port in this Project is considered to be essential and significant.

10.2 Recommendation

The followings are recommended for the maintenance and improvement of the Access Channel to Beira Port:

(a) For the purpose of improving the efficiency and safety on navigation of calling ships, it is recommended urgently to introduce the above mentioned dredger in order to recover and maintain the Access Channel to -8 m below CDL by using it,

(b) For the effective operation of the dredger, recruitent of new crews and shifting of existing experienced crews shall be planned and implemented well before the introduction of the new dredger,

(c) The training program of crews of the new dredger and engineers in charge of dredging plan and oceanographic survey should be appropriately arranged and should be begun before introducing the new dredger,

(d) The location of dumping areas is an important factor controlling the efficiency of dredging operation. Therefore, sounding surveys of the dumping areas shall be conducted as often as possible in order to establish the appropriate dredging and damping plan,

(e) The sedimentation volume in the Access Channel is very changeable by season and year, so that it is very important to establish an appropriate dredging plan on the careful study of the result of sounding surveys,

(f) In order to clarify the sedimentation phenomenon of the Access Channel, the extensive hydraulic surveys including its surrounding area shall be carried out at the wet and dry seasons every year,

(g) The dredging works are executed under the contract between CFM and EMODRAGA. The contract forms after the introduction of a new dredger should be studied carefully and prepared in advance by them in order to secure the sound finance of EMODRAGA.

APPENDICES

Appendix A-1 Scope of Works

SCOPE OF WORK

FOR

THE STUDY FOR MAINTENANCE AND IMPROVEMENT PLAN OF

ACCESS CHANNEL OF BEIRA PORT

IN

THE REPUBLIC OF THE MOZAMBIQUE

AGREED UPON BETWEEN

MINISTRY OF TRANSPORTS AND COMMUNICATIONS

AND

JAPAN INTERNATIONAL COOPERATION AGENCY

Maputo, October 1 1996

Mr. Antonio Fernando
Deputy Minister
Ministry of Transports and
Communications

Mr. Hozumi KATSUTA
Leader
Preparatory Study Team
JICA

p/ Mr. Mario Antonio Dimande
President and Chairman
Mozambique Ports and Railways

Mr. Rassul Khan G. Mahomed
Chairman
EMODRAGA E.P.

I. INTRODUCTION

In response to the request of the Government of the Republic of the Mozambique (hereinafter referred to as "GOM"), the Government of Japan (hereinafter referred to as "GOJ") has decided to conduct the Study for Maintenance and Improvement Plan of Access Channel of Beira Port in the Republic of the Mozambique (hereinafter referred to as "the Study"), in accordance with the relevant laws and regulations in force in Japan.

Accordingly, the Japan International Cooperation Agency (hereinafter referred to as "JICA"), the official agency responsible for the implementation of the technical cooperation programs of Japan, will undertake the Study in close cooperation with the authorities concerned of GOM.

The present document sets forth the Scope of Work with regarded to the Study.

II. OBJECTIVE OF THE STUDY

The objective of the Study is to formulate the maintenance and improvement plan of access channel and basin in Beira Port (hereinafter referred to as "the Port") to maintain the function of the Port.

III. SCOPE OF THE STUDY

To achieve the objective mentioned above, the Study shall cover the following items.

1. Evaluation of present conditions of the Port, access channel and dredging

(1) to review reports, plans, information and data relevant to the Study
(2) to survey present activities and utilization of the Port
(3) to review the present shoaling and dredging operation in the Port
(4) to conduct environmental survey
(5) to conduct natural conditions survey to support existing data and information

2. Preparation of effective countermeasures against shoaling problem in the Port

(1) to identify necessary function of access channel based upon future function of the Port.
(2) to analyze characteristics of shoaling
(3) to prepare the alternative countermeasures against shoaling problem.
(4) to evaluate effects of the countermeasures from cost and environmental viewpoints
(5) to select the best alternative countermeasure
(6) to prepare design criteria of dredger

3. Formulation of maintenance and improvement plan of access channel and basin

(1) to conduct preliminary design

(2) to conduct cost estimation

(3) to conduct economic and financial analysis

(4) to conduct environmental impact assessment (EIA)

(5) to formulate maintenance, management and operation plan for dredging

(6) to formulate implementation plan

(7) to conduct overall evaluation and recommendation

IV. STUDY SCHEDULE

The Study will be carried out, in accordance with the attached tentative work schedule shown in APPENDIX.

V. REPORTS

JICA shall prepare and submit the following reports in English to GOM.

1. Inception Report (20 copies)

This reports will include contents and implementation schedule of the Study and will be submitted at the commencement of the work in Mozambique.

2. Progress Report (20 copies)

This report is to be prepared on the basis of the first field survey, containing the results of the collected data and information and will be submitted within five (5) months after the commencement of the Study.

3. Interim Reports (20 copies)

This report will contain design criteria of dredger and countermeasures against shoaling problem. It will be submitted within seven (7) months after the commencement of the Study.

4. Draft Final Report (20 copies)

This report will be prepared as a draft of final report on maintenance and improvement plan of access and basin and be submitted within twelve (12) months after the commencement of the Study.

GOM will provide its comments within one (1) month after the receipt of the Draft Final Report.

5. Final Report (50 copies)

This report will be submitted within two (2) months after receipt of the comments on the Draft Final Report.

VI. UNDERTAKING OF GOM

1. To facilitate smooth conduct of the study, GOM shall take the following necessary measures :

(1) to secure the safety of the Japanese study team ;

(2) to permit the members of the Japanese study team to enter, leave and sojourn in the Mozambique for the duration of their assignment therein, and exempt them from alien registration requirements and consular fees ;

(3) to exempt the members of the Japanese study team from taxes, duties, fees and other charges on equipment, machinery and other materials brought into and out of the Mozambique for the conduct of the Study ;

(4) to exempt the members of the Japanese study team from income tax and charges of any kind imposed on or in connection with any emoluments or allowances paid to the members of the Japanese study team for their services in connection with implementation of the Study ;

(5) to provide necessary facilities to the Japanese study team for remittance as well as utilization of the funds introduced into the Mozambique from Japan in connection with the implementation of the Study ;

(6) to secure permission for entry into private properties and restricted areas for the implementation of the Study ;

(7) to secure permission for the Japanese study team to take all data and documents including maps, photographs related to the Study out of the Mozambique to Japan ; and

(8) to provide the medical services as needed. Its expenses will be chargeable on the members of the Japanese study team.

2. GOM shall bear claims, if any arises, against the members of the Japanese study team resulting from, occurring in the course of, or otherwise connected with, the discharge of their duties in the implementation of the Study, except when such claims arise from gross negligence or willful misconduct on the part of the members of Japanese study team.

3. Empresa Mocambicana de Dragagens, E. P. (hereinafter referred to as "EMODRAGA"), shall act as counterpart agency to the Japanese study team and also as coordinating body in relation with other governmental and non-governmental organizations concerned for the smooth implementation of the Study.

4. EMODRAGA shall, at its own expense, provide the Japanese study team with the

following, in cooperation with other agencies concerned :

(1) available data and information related to the Study, including aerial photographs and maps;

(2) counterpart personnel ;

(3) suitable office space with necessary equipment in Maputo and Beira ; and

(4) credentials or identification cards.

VII. UNDERTAKING OF GOJ

For the implementation of the Study, GOJ, through JICA, shall take the following measures:

(1) to dispatch , as its own expense, a study team to Mozambique.

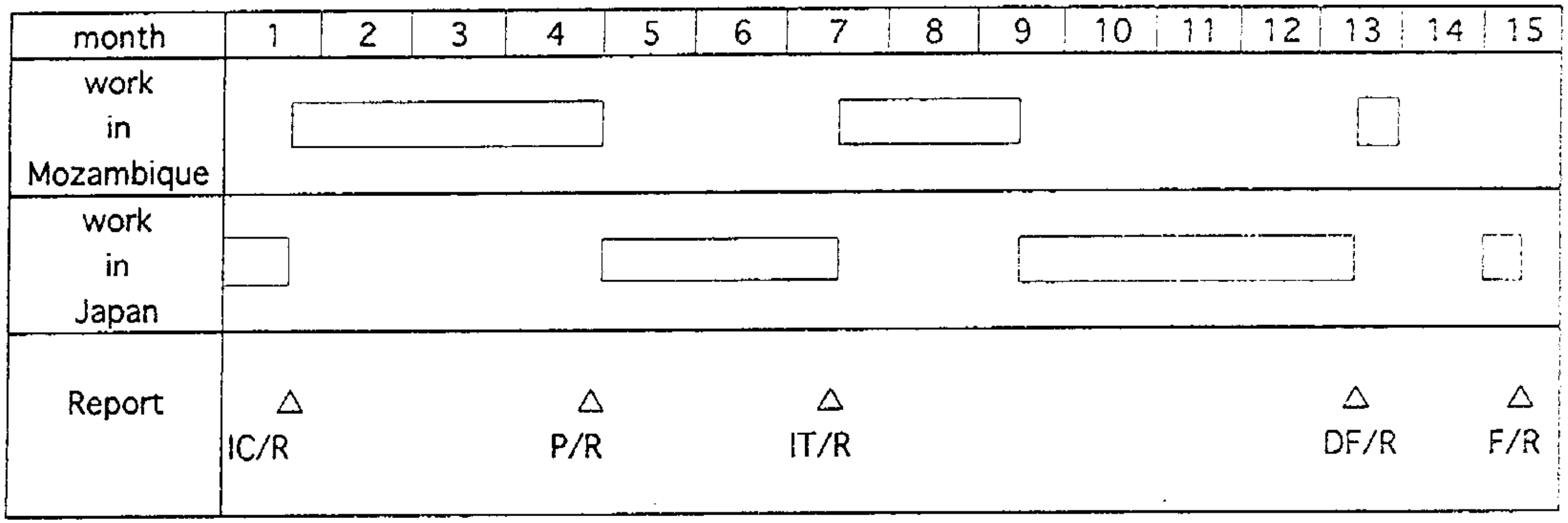
(2) to pursue technology transfer to the Mozambique counterpart personnel in the course of the Study.

VIII. CONSULTATION

JICA and EMODRAGA shall consult with each other in respect to any matter that may arise from or in connection with the Study.

APPENDIX

TENTATIVE SCHEDULE OF THE STUDY



ABBREVIATION

IC/R : Inception Report
P/R : Progress Report
IT/R : Interim Report
DF/R : Draft Final Report
F/R : Final Report

Appendix A-2 Natural Conditions

A-2-1 Bathymetric Survey Result, the Access Channel

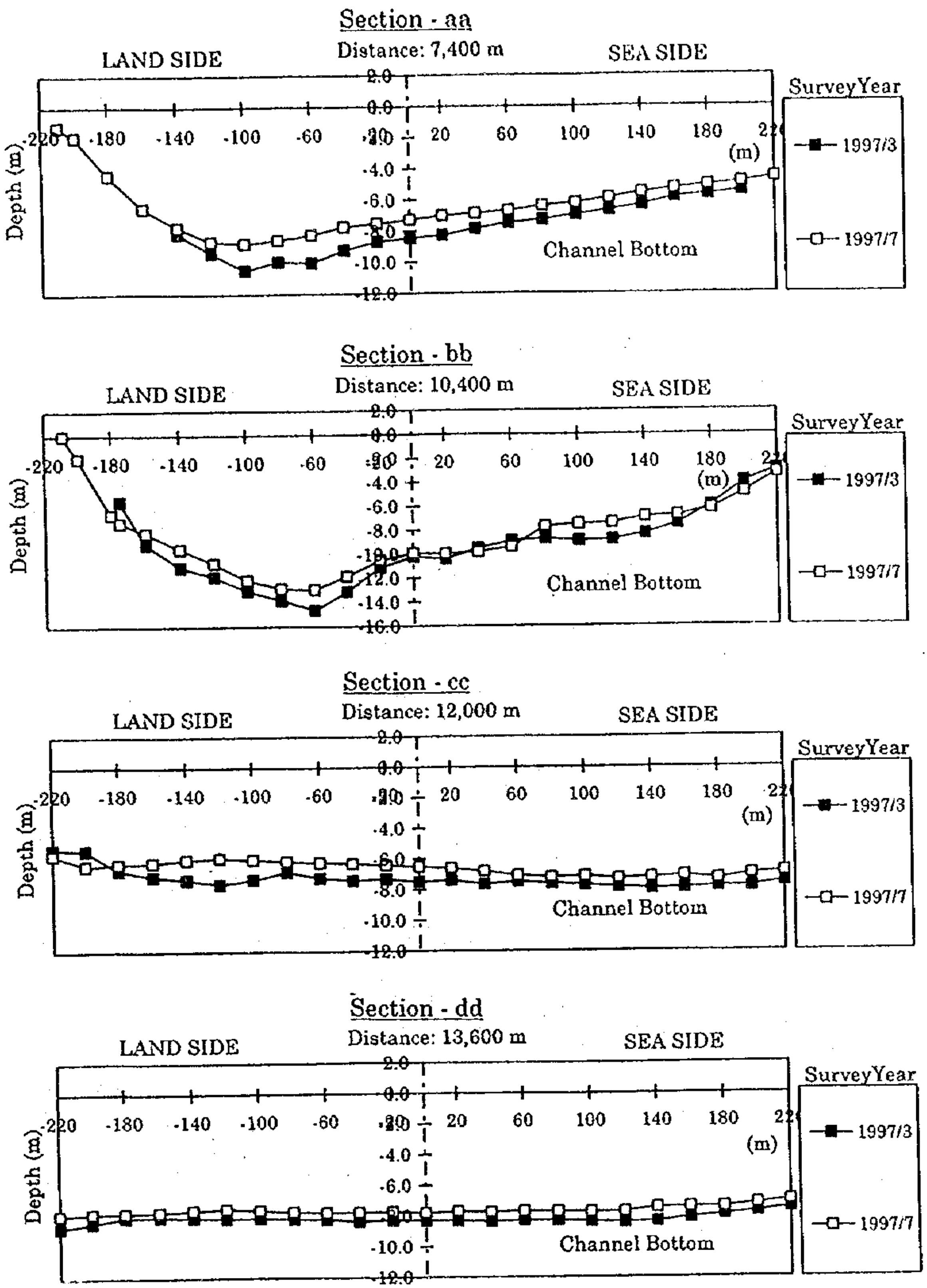


Figure A.2.1-1 Comparison of Sounding Survey Results, the Access Channel

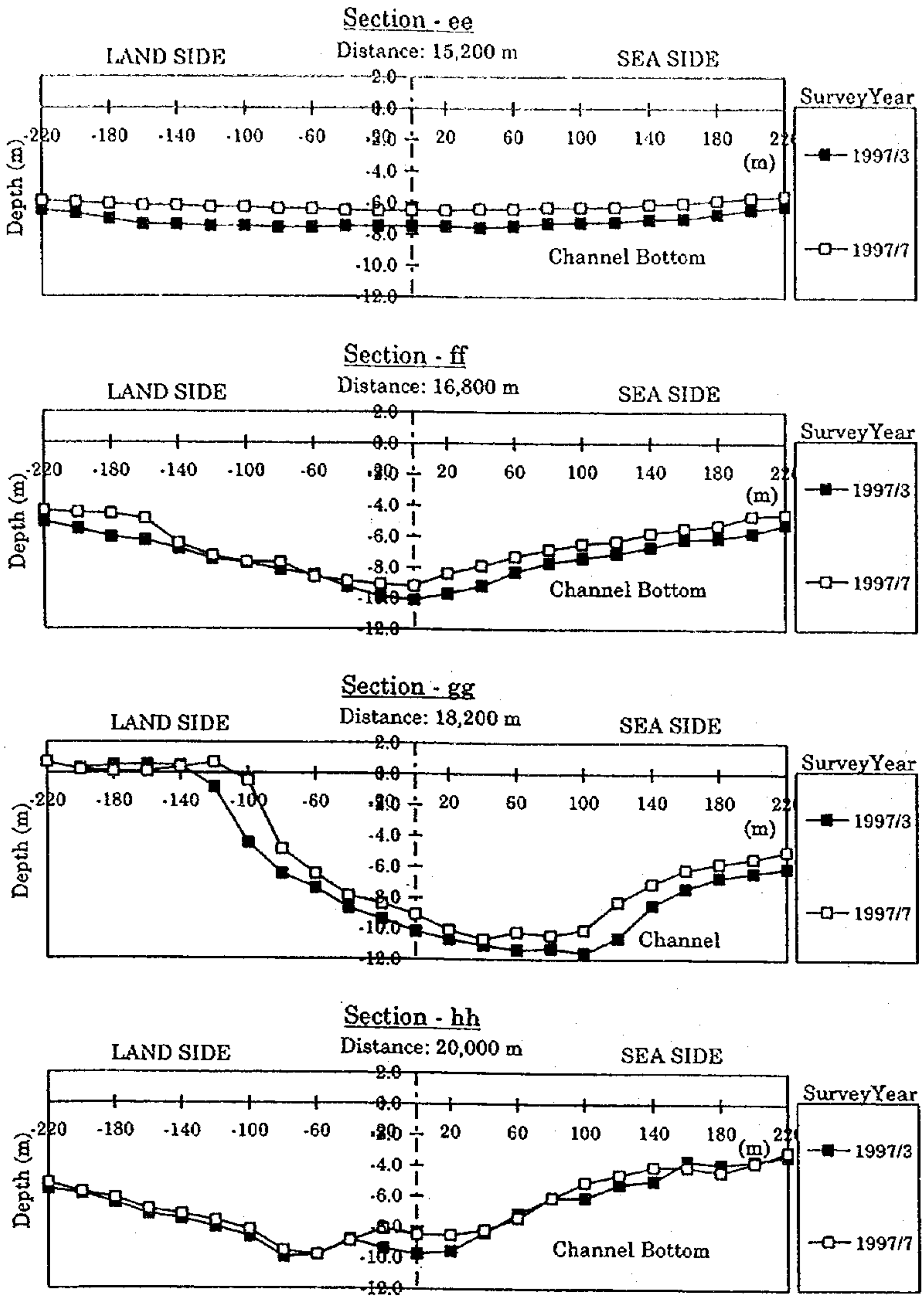


Figure A.2.1-2 Comparison of Sounding Survey Results, the Access Channel

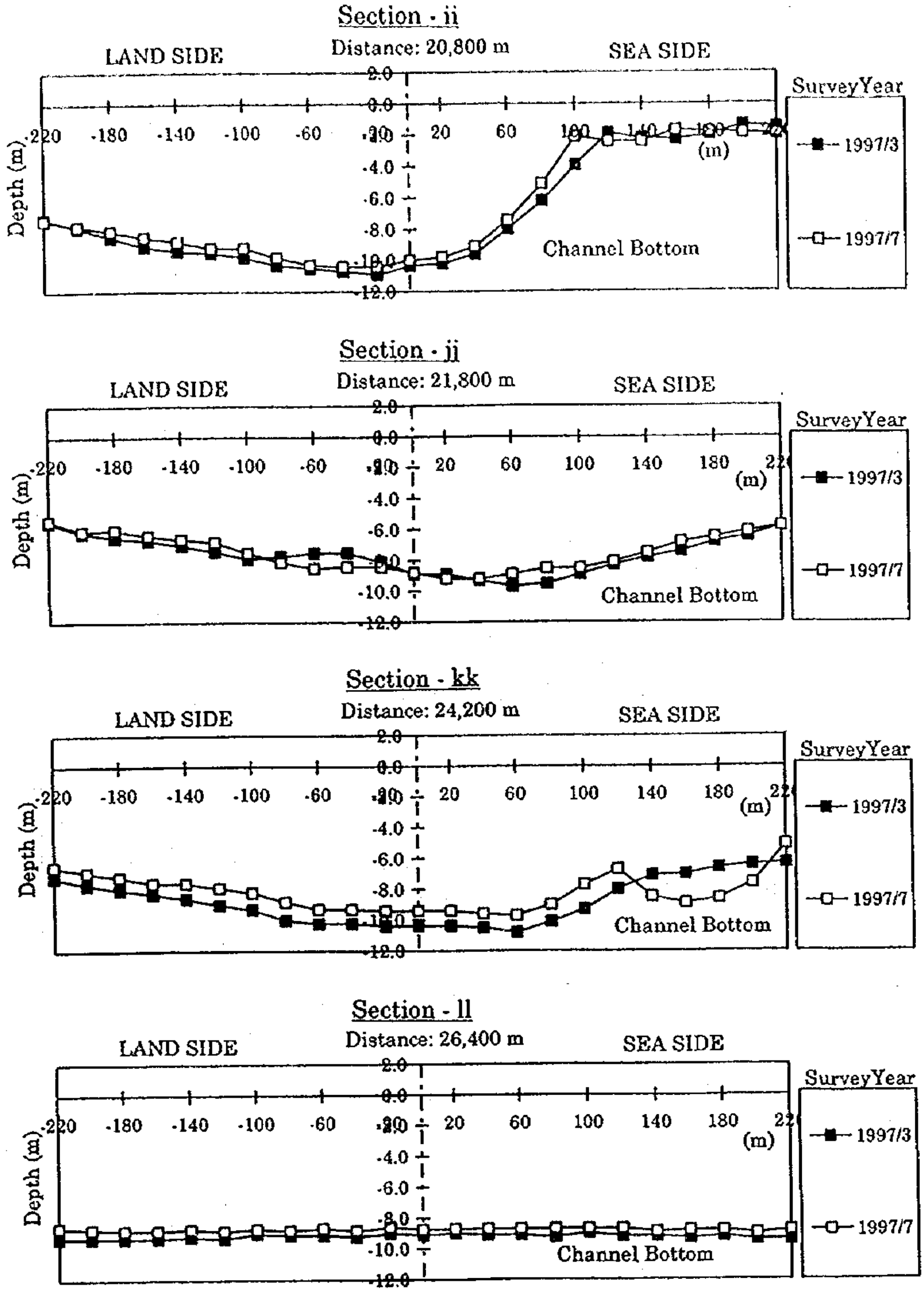
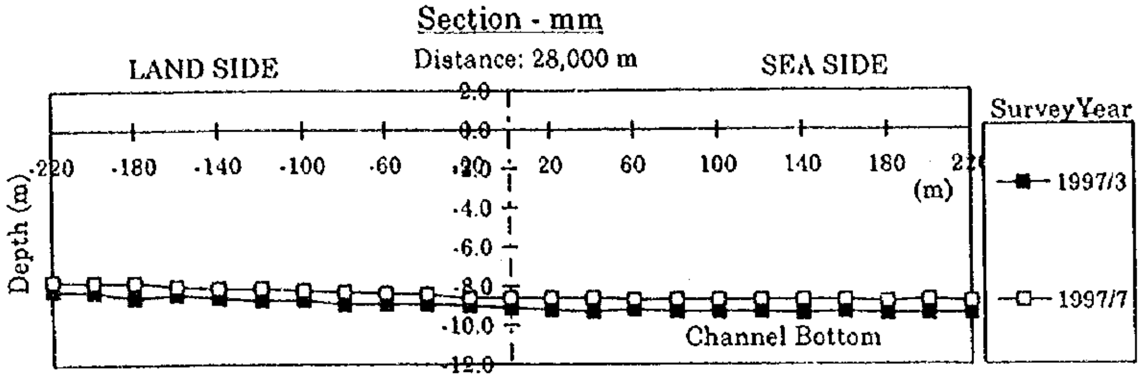
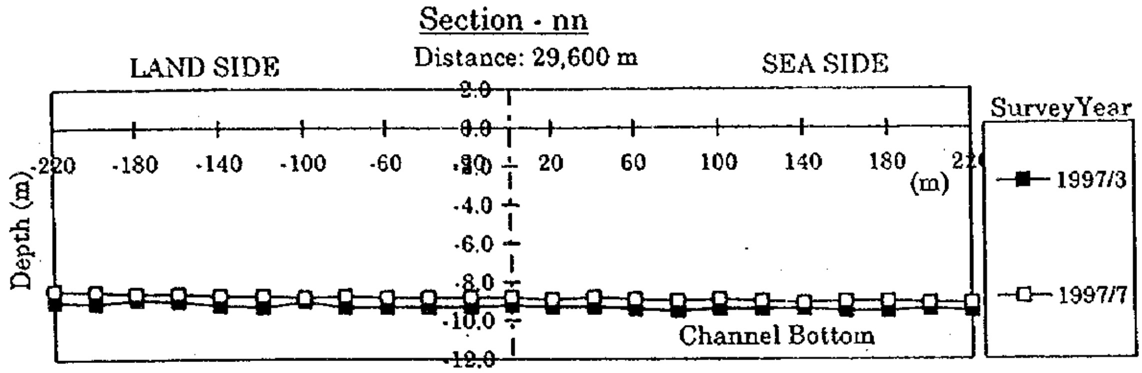
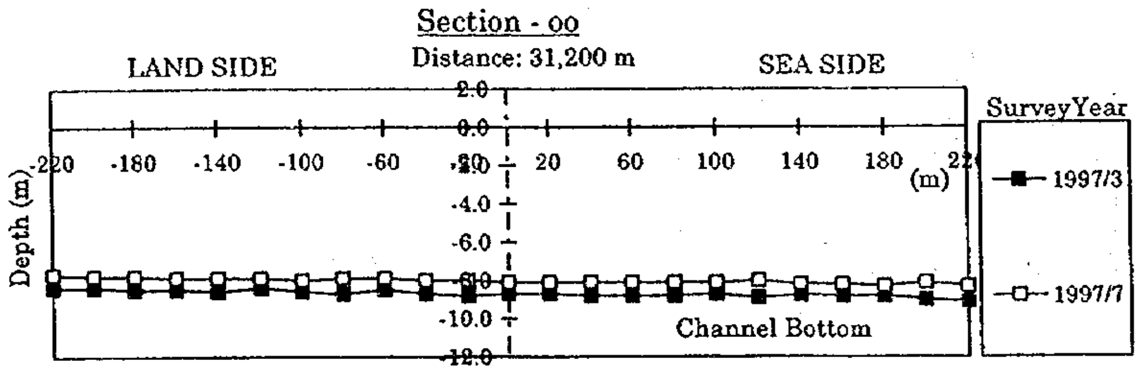


Figure A.2.1-3 Comparison of Sounding Survey Results, the Access Channel







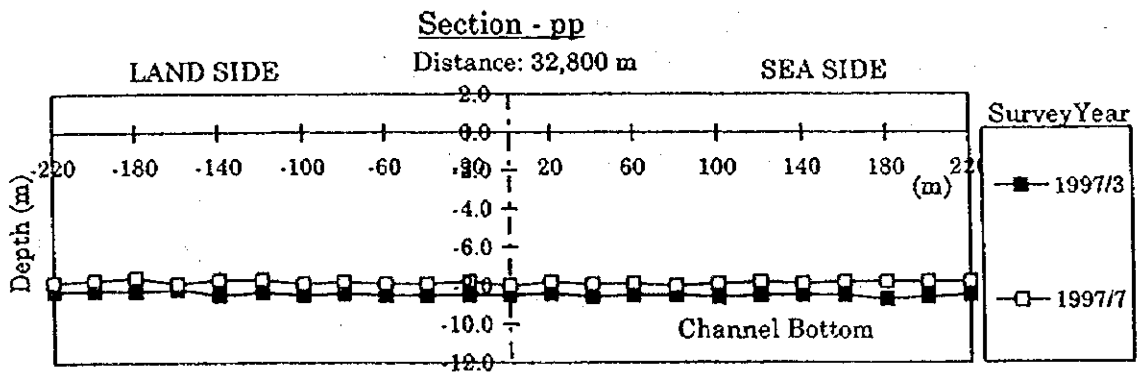
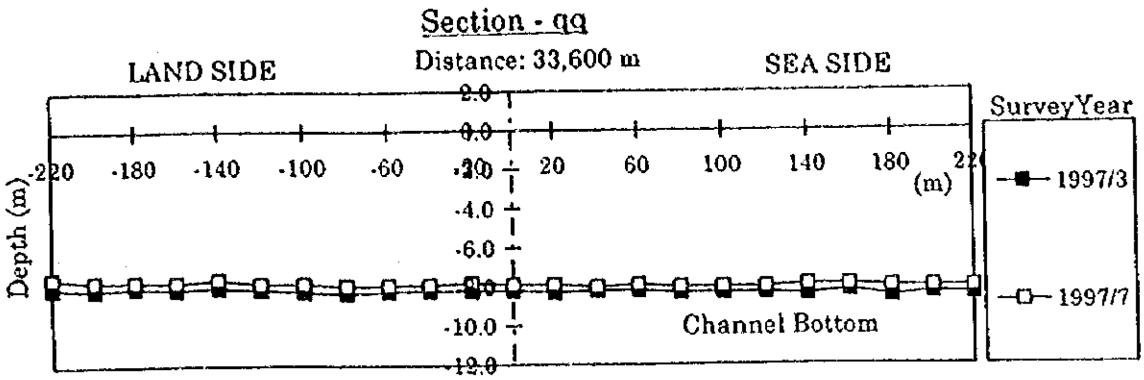


Figure A.2.1-4 Comparison of Sounding Survey Results, the Access Channel



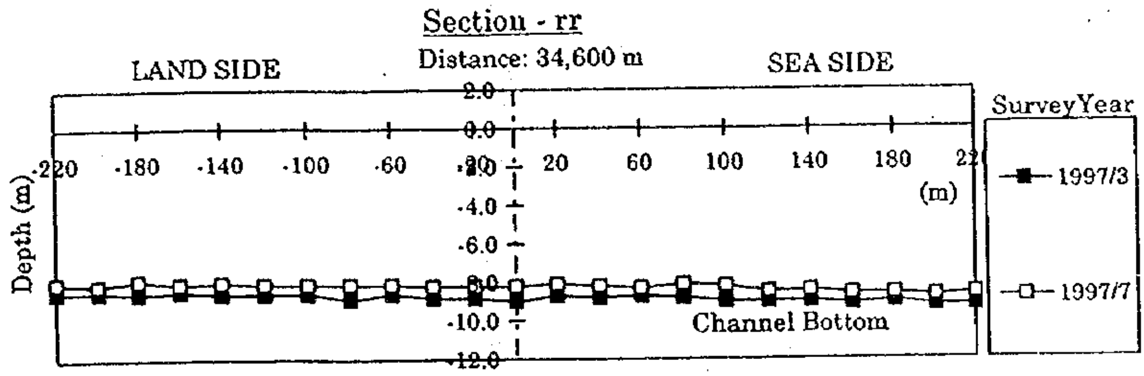


Figure A.2.1-5 Comparison of Sounding Survey Results, the Access Channel

A-2-2 Bathymetric Survey Result by 33 kHz and 210 kHz, the Access Channel

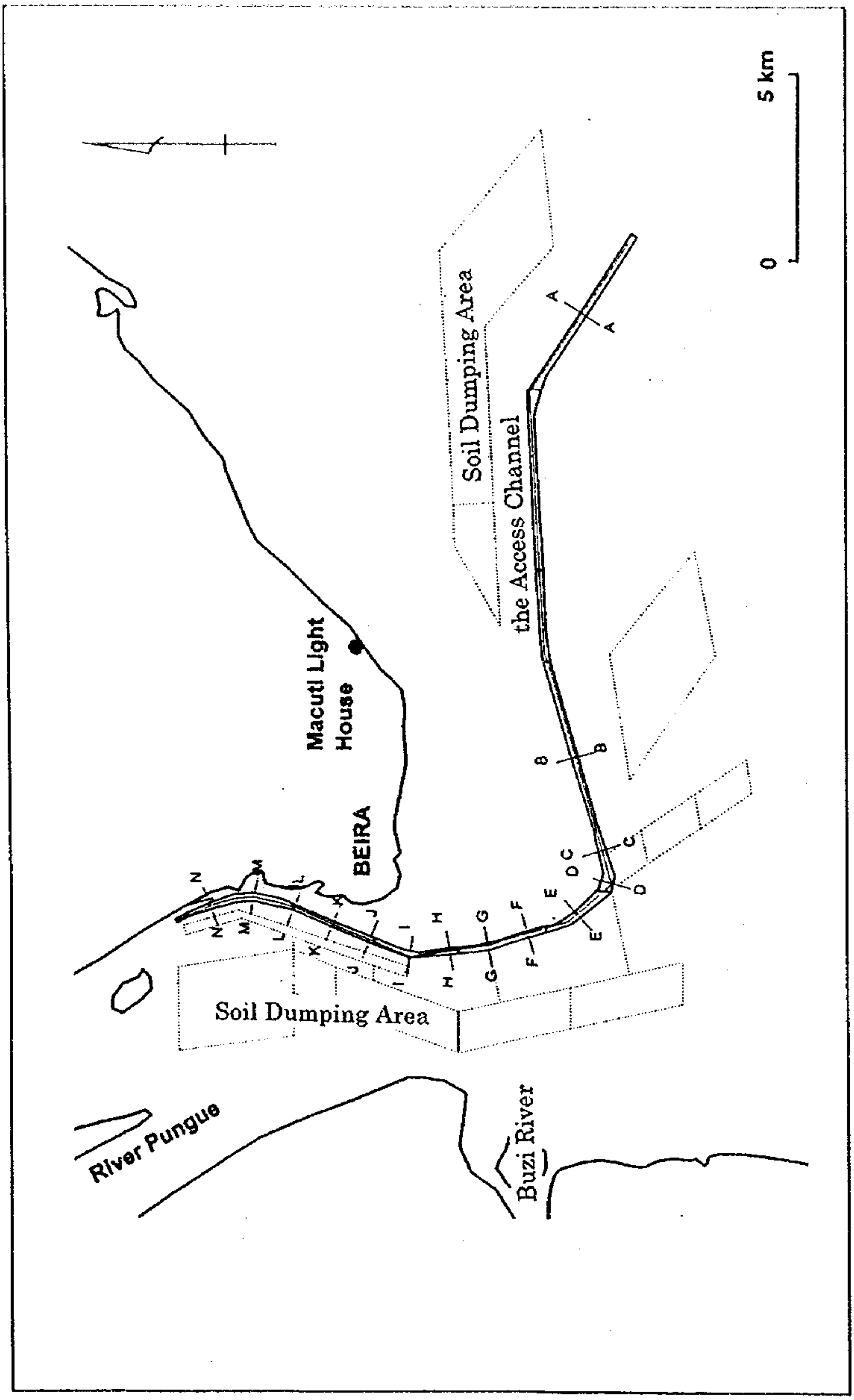


Figure A.2.2-1 Additional Sounding Survey Stations by 33 kHz and 210 kHz

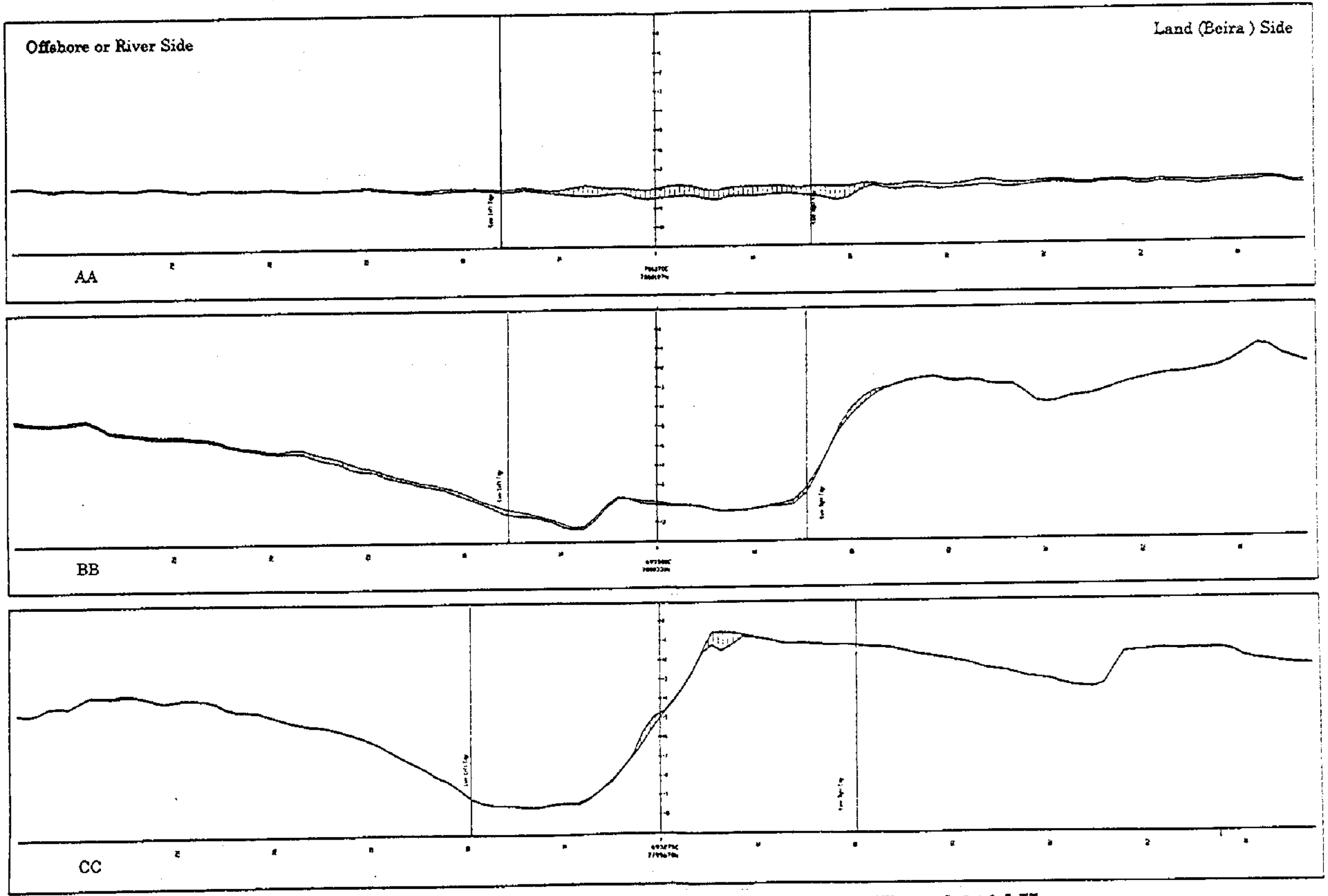


Figure A.2.2-2 Cross Section of the Access Channel by 33 kHz and 210 kHz

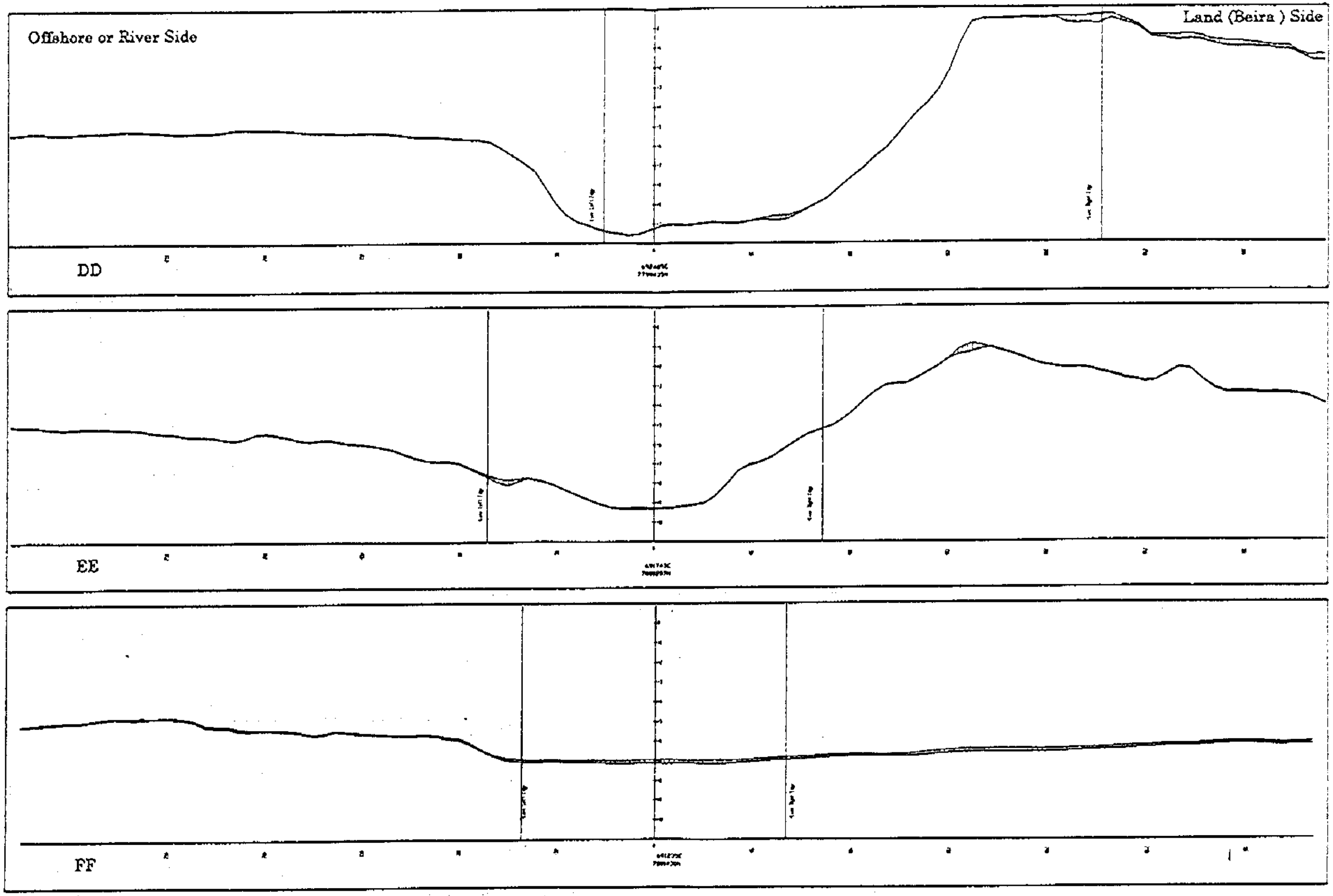


Figure A.2.2-3 Cross Section of the Access Channel by 33 kHz and 210 kHz

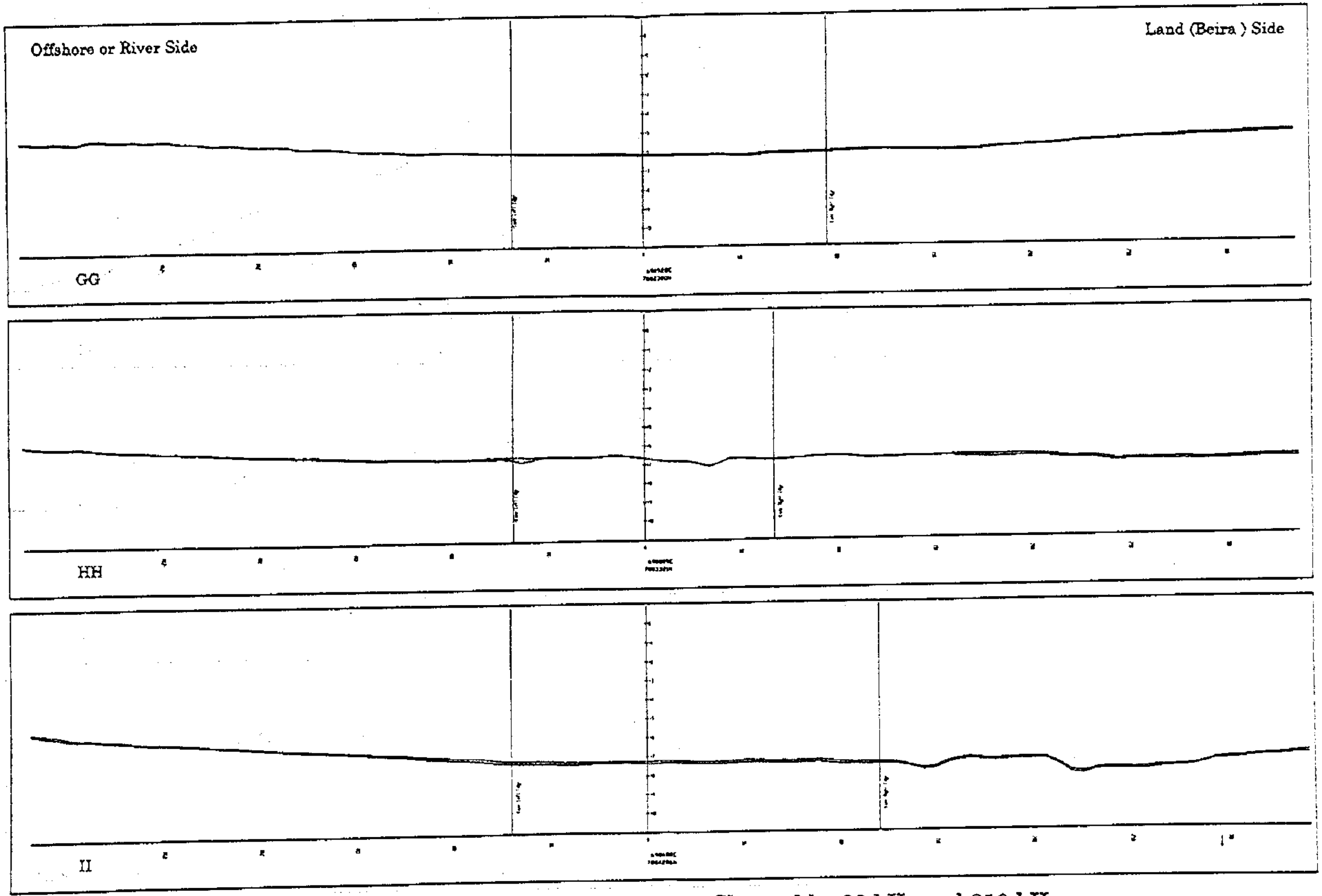


Figure A.2.2-4 Cross Section of the Access Channel by 33 kHz and 210 kHz

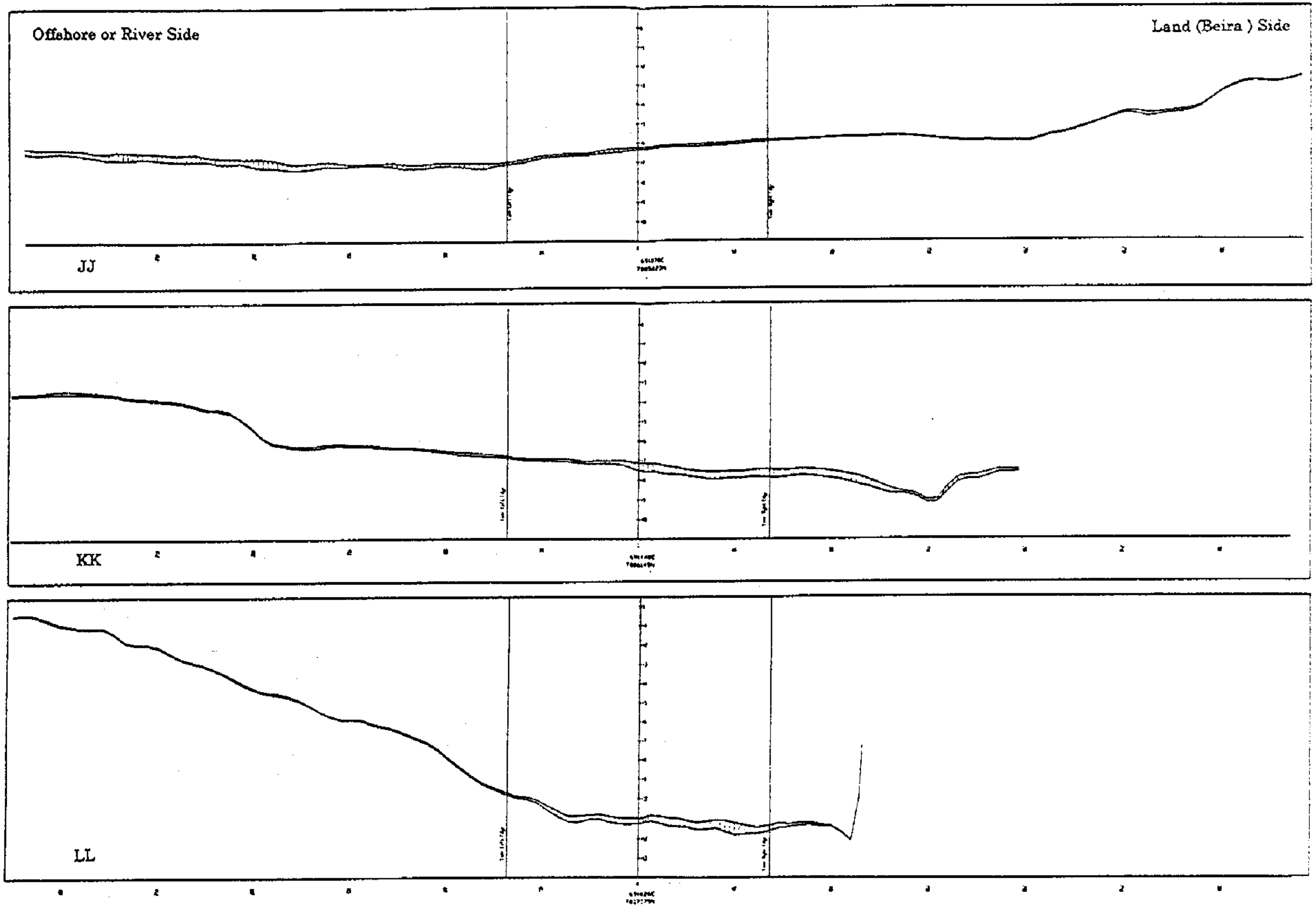


Figure A.2.2-5 Cross Section of the Access Channel by 33 kHz and 210 kHz

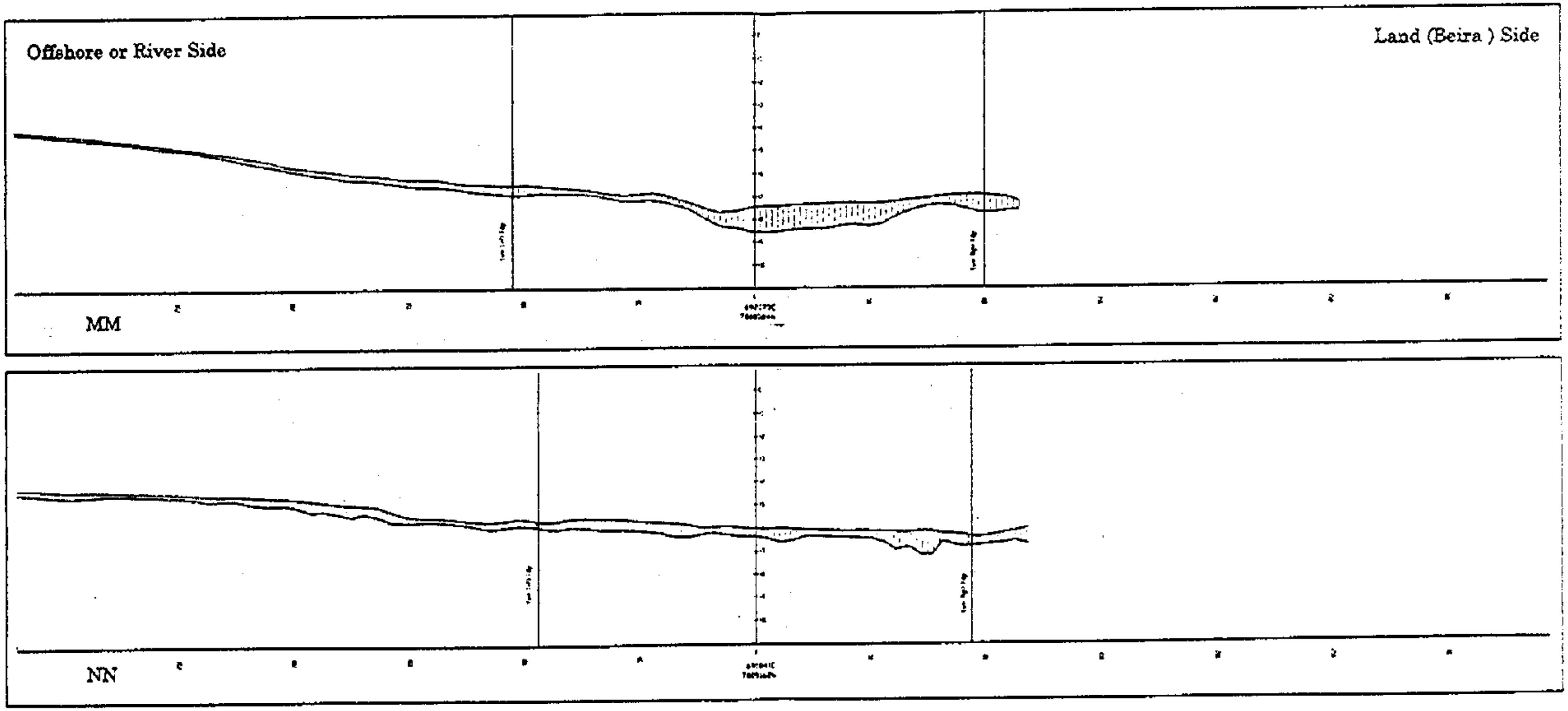


Figure A.2.2-6 Cross Section of the Access Channel by 33 kHz and 210 kHz

A-2-3 Float Tracking Results At Stations 2 and 3

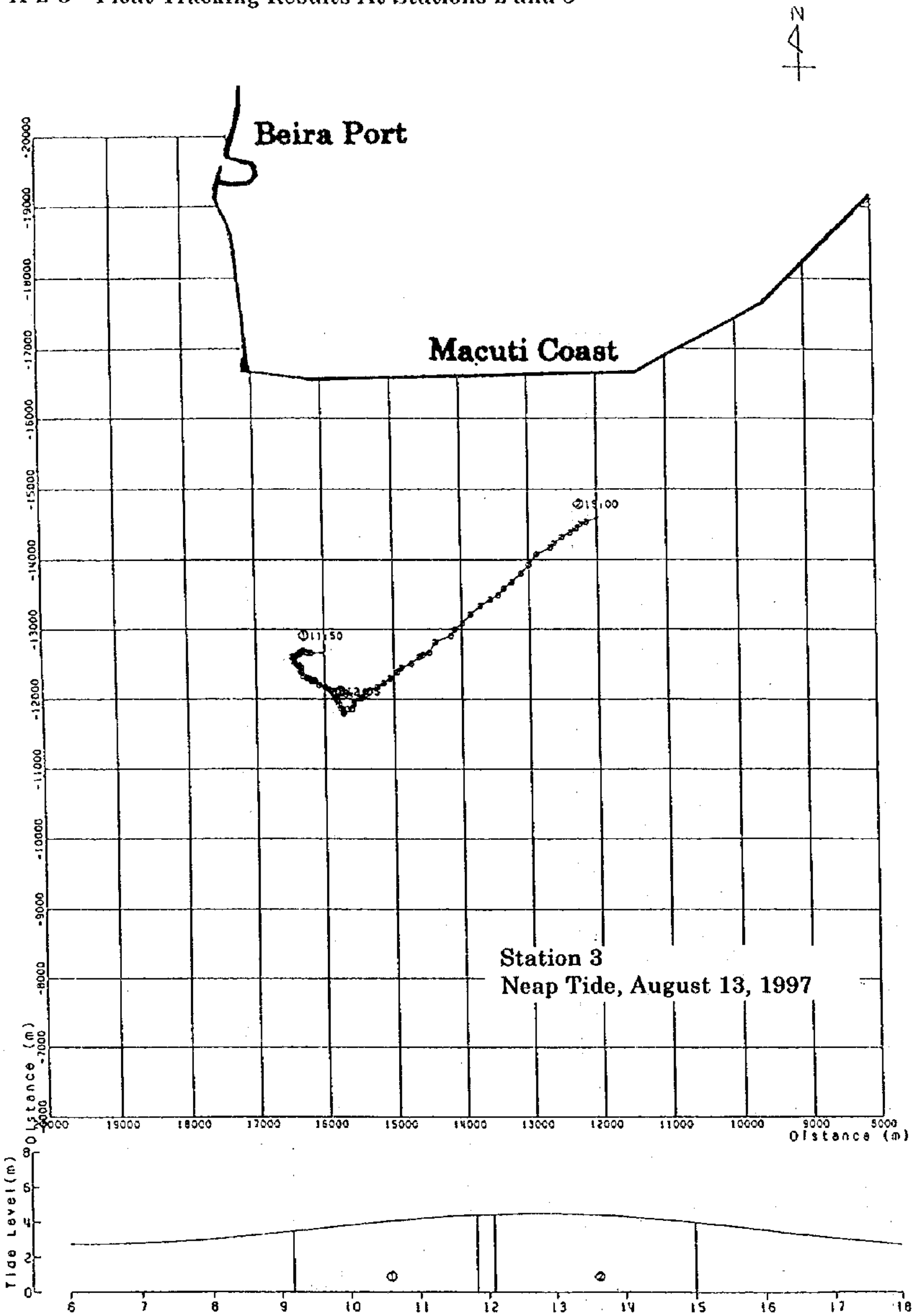


Figure A.2.3-1 Float Tracking Result

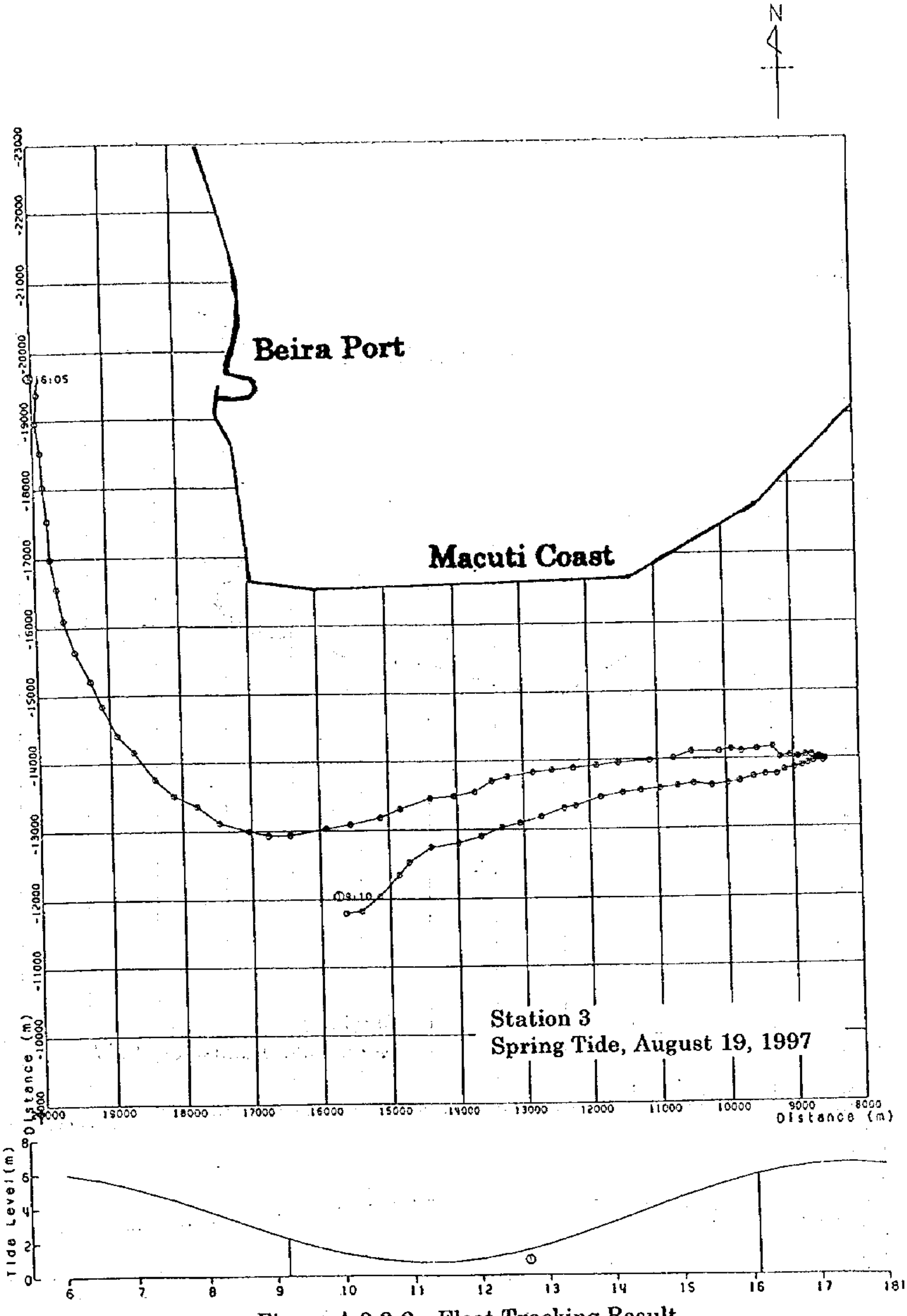


Figure A.2.3-2 Float Tracking Result

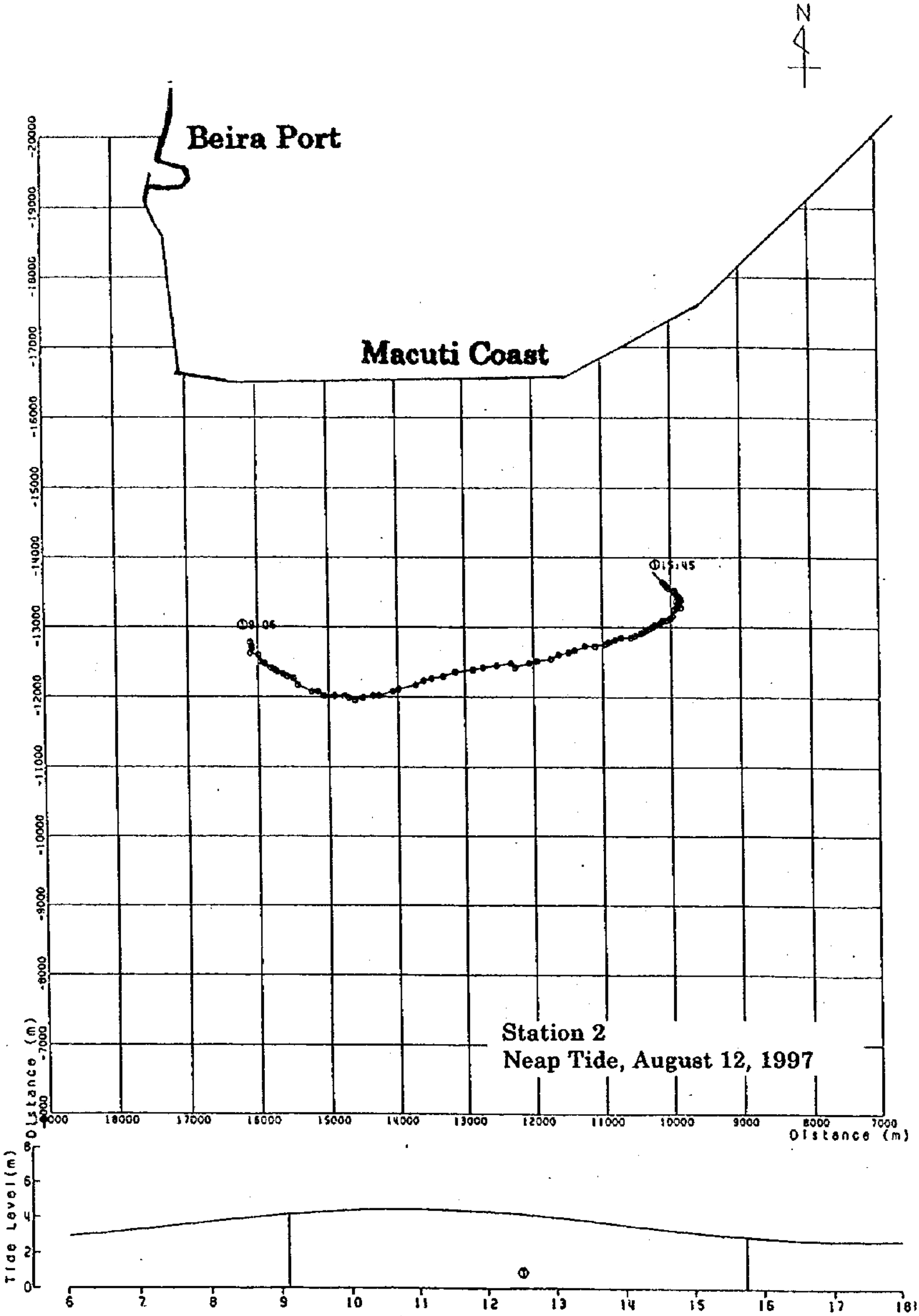


Figure A.2.3-3 Float Tracking Result

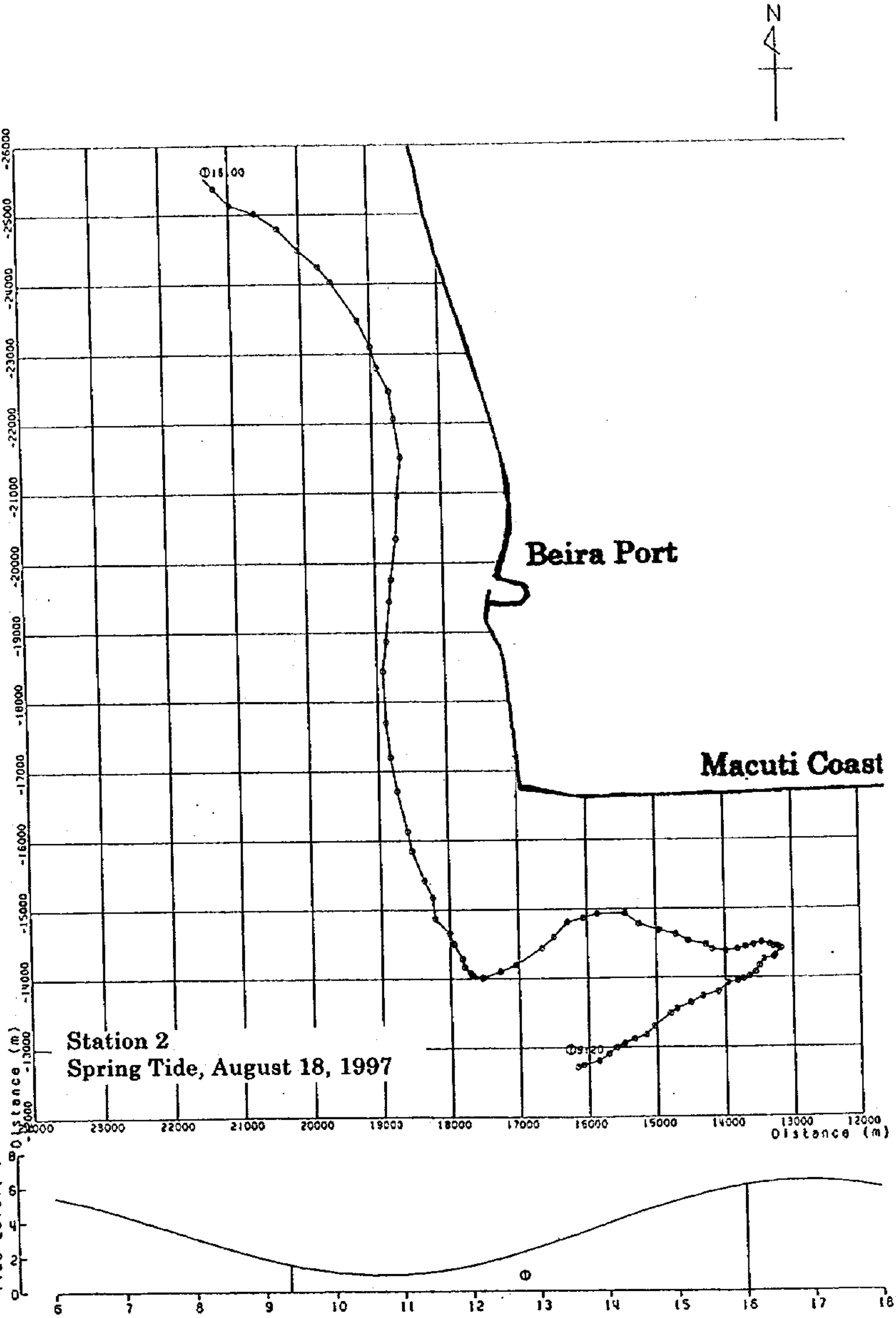
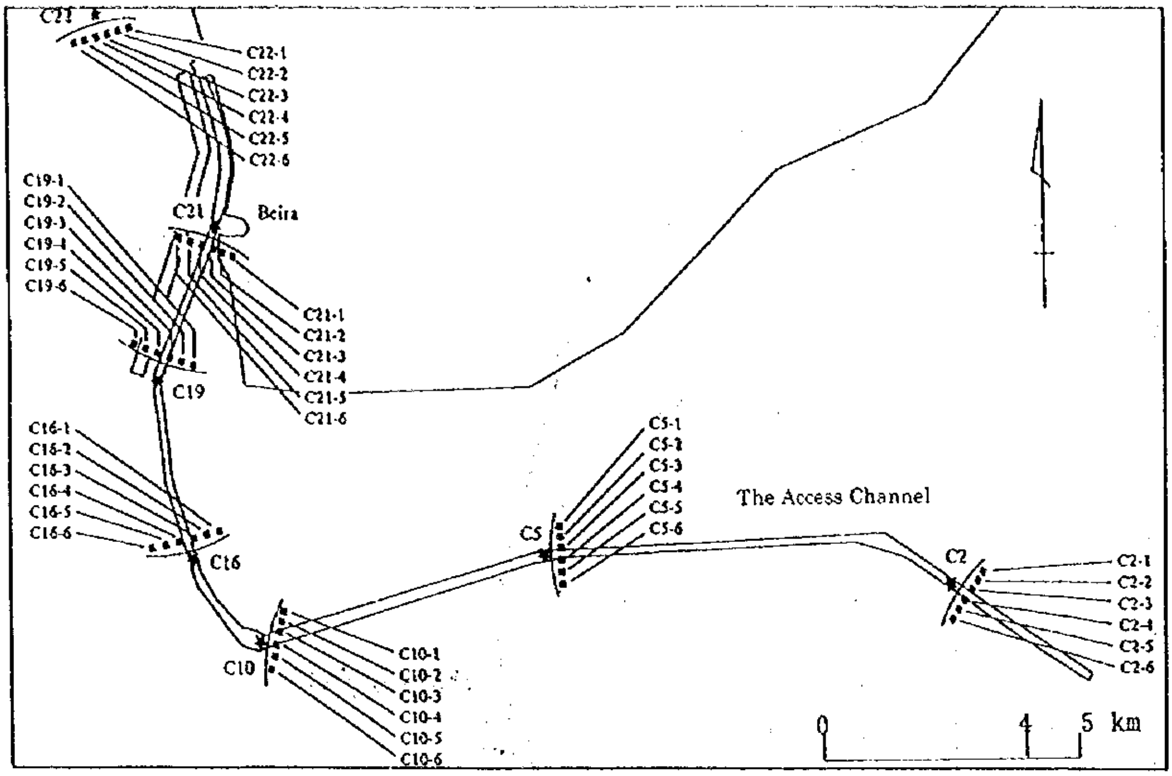
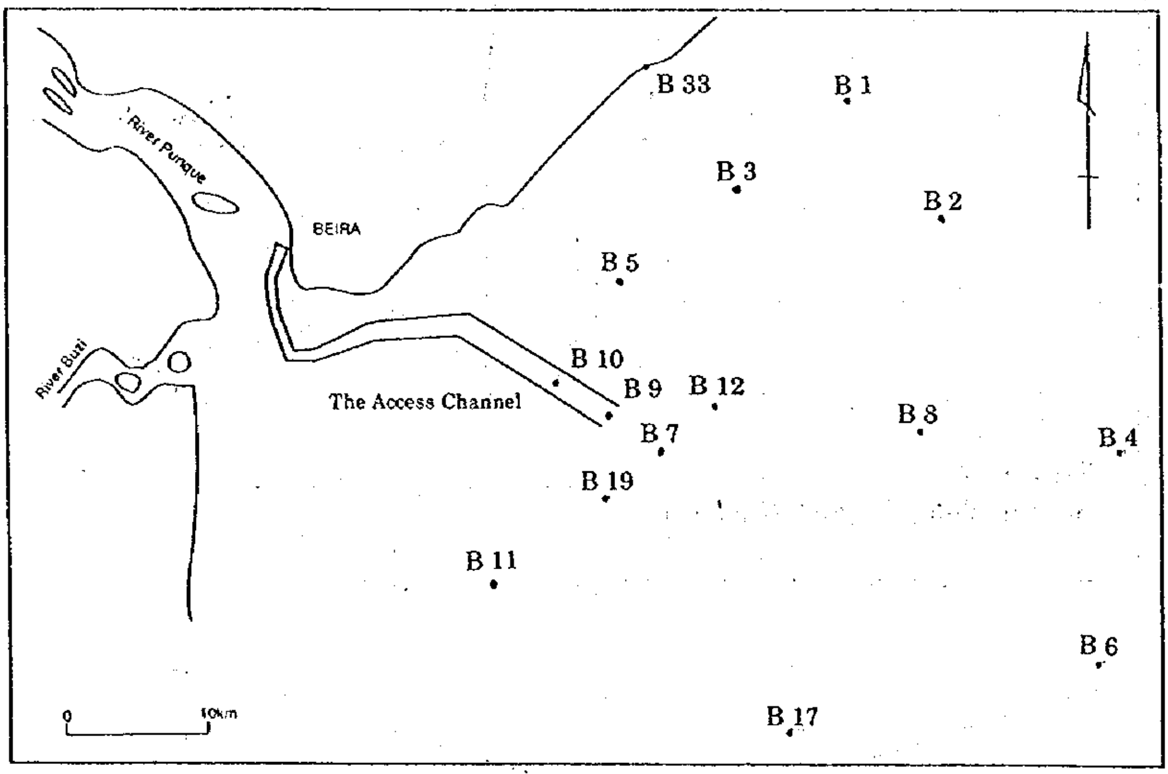


Figure A.2.3-4 Float Tracking Result

A-2-4 Bottom Sediment Survey Results in Dry Season 1997



Sampling Points across the Access Channel



Sampling Points Off Shore Area

Figure A.2.4-1 Sampling Points of Bottom Sediment

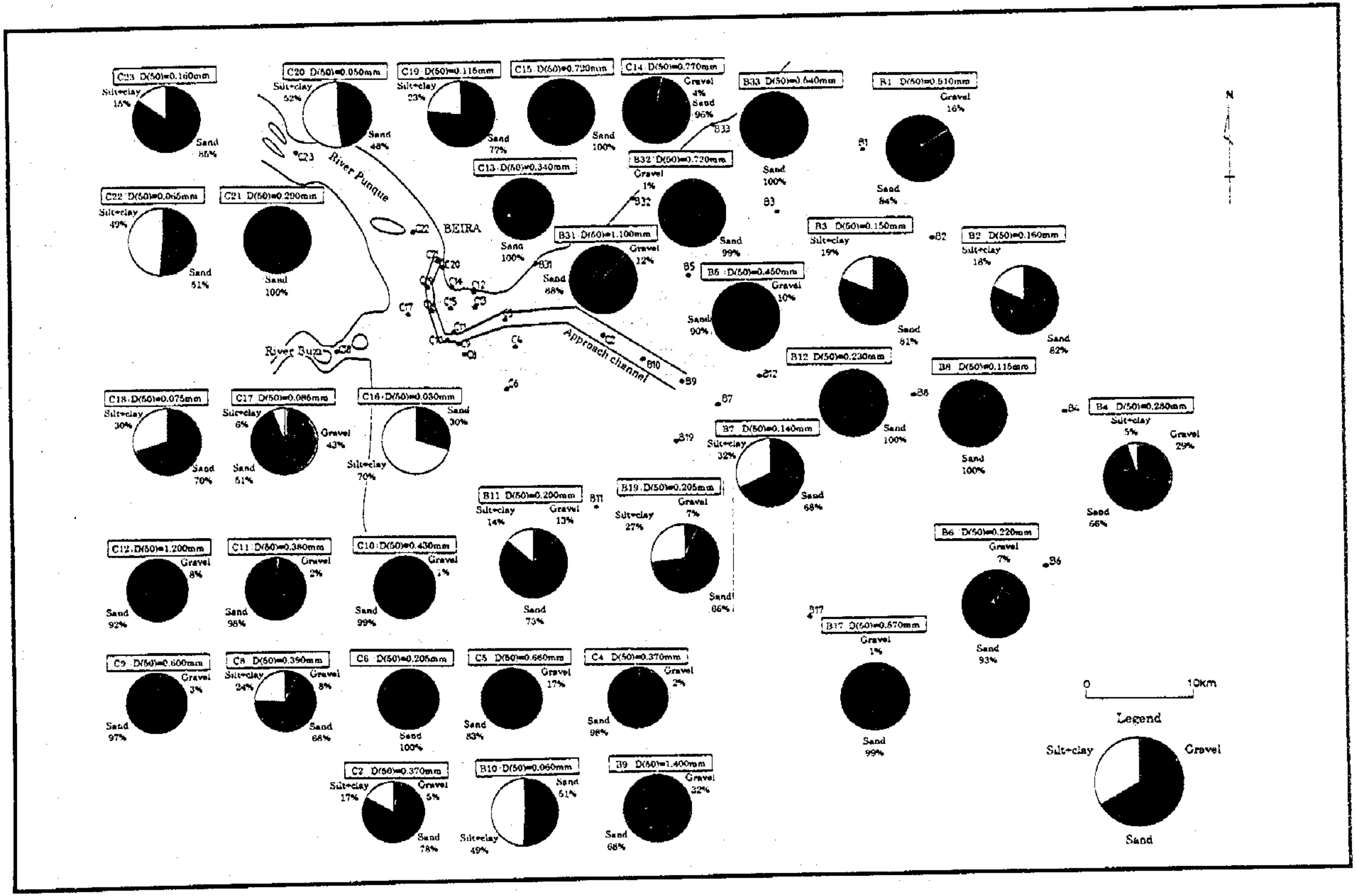


Figure A.2.4-2 Bottom Sediment Classification in the Adjacent Area in Dry Season

Table A.2.4-1 Characteristics of Bottom Sediment in Adjacent Area in Dry Season

Sample No.	Gravel (%)	Sand (%)	Silt+clay (%)	Texture/ Class	D(50) (mm)	Moist. Cont.(%)	Bulk Dens. (g/cm^3)	Dry Dens. (g/cm^3)	Void Ratio	S.G. (g/cm^3)	Component minerals
C2	5	78	17	slightly gravelly muddy sand	0.370	49.2	1.920	1.287	1.00	2.526	
C2/1	0	100	0	sand	0.370	23.8	1.881	1.619	0.74	2.648	
C2/2	0	61	39	muddy sand	0.150	51.2	1.231	0.814	2.17	2.652	
C2/3	0	32	68	sandy mud	0.030	133.7	0.862	0.369	5.91	2.619	
C2/4	0	56	44	muddy sand	0.090	206.4	0.842	0.276	8.24	2.537	
C2/5	0	55	45	muddy sand	0.090	190.2	0.966	0.333	6.66	2.477	
C5	17	83	0	gravelly muddy sand	0.660	16.8	2.052	1.757	0.51	2.648	average<4% iron-stained quartz particles with minor occurrences of shell and rock fragments
C5/1	2	98	0	sand	0.390	22.2	1.376	1.126	1.33	2.647	
C5/2	6	61	33	gravelly muddy sand	0.530	23.7	1.869	1.511	0.73	2.651	
C5/3	4	90	6	slightly gravelly sand	0.085	26.7	2.011	1.587	0.65	2.652	
C5/4	2	70	28	slightly gravelly muddy sand	0.240	49.8	1.708	1.140	1.24	Inadequate	
C5/5	2	98	0	slightly gravelly sand	0.400	23.3	1.894	1.536	0.73	2.646	
C10	1	99	0	sand	0.430	19.7	1.753	1.644	0.61	2.650	average<4% iron-stained quartz particles with minor occurrences of shell and rock fragments
C10/1	2	89	9	slightly gravelly muddy sand	0.300	22.6	1.988	1.622	0.62	2.625	
C10/2	4	96	0	slightly gravelly sand	0.770	22.2	1.888	1.545	0.72	2.653	
C10/3	1	99	0	sand	0.380	21.4	1.893	1.559	0.70	2.640	
C10/4	0	100	0	sand	0.740	21.6	1.923	1.581	0.68	2.646	
C10/5	2	98	0	slightly gravelly sand	0.600	21.2	1.948	1.607	0.65	2.648	
C16	0	30	70	sandy mud	0.030	157.4	1.306	0.607	4.03	2.525	<<1% ilmenite,Zircon and Rutile
C16/1	0	30	70	sandy mud	0.030	85.4	1.279	0.690	2.70	2.654	
C16/2	0	35	65	sandy mud	0.030	120.3	1.249	0.667	3.50	2.602	
C16/3	0	22	78	sandy mud	0.023	179.5	1.257	0.450	4.67	2.602	
C16/4	0	31	69	sandy mud	0.026	214.4	1.249	0.397	5.42	Inadequate	
C16/5	0	30	70	sandy mud	0.028	83.3	1.335	0.728	2.50	2.663	
C19	0	77	23	muddy sand	0.115	67.5	1.500	0.896	1.85	2.623	
C19/1	0	36	64	sandy mud	0.032	178.6	1.000	0.359	6.10	2.607	
C19/2	0	17	83	sandy mud	0.018	175.3	1.337	0.486	4.25	2.606	
C19/3	0	27	73	sandy mud	0.024	132.4	1.381	0.427	4.97	2.647	
C19/4	0	61	39	muddy sand	0.088	75.2	1.605	0.916	1.78	2.644	
C19/5	0	47	53	sandy mud	0.050	95.3	1.508	0.772	2.30	2.657	
C21	0	100	0	sand	0.290	23.8	1.791	1.447	0.83	2.643	
C21/1	0	100	0	sand	0.500	23.6	1.869	1.512	0.75	2.647	
C21/2	0	15	85	sandy mud	0.017	169.3	1.404	0.521	3.89	2.648	
C21/3	3	91	6	slightly gravelly sand	0.560	23.4	1.849	1.498	0.78	2.643	
C21/4	0	44	56	sandy mud	0.040	87.8	1.513	0.806	2.16	Inadequate	
C21/5	0	9	91	mud	0.012	131.3	1.355	0.577	3.42	Inadequate	
C22	0	51	49	muddy sand	0.065	113.2	1.440	0.675	2.78	2.574	<1% Mainly ilmenite with lesser amounts of Zircon and Rutile
C22/1	0	55	45	muddy sand	0.076	105.4	1.490	0.725	2.52	2.603	
C22/2	0	77	23	muddy sand	0.100	37.4	1.897	1.380	0.9	2.659	
C22/3	0	48	52	sandy mud	0.053	80.8	1.560	8.630	2.08	2.662	
C22/4	3	72	25	slightly gravelly muddy sand	0.300	48.1	1.793	1.211	1.2	2.637	
C22/5	1	80	19	muddy sand	0.380	41.8	1.850	1.305	1.04	2.639	
CON1	0	41	59	sandy mud	0.035	290.5	1.185	0.303	7.42	2.606	
CON2	0	36	64	sandy mud	0.027	242.8	1.213	0.354	6.20	Inadequate	
CON3	0	56	44	muddy sand	0.085	255.4	1.170	0.329	6.75	Inadequate	
CON4	0	56	44	muddy sand	0.085	264.9	1.203	0.330	6.73	2.606	
CON5	0	56	44	muddy sand	0.080	187.7	1.346	0.468	4.51	Inadequate	

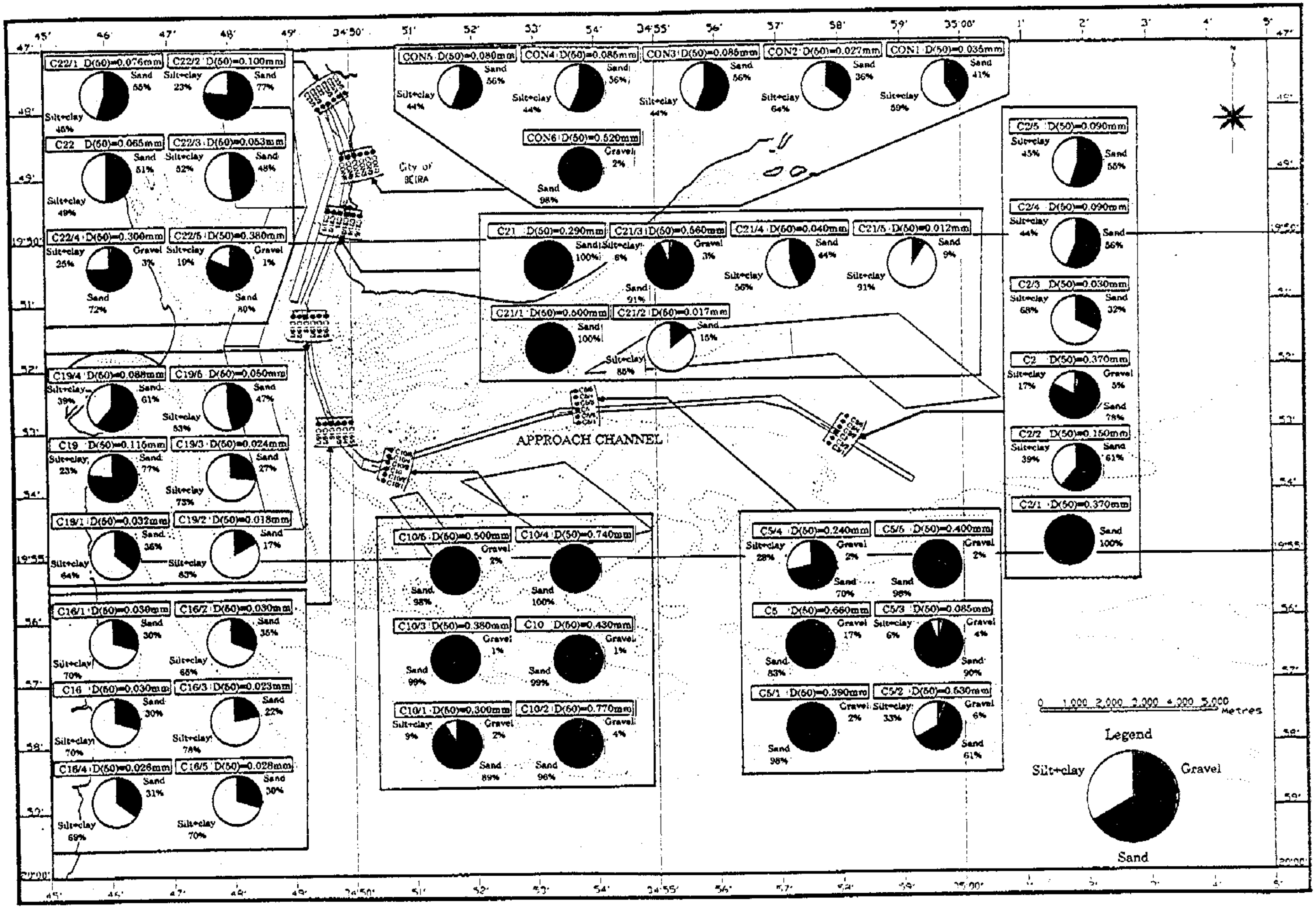


Figure A.2.4-3 Bottom Sediment Classification in Access Channel in Dry Season

Table A.2.4-2 Characteristics of Bottom Sediment in Access Channel in Dry Season

Sample No.	Gravel (%)	Sand (%)	Silt+clay (%)	Texture/ Class	D(50) (mm)	Moist. Cont.(%)	Bulk Dens. (g/cm^3)	Dry Dens. (g/cm^3)	Void Ratio	S.G. (g/cm^3)	Component minerals
C2	5	78	17	slightly gravelly muddy sand	0.370	49.2	1.920	1.287	1.00	2.526	
C4	2	98	0	sand	0.370	17.8	1.739	1.476	0.78	2.650	
C5	17	83	0	gravelly muddy sand	0.660	16.3	2.052	1.757	0.51	2.648	average<4% iron-stained quartz particles with minor
C6	0	100	0	sand	0.205	21.6	1.663	1.368	0.94	2.656	occurrences of shell and rock fragments
C8	8	68	24	gravelly muddy sand	0.390	52.9	1.707	1.116	1.38	2.631	
C9	3	97	0	slightly gravelly sand	0.600	12.8	1.687	1.496	0.77	2.656	
C10	1	99	0	sand	0.430	19.7	1.753	1.644	0.61	2.65	average<4% iron-stained quartz particles with minor
C11	2	98	0	slightly gravelly sand	0.380	16.7	1.767	1.514	0.75	2.649	occurrences of shell and rock fragments
C12	8	92	0	gravelly sand	1.200	3.2	1.568	1.519	0.74	Inadequate	
C13	0	100	0	sand	0.340	20.0	1.686	1.405	0.89	2.648	
C14	4	96	0	slightly gravelly sand	0.770	12.8	1.799	1.595	0.66	2.653	
C15	0	100	0	sand	0.720	22.2	1.796	1.468	0.81	2.655	
C16	0	30	70	sandy mud	0.030	157.4	1.306	0.507	4.03	2.525	<<1% ilmenite,Zircon and Rutile
C17	43	51	6	muddy sandy gravel	0.085	196.0	1.242	0.420	5.07	2.601	
C18	0	70	30	muddy sand	0.075	38.6	1.838	1.326	0.98	2.670	
C19	0	77	23	muddy sand	0.115	67.5	1.500	0.896	1.85	2.623	
C20	0	48	52	sandy mud	0.050	226.6	1.236	0.378	5.75	2.554	
C21	0	100	0	sand	0.290	23.8	1.791	1.447	0.83	2.643	
C22	0	51	49	muddy sand	0.065	113.2	1.440	0.675	2.78	2.574	<1% Mainly ilmenite with lesser amounts of
C23	0	85	15	muddy sand	0.160	35.1	1.790	1.325	0.98	2.672	Zircon and Rutile
B1	16	84	0	gravelly sand	0.510	21.7	2.005	1.647	0.61	2.663	
B2	0	82	18	muddy sand	0.160	41.5	1.814	1.282	1.01	2.649	
B3	0	81	19	muddy sand	0.150	33.1	1.875	1.409	0.83	2.648	
B4	29	66	5	gravelly sand	0.280	20.2	1.845	1.535	0.73	2.663	
B5	10	90	0	gravelly sand	0.450	17.5	1.869	1.591	0.67	2.650	
B6	7	93	0	gravelly sand	0.220	26.0	1.804	1.432	0.86	2.648	
B7	0	68	32	slightly gravelly muddy sand	0.140	65.5	1.625	0.982	0.61	2.619	
B8	0	100	0	sand	0.115	23.0	1.796	1.460	0.82	2.650	
B9	32	68	0	sandy gravel	1.400	26.8	1.865	1.471	0.80	2.732	
B10	0	51	49	muddy sand	0.060	30.0	1.894	1.448	0.78	2.670	
B11	13	73	14	gravelly muddy sand	0.200	29.6	1.914	1.447	0.78	2.636	
B12	0	100	0	sand	0.230	23.1	1.834	1.490	0.78	2.644	
B17	1	99	0	sand	0.570	16.0	1.815	1.565	0.69	2.652	
B19	7	66	27	gravelly muddy sand	0.205	71.4	1.584	0.924	1.76	2.642	
B31	12	88	0	gravelly sand	1.100	14.1	2.096	1.837	0.44	2.654	average<4% iron-stained quartz particles with minor
B32	1	99	0	sand	0.720	16.7	1.836	1.573	0.68	2.655	occurrences of shell and rock fragments
B33	0	100	0	sand	0.540	20.0	1.821	1.518	0.75	2.652	

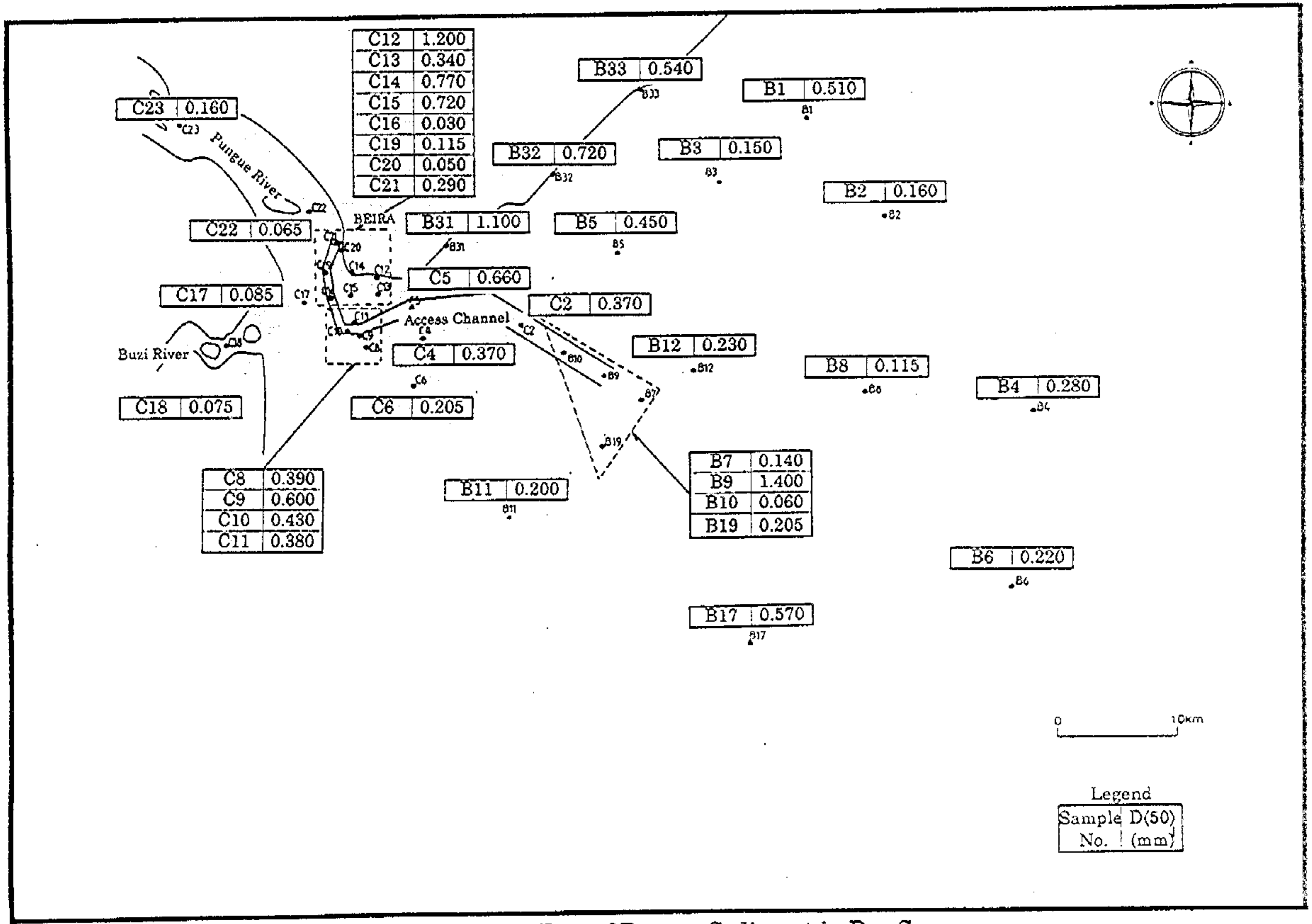


Figure A.2.4-4 $D_{(50)}$ of Bottom Sediment in Dry Season

Appendix A-3 Sedimentation Analysis

A-3-1 Sedimentation between February 1997 and July 1997

Table A.3.1-1 Sedimentation Volume
between February 1997 and July 1997 (m^3)

Section	February 1997 to July 1997	August 1990 to August 1991
E6	704,439	159,404
E7	615,732	185,411
E8	701,035	283,540
E6+E7+E8	2,021206	628,355
E9	343,350	448,641
E10	692,793	531,762
E11	308,524	290,739
E9+E10+E11	1,344,667	1,271,142
E12	265,644	83,783
E13	207,353	346,148
E14	591,659	502,050
E12+E13+E14	1,064,656	931,981
Total	4,430,529	2,831,478

The sedimentation volume for only 6 months between February and August in 1997 was calculated to be 4,430 x 10^3 m^3 as shown in the above table. This value is extremely large, compared with the value of 2,831 x10^3 m^3 for the first year immediately after the capital dredging. Especially, the volume of E6 to E8 is very large. The followings is supposed as the reason.

The wet season in 1997 had the heaviest rain in the last ten years, having many attacks of cyclones. Therefore, currents flowing-out from the Pungue River were strong, so that the Access Channel seems to have been scoured severely. Then, most of materials discharged from the Punque and Buzi Rivers probably had deposited in their estuary or in the shoal area around the Access Channel. Moreover, sand transported from the northern coast by severe waves also had deposited in the shoal area around the Access Channel. These materials would, in the following dry season, entered into the Access Channel to shoal it severely.

The above phenomenon is abnormal and the sedimentation is only for half an year, so that data of the above table were excluded in the consideration of the maintenance dredging volume.

A-3-2 Computer Simulation

(1) Tidal current model

To calculate the tidal current pattern in the study area, the following equations for 2-dimensional tidal current model was solved by using the finite difference method.

[Conservation equation]

$$\frac{\partial \eta}{\partial t}+\frac{\partial M}{\partial x}+\frac{\partial N}{\partial y}=0 \qquad \text{(A.3-1)}$$

[Momentum equations]

$$\frac{\partial M}{\partial t}+\frac{\partial uM}{\partial x}+\frac{\partial vM}{\partial y}+g(h+\eta)\frac{\partial \eta}{\partial x}+\frac{gn^2\sqrt{M^2+N^2}}{(h+\eta)^{7/3}}M-A_H\left(\frac{\partial^2 M}{\partial x^2}+\frac{\partial^2 M}{\partial y^2}\right)=0$$

$$\frac{\partial N}{\partial t}+\frac{\partial uN}{\partial x}+\frac{\partial vN}{\partial y}+g(h+\eta)\frac{\partial \eta}{\partial y}+\frac{gn^2\sqrt{M^2+N^2}}{(h+\eta)^{7/3}}N-A_H\left(\frac{\partial^2 N}{\partial x^2}+\frac{\partial^2 N}{\partial y^2}\right)=0$$

(A.3-2),(A.3-3)

where t,x,y = time, coordinates; η,M,N,u,v = water level, unit discharge in x and y direction, depth-averaged velocities in x and y direction; h = water depth at mean water level; A_H = horizontal mixing coefficient; n = manning roughness coefficient; g = acceleration of gravity.

As the boundary condition of seaward side, water levels as a function of time of spring tide was given and the land-ward boundary condition was treated as moving boundary due to drying and flooding.

Comparing with observed current, calibration of the model was carried out by adjusting the roughness parameter.

The result of the tidal current model was used as the input data of the wave model and the sedimentation model.

(2) Wave model

To calculate the wave distribution in the study area, the following conservation equation of wave action was solved.

$$\frac{\partial}{\partial x}\left(\frac{E}{\varpi}(C_g\cos\theta+u)\right)+\frac{\partial}{\partial y}\left(\frac{E}{\varpi}(C_g\sin\theta+v)\right)=\varepsilon \cdot \qquad \text{(A.3-4)}$$

where E = wave energy; θ = wave direction; Cg = wave group velocity relative to current; ϖ = angular frequency relative to current; ε = energy dissipation.

The effects of shoaling, refraction in the presence of current and wave breaking were taken into account in the simulation model.

Under the typical tidal level during spring tide and offshore storm wave condition, wave simulation was carried out against computed tidal current field in the study area.

The result of the wave model also was used as the input data of the sedimentation model.

(3) Sedimentation model

Bijker's sedimentation model was applied for calculating the siltation volume in the access channel between Section E6 and E14 induced by tidal currents and waves, in which the heaviest sedimentation was recorded.

In the sedimentation model as shown in Figure A.3-1, a horizontal sediment transport rate S(x) and a siltation rate in the channel DS are expressed as follows.

$$S(x) = (S_0-S_1)\exp(-\beta x) + S_1 \qquad (A.3\text{-}5)$$

$$DS = [(S_0-S_1)\{1-\exp(-\beta B/\sin\alpha)\}]\sin\alpha \qquad (A.3\text{-}6)$$

where ,

- S_0 : horizontal sediment transport rate under equilibrium condition at upstream of the channel.
- S_1 : horizontal sediment transport rate under equilibrium condition at depth of the channel.
- α : angle between current direction and the channel
- B : channel width
- β : attenuation rate of horizontal sediment transport formulated as the function of local current, wave and sediment characteristics proposed

In applying the Bijker's model, the channel was divided into segments of 200 m in length along the channel and the sedimentation rate was calculated in each segment. As the first step in the calculation of the sedimentation rate at each segment during one tide cycle was calculated with current and wave every hour and the upstream depth (h_0) as shown in Figure A.5-1 was switched according to current directions. Then the annual siltation rate against the siltation for one tide cycle calculation is determined on the base of the annual siltation volume obtained from the analysis of the sounding survey.

To examine the effect of wave action on the sedimentation rate of the access channel, the annual siltation volume excluding wave action is calculated. An example of calculated siltation volume in case Y-0 with and without wave action shown in Figure A.3-2 shows that the contribution of strong tidal current on the siltation in the access channel is predominated compared with wave action.

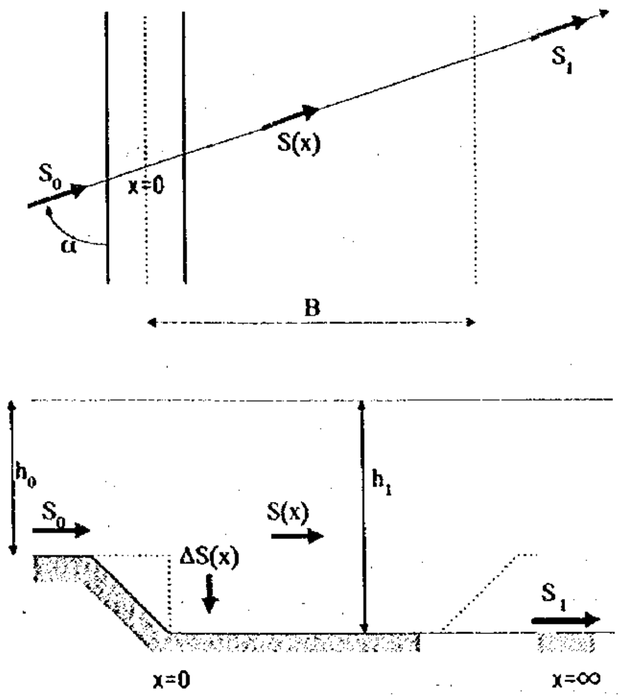


Figure A.3-1 Definition Sketch of Sedimentation Model

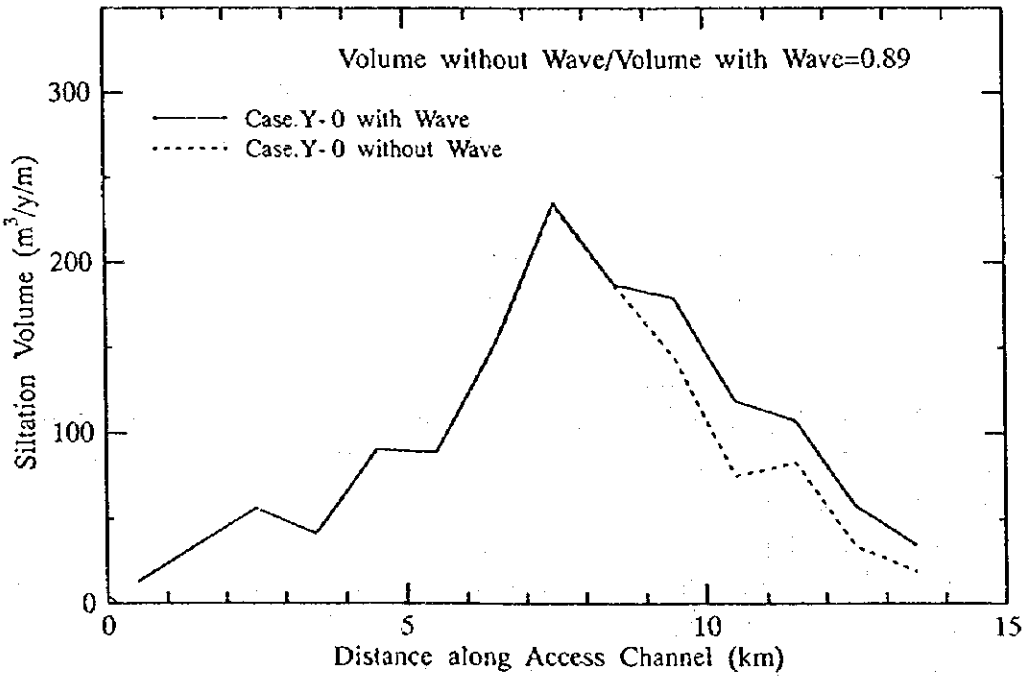


Figure A.3-2 Calculated Annual Siltation Volume with and without Wave Action (Y-0:h=8.0,8.5m)

(4) Sedimentation in the dumping areas

To estimate the tendency of sedimentation in the dumping areas shown in Figure A.3-3, the following conservation equation of bottom sediment was solved.

$$\frac{\partial Z_b}{\partial t} + \frac{1}{(1-\lambda)}\left(\frac{\partial q_x}{\partial x} + \frac{\partial q_y}{\partial y}\right) = 0 \qquad \text{(A.3-7)}$$

where Z_b = bed level ; q_x, q_y = the components of sediment transport rate induced by tidal current ; λ = porosity factor.

With the sediment transport formula proposed by Brown, the transport rates induced by tidal current are given by:

$$q_x = q\frac{u}{\sqrt{u^2+v^2}} \quad , q_y = q\frac{v}{\sqrt{u^2+v^2}} \quad , \frac{q}{w_s d} = 40\left(\frac{\tau}{(s-1)gd}\right)^3 \qquad \text{(A.3-8)}$$

where q = sediment transport rate ; u,v = the components of tidal current velocity ; w_s, d, s = fall velocity, mean diameter and specific gravity of sediment ; τ = bed shear stress due to tidal current.

Using the depth, mean diameter tabulated in Table A.3-2 and the result of tidal current simulation as shown in A.3(3), the sedimentation rate and the potential sediment transport volume from the inside of the dumping area to outside of that were estimated.

The result of calculation tabulated in Table A.3-2 shows that all dumping area have the erosion tendency with erosion rate of about 0.1～0.2m/year. However a part of the dumping area 1 in which the sediment at the boundary of the dumping area is transported toward the access channel as shown in Figure A.3-4 should be use with care.

Table A.3-2 Calculation Conditions of Sedimentation in Dumping Areas and Results of Calculation.

Dumping area	1	2	3	Remarks
depth (m)	6.0	5.0	4.0	as depth resulted dumping
mean diameter (mm)	0.20	0.45	0.15	as dumped sediment
annual averaged erosion rate (m/year)	0.07	0.15	0.17	
annual erosion volume (million m^3/year)	1.40	0.29	0.63	

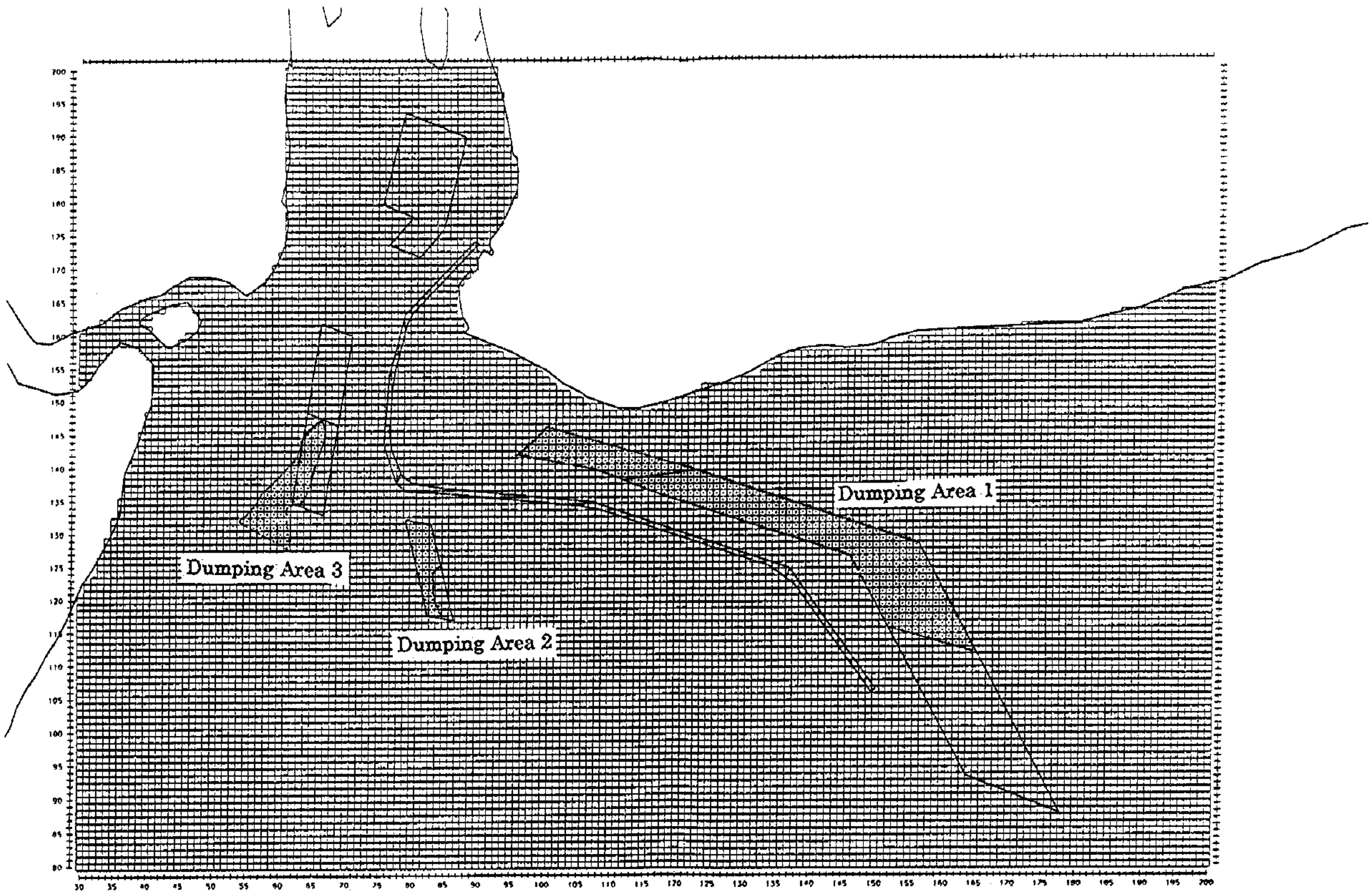


Figure A.3-3 Location of Dumping Areas

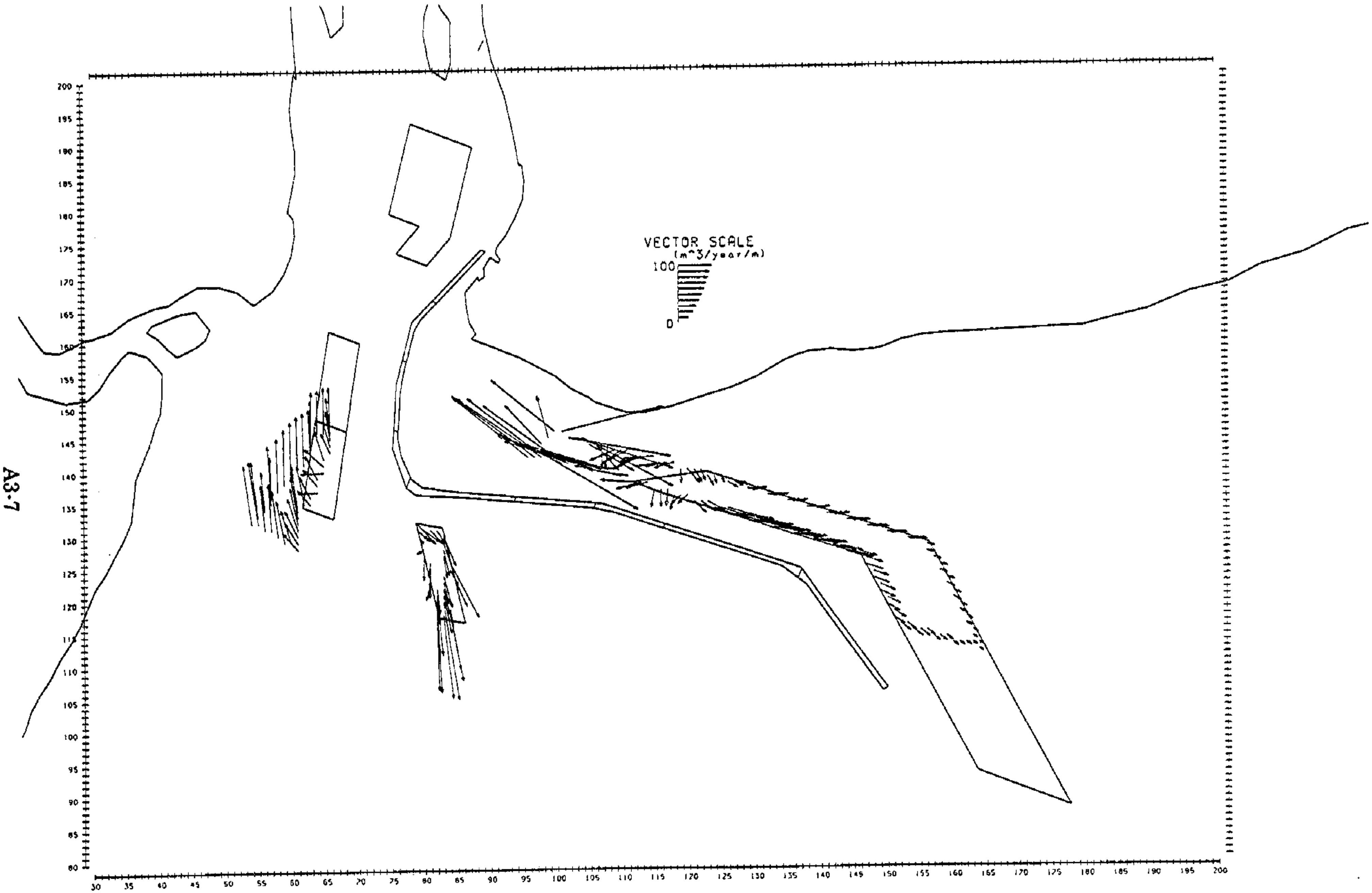


Figure A.3-4 Calculated Sediment Transport Rate at Boundary of Dumping Area

Appendix A-4 Maintenance Dredging

A-4-1 Interim Dredging Plan

Interim dredging includes dredging works in Maputo, Beira and Quelimane Ports with dredgers provided by the client as summarized below.

1 Beira Port

1.1 Channel

-Dredger	Split hull type, Hopper capacity: 1600-2000 m³ available 24 hours a day, 7 days a week, 300 days a year
-Dredging areas	E3, E5, E15, E8, E10, E11 Channel width 135 – 250 m Channel depth 8 – 9.2 m Side slope 1/10
-Dumping areas	D2 (30 %), D4 (70 %)
-Soil to be dredged	Silt, sand and soft clay 3.3 million m³/y

1.2 Berthing areas

-Dredger	Grab dredger "Lurio" available 72 (6 x 12) hours a week and 25 weeks a year
-Split barges	BDB1 and BDB2 with a hopper capacity of 650 m³ each
-Tug boats	"Chire" 720 HP and "Rambe" 300 HP
-Survey boat	"Tiky II"
-Dredging areas	Berth 2 – 5, -12 m Berth 6 – 11, -9.5 m Berth 13, -13.5 m Chiveve fishery port, -5 m Tug boat jetty, -6 m
-Dumping area	D5
-Soil to be dredged	Silt 0.01 million m³/y

2 Maputo Port

2.1 Channel

-Dredger	Trailing hopper suction dredger "Rovuma" Hopper capacity: 1500 m³

	available 72 hours (6 x 12) a week and 45 weeks a year	
-Dredging areas	Matola, Catembe, Polana, Xefina, Northern approach and Southern approach channels	
	Channel width	100 – 260 m
	Channel depth	9.4 m
	Side slope	1/10
-Dumping areas	between km 20.8 – 23.6	
-Soil to be dredged	Silt, sand and soft clay	
	1.5 million m^3/y	

2.2 Berthing areas

-Dredger	Backhoe dredger "Tembe"
	available 72 (6 x 12) hours a week and 40 weeks a year
-Split barges	2 barges with a hopper capacity of 150 m^3 each
-Tug/survey boat	"Saskia"
-General service boat	"Chali"
-Dredging areas	-6, -7, -9, -11, -12 m
-Dumping area	South bank of River Espirito upstream of Catembe
-Soil to be dredged	Silt
	0.015 million m^3/y

3 Quelimane Port

Channel and Berthing areas

-Dredger	Grab dredger "Lurio"		
	available 72 (6 x 12) hours a week and 20 weeks a year		
-Split barges	BDB1 and BDB2 with a hopper capacity of 650 m^3 each		
-Tug boats	"Chire" 720 HP and "Rambe" 300 HP		
-Survey boat	"Tiky II"		
-Dredging areas	Berth front 300 m x 250 m		
		Depth	5 m
	Connection area, -5 m		
	Channel,	Width	60 m
		Depth	4 m
		Side slope	1/10
-Dumping area	East river bank		
-Soil to be dredged	Silt and fine sand		
	0.015 million m^3/y		

A-4-2 Maintenance Dredging Plan 97, EMODRAGA

Table A.4.2-1 Production Plan of Beira Port, 1997

Mozambique Dredging Company (EMODRAGA)

Production Plan for 1997
Beira Port Dredging
Grab Dredger - Lurio

	Trimesters												Total
	I			II			III			IV			
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Indicators	5	4	4	5	4	4	5	4	4	5	4	4	
Volume of production yield /hr (m3)	90 m3												
No. of hours for dredging operation / month	131	120	48	* -	125	120	136	125	125	136	120	131	1,317 hrs
Dredging volume / month (m3)	11,790	10,800	4,320	* -	11,250	10,800	12,240	11,250	11,250	12,240	10,800	11,790	
Dredging volume / trimester (m3)	48,960			22,050			34,740			34,830			
Dredging volume / year (m3)	118530 m3												

* Docking

Table A.4.2-2 Activity Schedule of EMODRAGA in Beira Port, 1997

Mozambique Dredging Company (EMODRAGA)

Maintenance Division

Activity Schedule for 1997

Activity	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1. Hopper Dredger - Lurio												
- Importation of Accessories and Spareparts	####	####	####	####	####	####						
- Technical Assistance and Preventive Maintenance	####	####	####	####	####	####	####	####	####	####	####	####
- Annual Docking and Repair			####									
- Engine Decarbonizing (Gantry)			####									
- Port-Cabin Repair		##	##									
2. Tug - Chire												
- Importation of Accessories and Spareparts	####	####	####	####	####	####						
- Technical Assistance and Preventive Maintenance	####	####	####	####	####	####	####	####	####	####	####	####
- Annual Docking and Repair				####								
- Engine Decarbonizing and Generators				####								
3. Tug - Rambe												
- Importation of Accessories and Spareparts	####	####	####	####	####	####						
- Technical Assistance and Preventive Maintenance	####	####	####	####	####	####	####	####	####	####	####	####
- Annual Docking and Repair					####							
- Engine Decarbonizing					####							
4. Hopper Barge I												
- Importation of Accessories and Spareparts	####	####	####	####	####	####						
- Technical Assistance and Preventive Maintenance	####	####	####	####	####	####	####	####	####	####	####	####
- Annual Docking and Repair						####						
- Decarbonizing the Generators (2)						####						

5. Hopper Barge II	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
- Importation of Accessories and Spareparts	####	####	####	####	####	####						
- Technical Assistance and Preventive Maintenance	####	####	####	####	####	####	####	####	####	####	####	####
- Annual Docking and Repair					####							
- Decarbonizing the Generators (2)					####							
- Repair of Hydraulic System					####							
6. Hopper Barge IV												
- Technical Assistance and Preventive Maintenance	####	####	####	####	####	####	####	####	####	####	####	####
- Annual Docking and Repair						####						
- Decarbonizing the Generators						####						
7. Tiky II												
- Importation of Accessories and Spareparts	####	####	####	####	####	####						
- Technical Assistance and Preventive Maintenance	####	####	####	####	####	####	####	####	####	####	####	####
- Annual Docking and Repair			####				####				####	
- Engine Decarbonizing			####				####				####	

A-4-3 Maintenance Dredging Plan of 2 x 1,000 m³ Dredgers

Table A.4.3-1 Maintenance Dredging Plan (soil to be dumped at a distant site at low tide)

Hopper Capacity = 1000 m3 Ship speed full 10.2 kt. Dredging Time Silt 1.00 hr Sand 1.25 hr Turning Time 0.25 hr ballast 10.5 kt

Section	E5		E15		E4		E6		E7		E8		E9	E10	E11	E12	E13	E14	Total
Siltation Vol m^3/y	120,488		187,005		276,146		113,057		128,696		148,823		287,820	614,958	101,051	30,637	62,313	429,005	2,499,999
Siltation Vol %	5		7		11		5		5		6		12	25	4	1	2	17	100
Soil: Silt or Sand	Silt		Silt		Silt		Silt		Sand		Sand		Sand	Sand	Sand	Sand	Sand	Silt	
Dred'g/Turn'g Time hr	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.25	
Soil in Hopper %	55		55		55		55		75		75		75	75	75	75	75	55	
Soil in Hopper m3	550		550		550		550		750		750		750	750	750	750	750	550	
Dumping Area	D1 (98%)	D2	D1 (98%)	D2	D1 (98%)	D2	D1 (98%)	D2	D1 (90%)	D2	D1 (90%)	D2	D2 (100%)	D2 (100%)	D4	D4	D4	D4	
Sailing Distance km	11.0	13.1	9.2	11.3	9.7	11.8	6.9	9.0	4.9	10.7	3.0	8.5	2.7	1.7	1.8	1.5	1.5	1.5	
Sailing Time to DA hr	0.58	0.69	0.48	0.60	0.51	0.62	0.37	0.48	0.26	0.57	0.16	0.45	0.14	0.09	0.10	0.08	0.08	0.08	
Dumping Time hr	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.15	
Sailing Time fm DA hr	0.56	0.67	0.47	0.58	0.50	0.60	0.36	0.46	0.25	0.55	0.15	0.44	0.14	0.08	0.09	0.08	0.08	0.08	
Cycle Time hr	2.54	2.76	2.36	2.58	2.41	2.63	2.12	2.34	2.26	2.87	2.06	2.64	2.03	1.92	1.94	1.91	1.91	1.56	
Av Cycle Time hr	2.55		2.36		2.41		2.13		2.32		2.12		2.03	1.92					
Required No of Cycle	219		340		502		206		172		198		384	820	135	41	83	780	3879
Req'd Working Hour hr	558.2		802.5		1211.2		436.8		397.7		420.8		779.8	1576.2	261.1	77.9	158.4	1214.2	7,895
Working Hour Ratio %	7.1		10.2		15.3		5.5		5.0		5.3		9.9	20.0	3.3	1.0	2.0	15.4	100.0
T.Dred/Turn'g Time hr	273.8		425.0		627.6		256.9		257.4		297.6		575.6	1229.9	202.1	61.3	124.6	975.0	5,307.0
Sailing Time hr	251.5		326.4		508.3		149.1		97.4		73.6		108.2	141.3	25.3	6.4	13.0	122.2	1,822.8
Dumping Time hr	32.9		51.0		75.3		30.8		42.9		49.6		95.9	205.0	33.7	10.2	20.8	117.0	765.1
																		Total	7,894.9

Silt/Sand Ratio %	
Silt	45
Sand	55

Average Cycle Time 2.04 hr

Annual Working Hours	
Week	44
Day	5
Hour	24
Efficiency	0.8
	4,224 hr

Annual Required Working Hours		
Dred'g/Turn'g Time	5,307 hr	67%
Sailing Time	1,823 hr	23%
Dumping Time	765 hr	10%
Total	7,895 hr	100%

Required Working Hours 7,895 hr

Required/Annual Working Hours Ratio 187 %

Table A.4.3-2, Maintenance Dredging Plan (Sections E9-E14 to be dredged at low tide)

Hopper Capacity = 1000 m3 Dredging Time Silt 1.00 hr Sand 1.25 hr Turning Time 0.25 hr
Ship speed full 10.2 kt. ballast 10.5 kt

Section	E5	E15	E4	E6	E7	E8	E9	E10	E11	E12	E13	E14	Total
Siltation Vol m^3/y	120,488	187,005	276,146	113,057	128,696	148,823	287,820	614,958	101,051	30,637	62,313	429,005	2,499,999
Siltation Vol %	5	7	11	5	5	6	12	25	4	1	2	17	100
Soil: Silt or Sand	Silt	Silt	Silt	Silt	Sand	Sand	Sand	Sand	Sand	Sand	Sand	Silt	
Dred'g/Turn'g Time hr	1.25	1.25	1.25	1.25	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.25	
Soil in Hopper %	55	55	55	55	75	75	75	75	75	75	75	55	
Soil in Hopper m3	550	550	550	550	750	750	750	750	750	750	750	550	
Dumping Area	D1	D1	D1	D1	D1	D1	D2(100%)	D2(100%)	D4	D4	D4	D4	
Sailing Distance km	11.0	9.2	9.7	6.9	4.9	3.0	2.7	1.7	1.8	1.5	1.5	1.5	
Sailing Time to DA hr	0.58	0.48	0.51	0.37	0.26	0.16	0.14	0.09	0.10	0.08	0.08	0.08	
Dumping Time hr	0.15	0.15	0.15	0.15	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.15	
Sailing Time fm DA hr	0.56	0.47	0.50	0.36	0.25	0.15	0.14	0.08	0.09	0.08	0.08	0.08	
Cycle Time hr	2.54	2.36	2.41	2.12	2.26	2.06	2.03	1.92	1.94	1.91	1.91	1.56	
Av Cycle Time hr	2.54	2.36	2.41	2.12	2.26	2.06	2.03	1.92					
Required No of Cycle	219	340	502	208	172	198	384	820	135	41	83	780	3879
Req'd Working Hour hr	557.3	801.0	1209.0	435.9	387.2	409.4	779.8	1576.2	261.1	77.9	158.4	1214.2	7,867
Working Hour Ratio %	7.1	10.2	15.4	5.5	4.9	5.2	9.9	20.0	3.3	1.0	2.0	15.4	100.0
T.Dred/Turn'g Time hr	273.8	425.0	627.6	256.9	257.4	297.6	575.6	1229.9	202.1	61.3	124.6	975.0	5,307.0
Sailing Time hr	250.6	325.0	506.1	148.1	86.9	62.2	108.2	141.3	25.3	6.4	13.0	122.2	1,795.4
Dumping Time hr	32.9	51.0	75.3	30.8	42.9	49.6	95.9	205.0	33.7	10.2	20.8	117.0	765.1
												Total	7,867.5

Silt/Sand Ratio %	
Silt	45
Sand	55

Average Cycle Time
2.03 hr

Annual Working Hours	
Week	44
Day	5
Hour	24
Efficiency	0.8
	4,224 hr

Annual Required Working Hours		
Dred'g/Turn'g Time	5,307 hr	67%
Sailing Time	1,795 hr	23%
Dumping Time	765 hr	10%
Total	7,867 hr	100%

Required Working Hours
7,867 hr

Required/Annual Working Hours Ratio 186 %

A-4-4 Economic Loading

(Extracted from Technical Note of Port and Harbour Research Institute, Ministry of Transport, Japan, No.23)

1 Introduction

In the case that a trailing suction hopper dredger is used to dredge seabed consisting of soft silt, an overflow method is taken to increase a content of soil in a hopper. In dredging soft materials with slow settling velocity, there is limit of time after which continuation of overflow to increase a hopper load becomes uneconomical due mainly to escaping of soil disturbed by pumped water falling into hopper. The economical loading time can be found between the time of start of overflow and the time of a hopper filled full with soil. To maximize efficiency of dredging operation, length of overflow time must be determined in relation with such various factors as dredging time, change of soil content of overflow water, sailing time for dumping, etc. Method to determine the optimum overflow time is discussed below.

2 Increase of Dredging Cycles by Part Hopper Load

Dredging efficiency can be improved by reducing the pumping time without completely filling the hopper and hence increasing dredging cycles. The following example demonstrates this idea;

Pumping Hour	0.5	1	2	3
Soil in Hopper (m^3)	300	500	700	800
Dumping Hour	1	1	1	1
Cycle Time	1.5	2	3	4
Productivity (m^3/h)	200	250	233	200

In the above case, pumping hour longer than 1 hour, through increasing hopper load, decreases productivity.

3 Economic Loading Theory

3.1 Loading Efficiency

The efficiency dredging operation is determined by such various factors as physical characteristics of soil to be dredged, condition of suspension of pumped soil and shape of the hopper, etc. Since the mixture of soil and water discharged to the hopper is agitated by continuous flow, there is definite formula defining settlement and sedimentation mechanism in the hopper. To calculate the economic loading, the following simplified formula can be adopted. Basic concept of the theory is illustrated in Figure A.4.4-1 in which,

Gp : volume of pumped soil per hour

Gh : volume of loaded soil in hopper per hour

Efficiency of loading pumped soil into hopper, E is given as :

$$E = \frac{Gh}{Gp} \qquad (1)$$

The loading efficiency remains 100 percent until the hopper is filled full. After overflow starts, the loading efficiency goes down gradually for sandy soil and quickly for soft soil. The mean loading efficiency, Em from starting time till certain time T is given by a ratio of loaded soil volume in hopper and pumped soil volume as below;

$$Em = \frac{\int_0^T Gh\,dt}{\int_0^T Gp\,dt} \qquad (2)$$

Assuming that there is no significant change of Gp in time, the above equation in converted as below;

$$Em = \frac{\int_0^T E\,dt}{T} \qquad (3)$$

3.2 Overall Loading Efficiency

Overall loading efficiency including dredging operations is determined by the following factors:

(a) Time required for loading soil into hopper.
(b) Time required for sailing to / from a dumping area.
(c) Time required for turning a dredger.
(d) Time required for dumping soil.
with,
(a)=T and (b)+(c)+(d)=T'

if we assume that T' is constant in each dredging cycle and also Gp remains constant, the overall loading efficiency, Eo is determined as;

$$Eo = \frac{\int_0^T Gh\,dt}{T + T'} \qquad (4)$$

To maximize productivity of dredging operation, a dredger shall be operated with loading time T giving the maximum overall loading efficiency. Optimum economic loading time will be found on a point where a loading efficiency equals to an overall loading efficiency.

3.3 Economic Loading in Beira Port

There is no detailed data available in Beira Port to apply the above theory. Based on the data collected in Japan, a sample calculation is conducted. The results are shown in Tables A.4.4-1 to A.4.4-3 and summarized as below;

Section	Soil	Dumping Distance	Time to Overflow	Sailing Time, etc.	Economic Loading Time
E 4	Silt	9.7 km	18 min	83.4 min	60 min
E 4	Silt	15.5 km	18 min	120 min	84 min
E 10	Sand	1.7 km	18 min	40.2 min	(full in 75 min)

Loading efficiency is assumed for silt and sand as below respectively;

$E=-0.207\log_{10}ta+0.55$ Silt

$E=1-0.3 \times ta/60$ Sand

where, ta : time after overflow

As shown in the above sample calculation, in the case of dredging soft silt and dumping it at remote dumping area, it is more economical to dredge and load soil longer. While, for sand it is economical to fill a hopper full in most cases except for the case in which sailing time, etc. is less than about 0.5 hours.

To calculate an economic loading time in the channel of Beira Port, collection of necessary data through on board tests shall be conducted.

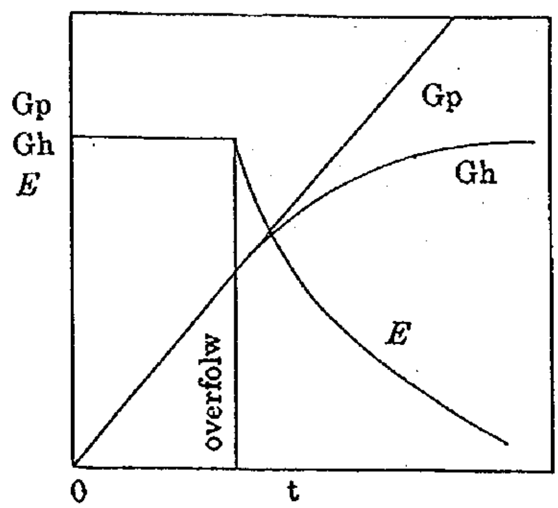


Figure A.4.4-1 Volumes of Pumped and Loaded Soil

Table A.4.4-1 Economic Dredging Time (min.)

Section	E4	Dumping Area/Distance	D1, 9.7km
Soil	Silt w/sand		
Overflow Time: to	18	min	
Sailing Time,etc: t'	83.4	min	
Pumping Rate of Soil	36	m3/min	

Dredging Time min	Loading Efficiency	Overall Loading Efficiency	Soil Vol Loaded
t	f(t)	∫f(t)dt/(t+t')	m3
0			
~	1.000		
18			
20	0.488	0.185	690
22	0.425	0.190	722
24	0.389	0.194	751
26	0.363	0.198	778
28	0.343	0.200	804
30	0.327	0.203	828
32	0.313	0.205	851
34	0.301	0.207	873
36	0.290	0.208	894
38	0.281	0.209	915
40	0.272	0.210	935
42	0.264	0.211	954
44	0.257	0.212	973
46	0.250	0.213	991
48	0.244	0.213	1009
50	0.238	0.214	1026
52	0.233	0.214	1043
54	0.228	0.214	1060
56	0.223	0.214	1076
58	0.218	0.215	1092
60	0.214	0.215	1107
62	0.210	0.214	1123
64	0.206	0.214	1138
66	0.202	0.214	1152
68	0.198	0.214	1167
70	0.195	0.214	1181
72	0.191	0.214	1195
74	0.188	0.213	1208
76	0.185	0.213	1222
78	0.182	0.213	1235
80	0.179	0.212	1248
82	0.176	0.212	1261
84	0.173	0.211	1273
86	0.171	0.211	1286
88	0.168	0.210	1298
90	0.166	0.210	1310

Table A.4.4-2 Economic Dredging Time (min.)

Section	E4	Dumping Area/Distance	D4, 15.5 km
Soil	Silt w/sand		
Overflow Time: to	18	min	
Sailing Time,etc: t'	120	min	
Pumping Rate of Soil	36	m3/min	

Dredging Time min	Loading Efficiency	Overall Loading Efficiency	Soil Vol Loaded
t	f(t)	∫f(t)dt/(t+t')	m3
0			
~	1.000		
18			
20	0.488	0.137	690
22	0.425	0.141	722
24	0.389	0.145	751
26	0.363	0.148	778
28	0.343	0.151	804
30	0.327	0.153	828
32	0.313	0.156	851
34	0.301	0.157	873
36	0.290	0.159	894
38	0.281	0.161	915
40	0.272	0.162	935
42	0.264	0.164	954
44	0.257	0.165	973
46	0.250	0.166	991
48	0.244	0.167	1009
50	0.238	0.168	1026
52	0.233	0.168	1043
54	0.228	0.169	1060
56	0.223	0.170	1076
58	0.218	0.170	1092
60	0.214	0.171	1107
62	0.210	0.171	1123
64	0.206	0.172	1138
66	0.202	0.172	1152
68	0.198	0.172	1167
70	0.195	0.173	1181
72	0.191	0.173	1195
74	0.188	0.173	1208
76	0.185	0.173	1222
78	0.182	0.173	1235
80	0.179	0.173	1248
82	0.176	0.173	1261
84	0.173	0.173	1273
86	0.171	0.173	1286
88	0.168	0.173	1298
90	0.166	0.173	1310

Table A.4.4-3 Economic Dredging Time (min.)

Section	E10	Dumping Area/Distance	D2, 1.7km
Soil	Sand		
Overflow Time: to	18	min	
Sailing Time,etc: t'	40.2	min	
Pumping Rate of Soil	22.5	m3	

Dredging Time min t	Loading Efficiency f(t)	Overall Loading Efficiency $\int f(t)dt/(t+t')$	Soil Vol Loaded m3
0			
~	1.000		
18			
20	0.990	0.332	449.775
22	0.980	0.353	494.100
24	0.970	0.372	537.975
26	0.960	0.390	581.400
28	0.950	0.407	624.375
30	0.940	0.422	666.900
32	0.930	0.436	708.975
34	0.920	0.450	750.600
36	0.910	0.462	791.775
38	0.900	0.473	832.500
40	0.890	0.484	872.775
42	0.880	0.493	912.600
44	0.870	0.502	951.975
46	0.860	0.511	990.900
48	0.850	0.519	1029.375
50	0.840	0.526	1067.400
52	0.830	0.533	1104.975
54	0.820	0.539	1142.100
56	0.810	0.545	1178.775
58	0.800	0.550	1215.000
60	0.790	0.555	1250.775
62	0.780	0.559	1286.100
64	0.770	0.563	1320.975
66	0.760	0.567	1355.400
68	0.750	0.571	1389.375
70	0.740	0.574	1422.900
72	0.730	0.577	1455.975
74	0.720	0.579	1488.600
76	0.710	0.582	1520.775
78	0.700	0.584	1552.500
80	0.690	0.586	1583.775

Appendix A-5 Economic and Finance Analysis

A-5-1 Economic Analysis

Table A.5.1-1 Type of traffic on Beira port in 1995 (unit : metric tonnes)

Type of Traffic	Container Cargo					Dry Cargo		POL		Total Cargo	
	TEU			Weight							
year / unit	TEU	%	%	tonnes	%	tonnes	%	tonnes	%	tonnes	%
1.1.1 Exports	9,865			98,650	35.0	184,350	65.0			283,000	100
1.1.2 Imports(excl.POL)	2,433			24,330	5.0	424,670	95.0			449,000	100
1.1.3 POL				0		0		986,400	100	986,400	100
1.1 Zimbabwe Total	12,298	49.7%	57.8%	122,980		609,020				1,718,400	100
2.2.1 Exports	4,378			43,780	77.0	13,520	23.0			57,300	100
2.2.2 Imports(excl.POL)	1,780			17,800	14.0	105,200	86.0			123,000	100
2.2.3 POL								18,900	100	18,900	100
1.2 Malawi Total	6,158	24.9%	28.9%	61,580	38.0	118,720		18,900		199,200	100
2.3.1 Exports	122			1,220	5.0	23,780	95.0			25,000	100
2.3.2 Imports(excl.POL)	165			1,650	6.0	24,350	94.0			26,000	100
1.3 Zambia Total	287	1.2%	1.3%	2,870		48,130				51,000	100
1.4 Botswana(import)	16	0.1%	0.1%	162	18.0	738	82.0			900	100
1. Transit traffic Total	18,759	75.9%	88.2%	187,592	9.5	776,608	39.5	1,005,300	51	1,969,500	100
2.1.1 Exports	450			4,500	7.0	59,800	93.0			64,300	100
2.1.2 Imports(excl.POL)	1,957			19,565	7.0	259,935	93.0			279,500	100
2.1.3 POL	0							121,600	100	121,600	100
2.1 International traffic	2,407	9.7%	11.3%	24,065	5.0	319,735	69.0	121,600	26	465,400	100
2.2 Cabotage	113	0.5%	0.5%	1,130	2.0	52,170	98.0			53,300	100
2. Mozambique	2,520	10.2%	11.8%	25,195	5.0	371,905	72.0	121,600	23	518,700	100
Grand Total Cargo in 1995	21,279	86.1%	100%	212,787	9.0	1,148,513	46.0	1,126,900	45	2,488,200	100
Empties of Container cargo	3,448	13.9%									
Grand Total include empties in 1995	24,727	100%									

(Source : SATCC,Table-A4.3.1-6)

Table A.5.1-2 Forecast of Type of traffic on Beira port in 2002

(unit : metric tons)

Type of Traffic (year / unit)	Container Cargo TEU	TEU %	TEU %	Weight tons	Weight %	Dry Cargo tons	Dry Cargo %	POL tons	POL %	Total Cargo tons	Total Cargo %
1.1.1 Exports	20,335			203,350	35.0	377,650	65.0			581,000	100
1.1.2 Imports(excl.POL)	2,574			25,741	5.5	442,959	94.5			468,700	100
1.1.3 POL				0		0		1,043,600	100.0	1,043,600	100
1.1 Zimbabwe Total	22,909	52.7%	61.2%	229,091	10.9	820,609	39.2	1,043,600	49.9	2,093,300	100
2.2.1 Exports	9,055			90,552	77.0	27,048	23.0			117,600	100
2.2.2 Imports(excl.POL)	1,883			18,832	38.3	30,368	61.7			49,200	100
2.2.3 POL								20,000	100.0	20,000	100
1.2 Malawi Total	10,938	25.2%	29.2%	109,384	58.6	57,416	30.7	20,000	10.7	186,800	100
2.3.1 Exports	257			2,565	5.0	48,735	95.0			51,300	100
2.3.2 Imports(excl.POL)	175			1,746	27.3	4,654	72.7			6,400	100
1.3 Zambia Total	431	1.0%	1.2%	4,311	7.5	53,389	92.5			57,700	100
1.4 Botswana(import)	17	0.0%	0.0%	171	21.4	629	78.6			800	100
1. Transit traffic Total	34,296	78.9%	91.7%	342,958	14.7	932,042	39.9	1,063,600	45.5	2,338,600	100
2.1.1 Exports	495			4,949	7.0	65,751	93.0			70,700	100
2.1.2 Imports(excl.POL)	2,477			24,766	7.0	329,034	93.0			353,800	100
2.1.3 POL	0							144,700	100.0	144,700	100
2.1 International traffic	2,972	6.8%	7.9%	29,715	5.2	394,785	69.4	144,700	25.4	569,200	100
2.2 Cabotage	137	0.3%	0.4%	1,372	2.0	67,228	98.0			68,600	100
2. Mozambique	3,109	7.2%	8.3%	31,087	4.9	462,013	72.4	144,700	22.7	637,800	100
Grand Total Cargo in 2002	37,404	86.1%	100%	374,045	12.6	1,394,055	46.8	1,208,300	40.6	2,976,400	100
Empties of Container cargo	6,039	13.9%									
Grand Total include empties in 2002	43,443	100%									

Table A.5.1-3 Forecast of Type of traffic on Beira port in 2007

(unit : metric tonnes)

Type of Traffic	Container Cargo					Dry Cargo		POL		Total Cargo	
	TEU			Weight							
year / unit	TEU	%	%	tonnes	%	tonnes	%	tonnes	%	tonnes	%
1.1.1 Exports	23,590			235,900	35.0	438,100	65.0			674,000	100
1.1.2 Imports(excl.POL)	2,967			29,666	5.5	510,434	94.5			540,100	100
1.1.3 POL				0		0		1,202,700	100.0	1,202,700	100
1.1 Zimbabwe Total	26,557	53.0%	61.5%	265,566	11.0	948,534	39.2	1,202,700	49.8	2,416,800	100
2.2.1 Exports	10,511			105,105	77.0	31,395	23.0			136,500	100
2.2.2 Imports(excl.POL)	2,170			21,704	38.3	34,996	61.7			56,700	100
2.2.3 POL								23,000	100.0	23,000	100
1.2 Malawi Total	12,681	25.3%	29.4%	126,809	58.7	66,391	30.7	23,000	10.6	216,200	100
2.3.1 Exports	298			2,975	5.0	56,525	95.0			59,500	100
2.3.2 Imports(excl.POL)	201			2,012	27.2	5,388	72.8			7,400	100
1.3 Zambia Total	499	1.0%	1.2%	4,987	7.5	61,913	92.5			66,900	100
1.4 Botswana(import)	20	0.0%	0.0%	198	21.9	702	78.1			900	100
1. Transit traffic Total	39,756	79.3%	92.1%	397,558	14.7	1,077,542	39.9	1,225,700	45.4	2,700,800	100
2.1.1 Exports	536			5,362	7.0	71,238	93.0			76,600	100
2.1.2 Imports(excl.POL)	2,714			27,139	7.0	360,561	93.0			387,700	100
2.1.3 POL	0							158,600	100.0	158,600	100
2.1 International traffic	3,250	6.5%	7.5%	32,501	5.2	431,799	69.3	158,600	25.5	622,900	100
2.2 Cabotage	150	0.3%	0.3%	1,504	2.0	73,696	98.0			75,200	100
2. Mozambique	3,401	6.8%	7.9%	34,005	4.9	505,495	72.4	158,600	22.7	698,100	100
Grand Total Cargo in 2007	43,156	86.1%	100%	431,563	12.7	1,583,037	46.6	1,384,300	40.7	3,398,900	100
Empties of Container cargo	6,967	13.9%									
Grand Total include empties in 2007	50,124	100%									

Table A.5.1-4 Forecast of Type of traffic on Beira port in 2017

(unit : metric tonnes)

Type of Traffic	Container Cargo					Dry Cargo		POL		Total Cargo	
	TEU			Weight							
year / unit	TEU	%	%	tonnes	%	tonnes	%	tonnes	%	tonnes	%
1.1.1 Exports	35,357			353,570	35.0	656,630	65.0			1,010,200	100
1.1.2 Imports(excl.POL)	4,295			42,952	5.5	739,148	94.5			782,100	100
1.1.3 POL				0		0		1,741,400	100.0	1,741,400	100
1.1 Zimbabwe Total	39,652	53.5%	62.2%	396,522	11.2	1,395,778	39.5	1,741,400	49.3	3,533,700	100
2.2.1 Exports	15,747			157,465	77.0	47,035	23.0			204,500	100
2.2.2 Imports(excl.POL)	3,142			31,424	38.3	50,676	61.7			82,100	100
2.2.3 POL								33,400	100.0	33,400	100
1.2 Malawi Total	18,889	25.5%	29.6%	188,889	59.0	97,711	30.5	33,400	10.4	320,000	100
2.3.1 Exports	446			4,460	5.0	84,740	95.0			89,200	100
2.3.2 Imports(excl.POL)	291			2,913	27.5	7,687	72.5			10,600	100
1.3 Zambia Total	737	1.0%	1.2%	7,373	7.4	92,427	92.6			99,800	100
1.4 Botswana(import)	29	0.0%	0.0%	286	23.8	914	76.2			1,200	100
1. Transit traffic Total	59,307	80.1%	93.0%	593,070	15.0	1,586,830	40.1	1,774,800	44.9	3,954,700	100
2.1.1 Exports	679			6,790	7.0	90,210	93.0			97,000	100
2.1.2 Imports(excl.POL)	3,595			35,945	7.0	477,555	93.0			513,500	100
2.1.3 POL	0							210,100	100.0	210,100	100
2.1 International traffic	4,274	5.8%	6.7%	42,735	5.2	567,765	69.2	210,100	25.6	820,600	100
2.2 Cabotage	199	0.3%	0.3%	1,992	2.0	97,608	98.0			99,600	100
2. Mozambique	4,473	6.0%	7.0%	44,727	4.9	665,373	72.3	210,100	22.8	920,200	100
Grand Total Cargo in 2017	63,780	86.1%	100%	637,797	13.1	2,252,203	46.2	1,984,900	40.7	4,874,900	100
Empties of Container cargo	10,297	13.9%									
Grand Total include empties in 2017	74,076	100%									

A-5-2 Financial Analysis

Table A.5.2-1 Benefits of Saving in Ship Staying Cost (Channel Depth: 8 m)

(unit : hours, US$)

Draft (m)	DWT	Ships in 1996	Waiting Cost ①US$/day	Waiting Time 2000 ② 5m	③ 7m	④=②−③	(①×④)/48	Waiting Time 2002 ② 5m	③ 7.5m	④=②−③	(①×④)/48	Waiting Time 2007 ② 5m	③ 8m	④=②−③	(①×④)/48	Waiting Time 2012 ② 5m	③ 8m	④=②−③	(①×④)/48
≥9.0	18,000~26,000	14	13,000	1,374	229	1,145	310,104	1,518	210	1,308	354,386	1,843	201	1,642	444,708	2,144	235	1,909	517,021
≥8.0	10,000~16,000	33	8,880	2,144	552	1,602	293,857	2,251	544	1,707	315,084	2,513	505	2,008	370,643	2,727	549	2,178	402,023
≥7.0	8,000~10,000	12	6,530	1,493	596	897	122,029	1,709	637	1,073	145,905	2,077	750	1,327	180,527	2,379	881	1,498	203,790
≥6.0	6,000~8,000	54	3,630	109	39	70	5,294	120	43	78	5,861	173	57	116	8,773	184	80	104	7,865
≥5.0	2,000~6,000	37	2,900	13	13	0	0	21	20	1	60	25	24	1	60	37	31	6	363
<5.0	~2,000	2	1,450	34	34	0	0	38	38	0	0	42	42	0	0	54	54	0	0
Containers Sub Total		152		5,167	1463	3,704	731,284	5,657	1,491	4,167	821,295	6,673	1,579	5,094	1,004,712	7,525	1,830	5,696	1,131,061
≥10.0	26,000~28,000	1	8,080	1,426	107	1,319	222,032	1,842	91	1,551	261,085	2,144	82	2,062	347,103	2,580	95	2,485	418,308
≥9.0	20,000~26,000	8	8,000	3,443	277	3,166	527,667	3,742	273	3,469	578,167	4,670	284	4,386	731,000	5,712	319	5,393	898,833
≥8.0	16,000~20,000	15	7,840	673	108	565	92,283	752	116	637	103,962	874	132	742	121,193	975	156	819	133,770
≥7.0	8,000~16,000	48	5,230	94	64	30	3,269	111	61	50	5,448	135	67	68	7,409	170	81	89	9,697
≥6.0	4,000~8,000	12	3,000	41	40	1	63	54	48	6	375	66	61	5	313	80	74	6	375
≥5.0	2,000~4,000	4	2,500	43	41	2	104	54	48	6	313	66	62	4	208	82	78	4	208
<5.0	~2,000	21	2,000	74	74	0	0	84	84	0	0	95	95	0	0	108	108	0	0
Dry Cargo Sub Total		109		5,794	711	5,083	845,417	6,439	721	5,719	949,349	8,050	783	7,267	1,207,227	9,707	911	8,796	1,461,197
≥10.0	30,000~32,000	1	15,800	4,087	345	3,742	1,231,742	4,188	250	3,939	1,296,423	4,556	157	4,399	1,448,004	5,578	194	5,334	1,755,775
≥9.0	22,000~26,000	30	12,640	1,442	149	1,293	340,490	1,508	127	1,382	363,795	1,709	124	1,585	417,383	2,111	154	1,957	515,343
≥8.0	16,000~20,000	22	9,480	469	90	379	74,853	536	176	360	71,100	771	84	687	135,683	871	96	775	153,063
≥7.0	~16,000	9	8,430	101	74	27	4,742	119	68	57	9,045	151	72	79	13,874	202	85	117	20,546
Tankers		62		6,099	658	5,441	1,651,828	6,351	620	5,732	1,740,363	7,187	437	6,750	2,014,944	8,712	529	8,183	2,444,729
≥6.0	4,000~	1	3,000	9	5	4	250	11	7	4	250	13	10	3	188	17	13	4	250
≥5.0	2,000~4,000	0	2,500	72	58	14	729	88	76	12	625	137	121	16	833	163	158	5	260
<5.0	~2,000	40	2,000	295	288	7	292	302	295	7	292	318	318	0	0	342	342	0	0
Cabotages Sub Total		41		376	351	25	1,271	401	378	23	1,167	468	449	19	1,021	522	513	9	510
Benefits of Saving in Ship Staying Cost				17,436	3,183	14,253	3,229,798	18,848	3,209	15,640	3,512,173	22,378	3,248	19,130	4,227,904	26,166	3,783	22,683	5,037,453

Draft (m)	DWT	Ships in 1996	Waiting Cost ①US$/day	Waiting Time 2017 ② 5m	③ 8m	④=②−③	(①×④)/48	Waiting Time 2022 ② 5m	③ 8m	④=②−③	(①×④)/48	Waiting Time 2026 ② 5m	③ 8m	④=②−③	(①×④)/48
≥9.0	16,000~26,000	11	13,000	2,305	281	2,134	577,058	2,580	298	2,282	618,042	2,693	322	2,371	642,146
≥8.0	10,000~16,000	33	8,880	2,908	627	2,281	421,035	3,116	710	2,406	444,108	3,169	787	2,382	439,678
≥7.0	8,000~10,000	12	6,530	2,593	982	1,611	219,163	2,754	1,079	1,675	227,670	2,861	1,129	1,732	235,624
≥6.0	6,000~8,000	54	3,630	192	99	93	7,033	211	126	85	6,428	218	137	81	6,126
≥5.0	2,000~6,000	37	2,900	51	38	13	785	56	44	12	725	66	47	19	1,148
<5.0	~2,000	2	1,450	70	70	0	0	84	84	0	0	90	90	0	0
Containers Sub Total		152		8,209	2,077	6,132	1,275,975	8,801	2,341	6,460	1,297,172	9,097	2,512	6,586	1,324,721
≥10.0	26,000~28,000	1	8,080	2,982	109	2,873	483,622	3,317	123	3,194	537,657	3,484	131	3,353	564,422
≥9.0	20,000~26,000	8	8,000	6,868	354	6,514	1,085,667	8,130	390	7,740	1,290,000	8,978	409	8,569	1,428,167
≥8.0	16,000~20,000	15	7,840	1,062	178	884	144,387	1,179	202	977	159,577	1,273	218	1,055	172,317
≥7.0	8,000~16,000	48	5,230	206	95	111	12,094	240	113	127	13,838	279	121	158	17,215
≥6.0	4,000~8,000	12	3,000	93	87	6	375	104	98	6	375	123	113	10	625
≥5.0	2,000~4,000	4	2,500	97	93	4	208	111	106	5	260	133	122	11	573
<5.0	~2,000	21	2,000	129	129	0	0	153	153	0	0	168	168	0	0
Dry Cargo Sub Total		109		11,437	1,045	10,392	1,726,353	13,234	1,185	12,049	2,001,706	14,438	1,282	13,156	2,183,318
≥10.0	30,000~32,000	1	15,800	8,935	248	8,687	2,201,138	8,911	318	8,593	2,828,529	10,285	364	9,921	3,265,663
≥9.0	22,000~26,000	30	12,640	2,647	184	2,463	648,590	3,317	214	3,103	817,123	3,819	235	3,584	943,787
≥8.0	16,000~20,000	22	9,480	1,072	118	954	188,415	1,273	143	1,130	223,175	1,407	161	1,246	246,085
≥7.0	~16,000	9	8,430	245	101	144	25,290	268	117	151	26,519	295	125	170	29,856
Tankers		62		10,899	651	10,248	3,063,433	13,769	792	12,977	3,895,347	15,806	885	14,921	4,485,390
≥6.0	4,000~	1	3,000	19	15	4	250	22	18	4	250	23	21	2	125
≥5.0	2,000~4,000	0	2,500	200	190	10	521	213	213	0	0	255	232	23	1,198
<5.0	~2,000	40	2,000	372	372	0	0	405	405	0	0	425	425	0	0
Cabotages Sub Total		41		591	577	14	771	640	636	4	250	703	678	25	1,323
Benefits of Saving in Ship Staying Cost				31,136	4,350	26,786	6,016,631	30,444	4,054	31,490	7,194,476	40,044	6,357	34,687	7,994,753

Source : Waiting Cost(Time Charterage of ship), Lloyd's Shipping Economist, 1997

Table A.5.2-2 Benefits of Saving in Ship Staying Cost (Channel Depth: 9 m)

(unit : hours, US$)

Draft (m)	DWT	Ships in 1996	Waiting Cost ① US$/day	Waiting Time 2000 ② 5m	③ 7m	④=②−③	(①×④)/48	Waiting Time 2002 ② 6m	③ 7.5m	④=②−③	(①×④)/48	Waiting Time 2007 ② 6m	③ 9m	④=②−③	(①×④)/48	Waiting Time 2012 ② 5m	③ 9m	④=②−③	(①×④)/48
≧9.0	16,000~28,000	14	13,000	1,374	220	1,148	310,104	1,818	210	1,309	354,386	1,843	174	1,669	452,021	2,144	203	1,941	325,666
≧8.0	10,000~16,000	33	8,880	2,144	552	1,592	293,857	2,251	544	1,707	315,084	2,513	503	2,010	371,013	2,727	543	2,184	403,130
≧7.0	8,000~10,000	12	6,530	1,493	596	897	122,029	1,709	637	1,073	145,905	2,077	750	1,327	180,527	2,379	881	1,498	203,790
≧6.0	6,000~8,000	54	3,630	109	39	70	5,794	120	43	78	5,881	173	57	116	8,773	184	80	104	7,865
≧5.0	2,000~6,000	37	2,900	13	13	0	0	21	20	1	60	25	24	1	60	37	31	6	363
<5.0	~2,000	2	1,450	34	34	0	0	38	38	0	0	42	42	0	0	54	54	0	0
Containers Sub Total		152		5,167	1463	3,704	731,284	5,657	1,491	4,167	821,295	6,673	1,550	5,123	1,012,394	7,525	1,792	5,733	1,140,635
≧10.0	26,000~28,000	1	8,080	1,426	107	1,319	222,032	1,642	91	1,551	261,085	2,144	36	2,108	354,847	2,580	40	2,540	427,567
≧9.0	20,000~26,000	8	8,000	3,443	277	3,166	527,667	3,742	273	3,469	578,167	4,670	194	4,476	746,000	5,712	237	5,475	912,500
≧8.0	16,000~20,000	15	7,840	673	108	565	92,283	752	116	637	103,962	874	97	777	126,910	975	119	856	139,813
≧7.0	8,000~16,000	48	5,230	94	64	30	3,269	111	61	50	5,448	135	67	68	7,409	170	81	89	9,697
≧6.0	4,000~8,000	12	3,000	41	40	1	63	54	48	6	375	66	61	5	313	80	74	6	375
≧5.0	2,000~4,000	4	2,500	43	41	2	104	54	48	6	313	66	62	4	208	82	78	4	208
<5.0	~2,000	21	2,000	74	74	0	0	84	84	0	0	95	95	0	0	108	108	0	0
Dry Cargo Sub Total		109		5,794	711	5,083	845,417	6,439	721	5,719	949,349	8,050	612	7,438	1,235,687	9,707	737	8,970	1,490,161
≧10.0	30,000~32,000	1	15,800	4,087	345	3,742	1,231,742	4,186	250	3,939	1,296,423	4,556	116	4,440	1,461,500	5,528	139	5,389	1,773,879
≧9.0	22,000~26,000	30	12,640	1,442	149	1,293	340,490	1,508	127	1,382	363,795	1,709	98	1,611	424,230	2,111	123	1,988	523,507
≧8.0	16,000~20,000	22	9,480	469	90	379	74,853	536	176	360	71,100	771	62	709	140,028	871	73	798	157,605
≧7.0	~16,000	9	8,430	101	74	27	4,742	119	66	52	9,045	151	56	95	16,684	202	66	136	23,885
Tankers		62		6,099	658	5,441	1,651,826	6,351	620	5,732	1,740,363	7,187	332	6,855	2,042,442	8,712	401	8,311	2,478,876
≧6.0	4,000~	1	3,000	9	5	4	250	11	7	4	250	13	10	3	168	17	13	4	250
≧5.0	2,000~4,000	0	2,500	72	58	14	729	88	76	12	625	137	121	16	833	163	158	5	260
<5.0	~2,000	40	2,000	295	288	7	292	307	295	7	292	318	318	0	0	342	342	0	0
Cabotages Sub Total		41		376	351	25	1,271	401	376	23	1,167	468	449	19	1,021	522	513	9	510
Benefits of Saving in Ship Staying Cost				17,136	3,183	11,253	3,229,708	18,818	3,209	15,640	3,612,173	22,378	2,943	19,436	4,291,513	26,466	3,443	23,023	5,110,382

Draft (m)	DWT	Ships in 1996	Waiting Cost ① US$/day	Waiting Time 2017 ② 5m	③ 9m	④=②−③	(①×④)/48	Waiting Time 2022 ② 6m	③ 9m	④=②−③	(①×④)/48	Waiting Time 2026 ② 6m	③ 9m	④=②−③	(①×④)/48
≧9.0	16,000~28,000	14	13,000	2,396	231	2,164	586,083	2,580	261	2,329	630,771	2,693	261	2,432	658,667
≧8.0	10,000~16,000	33	8,880	2,908	623	2,285	421,773	3,116	686	2,430	448,538	3,169	717	2,452	452,598
≧7.0	8,000~10,000	12	6,530	2,593	982	1,611	219,163	2,754	1,079	1,676	227,870	2,861	1,129	1,732	235,624
≧6.0	6,000~8,000	54	3,630	192	99	93	7,033	211	126	85	6,428	218	137	81	6,126
≧5.0	2,000~6,000	37	2,900	51	38	13	785	56	44	12	725	66	47	19	1,148
<5.0	~2,000	2	1,450	70	70	0	0	84	84	0	0	90	90	0	0
Containers Sub Total		152		8,209	2,043	6,166	1,234,838	8,801	2,270	6,531	1,314,331	9,097	2,381	6,716	1,354,163
≧10.0	26,000~28,000	1	8,080	2,982	45	2,937	494,395	3,317	50	3,267	549,945	3,484	54	3,430	577,383
≧9.0	20,000~26,000	8	8,000	6,868	281	6,587	1,097,833	8,130	315	7,815	1,302,500	8,978	334	8,644	1,440,667
≧8.0	16,000~20,000	15	7,840	1,062	139	923	150,757	1,179	156	1,023	167,090	1,273	164	1,109	181,137
≧7.0	8,000~16,000	48	5,230	206	95	111	12,094	240	113	127	13,838	279	121	158	17,215
≧6.0	4,000~8,000	12	3,000	93	87	6	375	104	98	6	375	123	113	10	625
≧5.0	2,000~4,000	4	2,500	97	93	4	208	111	106	5	260	133	122	11	573
<5.0	~2,000	21	2,000	129	129	0	0	153	153	0	0	168	168	0	0
Dry Cargo Sub Total		109		11,437	869	10,568	1,755,663	13,234	991	12,243	2,034,008	14,438	1,076	13,367	2,217,600
≧10.0	30,000~32,000	1	15,800	6,935	161	6,774	2,229,775	8,911	186	8,725	2,871,979	10,285	202	10,083	3,318,988
≧9.0	22,000~26,000	30	12,640	2,647	141	2,506	659,913	3,317	159	3,158	831,607	3,819	168	3,651	961,430
≧8.0	16,000~20,000	22	9,480	1,072	90	982	193,945	1,273	108	1,165	230,088	1,407	119	1,288	254,380
≧7.0	~16,000	9	8,430	245	78	167	29,329	268	88	180	31,613	295	95	200	35,125
Tankers		62		10,899	470	10,429	3,112,963	13,769	541	13,228	3,965,286	15,806	584	15,222	4,569,923
≧6.0	4,000~	1	3,000	19	15	4	250	22	18	4	250	23	21	2	125
≧5.0	2,000~4,000	0	2,500	200	190	10	521	213	213	0	0	255	232	23	1,198
<5.0	~2,000	40	2,000	372	372	0	0	405	405	0	0	425	425	0	0
Cabotages Sub Total		41		591	577	14	771	640	636	4	250	703	678	25	1,323
Benefits of Saving in Ship Staying Cost				31,136	3,959	27,177	6,104,234	30,444	4,438	32,006	7,313,876	40,044	4,719	35,325	8,143,008

Source : Waiting Cost(Time Charterage of ship), Lloyd's Shipping Economist, 1997

Table A.5.2-3 Benefits of Saving in Ship Staying Cost (Channel Depth: 7 m)

(unit : hours, US$)

Draft (m)	DWT	Ships in 1996	Waiting Cost ① US$/day	Waiting Time 2000 ② 6m	③ 7m	④=②−③	(①×④)/48	Waiting Time 2002 ② 5m	③ 7m	④=②−③	(①×④)/48	Waiting Time 2007 ② 6m	③ 7m	④=②−③	(①×④)/48	Waiting Time 2012 ② 5m	③ 7m	④=②−③	(①×④)/48
≥9.0	16,000~26,000	14	13,000	1,374	229	1,145	254,699	1,518	241	1,277	328,661	1,843	203	1,680	408,621	2,144	298	1,846	474,560
≥8.0	10,000~16,000	33	8,860	2,144	552	1,592	279,164	2,251	606	1,648	288,458	2,513	687	1,826	320,197	2,727	771	1,956	342,993
≥7.0	8,000~10,000	12	6,530	1,493	596	897	115,928	1,709	647	1,062	137,252	2,077	778	1,299	167,682	2,379	905	1,474	190,499
≥6.0	6,000~8,000	54	3,630	109	39	70	5,029	120	45	75	5,388	173	60	113	8,118	144	86	58	7,041
≥5.0	2,000~6,000	37	2,900	13	13	0	0	21	20	1	57	25	24	1	57	37	31	6	344
<5.0	~2,000	2	1,450	34	34	0	0	38	38	0	0	42	42	0	0	54	54	0	0
Containers Sub Total (95%)		152		5,167	1463	3,704	694,720	5,657	1,597	4,060	759,717	6,673	1,854	4,819	902,776	7,525	2,145	5,380	1,015,837
≥10.0	26,000~28,000	1	8,060	1,426	107	1,319	222,032	1,642	114	1,528	257,213	2,144	137	2,007	337,845	2,580	164	2,416	406,693
≥9.0	20,000~26,000	8	8,000	3,443	277	3,166	527,667	3,742	295	3,447	574,500	4,670	358	4,312	718,667	5,712	452	5,260	876,667
≥8.0	16,000~20,000	15	7,840	673	108	565	92,283	752	122	630	102,900	874	159	715	116,783	975	191	784	128,053
≥7.0	8,000~16,000	48	5,230	94	64	30	3,269	111	70	41	4,467	135	83	52	5,666	170	96	74	8,063
≥6.0	4,000~8,000	12	3,000	41	40	1	63	54	48	6	375	66	61	5	313	80	74	6	375
≥5.0	2,000~4,000	4	2,500	43	41	2	104	54	48	6	313	86	82	4	208	82	78	4	208
<5.0	~2,000	21	2,000	74	74	0	0	84	84	0	0	95	95	0	0	108	108	0	0
Dry Cargo Sub Total		109		5,794	711	5,083	845,417	6,439	781	5,658	939,768	8,050	955	7,095	1,179,487	9,707	1,163	8,544	1,420,060
≥10.0	30,000~32,000	1	15,800	4,087	345	3,742	1,231,742	4,188	358	3,830	1,260,708	4,556	415	4,141	1,363,079	5,528	519	5,009	1,648,796
≥9.0	22,000~26,000	30	12,640	1,442	149	1,293	340,490	1,508	163	1,345	354,183	1,709	208	1,501	395,263	2,111	281	1,830	487,167
≥8.0	16,000~20,000	22	9,480	469	90	379	74,853	536	104	432	85,320	771	121	650	128,375	871	151	720	142,200
≥7.0	~16,000	9	8,430	101	74	27	4,742	119	77	42	7,376	151	87	64	11,240	202	101	101	17,738
Tankers		62		6,099	658	5,441	1,651,828	6,351	702	5,649	1,707,588	7,187	831	6,356	1,897,958	8,712	1,052	7,660	2,295,901
≥6.0	4,000~	1	3,000	9	5	4	250	11	7	4	250	13	10	3	188	17	13	4	250
≥5.0	2,000~4,000	0	2,500	72	58	14	729	88	76	12	625	137	121	16	833	163	158	5	260
<5.0	~2,000	40	2,000	295	288	7	292	302	295	7	292	318	318	0	0	342	342	0	0
Cabotages Sub Total		41		376	351	25	1,271	401	378	23	1,167	468	449	19	1,021	522	513	9	510
Benefits of Saving in Ship Staying Cost				17,436	3,183	14,253	3,193,234	18,848	3,458	16,390	3,408,240	22,378	4,089	18,289	3,981,236	26,466	4,853	21,613	4,732,308

Draft (m)	DWT	Ships in 1996	Waiting Cost ① US$/day	Waiting Time 2017 ② 5m	③ 7m	④=②−③	(①×④)/48	Waiting Time 2022 ② 6m	③ 7m	④=②−③	(①×④)/48	Waiting Time 2025 ② 6m	③ 7m	④=②−③	(①×④)/48
≥9.0	16,000~26,000	14	13,000	2,398	328	2,067	531,822	2,580	357	2,223	571,959	2,693	369	2,324	607,940
≥8.0	10,000~16,000	33	8,860	2,908	821	2,087	365,984	3,116	678	2,238	392,443	3,169	896	2,273	398,580
≥7.0	8,000~10,000	12	6,530	2,593	1,032	1,661	201,743	2,754	1,156	1,598	206,525	2,861	1,220	1,641	212,082
≥6.0	6,000~8,000	54	3,630	192	104	88	6,322	211	127	84	6,035	218	145	73	5,245
≥5.0	2,000~6,000	37	2,900	51	38	13	746	56	44	12	689	66	47	19	1,091
<5.0	~2,000	2	1,450	70	70	0	0	84	84	0	0	90	90	0	0
Containers Sub Total (95%)		152		8,209	2,393	5,816	1,106,597	8,901	2,646	6,166	1,177,850	9,097	2,767	6,330	1,214,943
≥10.0	26,000~28,000	1	8,060	2,982	192	2,790	469,650	3,317	226	3,091	520,318	3,484	248	3,236	544,727
≥9.0	20,000~26,000	8	8,000	6,868	570	6,298	1,049,667	8,130	717	7,413	1,235,500	8,978	817	8,161	1,360,167
≥8.0	16,000~20,000	15	7,840	1,062	228	834	136,220	1,179	268	911	148,797	1,273	288	985	160,883
≥7.0	8,000~16,000	48	5,230	206	110	96	10,460	240	125	115	12,530	279	145	134	14,600
≥6.0	4,000~8,000	12	3,000	93	87	6	375	104	98	6	375	123	113	10	625
≥5.0	2,000~4,000	4	2,500	97	93	4	208	111	106	5	260	133	122	11	573
<5.0	~2,000	21	2,000	129	129	0	0	153	153	0	0	168	168	0	0
Dry Cargo Sub Total		109		11,437	1,409	10,028	1,668,580	13,234	1,693	11,541	1,917,781	14,438	1,901	12,537	2,081,575
≥10.0	30,000~32,000	1	15,800	6,935	670	6,265	2,062,229	8,911	871	8,040	2,646,500	10,285	1,022	9,263	3,049,071
≥9.0	22,000~26,000	30	12,640	2,647	322	2,325	612,250	3,317	392	2,925	770,250	3,819	433	3,386	891,647
≥8.0	16,000~20,000	22	9,480	1,072	191	881	173,998	1,273	231	1,042	205,795	1,407	265	1,142	225,545
≥7.0	~16,000	9	8,430	245	114	131	23,007	268	141	127	22,304	295	154	141	24,763
Tankers		62		10,899	1,297	9,602	2,871,484	13,769	1,635	12,134	3,644,849	15,806	1,874	13,932	4,191,076
≥6.0	4,000~	1	3,000	19	15	4	250	22	18	4	250	23	21	2	125
≥5.0	2,000~4,000	0	2,500	200	190	10	521	213	213	0	0	255	232	23	1,198
<5.0	~2,000	40	2,000	372	372	0	0	405	405	0	0	425	425	0	0
Cabotages Sub Total		41		591	577	14	771	640	630	4	250	703	678	25	1,323
Benefits of Saving in Ship Staying Cost				31,136	5,676	25,460	5,646,432	36,444	6,610	29,834	6,740,830	40,044	7,220	32,824	7,488,867

Source : Waiting Cost(Time Charterage of ship), Lloyd's Shipping Economist, 1997

Table A.5.2-4 Benefits of Saving in Ship Staying Cost (Channel Depth: 6.5 m)

(unit : hours, US$)

Draft (m)	DWT	Ships in 1996	Waiting Cost ①US$/day	Waiting Time 2000 ② 5m	③ 6.5m	④=②−③	(①×④)/48	Waiting Time 2002 ② 5m	③ 6.5m	④=②−③	(①×④)/48	Waiting Time 2007 ② 5m	③ 6.5m	④=②−③	(①×④)/48	Waiting Time 2012 ② 5m	③ 6.5m	④=②−③	(①×④)/48
≥9.0	16,000~26,000	14	13,000	1,374	316.6	1,059	262,270	1,518	326.6	1,192	283,974	1,843	349.5	1,494	356,951	2,144	393	1,761	417,322
≥8.0	10,000~16,000	33	8,860	2,144	741.6	1,403	227,813	2,251	778.6	1,473	239,183	2,513	854.5	1,659	269,396	2,727	946.5	1,781	289,213
≥7.0	8,000~10,000	12	6,530	1,493	631.5	862	103,136	1,709	700.6	1,000	120,734	2,077	861.6	1,226	146,713	2,379	982	1,397	167,244
≥6.0	6,000~8,000	54	3,630	109	46.6	63	4,159	120	63	87	4,459	173	73.5	100	6,622	184	96.5	88	5,823
≥5.0	2,000~6,000	37	2,900	13	13	0	0	21	20	1	53	25	24	1	53	37	31	6	319
<5.0	~2,000	2	1,450	34	34	0	0	38	38	0	0	42	42	0	0	54	54	0	0
Containers Sub Total (88%)		152		5,167	1782	3,386	567,384	5,657	1916.5	3,741	648,404	6,673	2195	4,478	778,734	7,525	2503	5,022	879,921
≥10.0	26,000~28,000	1	8,080	1,426	175.6	1,251	210,501	1,642	206	1,436	241,727	2,144	288	1,856	312,427	2,580	368.5	2,212	372,269
≥9.0	20,000~26,000	8	8,000	3,443	586.5	2,858	476,250	3,742	628	3,114	519,000	4,670	742	3,928	654,667	5,712	874.5	4,838	806,250
≥8.0	16,000~20,000	15	7,840	673	143	530	86,567	752	166.6	596	97,265	874	198	678	110,413	975	243	732	119,560
≥7.0	8,000~16,000	48	5,230	94	87.5	27	2,887	111	76	35	3,814	135	96.5	39	4,195	170	120	50	5,448
≥6.0	4,000~8,000	12	3,000	41	38	3	188	54	48	6	375	66	61	5	313	80	74	6	375
≥5.0	2,000~4,000	4	2,500	43	39.5	4	182	54	48.6	6	286	66	62	4	208	82	78	4	208
<5.0	~2,000	21	2,000	74	74	0	0	84	84	0	0	95	95	0	0	108	108	0	0
Dry Cargo Sub Total		109		5,794	1,123	4,671	778,575	6,439	1,247	5,192	867,487	8,050	1,543	6,508	1,082,222	9,707	1,866	7,841	1,304,110
≥10.0	30,000~32,000	1	15,800	4,087	708.6	3,379	1,112,090	4,188	732	3,456	1,137,600	4,556	844	3,712	1,221,867	5,528	1080.5	4,448	1,463,969
≥9.0	22,000~26,000	30	12,640	1,442	269	1,173	308,890	1,508	286	1,222	321,793	1,709	338.5	1,371	360,898	2,111	432	1,679	442,137
≥8.0	18,000~20,000	22	9,480	469	112	357	70,508	538	136	400	79,000	771	161	610	120,475	871	202.5	668	132,029
≥7.0	~16,000	9	8,430	101	71	30	5,269	119	75.6	44	7,640	151	85	66	11,591	202	97.5	105	18,353
Tankers		62		8,099	1160.5	4,939	1,496,758	6,351	1229.5	5,122	1,546,033	7,187	1428.5	5,759	1,714,831	8,712	1812.5	6,900	2,056,487
≥6.0	4,000~	1	3,000	9	5	4	250	11	7	4	250	13	10	3	188	17	13	4	250
≥5.0	2,000~4,000	0	2,500	72	58	14	729	88	76	12	625	137	121	16	833	163	158	5	260
<5.0	~2,000	40	2,000	295	288	7	292	302	295	7	292	318	318	0	0	342	342	0	0
Cabotages Sub Total		41		376	351	25	1,271	401	378	23	1,167	468	449	19	1,021	522	513	9	510
Benefits of Saving in Ship Staying Cost				17,436	4,417	13,020	2,861,085	18,818	4,771	14,077	3,058,070	22,378	5,615	16,763	3,576,809	26,466	6,605	19,772	4,241,028

Draft (m)	DWT	Ships in 1996	Waiting Cost ①US$/day	Waiting Time 2017 ② 5m	③ 6.5m	④=②−③	(①×④)/48	Waiting Time 2022 ② 5m	③ 6.5m	④=②−③	(①×④)/48	Waiting Time 2025 ② 5m	③ 6.5m	④=②−③	(①×④)/48
≥9.0	16,000~26,000	14	13,000	2,396	440.6	1,955	408,823	2,580	606	2,076	494,642	2,693	543	2,150	612,417
≥8.0	10,000~16,000	33	8,860	2,908	1025	1,883	305,862	3,116	1126	1,990	323,242	3,169	1176.5	1,993	323,648
≥7.0	8,000~10,000	12	6,530	2,593	1106.6	1,488	178,079	2,754	1208.6	1,546	185,022	2,861	1260	1,601	191,666
≥6.0	6,000~8,000	54	3,630	192	112.5	80	5,291	211	130.6	81	5,357	218	148	70	4,659
≥5.0	2,000~6,000	37	2,900	51	38	13	691	56	44	12	638	66	47	19	1,010
<5.0	~2,000	2	1,450	70	70	0	0	84	84	0	0	90	90	0	0
Containers Sub Total (88%)		152		8,209	2791.5	5,418	955,745	8,801	3098	5,703	1,008,601	9,097	3264.5	5,833	1,033,400
≥10.0	26,000~28,000	1	8,080	2,982	448	2,534	426,557	3,317	526.5	2,791	469,734	3,484	576.6	2,908	489,429
≥9.0	20,000~26,000	8	8,000	6,868	1023.6	5,845	974,083	8,130	1191	6,939	1,156,500	8,978	1301.5	7,677	1,279,417
≥8.0	16,000~20,000	15	7,840	1,002	296.6	706	115,032	1,179	355	824	134,587	1,273	387	886	144,713
≥7.0	8,000~16,000	48	5,230	206	143	63	6,664	240	166	74	8,063	279	189.6	90	9,757
≥6.0	4,000~8,000	12	3,000	93	87	6	375	104	98	6	375	123	113.6	10	594
≥5.0	2,000~4,000	4	2,500	97	93	4	208	111	106	5	260	133	122	11	573
<5.0	~2,000	21	2,000	129	129	0	0	153	153	0	0	168	168	0	0
Dry Cargo Sub Total		109		11,437	2,220	9,217	1,533,119	13,234	2,596	10,639	1,769,519	14,436	2,858	11,580	1,924,478
≥10.0	30,000~32,000	1	15,800	6,935	1445.6	5,490	1,806,960	8,911	1926.6	6,985	2,299,065	10,285	2286.6	7,999	2,632,840
≥9.0	22,000~28,000	30	12,640	2,647	549.5	2,098	552,342	3,317	698.6	2,619	689,538	3,819	704.5	3,025	796,457
≥8.0	16,000~20,000	22	9,480	1,072	263	809	159,778	1,273	335	938	185,255	1,407	390.5	1,017	200,759
≥7.0	~16,000	9	8,430	245	117.5	128	22,392	268	154.6	114	19,933	295	181	114	20,021
Tankers		82		10,899	2375.5	8,524	2,541,472	13,769	3114.5	10,655	3,193,791	15,806	3652.5	12,154	3,650,071
≥6.0	4,000~	1	3,000	19	15	4	250	22	18	4	250	23	21	2	125
≥5.0	2,000~4,000	0	2,500	200	190	10	521	213	213	0	0	255	232	23	1,198
<5.0	~2,000	40	2,000	372	372	0	0	405	405	0	0	425	425	0	0
Cabotages Sub Total		41		591	577	14	771	640	636	4	250	703	678	25	1,323
Benefits of Saving in Ship Staying Cost				31,136	7,964	23,172	6,031,107	36,444	9,444	27,000	6,072,362	40,044	10,453	29,591	6,609,272

Source : Waiting Cost(Time Charterage of ship), Lloyd's Shipping Economist, 1997

Table A.5.2-5 Benefits of Saving in Ship Staying Cost (Channel Depth: 6 m)

(unit : hours, US$)

Draft (m)	DWT	Ships in 1996	Waiting Cost ①US$/day	Waiting Time 2000 ② 5m	③ 6m	④=②−③	(①×④)/48	Waiting Time 2002 ② 5m	③ 6m	④=②−③	(①×④)/48	Waiting Time 2007 ② 5m	③ 6m	④=②−③	(①×④)/48	Waiting Time 2012 ② 5m	③ 6m	④=②−③	(①×④)/48
≥9.0	16,000~28,000	14	13,000	1,374	402	972	210,600	1,518	412	1,106	239,633	1,843	436	1,407	304,850	2,144	488	1,656	358,800
≥8.0	10,000~16,000	33	8,660	2,144	931	1,213	179,120	2,251	951	1,300	191,967	2,513	1,022	1,491	220,171	2,727	1,122	1,605	237,005
≥7.0	8,000~10,000	12	6,530	1,493	667	828	89,896	1,709	754	966	103,936	2,077	925	1,152	125,376	2,379	1,059	1,320	143,660
≥6.0	6,000~8,000	54	3,630	109	54	55	3,328	120	61	60	3,570	173	87	86	5,203	184	107	77	4,659
≥5.0	2,000~6,000	37	2,900	13	13	0	0	21	20	1	48	25	24	1	48	37	31	6	290
<5.0	~2,000	2	1,450	34	34	0	0	38	38	0	0	42	42	0	0	54	54	0	0
Containers Sub Total (80%)		152		5,167	2101	3,066	482,944	5,657	2,236	3,421	539,154	6,673	2,536	4,137	655,648	7,525	2,861	4,664	744,414
≥10.0	26,000~28,000	1	8,080	1,426	244	1,182	198,970	1,642	298	1,344	226,240	2,144	439	1,705	287,008	2,580	573	2,007	337,845
≥9.0	20,000~26,000	8	8,000	3,443	894	2,549	424,833	3,742	961	2,781	463,500	4,670	1,126	3,544	590,667	5,712	1,297	4,415	735,833
≥8.0	16,000~20,000	15	7,840	673	178	495	80,850	752	191	561	91,630	874	237	637	104,043	975	295	680	111,067
≥7.0	8,000~16,000	48	5,230	94	71	23	2,506	111	82	29	3,160	135	110	25	2,724	170	144	26	2,833
≥6.0	4,000~8,000	12	3,000	41	36	5	313	54	48	6	375	66	61	5	313	80	74	6	375
≥5.0	2,000~4,000	4	2,500	43	38	5	260	54	49	5	260	66	62	4	208	82	78	4	208
<5.0	~2,000	21	2,000	74	74	0	0	84	84	0	0	95	95	0	0	108	108	0	0
Dry Cargo Sub Total		109		5,794	1,535	4,259	707,732	6,439	1,713	4,726	785,165	8,050	2,130	5,920	984,963	9,707	2,569	7,138	1,188,161
≥10.0	30,000~32,000	1	15,800	4,087	1072	3,015	992,438	4,188	1,106	3,082	1,014,492	4,556	1,273	3,283	1,080,654	5,528	1,642	3,886	1,279,142
≥9.0	22,000~26,000	30	12,640	1,442	389	1,053	277,290	1,508	409	1,099	289,403	1,709	469	1,240	326,533	2,111	603	1,508	397,107
≥8.0	16,000~20,000	22	9,460	469	134	335	66,163	536	168	368	72,680	771	201	570	112,575	871	254	617	121,858
≥7.0	~16,000	9	8,430	101	68	33	5,798	119	74	45	7,903	151	83	68	11,943	202	94	108	18,968
Tankers		62		8,099	1663	4,436	1,341,686	8,351	1,757	4,594	1,384,478	7,167	2,026	5,161	1,531,705	8,712	2,593	6,119	1,817,073
≥6.0	4,000~	1	3,000	9	5	4	250	11	7	4	250	13	10	3	188	17	13	4	250
≥5.0	2,000~4,000	0	2,500	72	58	14	729	88	76	12	625	137	121	16	833	163	158	5	260
<5.0	~2,000	40	2,000	295	288	7	292	302	295	7	292	318	318	0	0	342	342	0	0
Cabotages Sub Total		41		376	351	25	1,271	401	378	23	1,167	468	449	19	1,021	522	513	9	510
Benefits of Saving in Ship Staying Cost				17,436	5,650	11,780	2,633,632	18,818	6,084	12,764	2,709,964	22,378	7,141	15,237	3,173,337	26,466	8,636	17,930	3,750,139

Draft (m)	DWT	Ships in 1996	Waiting Cost ①US$/day	Waiting Time 2017 ② 5m	③ 6m	④=②−③	(①×④)/48	Waiting Time 2022 ② 5m	③ 6m	④=②−③	(①×④)/48	Waiting Time 2025 ② 5m	③ 6m	④=②−③	(①×④)/48
≥9.0	16,000~28,000	14	13,000	2,395	553	1,842	399,100	2,580	653	1,927	417,517	2,693	717	1,976	428,133
≥8.0	10,000~16,000	33	8,660	2,908	1,229	1,679	247,932	3,116	1,374	1,742	257,235	3,169	1,457	1,712	252,805
≥7.0	8,000~10,000	12	6,530	2,593	1,179	1,414	153,890	2,754	1,281	1,493	162,466	2,881	1,300	1,581	169,889
≥6.0	6,000~8,000	54	3,630	192	121	71	4,296	211	134	77	4,659	218	151	67	4,054
≥5.0	2,000~6,000	37	2,900	51	38	13	678	56	44	12	580	66	47	19	918
<5.0	~2,000	2	1,450	70	70	0	0	84	84	0	0	90	90	0	0
Containers Sub Total (80%)		152		8,209	3,190	5,019	805,647	8,801	3,550	5,261	842,479	9,097	3,762	5,335	855,799
≥10.0	26,000~28,000	1	8,080	2,982	704	2,278	383,463	3,317	827	2,490	419,150	3,484	905	2,579	434,132
≥9.0	20,000~26,000	8	8,000	6,868	1,477	5,391	898,500	8,130	1,665	6,465	1,077,500	8,978	1,786	7,192	1,198,667
≥8.0	16,000~20,000	15	7,840	1,062	365	697	113,843	1,179	442	737	120,377	1,273	486	787	128,543
≥7.0	8,000~16,000	48	5,230	206	176	30	3,269	240	207	33	3,596	279	234	45	4,903
≥6.0	4,000~8,000	12	3,000	93	87	6	375	104	98	6	375	123	114	9	563
≥5.0	2,000~4,000	4	2,500	97	93	4	208	111	106	5	260	133	122	11	573
<5.0	~2,000	21	2,000	129	129	0	0	153	153	0	0	168	168	0	0
Dry Cargo Sub Total		109		11,437	3,031	8,406	1,399,659	13,234	3,498	9,736	1,621,256	14,438	3,815	10,623	1,767,380
≥10.0	30,000~32,000	1	15,800	6,935	2,221	4,714	1,551,692	8,911	2,982	5,929	1,951,629	10,285	3,551	6,734	2,216,608
≥9.0	22,000~26,000	30	12,640	2,647	777	1,870	492,433	3,317	1,005	2,312	608,827	3,819	1,156	2,663	701,257
≥8.0	16,000~20,000	22	9,480	1,072	335	737	145,558	1,273	439	834	164,715	1,407	516	891	175,973
≥7.0	~16,000	9	8,430	245	121	124	21,778	268	168	100	17,563	295	208	87	15,279
Tankers		62		10,899	3,454	7,445	2,211,460	13,769	4,594	9,175	2,742,733	15,808	5,431	10,375	3,109,117
≥6.0	4,000~	1	3,000	19	15	4	250	22	18	4	250	23	21	2	125
≥5.0	2,000~4,000	0	2,500	200	190	10	521	213	213	0	0	255	232	23	1,198
<5.0	~2,000	40	2,000	372	372	0	0	405	405	0	0	425	425	0	0
Cabotages Sub Total		41		591	577	14	771	640	636	4	250	703	678	25	1,323
Benefits of Saving in Ship Staying Cost				31,136	10,252	20,884	4,417,736	36,444	12,278	24,166	6,206,720	40,044	13,686	26,358	6,733,619

Source : Waiting Cost(Time Charterage of ship), Lloyd's Shipping Economist, 1997

Table A.5.2-6 Culculation of EIRR in the case of channel water depth with 9 m (Case A)

(unit : US$)

Year	Benefit of Saving				(A) Total	(B) Investment Cos	(A)-(B)
	in Ship Staying Cost	to cost up in transportatic	in transportation cost of tanker	of dredging cost to 5m water depth	Benefit	Operation cost	Net Benefit
2000	3,229,798	1,419,577	768,992	1,565,973	6,984,341	31,912,986	-24,928,645
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	3,693,382	1,531,416	834,364	1,565,973	7,625,134	2,612,986	5,012,148
2004	3,883,940	1,570,620	857,366	1,565,973	7,877,899	2,612,986	5,264,913
2005	4,084,330	1,610,828	881,003	1,565,973	8,142,134	2,473,015	5,669,118
2006	4,295,058	1,652,065	905,292	1,565,973	8,418,388	2,473,015	5,945,373
2007	4,291,543	1,694,358	930,250	1,565,973	8,482,124	2,473,015	6,009,108
2008	4,492,405	1,761,116	964,385	1,565,973	8,783,879	2,473,015	6,310,863
2009	4,702,668	1,830,503	999,773	1,565,973	9,098,917	2,473,015	6,625,902
2010	4,922,773	1,902,625	1,036,459	1,565,973	9,427,830	2,473,015	6,954,815
2011	4,922,773	1,902,625	1,036,459	1,565,973	9,427,830	2,473,015	6,954,815
2012	4,922,773	1,902,625	1,036,459	1,565,973	9,427,830	2,473,015	6,954,815
2013	4,922,773	1,902,625	1,036,459	1,565,973	9,427,830	2,473,015	6,954,815
2014	4,922,773	1,902,625	1,036,459	1,565,973	9,427,830	2,473,015	6,954,815
2015	4,922,773	1,902,625	1,036,459	1,565,973	9,427,830	2,473,015	6,954,815
2016	4,922,773	1,902,625	1,036,459	1,565,973	9,427,830	2,473,015	6,954,815
2017	4,922,773	1,902,625	1,036,459	1,565,973	9,427,830	2,473,015	6,954,815
2018	4,922,773	1,902,625	1,036,459	1,565,973	9,427,830	2,473,015	6,954,815
2019	4,922,773	1,902,625	1,036,459	1,565,973	9,427,830	2,473,015	6,954,815
2020	4,922,773	1,902,625	1,036,459	1,565,973	9,427,830	2,473,015	6,954,815
2021	4,922,773	1,902,625	1,036,459	1,565,973	9,427,830	2,473,015	6,954,815
2022	4,922,773	1,902,625	1,036,459	1,565,973	9,427,830	2,473,015	6,954,815
2023	4,922,773	1,902,625	1,036,459	1,565,973	9,427,830	2,473,015	6,954,815
2024	4,922,773	1,902,625	1,036,459	1,565,973	9,427,830	2,473,015	6,954,815
					221,396,648	EIRR=	21.97%

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

Table A.5.2-7 Culculation of EIRR in the case of channel water depth with 7 m (Case B)

(unit : US$)

Year	Benefit of Saving in Ship Staying Cost	to cost up in transportatio	of dredging cost to 5m water depth	(A) Total Benefit	(B) Investment Cos Operation cost	(A)-(B) Net Benefit
2000	3,193,234	951,117	1,565,973	5,710,324	25,012,986	-19,302,662
2001	3,300,737	975,465	1,565,973	5,842,175	2,105,580	3,736,596
2002	3,408,240	1,000,437	1,565,973	5,974,650	2,105,580	3,869,071
2003	3,576,038	1,026,048	1,565,973	6,168,060	2,105,580	4,062,480
2004	3,752,098	1,052,315	1,565,973	6,370,386	2,105,580	4,264,807
2005	3,936,825	1,079,255	1,565,973	6,582,053	2,105,580	4,476,473
2006	4,130,648	1,106,884	1,565,973	6,803,504	2,105,580	4,697,925
2007	3,981,236	1,135,220	1,565,973	6,682,429	2,105,580	4,576,849
2008	4,171,443	1,179,947	1,565,973	6,917,364	2,105,580	4,811,784
2009	4,370,738	1,226,437	1,565,973	7,163,148	2,105,580	5,057,568
2010	4,579,554	1,274,759	1,565,973	7,420,286	2,105,580	5,314,706
2011	4,579,554	1,324,984	1,565,973	7,470,511	2,105,580	5,364,932
2012	4,579,554	1,377,189	1,565,973	7,522,716	2,105,580	5,417,136
2013	4,579,554	1,431,450	1,565,973	7,576,977	2,105,580	5,471,397
2014	4,579,554	1,487,849	1,565,973	7,633,376	2,105,580	5,527,796
2015	4,579,554	1,487,849	1,565,973	7,633,376	2,105,580	5,527,796
2016	4,579,554	1,487,849	1,565,973	7,633,376	2,105,580	5,527,796
2017	4,579,554	1,487,849	1,565,973	7,633,376	2,105,580	5,527,796
2018	4,579,554	1,487,849	1,565,973	7,633,376	2,105,580	5,527,796
2019	4,579,554	1,487,849	1,565,973	7,633,376	2,105,580	5,527,796
2020	4,579,554	1,487,849	1,565,973	7,633,376	2,105,580	5,527,796
2021	4,579,554	1,487,849	1,565,973	7,633,376	2,105,580	5,527,796
2022	4,579,554	1,487,849	1,565,973	7,633,376	2,105,580	5,527,796
2023	4,579,554	1,487,849	1,565,973	7,633,376	2,105,580	5,527,796
2024	4,579,554	1,487,849	1,565,973	7,633,376	2,105,580	5,527,796
				178,171,717	EIRR=	22.52%

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

Table A.5.2-8 Culculation of EIRR in the case of channel water depth with 6.0 m (Case C)

(unit : US$)

Year	Benefit of Saving in Ship Staying Cost	Benefit of Saving to cost up in transportatio	Benefit of Saving of dredging cost to 5m water depth	(A) Total Benefit	(B) Investment Cos Operation cost	(A)-(B) Net Benefit
2000	2533632	482,656	1,565,973	4,582,261	20,458,780	-15,876,519
2001	2,621,798	495,012	1,565,973	4,682,783	1,758,780	2,924,003
2002	2,709,964	507,685	1,565,973	4,783,622	1,758,780	3,024,842
2003	2,876,953	520,681	1,565,973	4,963,607	1,758,780	3,204,827
2004	3,054,232	534,011	1,565,973	5,154,215	1,758,780	3,395,435
2005	3,242,434	547,681	1,565,973	5,356,089	1,758,780	3,597,309
2006	3,442,234	561,702	1,565,973	5,569,909	1,758,780	3,811,129
2007	3,173,337	576,082	1,565,973	5,315,392	1,758,780	3,556,612
2008	3,330,366	598,779	1,565,973	5,495,118	1,758,780	3,736,338
2009	3,495,165	622,371	1,565,973	5,683,510	1,758,780	3,924,730
2010	3,668,120	646,893	1,565,973	5,880,985	1,758,780	4,122,205
2011	3,668,120	672,380	1,565,973	5,906,473	1,758,780	4,147,693
2012	3,668,120	698,872	1,565,973	5,932,965	1,758,780	4,174,185
2013	3,668,120	726,408	1,565,973	5,960,500	1,758,780	4,201,720
2014	3,668,120	755,028	1,565,973	5,989,121	1,758,780	4,230,341
2015	3,668,120	755,028	1,565,973	5,989,121	1,758,780	4,230,341
2016	3,668,120	755,028	1,565,973	5,989,121	1,758,780	4,230,341
2017	3,668,120	755,028	1,565,973	5,989,121	1,758,780	4,230,341
2018	3,668,120	755,028	1,565,973	5,989,121	1,758,780	4,230,341
2019	3,668,120	755,028	1,565,973	5,989,121	1,758,780	4,230,341
2020	3,668,120	755,028	1,565,973	5,989,121	1,758,780	4,230,341
2021	3,668,120	755,028	1,565,973	5,989,121	1,758,780	4,230,341
2022	3,668,120	755,028	1,565,973	5,989,121	1,758,780	4,230,341
2023	3,668,120	755,028	1,565,973	5,989,121	1,758,780	4,230,341
2024	3,668,120	755,028	1,565,973	5,989,121	1,758,780	4,230,341
				141,147,755	EIRR=	21.55%

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

Table A.5.2-9 Culculation of EIRR in the case of channel water depth with 8 m (Case G)

(unit : US$)

Year	Benefit of Saving in Ship Staying Cost	to cost up in transports	in transportation cost of tanker	of dredging cost to 5m water depth	(A) Total Benefit	(B) Investment Operation cost	(A)-(B) Net Benefit
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	3,691,455	1,531,416	834,364	1,565,973	7,623,207	2,612,986	5,010,221
2004	3,879,888	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	8,409,431	2,351,053	6,058,378
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	8,717,955	2,351,053	6,366,902
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
2025	4,852,057	1,902,625	1,036,459	1,565,973	9,357,114	2,351,053	7,006,061
2026	4,852,057	1,902,625	1,036,459	1,565,973	9,357,114	2,351,053	7,006,061
2027	4,852,057	1,902,625	1,036,459	1,565,973	9,357,114	2,351,053	7,006,061
2028	4,852,057	1,902,625	1,036,459	1,565,973	9,357,114	2,351,053	7,006,061
2029	4,852,057	1,902,625	1,036,459	1,565,973	9,357,114	2,351,053	7,006,061
Note : Handling capacity per annum of container is maximam in 2010					229,854,523	EIRR=	24.48%

Appendix A-6 Study Team and Study Schedule

A-6 Advisory Committee, Study Team and Study Schedule

1. Advisory Committee

The Advisory Committee consists of three experts.

Name	Assignments
Mr. Hozumi KATSUTA	Team Leader
Mr. Tetsuya SHIRAISHI	Member
Mr. Yasuyuki NAKAGAWA	Member

2. Study Team

The Study Team consists of nine experts.

Name	Assignments
Dr. Shoji SATO	Chief Consultant, Waterway Planning and Environmental Assessment
Mr. Hisanori KATO	Port Planning and Dredging Plan
Mr. Yutaka OCHI	Access Channel Protection Work
Mr. Katsuhiro SATO	Siltation Analysis
Mr. Shinji OKADA	Natural and Environmental Condition Survey
Mr. Masakiyo MURAOKA	Natural Condition Survey
Mr. Toshimasa SUZUKI	Dredging Design and Cost Estimate
Mr. Masakazu ISHIHARA	Economic and Financial Analysis
Dr. Mohan Prasad SHARMA	Coordinator

3. Study Schedule

Study in the Mozambique was conducted as follows;

Field Study	Period	Activities
First Field Study	Jan 14-Mar 27,1997	Submission of Inception Report, Data Collection and Natural Condition Survey
Second Field Study	Apr 18-May 2,1997	Supplementary Survey on Natural Condition
Third Field Survey	Jul 17-Sept 9,1997	Submission of Interim Report, Data Collection and Natural Condition Survey
Fourth Field Survey	Jan 25-Feb 13,1998	Submission of Draft Final Report

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