

5. Long-term development plan

5.1 Long-term development plan of the port facilities

5.1.1 Elements to be considered in Long-term plan

The following items shall be taken into considerations in the process of the master planning:

(1) Time worn Old Jetty

On the basis of the Study Teams own observation of the existing Old Jetty, it is concluded that the beams of the structure need full replacement, though minor repair work is being done at present. In the master planning, it is assumed that the Old Jetty is no longer usable.

(2) Dry bulk cargoes

It is expected that cement is carried by specialized ships, i.e., cement tankers, for annual handling volume is quite large. In the same manner, fertilizers is also expected to be carried in dry bulk carrier. Thus, a bulk terminal, which cement, fertilizer and bitumen are handled, shall be planned in the long-term plan.

(3) Zoning of wharves

In the long-term plan, wharves are zoned in three blocks to handle the following three different types of cargoes specifically:

a. Container cargoes

b. General cargoes

Bagged cargoes (rice, sugar), steel, machinery, and other commodities

c. Bulk cargoes

Cement, fertilizer and bitumen.

The location of the berth, storage yard, shed and port roads should be determined so that traffic of these three types of cargoes do not block the passage of one another.

(4) Consideration on environment

a. Consideration of the fishing villages, private houses, etc. near the port

There is a fishing village to the north of existing New Quay of Sihanoukville Port. Though the Port authority of Sihanoukville has requested the Ministry of Public Works and Transport to take action to authorize the port area of Sihanoukville Port, the land use plan of the

whole water and land area surrounded by the breakwaters and the relocation plan of the private properties and residents have not yet fixed.

Therefore, in the master planning, due consideration should be made so that impacts on the existing socioeconomic structure be minimal.

b. Consideration of hydrologic system in the waterfront area of the port

The land area near the New Port area is low and swampy. There are several ponds within and outside of the present port area. During rainy season, these ponds play a role as the buffer of heavy runoff from hills surrounding the port. The reclamation of new wharf may result in change of hydrologic system of the low land area.

(5) Container transportation by railway

The Cambodia Railway has started container freight train in early 1996. With the establishment of the Dry Port in Phnom Penh, the railway has a potential to carry substantial share of container cargoes between Sihanoukville Port and the Dry Port. Thus, the Master Plan should take into account of the space for future operation of rail container terminal.

5.1.2 Number of berths required in 2015

The number of berth required are calculated for various staged of the project as shown in Table - 5.1.2-1 with the assumption that the handling efficiency shall be upgraded as shown in Table - 4.2.3-1 and that the berth occupancy rate as a whole should be at the level of 60% where the actual working days is assumed to be 320 days.

The following number of berths will be required:

- i) High and Middle cases; 10 berths, and
- ii) Low case; 8 berths.

The required number of berths for the short-term plan is calculated to give an idea of the scale of the short-term plan, which shall be carefully examined and refined through the feasibility study(second stage of the study). On the basis of the numbers of required berths, the layout plans drawn for each stage of the project are shown in Fig. - 5.1.3-1, 2, 3, 4.

- Fig. - 5.1.3-1: Layout plan for High and Middle Case, Plan-1 (H-1 and M-1)
- Fig. - 5.1.3-2: do. , Plan-2 (H-2, and M-2)
- Fig. - 5.1.3-3: Layout plan for Low Case, Plan-1 (L-1)
- Fig. - 5.1.3-4: do. , Plan-2 (L-2)

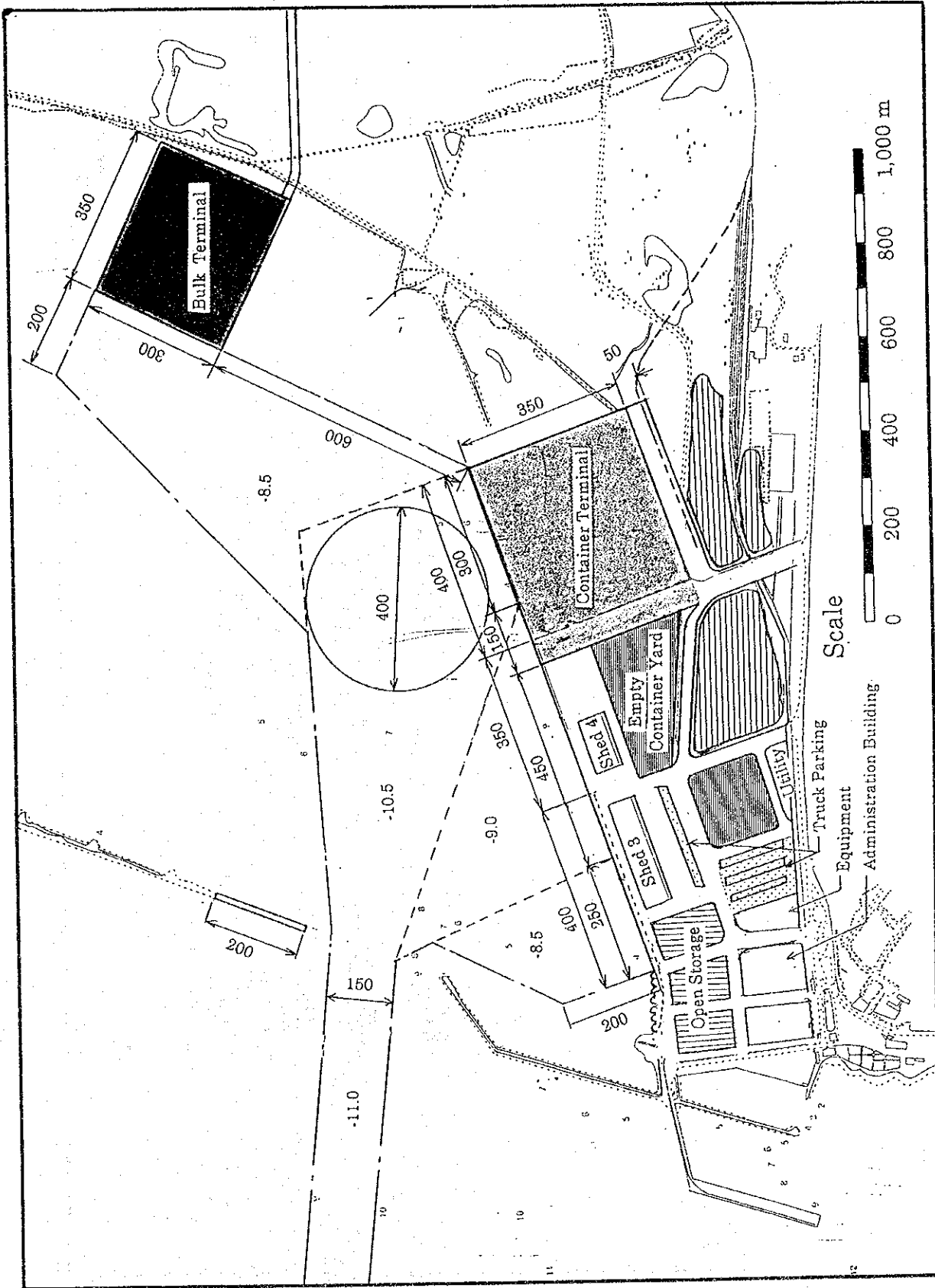


Fig. - 5.1.3-1 Long-term layout plan (2015, High and middle case), Plan-1 (H-1 and M-1)

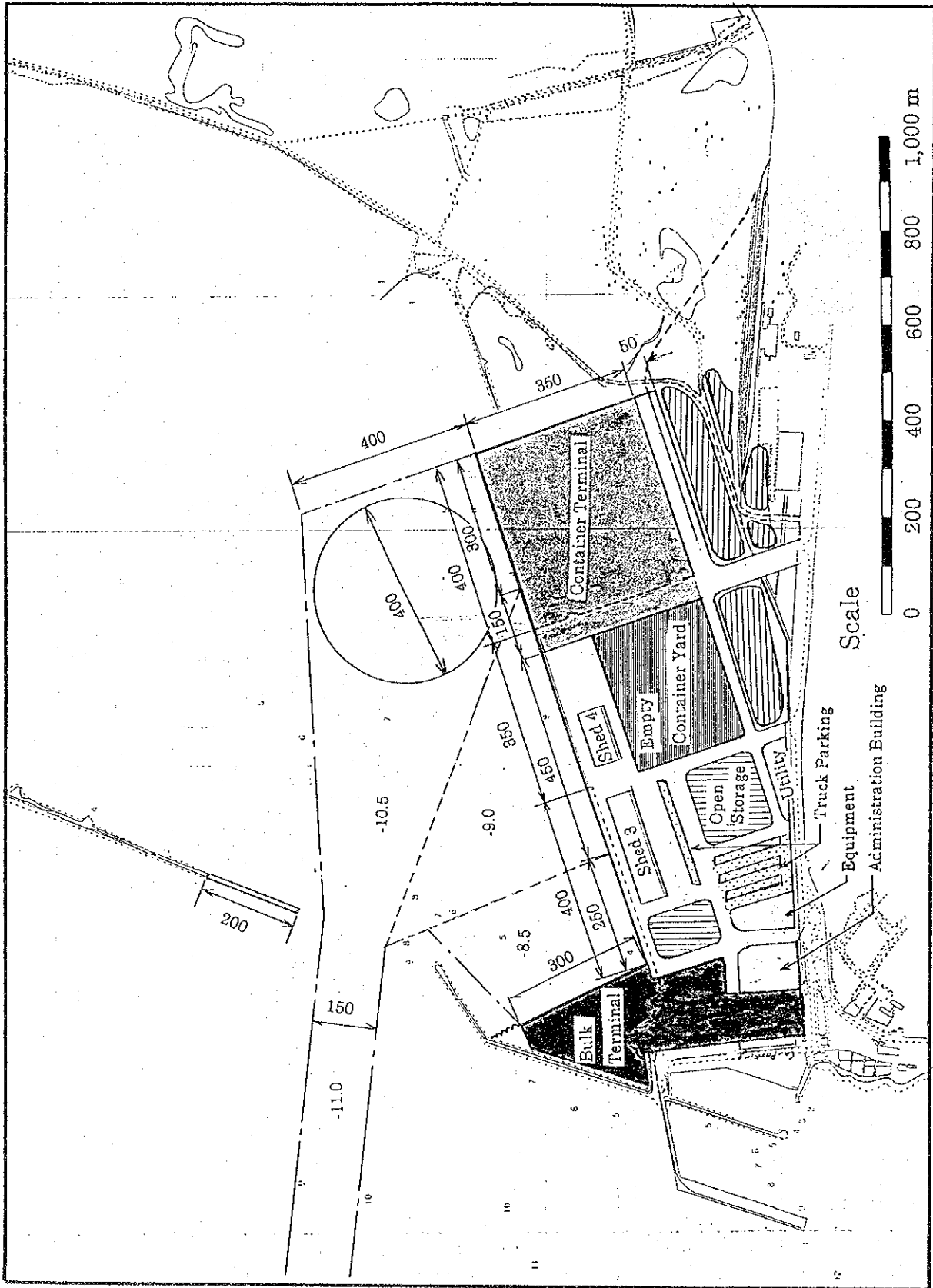


Fig - 5.1.3-2 Long-term layout plan (2015, High and middle case), Plan-2 (H-2 and M-2)

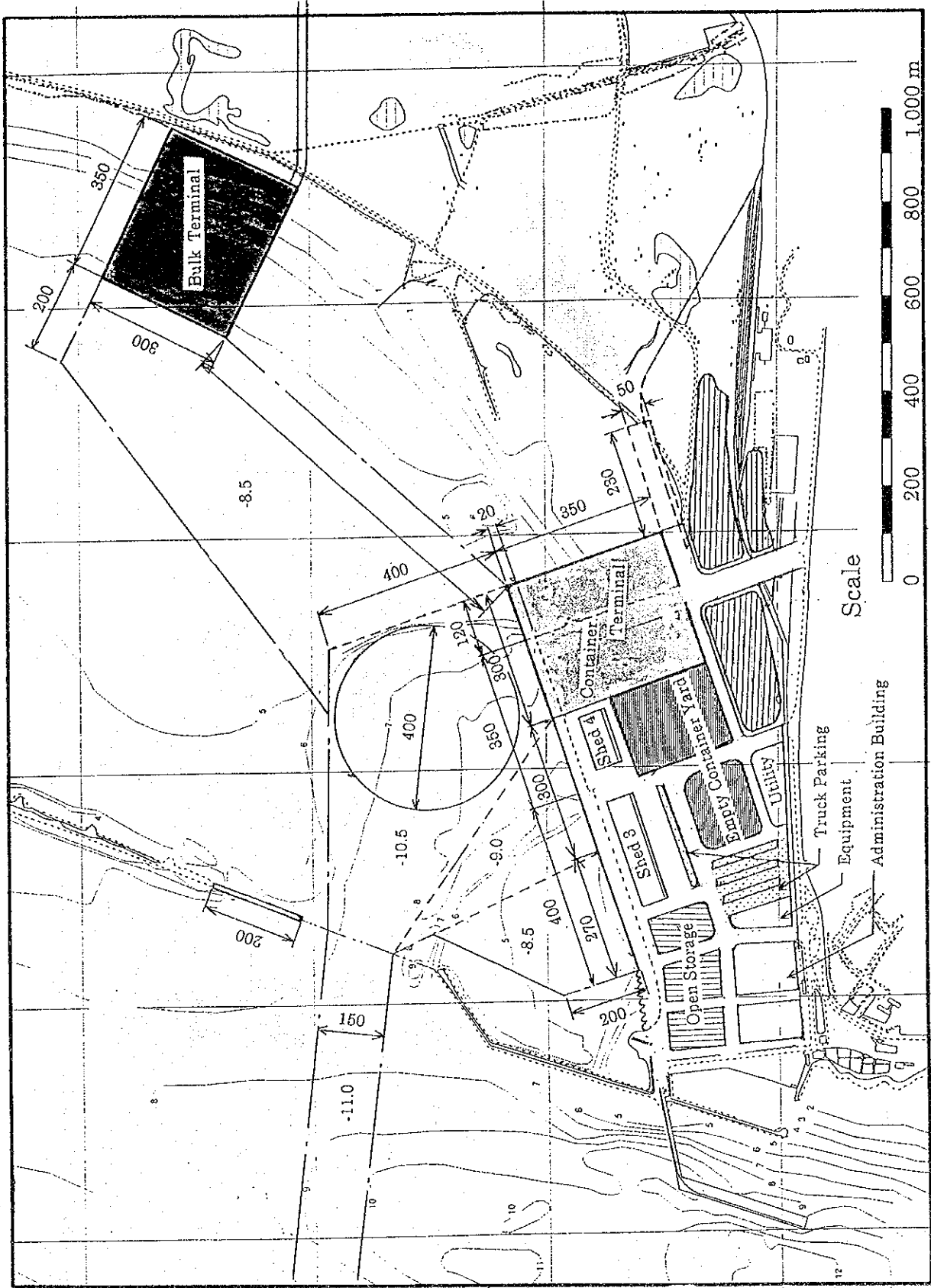


Fig. - 5.1.3-3 Long-term layout plan (2015, Low case), Plan-1 (L-1)

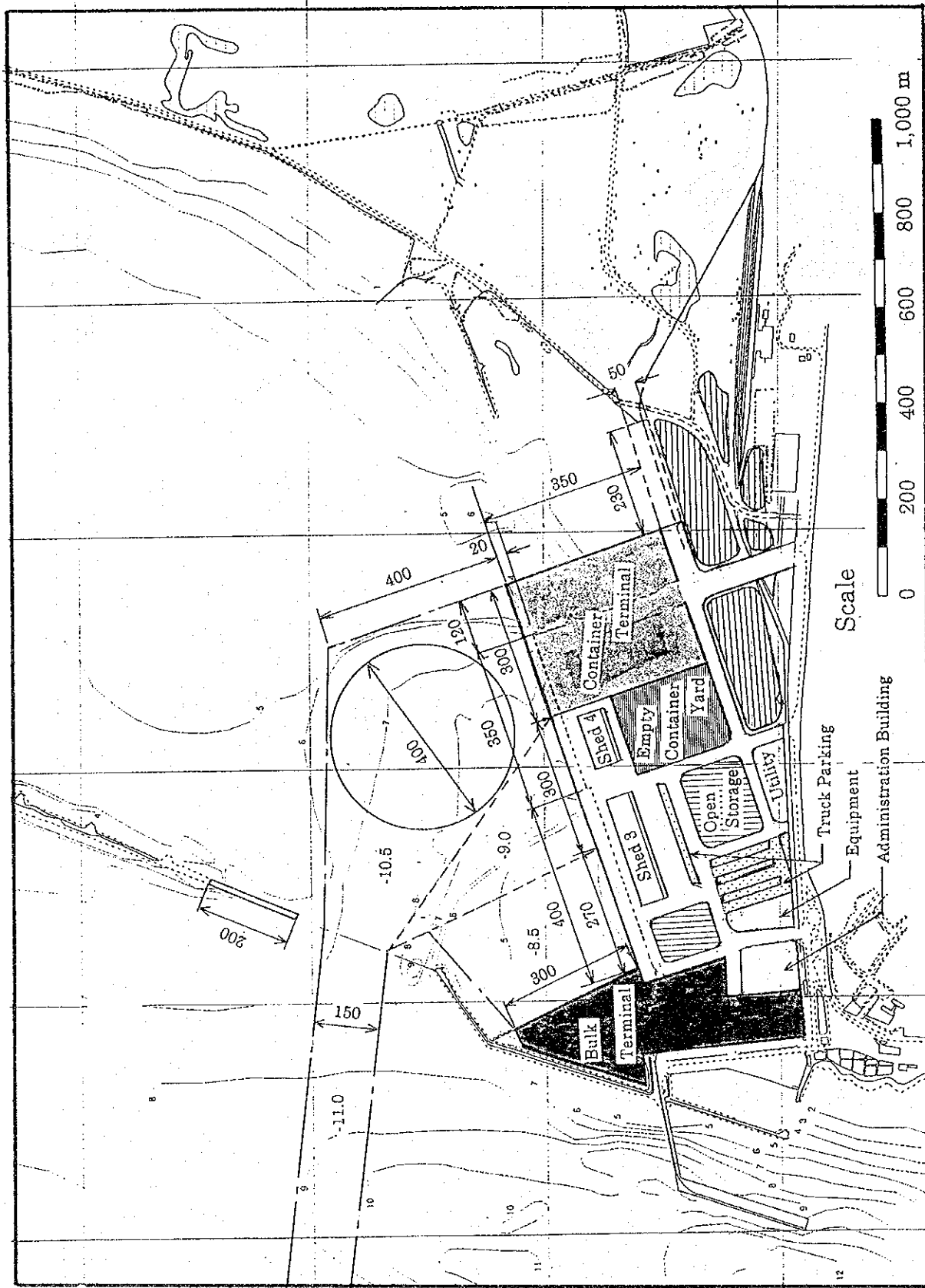


Fig. - 5.1.3-4 Long-term layout plan (2015, Low case), Plan-2 (L-2)

The difference between the alternative plans Plan-1(H-1 and M-1, and L-1) and Plan-2(H-2 and M-2, and L-2) is the location of the dry bulk terminal. The concepts of these two alternative plans are as follows:

a. Plan-1

The bulk terminal is located to the north of present port facilities, where open spaces available in the land area behind the terminal. This land space has a potential to be developed for the activities of industries such as cement and fertilizer packing factory, and distribution center.

The space in the water area between the bulk terminal and the container terminal remain unattached in order to reserve the existing hydrological system, and the water and land space for the future expansion - beyond the year 2015 - of container terminal and docking facilities of small boats such as tugs and pilot boats. The new terminal together with the new access roads to the terminal and land area nearby would also give an impact to promote the private investment in the area.

b. Plan-2

This alternative plan is intended to fully develop the present port area. On one hand, the maximum flexibility is left for the future expansion plan beyond 2015 toward the north of existing New Quay. On the other hand, however, the expansion of the bulk terminal to the south is bounded. There is not enough space in the port area to invite industries related to bulk cargoes.

Table - 5.1.2-1 Requirement of berth at various stages of the project

(1) Long-term Plan (2015)

Class of Berth	Berth		Number of berth length required													
	Length m	Depth m	High				Middle				Low					
			Req.	B. No.	m	B.O.R	Req.	B. No.	m	B.O.R	Req.	B. No.	m	B.O.R		
10,000 DWT Berth	165	9	0	0	0			0	0			0	0			
7,000 DWT Berth	150	8.5	3.21	3	450			2.84	3	450			2.3	3	450	
5,000 DWT Berth	120	7.5	1.87	2	240	65.0		1.63	2	240	62.6		1.3	1	120	62.3
						%					%				%	
Container Berth	150	8.5	2.35	3	450	64.0		2.05	3	450	47.7		1.6	2	300	54.3
						%					%				%	
Bulk Terminal	150	8.5	1.71	2	300	54.9		1.59	2	300	55.8		1.4	2	300	49.7
						%					%				%	
Total Berths				10	1,440	64.0			10	1,440	56.8			8	1,170	57.1
						%					%				%	

(2) Short-term Plan (2005)

Class of Berth	Berth		Number of berth length required													
	Length m	Depth m	High				Middle				Low					
			Req.	B. No.	m	B.O.R	Req.	B. No.	m	B.O.R	Req.	B. No.	m	B.O.R		
10,000 DWT Berth	165	9	1.7	2	330			1.4	2	330			1.3	2	330	
7,000 DWT Berth	150	8.5	0.9	1	150			0.9	1	150			0.8	1	150	
5,000 DWT Berth	120	7.5	3.8	3	360	74.2		3.4	3	360	66.1		3.1	3	360	61.2
						%					%				%	
Container Berth	120	7.5	1.3	2	240	44.6		1.1	2	240	37.9		1	1	120	67.1
						%					%				%	
Total Berths				8	1,080	66.8			8	1,080	59.1			7	960	62.0
						%					%				%	

(3) Urgent Plan

Class of Berth	Berth		Number of berth length required												
	Length m	Depth m	High				Middle				Low				
			Req.	B. No.	m	B.O.R	Req.	B. No.	m	B.O.R	Req.	B. No.	m	B.O.R	
7,000 DWT Berth	150	8.5							2	300					
5,000 DWT Berth	120	7.5							2	240					
3,000 DWT Berth	100	6.5							1	100	64.6				
											%				
Container Berth	110	7.5							1	110	73.7				
											%				
Total Berths									6	750	73.7				
											%				

Note: B.O.R denotes the Berth Occupancy Rate

5.1.3 Construction schedule

With respect to the berthing facilities, the Long-term development plan consists of four major elements:

- a. Renovation of the quarry wall in front of the Shed 3 to a 400 m long pier for general cargoes,
- b. Construction of a 400 long new container wharf, which is an extension of existing New Quay to the north, and
- c. Construction and reclamation of 300 m long bulk terminal, and the relocation of storage of bitumen to the new bulk terminal,
- d. Dredging of approach channel and water area in the breakwaters.

It is recommended that these four elements of expansion be performed in the following schedule:

Among these elements, the renovation of the quarry wall is most urgent, because the port requires an alternative facility to the timeworn Old Jetty for the handling of general cargoes, especially bagged cargoes. This stage will be proposed as the urgent measure in Chapter 7 in this report.

The second priority should be given to the construction of new container terminal as well as the purchase of handling equipment for containers, because the volume of container cargoes is expected to increase rapidly. This stage of the development plan will be proposed as the short-term plan, the feasibility of which shall be examined fully in the later stage of the current study.

The construction of the bulk terminal shall be done at the final stage of the Long-term development. Dredging shall be done in accordance with the stages of the development of new berthing facilities.

In addition to these major elements, the following works shall be included:

- a. Pavement of open storage yards and parking lots for cargo trucks and trailers,
- b. Purchase and installation of cargo handling equipment,
- c. Construction of New Port roads,
- d. Installation of navigation aids, and
- e. purchase of tug boats.

These elements can also be done in accordance with the staged development of the berthing facilities.

5.2 Long-term development plan of management and operation

5.2.1 General principles of port management and operation

(1) Port management and operation

In executing port projects, proper port planning and efficient management and operation are fundamental requirements. The functional layout and design of port facilities must be based on excellent port planning to successfully realize port projects. If a management and operation system is inappropriate, the full benefits of modernized port facilities cannot be enjoyed. In this sense, there is an interdependent relationship between the management and operation system and design of port facilities.

There is no definitive management and operation system that has been adopted in ports all over the world. The structure of the port management body at each port is slightly different depending on historical, socio-economic and institutional factors. However, the final goal is the same: to utilize the port facilities in a such a way that the maximum benefits are generated.

In principle, port management is a kind of commercial business, so the following three points are commonly required for port management and operation to satisfy users around the world.

- Efficiency

In order to ensure efficient utilization of the port facilities and port services, and to minimize the cost of transport through the port, efficient port management and operation are indispensable.

- Provision of services at reasonable charges

The following points should be considered in terms of the port tariff structure.

- i) The revenue from the tariff can cover costs for construction, management, maintenance and repair.
- ii) The tariff should be rational in correspondence with the service provided.
- iii) The tariff structure should include system which leads to more effective management and operation of the port. This implies that tariff structure provides an incentive for vessels and cargo to move efficiently through the port.
- iv) The tariff structure and the way of imposition should be as simple as possible.

- Reliability and safety

Delivery/receiving or unloading/loading of cargo and arrival/departure of vessels must be carried out on time and correctly. Operation of cargo and vessels must be carried out in a safe manner.

Even if the above factors are given different priorities, it is impossible to attract users to ports without all of them. When the above requirements are satisfied, port activities can be

promoted and the port management body can make the best use of port facilities.

(2) Port administration body (Port authority)

Port activity has a great influence on the national economy. Safeguarding the national interest should be the first priority of port management and operation. In particular, in developing countries, ports are one of the vital instruments of the national economic policy to achieve a so called economic take-off. Therefore, it is better for ports to be under the strong supervision of the government to facilitate optimum capital distribution and the realization of a trade policy. In other words, the basic role of ports is normally to function as a public facility.

On the other hand, port management is a kind of commercial business in terms of provision of services for port users. A much more flexible, business-like system of management is required, free from political pressures and frictions.

Therefore, the port is on the one hand a public enterprise and on the other a commercial one. A port authority is established to reconcile this dualistic nature of ports. The port authority is a separate autonomous body under the general overall supervision of the government, and in charge of the current administration and development of the port, within the framework of the national economic policy. On the other hand, autonomy cannot be achieved by a port unless it has a wide measure of financial independence and self-sufficiency, and these make the port administration body more sensitive to cost and benefits. To raise the capacity of the port authority to its highest level, it is necessary to adhere to the following essential principles.

- Autonomy
- Authority over whole port area and main port function
- Financial independence
- Commercial management methods

a. Autonomy

Port authority should be responsible for port improvement and expansion plans and for maintenance of all existing port facilities. It should have the right to select and appoint personnel in accordance with their professional abilities. It should be able to lease some property to private firms in case of need, incur financial obligations in its own name and in general to act as legal entity. Therefore, government's control should be limited to a minimum number of area. The following, however, should be subject to government approval.

- Plans for major port expansion and improvement
- General level of main port dues
- Annual budget
- Loans and obligations exceeding a certain limit

- Sale or long-term lease of property exceeding a certain amount

The two requirements, autonomy and government control, should be reconciled to realize efficient port management without deviating from the economic policy of the government.

b. Authority

A port administration body should have authority over whole port area and main port function. Port operation cannot be performed with full efficiency unless the port management body owned all land and facilities, such as infrastructure, quay cranes and so on, in the port area to control and coordinate all port activities on wharves and piers, land facilities and port water. Also, the planning of future port expansion cannot be made properly unless the port can freely dispose of the entire undeveloped water frontage within the port area.

However, highly specialized terminals, which are used by one single customer with sufficient volume of cargo, for example, berths for loading ores or crude oil, can remain in private ownership, under a certain degree of supervision by the port administration body.

c. Financial independence

Autonomy cannot be achieved by a port unless it has a wide measure of financial independence. Therefore, port charges and any other receipts of the port should be used exclusively for port administration, maintenance and improvement. Port charges should be kept at a reasonable level to cover normal current expenses, including amortization and repayment of loans. Only funds for investment to major infrastructure and superstructure based on a port extension or improvement plan should in case of need be supplied by the government, either in the form of direct donation or of low-interest loans.

d. Commercial management methods

In port management and operation, new problems constantly arise and must be solved quickly. Port management is a kind of business so the administration body must always fight against rising costs. Therefore, ports cannot be managed in accordance with the bureaucratic systems prevailing in most governmental departments. The management must be flexible and be able to make decisions according to the merits of each case, rather than according to formalities and rigid regulations.

Clearly defining responsibilities and an organization chart are essential conditions of efficient management. An organization chart with responsibilities of each section should be publicized to enhance internal cooperation among related departments or sections and the control of organization by the staff of an administration department.

The port administration must have the freedom to adjust its organization and the level of expenses to the changing requirements of traffic and conditions of port operations. A certain

section should be in charge of analysis of those changing situations, correction of related information and research of needs of port users.

Port management should not sit and wait for the traffic to come but should make all efforts to attract traffic. Therefore, one more aspect of the need of a business-like approach to port problems is the necessity of promotional activities. A reasonable amount of publicity and close contact with ship companies and their agents, local and international commerce, industrial organization and with all actual and potential port users can greatly contribute to improving the image of the port, making known its advantages and opportunities and promoting a steady growth of traffic. Also, these activities of port promotion can bring to light current problems of the port and stimulate their quick resolution.

5.2.2 Modernization of port management and operation

(1) Required functions for Sihanoukville Port

Sihanoukville Port, which is the major port in Cambodia, is managed and operated by the Port authority of Sihanoukville. The Port authority of Sihanoukville is a government body which belongs to the Ministry of Public Works and Transport and has authority of planning, construction, management and operation and maintenance of port facilities. Port operation, such as pilotage, tugs, cargo handling, maintenance of equipment and so on, is done by them. Container cargo has been handled in this port since 1992, and has a tendency to increase. Sihanoukville Port will be involved in progress of containerization from now on.

Under the situation, if the port is to be attractive and profitable port for users, attention must be given the following points.

a. Administration of port area

In Cambodia, port area is not ordained by law. Therefore, the boundary of port area managed by Sihanoukville Port is not clear. This situation will create problems for the port development in future. The port area should be defined including future expansion.

b. Organization

In order to realize efficient port management and operation related to a basic policy and plan and ensure sound finance for the port development, it is necessary to introduce or reinforce sections which are in charge of the following functions:

- Port development
- Personnel affairs
- Port promotion
- Port statistics

c. Administration and management system

In order to promote rational and efficient management, it is important to introduce measures for activation of administration and management system. In particular, communication among sections should be improved.

d. Port operation

To carry out the port management and operation effectively, the port operation should be considered from the commercial business standpoint. That is "efficiency", "provision of service at reasonable charges" and "reliability and safety" as described in 5.2.1 (1).

We propose to construct a new container terminal for handling efficiently the increasing container cargo in proportion to containerization in Cambodia. It is necessary to examine not only a suitable cargo handling system but also the best management system for the container terminal.

e. Statistic system

Systematic collection and compilation of data and information on various port affairs is a basic requirement for sound and effective port administration. Port statistics required for planning, administration, management, operation, budgeting, accounting and auditing should normally cover the essential fields including port activities, facilities, financial status, organization and personnel affairs, engineering management and other related information.

However, under the existing condition, the forms and methods of record keeping have not been established, nor has a computer system been introduced. Improvements in this areas will be necessary.

f. Training system

At Sihanoukville Port, employees in each section should control port activities appropriately to materialize efficient management and operation such as quick cargo handling, farsighted investment, profitable financial management and so on. In other words, it is important through training to give staff full knowledge and understanding both on technological and functional requirement of the port and to make them cost-conscious and efficient in conducting their duty and assignment. At present, Sihanoukville Port is preparing various plans of employee training for the purpose of development of human resources. It is also necessary to examine and introduce a more effective training system for future port development.

g. Port promotion

Port promotion is one of the most important fields of activities for attracting port users: shipping lines, shipping agents, forwarders, shippers consignees and so on. There are mainly three objectives of port promotion.

- To increase cargo volume and the number of calling vessels by port sales.
- To improve international cultural exchange.
- To emphasize importance of ports to a nation.

Sihanoukville Port does not seem active in promoting itself. In future, sales activities of the port will be vital for securing adequate level of revenues from users at the Sihanoukville port.

h. Computerization

Computer system has been introduced to port management and operation in many countries for handling port related information efficiency. Sihanoukville Port, however, has not introduced computers to all aspects of its operations. It is necessary to gradually introduce information system in port activities such as terminal operation, payroll, stock control, financial, and personnel administration etc.

At Sihanoukville Port, several sections have personal computers but these are not used very effectively. Also, for the purpose of more effective use of personnel computers, introduction of suitable software and more frequent and periodical training are required.

(2) Port management and operation in future

This section discusses the measures to improve managerial weak points in Sihanoukville Port.

a. Organization

1) Activate the organization

Generally speaking, inner organization of executive department (head office) should be simplified and streamlined. The following points need to be considered in order to activate the organization.

- Training middle-ranked staff for positions of authority.
(For adjustment of gap between the few high ranking staffs and the majority of workers)
- Establishment of system and clear criteria for promotion of regular staff.
(Personnel changes not influenced by higher-ranking staff's change)
- Sharing information for strengthening organization.
- Necessity of incentive for workers.
(Measures to prevent well-trained personnel from flowing out of the organization)
- Establishment of task force for improving organization consisting of efficiency specialists.
(For objective proposal to improve the organization)

2) Reinforce of port planning section

Port planning section is in charge of preparing port development policy which indicates future conditions of the port.

In order to realize the proposed port plans, it is essential to secure active utilization of the plans through such efforts by Sihanoukville Port as promoting full understanding on the plan, securing adequate financial support with proper budgetary arrangements and reviewing periodically the plan according to the actual situation of the country and region.

Therefore, it is necessary to improve section of port planning for future port development. Establishing a task force consisting of experts is another way to assist in strengthening the planning section.

3) Introduction or reinforcement of port promotion and statistic sections

Port sales and statistic system, mentioned below in this chapter, are essential to support every day activities. In Sihanoukville Port, the sections in charge of these works should be created or reinforced.

4) Introduction of port management and operation strategy section

Port management and operation strategy section is in charge of preparing personnel affairs policy and port promotion policy. These policies should be prepared as part of the strategy which leads to the establishment of a proper future port management and operation system.

b. Personnel administration

1) Introduction of measures for activation of the organization

For activation of the organization, not only its reformation but also the improvement of minds of its personnel toward rational and efficient management are important. For this purpose, many companies adopt a Quality Control (QC) circle and a proposal activity system.

● Quality Control (QC) circle

A QC circle is an activity for improvement involving each individual employee. Normally it is carried out by a group within a single division or section. Members of the group identify problems concerning quality, safety, efficiency etc. and voluntarily try to solve the problems with everyone's cooperation. It also has an effect on the improvement of working mind of personnel since many people take part in the activity and find satisfaction in seeing their suggestions implemented. Many companies hold presentation conferences or award ceremonies in order to promote it and to learn from other activities. It is also done by a project team extending through several divisions concerned.

- Proposal activities system

A proposal activities system is a system whereby top managers invite proposal or new ideas on concrete improvement measures from all employees and adopt what they consider to be the best proposals. These kinds of activities would give all personnel a good opportunity to think over their own tasks and to contribute to their rationalization. It is recommended that Sihanoukville Port introduces and develops these kinds of activities throughout its organization.

However there are many cases where these activities begin to lose their novelty and the number of proposals decreases as time goes by, although they work well at first. Therefore it is important for top managers to make quick and effective decisions.

2) Personnel evaluation system

It is thought necessary to raise morale of personnel and to promote their ability to discharge duties for proper port management. Personnel management system to realize this will be important.

One way to improve personnel ability is to evaluate their ability properly and fairly with objective standards and reflect that evaluation in promotions and wages. Through this evaluation, the proper personnel transfer according to experience, knowledge and judgment becomes possible. Moreover it also gives personnel the incentive to work hard and display their ability because they are satisfied with the proper evaluation of their works.

The following points should be kept in mind at the time of the evaluation.

- Evaluation should be done not only for promotion and wages but also for the nurturing of personnel. So it is important to look at the shortcoming or promising points of each employee and to evaluate their efforts to rectify/cultivate them.
- A manager of each section should make efforts to improve abilities of personnel under them through training on the job or through some training courses and seminars.
- Evaluating items should include the contribution and attitude toward efficient business.

3) Communication

Objective of communication is shown below:

- To promote a better understanding on the part of employees of the policies of organization and to allow employees to air request and complaints.
- To make communication easy and to heighten morale of employees.
- To promote cooperation and instill in employees a sense of responsibility and to

abolish sectionalism.

Channel of communication is shown below:

- Channel from top to bottom Command, Notification, Instruction and so on
- Channel from bottom to top Report, Offering operation, Proposal activity
and so on
- Lateral channel Liaison meeting, Notice for circulation, Informal
gathering for discussion

Lack of communication in organization is frequently caused by the lack of a smooth lateral relationship rather than relation between top and bottom. Withholding of information is an effective means for one section to hold power over another, however this hinders the activities of an organization as a whole.

QC circle and a proposal activity system, as mentioned above, are effective measures to activate communication.

4) Others

A house journal is another measure to promote communication. A house journal is a newspaper published by the management body which details the organization's prospects, imparts broad knowledge of current undertakings and can serve as a forum to hear opinions and requests of employees. It should not be one-sided communication from top to bottom. Rather, it should promote mutual understanding between top and bottom and make lateral communication among employees smooth. This will result in a stronger organization.

c. Port operation

Generally, the best management of container terminals is performed by a single organization which has enough skillful officers and workers, to be able to supply full service to customers (shipping companies, shippers/consignees), from receiving containers to leading them onboard ship, or from discharging containers to delivery to the consignees. The CFS operator in the container terminal is expected to be the same as the container terminal operator.

At present, Sihanoukville Port does not have a container terminal. Concerning management and operation body of the new container terminal, the important thing to be considered is to choose the best method which enables a port management body to operate a port efficiently and effectively without sacrificing public interest, based on a detailed examination of the present situation of the study port rather than seeking a common management and operation system.

An example of organization for container terminal is shown in Fig. - 5.2.2-1. This was

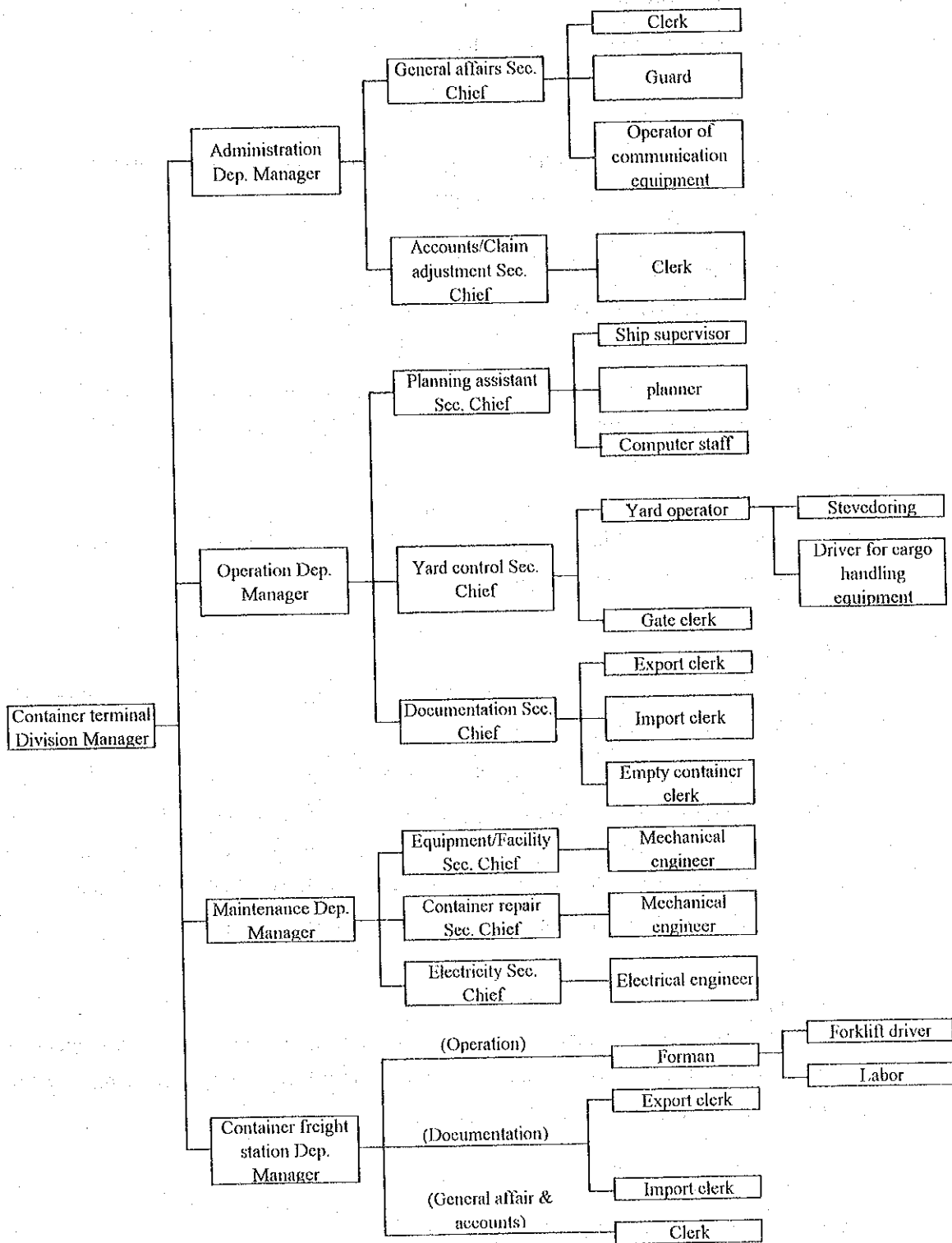


Fig. - 5.2.2-1 Example of new organization for the container terminal (Sihanoukville Port)

made based on the case of a typical container terminal. Following is a short explanation of the business of each section of the container terminal.

1) *General affair section:*

Administration of terminal properties and cost, labor costs and the flow of general administration funds. Other general affairs.

2) *Accounting/Claim adjustment section:*

Issuing bills for loading/unloading containers, storage, delivering, and repairing. Receiving charges.

Dealing with all claims which are concerned with human life injure, container ships, terminal facilities and equipment, containers, vehicles and so on.

3) *Planning assistant section:*

Planning of container ship stevedoring, container marshaling in the container yard, shifting within the container yard and so on.

4) *Yard control section:*

- (a) Arrangement of necessary equipment and their drivers, and other workers for performing the above operations.
- (b) Controlling yard operation at the operation center in the office. Controlling road trailers arranged for by the shipper/consignee, in the container terminal area.
- (c) Clerical work of container delivery and receiving at a gate house, inspection of the exterior condition of loaded containers, and damage inspection of empty containers which are returned from the consignee, or discharged from a ship.

5) *Documentation section:*

Issuing and typing of necessary documents for export/import containers. Arrangement for government official's inspection. Inventory control of empty containers, and the documentation of their delivery.

6) *Equipment/Facilities section:*

Maintenance of terminal equipment and facilities.

7) *Container repair section:*

Inspection of damaged and dirty containers which are returned to a gate house or discharged from a container ship. Cleaning and damage repair of containers, and inventory control of repairing materials.

8) *Electricity section:*

Maintenance, checking, and repair of electrical equipment which is concerned with the transformer substations, illumination of the terminal, refrigerated containers, and cargo handling (container gantry crane, transtainer, etc.).

9) *CFS department:*

(Operation)

- (a) Planning of cargo operation such as delivery/receiving, storage, container vanning and devanning at the CFS.
- (b) Arrangement, operation orders, and supervising of necessary equipment, their drivers and other workers.
- (c) Control of shipper/consignee's vehicles at the CFS.

(Documentation)

Issuing and typing of necessary documents for export/import containers.
Arrangement for government official's inspection.

(General affairs and accounts)

Bill issuing for all charges for CFS operations, and collection.

d. *Statistic system*

It is necessary to introduce a statistic system in Sihanoukville Port, to support formulation of the port plan, port strategy and promotion of the port. The following points need to be considered.

- Establishment of systematic forms and methods of data collection.
- Construction of a data base automatically through collection work.
- Carrying out of above-mentioned works in cooperation with the related sections.
- Making the annual reports, monthly reports and other publications.
- Timely provision of useful information to the management of Sihanoukville Port and to the public.
- Introduction computer system and computer training for staffs in statistic section.

e. *Port promotion*

Sihanoukville Port dose not have special section for port promotion. At the first step, it is essential that Sihanoukville Port establishes a special section in charge of port sales. To go ahead with it concretely, the following actions as port sales are recommended.

- To collect information on port users' requirements.
- Establishment of port promotion strategy focusing on the most effective target groups of users.
- Under the systematic action program, the staffs should call for sales at shipping companies or shippers and point out the real merits of utilizing Sihanoukville Port.
- It is useful for effective sales activities to prepare an attractive brochure in which the sales points including various advantages and merits for the target users are explained plainly.
- To hold seminars to introduce this port to shippers of various countries is another effective way to assist the promotion activities.

f. Training system

The objective of employee training is to improve the capability of each worker, which in turn will lead to efficient port management and operation. Through training, employees should gain expert knowledge, leadership ability, skill to operate port equipment and so on. They should understand the current port condition and manage and operate the ports considering problems which are expected to occur in future.

In addition, to gain more effect, they should make efforts to self-educate. From the view point of the efficiency of training, it is desirable to do periodical training for many employees and special training for executives or technical employee/staffs. The concrete objectives by kinds of employees are as follows. Also, an example of the programs is shown in Table - 5.2.2-1.

1) For all staff

Training courses for all staff begin at the time of employment and continue periodically. By attending these courses, employees gain basic knowledge on general administration and leadership ability. Employees will gradually develop a broader understanding of the nature of ports which will help them to cope with problems of port administration.

2) For Secretaries (Staff mainly engaged in management or finance)

By attending training courses on general administration, financial management, accounts system, related laws and regulations and so on, secretaries gain a better understanding of port management, and will thus execute their duties more effectively.

3) For Engineers (Staff mainly engaged in construction or maintenance and repair)

By attending training courses on civil engineering, architecture, electrical engineering, mechanical engineering and so on, engineers gain a better understanding of port construction and maintenance, and will thus execute their duties more effectively.

4) For Operators (Staff mainly engaged in marine and port operation)

By attending training courses on marine operation, cargo handling, operation and maintenance of port equipment and so on, operators will attain a higher level of skill and thus the efficiency of port operations will be enhanced.

5) For personal computer operators

By attending training courses on personal computer, personal computer operators will be able to use personal computers for daily work using application software such as word processor, calculation format and drawing processor. More quickness and accuracy of daily work will be expected.

From the viewpoint of the future situation of Sihanoukville Port, it is advisable that not only basic training in the field of port and skill acquisition training but also computer system training should be introduced. In order to assist in training and skill acquisition, the following measures should be considered.

- Overseas training

Special intensive training on computer and handling equipment could be done abroad. Graduates of these courses could in turn become instructors.

- Inviting specialists from abroad

The field training is very useful to the skill acquisition. Therefore, invitation of technical supporting specialists or engineers on the port activities make it possible to accelerate technology transfer.

Table - 5.2.2-1 (a) Training program

Subject		Program	Remark
For all staff	New staff	Basic knowledge of general administration, port management	Grasp actual situation of port
	Middle staff	Advanced knowledge of general administration, port management	Heightening self-awareness as middle staff
	Executive staff	Management, command and problem settlement ability	Enhancement of leadership capability, nurturing development of staff, raising their moral
For secretaries		Administration, Port management, Related law and regulation, Procurement, Accounting, etc.	
For engineers		Civil engineering, Architecture, Electrical engineering, Mechanical engineering	

Table - 5.2.2-1 (b) Training program for operators (theory)

Subject	Course		Details
Basic	Mechanical engineering	Hydraulics	Machine components, combustible gases and oxygen, structure of gas welding equipment etc. hydraulic circuit symbols etc.
		Machinery Components Gas welding Arc welding	
	Electrical engineering		General electric, telephone equipment, electrical equipment for vehicles, electrical devices for cranes, and other cargo handling equipment, electrical circuit diagrams etc.
	Construction, transportation and machinery		Classification of transportation equipment, uses of transportation and loading equipment, structure and functions of motors, travel gear, operating gear etc.
	Production engineering		Production planning, operations analysis, management of production stage, transportation, equipment, quality etc.
	Applied dynamics		Power, center of gravity, movement and kinetics, friction, work and energy, safety factor, permissible stresses and elastic energy, bending, twisting
	Slinging work		Slings apparatus, slinging technique, slinging signalling
	Safety and hygiene		The meaning of industrial safety, cranes of accidents, accident prevention, maintenance of hygiene, port and houbert safety, equipment safety, first aid, examples of accidents
Law and regulation		Port related laws and regulations	
Specialist	Port management and operation		Theory and policy of port management, and operation, knowledge of customs, tariff and insurance contracts
	Cargo handling		Type and method of cargo handling, international agreement
	Structure of cargo handling machinery	Forklifts	Types, structures, functions, handling and related regulations of cargo handling machinery
		Shovel loaders	
	Mobile cranes		
	Cranes		
Derrick			
Electricity and engines	Vehicle engineering		Internal combustion engines, fuel and fuel consumption, lubrication and hydraulic fluids
Cargo handling	Shipboard cargo handling		Safety operating techniques of cargo handling machinery, supervision and direction, preparation of cargo handling plan, ship structure, numerical inspection
	Onshore cargo handling		
Inspection and maintenance		Before and after operation of port cargo handling equipment, regular inspection and maintenance	

Table - 5.2.2-1 (c) Training program for operators (practical training)

Subject	Course		Details	
Basic	Inspection and maintenance		Structure of internal combustion engines, electrical motors and machine parts, adjustment and maintenance skills	
	Slingsignalling		Use of tackle, selection of wire ropes, estimating weight, judging center of gravity	
	Safety and hygiene work		Operating procedures for cargo handling machines, a full awareness of safety procedures and operating methods, first aid and hygiene techniques, operation of adjustment mechanisms, storage of dangerous materials	
Specialist	Cargo handling machinery operation	Forklifts	Preparations before operation, driving and cargo handling skills	
		Shovel loaders		
	Cranes			
	Derrick			
	Inspection and maintenance	Tool manufacturing work		End treatment of wire ropes and fibers, manufacture and maintenance of pallets
		Inspection and maintenance		Inspection and maintenance of cargo handling machinery
	Numerical inspection			Method of numerical inspection using tally sheets, type of cargoes, packing, classification, remarking
Cargo handling	Cargo handling work	Pallet cargo handling, container banning, manual cargo handling, hoist work, conveyor work, handling of heavy/large objects		
	Container cargo handling	Management and operation of container terminal		
Welding work	Gas welding Ark welding	Basic welding skill		

Table - 5.2.2-1 (d) Training program for personal computer operators

Course	Program
Introduction of computer	Basic knowledge, key operation, concept of computer programming, making program by BASIC
Practical training of software	Basic knowledge of office automation, software (word processor, calculation format, drawing processor) operation

5.2.3 Possible alternatives for privatization in management and operation

(1) General

Throughout the world, there is a tendency for port management and operation to move toward privatization. Many port authorities have already adopted privatization or are considering its adoption. However, it is very difficult to define and evaluate this so-called "privatization" because of peculiarities among individual ports and countries. In addition, each port authority has its own jurisdiction and duties. The range of duties of several representative port authorities is presented as shown in Table - 5.2.3-1. It should be recognized that the definition of "privatization" is a relative matter. The privatization scheme to be adopted depends upon the degree of remaining duties in the public sector.

As is commonly understood, public sector is normally not flexible in providing personnel or investment in response to the actual fluctuation of demand. In this sense, full involvement of a port authority in cargo handling services is not always suitable for increasing efficiency of such services under a competitive market, and increased situation of cargo flow in particular.

Therefore, it is necessary for Sihanoukville Port to examine introduction of privatization corresponding to the stage of national economic development in Cambodia. This will be one of the solutions to realize an efficient port operation and contribute to improvement of the Cambodian economy in the future.

Table - 5.2.3-1 Port authorities' duties in the world

Country Port	Japan Yokohama	U.S.A New York	Netherland Rotterdam	Philippines Manila	Thailand Bangkok	Malaysia Port Kelang	Singapore
Ownership	**	**	*	*	**	*	*
Berth allocation	**	**	*	*	*	**	*
Fee and charge	**	**	*	*	*	**	*
Statistic	*	*	*	*	*	*	*
Water traffic control			*	*			*
Shed and heaping yard	**			*	*	**	*
CY operation					**		*
CFS operation					*		*
Stevedoring						*	*
Longshore cargo handling					*	*	*
Warehouse					*	*	*
Tug					*	*	*
Line handling					*	*	*
Water supply					*		*
Pilot			*			*	*
Tally					*	*	*

Source: OCIDI Survey Report

Note: ** Leased berths and facilities are under the control of separate organization

(2) Merit of privatization

Generally speaking, the private sector runs business more efficiently than public sector because of the following reasons.

a. Incentive

When a business is run by the public sector, incentives to make the management efficient by reducing deficits doesn't work well since there is no possibility of bankruptcy. On the contrary, the prospect of bankruptcy compels private companies to run an efficient operation.

Workers in the public sector lack incentives to perform the best possible job. Wage systems are often so rigid that the diligence or ability of an employee go unrewarded. This type of situation usually results in lackadaisical efforts on the part of workers.

b. Competition

Introduction of principle of competition will induce incentives for effective management. When services are monopolized by a single company without any competition, it is difficult to judge whether the company provides effective services or not. Participation of plural companies makes a comparison possible.

c. Flexibility

Introduction of flexible management free from budget system, seniority system, formalism, strict application of regulations which are peculiar to officialism.

(3) Privatization scheme

Generally speaking, the method of terminal operation can be classified as in Table - 5.2.3-2.

Table - 5.2.3-2 Methods of privatization

Case	Land		Construction	Ownership	Port facilities		
	Ownership	Operation			Operation		
					Stevedoring	Shore-side cargo handling	operation of facilities
A-1	Public	Public	Public	Public	Public	Public	Public
A-2					Private	Public	Public
A-3					Private	Private	Public
B-1	Public	Private	Public	Public	Private	Private	Public/Private
B-2					Private	Private	Private
C	Public	Private	Private	Private	Private	Private	Private
D	Private	Private	Private	Private	Private	Private	Private

Case-A concentrates many port activities in the hands of the port authority. Under this method, the port authority becomes not only a public body for administration, maintenance and extension of the port but also a commercial enterprise performing functions which, in other fields of economic activity, are usually performed by private firms. This method has been adopted by Sihanoukville Port.

Case-B restricts responsibilities of the port authority in the field of port operations to administrative activities where it plays the role of coordinator and supervisor. The port authority is responsible for aspects of port development such as port planning, construction and maintenance of facilities, management and financing. Also, the port authority owns land and main port facilities such as the quay, apron, yard, transit shed and so on.

Case-C makes the port authority just a landowner. Lands are leased out to other private sectors which can only build facilities that are appropriate to the port plan. The staff of the port authority need not think about the detailed design of facilities, construction and maintenance, operation, financing and so on. Co-ordination and determining the amount of rent are the main responsibilities they have. Usually, there is a little work for the port staff to do under this method.

Case-D makes the private sector a owner of lands and port facilities. Therefore, a private entity operate all of port by itself. This method is only adopted in the case of a special terminal, for instance, an exclusive terminal for coal, iron ore and so on.

Ports should contribute to the national interest, development of hinterland cities and their economies, especially in developing countries. From this point of view, Case-A or Case-B is recommended.

Also, concerning construction and operation of terminals, the following privatization methods can be taken as samples even through the responsibilities of port authorities may differ from one another.

- LAQ (Lease a Quay)

A private sector makes a contract with a public sector to conduct port service business, through this contract the public sector leases a terminal including quay wall to the private sector. The private sector pays a lease charge.

- LUP (License to Use a port)

A public sector licenses private sector to conduct limited port activities in the terminal constructed by public sector.

- BOT (Built, Operate and Transfer)

A public sector permits private sector to construct a terminal under the condition that

the private sector uses it for certain period (usually 10 to 15 years) to recover the construction cost. After this period the terminal is transferred to the public sector.

(4) Application of privatization

Sihanoukville Port is an important public port which supports the national economy and contributes to development of hinterland. Public ports should be managed and operated not only for limited or specified users but for the open public, and should fairly accept all ships and cargoes of different companies.

It is advisable that Sihanoukville Port introduce privatization, which is one of the solution to realize an efficient port management and operation, corresponding to the stage of national economic development in Cambodia. Present operation of monopolistic cargo handling served by Sihanoukville Port should be modernized. It is advisable that Sihanoukville Port encouraged private sectors to enter into the area of cargo handling service by providing an attractive environment.

The following guidelines should be taken into account in introducing privatization.

- The ultimate objective of privatization of port operation is to maximize economic return from the port activity for both the public and private sectors under careful consideration on effective removal of possible inefficiency of public sector.
- Port functions and activities to be privatized should be limited within the areas where the privatized activities can be fully controlled under Sihanoukville Port, and the areas where the effect of privatization can be fully expected without any negative impact to sound performance of the port.
- The target areas to be privatized should be planned and arranged appropriately to guarantee the necessary conditions under which the free market system can be fully activated.
- In principal, ownership of the land and water areas necessary for Sihanoukville Port, and the basic port facilities such as water area for navigation channels, anchorages and berthing basins, public wharves, utility mains, reserved space/land for public use or future expansion should belong to Sihanoukville Port.
- Basic port facilities and major cargo handling equipment should be open to public use, but can be leased out to private sectors on a contract basis for their exclusive use under appropriate conditions.

According to above mentioned guidelines, Case A-3, Case B-1 or a combination of these are considered the best selection for Sihanoukville Port at the long-term stage. In addition to, each terminal such as container terminal, general cargo terminal and bulk cargo terminal should be open to public use (as mentioned below).

a. Container terminal

Containerization will progress in Cambodia, and in the beginning of the containerization process, semi container ships or small full container ships operated by various shipping companies will call on the port rather than big full container mother ships operated by the major companies. This kind of container terminal should be not used as a exclusive berth but be used as a public berth.

b. General cargo terminal

General cargo terminals are normally used by various users and handle a smaller amount of cargoes compared with container terminals. Naturally, these terminals should be open to public use.

c. Bulk cargo terminal

In the case of terminals for bulk cargo such as fruits, grain and maize, on-land facilities can be used by a specified entity, while the berth will be used by many shipping companies. Therefore, the berth should be open to public use.

When Sihanoukville Port introduces privatization, attention should be paid to the following subjects.

- Reduction of personnel

If privatization is introduced, from the management point view, there is a possibility that a reduction of personnel will occur. Sufficient examination of important matters such as national conditions, labor problems, social customs, compensation for dismissed workers and so on need to be made.

- Selection of private company

It is important to decide qualification criteria for private companies wishing to participate. Example of criteria are as below:

- Companies which are able to perform efficient cargo handling to fit customer demand
- Companies which can provide reliable service.

Also, it is necessary to select plural companies, in order to increase competition.

5.3 Preliminary design and cost estimate

5.3.1 General

Based on the study on the Long-term development plan as described in previous Sections, preliminary design and relevant cost estimates are made in this Section.

In compliance with the scale of the port facilities determined in Sections 5.1 and 5.2, subsequent studies on the general port layout, scale and type of facilities were made hereinafter from the technical points of view considering the related aspects such as natural conditions including sub-soil, meteorological and oceanographic situations, loading conditions, size and type of ships, type and volume of cargoes, materials and equipment availability, construction workability, safety of structures and systems, easy or less cost for maintenance and operations, environmental mitigation, least cost scale and systems, duration of facilities, etc.

5.3.2 Design condition

(1) Design standards

For the purpose of the preliminary design of the port facilities of the Long-term development plan, following design standards and technical literature were applied.

- 1) "Technical Standards for Port and Harbour Facilities in Japan" (1991)
- 2) UNCTAD's handbook "Port Development Volume"
- 3) "International Association of Lighthouse Authorities (IALA)' Guidelines

(2) Objective ships and berth dimensions

Objective ships and relevant berth dimensions by individual types of cargo are summarized in Table - 5.3.2-1.

Table - 5.3.2-1 Maximum objective ships and berth dimension

Type of cargo	Ship size				Berth		Remarks
	DWT (ton)	LOA (m)	Beam (m)	Draft (m)*	Length(m)	Depth (m)	
Container	24,000	215	30.0	10.5	245	12.0	1500 TEU
Gen. cargo	20,000	177	23.4	10	200	9.0**	
Dry Bulk	20,000	171	23.8	9.8	195	8.5**	

Notes: * Full draft ** For half loaded

(3) General design conditions

a. Seismic force

Taking into consideration that earthquakes occur seldom in Cambodia, the seismic coefficient of 0.05 was adopted for the purpose of the Study.

b. Winds

As described in Section 2.5.1, the maximum wind speed during the data available period in 1960-1969 and 1984-1995 was 27.0 m/sec. On the other hand, however, according to the data, recorded by the weather station of Cambodia National Meteorological Services (CNMS) in Sihanoukville showed 60m/sec in the year 1990. Since, there was no typhoons occurring in the area at that time, this 60m/sec wind velocity recorded must have been due to gusty winds or some kind of tornado, if the figure was correct.

Considering the above circumstances, the wind record of the above data available period was adopted for the wave hindcasting but except for the data of 60m/sec since it did not contribute to wave generation due to the short time duration.

As for the preliminary study of the individual port facilities, following wind speed was considered.

For ship berthing facilities	: 50 m/sec
For buildings	: 50 m/sec
For container gantry crane	
Max. operational	: 16 m/sec
To be clamped on rail	: 35 m/sec
Max. wind speed	: 50 m/sec

c. Wave

The design wave was hindcasted by using S-M-B and Bretschneider methods. The results thereof are summarized in Tables 5.3.2-2 and 5.3.2-3.

Another hindcasting for the occurrence frequency of wave height and period at the port entrance was also made and summarized in Tables in Appendix.

Table - 5.3.2-2 Equivalent deepwater wave

Data Period		Wind direction							
		N	NNE	SW	WSW	W	WNW	NW	NNW
1960	Ho' (m)	2.1	2.1	2.2	2.3	2.6	2.1	2.2	2.0
~1969	T (sec)	5.5	5.3	4.0	4.8	5.6	5.1	5.5	5.2
1984	Ho' (m)	1.3	-	2.2	-	2.4	-	2.2	-
~1995	T (sec)	4.2	-	4.0	-	5.2	-	5.4	-

Notes: Ho' = Equivalent deepwater wave height, T = Equivalent deepwater wave period
Return period: 50 years

Table - 5.3.2-3 Significant wave

Data Period		Wind direction							
		N	NNE	SW	WSW	W	WNW	NW	NNW
1960	H1/3 (m)	1.9	1.9	2.1	2.2	2.4	1.9	2.0	1.8
~1969	T1/3(sec)	5.5	5.3	4.0	4.8	5.6	5.1	5.5	5.2
1984	H1/3(m)	1.2	-	2.1	-	2.2	-	2.0	-
~1995	T1/3(sec)	4.2	-	4.0	-	5.2	-	5.4	-

Notes: H1/3 = Significant wave height, T1/3 = Significant wave period
Return period: 50 years

Based on the above results of wave hindcastings, the design wave was determined as shown below:

For equivalent deepwater wave	Wave height: Ho' = 2.6 m
	Wave period: T = 5.6 sec
For the design of breakwater	Wave height: H1/3 = 2.4 m
	Wave period: T = 5.6 sec

d. Current

Based on the results of current survey conducted by the Study Team, a harmonic analysis was made [refer to Section 5.3.4(8)]. The results of the harmonic analysis for north navigation channel (observation point C2) show that the main direction of the current is NNE and SSW with the maximum current speed of 1 knot (approx. 0.5 m/sec).

e. Sub-soil condition

Considering the soil investigation results, as summarized in Section 2.5.1, design condition of the sub-soil for the proposed container berth was determined as shown in the table hereunder:

Table - 5.3.2-4 Sub-soil conditions

Classification of soil	Elevation (m)	SPT (N-value)	Unit weight (tf/m ³)	Internal friction angel
Silty sand	-5.0 to -12.0	0	1.8	20°
	-12.0 to -15.5	3		26°
Sandy silt to sandy clay	-15.5 to -21.0	2 to 14		32°
Rock	below -21.0	> 50		> 40°

Note, SPT:Standard Penetration Test

f. Loading conditions of cargoes and cargo handling equipment

Following loading conditions were considered for the preliminary design.

1) Cargo surcharge

- Container yard: 5.5 ton/m² (max.)
- Container berth apron 3.0 ton/m²
- General cargo yard/apron: 1.5 ton/m²
- Empty container yard: 1.5 ton/m²

2) Cargo handling equipment

- Container gantry crane Max. wheel load: 45 ton
Dead weight : 600 ton
- Transfer crane Max. wheel load: 30 ton
- Truck crane (200 ton) Max. outrigger load: 120 ton
- Forklift Max. wheel load: 45 ton
- Truck (T-20) Max. wheel load: 8 ton

g. Berthing velocity of ships

Considering the size of objective ships which are relatively large, and compulsory pilot system of the port, berthing velocity of 10 cm/sec is considered for the study.

h. Duration of the facilities

For those main port facilities such as quays and breakwater, 50 years life time is considered for the design and estimation purpose.

5.3.3 Quay construction plan

(1) Quay extension plan

Based on the Long-term development plan the following layout cases of quay structures were studied. For the relevant layout plans, see Figs - 5.3.3-1 to 4.

Cases H-1 and M-1

Type of berth	Type of quay structure	length of quay (m)	Nominal water depth (m)	Berth water depth (m)	Remarks
Container	A	330	-12.0	-10.5	transitional
	B	70	-9.0 to -12.0	-9.0 to -10.5	
General cargo	C-1	50	-9.0	-9.0	
	C-2	300	-9.0	-9.0	
	E	160	-9.0	-9.0	
	E	240	-8.5	-8.5	
Bulk cargo	D	300	-8.5	-8.5	
Total		1450			

Case L-1

Type of berth	Type of quay structure	length of quay (m)	Nominal water depth (m)	Berth water depth (m)	Remarks
Container	A	120	-12.0	-10.5	
	C-3	200	-10.5	-10.5	
General cargo	C-4	150	-10.5	-9.0	
	E	160	-9.0	-9.0	
	E	240	-8.5	-8.5	
Bulk cargo	D	300	-8.5	-8.5	
Total		1170			

Cases H-2 and M-2

Type of berth	Type of quay structure	length of quay (m)	Nominal water depth (m)	Berth water depth (m)	Remarks
Container	A	330	-12.0	-10.5	transitional
	B	70	-9.0 to -12.0	-9.0 to -10.5	
General cargo	C-1	50	-9.0	-9.0	
	C-2	300	-9.0	-9.0	
	E	160	-9.0	-9.0	
	E	240	-8.5	-8.5	
Bulk cargo	F	300	-8.5	-8.5	
Total		1450			

Case L-2

Type of berth	Type of quay structure	length of quay (m)	Nominal water depth (m)	Berth water depth (m)	Remarks
Container	A	120	-12.0	-10.5	
	C-3	200	-10.5	-10.5	
General cargo	C-4	150	-10.5	-9.0	
	E	160	-9.0	-9.0	
	E	240	-8.5	-8.5	
Bulk cargo	F	300	-8.5	-8.5	
Total		1170			

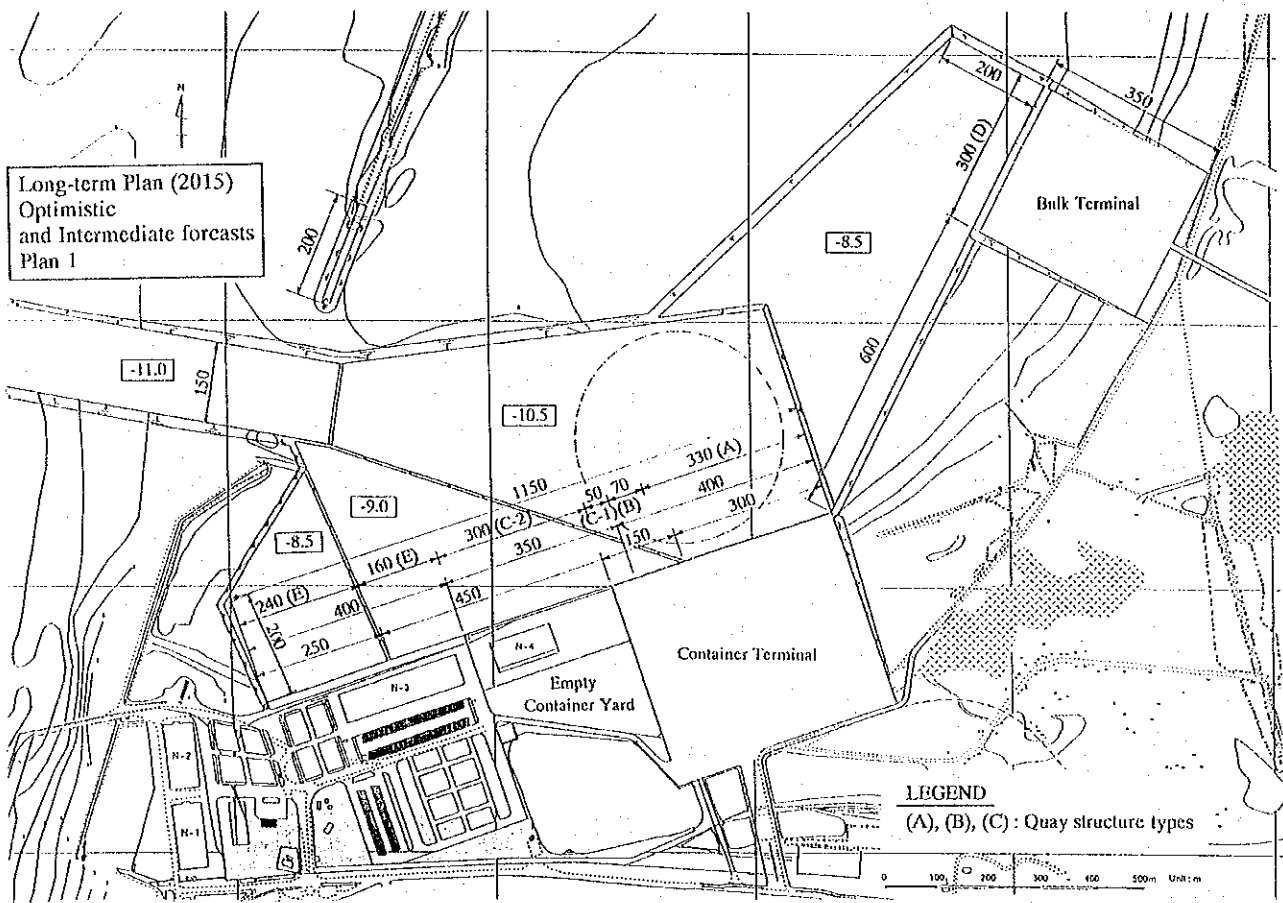


Fig. - 5.3.3-1 Location plan of quay structure by type, Case H-1, M-1

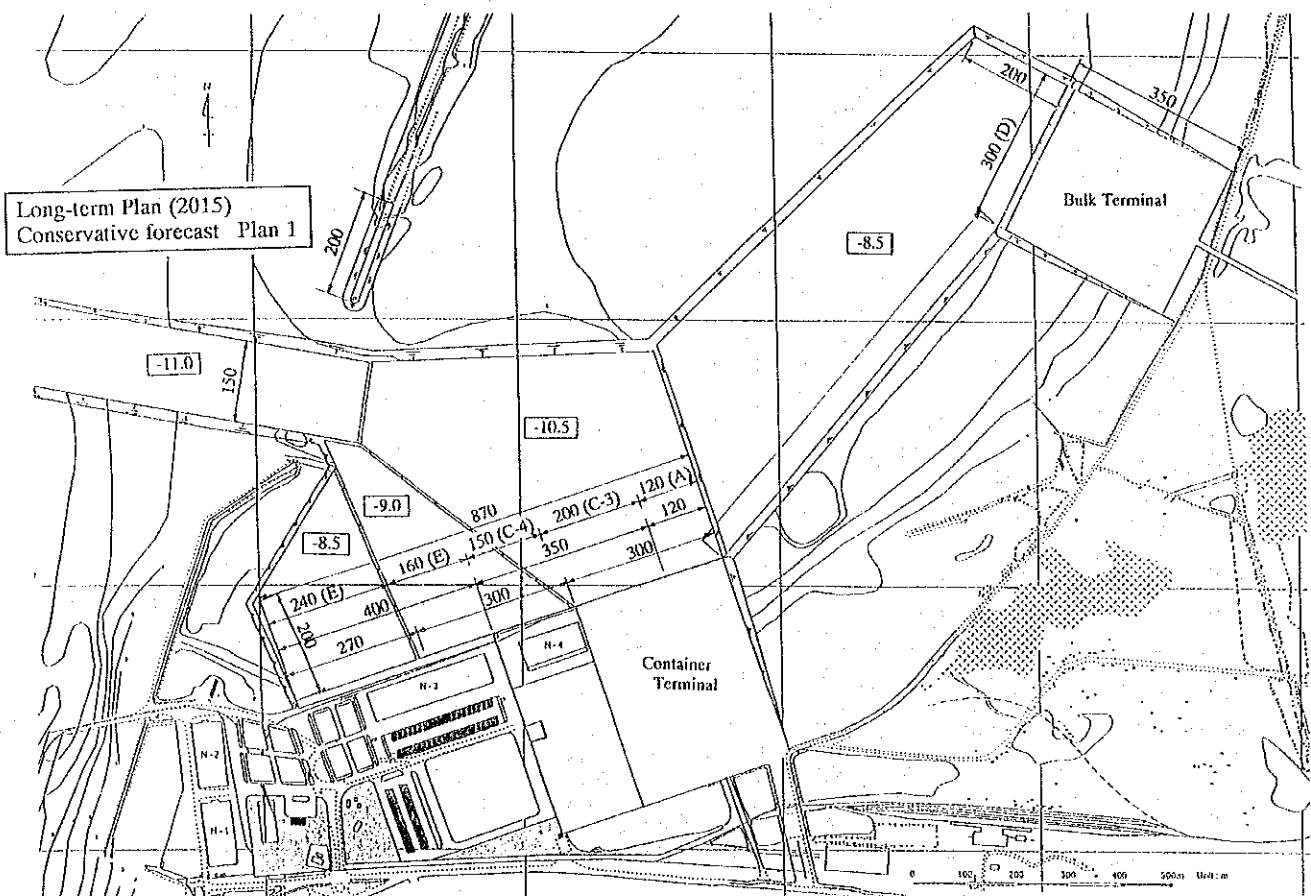


Fig. - 5.3.3-2 Location plan of quay structure by type, Case L-1

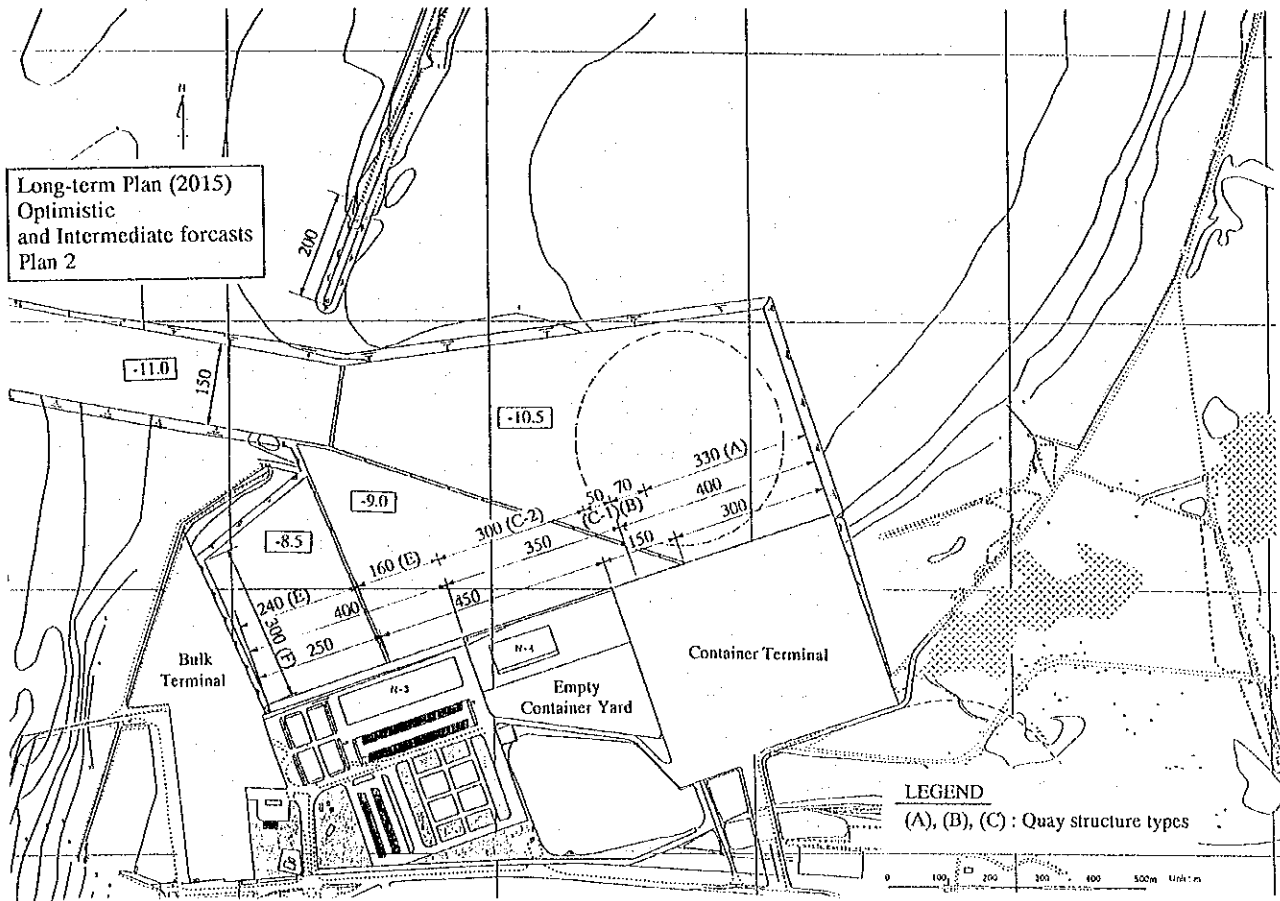


Fig. - 5.3.3-3 Location plan of quay structure by type, Case H-2, M-2

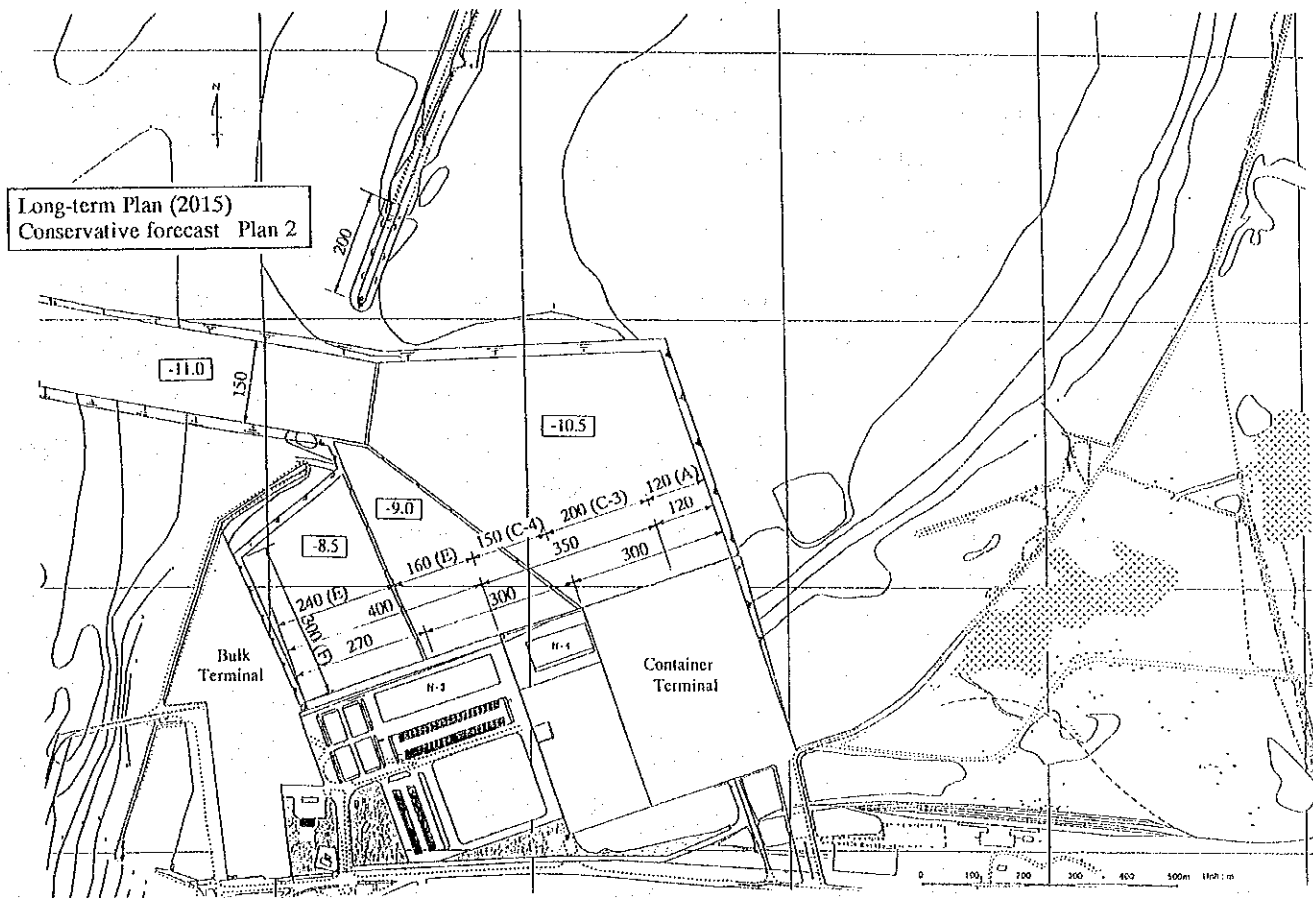


Fig. - 5.3.3-4 Location plan of quay structure by type, Case L-2

(2) Quay structure

a. General

To determine the quay structure following major points were taken into consideration.

- 1) The hard strata along the proposed face line of the quay is inclined from the west end of the general cargo quay near to the Point Loune where Rock layer is exposed above water level, to east end of the "New Quay" where the depth of the hard stratum is deeper than -25m. This erratic depth of the hard stratum affected the selection of the type of structure, i.e. for the shallow rock area a gravity type of structure will be economical while for the deep rock area a pile type structure will be preferable. A comparative study among several alternative structural types have been made in this Section.
- 2) As long as the cost of the structure allowed, a vertical wall type structure is not preferable for the quay structure, since the reflected wave in front of the quay will be a standing-wave and disturb the port operations.
- 3) For the container cargo and bulk cargo berths, heavy cargo handling equipment should be considered. In case of container berth, the quay structure was so designed to be a part of the foundation of the gantry crane simultaneously.
- 4) The existing "New Quay" was determined to utilize as much as possible in combination with the newly proposed structure and/or to renovate with minimal construction cost to be a part of the new line up of the berthing facilities.

b. Comparison of structural types

A comparative study among several alternative structural types was made to determine the most suitable type. As shown in the following Table, "concrete deck on steel pipe pile type" is most suitable as long as the sub-soil is not so hard. In case that the hard stratum is shallow, "concrete block type" seems economical. The said "type", however, will cause the side effects of wave reflection as mentioned in the previous paragraph. A wave dissipating concrete block type was also considered although it will increase the construction costs by a small amount.

Table - 5.3.3-1 Comparison of quay structural types

Structural type	Advantage	Disadvantage	Ratio of construction cost
Concrete deck on steel pipe pile type	<ul style="list-style-type: none"> * Least cost * Usable for crane foundation simultaneously * Settlement of foundation is negligible * Wave reflection is minimal * Less construction period 	<ul style="list-style-type: none"> * Corrosion of the steel pipe piles will need corrosion protection * Horizontal deflection of the structure is bigger than other types * Maintenance cost is higher 	1.0
Concrete block type	<ul style="list-style-type: none"> * Suitable for shallow rock sub-soil * Firm against collision of vessel to the quay structure 	<ul style="list-style-type: none"> * High wave reflection * Wide casting yard is required * Settlement of the foundation * Big size crane is required for big water depth quay * Separate crane foundation is needed 	1.2
Wave dissipating concrete block type	Same as concrete block type except for wave reflection which is less.		1.4
Concrete caisson type	<ul style="list-style-type: none"> * Same as concrete block type * Solid structure 	<ul style="list-style-type: none"> * Caisson launching facility is required * High wave reflection * Long construction period * Settlement of the foundation 	1.5
Concrete caisson with slit type	<ul style="list-style-type: none"> * Same as concrete caisson type * Less wave reflection 	<ul style="list-style-type: none"> * Caisson launching facility is required * Long construction period * Settlement of the foundation * High cost 	1.7

c. Recommended quay structures

1) Container berth

a) Types A and B: (See Figs. - 5.3.3-5 and 6)

To meet the deep bearing stratum, a concrete deck on steel pipe piles type is recommended. Two (2) pile rows are to carry the container crane loads thereon. The sea bed below the riprap stone is replaced with reclaimed fill material to avoid circular rupture on the sea-bed which will be caused due to the additional load of reclaimed fill and container cargo surcharge loads.

b) Type C-1: (See Fig. - 5.3.3-7)

To convert the existing "New Quay" to container cargo berth, a sea-side container rail track is installed on the top of the existing concrete blocks. For this purpose the coping concrete and some concrete blocks underneath should be demolished and replaced with cast in-situ concrete. The settlement of the sub-soil under the concrete blocks by the additional crane loads was presumed to be 5 to 10 cm, thus adjustment of the crane rail height will be needed as settlement occurs. For this purpose, the crane rail

foundation and the rail clamp bolts should be adjustable. To support the land-side crane wheels, another rail foundation with steel pipe piles is required. Those two rail beams are connected with tie rods so that the rail gauge will be kept in proper distance to each other.

c) Type C-3: (See Fig. - 5.3.3-8)

In order to accommodate deeper draft vessels as proposed in Layout plan cases L-1 and L-2, a steel pipe pile wall is proposed in front of the existing concrete block wall. Another crane beam foundation is working as the anchor piles of the tie rods.

2) General cargo berth

a) Type C-2: (See Fig. - 5.3.3-7)

This section is to utilize the existing "New Quay" structure as is, with additional accessories for the quay such as rubber fenders, concrete curbs, ladders, bits, and stone-fills on the frontal sea bed for scouring protection.

b) Type C-4: (See Fig. - 5.3.3-8)

This section is similar to Type C-3, but without crane rail and cable pit.

c) Type E: (See Fig. - 5.3.3-10)

Wave dissipating concrete block type is recommended for the new General Cargo Berth. This type is suitable, considering the depth of hard stratum underneath and the wave conditions in front of the quay. Regardless of the structural type of this quay extension, removal of riprap on the existing revetment is needed.

3) Bulk cargo berth

a) Type D: (See Fig. - 5.3.3-9)

Concrete deck on steel pipe piles type for Layout plan case H-1, M-1 and L-1. Since, there is a possibility of encountering the shallow rock layers in this proposed area, further soil confirmatory boring will be needed.

b) Type F: (See Fig. - 5.3.3-11)

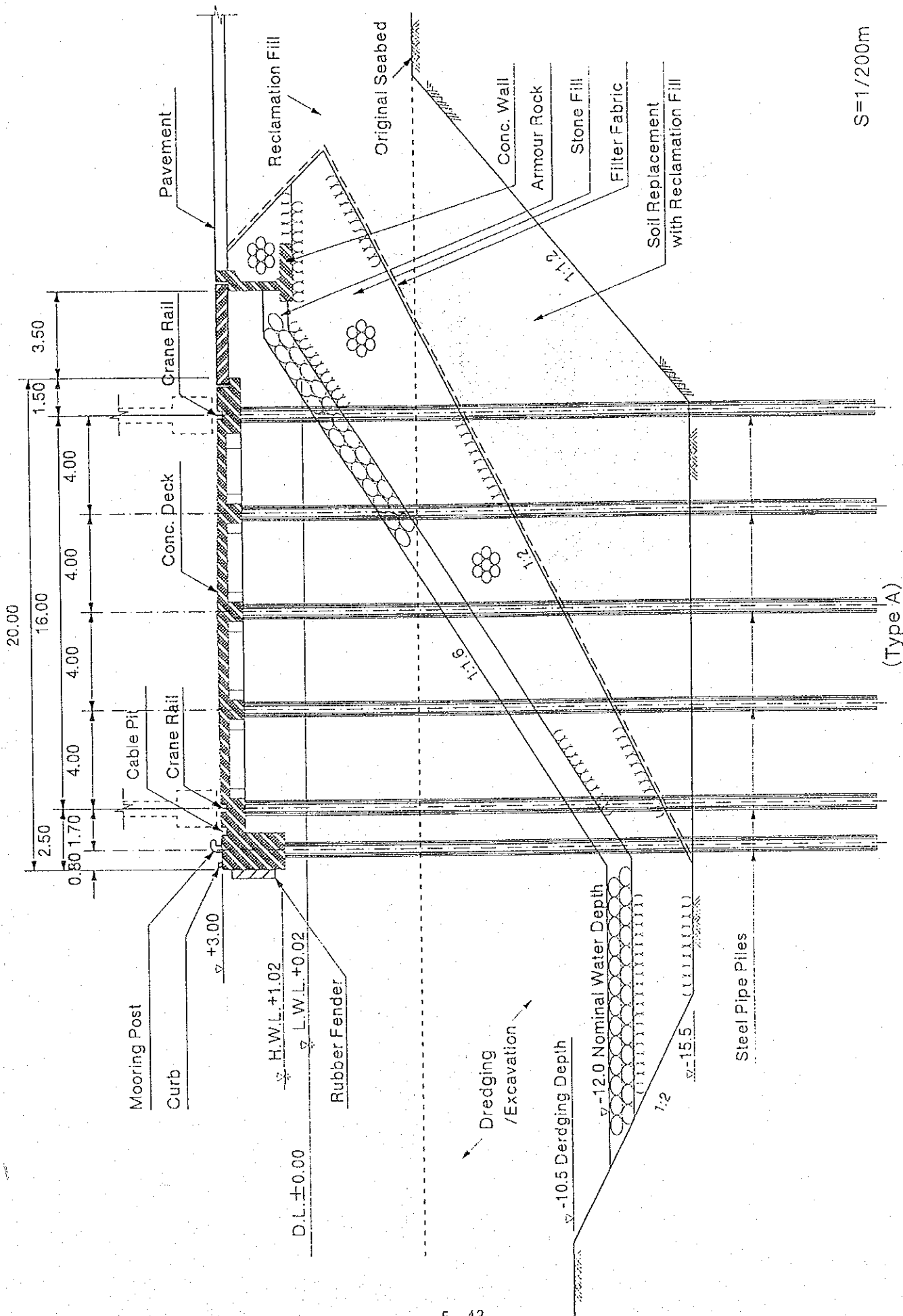
Considering the shallow rock layer in the proposed area, a concrete block type is recommended for the bulk cargo berth of the Layout plan cases H-2, M-2 and L-2.

d. Soil consolidation of proposed container terminal area

Based on the soil investigation data, soil consolidation of container terminal was presumed to be 0.9 to 1.0m. To accelerate this settlement during the construction period, a pre-load construction or other measures will be required and the relevant additional soil volume was also considered for the reclamation volume. For this reason a flexible type pavement for the container yard such as interlocking blocks is recommended.

(3) General Layout Plan

In order to give more realistic image of long term development plan, general layout plans of Cases M-1 and M-2 are shown in Figs. - 5.3.3-12 and 13 and Tables 5.3.3-2 and 5.3.3-3.



S=1/200m

(Type A)

Fig. - 5.3.3-5 Typical cross section of berthing facilities (-10.5m Container berth)

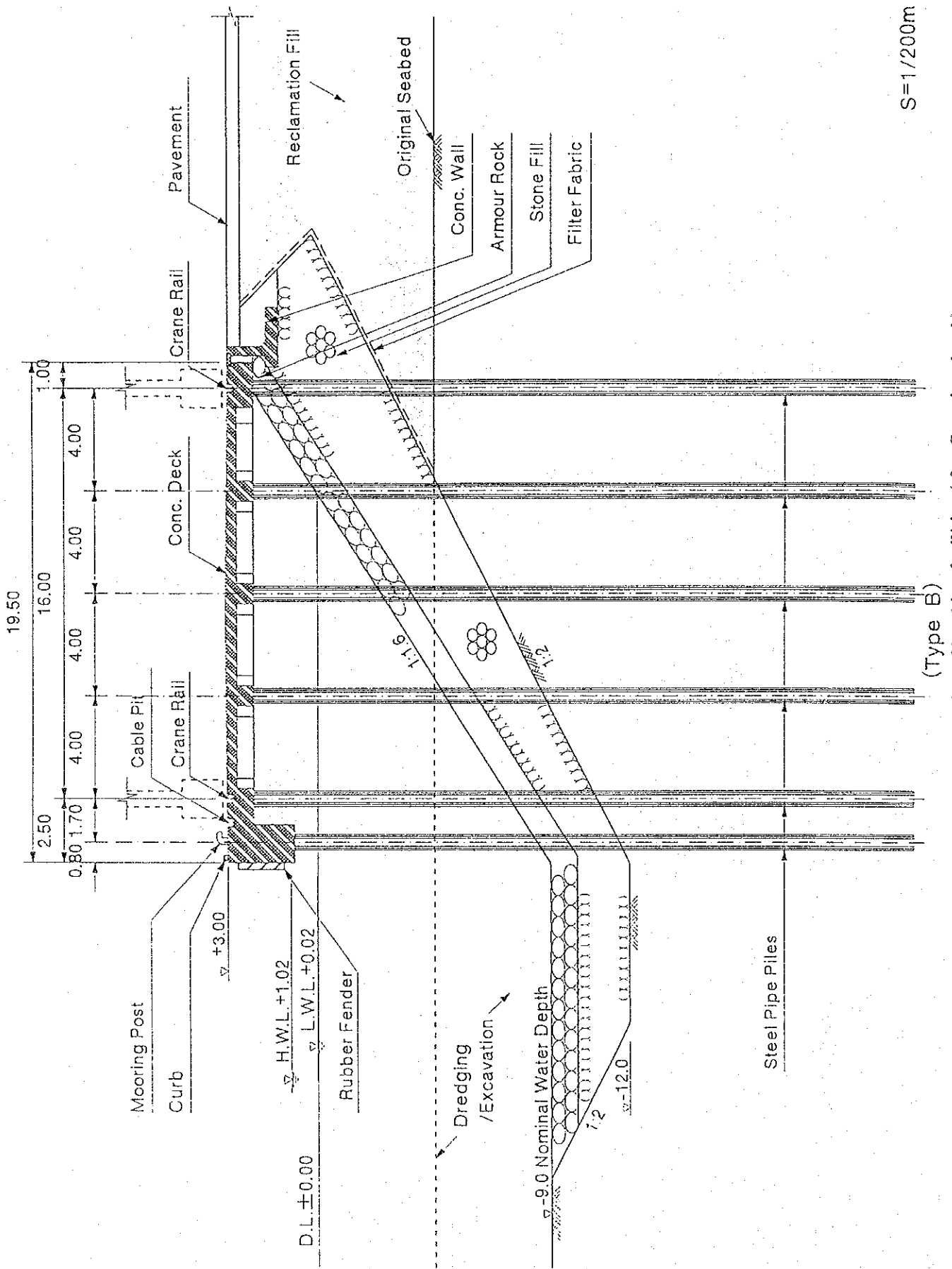
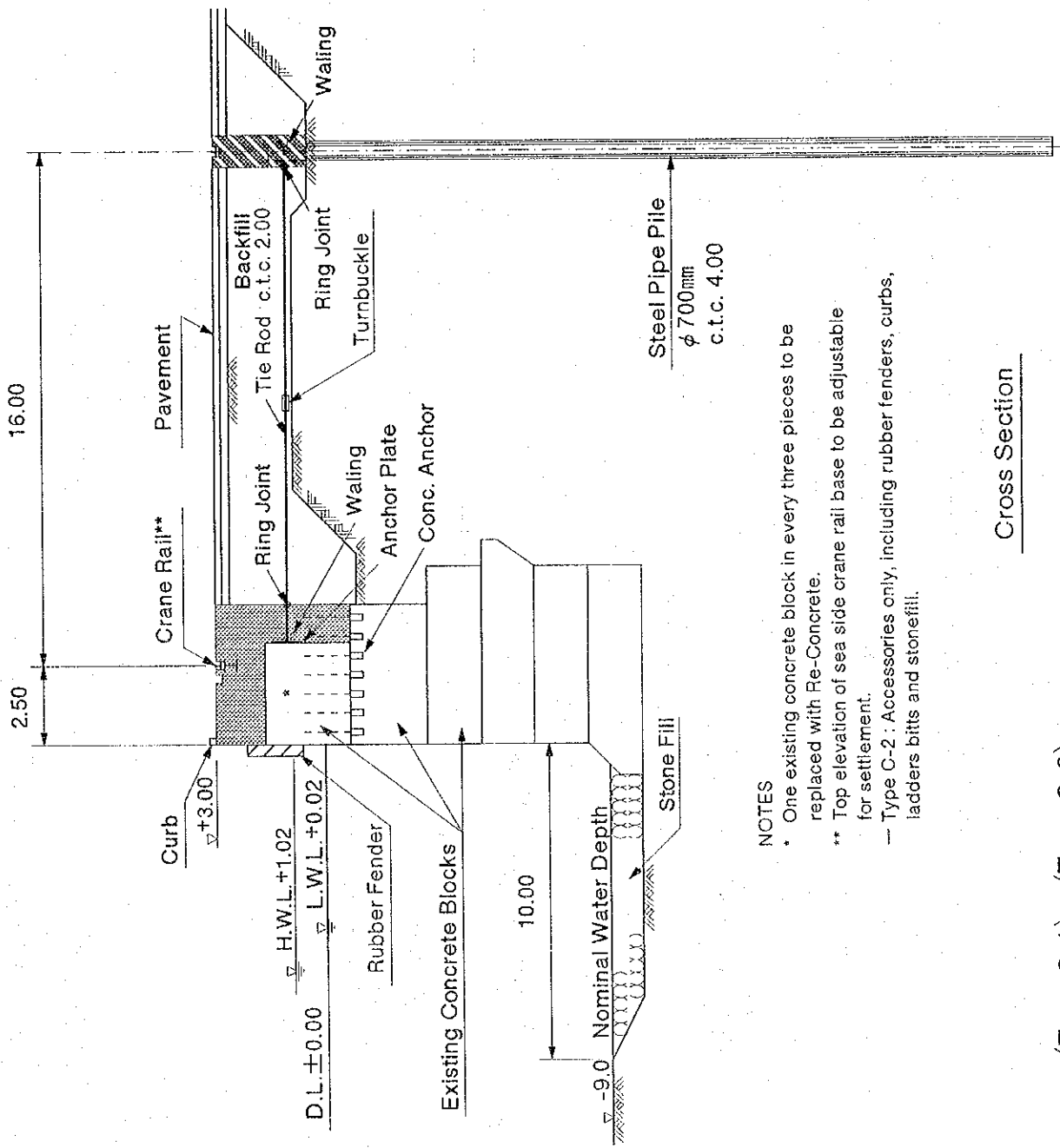


Fig. - 5.3.3-6 Typical cross section of berthing facilities (-9m Container berth)

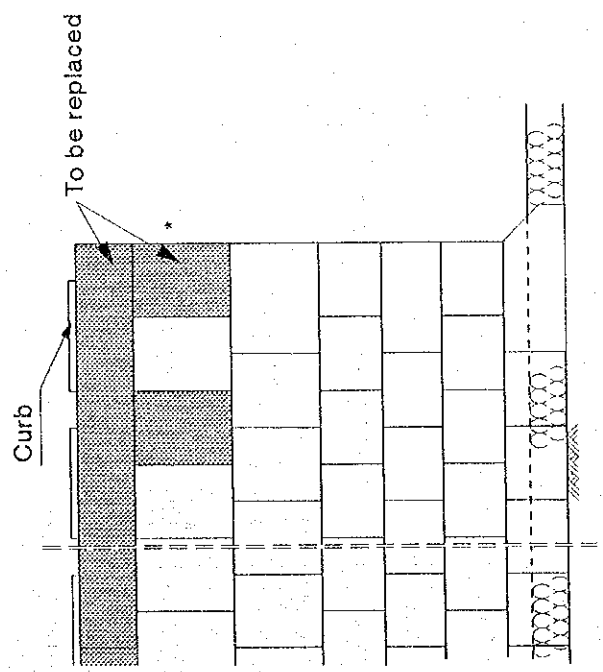


S=1/200m

NOTES

- * One existing concrete block in every three pieces to be replaced with Re-Concrete.
- ** Top elevation of sea side crane rail base to be adjustable for settlement.
- Type C-2 : Accessories only, including rubber fenders, curbs, ladders bits and stonefill.

Cross Section



Front Elevation

(Type C-1) (Type C-2)

Fig. - 5.3.3-7 Renovation of the "New Quay" for container crane foundation

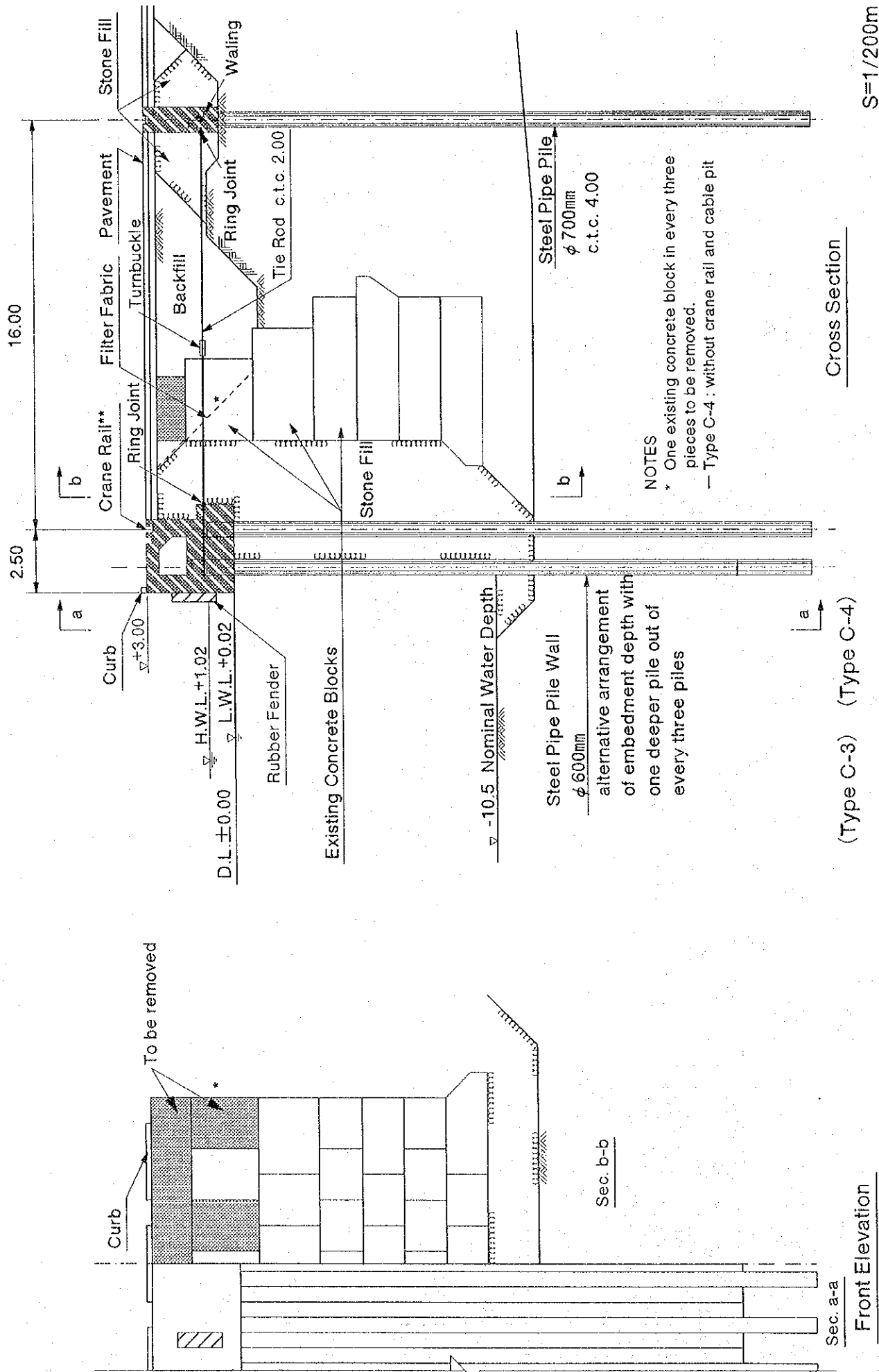
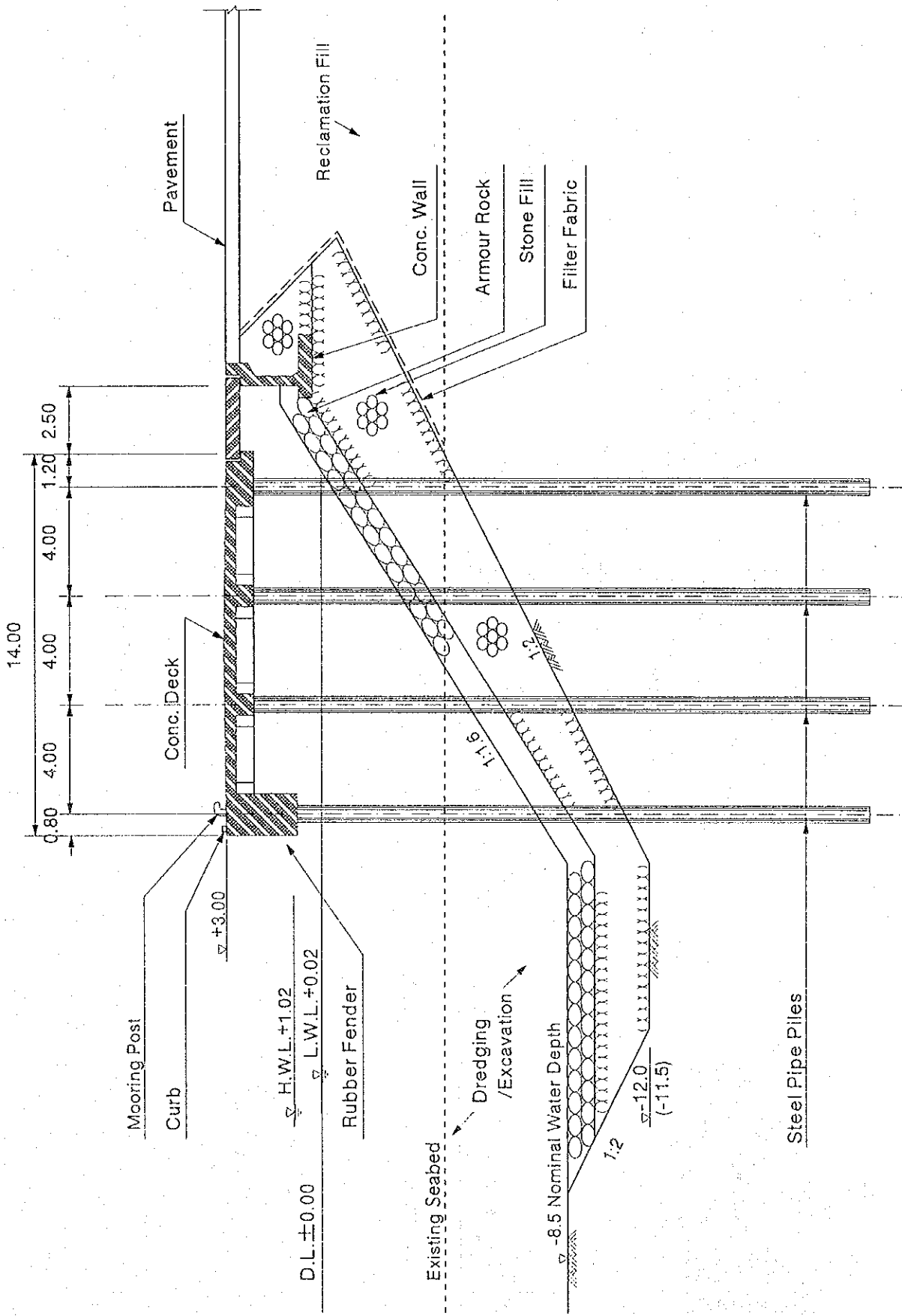


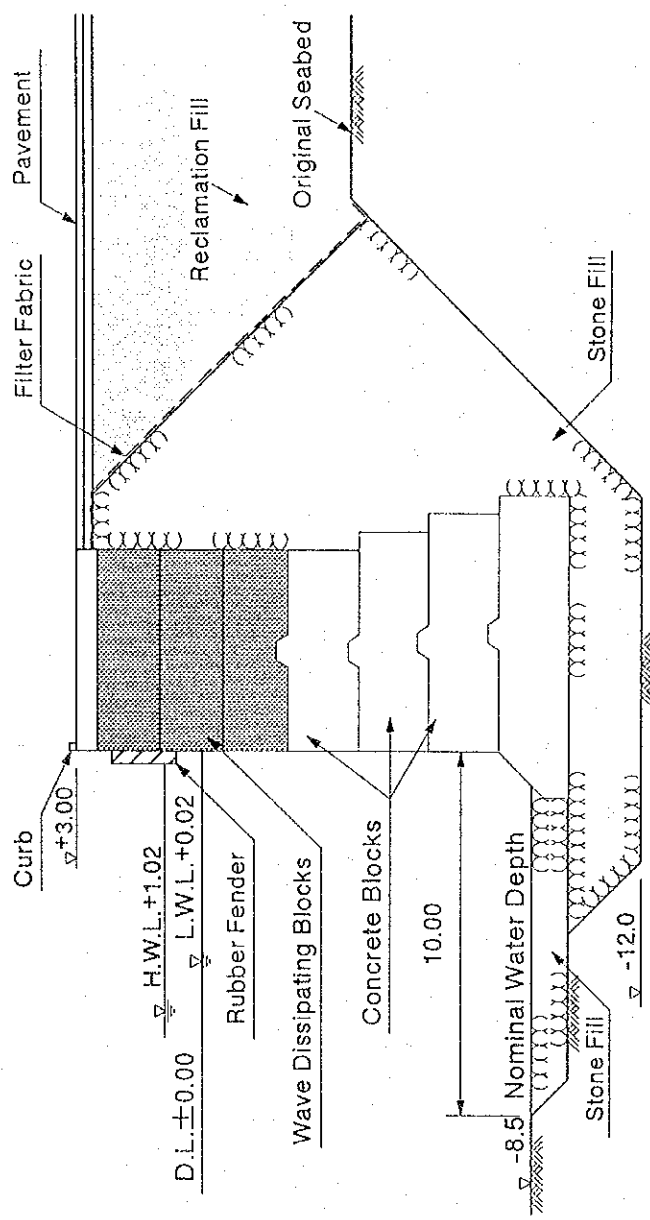
Fig. - 5.3.3-8 Renovation of the "New Quay" for container crane foundation



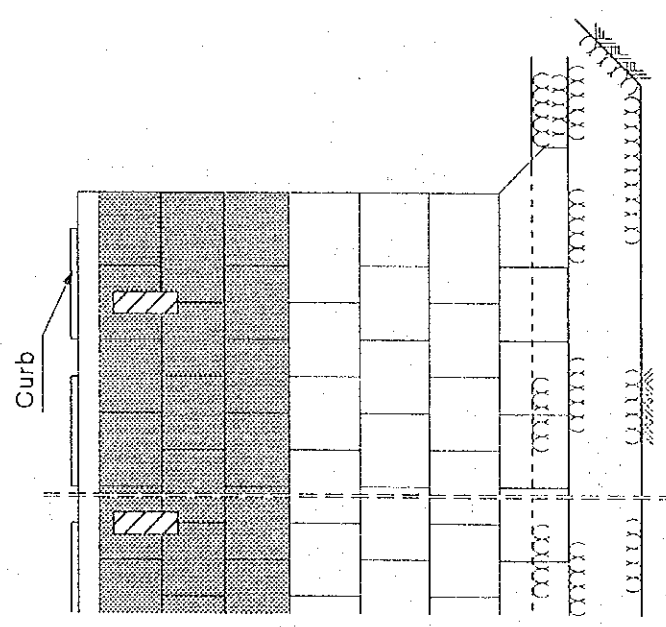
S=1/200m

(Type D)

Fig. - 5.3.3-9 Typical cross section of berthing facilities (-8.5m Bulk cargo berth)



Cross Section

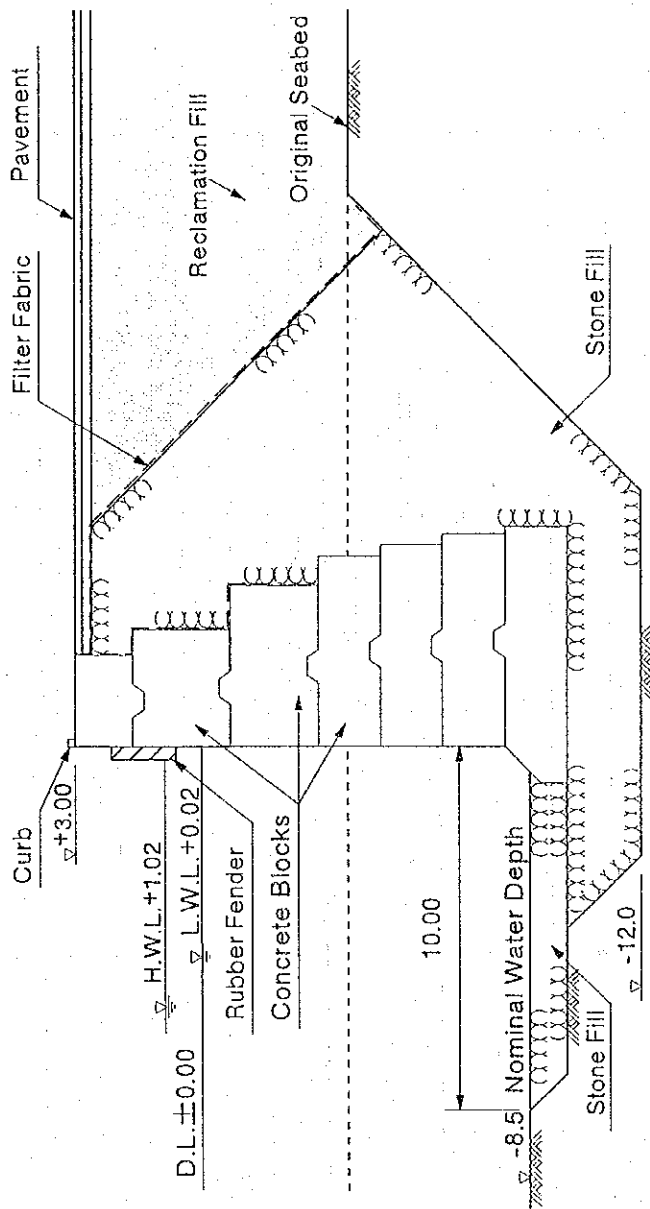


Front Elevation

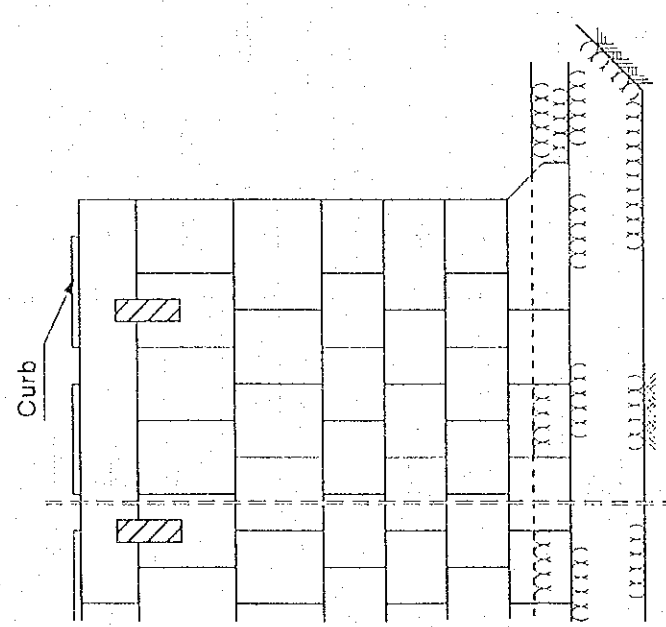
S=1/200m

(Type E)

Fig. - 5.3.3-10 Typical cross section of berthing facilities (-8.5~-9.0m General cargo berth)



Cross Section



Front Elevation

(Type F)

S=1/200m

Fig - 5.3.3-11 Typical cross section of berthing facilities (-8.5m Bulk cargo berth)

Table 5.3.3-2 List of proposed facilities for Long-term plan (Case M-1)

No.	Facilities	No.	Facilities
0	Port Basin and Navigation Channel Dredging	18	Open Storage (Future)
1	Container Terminal	19	Parking Area
2	Container Cargo Berth	20	Parking Area (Future)
3	General Cargo Berth (Existing "New Quay")	21	Administration / Office Building
4	General Cargo Berth	22	Bulk Cargo Terminal
5	Bulk Cargo Berth	23	Cement Silo / Pneumatic Unloader
6	Gantry Crane	24	Bitumen Tank
7	Transfer Crane	25	Generator House
8	CFS	26	Water Pump House
9	Maintenance Work Shop	27	Fire Fighting Pump House
10	Container Fumigation Facility	28	Diversion of Road to Existing Oil Terminal
11	Container Repair Facilities	29	Empty Container Yard
12	Container Cleaning Facilities	30	Future Railway Terminal
13	Truck Scale	31	Renovation of Existing Shed N-3
14	Customs Office	32	Conversion of Existing Shed N-1 to CFS
15	Gate House	33	Navigation Aids
16	Gate	34	Breakwater
17	Open Storage		

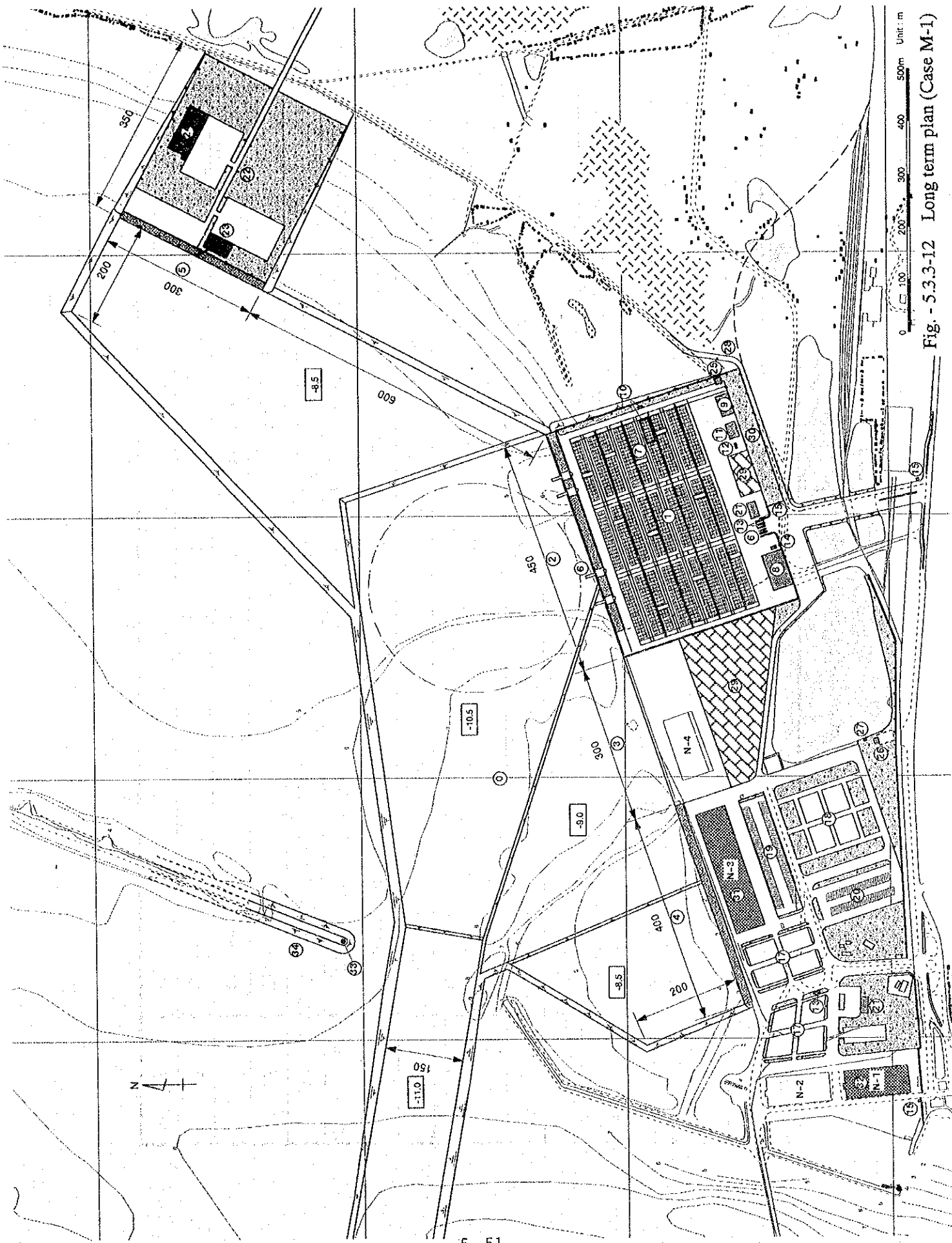


Fig. - 5.3.3-12 Long term plan (Case M-1)

Table 5.3.3-3 List of proposed facilities for Long-term plan (Case M-2)

No.	Facilities	No.	Facilities
0	Port Basin and Navigation Channel Dredging	17	Open Storage
1	Container Terminal	18	Open Storage (Future)
2	Container Cargo Berth	19	Parking Area
3	General Cargo Berth (Existing "New Quay")	20	Parking Area (Future)
4	General Cargo Berth	21	Administration / Office Building
5	Bulk Cargo Berth	22	Bulk Cargo Terminal
6	Gantry Crane	23	Cement Silo / Pneumatic Unloader
7	Transfer Crane	24	Bitumen Tank
8	CFS	25	Generator House
9	Maintenance Work Shop	26	Water Pump House
10	Container Fumigation Facility	27	Fire Fighting Pump House
11	Container Repair Facilities	28	Diversion of Road to Existing Oil Terminal
12	Container Cleaning Facilities	29	Empty Container Yard
13	Truck Scale	30	Future Railway Terminal
14	Customs Office	31	Navigation Aids
15	Gate House	32	Breakwater
16	Gate		

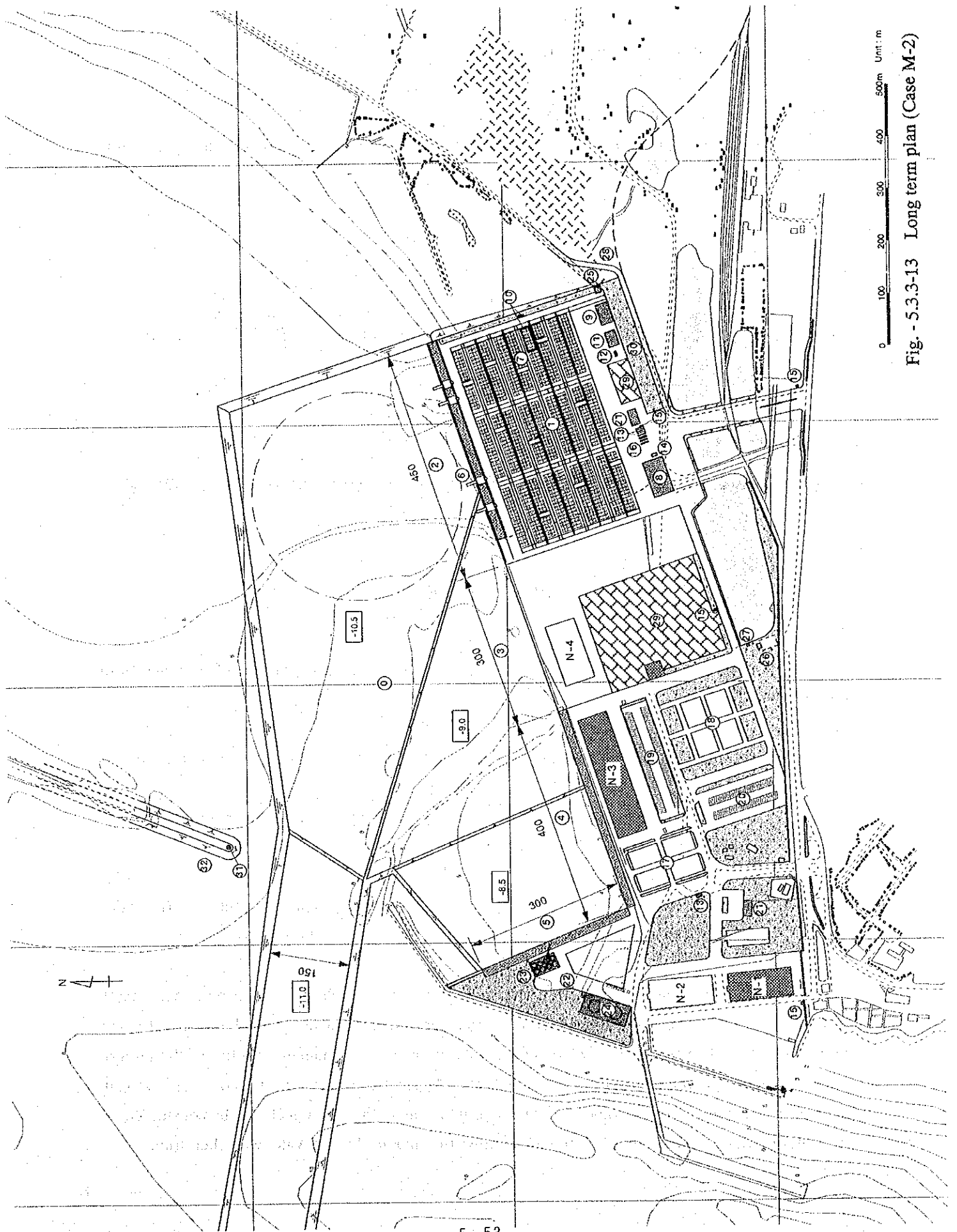


Fig. - 5.3.3-13 Long term plan (Case M-2)