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No. 62

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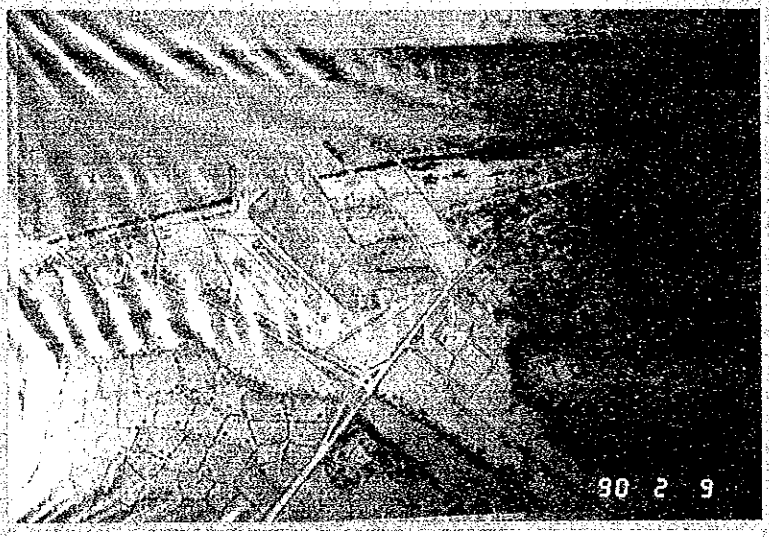
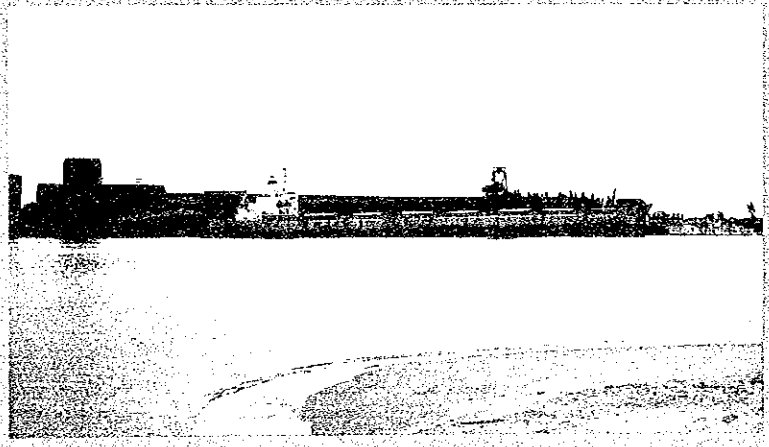
N E W M A N G A L O R E P O R T

THE FEASIBILITY STUDY ON THE IMPROVEMENT PLAN
of
NEW MANGALORE PORT





FINAL REPORT AUGUST 1990
(SUMMARY)

J I C A

JAPAN INTERNATIONAL COOPERATION AGENCY

I N D I A

N E W M A N G A L O R E P O R T

THE FEASIBILITY STUDY ON THE IMPROVEMENT PLAN
of
N E W M A N G A L O R E P O R T

F I N A L R E P O R T AUGUST 1 9 9 0
(S U M M A R Y)

PREFACE

In response to a request from the Government of India, the Japanese Government decided to conduct a study on the Feasibility Study on the Improvement Plan of New Mangalore Port and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to India a survey team headed by MR. Haruo Okada and composed of members from the Overseas Coastal Area Development Institute of Japan (OCDI) and Yachiyo Engineering Co., Ltd, three times from September, 1989 to July, 1990.

The team held discussions with the concerned officials of the Government of India, and conducted field surveys. After the team returned to Japan, further studies were made and the present report was prepared.

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

I wish to express my sincere appreciation to the officials concerned of the Government of India for their close cooperation extended to the team.

August, 1990

Kensuke Yanagiya
President
Japan International Cooperation Agency

LETTER OF TRANSMITTAL

August, 1990

Mr. Kensuke Yanagiya
President
Japan International cooperation Agency

Dear Mr. Yanagiya:

It is my great pleasure to submit herewith the Report for the Feasibility Study on the Improvement Plan of New Mangalore Port.

The Study Team which consists of the Overseas Coastal Area Development Institute of Japan and the Yachiyo Engineering Co., Ltd., headed by myself, conducted a survey in India from September 1989 to July 1990 at the contract of the Japan International Cooperation Agency.

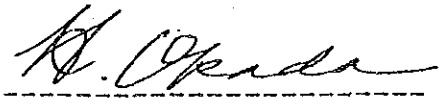
The findings of this survey were fully discussed with the Indian couterparts to formulate the Master Plan for the period up to the year 2004/05 and to formulate and examine the feasibility of the Short-term Plan for the period up to the year 1994/95 and were then compiled into this report. As a result of the Study, the implementation of the projects herein proposed is regarded as crucial not only to the socioeconomic development of the southern region of India centered by the State of Karnataka and also regarded as viable from economic and financial viewpoints.

I earnestly wish that the Plan herein proposed will be implemented at the possible earliest by the Government of India.

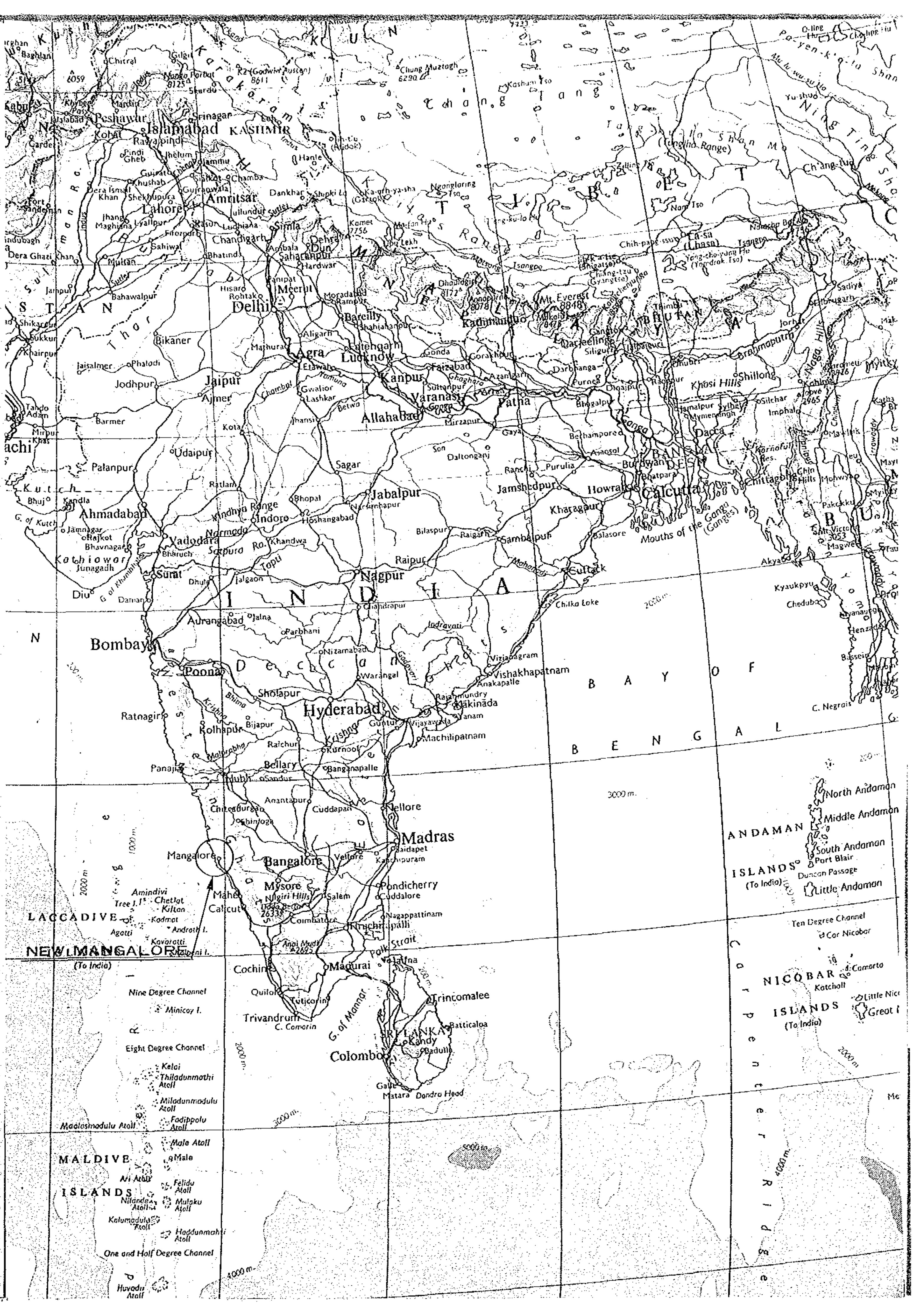
On behalf of the Study Team, I would like to express my deepest appreciation to the Government of India, the New Mangalore Port Trust and the various organizations concerned with the Study for their brilliant cooperation and assistance and for the heartfelt hospitality which they extended to the Team during their stay in India.

I am also greatly indebted to the Japan International Cooperation Agency, the Ministry of Foreign Affairs, the Ministry of Transport, the Japanese Embassy and the JICA Office in India for giving us valuable suggestions and assistance during the field surveys and the preparation of this report.

Respectfully,



Haruo Okada
Leader
Japanese Team for the
Feasibility
Study on the Improvement Plan
of New Mangalore Port
(Exective Director, the Overseas
Coastal Area Development
Institute of Japan)



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Jodhpur
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Surat
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Bhopal
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Bombay
Poona
Hyderabad
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Kakinada
B A Y O F
B E N G A L
Bellary
Nellore
Madras
Mangalore
NEW MANGALORE
(To India)
Bangalore
Mysore
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Trivandrum
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(To India)
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Port Blair
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Ten Degree Channel
Car Nicobar
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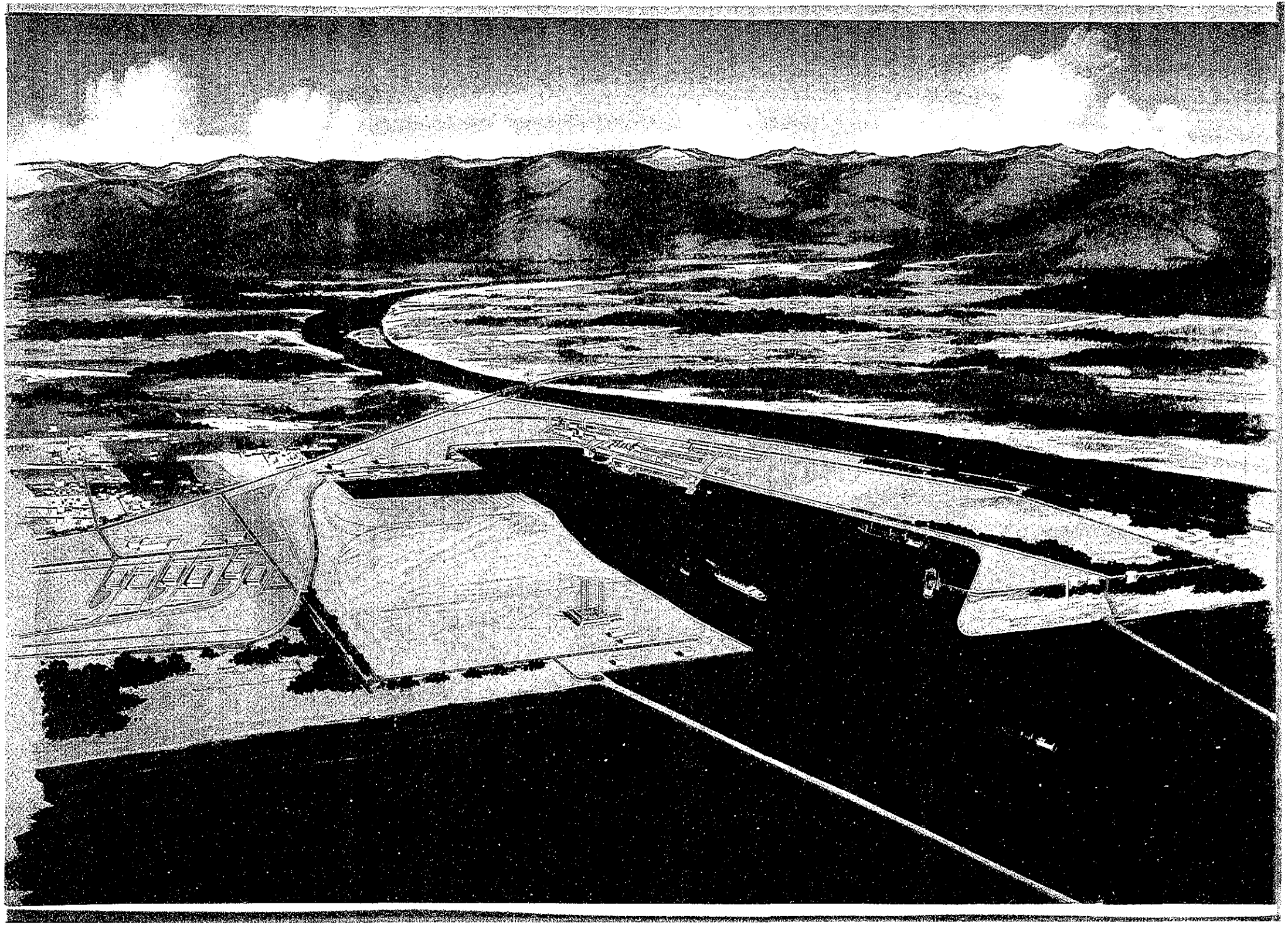

ABBREVIATION

ADB	Asian Development Bank
CFC	Conversion Factor for Consumption
CWPRS	Central Water and Power Research Station
DWT	Dead Weight Tonnage
EIRR	Economic Internal Rate of Return
FIRR	Financial Internal Rate of Return
GDP	Gross Domestic Product
GRT	Gross Ragistered Tonnage
IBRD	International Bank for Reconstruction and Development
ICD	Inland Container Depot
IPA	Indian Ports Association
JICA	Japan International Cooperation Agency
KIOCl	Kudremukh Iron Ore Company Limited
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
MOST	Ministry of Surface Transport
MCF	Mangalore Chemicals & Fertilizer Limited
MOST	Ministry of Surface Transport
NMP	New Mangalore Port
NMPT	New Mangalore Port Trust
NTPC	National Thermal Power Plant
OCDI	Overseas Coastal Area Development Institute of Japan
OECF	Overseas Economic Cooperation Fund
PHRI	Port and Harbour Research Institute, Ministry of Transport, Japan
POL	Petroleum, Oil and Lubricant
Rs	Rupees
SCF	Standard Conversion Factor
SCI	Shipping Corporation of India
TEU	

EXCHANGE RATE

$ 1 = Rs. 16.75

CONTENTS (VOLUME 1)

CONCLUSION AND RECOMMENDATIONS

CONCLUSIONS

1. Need to Make Improvements to New Mangalore Port

1) New Mangalore Port(NMP) handled over 5 million tonnes of iron ore in 1988/89, which accounted for over 70% of all cargo handled at NMP. This volume has almost reached the capacity of the iron ore handling facility, and NMP needs to be competitive with other ports in India which have and/or plan to have iron ore handling facilities for large carriers. Therefore, the iron ore handling facility should be improved so that larger carriers can be accommodated to export more iron ore.

2) Plans for an oil refinery plant and a coal thermal power plant are being prepared in the vicinity of NMP, and NMP is expected to handle crude oil, oil products and coal. Crude oil would be imported from the Persian Gulf and Bombay High by large tankers. Therefore, handling facilities for these commodities should be prepared and the crude handling facility should accept large tankers.

3) The present channel and basin of NMP suffer from siltation every year, which forces the New Mangalore Port Trust (NMPT) to spend a large percentage of its budget on maintenance dredging. Since when the channel and basin are enlarged to accommodate larger vessels, a greater volume of siltation is likely to take place, some appropriate countermeasures will be needed.

4) Although not yet authorized by the national government, a LNG handling plan at NMP is being prepared by the Gas Authority of India. Because LNG is an inflammable material, the handling and processing facilities should be located far from other facilities for safety reasons. Thus, NMP has to reserve a site to meet this prerequisite for future development.

5) In order to meet these requirements, the existing master plan, which was formulated in 1985, should be reviewed, and a short-term plan with a target year of 1994/95 should formulated.

2. Natural conditions Requiring Special Attention

1) Siltation

The outer channel is almost filled up with silt every year and silt also comes into the basin. The siltation takes place during the south-west monsoon season, with a thickness of about 3m at most. There are several possible siltation sources, but the source cannot be designated in this study.

2) Hard Rock Strata

Hard rock strata exist at a relatively shallow level in the basin. The rock strata have been already cut for the present facility, so the shallowest level is about -13.5m. Since the shallow rock strata are distributed near the lagoon entrance, rock dredging is inevitable if the basin is to be deepened.

3. Master Plan

(Demand Forecast and Target Year)

1) The Master Plan is reviewed with a target year of 2004/05.

2) Demand forecast of cargo volume handled at NMP was made as follows:

Demand Forecast(2004/05)

(unit: '000 tonnes)

Export	
Iron Ore	10,000
Oil Products	3,160
Others	660
Sub-total	13,820
Import	
Crude Oil	6,000
Coal	12,120
Others	3,030
Sub-total	21,150
Total	34,970

(Planning Frame)

The most important points of this plan are to decide on the scales of iron ore and crude oil berths, to arrange layout of these berths, oil

products berths and coal berths and to determine a countermeasure against siltation.

The scale of the berths, that is, the depth at the berths should be decided by considering the handling volume in the target year, trends in ship sizes and dredging of hard rock strata spreading in the basin, which is the most costly part of the project. We have selected 100,000 DWT class as the maximum ship size for the iron ore and crude oil berths considering these points.

The layout of these berths should be arranged on the basis of the layout plan of the existing master plan to some extent and harmonized with the existing facilities.

A breakwater has been chosen as countermeasure against siltation. The layout and length of the breakwater have been determined to minimize the total construction cost of the breakwater as well as the maintenance dredging cost, because the more the breakwater is extended, the less siltation there will be.

Moreover, the short-term plan should be considered as a stage plan of the master plan. So, the master plan should be formulated from both long-term and short-term perspectives.

(Infrastructure Plan)

1) Improvement of the Existing Iron Ore Berth to 100,000 DWT Class

The maximum iron ore carrier size to be accepted with only minor modifications to the shiploader currently installed and a 33m extension of the berth length is 100,000DWT, and it would cost much more to accept carriers above the 100,000DWT class. Moreover, the cost of dredging the hard rock spreading in the basin would skyrocket as the dredging thickness became greater, and maintenance dredging costs would be also higher for a deeper basin and channel. Accordingly, the existing iron ore berth should be improved to handle ships up to the 100,000DWT class.

2) Construction of an Additional Iron Ore Berth

Because a single iron ore berth cannot meet the demand for 10 million tonnes of iron ore, an additional berth could be constructed next to the existing berth.

3) Reconstruction of the Existing Oil Products Jetty to a Crude Jetty of the 100,000DWT Class

The existing oil products jetty can be reconstructed by adding a couple of mooring and breasting dolphins.

4) Construction of Two Oil Products Jetties of 85,000 and 35,000 DWT Class

Although the size of oil products tankers is not expected to exceed 35,000 DWT, an 85,000 DWT class products jetty is planned in the lagoon to accept oil products tankers. This jetty will also be able to accept crude tankers when the crude jetty cannot be used, for whatever reasons. The difference in cost between a 35,000 DWT class jetty and an 85,000 DWT class one could be marginal. Both crude oil and oil products tankers can use this jetty before the existing oil products jetty is reconstructed to a crude jetty. The jetty will be constructed on the shore of the lagoon without excavating the land. The second oil products jetty of 35,000 DWT class could be constructed inside the southern breakwater (in the outer port area) if needed.

5) Construction of three coal Berths

Three coal berths of 50,000 DWT class each are planned in the proposed west dock.

6) LNG jetty

In the future, LNG is expected to be handled at NMP. LNG is so inflammable and dangerous that the jetty should be located as far from other facilities as possible. therefore, it is planned for the outer port area;inside the southern breakwater. Although a second oil products jetty is also planned there, only four LNG carriers a month could call at it, and the oil products jetty would not have to accommodate many tankers because the crude oil and oil products jetties located in the lagoon could handle large volumes. So, there would be no problem in this regard.

7) Extension of both Breakwaters

An extension of about 900m of each breakwater is planned to reduce siltation volume, calm the basin and water area in front of the berths

and secure adequate stopping distance for vessels.

8) Deepening and Widening of the Basin and channel

In order to accommodate iron ore carriers and crude oil tankers of the 100,000 DWT class, the basin and the channel are planned to be widened and deepened.

9) Reclamation of Southern Shore for LNG Terminal

Since it would be better if the cryogenic unloading lines were as short as possible, the LNG processing facilities should be located as near the unloading jetty as possible. Moreover, as stated above, facilities related to LNG should be located as far from other facilities as possible. Therefore, the southern shore area could be reclaimed for the LNG terminal.

10) Other Facilities

Plans for other facilities, such as general cargo berths and a RO/RO berth, remain unchanged.

(Handling Equipment)

1) Shiploader

Chute modification for 100,000 DWT class vessels, speed up of boom conveyor, extension of travelling rail, etc., are planned for the iron ore handling equipment at the existing iron ore berth. And a new shiploader should be installed if an additional iron ore berth is constructed.

2) Conveyors

Construction of a new drive unit on the existing berth and capacity up and extension of conveyors are planned.

3) Reclaimer

Additional reclaimers for concentrate and pellets would be needed.

4) Stockyard

Extension of shed for concentrate and yard for pellets is planned.

(Others)

1) Procurement of Tugboats

In order to maneuver and berth 100,000 DWT class vessels, four tugboats of 3,000 HP class are usually needed. Since at present, NMPT has only two tugboats of 2,000 HP each and one of 1,350 HP, two tugboats of 3,000HP will have to be procured.

2) Installation of Advanced Navigational Aids

Navigation to NMP would be difficult due to extension of the outer approach channel. so, an advanced navigational aid system consisting of a radar beacon, light beacon, light buoys, etc., should be installed.

(Required Total Cost for Master Plan)

Total	210 Crore Rs.
Infrastructure	121
Equipment	82
Others	7

4. Short-term Plan

(Demand Forecast and Target Year)

1) The Short-term Plan is formulated with a target year of 1994-95

2) Demand forecast of cargo volume handled at NMP was made as follows:

Demand Forecast (1994/95)

(unit: '000 tonnes)

Exports	
Iron Ore	7,500
Oil Products	1,570
Others	570
Sub-total	9,640
Imports	
Crude Oil	3,000
Others	1,970
Sub-total	4,970
Total	14,610

(Infrastructure Plan)

1) Improvement of the Existing Iron Ore Berth to 100,000 DWT Class
2) Reconstruction of the Existing Oil Products Jetty to Crude Jetty of 100,000 DWT Class
3) Construction of An Oil Products Jetty of 85,000 DWT Class
4) Extension of Both Breakwaters by about 900 m
5) Deepening and Widening of the Basin and Channel

(Handling Equipment)

1) The Existing Shiploader Modification
2) Construction of a New Drive Unit on the Existing Berth, Capacity Up and Extension of Conveyors
3) Extension of Shed for concentrate and Yard for Pellets

(Others)

1) Procurement of Two Tugboats
2) Installation of Advanced Navigational Aids

(Required Total Cost for Short-term Plan)

Total	136 Crore Rs.
Infrastructure	106
Equipment	23
Others	7

5. Economic and Financial Analysis of the Short-term Plan

1) Economic Analysis

The Short-term Plan is evaluated using the Internal Rate of Return (IRR) which is calculated based on cost-benefit analysis from the viewpoint of the national economy (thus, it can be called the economic internal rate of return; EIRR). Benefits considered are the savings in ships' staying costs and freight costs, while costs are construction costs, repair/maintenance costs and operation/administration costs. The internal rate of return, using 30 years as the period of economic calculation, is 23%.

This shows that the Short-term Plan is feasible from the viewpoint of the national economy.

2) Financial Analysis

The viability of the Short-term Plan is analysed based on the Financial Internal Rate of Return (FIRR) using the Discount Cash Flow Method. The FIRR of the Short-term Plan using the same project period is calculated to be 12%. The financial soundness of the NMPT will be maintained during the project period if a soft loan can be introduced.

3) Evaluation

Judging from the above, we conclude that the Short-term Plan with a target year of 1994/95 is feasible both economically and financially.

RECOMMENDATIONS

1. Tariffs

Following the raising of the tariffs of New Mangalore Port such as port dues, berth hire charge, wharfage, etc., in April 1990, the financial status of the port trust has improved. Financial analysis made in this report shows that the FIRR of the proposed project is calculated to be about 8% under the new current tariff conditions. If a higher FIRR, for instance 12%, is required, the tariffs will have to be raised by 10% in 1994 fiscal year when improved facilities are commissioned, or by 20% in 1999 fiscal year.

The iron ore berth is being used exclusively by the K.I.O.C.L. despite having been constructed as a public berth. Again, the crude oil and oil products jetties will be in the similar situation. As the exclusive users will enjoy the convenience of exclusive use, the possibility of imposing special tariffs or charging a part of the berth construction costs on the users can be examined.

2. Financial Aids for Unprofitable Public Facilities

A port works only when several basic facilities, such as breakwaters, channels, basins, wharves, handling equipment, etc., have been prepared. Of these facilities, breakwaters, channels and basins are expensive and at the same time unprofitable facilities. On the other hand, construction of these facilities produces great demand for labor, production would be stimulated in industries that supply the materials and the construction machines and of course other forms of demand would be stimulated in the service sector. In other words, the economic effects of construction of these facilities would spread nation-wide. Therefore, part of the cost of constructing/maintaining the breakwater, channel and basin could be supplied by the national government. Subsidies, low-interest loans, tax exemptions, etc., are possible policies. Moreover, these policies could be also applied to facilities essential to export, for instance, the iron ore berth in this project.

3. Conservation of the Environment

1) Mitigation of Water contamination

New Mangalore Port requires a large amount of dredging both for

construction of new facilities and maintenance of the channel and basin, followed by dumping the dredged soil in the nearby sea area. This produces water turbidity, which possibly affects marine life. Therefore, it is recommended that a silt protector be used to mitigate spreading of the turbidity when the dredgers dump the soil into the sea. And the dumping point should be an adequate distance from the port mouth because it is possible that the turbidity produced in the dumping area will come into the port area where water exchange needs a considerable long time.

It was observed that water at the end of basin is turbid and reddish brown in color. Although we could not identify the pollution source (bark from imported timber, iron ore, vessels or others), something from the cargo handled and/or vessels at the port undoubtedly pollute the water. The water would be more turbid and bad-smelling without the prohibition of waste dumping into the water and the processing facility for contaminated water produced at the wharves.

Monitoring of water pollution is also important. Necessary countermeasures can be made if extraordinary pollution level is monitored.

2) Protection from Shore Erosion

Extension of the breakwaters might block littoral sand drift along the shore and produce an imbalance in sand movements, which could result in accumulation and erosion of the shore. Therefore, periodic observation of the shoreline and sounding of the nearby sea area during and after extension of the breakwaters are recommended so erosion can be stopped as soon as possible. And, if it is judged that erosion is certainly taking place, countermeasures such as installation of jetties or offshore breakwaters at the shore should be considered.

4. Improvement of Productivity of Loading/Unloading at General Cargo Berth

Currently, productivity of cargo handling at the general cargo berths of New Mangalore Port is almost the worst of India's major ports, which would result in weekening competitive power among these ports. This is due to:

a. low cargo-handling productivity

b. long non-working time while ships are berthing

Therefore, an appropriate cargo-handling flow system from ship to storage facilities and truck/train, and vice versa, should be established. This system might include adequate usage of handling equipment for prompt conveyance of cargo unloaded from ships to a storage area/shed and vice versa. Additionally, simplification and quickening of the customs and trading procedures is required.

5. Capacity of Handling Equipment at the Iron Ore Berth

Improvement of the iron ore handling equipment, including expansion of the stockyard, is recommended in the report. Although the K.I.O.C.L. can manage to export more than 5 million tonnes of iron ore using the present stockyard, iron ore carriers could be forced to wait for lack of iron ore in the stockyard. It is commonly said that the required capacity of a stockyard should not be less than 20% of the annual throughput (1.5 million tonnes in the case of an annual throughput of 7.5 million tonnes). However, expansion of the yard to the required capacity would cost a great deal. So in this report, improvement (extension) of the stockyard in order to maintain the same service level (staying days) as that at present is proposed. However, we recommend that the K.I.O.C.L. try to extend capacity of the stockpile up to the required capacity.

6. Handling of Hazardous Materials and Products

Hazardous materials and products, crude oil, oil products and LPG will be handled at the crude jetty and oil products jetties. The distance between the two jetties needed to ensure safety is guaranteed in the plan. Additionally, an adequate fire extinguisher system should be provided at each jetty. Moreover, it is recommended that a berth master be distributed to control hazardous commodity handling and ship maneuvering.

7. Coal Handling

Transporting all the fuel coal to the thermal power plant through NMP is questionable because rail transportation costs are high and because such a large amount of coal could be handled more cheaply by constructing an offshore jetty at the site. Therefore, a further comparative study is needed.

If a large amount of coal is handled at NMP, the other cargoes and vicinity area would suffer from coal dust flying from the coal stockpile. To coat the pile with chemicals, to wrap them with sheet and to block coal dust with fence/net are possible measures. Spraying water on the stockpile is required to prevent the coal from catching fire as well as preventing coal dust from blowing off.

Acid water containing coal would be drained from the coal stockpile into the basin and the drainage would contaminate the water in the basin. Thus a water processing facility will be needed in the coal terminal area.

8. Navigational Aids

After the improvement of the facilities, the length of the channel would be extended to about eight km. In such a long waterway with limited width, having only leading lights on the center line of the channel, such as those currently installed, is not adequate. Advanced navigational aids such as a radio beacon system and flashing light buoys are required. Moreover, powerful tugboats are needed to attend large vessels such as 100,000 DWT iron ore carriers and curde oil tankers. The NMPT currently has two 2,000 HP tugs and one smaller one, and they are not enough for large vessel maneuvering attendance. So, at least two tugs with 3,000 HP or so each should be procured.

9. Further Study to Be Conducted by the NMPT

Some researchers in India are of the opinion that the soil dumped outside the port returns to the channel. And there is a possibility that the sea bottom is changing in the vicinity due to the breakwater extension. Therefore, the following studies should be conducted by the NMPT:

i) Tracer Study of the Dumped Soil,
ii) Periodical Sounding of the Sea Area in the Vicinity.

SUMMARY

1. INTRODUCTION

1.1 Background of the Study

New Mangalore Port (NMP) is one of the eleven major ports of India. The port plays an important role in the iron ore trade together with Mormugao Port, Visakhapatnam Port and Madras Port. NMP handles 7.1 million tons of cargo in total in 1988-89, over 70% of which is iron ore exported to Japan and Eastern European countries.

NMP has a -13.5m-deep, 5.5km-long navigational channel and a -13.0m-deep turning basin, which require 3 -4 million m^3 of dredging every year to maintain the depth.

Although other major ports in India accommodate iron ore vessels of 130,000-150,000 DWT size and have enlargement plans of the faciliteis, the present iron ore terminal of NMP can receive vessels of 60,000 DWT size at most.

Moreover, an oil refinery plant plan and a coal thermal power plant (30km north from NMP) are being prepared. The fuel and products are expected to be handled at NMP.

Accordingly, the main subjects for NMP are as follows:

(1) Formulation of an improvement plan for the iron ore handling facility.
(2) Review of the existing plan for the oil handling facility.
(3) Review of the existing Master Plan.

1.2 Objectives of the Study

The objectives of the Study are:

(1) to review the Master Plan of New Mangalore Port with a long-term perspective for the period up to the year 2005.
(2) to formulate an Improvement Plan for New Mangalore Port for accommodating larger size iron ore and oil vessels in accordance with the investment profile for the 8th Five-Year Plan (1990/1995) of the Government of India.
(3) to determine the technical, economic, and financial feasibility of the Improvement Plan.

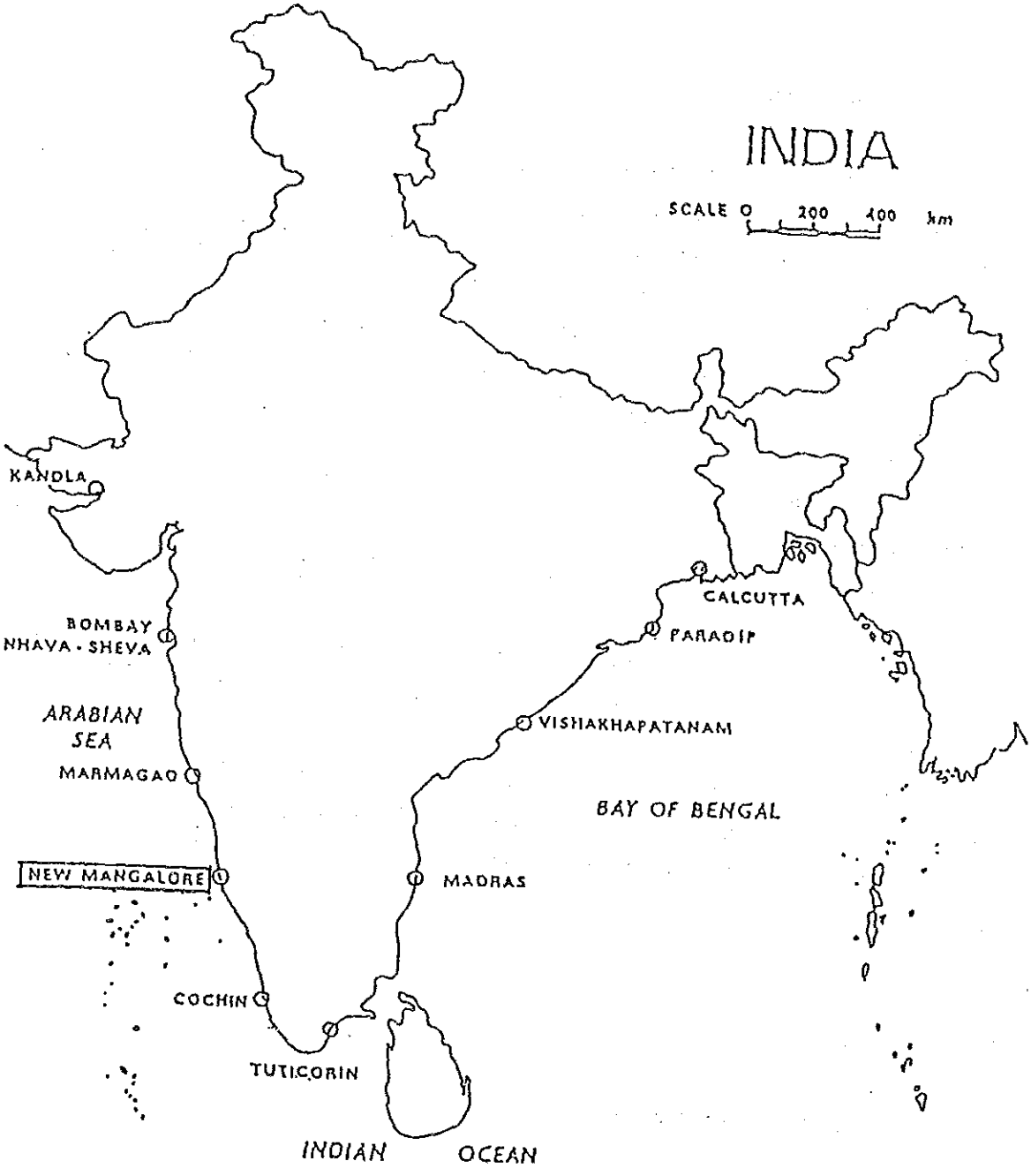

Figure-1.2.1 Major Ports in India

1.3 Scope of the Study

The study was carried out according to the flow chart shown in Figure-1.3.1.

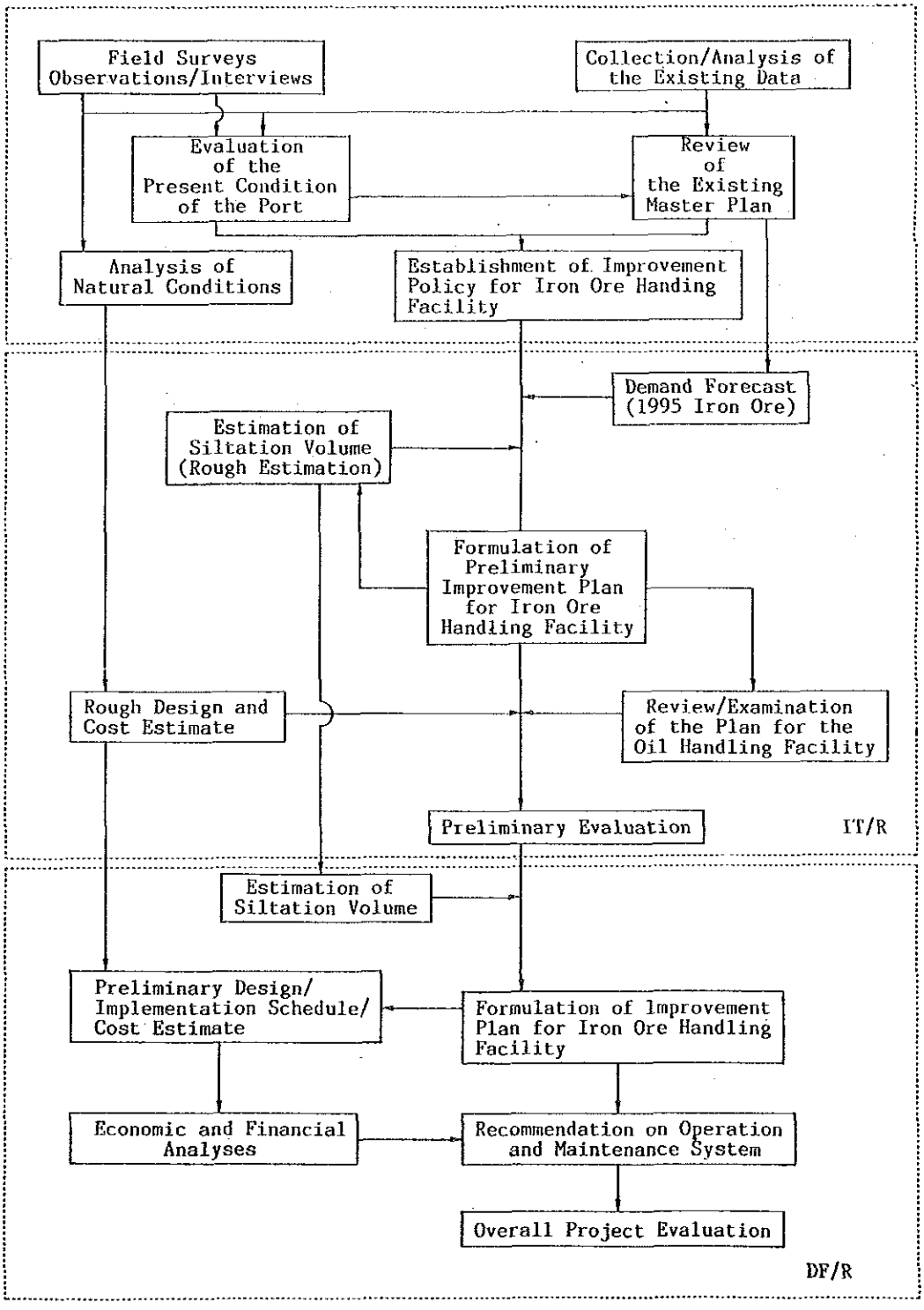

Figure-1.3.1 Working Procedure of the Study

1.4 Organization of the Study Team

The Study Team consists of twelve experts. Their names and responsibilities are listed below.

Name	Responsibility
Haruo OKADA	Leader
Hiroshi HORIKAWA	Port Planning/Demand Forecast
Yukio KAMEI	Countermeasures Against Siltation/ Dredging Planning
Kenji HATTORI	Economic Analysis
Yutaka YOSHIMORI	Operation Planning/Financial Analysis
Yuzuki MUROGA	Cargo Handling System Planning
Mitsuo IGARASHI	Natural Conditions (Oceanographic)
Katsutoshi SUZUKI	Natural Conditions (Soil)
Touru WATANABE	Natural Conditions (Soil)
Masao ITOI	Siltation Volume Estimation
Shuji SEKIGUCHI	Facilities Design
Takahisa SOGABE	Construction Method/Cost Estimation

2. PRESENT SITUATION OF THE PORT

2.1 Locational Condition and Hinterland

(1) Introduction

The land area of Karnataka is 191,757 square kilometers (approximately 6% of the total land area of India: 3.29 million square kilometers) and is situated in the western part of the Deccan Peninsula.

(2) Population

According to the 1981 census Karnataka had a population of 37,135,714 with a density of 194 per square kilometer and ranks in population as the eight state in India.

(3) Economy

Gross domestic product at factor cost (at 1970-71 Prices) of Karnataka is 33,358 million rupees while India as a whole is 681,074 million rupees in 1986/87. Per capita GDP (at 1970-71 Prices) is 799 rupees in 1986/87 which is almost same as that of India.

Sectorial distribution of GDP (at 1970-71 Prices) of Karnataka is as follows:

(Unit:%)

		Karnataka	India
1986-87	Agriculture	41.5	N.A.
	Manufacturing	21.6	N.A.
	Other	36.9	N.A.

(4) Transportation

(i) Roads

The total road length in the state as of March 1986 was 112,923 km of which national highways accounted for 1,968 km, state highways 7,912 km, major district roads 15,999 km, other district roads 7,072 km and village roads 45,495 km.

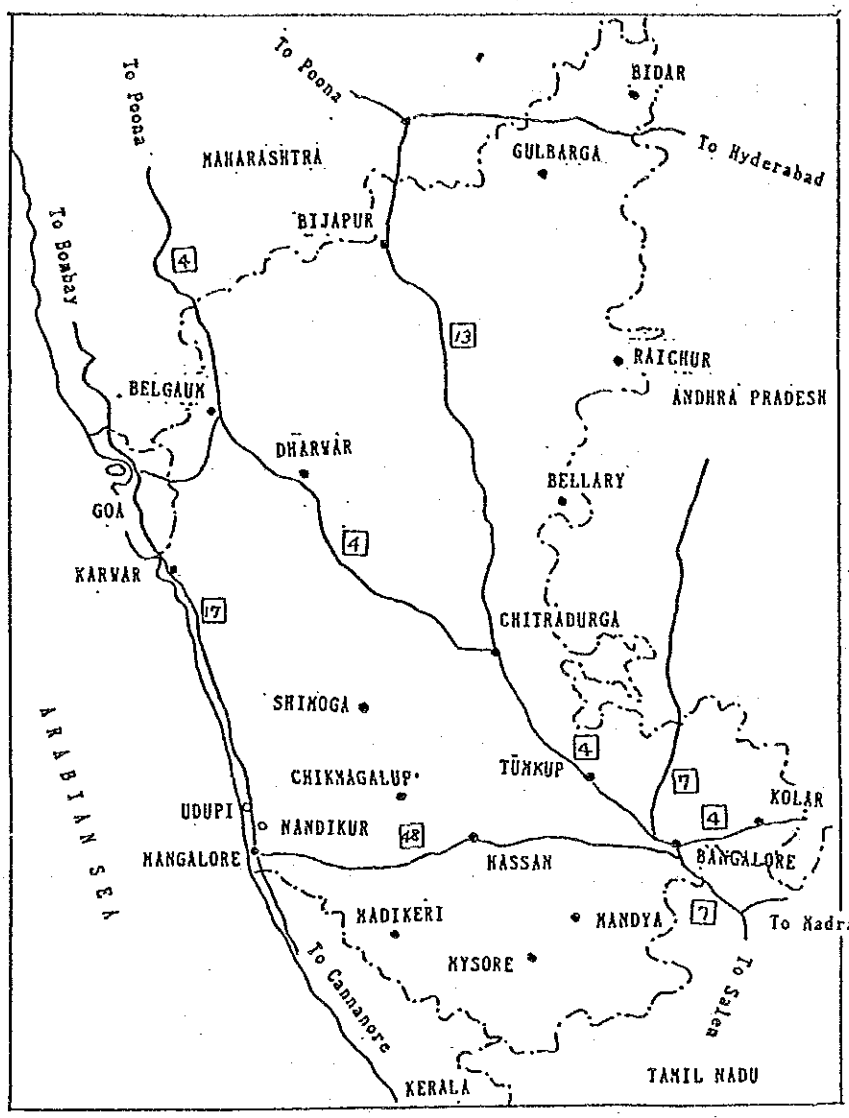

Figure-2.1.1 Highway Network in Karnataka

(ii) Railways

The routes length of railways in the state as on date is 3,024 km as against 2,634 km, as of November 1956, which meant an increase of 390 km over 31 years. The important railways in Karnataka state are described as follows. Railways found in the state are shown in Figure-2.1.2.

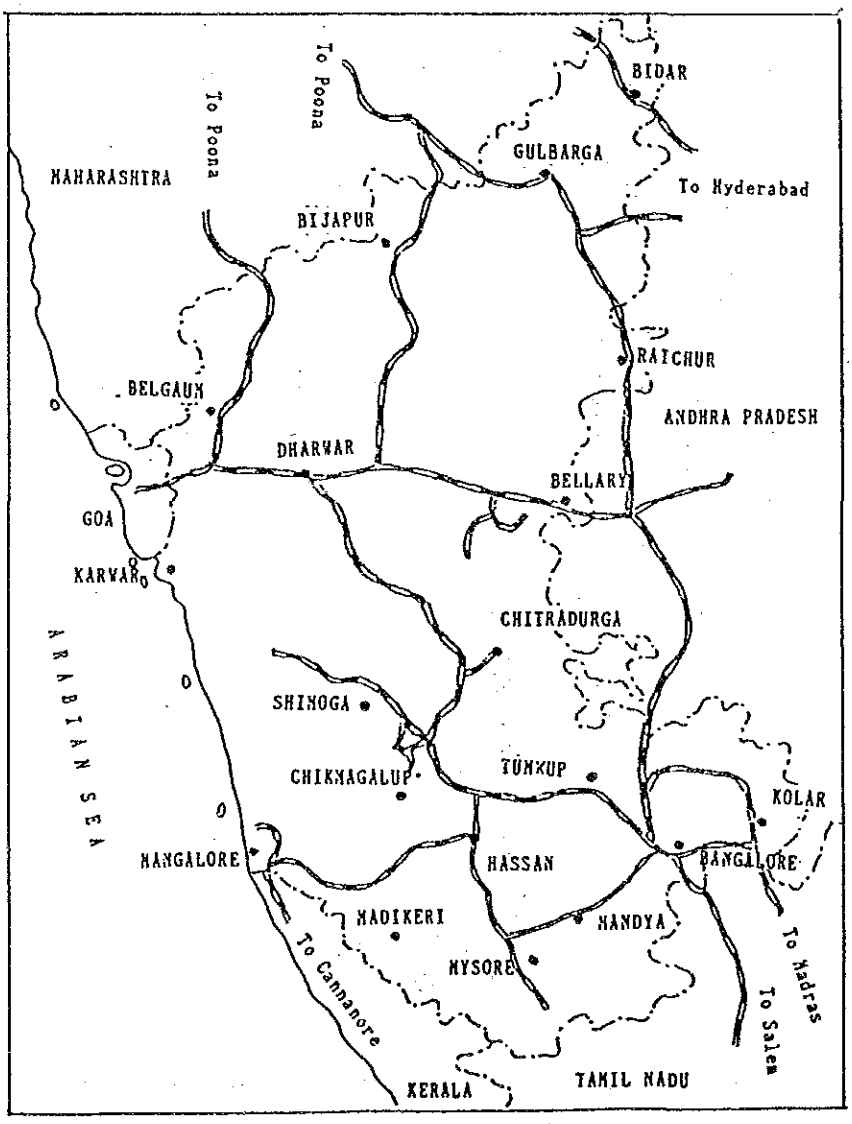

Figure-2.1.2 Railway Network in Karnataka

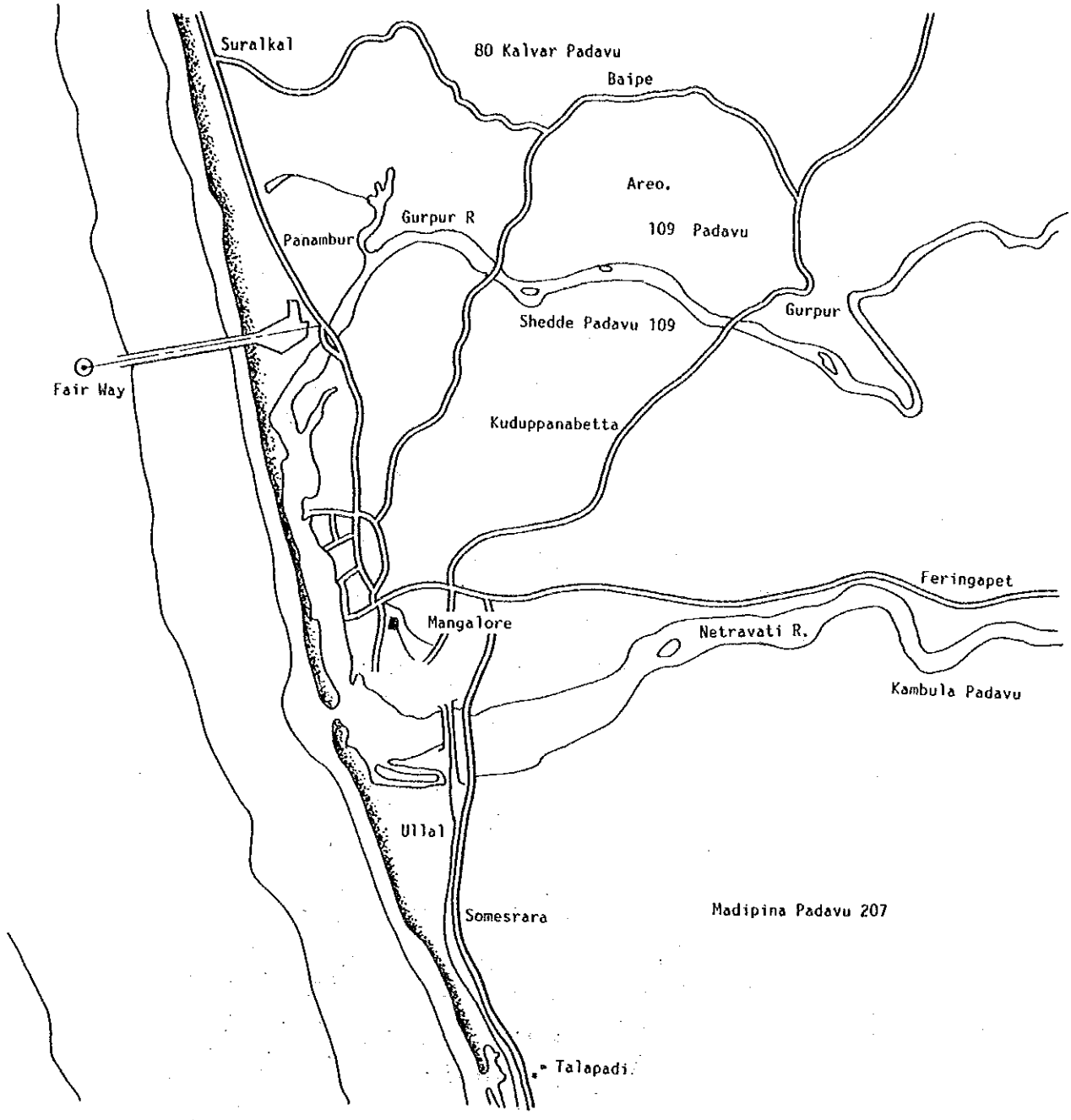

Figure-2.1.3 New Mangalore Port and Vicinity

(iii) Air Transport

The Indian Airlines Corporation (IAC) maintains two airports in the state: one at Bangalore and the other at Mangalore. Mangalore is connected with Bombay and Bangalore. Bangalore is connected with all the state capitals of India.

(iv) Ports

Karnataka is a maritime state with a coastal belt of 287 km covering the Uttara Kannada and Dakshina Kannada districts, with a total of 20 ports. Except Karwar Port, all other ports are riverine ports situated near the junction of the river in question with the Arabian Sea. Excluding New Mangalore Port, the handling capacity of 1.2 million tonnes. There are 15 lighthouses in the state.

2.2 Land Use

Two major firms, KIOCL and MCF, are located next to the port. A railway marshalling yard, a commercial area where the New Mangalore Port Trust Administration Office is located and a residential area for staff members of the Port Trust occupy the northern part of the port area. Additionally, the oil storage and distribution terminal of the Indian Oil Corporation is located at the south edge of the area (Figure-2.2.1).

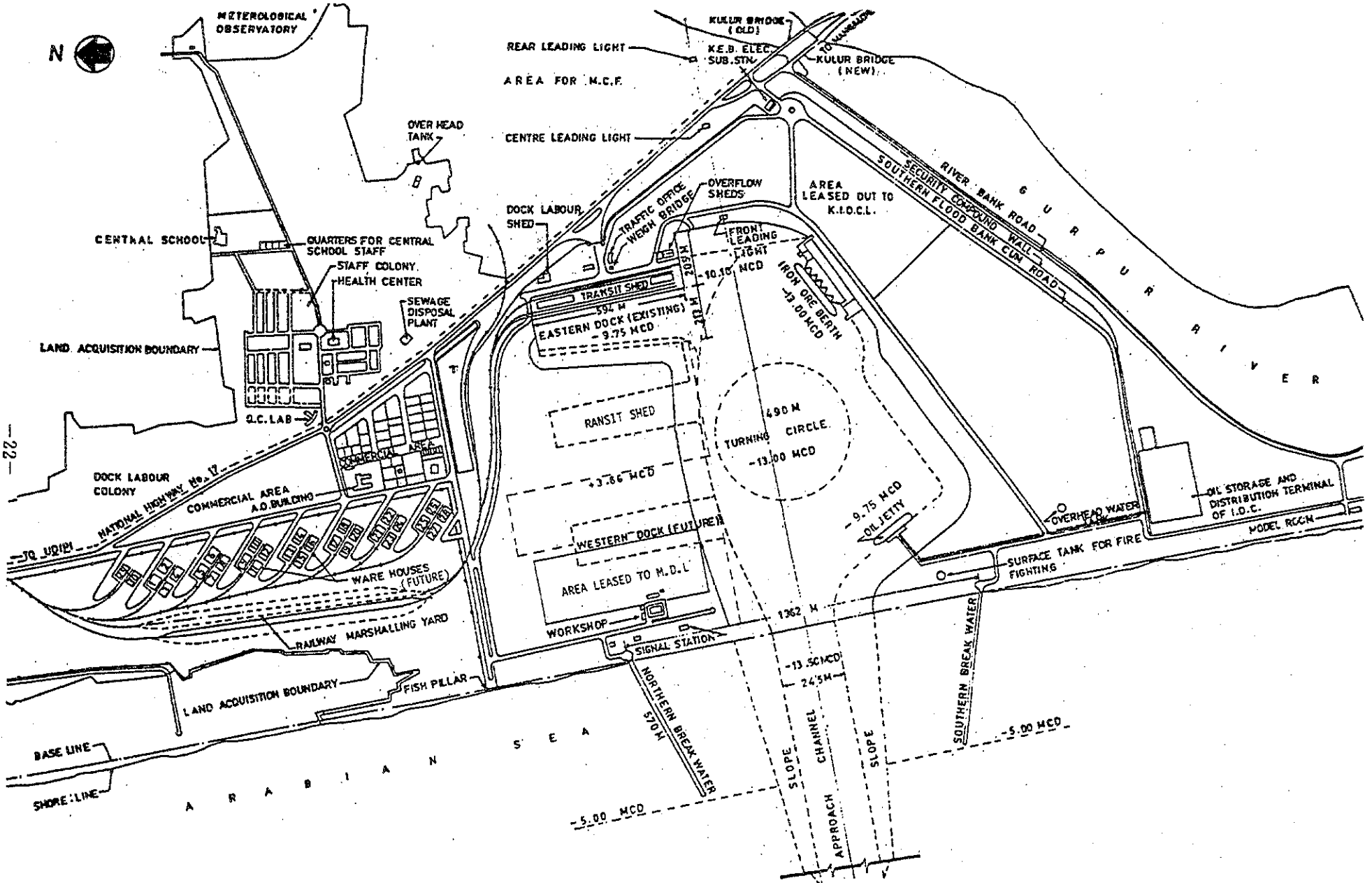

Figure-2.-.1 Land Use in and around New Mangalore Port

2.3 Existing Port Facilities

2.3.1 Mooring Facilities

New Mangalore Port now has six berths and a shallow-water berth as shown in Table-2.3.1.

Table-2.3.1 Berth Particulars

Sl. No.	Description of berth	Draught (in meters)	Length of berths(in meters)	Remarks
1.	Berth No. 1	9.45	198	a straight continuous wharf 594 meters in length
2.	Berth No. 2	9.45	198	
3.	Berth No. 3	10.10	198	
4.	Shallow Berth	6.50	125	
5.	Oil Jetty	9.75	330	Length between centers of extreme moorings
6.	Iron Ore Berth	12.50	285	With mechanized shiploader
7.	Additional Berth	9.15	250	

2.3.2 Cargo handling equipment

The port has various types of cargo handling equipment. This consists of 3 wharf cranes with capacities ranging from 3 to 10 tonnes, 4 mobile cranes with capacities from 5 to 22 tonnes, 2 crawler-mounted cranes with capacities from 18 to 30 tonnes and two forklift trucks with capacities of 3 tonnes. The iron ore berth has a shiploader with a loading capacity of 6,000 tonnes per hour.

2.3.3 Channel and Basin

The approach channel and the turning basin are shown in Figure-2.3.2. This drawing also shows the location of the northern and southern breakwaters.

Approach channel

Length : 5,430 m

Width : 245 m

Depth of water below chart datum : 13.5 m

Permissible draught : 12.5 m

Turning basin

Diameter : 490 m

Depth of water below

chart datum : 13.0 m

Permissible draught : 12.5 m

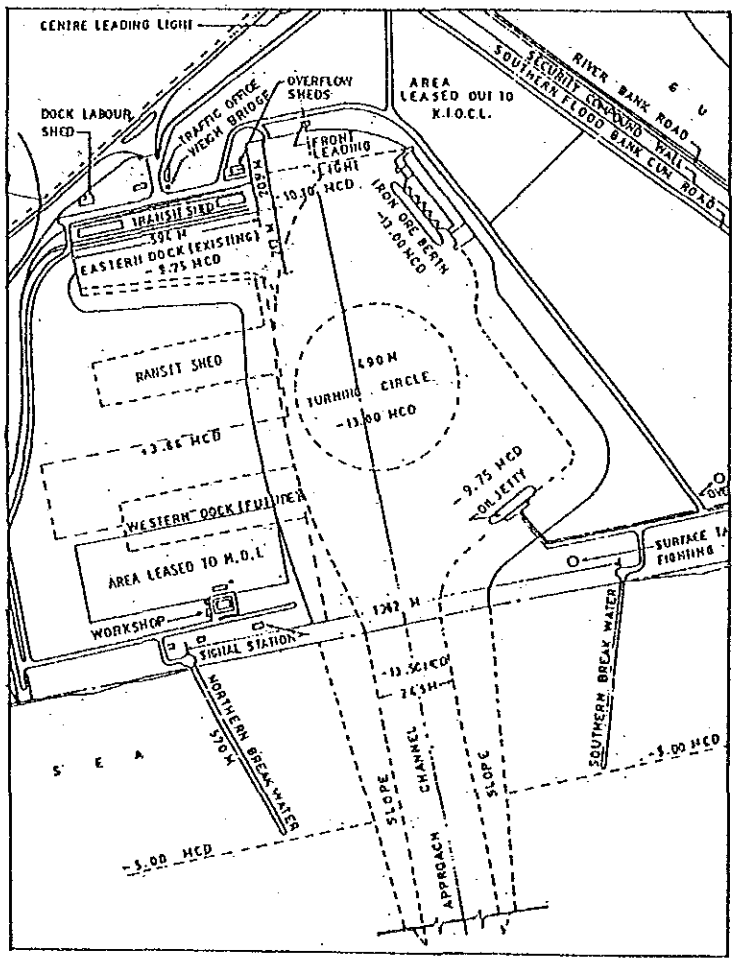

Figure-2.3.2 The Channel and the Basin

2.3.4 Breakwater

Breakwaters are located around the mouth of the port with a length of 570m each, to the depth of -5m.

However the tranquilility of the channel and the basin is not ensured against waves in monsoon season because the breakwaters aren't long enough.

The breakwaters are of the rubble-mound type with side berms.

A sectional diagram of the breakwaters is provided below:

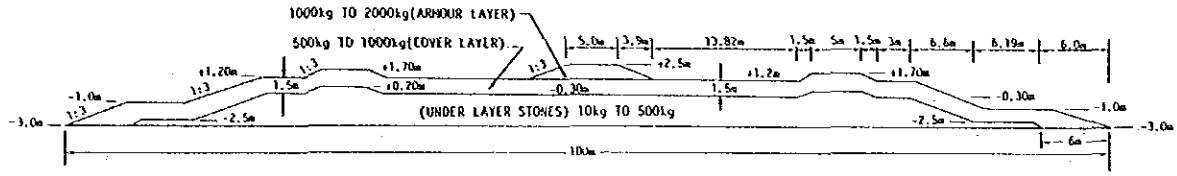

Figure-2.3.3 Section of the Breakwater at -3.0m C.D

2.3.5 Handling Equipment

New Mangalore Port has various handling equipment, all of which except the equipment on the iron ore berth are light and simple. Here, only the equipment on the iron ore shiploading system are presented.

Using this system, both ground/concentrated ore (concentrate) and pelletized ore (pellets) are handled and loaded onto ships. The system is depicted in Figure-2.3.4.

Concentrate is reclaimed from the concentrate stockyard by reclaimers RK01 or RK02, loaded on belt conveyers CB85 or CB86, transported through conveyers CB89 and CB92, and loaded onto ships by the shiploader on the berth.

Pellets are reclaimed from the pellet stockyard by the reclaimer for pellets, loaded on belt conveyer CB434, transported through conveyers CB89 and CB92 and loaded onto ships by the shiploader.

The shiploader is of the boom shuttling and derricking type. The nominal shiploading capacity is 6000t/h for concentrate and the chute max. radius is 32m from the seaside rail, so it can load onto 60,000 DWT class ships.

The nominal handling capacity of the existing equipment and stockyard capacity are shown in Table-2.3.1 below.

Table-2.3.1 Nominal Handling Capacity of Existing Equipment

Equipment	Capacity t/h	Concentrate	Pellet
Shiploader	Boom conveyor	6,000	3,500
Conveyor	Wharf CB92	6,800	3,500
	Cross CB89	6,800	3,500
	Outgoing CB85,86	3,000 x 2	
	Outgoing CB434		6,600
Reclaimer	RK01,02	3,500 x 2	
	RK		5,000
Stockyard	Capacity t	200,000 x 2t	150,000 t

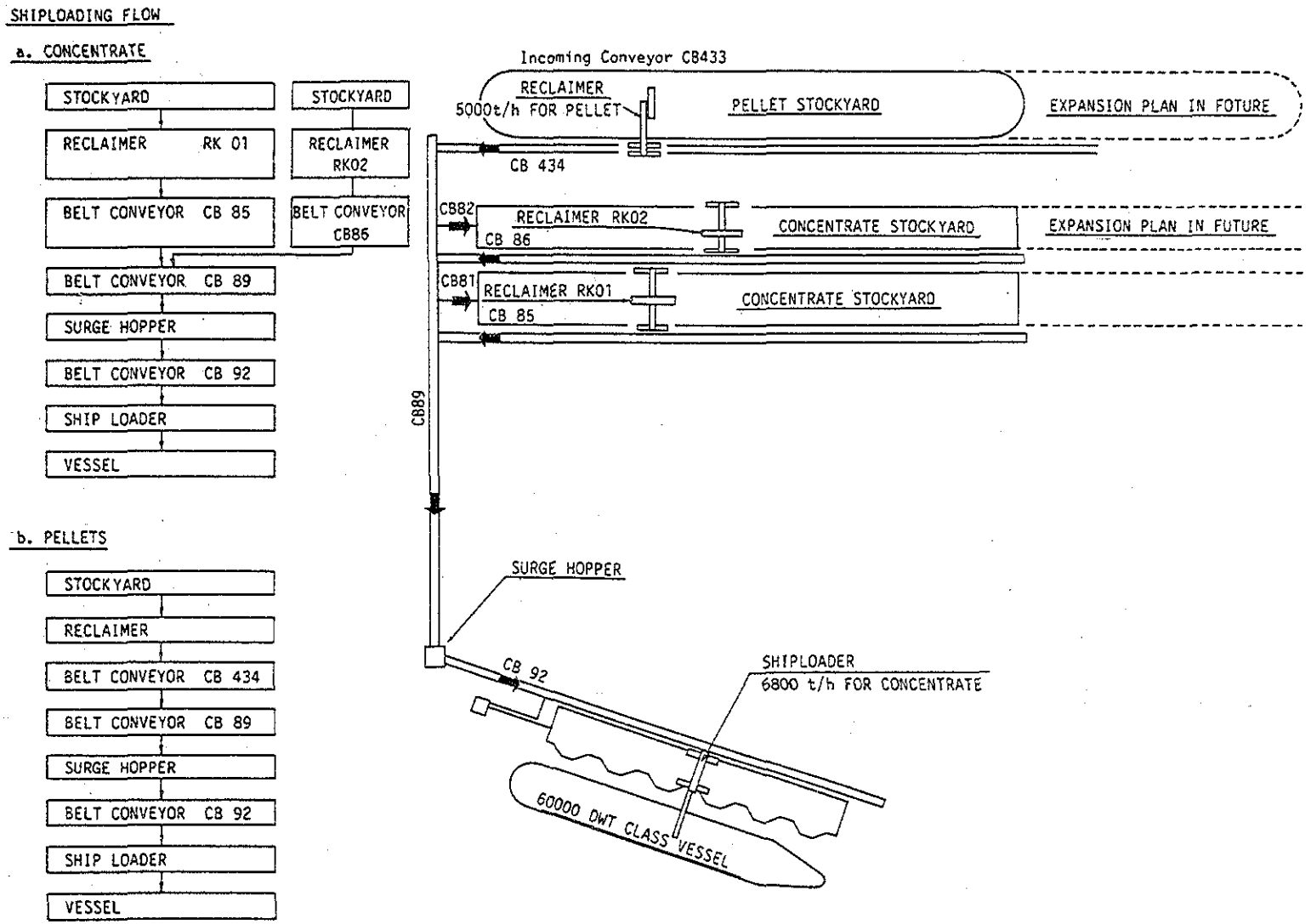

Figure-2.3.4 Layout of Ore Shiploading System (Existing) Kudremukh Iron Ore Co. Ltd. New Mangalore

2.4 Natural Conditions

2.4.1 Meteorology.

The climate of Mangalore has a regular variation on account of the alternating SW and NE monsoon. The main season with their principal characteristics are given below:

- The cool season (December to March), when winds are NE and the weather is dry with little cold except in the Southern area.

- The hot season (April and May), winds are light and variable with sea breezes on the land. Tropical cyclonic storms (cyclones) may cross the Arabian Sea in this season.

- The SW monsoon or rainy season(June to September). The wind over the sea is between SW and W, but mainly W to NW along the coast. In much of the Mangalore area, most rainfall occurs during the SW monsoon.

- The interim period (October and November) is marked by light winds the with land and sea breezes. Occasional tropical cyclones occur in the Arabian Sea in this period. While the average frequency of cyclonic storms in the Arabian Sea is about one per year, there have been years in which two or three have occurred, and also periods of one or two years without one, based on the Meteorological records of the past 30 years.

2.4.2 Oceangrophical

(1) Wave observation

A wave rider buoy was installed at the extremity of the channel where the depth of water is about -15m. Observations were made from OCT/89' to May/90' for months.

In this survey period a monsoon season, in which high waves are expected to occur, is not included, but the records of 1974 and 1975 in the monsoon season is available as supplementary data.

a. Wave height and frequency

In October, at the end of the monsoon season, the wave heights were comparatively high 0.5 - 0.99m accounting for 78%. Wave heights of more than 1.0m were measured accounting for 9%. In November and December, the sea is generally very calm and in November the wave heights were 0.0 - 0.49m and 0.5 - 0.99 accounting for 75% and 25% respectively. In December waves of 0.5 - 0.99m height appeared accounting for 57 -78%.

Interim period of cool seasons to SW monsoon (April to May) the wave height become higher gradualy. In May, the wave height 0.55 - 0.99 were accounting for 30%, 1.00 - 1.49 and 1.50 - 1.99 were accounting for 36% and 31% respectively. In partiqular high wave of 2.00 to 2.49m were appeared accounting for 3.3%.

The frequency of wave distinguished in 6.0 - 8.0 sec. In this period, the significant wave height was H1/3=2.14 (T=7.4 sec) and the maximum height was Hmax=3.1m (Tmax=10 sec).

b. Wave direction

The predominant wave direction was distinguished as from the west (280°) in this period. South-west (220°) direction waves followed predominant west direction.

(2) Tidal current

Tidal current observations were carried out in two ways. First, three sets of currentmeters were installed with anchor buoys in the outer port, and observation were conducted for 15 day. Second, tidal currents were observed for 24 hours by one currentmeter inside the basin. The outline of observation results are as follows:

a. Outer port

Generally, the tidal current is weak. The maximum current velocities are ranges 24 to 57 cm/sec. At near the port entrance, current velocity is strong and it is 57 cm/sec with a direction paralled to the navigation channel. The current direction is changing clockwise.

b. Basin

Tidal current in the basin is weak and its velocity is less than 0.15 cm/sec. The current direction is distinguished as WNW - NW.

2.4.3 Geology

At the New Mangalore Port a number of borings, including the ones executed in the pre-construction stage, have been conducted.

In 1975 deepening of the navigational channel and basin was planned in order to enable larger size vessels to call at the port. The sonic prospecting and probings for the purpose of clarifying the bed rock stratum were executed.

However some discrepancy was found between borings and sonic prospecting. Consequently the purpose of the geological investigation to be executed in this study are:

a. To confirm the distribution of the bedrock stratum.
b. To clarify the characteristic of the bedrock material.
c. To determine subsoil property necessary for the improvement design of the iron ore berth and oil jetty.

Figure-2.4.1 shows location of the geological investigation executed in this study.

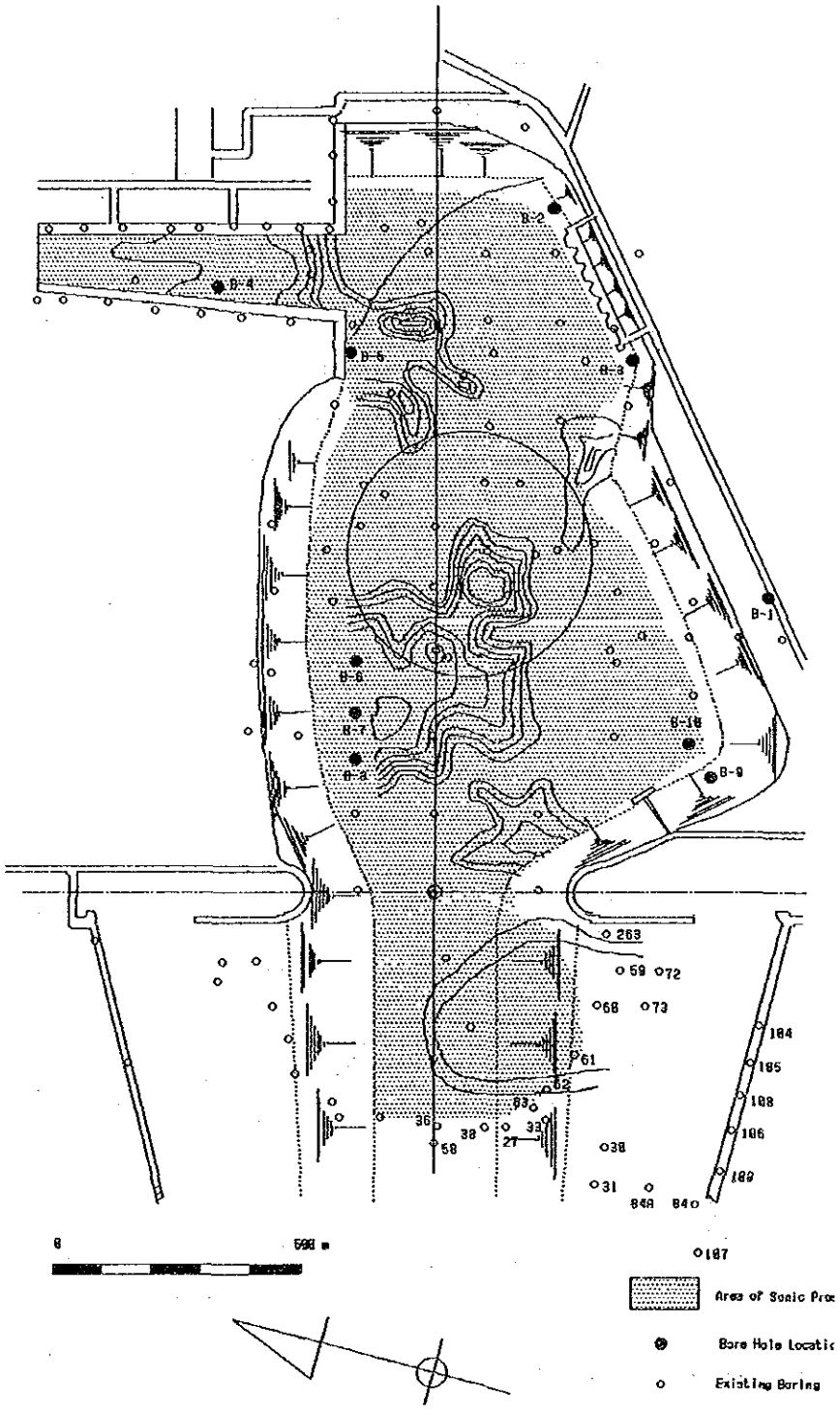

Figure-2.4.1 Location of the Geological Investigation

(1) Brief description of the geological condition

Figure-2.4.2 shows the rough sketch of geological strata around the New Mangalore Port and the navigational channel. From the top, the geological strata consists of a sandy soil layer, clayey soil layer and bed rock. Each soil layer is not homogeneous and includes alternative layers of sand and clay.

Stiffness and density of soil layers fluctuate in a wide range, however the strata consist of relatively hard soil in general. Underneath the soil layer, the bedrock strata composed of hard granite rock varies from a depth of 14 m to 25 m from the datum level. Around the breakwater, the subsoil consists of soft to medium-stiff marine clay. The N value of this layer ranges from 3 to 5.

Alluvial soft marine clay seems to extend seaward 1.5 km or further from the shore line , however the soil properties of the layer are not clear.

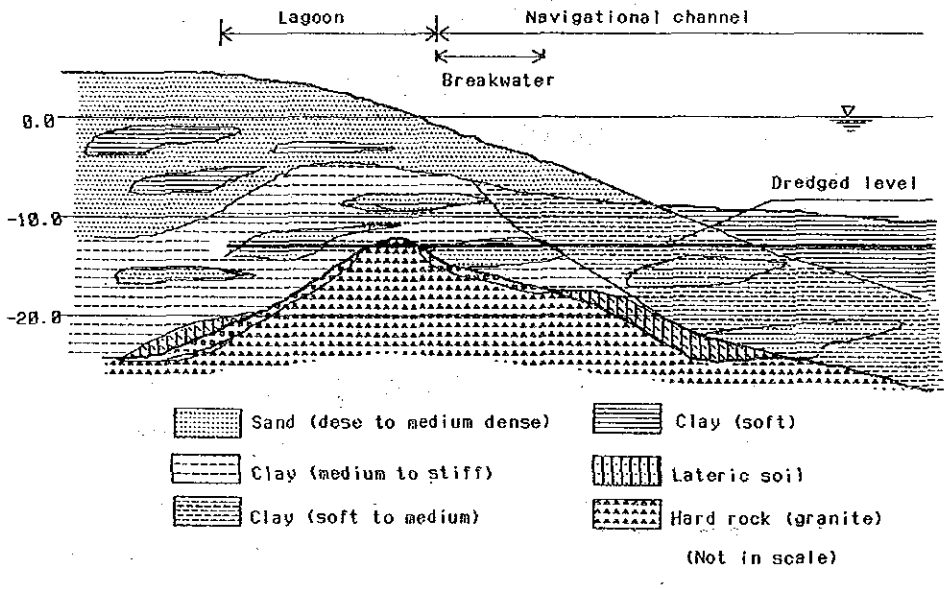

Figure-2.4.2 Rough Sketch of the Geological Strata

(2) Bed-rock strata

Figure 2.4.3 shows sea bed-rock contour map prepared by results of sonic prospecting, boring and existing data.

According to the results of sonic survey, the area where the sea bed-rock appear shallower than 20 meter from chart datum are mainly cargo berth area and 200 meters to 700 meters on the center line of navigation channel from outlet of the lagoon.

The depth of sea bed-rock is approximately 11 to 15 meter at the cargo berth area, but at the berth No.3 and the additional berth area, the rock outcrops at -9.8m and -7m were found respectively by the existing data.

At the 200 - 700m from outlet of lagoon, the depth of sea bed-rock is approximately 14 to 20m. Sea bed-rock in this area was dredged by blasting in the stage of capital dredging up to -13.5m.

According to the results of sonic prospecting, the surface of sea bed-rock seem to be zig zag shape and it is considered that many huge pieces of blasted sea bed-rock are remain on the top of the bed-rock after dredging.

BED ROCK CONTOUR MAP

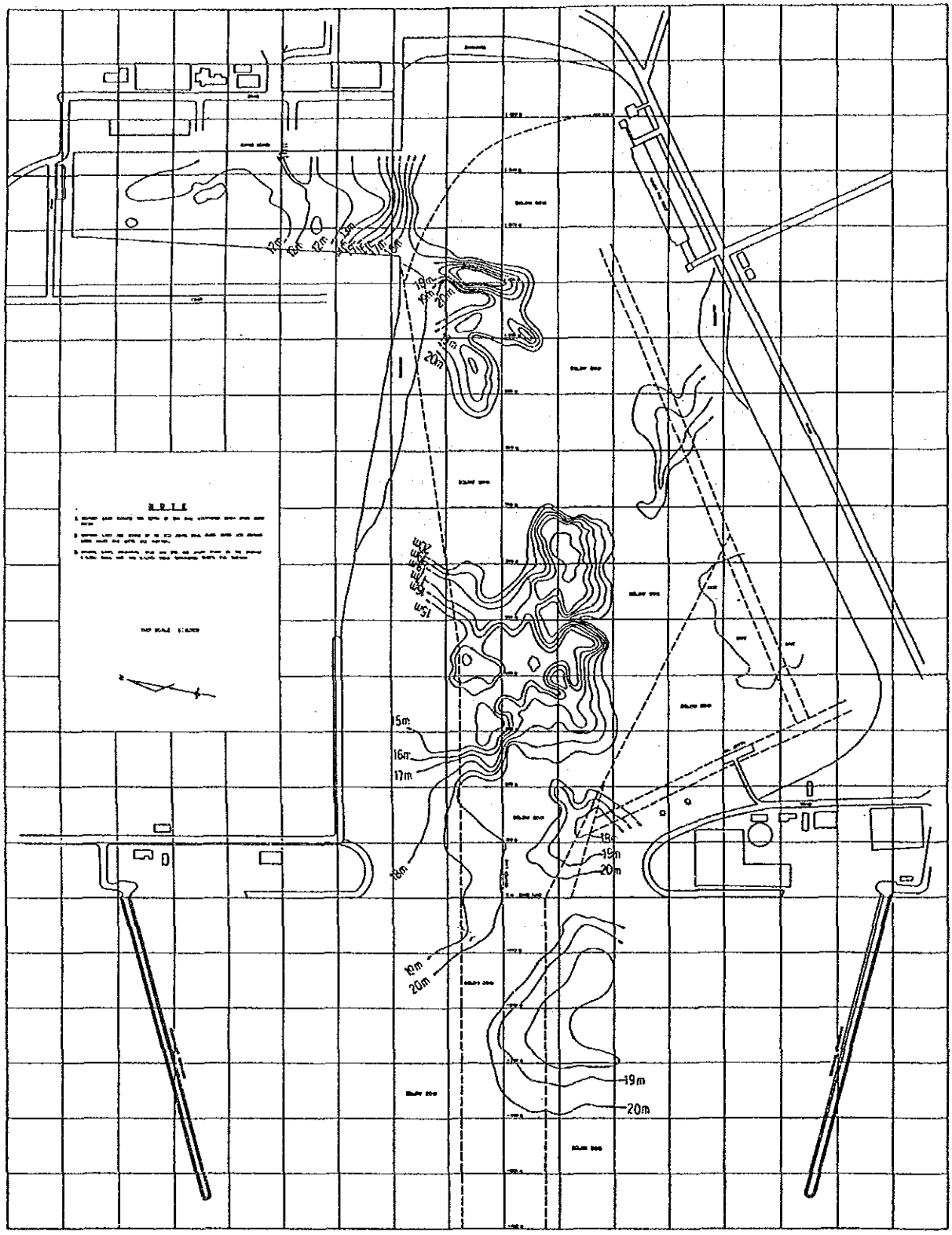

Figure-2.4.3 Distribution of the Bed Rock Stratum

(3) Result of Seismic Survey

Figure-2.4.4 shows the results of the seismic survey.

The velocity of Primary wave (Vp) transmitting through rock was measured as 4,500 to 5,000 m/sec, and it means that the rock stratum is composed of very hard rock.

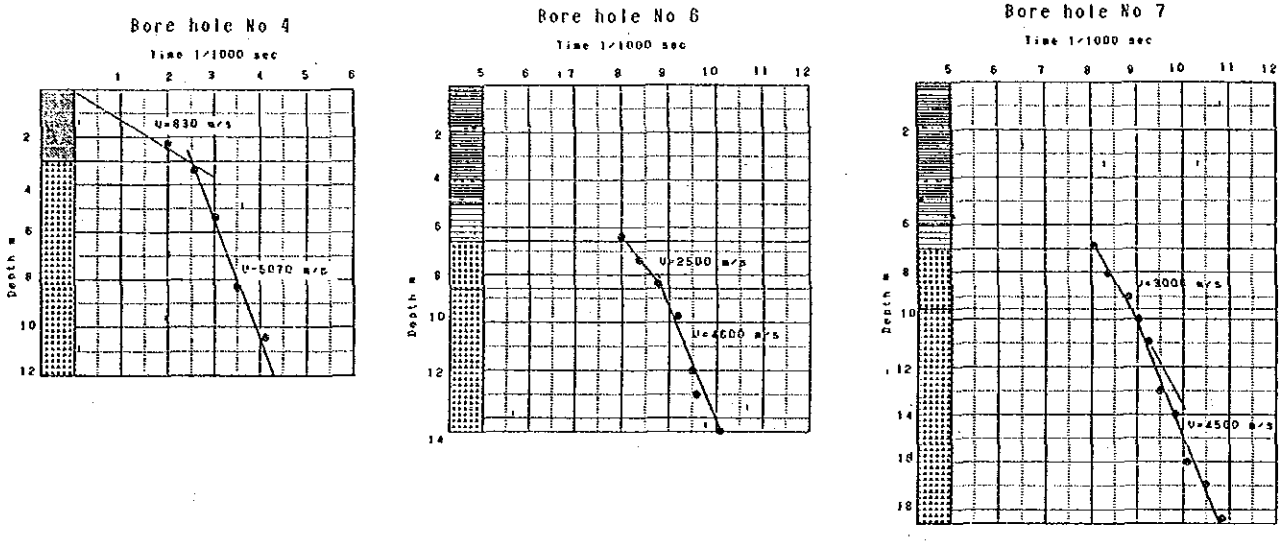

Figure-2.4.4 Results of the Seismic Survey

2.4.4 Siltation in the Channel and the Lagoon

(1) Characteristics of Siltation

New Mangalore Port is located between Goa and Cochin on the west coast of India. Siltation in the outer approach channel and the lagoon is a serious problem in New Mangalore Port, just as in another major ports on the west coast of India. The yearly volume (1982-1987)of maintenance dredging in the outer approach channel and the lagoon is presented in Table-2.4.1. The average volume of dredging per year for the six years is 2.50 million cubic meters, of which 1.57 million cubic meters is taken from the outer approach channel, and 0.93 million cubic meters from the lagoon. From Table-2.4.2, it appears that the maintenance dredging volume varies from year to year and shows a high value every alternate year. The main reasons for the variation of dredged volume in various years are as follows:

1) The siltation volume to be dredged is roughly of the order of 3 million cubic meters and hence the maintenance dredging volume over 3 million cubic meters can be considered normal.

2) The maintenance dredging volume less than 2 million cubic meters is small compared with the siltation volume to be dredged. This situation occurs from the following reasons.

   (a) Financial constraints

   (b) Dredgers are sometimes deployed in a hard patch area, hence the dredging in the channel can not be carried out to the required depth and width.

   (c) Non-availability of dredgers due to the deployment of dredgers at another ports.

Although the outer approach channel in the original plan is 5,340m long, 245m wide and -13.5m deep, the maintenance dredging in the outer approach channel is being carried out for a limited width of 152m and also a limited depth of -12.5m due to the above mentioned constraints. The maintenance dredging in the lagoon is also limited to a specified depth which is less than that of the original plan.

To investigate the actual situations of siltation, sounding maps for the latest five years prepared by the New Mangalore Port Trust (NMPT) have been analyzed. From these analysis, the characteristics of siltation in the outer approach channel and the lagoon is summarized as follows.

Table-2.4.1 The yearly volume of the maintenance dredging

(Kamath*) unit:cubic meters

year	channel(a)	lagoon(b)	(a)+(b)
1982	1,242,600	444,300	1,686,900
1983	1,934,350	1,178,760	3,113,110
1984	1,026,450	824,750	1,851,200
1985	2,062,490	1,234,400	3,296,890
1986	1,088,928	871,964	1,960,901
1987	2,039,688	1,053,306	3,092,994
mean	1,565,751	934,580	2,500,311

* M.M. Kamath, Dredging for Port Development, Case Study, Maintenance Dredging Practice at New Mangalore Port

1) Table 2.4.2 shows the total siltation volume during the monsoon season of every year. This table was made by the comparison of sounding maps surveyed at pre-monsoon and post monsoon periods. The surveys at pre-monsoon were carried out in April or May, and the surveys at post-monsoon in September or October.

According to Table-2.4.2 the siltation volume in the outer approach channel amounts to about two million cubic meters or more. There are some years when the volume approaches nearly three million cubic meters. The siltation volume in the lagoon is about 0.95 million cubic meters on the average of four years except 1989.

2) As for distribution of the siltation volume, the depth of siltation is maximum in the area on both side of the base line in the outer approach channel and the lagoon. The depth of siltation decreases with the distance from the area of maximum siltation.

Table-2.4.2 The siltation volume during one monsoon season

unit:cubic meters

year	channel(a)	lagoon(b)	(a)+(b)	dredging volume per year
1984	2,195,450	-	-	1,851,200
1985	1,911,000	1,152,000	3,063,000	3,296,890
1986	1,700,000*	812,500	2,512,500	1,960,892
1987	2,826,625	968,500	3,795,125	3,092,994
1988	2,971,750	861,900	3,833,650	-
1989	-	691,100	-	-

* The siltation volume in the channel in 1986 calculated by the above method was 0.63 million cubic meters. However, in the year a dredging operation was partially carried out in the channel before the post monsoon soundings. Therefore, the siltation volume in the channel in 1986 was taken from the value calculated by the NMPT using another method.

However, as can be detected by a detailed examination of depth surveyed just after monsoon (abbreviated to POM depth, hereafter), the area where the POM depth is the shallowest is often located 0.5 km to 1.5 km west (offshore) of the base line rather than in the vicinity of the base line. To see this in more detail, Figure-2.3.5 shows the depth in the channel, for 1987 and 1988. In these years the siltation volumes in the channel were very large. In the figure, both the PRM (depth surveyed at pre-monsoon) and POM depths on the center line are plotted in addition to the POM depth on the line 400 m north of the center line. From this figure it is noticed that the POM depth on the center line is the shallowest in the area 1.0 km to 1.5 km west of the base line.

In addition, a conspicuous feature in the figure is that the POM depth on the center line is very similar to the depth on the line 400 m north of the center line in the offshore area which is more than 2 km to 2.5 km from the base line. This indicates that the channel lying more than 2 km to 2.5 km offshore from the base line is completely filled up with sediments during a southwest monsoon season.

3) The depth in the channel and the lagoon measured in the post monsoon season is fairly uniform both along and across the center line.

4) Comparing depths between the post monsoon and pre-dredging times and also between the post dredging and the pre-monsoon times, it is found that changes of depths during these periods are very small in both the channel and the lagoon and there is even a tendency for depths to slightly increase.

Therefore, it is clear that most of annual siltation takes place during the southwest monsoon period.

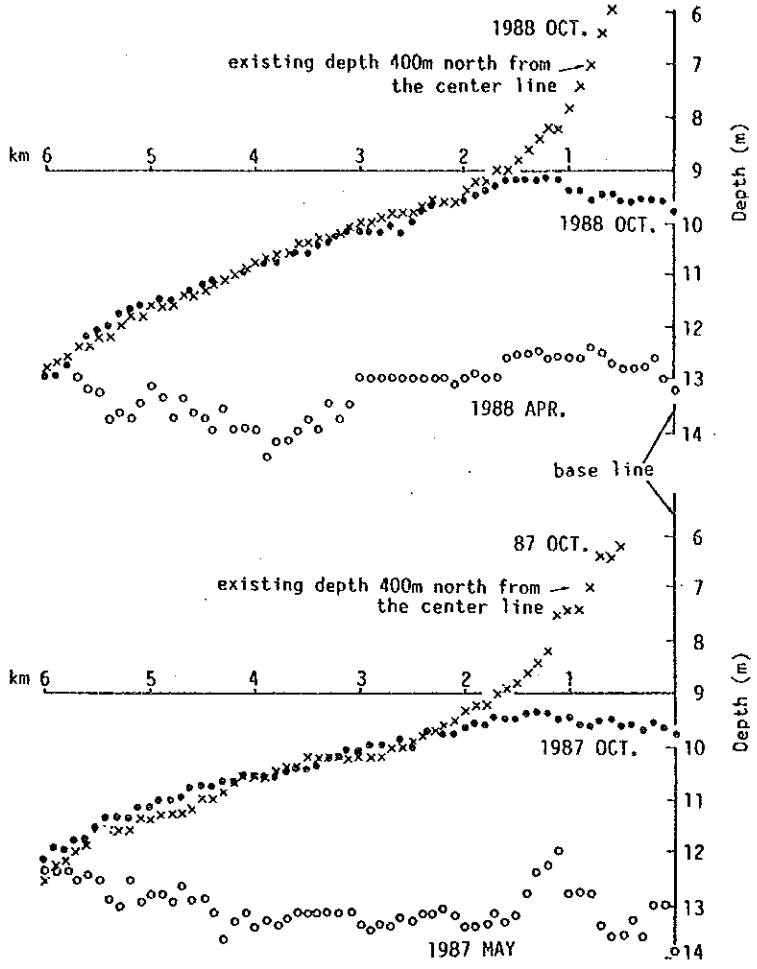

Figure-2.4.5 Distribution of the depth along the center line (A comparison between the pre-monsoon and the post monsoon survey 1987,1988)

(2) Characteristics of Sediment

The New Mangalore Port Trust (NMPT) has conducted soil sampling and analysis every year since 1984. The soil sampling is conducted along three lines; the center line and the lines 700 m north and south of the center line. A summary of the soil survey in 1986, when two sampling operations were conducted in the pre-monsoon (May) and the post monsoon (September) periods, is presented in Table-2.4.3. Data within a distance of 250 m from the shore line on the northern and southern lines are excluded from the table.

According to the table, the silt and clay content in the post monsoon period is generally greater than 80 % and the overall average of silt and

clay content is about 85 % or more on all three lines. However along the lines 700 m north and south of the center line there is no silt and clay but only fine sand from the base line to 250 m offshore.

This implies that the materials responsible for siltation in the channel and the lagoon are the sediments widely distributed in the area beyond 250 m offshore from the shore line with depth greater than about 5 m. The fact that there is no silt and clay in the onshore area, which is shallower than about 5 m, suggests that these shallow areas are zones of breaking waves where silt and clay can not remain on the bottom since they are always suspended in water by the breaking waves and flow towards offshore.

Table-2.4.3 The summary of soil surveys conducted by the NMPT in 1986
Contents of silt and clay, %

Location		May	September
center line	mean	70	84
	range	55 to 85	73 to 91
	standard deviation	10	6
lagoon	mean	74	85
	range	63 to 81	79 to 91
	standard deviation	6	4
700 m north from c/l	mean	74	91
	range	67 to 81	85 to 95
	standard deviation	4	3
700 m south from c/l	mean	63	88
	range	48 to 78	85 to 90
	standard deviation	12	1

Note: For the two lines 700m north and south of the center line silt and clay content of the samples in the onshore area from the base line to 250m offshore are zero and they are excluded in calculations of the mean etc.

3. PRESENT SHIPPING AND CARGO TRAFFIC

3.1 Present Shipping Traffic

3.1.1 No. of Vessels Calling at the Port

Table-3.1.1 shows the number of vessels calling at the port. This table shows that the number of vessels has increased by 1.88 times between 1980-81 and 1987-88. The increase in the number of vessels handled was mainly due to an increase in calls by iron ore carriers.

Table-3.1.1 No. of Vessels Calling at New Mangalore Port

Period	1980-81	81-82	82-83	83-84	84-85	85-86	86-87	87-88
Foreign Trade	167	200	215	255	293	234	319	344
Domestic Trade	60	54	40	44	49	65	86	82
TOTAL	227	254	255	299	342	309	405	426

3.1.2 Vessel Types and Sizes

Table-3.1.2 explains the number of vessels by type handled at the port between the 1980-81 period and the 1987-88 period and shows that both tankers and bulk carriers increased drastically in number between 1985-86 and 1986-87.

Table-3.1.2 No. of Vessels Calling at New Mangalore Port by Type

Period	1980-81	81-82	82-83	83-84	84-85	85-86	86-87	87-88
Bulk Carriers	26	40	43	69	82	68	116	120
General Cargo	163	159	152	172	189	173	182	201
Tankers	38	55	60	53	71	68	107	105
TOTAL	227	254	255	294	342	309	405	426

Bulk Carriers: Fertilizer, Iron Ore, Other One, Steel Scrap, Coal
General Cargo: Cement, Timber, Other Cargo
Tankers : P.O.L., Liquid Ammonia, Phosphoric Acid, Edible Oil

The number of vessels handled at the iron ore berth and the oil jetty in 1988-89 by DWT class is shown in Table-3.1.3 and 3.1.4.

Table-3.1.3 DWT of Vessels which moored at the Iron One Berth (1988/89)

Vessel Size (DWT)	No. of Vessel
0 - 9,999	0
10,000 - 19,999	7
20,000 - 29,999	39
30,000 - 39,999	21
40,000 - 49,999	31
50,000 - 59,999	10
60,000 - 69,999	19
70,000 - 79,999	8
80,000 -	0
TOTAL	135

Table-3.1.4 DWT of Vessels which moored at the Oil Jetty (1988/89)

Vessel Size (DWT)	No. of Vessel
0 - 4,999	1
5,000 - 9,999	8
10,000 - 14,999	0
15,000 - 19,999	24
20,000 - 24,999	20
25,000 - 29,999	20
30,000 - 34,999	2
35,000 -	0
TOTAL	75

3.2 Present Cargo Traffic

3.2.1 Cargo Traffic Volume

Table-3.2.1 show export and import cargo traffic at the port from 1980-81 to 1988-89 and indicates that about seven times the cargo volume handled in 1980-81 was handled in 1988-89. The drastic increase in export cargo volume is mainly due to the increase in iron ore exports by Kudremukh Iron Ore Company Limited (K.I.O.C.L.).

Table-3.2.1 Cargo Traffic Through New Mangalore Port

('000 t)

Period	1980-81	81-82	82-83	83-84	84-85	85-86	86-87	87-88	88-89
Export	323	830	1431	1595	2387	2690	4243	4803	5517
Import	639	822	851	1242	995	996	1197	1305	1567
TOTAL	962	1652	2282	2837	3382	3686	5431	6108	7084

3.2.2 Cargo Traffic by Commodity

(Exports)

The predominant export cargo is iron ore, which has been handled on a large scale since 1981-82 and accounted for 90.8% of the port's total export cargo as expressed in tonnage in 1988-89. The other main export commodities are granite stone, coffee, manganese ore and chrome ore (Table-3.2.2).

Table-3.2.2 Cargo Traffic by Commodity Through New Mangalore Port(Exports)

('000 t)

Period	1980-81	81-82	82-83	83-84	84-85	85-86	86-87	87-88	88-89
Iron Ore	3	547	1122	1231	1727	2260	3873	4357	5011
Other Ore	43	66	70	47	94	80	37	47	33
Granite Stone	174	118	147	168	273	215	244	314	386
Coffee	63	45	47	39	32	43	49	46	43
Others	40	54	45	110	261	92	31	39	44
TOTAL	323	830	1431	1595	2387	2690	4243	4803	5517

(Imports)

The current main commodities handled at the port are P.O.L, timber, fertilizer materials and steel scrap.

The volume of each commodity handled at the port in the past decade is shown in Table-3.2.3.

Table-3.2.3 Cargo Traffic by Commodity Through New Mangalore Port(Imports)

('000 t)

Period	1980-81	81-82	82-83	83-84	84-85	85-86	86-87	87-88	88-89
Cement	87	86	278	359	36	41	14	1	1
Fertilizer	207	180	153	211	247	219	165	93	46
Steel Scrap	21	37	42	39	59	81	120	90	117
Timber	0	0	0	0	0	65	204	342	375
P.O.L.	310	364	351	348	437	412	533	461	571
Lq. Ammonia /Phos. Acid	0	0	0	0	16	17	57	79	141
Edible Oil	0	0	0	0	27	47	57	116	42
Food Grains	4	152	22	141	83	0	0	2	62
Others	10	3	5	144	90	111	47	121	212
TOTAL	639	822	851	1242	995	996	1197	1305	1567

(Container Cargo)

The number of containers in TEU, loaded and empty, handled at the port in the past five years is shown in Table-3.2.4. The containerized cargo tonnage is shown in Table-3.2.5.

Table-3.2.4 Containers Handled at New Mangalore Port

units in TEU

Period	Shipped		Landed		TOTAL
	Empty	Loaded	Empty	Loaded	
1984-85	182	472	380	213	1247
1985-86	403	515	528	367	1813
1986-87	164	1369	1198	329	3060
1987-88	865	752	597	817	3031
1988-89	635	488	383	720	2226

Table-3.2.5 Tonnage Handled in Containers through New Mangalore Port

Period	Tonnes
1984-85	8303
1985-86	8828
1986-87	24054
1987-88	21130
1988-89	20461

4. PORT MANAGEMENT AND OPERATION

4.1 Performance of Ships

The performance of ships by ship type among major ports in 1986/87 is compared based on the following three indicators:

A. Average output per effective working hour

This indicator shows the cargo handling efficiency at the ship face during net working hours per ship. The non-working time at the berth, which reduces the output, is excluded.

B. Average non-working time at berth

This indicator shows the importance of factors limiting cargo-handling operations at ship face, taking into account that some portion of this time is unavoidable from the viewpoint of ship maneuvering. This indicator is not influenced by ship size or parcel size.

C. Average pre-berthing waiting time

This indicates the importance of factors such as the non-availability of suitable berths in the port.

4.1.1 Break bulk ships

The table below shows the performance of break bulk ships in ports:

Table-4.1.1 Comparison of Ship Performance (Break bulk)

Port	Indicator A	Indicator B	Indicator C
New Mangalore	46 tonnes	3.58	1.36
Calcutta	24	4.64	0.73
Haldia	39	3.87	2.85
Bombay	38	2.90	0.27
Madras	56	2.28	0.47
Cochin	34	2.43	0.83
Visag	50	2.17	0.67
Mormugao	30	3.07	2.28
Paradip	25	1.96	1.45
Tuticorin	42	2.00	0.17

4.1.2 Dry bulk ships (Mechanized operation)

The table below shows the performance of dry bulk ships operated mechanically:

Table-4.1.2 Comparison of Ship Performance (Dry-bulk Mechanized)

Port	Indicator A	Indicator B	Indicator
New Mangalore	1,243 tonnes	0.87	5.16
Haldia	610	3.03	1.33
Madras	3,480	1.24	0.98
Visag	1,694	3.13	1.81
Mormugao	821	0.86	3.75
Paradip	1,447	2.20	4.82
Tuticorin	433	0.43	0.71

4.1.3 Dry bulk ships (Conventional operation)

The table below shows the performance of dry bulk ships operated conventionally.

Table-4.1.3 Comparison of Ship Performance (Dry bulk Conventional)

Port	Indicator A	Indicator B	Indicator C
New Mangalore	49 tonnes	18.5	3.94
Calcutta	32	5.04	0.97
Haldia	113	1.98	2.76
Bombay	63	3.47	2.30
Madras	89	5.26	1.31
Cochin	51	13.58	3.47
Visag	56	3.67	1.69
Mormugao	93	4.46	0.54
Paradip	131	1.74	2.01
Tuticorin	81	1.30	0.20

4.2 Profits and Losses

The table below shows the Profits and Losses of N.M.P.T:

Table-4.2.1 Profit & Loss (1983/84 - 1987/88)

	83/84	84/85	85/86	87/88	88/89
Operating Income	83,768	106,720	131,378	179,041	196,438
Operating Expenditure	67,870	84,472	104,169	112,003	131,898
Operating Surplus(+) Deficit(-)	15,898	22,248	27,209	67,038	64,540
(+) Financial & Misc. Income	9,746	13,381	9,728	12,494	11,904
Balance	25,644	35,629	36,937	79,532	76,544
(-) Financial & Misc. Expenditure	12,904	17,857	27,524	47,087	47,618
Balance	12,740	17,772	9,413	32,445	28,826
(+) Amount withdrawn from Reserves	-	-	-	-	-
Balance	12,740	17,772	9,413	32,445	28,826
(+) Transfer to Funds Debt charges etc.	125	125	125	2,520	7,605
Net Surplus (+) Deficit (-)	12,615	17,647	9,288	29,925	21,221