14. Port Master Plan for 2020

14.1 Basic Requirements

(1) Design ship for container terminals

Taking into account ever-enlarging vessel sizes, an 8,000TEUs container vessel is adopted as the design ship for transshipment terminals. The dimensions of the design ship are 390m in length, 48m in width, and 16m in draft. To cater for this size of vessel, new transshipment terminals need to have an alongside depth of 18m.

(2) Navigational safety

The width of the approach channel should be equal to the length of the design ship to ensure safe and smooth vessel maneuvering. The minimum under-keel clearance is 10% of the design ship inside the harbor and 15% in the outer approach channel.

The navigable width at the present harbor entrance is 250m. With a growing number of calling vessels taken into consideration, the harbor entrance needs to be widened to enable the vessels to pass each other. When a ship makes a bow turning with tugboats assistance, the turning circle needs to have a diameter of double the length of the design ship. This is also the case with ships with thrusters.

(3) Calmness in the channels and basins

Breakwaters have to be provided to ensure smooth maneuvering in turning basins and safe mooring at quays. Quayside wave height ($H_{1/3}$) should be lower than 50cm during over 95 % of a year. The master plan is expected to propose a port geometry which can reduce surge.

(4) Interface with the hinterland

Port areas should be grouped according to the activities. A proper zoning plan has to be prepared to separate different port activities, thus avoiding congestion and ensuring efficient operation. Smooth interface of the port and the hinterland is indispensable to ensure the maximum efficiency of economic activities.

(5) Flexibility in the pace of development

Layout plans need to ensure flexibility in the pace of the development. Therefore, phased planning has to be envisaged in layout plans from the start.

(6) Environmental concerns

Impacts of the port development on the environment need to be minimized. Mangrove culture and coastal erosion are some of the main concerns

(7) Construction costs

Configuration of the main port facilities needs to be proposed so as to minimize the construction costs. The balance between dredging volume and reclamation volume is one of the key factors impacting on the overall costs.

14.2 Specific Requirements

14.2.1 Royal Navy

A future frigate with LOA of 125m, and draft of 5.5m is considered to be the design vessel. Royal Navy needs a quay of 300 m in length. The entrance should be available 24hours a day and be provided with a minimum turning circle of 250m in diameter. The required water depth is – 7m for a future frigate, or 1.5m below the draft of the ship.

14.2.2 Royal Yacht Squadron

The design vessel is 150m in length and needs a minimum alongside depth of 8.4m. A minimum berth frontage of approximately 400m is required to provide suitable alongside berths for the three major ships. For the boats, a berth frontage of approximately 90m with boat mooring pontoons along the length of the jetty is needed. The water depth of the basin should be consistent with the dimension of the major ships.

14.3 Development Sites

14.3.1 Characteristics of the Project Area

The topography of the coastal areas to the east and west of Port Salalah differs sharply. The coast to the east of the port is a flat beach open to the sea. The coast to the west of the port is a rocky cliff with small bays. Neither coast can provide a natural harbor. The western coast is out of the question as a development site for the port expansion. The land behind the coast is hilly and not suitable for development. In addition, the cliffs precipitously fall into the sea to the depth of 30m within one kilometer from the shoreline. On the other hand, the eastern coast provides a gentle slope with a gradient of 1 to 200. Development sites are therefore limited to the eastern coasts.

14.3.2 Constraints to the Port Expansion

The eastern coast has the following constraints as a development site:

(1) Wadis
(2) Fishery harbor
(3) Mangrove communities
(4) Coastal erosion
(5) Wave

14.3.3 Evaluation of the Project Area

The Study Team evaluated the project area to identify prospective development sites. The project area was divided into one square kilometer grids and then each grid was evaluated taking into account the above mentioned constraints. Taken together, the study findings support a port expansion in the direction of east to northeast.

14.4 Alternative Layouts

14.4.1 Identification of the Prospective Development Sites

The Study Team identified five prospective development sites taking into account the evaluation of the project area, the layout of the existing facilities, and the topography of the area (See Figure 14.4.1). The five sites were then evaluated from various viewpoints (See Table 14.4.1). Though each site has advantages and disadvantages, Site A is slightly preferable to Site B and C from a viewpoint of natural conditions. Site D is clearly inferior to the other four because of environmental concerns.

14.4.2 Conceptual Layouts

Due to the topographical constraints mentioned in section 14.3.2, a large-scale reclamation directly extended from the present shoreline behind Site B was excluded in the alternative formulation. A large-scale development at Site D was also excluded for the reasons mentioned in section 14.4.1. Bearing these factors in mind, the Study Team prepared three conceptual layout plans and then compared them with the concept of the H.P.A. Layout Plan (See Table 14.4.2).

Based on the comparison among the four conceptual layouts (See Table 14.4.2), the Study Team proposes that Conceptual Layout 3 and H.P.A. layout be further examined. Conceptual Layout 1 is discarded because of a great imbalance between dredging volume and reclamation volume. Conceptual Layout 2 is not recommendable either because it can not respond to further expansion needs in future.

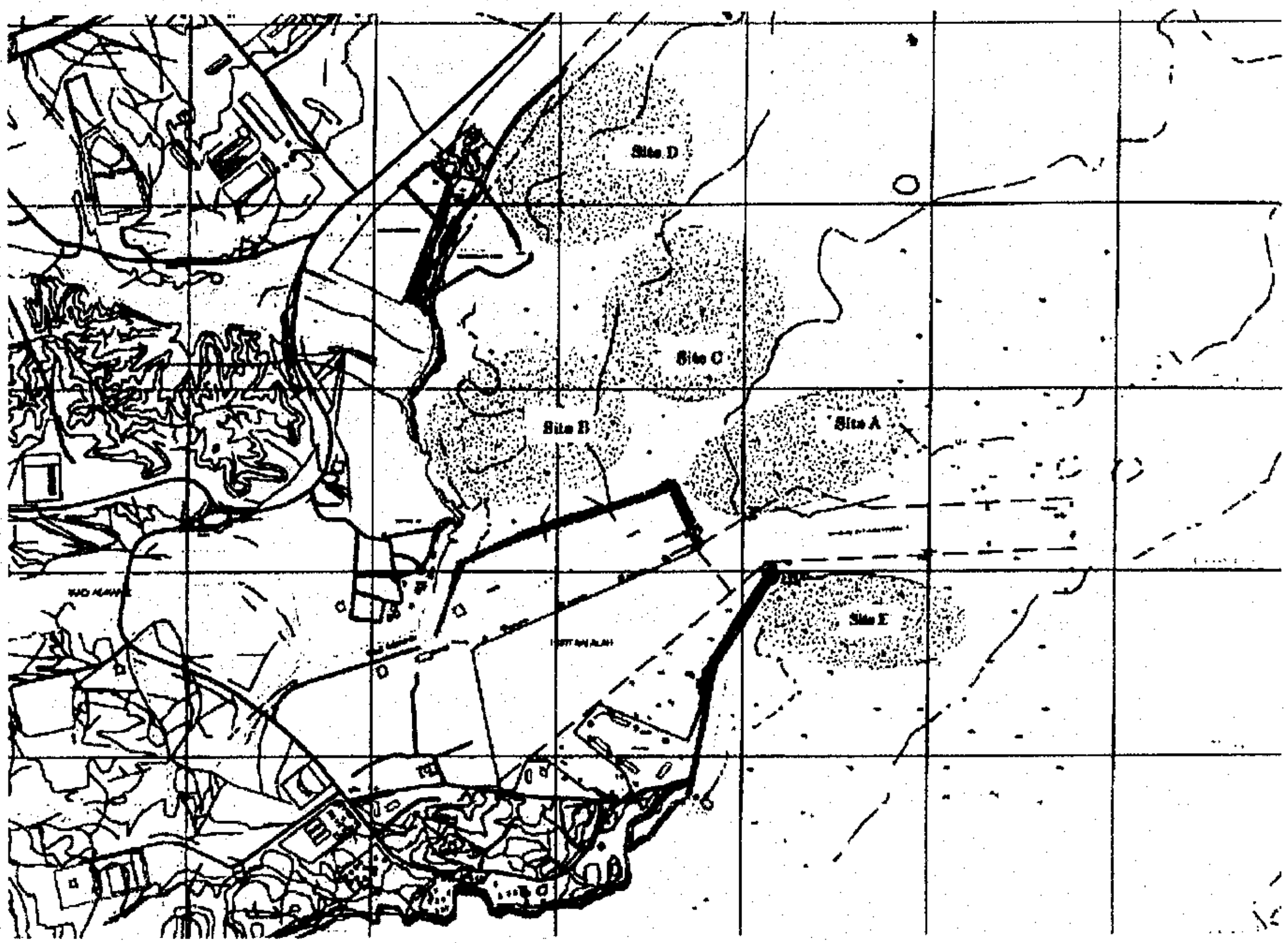


Figure 14.4.1 Development Sites

Table 14.4.1 Observation on the Prospective Development Sites

Alternative sites / Factors	Site A	Site B	Site C	Site D	Site E
Deep-draft quays	Suitable	Large volume of dredging is required	Suitable	Large volume of dredging is required	Suitable
Surge issue	Change in the natural period of the basin needs to be examined	No surge is expected unless another closed basin is created	No surge is expected unless another closed basin is created	No surge is expected unless another closed basin is created	Change in the natural period of the basin needs to be examined
Initial investment	Extension of the east breakwater is necessary	Some measure needs to be taken to provide sufficient shelter from the south to southeast waves	New breakwater is required to provide sufficient shelter from the south to southeast waves	Some measure needs to be taken to provide sufficient shelter from the south to southeast waves	Extension of the east breakwater is necessary
Access from hinterland	Existing terminal road needs to be expanded	New access road is required	New access road connected to other site is required	New access road is required	Existing terminal road needs to be expanded
Maintenance	No major issue is in sight	Wadi Adawnib and Wadi Nar may cause sedimentation	Wadi Adawnib and Wadi Nar may cause sedimentation	Littoral drift needs to be examined	No major issue is in sight
Balance between dredging and reclamation	Reasonable balance is attainable	Dredging volume surpasses reclamation volume	Reasonable balance is attainable	Dredging volume surpasses reclamation volume	Reclamation volume surpasses dredging volume
Coastal erosion	Effects of the extension of the breakwater need to be examined	No major erosion is expected	Effects of the new breakwater need to be examined	Adjacent beach will experience the effects of littoral drift	Effects of the extension of the breakwater need to be examined
Mangrove community	Little impact is expected	Little impact is expected	Little impact is expected	Considerable impact is expected	Little impact is expected

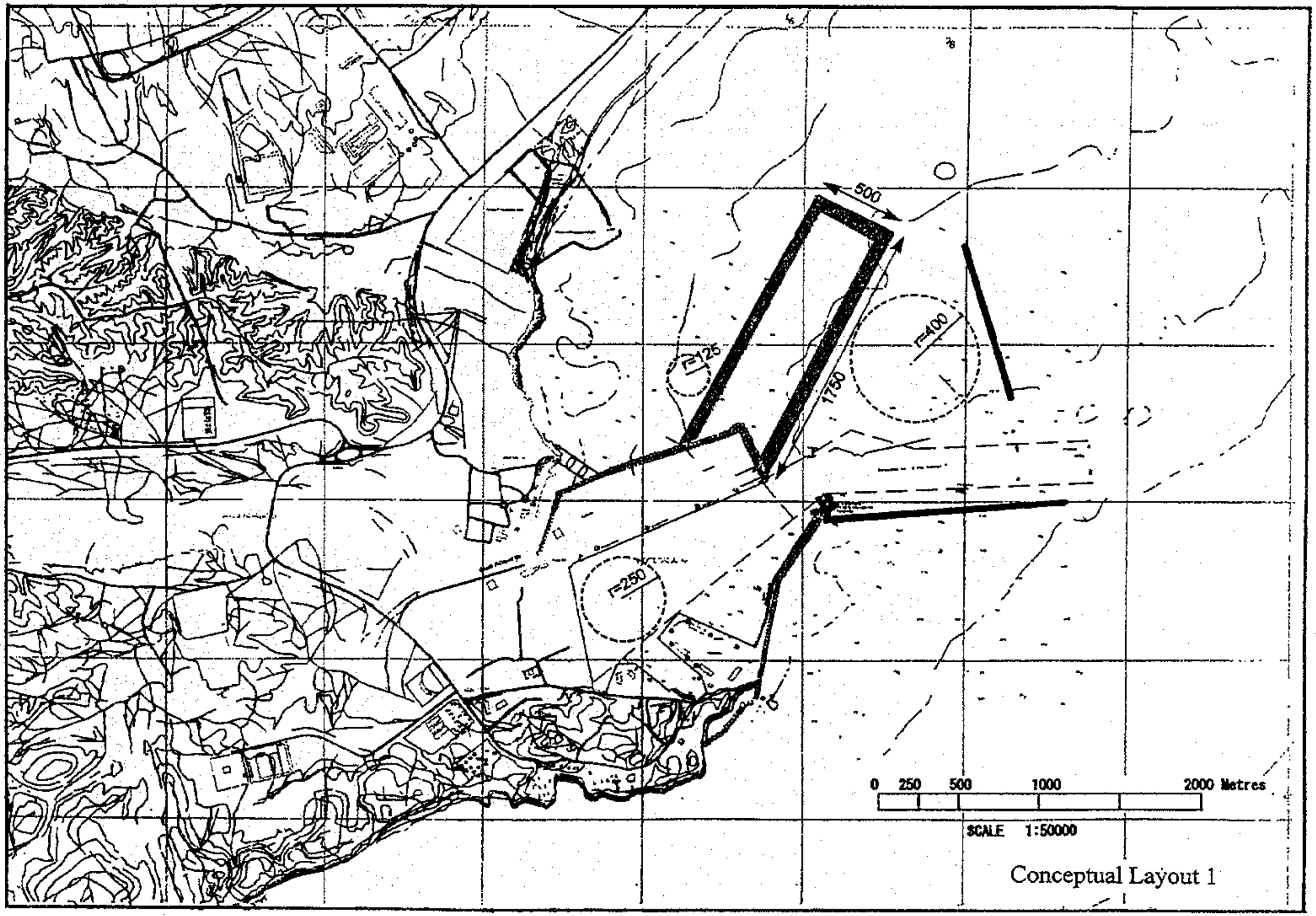


Figure 14.4.2 Conceptual Layout 1

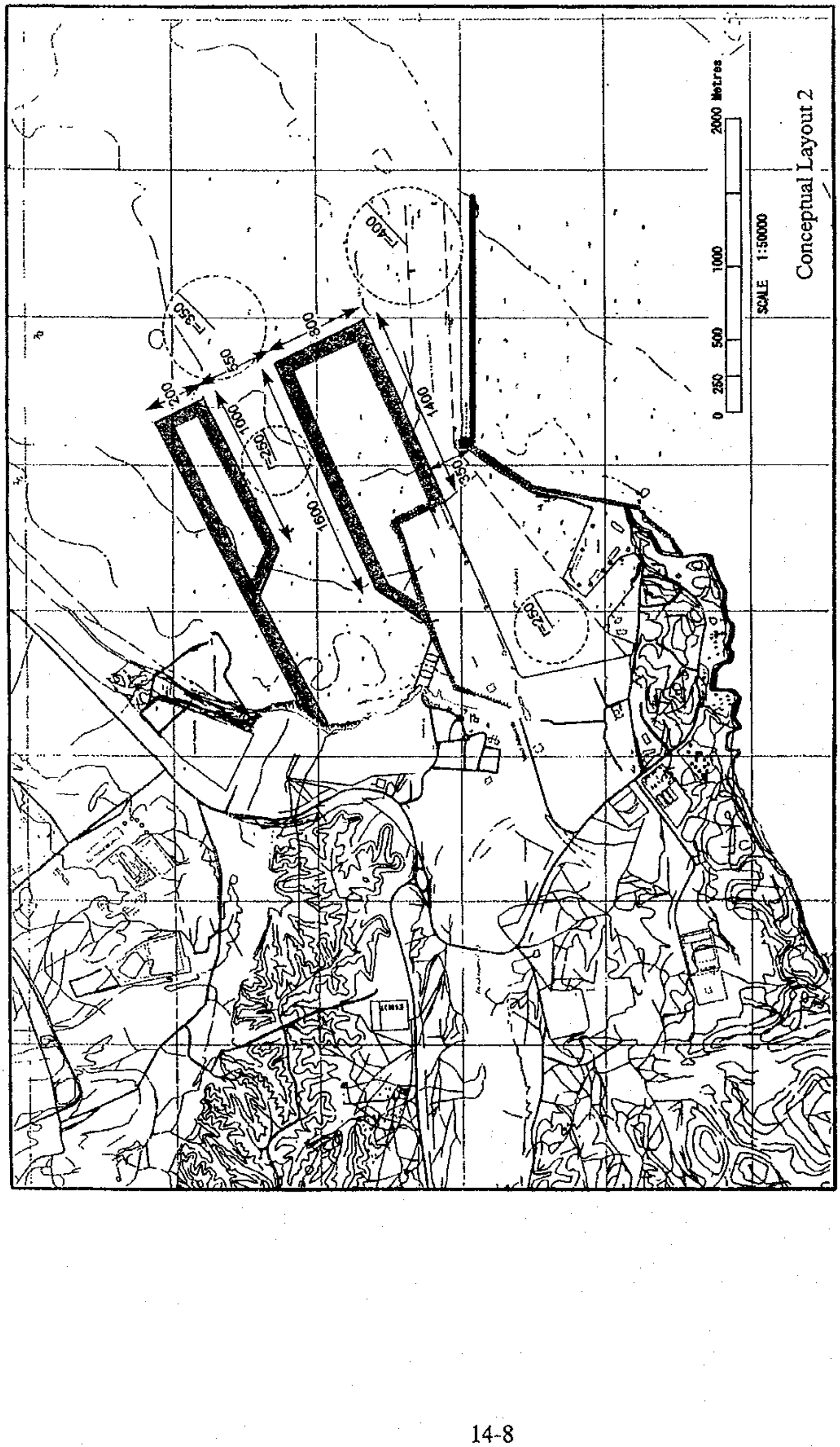


Figure 14.4.3 Conceptual Layout 2

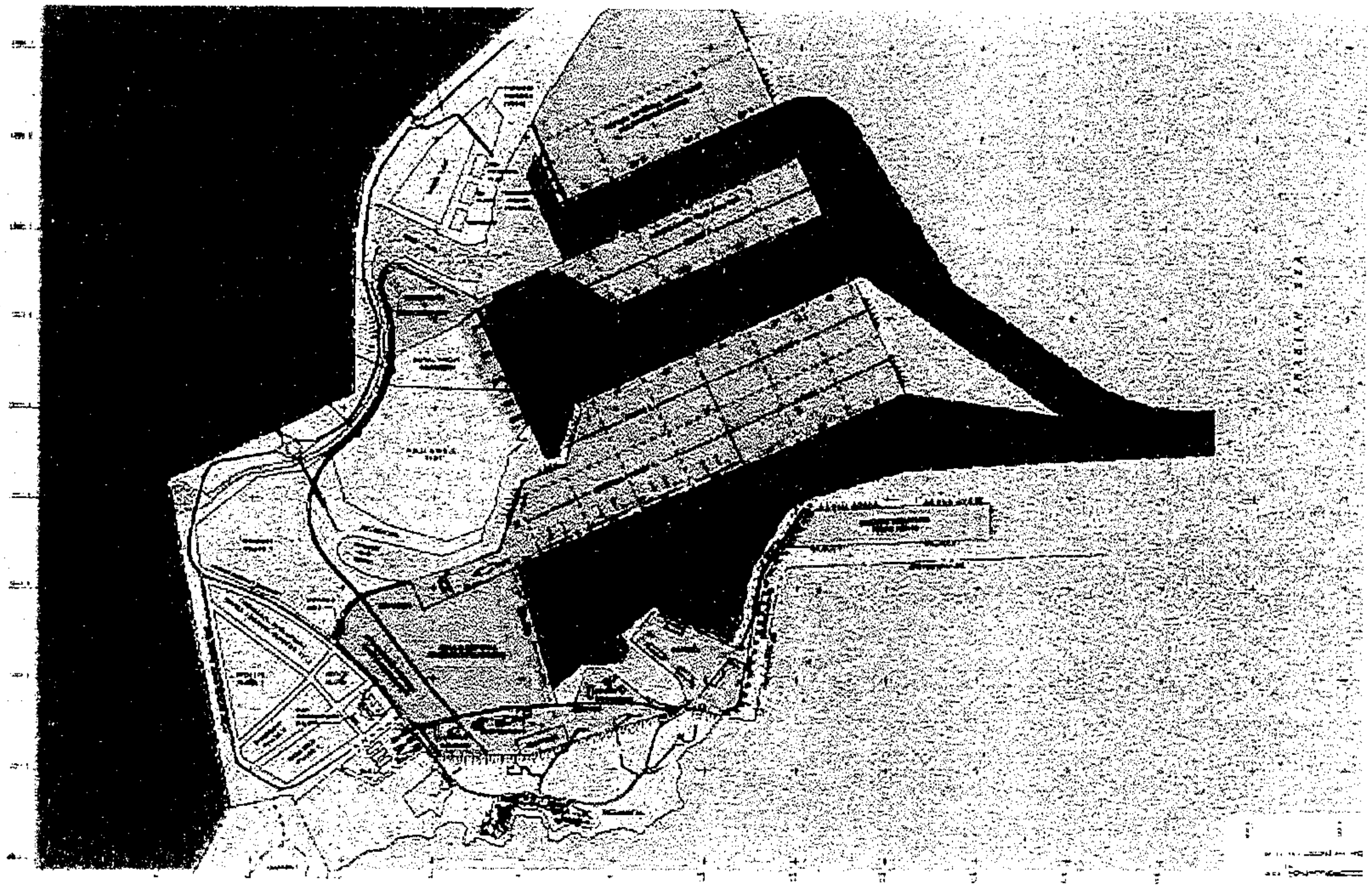


Figure 14.4.4 H.P.A. Layout

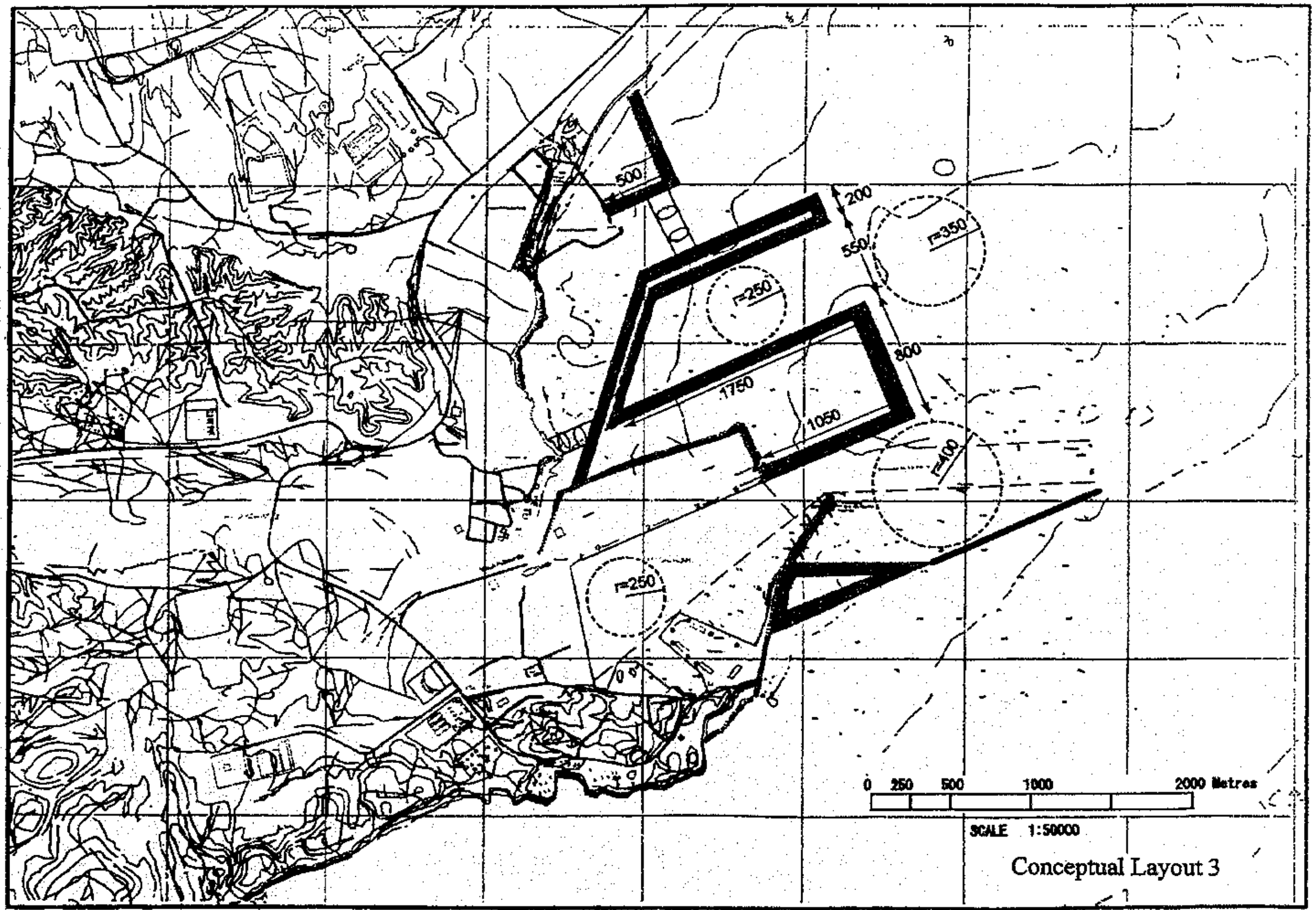


Figure 14.4.5 Conceptual Layout 3

Table 14.4.2 Comparison among the Conceptual Layouts

Alternative Layouts Factors	Conceptual Layout 1	Conceptual Layout 2	H.P.A. Layout Cpncept	Conceptual Layout 3
Access to the hinterland	Three	Two	Four	Four
Navigational safety	Congestion at the harbor entrance needs to be examined	No major issue is in sight	Additional approach channel has a sharp bend, posing difficulty for vessel maneuvers	Vessel maneuvers at the present harbor entrance become much easier
Initial investment	Extension of the east breakwater is needed	Extension of the east breakwater and creation of a offshore breakwater are needed	Extension of the east breakwater is needed	Removal of the half of the east breakwater and construction of a new east breakwater is needed
Future expansion	Further extension of the two piers	Rather difficult	Envisaged at Site D	Envisaged at Site E
Surge issue	Numerical simulation is required for two basins	Numerical simulation is required for the existing basin	Numerical simulation is required for three basins	Numerical simulation is required for two basins
Wadis	Threat from Wadi Adawnib is significantly reduced Wadi Nar poses no problem	Threat from both wadis is significantly reduced	Siltation from Wadi Adawnib needs to be carefully examined	No threat from wadis is expected
Balance between dredging and reclamation	Reclamation volume greatly exceeds dredging volume	Dredging volume exceeds reclamation volume	Reclamation volume exceeds dredging volume unless the future expansion at Site D is included	Reclamation volume exceeds dredging volume
Coastal erosion	Effects of the breakwater extension need to be examined	Change in coastal currents is expected due to the creation of a offshore breakwater	Effects of the breakwater extension and future development at Site D need to be examined	Effects of the breakwater extension need to be examined
Mangrove community	Little impact is expected	Change in coastal currents may have an impact	Future expansion at Site D has an impact	Little impact is expected

14.5 Capacity Requirements

14.5.1 Container Berths

(1) Transshipment

The estimated demand of transshipment container for the year 2020 differs sharply depending on the development scenario. the Study Team proposes 6.2 million TEUs for the high growth scenario and 5.1 million TEUs for the low growth scenario Consequently the additional capacity required for 2020 is in the range of 3.1 million to 4.2 million TEUs.
The Study Team proposes a throughput estimate in the year 2005 with the same sets of scenarios as above.

Table 14.5.1 Additional Container Berths

Year	2005	2020
Container throughput	2.5-3.0 million TEUs	5.1-6.2 million TEUs
Additional berths	2	6-8

(2) Import/Export Containers

The annual throughput of import/export container is estimated to be 0.3 million TEUs at the year 2020 and thus negligibly small compared to the throughput of transshipment container. Since free zone activities is expected to generate most of the import/export container, demand forecast should be reexamined after the free zone starts its operation.

14.5.2 Conventional Berths

The annual throughput of bulk cargo in 2020 is estimated to be 1.9 million tons excluding fuel. The main item is animal feed, cereals, and cement. Since the cargo volume is relatively small, the new bulk terminal should be used as a multi-user terminal rather than as a single user terminal. If a grabbing crane of 800 t/h capacity are installed in one of the new terminal, they can handle up to 1.7 million tons of dry bulk cargo. Therefore, the new bulk terminal has more than enough capacity towards the target year.

The annual throughput of general cargo in 2020 is estimated to be 0.3-0.4 million tons If the bulk cargo is handled at the new bulk terminal, the berth occupancy ratio goes down to 20 %. Therefore, general cargo can be catered for at berths 1-4 towards the target year.

14.5.3 Oil Terminal

The local demand of fuel is expected to experience a marked decline upon completion of a

LNG pipeline. Although the demand will gradually increase afterwards, it will not greatly surpass the current level.Since Salalah is located at the halfway between Singapore and Rotterdam, two of the world's busiest bunkering points, it has a potential to become a major bunkering port. Since bunker oil prices are high in Salalah at present, the prices should be sharply cut in order to materialize the potential demand.

14.5.4 Passenger Terminal

In the year 2020, cruise ships are expected to call at Port Salalah 44-64 vessels a year, or twice to three times as frequently as in 1999. One dedicated passenger terminal is needed toward the end of the planning period.

14.6 Master Plan for 2020

14.6.1 Planning Principles

This master plan is targeted to develop Port Salalah toward 2020 in line with the development needs of the region. Economic viability of the specific projects is dealt with in section 14.8. The master plan also allocates some areas for future expansion which is not required up to 2020 according to the demand forecast.

14.6.2 Layout Plan

Table 14.6.1 Master Plan for 2020

Facility	Dimensions
Additional berths	18m draft container quay: 1,050m 16m draft container quay: 1,750m Passenger berth: 350m Government berth: 800m (Future expansion: 980m with 12m depth)
Additional terminal area	112ha (Additional 42ha for future expansion)
Handling equipment	Container: 15 gantries (18 rows), 9 gantries (22 rows), 48 RTGs, 96 yard tractors Conventional: 1 grab bucket crane
Container handling capacity	6 million TEUs/year
Breakwater	2,550 m
Dredging	17,393,000 m^3 (Additional 331,000 m^2 for future expansion)
Reclamation	15,062,000 m^3 (Additional 7,271,000 m^2 for future expansion)
Total cost	310 million R.O.

14.6.3 Container Terminals

The Study Team sets an 8,000 TEU vessel as the maximum design ship for the master plan (See section 8.1). The Study Team sets 350m as the standard quay length in the master plan. Currently 99% of container vessels are shorter than 300m and thus can safely berth at a 350m quay.

In setting the quay depth, the Study Team took into account the dimensions of the maximum design vessel and the distribution of the size of container vessels. The Study Team proposes that two berths have a depth of 18m and the remaining berths of the terminal have a depth of 16m.

The area for the proposed container terminals is 14 ha. Taking the quay length of 350m into account, the terminal area behind the quay needs to have a depth of 400m. Transfer crane (RTG) system is recommended in the expanded terminals. Since 99% of containers handled in Salalah is transshipment and thus land-side operation is minimal, two RTGs and eight yard tractors per gantry crane will be sufficient for the time being.

14.6.2 Conventional Terminal

Since the bulk cargo projected for 2020 is relatively small and diversified, the master plan proposes to equip the new bulk terminal with a grab bucket crane, which is excellent in versatility.

14.6.3 Oil Terminal

The timing and scale of further development of the oil terminal for bunkering need to be reviewed after bunkering service is started at the refurbished oil pier.

14.6.4 Passenger Terminal

The Study Team proposes that the terminal is 350m in length and 11m in depth which can cater for the longest cruise vessel, Queen Elizabeth 2.

14.6.5 Government Berths

The master plan allocates a quay of 700m to government use, 300m for the Royal Navy and 400m for the Royal Yacht Squadron. The depth alongside is 8.5m to cater for the largest design vessel. Another 100m berth frontage with a pontoon is allocated to the Royal Yacht Squadron for smaller boats. In order to avoid the mixture of different types of traffic, the government berths are linked with the hinterland by a bridge.

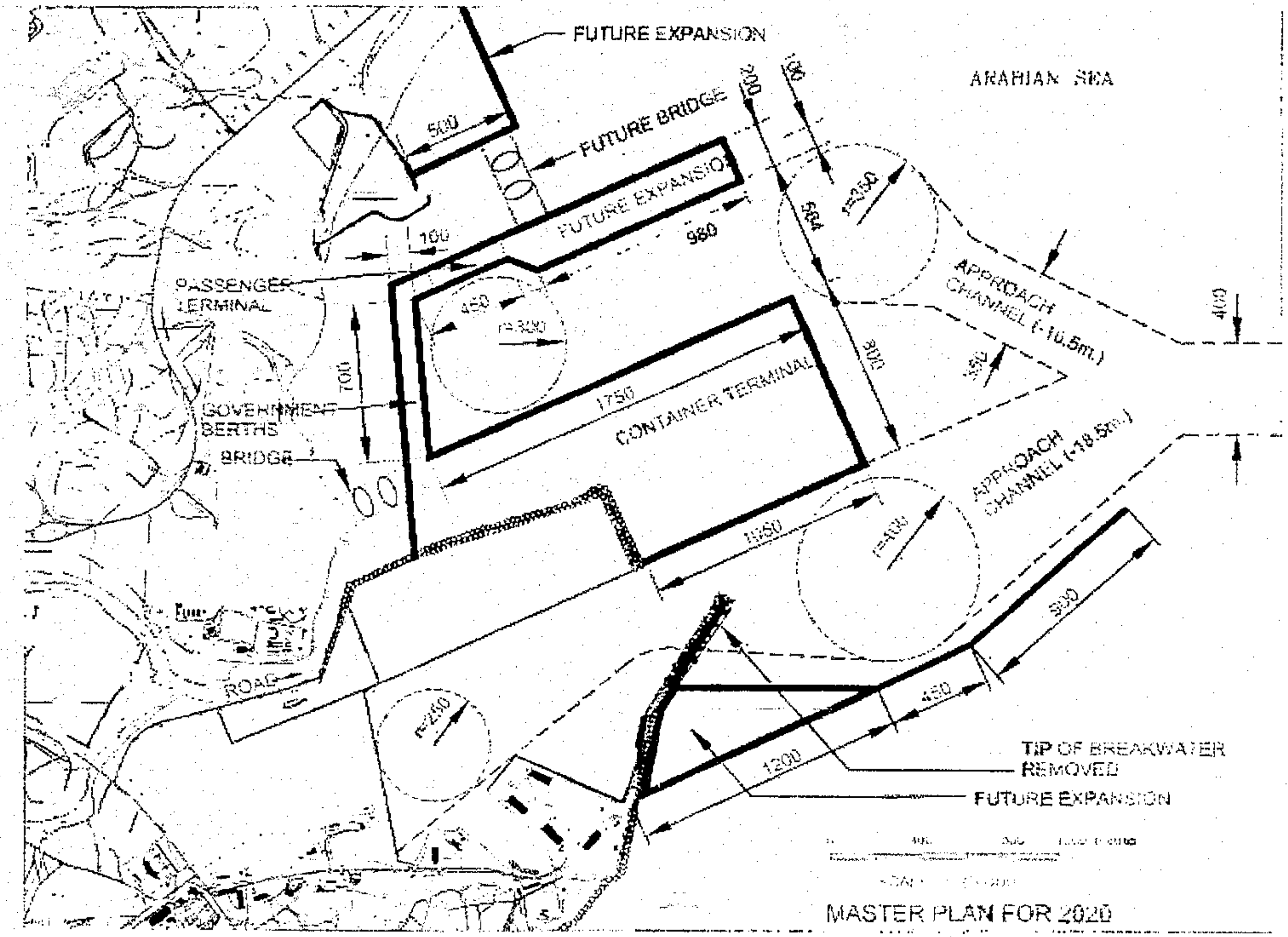


Figure 14.6.1 Master Plan

14.7 Preliminary Engineering Studies

14.7.1 General

The basic engineering concept will be compiled in accordance with the results of the survey to be conducted at the site.

14.7.2 Design Codes and Standard

The design of marine structures such as quay walls revetment, etc., for Salalah Port has been carried out on the basis of Technical Standard for Port and Harbor Facilities in Japan which are used as the basis for port design in Japan as well as in many developing countries world wide.

In the process of designing, technical information in the Sultanate of Oman was adopted with duly considered to reflect local conditions, particularly in the interpretation of structural properties of construction materials available on site and various kinds of environmental conditions, including seismic disturbances.

14.7.3 Comparison Study of Quay wall

Before finalizing the berth structure in the port development plan, it is necessary to select the prospective structural types of the berth for cost and technical comparison.

The soil condition of the proposed site is generally hard rock layer, and steel piles cannot easily be driven in this layer.

For comparison of quay wall type, the following three types was selected; namely,

(1) Block wall type
(2) Pile supported platform Type
(3) Caisson type

As a result, block wall type is recommended based on the soil condition, construction cost, construction equipment, and adjacent terminal quay structures.

14.7.4 Breakwater

The rubble mound type, same as existing east breakwater, is recommended for proposed breakwater considering availability of construction materials, subsoil condition of proposed site, construction cost and construction time.

14.7.5 Dredging and Reclamation

When the present container terminal was constructed in 1997 and 1998, a cutter suction pump dredger dredged the channel area effectively.

The same dredging and reclamation method will be recommended for the proposed port facilities of Salalah Port.

14.7.6 Construction Cost

The cost estimates are primarily based on the unit prices and rates in Salalah derived from the construction material and equipment price survey conducted by the Study Team in Jan. 2000.

The construction cost for Salalah Container Terminal that was completed in 1998 was inferred.

14.7.7 Construction Period

The construction period is primarily based on the natural conditions, material quantity, dredging volume, ability of construction equipment, and existing container terminal construction period are the decisive factor in the overall construction time. These factors were taken into full consideration for the entire construction period.

14.8 Phased Planning

14.8.1 Concepts

The master plan encompasses the port expansion envisaged in 2020. The Study Team classified the port development projects into the following three phases taking into account the demand forecast and the risks entailed:

Phase 1: Container terminal expansion and creation of the government berths (short term)
Phase 2: Further expansion of the container terminal, installment of cargo handling equipment in the new bulk terminal, and creation of a passenger terminal (long term)
Phase 3: Overall port development (future expansion)

14.8.2 Short-term Plan

The capacity of the present container terminal is estimated to be 2 million TEUs. According to the demand forecast, the container throughput is expected to reach that capacity in 2002-2003 (See section 13.3). The demand forecast projects an increase of the throughput to 2.5-3 million TEUs in 2005. In order to meet this growth, construction works for at least two berths should start in 2001 (See Figure 14.8.1).

The Study Team prepared two alternatives for the short-term development within the scope of the master plan for 2020 (See Figure 14.8.2, 14.8.3). One is the northward expansion (Plan A) and the other is the eastward extension (Plan B).

Table 14.8.1 Outline of the Two Alternatives for the Short-term Expansion

Facility	Plan A	Plan B
Additional berths	16m draft container quay: 700m Government berth: 800m	18m draft container quay: 1,050m Government berth: 800m
Additional terminal area	28ha	42ha
Handling equipment	Six gantry cranes (18 rows) 12 RTGs 24 yard tractors	Nine gantry cranes (22 rows) 18 RTGs 36 yard tractors
Container handling capacity	3 million TEUs/year	3.5 million TEUs/year
Breakwater	1,200m	2,550m
Dredging	13,779,000 m^3	6,722,000 m^3
Reclamation	3,060,000 m^3	7,003,000 m^3
Total cost	118 million R.O.	164 million R.O.

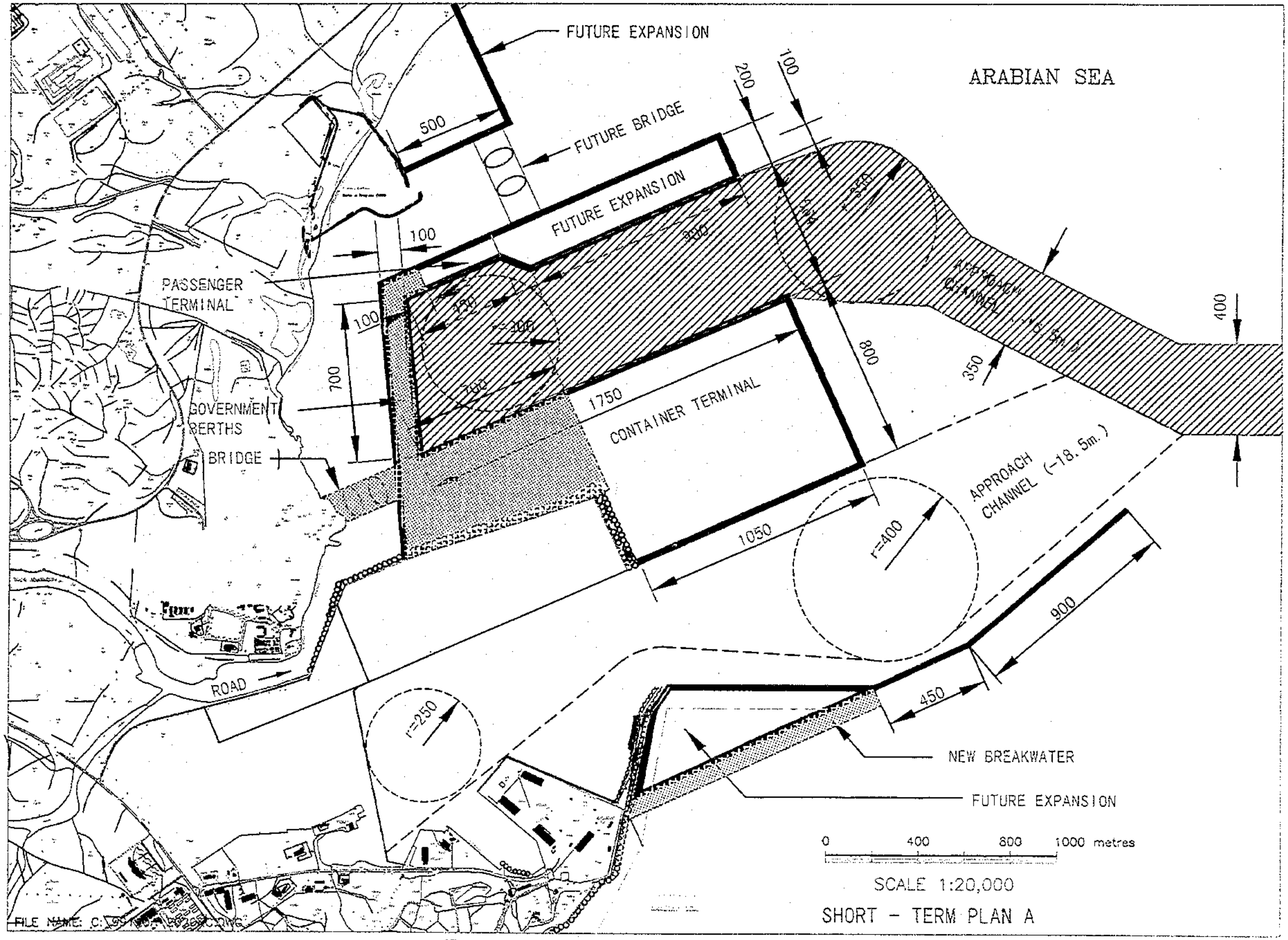


Figure 14.8.2 Short-term Plan A

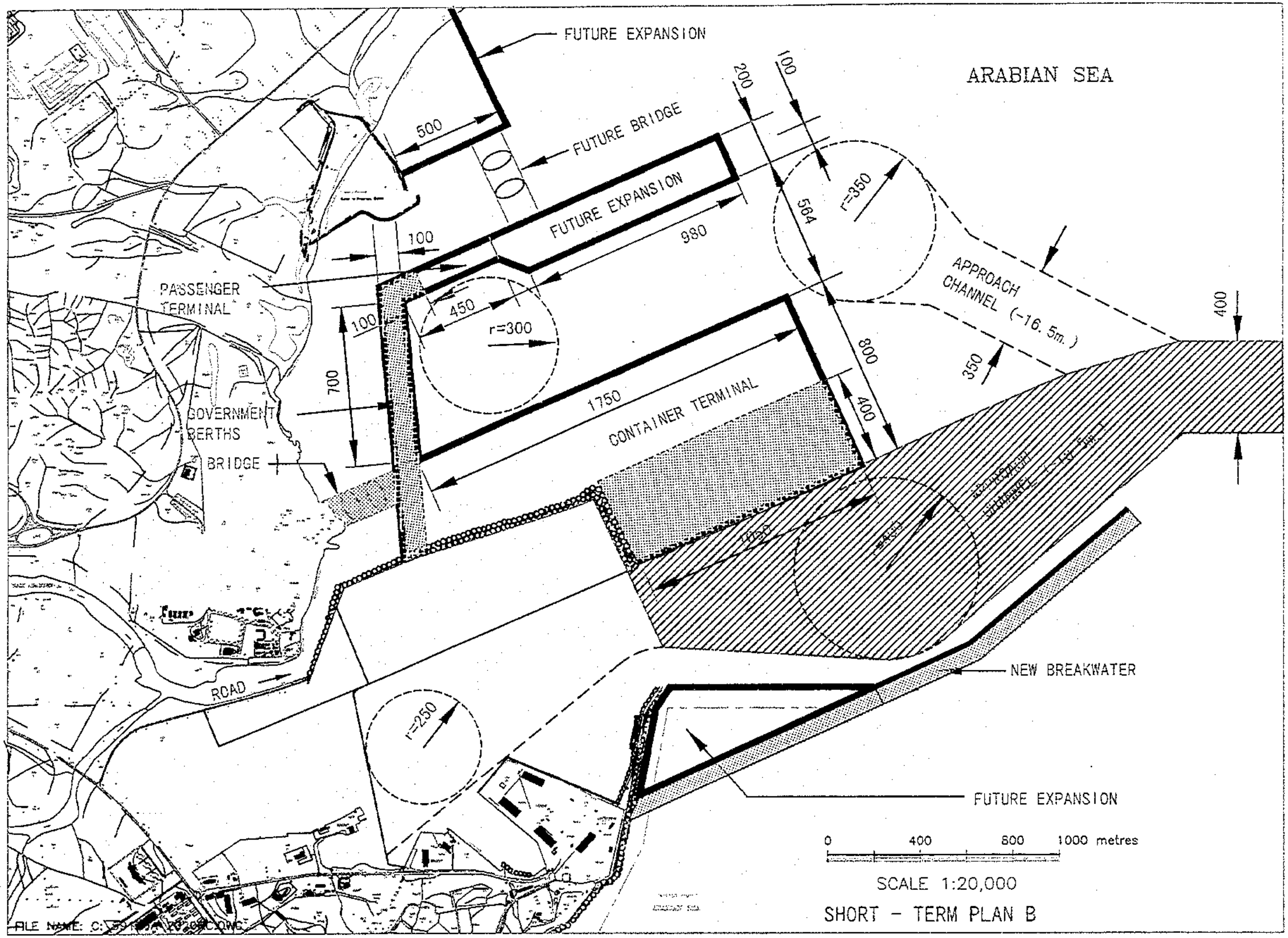


Figure 14.8.3 Short-term Plan B

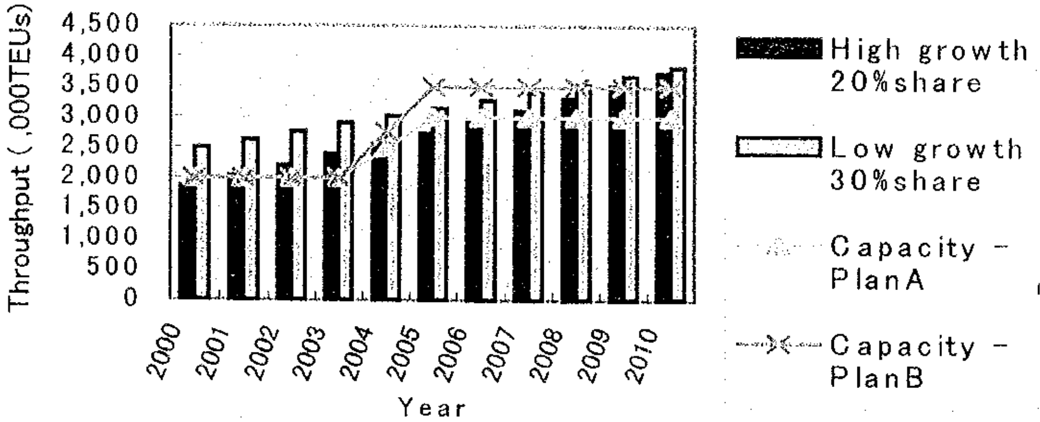


Figure 14.8.1 Estimated Transshipment Demand and Capacity Addition

The Study Team evaluated the two alternatives from various viewpoints. The conclusion is that Plan B is undoubtedly superior to Plan A from the viewpoints of flexible terminal operation, vessels waiting time, and wave disturbance.

14.8.3 Long-term Plan

Port Salalah should always have a spare capacity of not less than 300-400 thousand TEUs/year to capture the potential growth. For that reason, the relevant authorities should take appropriate actions when the spare capacity of the terminal comes close to the minimum spare capacity An expansion project needs to provide a capacity addition of at least 600-800 thousand TEU/year, or double the minimum spare capacity.

A passenger berth of 350m in length is included in the long-term plan. Congestion of the container terminal and the bulk terminal needs to be monitored to determine at what point the construction works of the passenger terminal should be started.

In order to make good use of the new bulk terminal, efficient handling equipment is indispensable. However, it will require users' investment in conveyers and silos as well. Since the existing conventional terminal has capacity large enough to deal with a sizable increase in demand, users are not likely to embark on a large investment in the foreseeable future. Efficient bulk cargo handling system needs to be provided when a large-scale private sector investment in the grain industry comes to the port.

14.8.4 Future Expansion

The Study Team allocated areas for future expansion in the master plan to respond to the projects which can not be proven viable at this time. Those projects include a ship repair yard, a bunker fuel terminal, and additional bulk handling terminals.

14.9 Wave Disturbance

14.9.1 Short-period Waves

The Study Team employed a numerical simulation model (Wave Diffraction Model by Takayama) to evaluate wave disturbance in the port basins caused by short-period waves. Wave height was evaluated in front of the main quays included in the master plan. Table 14.9.1 shows the estimated berth availability, or the proportion of the duration in which wave height is lower than 50 cm at the berth alongside. The Study Team prepared three alternative layouts and found that only master plan 3 provided a satisfactory level of berth availability for all the main quays. Those quays will be available during over 95 % of a year. The Study Team thus determined the configuration of the breakwater. Plan B can provide sufficient protection, while Plan A can not ensure safe berthing.

Table 14.9.2 Berth Availability (short-period waves)

(%)

	Existing layout	Master plan (3)	Short-term plan A	Short-term plan B
Bulk terminal	97.8	97.0	96.6	97.0
Existing container terminal	92.5	96.0	71.9	96.9
Eastward-extended container terminal	-	96.2	-	96.2
Northern basin container terminal	-	98.1	96.5	-
Government berths	-	97.0	50.2	93.1

14.9.2 Long-period Waves

A different numerical simulation model (The Boussinesq Equation Model) was employed to estimate the effects of long-period waves. Characteristics of the incoming long-period waves were determined taking into account the existing survey data. (See 8.2 and Table 14.9.3). The spectrum of incoming long-period waves was assumed as shown in Figure 14.9.2.

Table 14.9.3 Characteristics of Long-period Waves

Wave direction	Period	Spectrum density	Wave height ($H_{1/3}$)
S-SE	12-300 seconds	100 cm² second	11.7 cm

Wave height and wave period were evaluated besides the main quays included in the master plan. Harmful effects of long-period waves will be reduced in the port geometry proposed by the master plan (See Table 14.9.4). Long-period wave motions in front of the existing container terminal will become less serious since the master plan layout can reduce a wider range of energy than the existing one (See Figure 14.9.4). However, further study based on long-period wave observation data will be required to estimate the detailed nature of wave motions. The model testing currently carried out by MOTH will give another perspective on this issue.

Table 14.9.4 Wave Transformation Estimate (long-period waves)

(cm)

	Wave direction	Existing layout	Master plan
Existing container terminal	S	11.7	10.6
	SE	19.4	11.5
Bulk terminal	S	9.1	7.6
	SE	13.7	17.0
Eastward-extended container terminal	S	-	8.3
	SE	-	14.9
Northern basin container terminal	S	-	9.5
	SE	-	11.2
Government berths	S	-	10.4
	SE	-	15.1

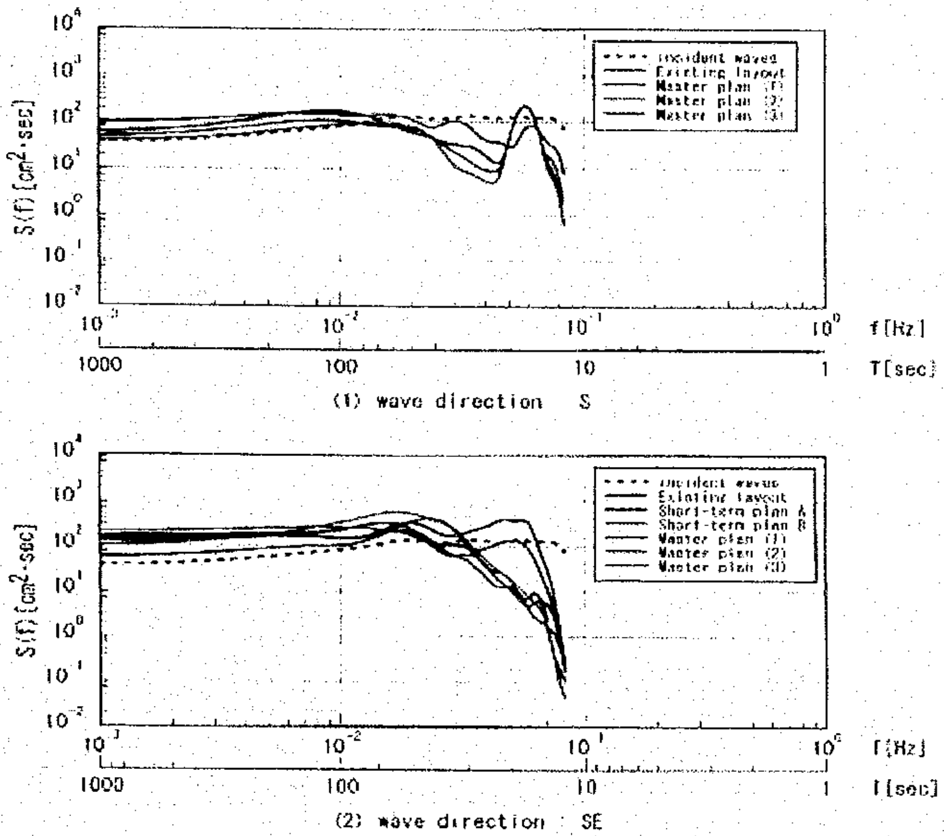


Figure 14.9.4 Energy Spectrum Comparison at the Existing Container Terminal

14.10 Capacity Evaluation

A numerical simulation model, "Witness", was employed to evaluate whether the port capacity would be sufficient to deal with the increasing cargo and vessel traffic throughout the planning period. Characteristics of the calling vessels, productivity of the terminal, navigation requirements were determined as shown in Table 14.10.1.

Table 14.10.1 Calling Vessels Conditions (in 2020)

Vessel type	Frequency of call	Productivity	Cargo volume	Maneuvering and idling time
Container (mother)	22 calls / week	Max 6 gantries 40 TEUs/crane	3.1 million TEUs 2,800 TEUs / vessel	3 hours
Container (feeder)	32 calls / week	Max 3 gantries 40 TEUs/crane	3.1 million TEUs 1,960 TEUs / vessel	2.25 hours
Bulk cement carrier	1 call / week	200 t/hour	500,000 t in total 10,000 t / vessel	2.25 hours
Dry bulk carrier	65 calls / year	500 t /hour	1.3 million t / year 20,000 t / vessel	2.25 hours
General cargo vessel	112 calls / year	Max 2 gangs 30 t/hour/gang	300,000 t / year 2,500 t / vessel	2.25 hours

1) These vessels are taken into account only for evaluating channel congestion

Berth occupancy ratio and average waiting time are shown in Table 14.10.2. This result indicates that the capacity provided by the master plan is sufficient to respond to the vessel traffic in 2020.

Table 14.10.2 Berth Occupancy Ratio

Berth	Berth occupancy ratio
Container berths	0.51
Bulk berths	0.30
General cargo berths	0.14
Oil berths	0.15

Table 14.10.3 Waiting Time

Vessel type	Average waiting time (minutes)
Container vessel (mother)	43
Container vessel (feeder)	55
Bulk cement carrier	197
Dry bulk carrier	106
Fuel tanker (local use)	29
Fuel tanker (bunkering)	88

Table 14.10.3 also indicates that it might be possible to handle containers with fewer berths or lower productivity. This is due to a linear quay alignment which enables flexible crane deployment.

14.11 Economics of Port Development

14.11.1 Purpose and Methodology of the Economic Analysis

This section evaluates the economic cost and benefits so that the government of Oman can compare various projects to assign priority in view of the national economy.

The economic internal rate of return (EIRR) based on the cost-benefit analysis is used to appraise the feasibility of a project from the viewpoint of national economy.

There are 8 cases to be studied in the economic analysis. Major 2 categories stand for the assumption of the cargo demand; low growth with 30% share and high growth with 20% share. Each of these demand growth cases have 4 different cases for port development; Plan A (Short Term), Plan A (Short Term + Long Term), Plan B (Short Term) and Plan B (Short Term + Long Term).

14.11.2 Assumptions

The base year means the starting year of the economic analysis. Taking into consideration the construction schedule, the year 2001 is set as the base year for this study.

Considering the depreciation period of the main infrastructure of the port, and the construction period thereof being 4 years, the period of calculation as the project life in the economic analysis is assumed to be 34 years from the beginning of construction; from the year 2001 to the year 2034.

The exchange rate assumed for this analysis is U.S.$1=0.385R.O.

In this study, the "without" case is defined as follows:

1)No investment is made for the infrastructure and port equipment for the expansion of the container port.
2)Transshipment container cargo volume will increase until it reaches the existing port capacity and then level off.
3)Investment for the Free Trade Zone adjacent to the port is not made, however, the investment for the expansion of the existing Industrial Estate is made as planned.

Since the project is to expand the container port to cater for the increasing transshipment container cargo, the most easily defined difference between "With" case and "Without" case is an increase in the revenue of the container port. In addition to this benefit, an increase in the industrial activities highly dependent on the container port was taken up as a measurable effect of the project. In order to measure this effect, the average value added versus production value in the industrial statistics of Oman was employed.

14.11.3 Economic Pricing

Economic pricing is not made in this economic analysis, as the difference between the market prices and international price is negligibly small in Oman.

14.11.4 Costs and Benefits

(1) Benefits

In view of the financial position of the Oman Government, the payment from SPS based on the concession agreement is the source of revenue. It includes land rent, royalty, franchise fee, income tax from SPS, and 20% of dividend from SPS if it is available.

However, in view of the Oman National Economy, the benefits expected from the port development are those directly or indirectly accrued from port construction and operation, regardless of the fact that they are quantifiable or not. The major ones will be:

1. Port charges paid to SPS,
2. Savings for those who use Salalah port, in terms of costs, time, or other convenience,
3. Value added accrued from the economic activities which will be generated by construction work of the port,
4. Value added accrued from the economic activities which will be generated by industrial development taking advantage of the port development,
5. Increase in employment opportunities accrued from the above port construction, port operation and the industrial development, and
6. Foreign exchange saving and earning from these activities.

Among the above major 6 benefits, 1 (port charges) and 2 (savings of port users) are the benefits arisen directly from the port development project. On the other hand, 3 and 4 are the trickle-down effects of port development. In calculating EIRR, item 1, 2, and 4 of the above benefits were taken in to account.

Benefits 5 and 6 include both direct and indirect benefits from the port development, and may overlap the benefits 1-4.

(2) Costs

Table 14.11.1 summarizes the items included in the financial and economic analysis.

Table14.11.1 Project Evaluation

The following items are counted either as costs or benefits in the financial and economic evaluations

Items	FIRR of SPS	FIRR of the Government	EIRR of Port Development (without secondary benefits)	EIRR of Port Development (including secondary benefits)
Construction of Infrastructure	-	Cost	Cost	Cost
Operation of Infrastructure	Cost	-	Cost	Cost
Procurement of Superstructure	Cost	-	Cost	Cost
Operation of Superstructure	Cost	-	Cost	Cost
Royalty Fee	Cost	Benefit	-	-
Rental Fee	Cost	Benefit	-	-
Franchise Fee	Cost	Benefit	-	-
Corporate Tax	-	Benefit	-	-
Dividend	-	Benefit (20% of the dividend)		
Salary for Employees	Cost	-	Cost	Cost
Port Charge	Benefit	-	Benefit	Benefit
Reduction of Transportation Costs	-	-	Benefit	Benefit
Value Added by Port-related Industries	-	-	-	Benefit (in the case of Omani investment)

14.11.5 Analysis

(1) EIRR

EIRRs of the proposed projects are shown in Table 14.11.2. EIRR is calculated in two cases; depending on whether the value added is included or not in the benefit. Regarding the construction costs of port infrastructure, the following will be the matters to be decided by the project owner (the Government, in this case):

1) Whether the construction costs of the Government berths and bridge should be included in the project costs or not, and
2) Whether all the breakwater construction costs should be shouldered by the short-term project or not.

Therefore, the EIRR calculation assumed three cases, depending on the costs included in the port infrastructure construction, namely,

1) All the port infrastructure construction costs.
2) The port infrastructure construction costs excluding that of the Government berths and bridge.
3) The port infrastructure construction costs excluding that of Government berth and bridge, with a part of breakwater construction costs, spread over to the long-term project.

(2) Conclusion

EIRR of the port development excluding the industrial development turned out to be rather low but fit in the range of 6 to 10%, which is considered to be reasonable for an infrastructure project. On the other hand, EIRR of the port development including Salalah industrial development as a whole will be very high. In addition, other benefits such as increased job opportunities and foreign currency earning, combined with multiplier effect on the general economy in the region would further improve EIRR.

Taking into account the above factors, the Study Team concludes that the proposed project is feasible in view of the national economy of Oman, on condition that an adequate set of policies will be taken for the development of industry and social infrastructure in the region.

Table 14.11.2 EIRR

			Govt FIRR	EIRR					
Benefit				Port charge + Reduction of transportation costs			Port charge + Reduction of transportation costs + Port-related industrial VA		
Costs of infrastructure construction				All costs included	W/O government berth & bridge	W/O government berth & bridge; a part of breakwater cost spread over to the long-term project	All costs included	W/O government berth & bridge	W/O government berth & bridge; a part of breakwater cost spread over to the long-term project
Plan A	Short	High (w/ 20% share)	3.3	7.2	8.2		40.3	42.3	
		Low (w/ 30% share)	3.9	8.0	9		41.3	43.4	
	Short & long	High (w/ 20% share)	5.3	9.4	10.1		48.5	53.0	
		Low (w/ 30% share)	4.8	9.1	9.9		50.9	56.0	
Plan B	Short	High (w/ 20% share)	3.2	6.1	6.7	8.8	34.0	35.4	40.0
		Low (w/ 30% share)	3.9	6.9	7.6	10.0	35.0	36.5	41.4
	Short & long	High (w/ 20% share)	5.5	6.6	6.9	7.4	32.5	33.7	37.5
		Low (w/ 30% share)	3.8	6.3	6.7	8.9	33.4	34.6	38.6

14-12 Financial Analysis

(1) Methodology and assumptions

The analysis focuses on the viability of the project itself and the financial soundness of the project. The financial viability has been evaluated in terms of the Financial Internal Rate of Return (FIRR). Construction is assumed to start in 2001, and commercial operation is assumed to start in mid-2004.

(2) Analyze pattern

The master plan includes two development plans, each with two cases.
Development plan A (short, short + long)
Development plan B (short, short + long)
Two scenarios are used to forecast the cargo handling volume. (In the high growth scenario, Salalah has a 20% share at the total container throughput of the region. In the low growth scenario, Salalah has 30% share). Therefore we calculate FIRR for a total of 8 cases.

GSO is assumed to be the owner of the port facilities and the new terminal is leased to the new terminal management entity. The new terminal management entity will pay the following fees to GSO.
A yearly royalty fee: US$64 thousand per berth to be increased 3% per year.
A yearly rental fee: US$186 thousand per berth to be increased 3% per year.
A yearly franchise fee: 50% of the net profit after tax when exceeding the aggregate of 15% of the Issued Share Capital.

Costs shouldered and revenues obtained by the new terminal management entity are assumed to be as listed in Table 14.12.1.

Table 14.12.1 Cost and Revenue Items

Revenue	Cost
1. Port dues	1. Installation of handling equipment
2. Tug Charges	2. Royalty Fee
3. Pilotage Charges	3. Rental Fee
4. Berthing Charges	4. Franchise Fee
5. Cargo handling Charges	5. Daily maintenance cost
	6. Administration and operation cost

(3) Calculation of FIRR

The results of the FIRR calculation in all cases are shown in Table 14.12.2.

Table 14.12.2 Result of the FIRR

	Plan A (short term)	Plan A (short term + long term)	Plan B (short term)	Plan B (short term + long term)
High growth/ 20% share	22.2	16.7	15.3	14.1
Low growth/ 30% share	28.3	19.2	20.1	17.0

In all cases, FIRR exceeds the interest rate of funds (8%).

Judging from this analysis, this project is assessed to be financially viable.

15. Port Management System

15.1 Identification of Problem Areas

15.1.1 Nationwide Port Development Plan

In Oman, port development is planned and executed on an individual project basis. There is no nationwide port development plan explicitly defined. For example, the scheme of port development, especially the role of the private sector, is different in each port. In order to make the most efficient use of the national budget and to avoid duplication of investment, the government must prioritize projects from the viewpoint of national development. For this purpose, a nationwide port development plan also should be established by the government.

15.1.2 Container Terminal

Container throughput at Port Salalah has been increasing steadily, exceeding 600 thousand TEUs in 1999. But the handling volume is still less than the capacity of existing facilities. For efficient use of the existing 4 berths and the new equipment, the cargo volume needs to be increased.

SPS posted a net loss of R.O. 3,750,117 in 1999. Cargo throughput must also be increased from the financial point of view. To increase the cargo volume, it is necessary for SPS to attract other shipping lines and also establish a well coordinated feeder network from various areas.

This container terminal was developed and designed as a transshipment port and more than 99% of container throughput is transshipment. As a result, while container handling service is available 24 hours, delivering/receiving cargoes service time is from 8:00 to 16:00. When the volume of import and export cargo from/to its hinterland increases, the operation policy and system should be reviewed to accommodate these import/export cargoes.

15.1.3 Conventional Terminal

A major problem in the conventional port is its profitability. In 1997, under the management and operation of MOTH, expenditure of the port was R.O. 1,386,527, 90 % of which was labor cost. Revenues from the port amounted to R.O. 658,606, covering only 48% of the expenditure. After SPS took over the management, its first measure to improve the conventional terminal was to reduce the excessive number of operation and engineering employees and to raise marine charges. However, other problems remain. The cargo handling efficiency is not satisfactory to port users. Some facilities have become deteriorated and require immediate rehabilitation, while some cargo handling equipment is becoming superannuated.

15.1.4 Vocational Training

The Ministry of Social Affairs, Labour & Vocational Training has stipulated a fixed Omanisation ratio in six areas of the private sector. In transport, storage and communications, the ratio should be 60%. In 1995, National Vocational Qualifications (NVQ) and General National Vocational Qualification (GNVQ) were introduced to promote Omanisation.

SPS believes that the current training system by the government doesn't meet the SPS's required standard and it didn't adopt the NVQ training system in 1999. SPS has proposed the establishment of a new training school in Salalah and is discussing the matter with relevant organizations. The organizations concerned basically admit the need for the training school, but the financing scheme remains to be fixed.

15.2 Urgent Measures

(1) Nationwide port development plan

In order to make the nationwide port development plan, an efficient system of collecting data and statistics of each port is necessary. The present statistic collecting system of MOTH is time-consuming and its items are not enough. Therefore it should be improved for MOTH to get sufficient data smoothly.

To conduct the process of establishment of the nationwide port development plan smoothly, an efficient coordination system, such as national port development meeting, which involves various port related organizations should be introduced.

(2) Establishment of Port Committee of Salalah

Port Salalah is a public asset and fair and transparent management is vital. Therefore it is necessary to establish "Port Committee" including MOTH, SPS, port users, local government, and persons of knowledge and experience. Main functions should be approval of port development plan, supervision of port activities, and coordination among port management body, port users, and local government

GSO has a plan to establish a similar committee called the "Port Planning and Regulator Committee"("PPRC") This committee will consist of representatives of GSO and SPS, representatives of existing users of the port, and persons experienced in planning, licensing and regulation of ports.

This PPRC has not yet been formally approved. Once it is established, we recommend that its functions be expanded to include those envisaged in the "Port Committee" described above. For this purpose, PPRC should include local government members as the representatives of the region Moreover SPS is expected to coordinate port development and FTZ development including investment timing of both projects. For this purpose PPRC should involve PEIE, which is responsible for FTZ development at present.

(3) Neutrality of Port Management and Operation

SPS is known to be under the influence of Maersk-Sealand. When other shipping companies consider using Port Salalah, they are likely to point out this issue and worry whether they will receive the same treatment as Maersk-Sealand.

To foster an image of neutrality which means that any shipping companies will be treated equally in any services, the following measures deserve consideration.

1)To advertise its neutral management policy to the shipping world through port sales activities

2)To change the composition of shareholders (to achieve more diversity)
3)To establish a neutral committee, for example PPRC, to guide and supervise SPS

(4) Improvement of the facilities and equipment of the conventional port

The rehabilitation work of the berths of the conventional terminal has already started but most of the improvement work of the handling equipment has not started. Greater efficiency of the conventional terminal is strongly required by port users, and therefore all improvement work should be started as soon as possible.

(5) Enhancement of user-friendliness

A "Port Users Meeting" to exchange opinions between the port management body and port users is currently held each month. However users claim that they don't receive a clear reply from SPS to their requests. It is necessary to enhance the function of this Meeting and it would be a good idea for a government representative to attend the meeting in order to coordinate between SPS and the port users from a neutral position.

To promote activities of the industries and new investment in the hinterland and to be competitive with conventional terminals of other ports, especially Port Sultan Qaboos, Port Salalah should provide higher productivity than Port Sultan Qaboos and attractive port charges, which are less than Port Sultan Qaboos.

15.3 Port Management Scheme

15.3.1 Container Terminal Utilization

There are three types of terminal utilization, which are "Open use (Public use)", "Prioritized use" and "Exclusive use". Both the port of Singapore and the port of Hong Kong, which are the largest container hub ports in the world and have high ratios of transshipment, basically adopt "Open (Public) use" system. Under this system plural shipping companies can use the berth, resulting in high productivity and competitive terminal charges.

15.3.2 Container Terminal Development Scheme

Concerning the new container terminal development, basic idea is as follows.

- As private investment increases, the financial burden of the public sector is reduced. But the private sector is often unwilling to make a large investment because of the substantial risk involved.
- The sole management body is assumed to be SPS.
- From the viewpoint of efficient use of port facilities and equipment, a single operator system (by SPS) is optimum. But a third company operation should also be considered if it is necessary to attract a new shipping company.
- To achieve high productivity and a large cargo throughput, which are essential for a transshipment port, "Open use" system is usually appropriate. But a large shipping company may request to use a terminal exclusively to maximize efficiency. In this case "Prioritized use" system should be introduced to attract shipping companies.

Based on the above, six cases are considered as follows. Basic berth allocation is "Open use" system, but "Prioritized use" system will be considered if requested by shipping companies, while "Exclusive Use" system is adopted only in Case-4.

(Case-1)GSO provides all facilities (infrastructure and superstructure). Terminal management and operation is conducted by SPS.

(Case-2)GSO provides infrastructure while SPS provides superstructure. Terminal management and operation is conducted by SPS.

(Case-3)GSO provides infrastructure while a third company provides superstructure. Terminal management is conducted by SPS while the terminal operator is the third company.

(Case-4)GSO provides infrastructure while a third company provides superstructure. Terminal management is conducted by SPS while the terminal operator is the third company. "Exclusive use" system is adopted when strongly requested by shipping companies.

(Case-5)SPS provides superstructure and a part of infrastructure(for example berths). Terminal management and operation is conducted by SPS.

(Case-6)A third company provides superstructure and a part of infrastructure(for example berths). Terminal management is conducted by SPS while the terminal operator is the third company.

An evaluation of above cases is made as follows.

- In case1, GSO must bear all investment costs by itself which involves a substantial risk. Private participation is limited to operation.
- In case 5 and 6, the private sector must make a large investment which involves a substantial risk. Furthermore the private sector would own the land although a port is a public asset.
- From the viewpoint of efficient use of port facilities and equipment, the single operator system by SPS is considered preferable. If, despite SPS's efforts to foster an image of neutrality, a third company operation is the only way to attract a new shipping company, then a third company operation should be introduced.
- For efficient utilization of berths, "Open use" system should be adopted as a basic scheme. But "Prioritized use" system also should be adopted if it will attract shipping companies.
- Considering above mentioned points, case 2 is considered to be preferable. But to satisfy the needs and requests of shipping companies, case 3 and 4 are also possible.

15.3.3 Port Development and Management

The sole management body of Salalah Port including container and conventional terminals is assumed to be SPS.

Conventional terminals cater for the needs of the region. Therefore, to support regional development, GSO should develop necessary infrastructure and set reasonable concession conditions which will allow SPS to offer low port charges. SPS should operate and maintain the conventional terminal based on the concession with the government.

Port development and management scheme of container terminal and conventional terminal is shown in Table 15.3.1.

Table 15.3.1 Port Development and Management Scheme

		Construction Procurement	Maintenance	Management	Operation
Existing Container Terminal	Infrastructure	GSO	SPS	SPS	SPS
	Superstructure	SPS			
Additional Container Terminal	Infrastructure	GSO	SPS(3rd Party)	SPS	SPS(3rd Party)
	Superstructure	SPS(3rd Party)			
Existing Conventional Terminal	Infrastructure	GSO*	SPS	SPS	SPS
	Superstructure	GSO,SPS*			
Additional Conventional Terminal	Infrastructure	GSO	SPS	SPS	SPS
	Superstructure	SPS			

Note: * Including rehabilitation work

15.4 Port Marketing Strategy

15.4.1 Port Sales

As a new comer to the transshipment business world, port sales are essential for Port Salalah to promote its name. SPS must play the main role in conducting port sales activities. But the Omani Government also should support and join these activities because the development of Port Salalah benefits not only SPS but also the Dhofar region and the government.

The following measures are recommended to promote port sales activities.

1)Improvement of web site of Port Salalah

2)Improvement and efficient usage of sales promotion materials (printed brochure and video)

3)Regular dispatch of Port Salalah Sales Missions (This mission is desirable to be formed by SPS and the government.)

4)Set up of port sales offices abroad in addition to the office in Dubai

15.4.2 Marketing Strategy

(1)Port Tariffs

Compared with Dubai Ports, the tariff level of Port Salalah is about 4% is higher. But Salalah is much closer to the main East-West shipping route than Dubai and, therefore, the present tariff level of Port Salalah is sufficiently competitive with Dubai Ports.

Compared with Singapore Port, charges of loading and discharging of laden 20 feet container are about 7 % higher at Port Salalah. But Port Salalah offers more than 50 % discount in average for over 200 thousand movements per year. It is said that the volume discount of Singapore Port is only about 10 % for over 400 thousand movements per year. Therefore it can be said that Port Salalah can compete with Singapore Port at the tariff levels for large class shipping companies. But Port Salalah aims at being a common user port and to achieve this target it must attract various shipping companies including middle and small class shipping companies. From this view point, standard tariffs should be reduced while volume discount rate should be increased from the present level.

(2)Network of Shipping Lines

Port Salalah must have not only trunk lines but also sufficient feeder service network to achieve success as a world class transshipment hub port. Main prospective market areas of hinterland development are Yemen, East Africa countries, and Indian Sub-Continent besides the United States, Europe, South-East Asia and Far East countries. From this viewpoint to increase trunk lines and to expand feeder network, especially from/to East Africa and Indian Sub-Continent, is very important.

(3)User Friendly Management

PSA communicates with its customers through the advisory council which it has set up with shipping companies calling PSA. Shipping companies set a high value on PSA's attitude. It is recommended that SPS forms a similar council with shipping companies calling Salalah.

(4)Introducing Modernized Facilities

Salalah port must take advantage of its new port status. Salalah boosts the most modern facilities and operating systems, and these are good tools of port sales. SPS has already installed super post panamax quay cranes with 22 rows which are world largest class cranes at present. SPS also should develop large depth quays, for example 18 meter quays.

(5)Increase of Base Cargo

To have not only transshipment cargo but also base cargo from/to hinterland is very important and will raise the status of Port Salalah. SPS should make efforts to develop its hinterland and to increase base cargo.

16. Engineering Design

16.1 Design structure

16.1.1 Design Criteria

The design criteria necessary for designing the port facilities is tabulated in Table 16.1.1.

Table 16.1.1 Design Criteria

Tidal levels	M.H.H.W +1.68m
	M.S.L +1.30m
	M.L.L.W +0.60m
Seismic disturbance	0.1W (W : Weight of structure)
Wave height for design of breakwater	7.0m
Vessel of design(max)	Container vessel 90,000DWT
Water depth of berth(max)	L.A.T-18m
Surcharge load of berth	Load condition 5.0t/m^2
Berthing velocity of ship	0.15m/sec
Design lifetime	50 years

16.1.2 Structural Design

Typical example of breakwater , quaywall, and revetment are shown in the following figures.

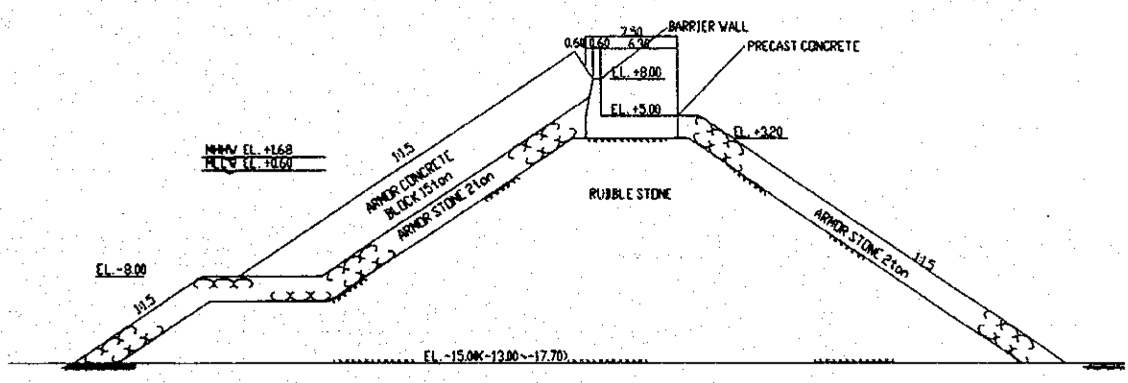
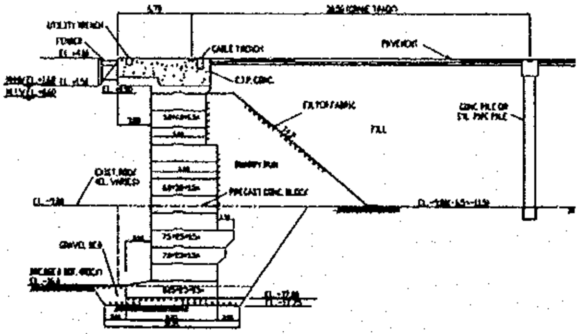
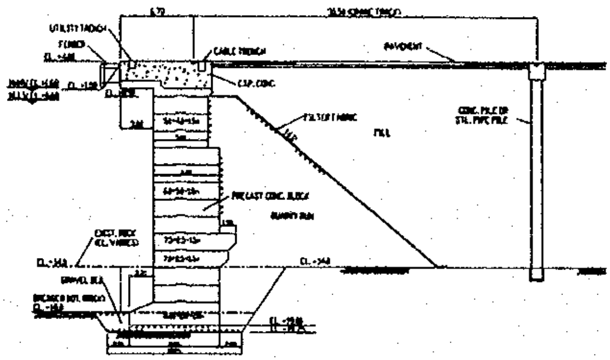


Figure 16.1.1 Breakwater



-16m Berths



-18m Berths

Figure 16.1.2 Container Warf

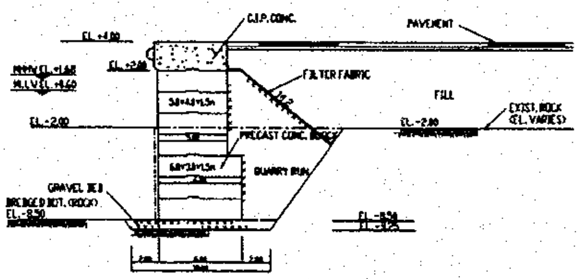


Figure 16.1.3 Government Warf

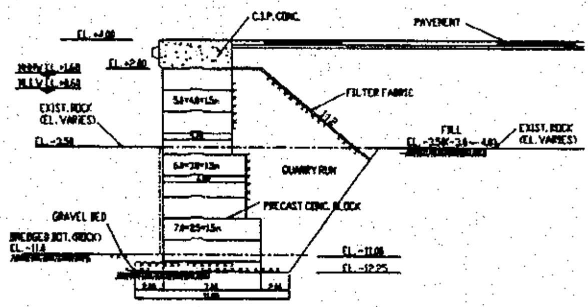


Figure 16.1.4 Passenger Warf

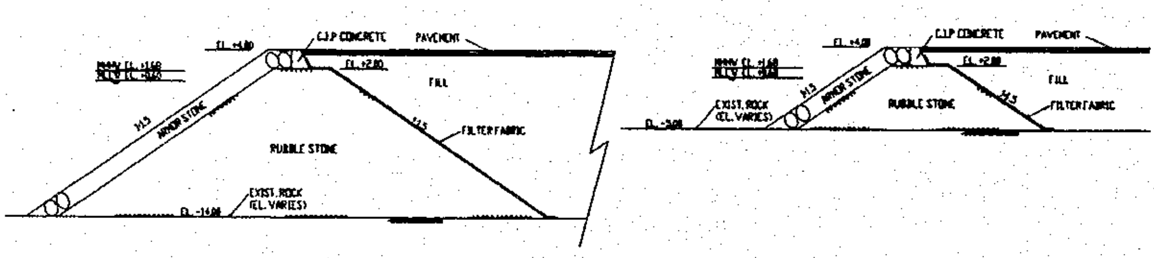


Figure 16.1.5 Revetment

16.2 Implementation Plan

16.2.1 JICA PLAN A

The implementation plan of JICA PLAN A is shown in Figure 16.2.1.

16.2.2 JICA PLAN B

The implementation plan of JICA PLAN B is shown in Figure 16.2.2.

16.3 Cost Estimation

16.3.1 Basic Condition for Cost Estimate

(1) The construction cost has been estimated based on the result of material survey cost on Jan.2000 at Salalah.
(2) Exchange rate of currency is fixed as follows:
US Dollar 1.0=OR 0.385
(3) Physical contingency is estimated at 10%.
(4) Engineering services fee is estimated at 5%.
(5) Indirect cost is estimated at 15%: contractors overhead and profit.
(6) Price escalation is not included for construction, equipment and engineering cost.
(7) The direct cost of construction is classified into the foreign and local currency components. The percentage distribution of the major items of construction materials, equipment and labor between the foreign and local currency components is shown in Table 16.3.1.

Table 16.3.1 Distribution of Construction Cost

No	Item	Foreign	Local
1	Breakwater	30%	70%
2	Dredging	90	10
3	Wharf	30	70
4	Bridge	70	30
5	Building	10	90
6	Mechanical	90	10
7	Electrical	90	10
8	Water Supply & Drainage	90	10
9	Cargo Handing Equipment	100	0

	No.	Description	Quantity	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Short Term I	1	Preparatory Work																					
	2	Breakwater	1,200m																				
	3	Dredging	$13{,}778{,}975m^3$																				
	4	Wharf	700m -16m 2Berth																				
	5	Government Berth	850m -8.5m																				
	6	Bridge	350m																				
	7	Building																					
	8	Erectrical																					
	9	Mechanical																					
	10	Cargo Handling Equipment	Container Crane 18lines 6Nos ,etc 36Nos.																				
	11	Miscellaneous Work																					
	12	Engineering Services																					
Long Term II-1	1	Preparatory Work																					
	1	Breakwater	1,350m																				
	2	Dredging	$3{,}614{,}150m^3$																				
	3	Wharf	1,050m -18m 3Berth																				
	4	Building																					
	5	Erectrical																					
	6	Mechanical																					
	7	Cargo Handling Equipment	Container Crane 22lines 9Nos ,etc 54Nos.																				
	8	Miscellaneous Work																					
	9	Engineering Services																					
II-2	1	Preparatory Work																					
	2	Wharf	1,050m -16m 3Berth																				
	3	Building																					
	4	Erectrical																					
	5	Mechanical																					
	6	Cargo Handling Equipment	Container Crane 18lines 9Nos ,etc 54Nos.																				
	7	Miscellaneous Work																					
	8	Bulk Terminal crane	800t/h																				
	9	Engineering Services																					
II-3	1	Preparatory Work																					
	2	Dredging	$96{,}850\ m^3$																				
	3	Passenger Berth	350m -11.0m																				
	4	Building etc																					
	5	Gunge Way	2Nos																				
	6	Miscellaneous Work																					
	7	Engineering Services																					

Figure 16.2.1. Construction Schedule of JICA PLAN A

		Description	Quantity	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
	No.			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	1	Preparatory Work																					
Short	2	Breakwater	2,550m																				
Term	3	Dredging	7,003,146m^3																				
	4	Wharf	1,050m -18m 3Berth																				
I	5	Government Berth	850m -8.5m																				
	6	Bridge	350m																				
	7	Building																					
	8	Erectrical																					
	9	Mechanical																					
	10	Cargo Handling Equipment	Container Crane 22lines 9Nos ,etc 54Nos.																				
	11	Miscellaneous Work																					
	12	Engineering Services																					
	1	Preparatory Work																					
Long	2	Dredging	10,801,725m^3																				
Term	3	Wharf	700m -16m 2Berth																				
	4	Building																					
II-1	5	Erectrical																					
	6	Mechanical																					
	7	Cargo Handling Equipment	Container Crane 18lines 6Nos ,etc 36Nos.																				
	8	Miscellaneous Work																					
	9	Engineering Services																					
	1	Preparatory Work																					
	2	Wharf	1,050m -16m 3Berth																				
	3	Building																					
II-2	4	Erectrical																					
	5	Mechanical																					
	6	Cargo Handling Equipment	Container Crane 18lines 9Nos ,etc 54Nos.																				
	7	Miscellaneous Work																					
	8	Bulk Terminal crane	800t/h																				
	9	Engineering Services																					
	1	Preparatory Work																					
	2	Dredging	96,850 m^3																				
	3	Passenger Berth	350m -11.0m																				
II-3	4	Building etc																					
	5	Gunge Way	2Nos																				
	6	Miscellaneous Work																					
	7	Engineering Services																					

Figure 16.2.2. Construction Schedule of JICA PLAN B

16.3.2 JICA PLAN A

Summary of the construction cost for JICA PLAN A is shown in Table 16.3.2.

(1) Short Term

The cost estimation of short term for JICA PLAN A is shown in Table 16.3.3.

(2) Long Term

The cost estimation of long term for JICA PLAN A is shown in Table.16.3.4.

(3) Future Term

The cost estimation of future term for JICA PLAN A is shown in Table 16.3.5.

16.3.3 JICA Plan B

Summary of the construction cost for JICA PLAN B is shown in Table 16.3.6.

(1) Short Term

The cost estimation of short term for JICA PLAN B is shown in Table 16.3.7.

(2) Long Term

The cost estimation of long term for JICA PLAN B is shown in Table.16.3.8

(3) Future Term

The cost estimation of future term for JICA PLAN B is shown in Table 16.3.9.

Table 16.3.2 Summary of the Construction Cost (PLAN A)

(Unit:1,000O.R)

Principal Items	Facilities and Handling Equipment	Dimension and Quantity	Short Term	Long Term	Short + Long	Future
Container Terminal	18m draft berth	1,050m	—	21,831	21,831	—
	16m draft berth	1,750m	13,727	19,716	33,443	—
	Cargo handling equipment	24 gantry cranes	14,667	49,503	64,170	—
		48 RTGs	5,056	15,167	20,223	—
		96yard tractors	308	923	1,231	—
Government berth		800m	7,128	—	7,128	—
Bridge		350m、400m	5,288	—	5,288	6,045
Passenger berth		350m	—	3,017	3,017	—
	Equipment	2 gangways	—	407	407	—
12m Draft berth etc			—	—	—	26,898
Breakwater		2,550m	20,918	30,837	51,755	—
Dredging		$17,725,000m^3$	41,201	11,095	52,296	14,846
Reclamation		$22,455,000m^3$				
Conventional Terminal	Cargo handling equipment	1 bulk crane	—	2,444	2,444	—
Building etc			10,098	31,833	41,931	—
TOTAL	—	—	118,391	186,773	305,164	47,789

Table 16.3.3 Breakdown of Project Cost(JICA PLAN-A)

(SHORT TERM DEVELOPMENT 2005)

Unit : 1,000 OR

No.	Work Item		Remarks	Unit	Quantity	Construction Cost		
						Foreign	Local	Total
I-1	Civil Work							
I-1-1	Breakwater	Breakwater Demoltion	Existing	m	410	-	1,087	1,087
I-1-2		New Breakwater	-13.0m to-17.7m	m	1,200	4,501	10,502	15,003
I-1-3	Dredging	Harbour Area①	-16.0m	m^3	10,028,350	21,060	2,006	23,066
I-1-4		Harbour Area②	-8.5m	m^3	197,000	414	39	453
I-1-5		Approach Channel	-16.5m	m^3	3,553,625	7,463	711	8,174
I-1-6	Reclamation	Container Terminal B	+4.0m	m^3	2,425,725	-	-	-
I-1-7		Government Berths	+4.0m	m^3	634,148	-	-	-
I-1-8	Container Terminal B	Quay wall	-16m , 2Berths	m	700	1,711	3,991	5,702
I-1-9		Sea wall	-8.5m to-16.0m	m	50	102	239	341
I-1-10		Revetment	+4.0m	m	450	117	1,049	1,166
I-1-11		Pavement		m^2	335,000	-	3,350	3,350
I-1-12	Government Berths	Quay wall	-8.5m	m	850	849	1,981	2,830
I-1-13		Revetment	+4.0m	m	1,420	138	1,240	1,378
I-1-14		Pavement		m^2	127,500	-	1,275	1,275
I-1-15	Bridge			m	350	2,848	1,220	4,068
I-1-16	Sub Total					39,203	28,690	67,893
I-1-17	Physical Contingency	10%of Sub total				3,920	2,869	6,789
I-1-18	Indirect Cost	15%of Sub total				5,880	4,304	10,184
I-1-19	Engineering Service	5%of Sub total				1,960	1,435	3,395
I-1-20	Total					50,963	37,298	88,261
I-2	Building, Electric, and Water Supply							
I-2-1	Building			L.S.	1	123	1,120	1,243
I-2-2	Electrical			L.S.	1	2,703	300	3,003
I-2-3	Mechanical			L.S.	1	949	106	1,055
I-2-4	Miscellaneous			L.S.	1	1,727	740	2,467
I-2-5	Sub Total					5,502	2,266	7,768
I-2-6	Physical Contingency	10%of Sub total				550	227	777
I-2-7	Indirect Cost	15%of Sub total				825	340	1,165
I-2-8	Engineering Service	5%of Sub total				275	113	388
I-2-9	Total					7,152	2,946	10,098
I-3	Cargo Handling Equipment							
I-3-1	Container Crane	18lines	3No.×2Berths	Nos	6	13,334	-	13,334
I-3-2	RTG			Nos	12	4,596	-	4,596
I-3-3	Yard Tractor			Nos	24	280	-	280
I-3-4	Sub Total					18,210	-	18,210
I-3-5	Physical Contingency	5%of Sub total				911	-	911
I-3-6	Engineering Service	5%of Sub total				911	-	911
I-3-7	Total					20,032	-	20,032
I-4	Grand Total					78,147	40,244	118,391

Table 16.3.4 Breakdown of Project Cost(JICA PLAN-A)

(LONG TERM DEVELOPMENT 2020)

Unit : 1,000 OR

No.	Work Item		Remarks	Unit	Quantity	Construction Cost		
						Foreign	Local	Total
II-1	Civil Work							
II-1-1	Breakwater	New Breakwater		m	1,350	7,116	16,605	23,721
II-1-2	Dredging	Harbour Area	-18.0m	m^3	1,467,900	3,083	294	3,377
II-1-3		Approach Channel	-18.5m	m^3	2,146,250	4,507	429	4,936
II-1-4		Harbour Area B	-11.0m	m^3	96,850	203	19	222
II-1-5	Reclamation	Container Terminal A	+4.0m	m^3	6,752,902	–	–	–
II-1-6		Container Terminal C	+4.0m	m^3	5,551,248	–	–	–
II-1-7	Reclamation	Passenger Berths	+4.0m	m^3	185,875	–	–	–
II-1-8	Container Terminal A	Quay wall	-18m , 3Berths	m	1,050	2,882	6,725	9,607
II-1-9		Sea wall	-16.0m to-18.0m	m	50	114	267	381
II-1-10		Revetment	+4.0m	m	400	250	2,255	2,505
II-1-11		Pavement		m^2	430,000	–	4,300	4,300
II-1-12	Container Terminal C	Quay wall	-16m , 3Berths	m	1,050	2,566	5,986	8,552
II-1-13		Revetment	+4.0m	m	400	250	2,255	2,505
II-1-14		Pavement		m^2	410,900	–	4,109	4,109
II-1-15	Passenger Berths	Quay wall	-11.0m	m	350	469	1,095	1,564
II-1-16		Revetment	+4.0m	m	350	42	382	424
II-1-17		Pavement		m^2	33,250	–	333	333
II-1-18	Sub Total					21,482	45,054	66,536
II-1-19	Physical Contingency	10%of Sub total				2,148	4,505	6,653
II-1-20	Indirect Cost	15%of Sub total				3,222	6,758	9,980
II-1-21	Engineering Service	5%of Sub total				1,074	2,253	3,327
II-1-22	Total					27,926	58,570	86,496
II-2	Building, Electric, and Water Supply							
II-2-1	Building			L.S.	1	369	3,360	3,729
II-2-2	Electrical			L.S.	1	8,108	900	9,008
II-2-3	Mechanical			L.S.	1	2,846	318	3,164
II-2-4	Miscellaneous①			L.S.	1	5,181	2,220	7,401
II-2-5	Miscellaneous②	Passenger Berths		L.S.	1	445	–	445
II-2-6	Passenger Terminal		2,000m^2	L.S.	1	–	740	740
II-2-7	Sub Total					16,949	7,538	24,487
II-2-8	Physical Contingency	10%of Sub total				1,695	754	2,449
II-2-9	Indirect Cost	15%of Sub total				2,542	1,131	3,673
II-2-10	Engineering Service	5%of Sub total				847	377	1,224
II-2-11	Total					22,033	9,800	31,833
II-3	Cargo Handling Equipment							
II-3-1	Container Crane	18lines	3No.×3Berths	Nos	9	20,001	–	20,001
II-3-2	Container Crane	22lines	3No.×3Berths	Nos	9	25,002	–	25,002
II-3-3	RTG			Nos	36	13,788	–	13,788
II-3-4	Yard Tractor			Nos	72	839	–	839
II-3-5	Gunge Way	Passenger Berth		Nos	2	370	–	370
II-3-6	Bulk Crane	Bulk Terminal	800t/h	Nos	1	2,222		2,222
II-3-7	Sub Total					62,222	–	62,222
II-3-8	Physical Contingency	5%of Sub total				3,111	–	3,111
II-3-9	Engineering Service	5%of Sub total				3,111	–	3,111
II-3-10	Total					68,444	–	68,444
II-4	Grand Total					118,403	68,370	186,773

Table 16.3.5 Breakdown of Project Cost(JICA PLAN-A)

(FUTURE DEVELOPMENT)

Unit : 1,000 OR

No.	Work Item		Remarks	Unit	Quantity	Construction Cost		
						Foreign	Local	Total
Ⅲ-1	Civil Work							
Ⅲ-1-1	Dredging	Harbour Area A	-12.0m	m^3	234,617	493	47	540
Ⅲ-1-4		Future Expansion A	+4.0m	m^3	1,883,722	-	-	-
Ⅲ-1-5		Future Expansion B	+4.0m	m^3	1,396,875	-	-	-
Ⅲ-1-6		Future Expansion C	+4.0m	m^3	3,804,550	-	-	-
Ⅲ-1-10	Future Expansion A	Quay wall	-12m	m	980	1,497	3,494	4,991
Ⅲ-1-11		Sea wall	-11.0m to-12.0m		142	217	506	723
Ⅲ-1-12		Revetment	+4.0m	m	200	70	626	696
Ⅲ-1-13		Revetment	+4.0m	m	1,080	239	2,150	2,389
Ⅲ-1-14		Pavement		m^2	205,500	-	2,055	2,055
Ⅲ-1-15	Future Expansion B	Revetment	+4.0m	m	1,160	140	1,267	1,407
Ⅲ-1-16		Pavement		m^2	257,000	-	2,570	2,570
Ⅲ-1-17	Future Expansion C	Sea wall	-10.0m	m	900	1,038	2,422	3,460
Ⅲ-1-18		Pavement		m^2	240,000	-	2,400	2,400
Ⅲ-1-19	Bridge			m	400	3,255	1,395	4,650
Ⅲ-1-20	Dredging			m^3	4,730,453	9,934	946	10,880
Ⅲ-1-21	Sub Total					16,883	19,878	36,761
Ⅲ-1-22	Physical Contingency	10%of Sub total				1,688	1,988	3,676
Ⅲ-1-23	Indirect Cost	15%of Sub total				2,532	2,982	5,514
Ⅲ-1-24	Engineering Service	5%of Sub total				844	994	1,838
Ⅲ-1-25	Total					21,947	25,842	47,789
Ⅲ-2	Building, Electric, and Water Supply							
Ⅲ-2-1	Building					—	—	—
Ⅲ-2-2	Electrical					—	—	—
Ⅲ-2-3	Mechanical					—	—	—
Ⅲ-2-4	Miscellaneous					—	—	—
Ⅲ-2-5	Sub Total					—	—	—
Ⅲ-2-6	Physical Contingency	10%of Sub total				—	—	—
Ⅲ-2-7	Indirect Cost	15%of Sub total				—	—	—
Ⅲ-2-8	Engineering Service	5%of Sub total				—	—	—
Ⅲ-2-9	Total					—	—	—
Ⅲ-3	Cargo Handling Equipment							
Ⅲ-3-1	Sub Total					—	—	—
Ⅲ-3-2	Physical Contingency	5%of Sub total				—	—	—
Ⅲ-3-3	Engineering Service	5%of Sub total				—	—	—
Ⅲ-3-4	Total					—	—	—
Ⅲ-4	Grand Total					21,947	25,842	47,789

Table 16.3.6 Summary of the Construction Cost（PLAN B）

(Unit:1,000O.R)

Principal Items	Facilities and Handling Equipment	Dimension and Quantity	Short Term	Long Term	Short + Long	Future
Container Terminal	18m draft berth	1,050m	28,260	—	28,260	—
	16m draft berth	1,750m	—	31,928	31,928	—
	Cargo handling equipment	24 gantry cranes	27,502	36,668	64,170	—
		48 RTGs	7,584	12,639	20,223	—
		96yard tractors	461	769	1,230	—
Government berth		800m	7,505	—	7,505	—
Bridge		350m、400m	5,288	—	5,288	6,045
Passenger berth		350m	—	3,017	3,017	—
	Equipment	2 gangways	—	407	407	—
12m Draft berth etc			—	—	—	26,898
Breakwater		2,550m	51,755	—	51,755	—
Dredging		17,725,000m^3	20,941	31,355	52,296	14,481
Reclamation		22,332,000m^3				
Conventional Terminal	Cargo handling equipment	1 bulk crane	—	2,444	2,444	—
Building etc			15,148	26,787	41,935	—
TOTAL	—	—	164,444	146,014	310,458	47,424

Table 16.3.7. Breakdown of Project Cost(JICA PLAN-B)

(SHORT TERM DEVELOPMENT 2005)

Unit : 1,000 OR

No.	Work Item		Remarks	Unit	Quantity	Construction Cost		
						Foreign	Local	Total
I-1	Civil Work							
I-1-1	Breakwater	Breakwater Demolition	Existing	m	410	-	1,087	1,087
I-1-2		New Breakwater	-13.0m to-20.0m	m	2,550	11,618	27,107	38,724
I-1-3	Dredging	Harbour Area①	-18.0m	m^3	1,467,900	3,083	294	3,376
I-1-4		Harbour Area②	-8.5m	m^3	2,847,000	5,979	569	6,548
I-1-5		Approach Channel	-18.5m	m^3	2,402,000	5,044	480	5,525
I-1-6		Approach Channel	-9.0m	m^3	5,000	11	1	12
I-1-7	Reclamation	Container Terminal A	+4.0m	m^3	6,377,798	-	-	-
I-1-8		Government Berths	+4.0m	m^3	625,348	-	-	-
I-1-9	Container Terminal A	Quay wall	-18m , 3Berths	m	1,050	2,882	6,725	9,608
I-1-10		Sea wall	-16.0m to-18.0m	m	50	114	267	381
I-1-11		Revetment	+4.0m	m	400	251	2,255	2,506
I-1-12		Revetment	+4.0m	m	1,100	495	4,448	4,943
I-1-13		Pavement		m^2	430,000	-	4,300	4,300
I-1-14	Government Berths	Quay wall	-8.5m	m	850	849	1,981	2,830
I-1-15		Revetment	+4.0m	m	1,420	138	1,240	1,377
I-1-16		Revetment	+4.0m	m	400	29	262	291
I-1-17		Pavement		m^2	127,500	-	1,275	1,275
I-1-18	Bridge			m	350	2,848	1,220	4,068
I-1-19	Dredging	from Long Term		m^3	281,246	591	56	647
I-1-20	Sub Total					33,932	53,567	87,498
I-1-21	Physical Contingency	10%of Sub total				3,393	5,357	8,750
I-1-22	Indirect Cost	15%of Sub total				5,090	8,035	13,125
I-1-23	Engineering Service	5%of Sub total				1,697	2,678	4,375
I-1-24	Total					44,112	69,637	113,749
I-2	Building, Electric, and Water Supply							
I-2-1	Building			L.S.	1	185	1,680	1,865
I-2-2	Electrical			L.S.	1	4,054	450	4,504
I-2-3	Mechanical			L.S.	1	1,423	159	1,582
I-2-4	Miscellaneous			L.S.	1	2,591	1,110	3,701
I-2-5	Sub Total					8,253	3,399	11,652
I-2-6	Physical Contingency	10%of Sub total				825	340	1,165
I-2-7	Indirect Cost	15%of Sub total				1,238	510	1,748
I-2-8	Engineering Service	5%of Sub total				413	170	583
I-2-9	Total					10,729	4,419	15,148
I-3	Cargo Handling Equipment							
I-3-1	Container Crane	22lines	3No.×3Berths	Nos	9	25,002	-	25,002
I-3-2	RTG			Nos	18	6,894	-	6,894
I-3-3	Yard Tractor			Nos	36	419	-	419
I-3-4	Sub Total					32,315	-	32,315
I-3-5	Physical Contingency	5%of Sub total				1,616	-	1,616
I-3-6	Engineering Service	5%of Sub total				1,616	-	1,616
	Total					35,547	-	35,547
I-4	Grand Total					90,388	74,056	164,444

Table 16.3.8. Breakdown of Project Cost(JICA PLAN-B)

(LONG TERM DEVELOPMENT 2020)

Unit : 1,000 OR

No.	Work Item		Remarks	Unit	Quantity	Construction Cost		
						Foreign	Local	Total
Ⅱ-1	Civil Work							
Ⅱ-1-1	Dredging	Harbour Area	-16.0m	m^3	7,378,350	15,495	1,476	16,970
Ⅱ-1-2		Harbour Area B	-11.0m	m^3	96,850	203	19	222
Ⅱ-1-3		Approach Channel	-16.5m	m^3	3,292,875	6,915	659	7,574
Ⅱ-1-4	Reclamation	Container Terminal B	+4.0m	m^3	2,459,325	-	-	-
Ⅱ-1-5		Container Terminal C	+4.0m	m^3	5,599,248	-	-	-
Ⅱ-1-6	Reclamation	Passenger Berths	+4.0m	m^3	185,875	-	-	-
Ⅱ-1-7	Container Terminal B	Quay wall	-16m , 2Berths	m	700	1,711	3,991	5,702
Ⅱ-1-8		Sea wall	-8.5m to-16.0m	m	50	102	239	341
Ⅱ-1-9		Pavement		m^2	335,000	-	3,350	3,350
Ⅱ-1-10	Container Terminal C	Quay wall	-16m , 3Berths	m	1,050	2,566	5,986	8,552
Ⅱ-1-11		Revetment	+4.0m	m	400	250	2,255	2,506
Ⅱ-1-12		Pavement		m^2	410,900	-	4,109	4,109
Ⅱ-1-13	Passenger Berths	Quay wall	-11.0m	m	350	469	1,095	1,564
Ⅱ-1-14		Revetment	+4.0m	m	350	42	382	424
Ⅱ-1-15		Pavement		m^2	33,250	-	333	333
Ⅱ-1-16	Dredging			m^3	-281,246	-591	-56	-647
Ⅱ-1-17	Sub Total					27,162	23,838	51,000
Ⅱ-1-18	Physical Contingency	10%of Sub total				2,716	2,384	5,100
Ⅱ-1-19	Indirect Cost	15%of Sub total				4,074	3,576	7,650
Ⅱ-1-20	Engineering Service	5%of Sub total				1,358	1,192	2,550
Ⅱ-1-21	Total					35,310	30,990	66,300
Ⅱ-2	Building, Electric, and Water Supply							
Ⅱ-2-1	Building			L.S.	1	308	2,800	3,108
Ⅱ-2-2	Electrical			L.S.	1	6,757	750	7,507
Ⅱ-2-3	Mechanical			L.S.	1	2,372	265	2,637
Ⅱ-2-4	Miscellaneous①			L.S.	1	4,318	1,850	6,168
Ⅱ-2-5	Miscellaneous②	Passenger Berths		L.S.	1	445	-	445
Ⅱ-2-6	Passenger Tarminal		2,000m^2	L.S.	1	-	740	740
Ⅱ-2-7	Sub Total					14,200	6,405	20,605
Ⅱ-2-8	Physical Contingency	10%of Sub total				1,420	641	2,061
Ⅱ-2-9	Indirect Cost	15%of Sub total				2,130	961	3,091
Ⅱ-2-10	Engineering Service	5%of Sub total				710	320	1,030
Ⅱ-2-11	Total					18,460	8,327	26,787
Ⅱ-3	Cargo Handling Equipment							
Ⅱ-3-1	Container Crane	18lines	3No.×5Berths	Nos	15	33,335	-	33,335
Ⅱ-3-2	RTG			Nos	30	11,490	-	11,490
Ⅱ-3-3	Yard Tracter			Nos	60	699	-	699
Ⅱ-3-4	Gunge Way	Passenger Berth		Nos	2	370	-	370
Ⅱ-3-5	Bulk Crane	Bulk Terminal	800t/h	Nos	1	2,222		2,222
Ⅱ-3-6	Sub Total					48,116	-	48,116
Ⅱ-3-7	Physical Contingency	5%of Sub total				2,406	-	2,406
Ⅱ-3-8	Engineering Service	5%of Sub total				2,406	-	2,408
	Total					52,927	-	52,927
Ⅱ-4	Grand Total					106,697	39,317	146,014

Table 16.3.9. Breakdown of Project Cost(JICA PLAN-B)

(FUTURE DEVELOPMENT)

Unit : 1,000 OR

No.	Work Item		Remarks	Unit	Quantity	Construction Cost		
						Foreign	Local	Total
Ⅲ-1	Civil Work							
Ⅲ-1-1	Dredging	Harbour Area A	-12.0m	m^3	234,617	493	47	540
Ⅲ-1-4		Future Expansion A	+4.0m	m^3	1,883,722	–	–	–
Ⅲ-1-5		Future Expansion B	+4.0m	m^3	1,396,875	–	–	–
Ⅲ-1-6		Future Expansion C	+4.0m	m^3	3,804,550	–	–	–
Ⅲ-1-10	Future Expansion A	Quay wall	-12m	m	980	1,497	3,494	4,991
Ⅲ-1-11		Sea wall	-11.0m to-12.0m		142	217	506	723
Ⅲ-1-12		Revetment	+4.0m	m	200	70	626	696
Ⅲ-1-13		Revetment	+4.0m	m	1,080	239	2,150	2,389
Ⅲ-1-14		Pavement		m^2	205,500	–	2,055	2,055
Ⅲ-1-15	Future Expansion B	Revetment	+4.0m	m	1,160	140	1,267	1,407
Ⅲ-1-16		Pavement		m^2	257,000	–	2,570	2,570
Ⅲ-1-17	Future Expansion C	Sea wall	-10.0m	m	900	1,038	2,422	3,460
Ⅲ-1-18		Pavement		m^2	240,000	–	2,400	2,400
Ⅲ-1-19	Bridge			m	400	3,255	1,395	4,650
Ⅲ-1-20	Dredging			m^3	4,608,149	9,677	922	10,599
Ⅲ-1-21	Sub Total					16,626	19,854	36,480
Ⅲ-1-22	Physical Contingency	10%of Sub total				1,663	1,985	3,648
Ⅲ-1-23	Indirect Cost	15%of Sub total				2,494	2,978	5,472
Ⅲ-1-24	Engineering Service	5%of Sub total				831	993	1,824
Ⅲ-1-25	Total					21,614	25,810	47,424
Ⅲ-2	Building, Electric, and Water Supply							
Ⅲ-2-1	Building					–	–	–
Ⅲ-2-2	Electrical					–	–	–
Ⅲ-2-3	Mechanical					–	–	–
Ⅲ-2-4	Miscellaneous					–	–	–
Ⅲ-2-5	Sub Total					–	–	–
Ⅲ-2-6	Physical Contingency	10%of Sub total				–	–	–
Ⅲ-2-7	Indirect Cost	15%of Sub total				–	–	–
Ⅲ-2-8	Engineering Service	5%of Sub total				–	–	–
Ⅲ-2-9	Total					–	–	–
Ⅲ-3	Cargo Handling Equipment							
Ⅲ-3-1	Sub Total					–	–	–
Ⅲ-3-2	Physical Contingency	5%of Sub total				–	–	–
Ⅲ-3-3	Engineering Service	5%of Sub total				–	–	–
Ⅲ-3-4	Total					–	–	–
Ⅲ-4	Grand Total					21,614	25,810	47,424