11-1-8 Proposed Land Use Plan

Fig. 1-1-19 shows the present land use within the part of CPT real estate around NSD & KPD.

Generally speaking, water front areas must be preserved for port activities in the future but in the case of the ports that is located in the congested city area and there exists the land requirement from the city side, the waterfront areas may sometimes be rendered to the city functions.

The required scale of storage facilities and the required port traffic facilities are presented in the previous sections (11-1-6 and 11-1-7). The required areas from the port side area summarized as follows as shown in Fig. 11-1-20.

① The area, which is now used for labour residences, at the Back side of No. 4 and No. 5 berths NSD must be required for container yards inside the dock boundary.

② The areas, which are now used for labour residences, at the back side of No. 27 and No. 28 berths, and No. 24 and No. 25 berths KPD2 must be required for storage area for general cargoes.

③ The areas at the east and west side of KPD1 inside the dock boundary will be used for port functions in the future.

④ The areas at the west side of KPD2 will not be required for port functions.

⑤ Three parts indicated by ① ② and ③ on the figure will be required for parking spaces.

⑥ The parts indicated by Ⓘ Ⓘⅰ and Ⓘⅱ on the figure will be required for present utilization.

⑦ The part indicated by Ⓐ on the figure, Dhobitalao Container Yard will be required for empty container pool.

⑧ The part indicated by Ⓑ on the figure will be rendered to city functions.

⑨ The part indicated by Ⓒ and Ⓓ on the figure will also be rendered to city functions.

CPT's land property plan is attached in Appendix 11-1-13.

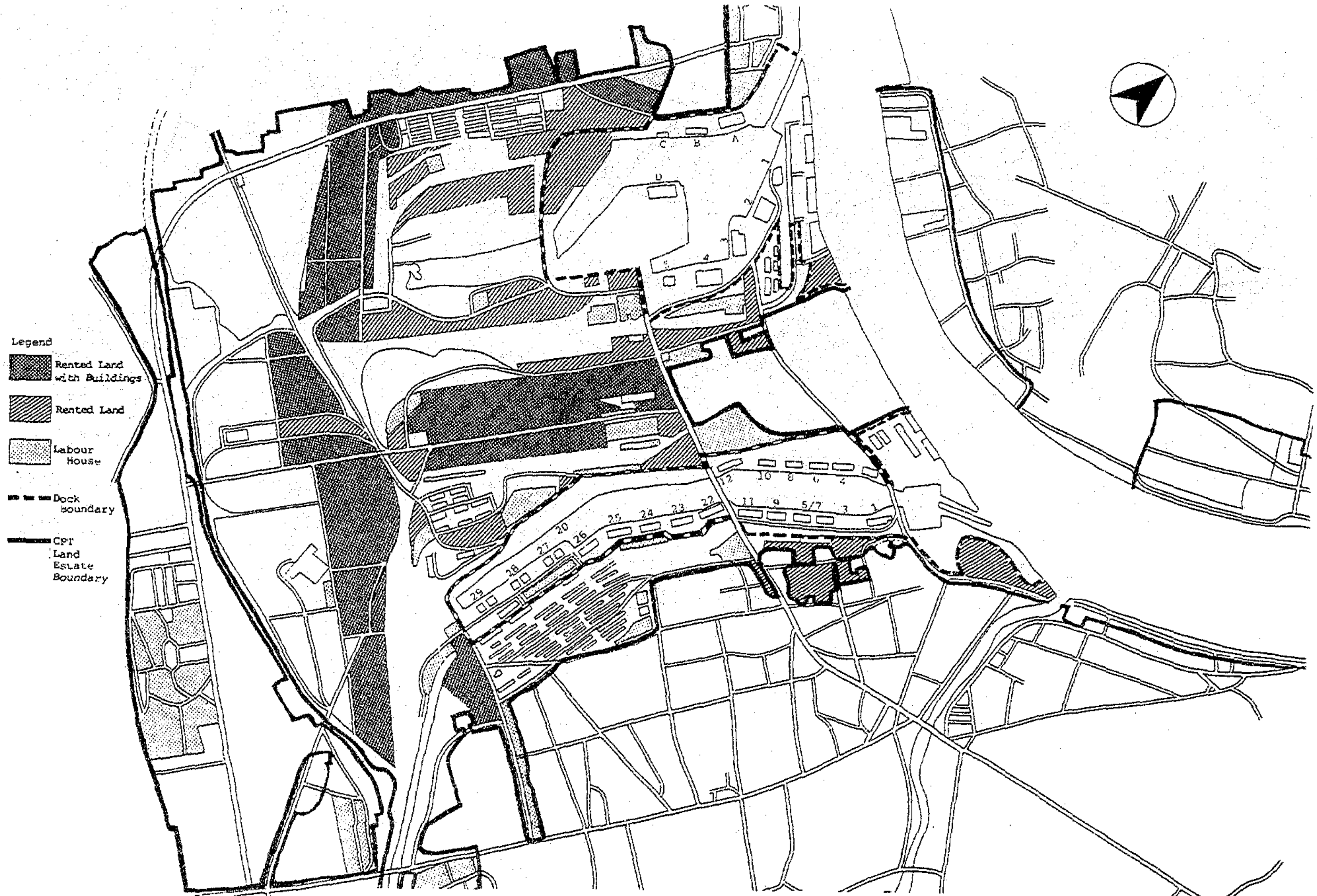


Fig. 11-1-19 Present Land Use within Part of CPT Land Estate

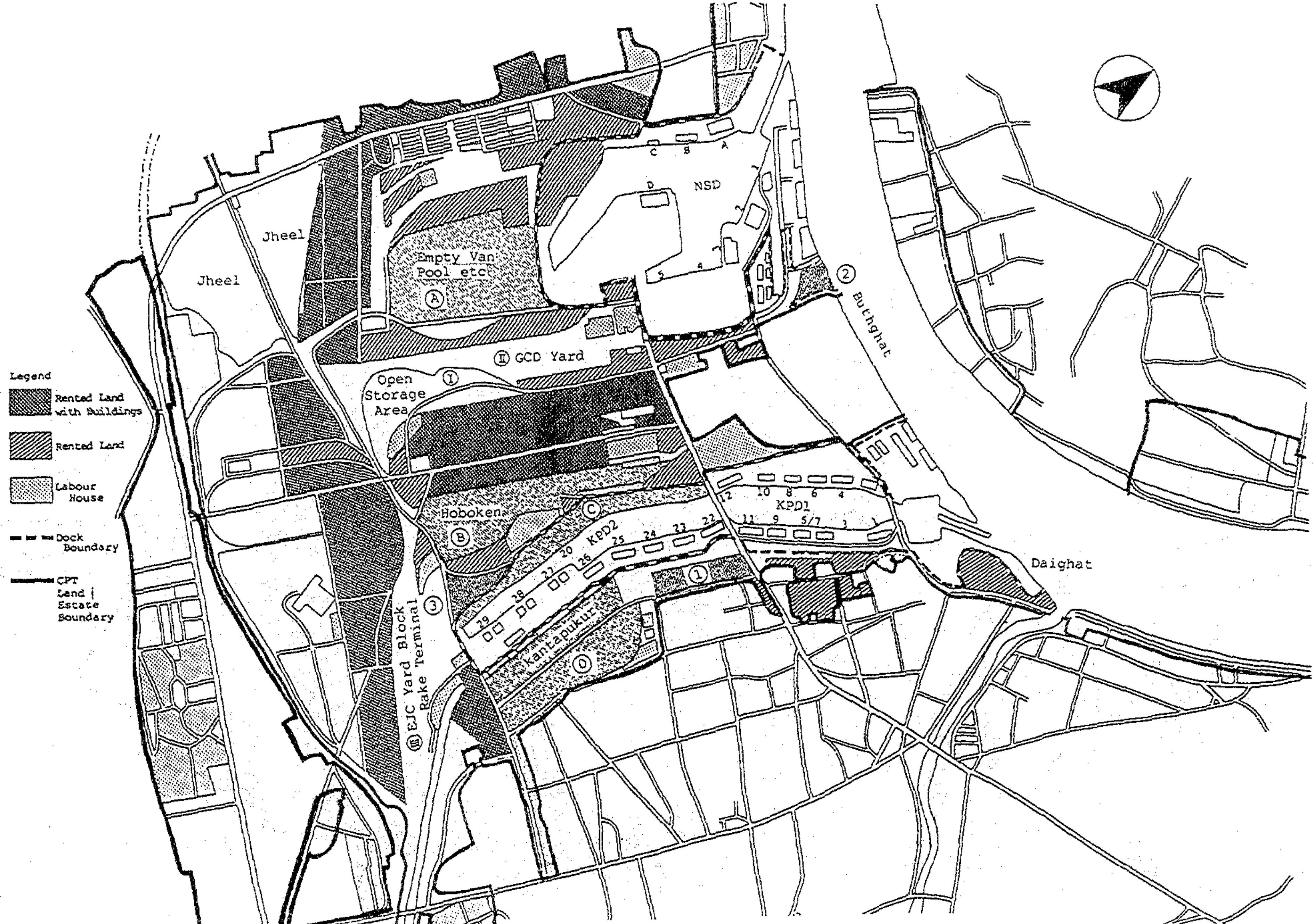


Fig. 11-1-20 Land Use Plan

11-1-9 Others

(1) Operating Machinery for Dock Gates

There are two dock systems at Calcutta port. They each have two dock gates which are operated by a water hydraulic system. The operating machinery consists of hydraulic rams, wire ropes, and pullies.

They are connected through an elaborate network of pipelines from the hydraulic engine room. When we examined the facility, the gates operated smoothly except for one stop.

a Dock gates and their operating machinery are one of the most important facilities for the dock system. They must be kept in good operating conditions at all times.

b It is easy to obtain spare parts for the proposed new equipment.

c Maintenance costs, running costs and trouble will be reduced.

1) Oil hydraulic system in stead of water hydraulic system

To get get high efficiency

To prevent oxidation of the power unit and pipelines.

2) The power units will be arranged near by each gate

The power units will be smaller than the existing units. The space for the new facility is easily available. The initial cost and maintenance cost will be reduced by the modern system and high efficiency will be realized.

3) Modernization of KPD and Lock Entrance

The Lock Entrance at KPD and NSD have not been changed since the Lock was put into commission in the year 1927.

To ensure uninterrupted shipping, it is essential to investigate the entrances in detail and the deteriorated parts of the Lock shall be replaced within the Master Plan period.

(2) Maintenance shop

A maintenance shop will be arranged at the port for the following reasons.

1) All cargo handling equipment must be kept in good operation condition. However, the necessary maintenance is not available outside of the port.

2) Some laborers can be employed at the maintenance shop.

3) Emergency or urgent repair will be executed quickly and smoothly at the maintenance shop.

All the necessary machines and tools will be provided at the shop. The detailed arrangement and design will be done at the detailed design stage.

11-2 Haldia Dock System

11-2-1 Planning premises

The major planning premises adopted here for the formulation of the master plan for Haldia Dock System are as follows.

(1) The major planning target is to efficiently acommodate the projected demand in 2005.
As for the future traffic, the estimations presented in other sections, i.e. functional allocation between two dock systems, demand forecast and shipping forecast will be adopted as the basic assumptions.

(2) Existing port facilities will be examined for possible improvement and full utilization before recommending construction of new port facilities.
Priority will be placed upon the improvement or expansion of handling equipment as against the cnstruction of additional terminals.

(3) The possibility of improving productivity for vessel/cargo handling will be explored.
Improved productivity will be adopted for planning instead of the actual historical figures as necessary. A more detailed analysis in this connection is presented in other section of this Report.

(4) The accessible draft at Haldia is assumed based on the figures presented by the CPT, ie. 10.67m in 2005 as against 8.6m at present.

(5) Comments of the counterparts on the preceding Reports are taken into consideration as appropriate.

11-2-2 Required Scale of the Port Facilities (Haldia)

In this section, the required scale of the basic port facilities, i.e. the number of the berthing facilities and lock entrances as well as the required enlargement of the basin within the dock system so as to efficiently accommodate the estimated future throughput is analysed. Equipment and port traffic facilities are considered in other sections. Two different approaches are adopted in this analysis to examine the required berthing facilities, viz. conventional estimation baced upon berth occupancy criteria etc. and a computer simulation based upon queuing theory.

The target year of the analysis is 2005 for the Master Plan.

(1) Berth Determination

Following is an analysis of the required number of berthing facilities by commodity.

1) POL/Other Liquid Bulk

a) Ship Size/Parcel Size/Productivity of Cargo Handling

At present, the existing oil jetty mostly handles 87,000 DWT crude oil tankers and 15000-35000 DWT product tankers. Due to the congestion at the existing jetty as well as the need to cope with the increasing future demand, a project to construct an additional jetty in addition to restregthening the existing jetty is now under way using OECF financing.

Ship size, parcel size per vessel and handling productivity are set as below by reffering to the report prepared by Engineers India Ltd. as well as the information provided by OCC for the project.

Commodity	Year	Ship Size	Percel Size	Productivity	Non-/ working time at berth
Crude	2005	144,000 DWT	75,000 Te	5,000 TPH	15 hrs
Product	2005	35,000 DWT	32,000 Te	1,500 TPH	15 hrs
Other Liquid Bulk	2005	12,000 - 25,000 DWT	11,000 - 23,000 Te (17,000 Te)	800 TPH	15 hrs

1) Here, it is assumed that crude tankers visit Haldia after offloading part of their cargo at Madras/Visap.

2) Productivity is provided by OCC.

b) Projected Traffic

Projected traffic is estimated as follows based upon the demand forecast and average parcel size.

Year	Commodity	Cargo Volume ('000 tons)	Parcel Size	NOs of Calling Ships	Remarks
2005	Crude	2,610	75,000 Te	35	
	Product	7,530	32,000 Te	235	
	Other Liquid	890	17,000 Te	52	

Here, it'is assumed that tankers will increase their parcel size up to 2005 taking advantage of the full permissible draft (10.67m).

c) Required Number of Berthing Facilities

At present, some POL cargo is handled at the Ore Berth within the Dock Complex (44% of the total POL product traffic was handled at the Ore Berth in 1986/87). However, it is envisaged that the Ore Berth will be used for coal traffic in the future. Therefore, it is assumed here that all POL product traffic will be handled at the oil jetties in the future.

The Required number of berthing facilities for POL etc., can be calculated as follows.

① Berth Occupancy Rate

The permissible berth occupancy rate is usually set as around 0.4 for one berth and around 0.6 for two or three berths as shown below.

Permissible Berth Occupancy Factors

No. of Berths (n)	Berth Occupancy Factor					
	tw/tb=0.20			tw/tb=0.30		
	Varying[a]	Uniform[a]	Unif./Var[a].	Varying[a]	Uniform[a]	Unif./Var[a].
1	0.18	0.30	1.67	0.25	0.39	1.56
2	0.40	0.55	1.38	0.49	0.63	1.29
3	0.53[b]	0.65[b]	1.22[b]	0.60[b]	0.72[b]	1.20[b]
4	0.62	0.72	1.16	0.68	0.78	1.15
5	0.67[b]	0.76[b]	1.14[b]	0.73[b]	0.82[b]	1.13[b]
6	0.70	0.79	1.13	0.76	0.84	1.11
8	0.75	0.84[b]	1.11[b]	0.80[b]	0.88[b]	1.10[b]
10	0.79	0.87[b]	1.10[b]	0.83	0.91[b]	1.09[b]
15	0.84[b]	0.91[b]	1.08[b]	0.88[b]	0.94[b]	1.07[b]
20	0.88	0.93[b]	1.06[b]	0.91	0.96[b]	1.05[b]

Source: Mettam, J.D., Forecasting Delays to Ships in Port, The Dock and Harbor Authority, London, England, April 1967.

a Berth service time.

b Estimated by interpolation or extrapolation.

When non-working time at berth is assumed as 15 hrs per vessel based upon the EIL Report,

Total time at berth per vessel :

(150,000 DWT Tanker) 75,000 Te/5,000 TPH + 15 hrs = 30 hrs

(Product Tanker) 32,000 Te/1,500 TPH + 15 hrs = 36 hrs

(Other Liquid Bulk) 17,000 Te/ 800 TPH + 15 hrs = 36 hrs

Total berth occupying hours :

30 hrs x 35 ships + 36 hrs x 235 ships + 36 hrs x 52 ships

= 11,382 hre

Berth occupancy rate per berth :

When only the existing jetty and the 2nd jetty are available,

$$\frac{11,382 \text{ hrs}}{330 \text{ days} \times 24 \text{ hrs} \times 2 \text{ berths}} = 0.72$$

However, the 15 hours of no-working time at berth could be reduced to 10 hrs as indicated in the following table. At Haldia, most of this non-worjing time at berth is for "waiting for sailing" (as of 1986/87, 9.5 hours out of the total 13.0 hours per vessel are dedicated for this purpose). In 2005, the vessels which have to wait for high-tide to sail out are 150,000 DWT tanker only (the ballast draft is 9.2m which cannot be accommodated at neap tide).

On the other hand, the ballast draft of 35,000 DWT product carriers is 5.4m; therefore, the vessels of this type can sail out at any time without any draft constraints in the River Hooghly.

Therefore, the installation of one shifting berth of minimal cost to accommodate 150,000 DWT tankers is one way to reduce the waiting time for sailing, and thus reduce the non-working time at berth.

Normally, the service time at berth is 10 hrs per vessel as follows.

Hours of Berth Time per Ship Call

Tankers Size (000) DWT	Fixed Struture Berth						Floating Buoy			
	150	200	250	300	400	500	200	300	400	500
Docking	4	4	4	4	4	4	3	3	3	3
Clearance	2	2	2	2	2	2	2	2	2	2
Unloading	15	18	21	23	28	35	18	23	28	35
Undocking	4	4	4	4	4	4	3	3	3	3
Total	25	28	31	33	38	45	26	31	35	43

Source: "Ship Cost" Model and Program, The World Bank, Whashington, D.C., 1985

Under this assumption, the berth occupancy rate is calculated as follows.

Total time at berth per vessel :

(150,000 DWT Tanker) 75,000 Te/5,000 TPH + 10 hrs = 25 hrs

(Product Tanker) 32,000 Te/1,500 TPH + 10 hrs = 31.3 hrs

(Other Liquid Bulk) 17,000 Te/ 800 TPH + 10 hrs = 31.3 hrs

Total berth occupying hours :

25 hrs x 35 ships + 31.3 hrs x 235 ships + 31.3 jrs x 52 ship

= 9,857 hrs

Berth occupancy rate per berth :

9,857 hrs/ 330 days x 24 hrs x 2 berths = 0.62

② Computer Simulation

A computer simulation was carried out based on queuing theory. Major assumptions are as follows.

Port Entry : once a day (2 hrs) available

Distribution of ship arrival time : Erlung Distribution (phase K = 2)

The major results of the computer simulation with the assumption of reducing non-working time at berth per vessel to 10 hrs are as follows.

Avg. berth ocupancy	Avg. pre-berthing detention (tw)	Avg. berth service time (tb)	tw/tb
0.62	7.8	30.8	0.25

The value of tw/tb is within the reasonable allowance.

③ Conclusions

In 2005, two working jetties, i.e. the existing and the 2nd oil jetty, are required. Also, the pumping rate should be improved as assumed in accordance with the information provided by OCC. In order to reduce the service time (non-working) at berth to 10 hrs the installation of one shifting berth of minimal cost may be recommended when required.

2) Coal

a) Ship size / parcel size

At present, the maximum ship size calling at Haldia is 47,721 DWT with maximum and average parcel size of 32,792 Te and 24,054 Te respectively. This implies vessels cannot be fully loaded due to the permissible draft limits in the River Hooghly. According to the RITES Report on Coal Transportation (Least Cost Solution for Coal Transportation to Coastal Thermal Power Stations, Feasibility Report, RITES, April 1988), the following dimensions for the vessels to be used in coastal coal transportation are economically optimal.

for Tuticurin (due to draft limits):

28,000 DWT, L = 164.77m

B = 31.38m

d = 8.97m

25,900 Te

On the other hand, 35,000 DWT carriers were assumed in the master plan study for Tuticorin by Indian Ports Association. In the same study, other alternatives of 25,000 DWT and 30,000 DWT were also examined.

Making necessary modification according to the available draft at Haldia, the following figures for ship size/parcel size are adopted here.

Year	Ship size	Parcel size	Remarks
2005	35,000 DWT 30,000 DWT 25,000 DWT	32,500 Te 27,500 Te 23,000 Te	d = 10.67 m

b) Productivity of Handling

As analysed in another section, the productivity of handling coal is assumed as follows.

Berth	Hanlding rate	Remarks
Coal Berth	610 t/hr	x 2 loaders
Converted Berth	480 t/hr	x 2 loaders

c) Projected Traffic

Year	Ship sizwe	Berths	Cargo volume ('000 tons)	No. of calling ships
2005	35,000 DWT	Coal Berth Converted Berth	2,182 1,968	69 62
	20,000 DWT	Coal Berth Converted Berth	2,182 1,968	80 72
	25,000 DWT	Coal Berth Converted Berth	2,182 1,968	95 86

Note : Allocation of cargo volume to berth is determined in such a way as to equalize berth occupancy rates of 2 berths.

d) Required Number of Berthing Facilities

① Berth Occupancy Rate

Total time at berth per vessel:

According to section 11-2-3, the productivity is;

for coal berth : 610 TPH x 2

for ore berth : 480 TPH x 2

The average non-working time per vessel is assumed as 1 day including the required time for berthing/deberthing, preparation for loading, documentation, waiting time for lock opening etc.

For 35,000 DWT vessels

Total time at berth per vessel:

(coal berth) $$\frac{32{,}000 \text{ Te}}{610 \text{ TPH} \times 2} + 24 \text{ hrs} = 50.3 \text{ hrs}$$

(Converted berth) $$\frac{32{,}000 \text{ Te}}{480 \text{ TPH} \times 2} + 24 \text{ hrs} = 57.3 \text{ hrs}$$

Total berth occupying hours:

(coal berth) 50.3 hrs x 69 ships = 3,471 hrs

(Converted berth) 57.3 hrs x 62 ships = 3,553 hrs

Berth occupancy rate per berth :

(coal berth) $$\frac{3{,}471 \text{ hrs}}{330 \text{ days} \times 24 \text{ hrs}} = 0.44$$

(Converted berth) $$\frac{3{,}553 \text{ hrs}}{330 \text{ days} \times 24 \text{ hrs}} = 0.45$$

For 30,000 DWT vessels

The time at berth per vessel:

(coal berth) $$\frac{27{,}500 \text{ Te}}{610 \text{ TPH} \times 2} + 24 \text{ hrs} = 46.5 \text{ hrs}$$

(Converted berth) $$\frac{27{,}500 \text{ Te}}{480 \text{ TPH} \times 2} + 24 \text{ hrs} = 52.6 \text{ hrs}$$

Total berth occupying hours:

(coal berth) 46.5 hrs x 80 ships = 3,720 hrs

(Converted berth) 52.6 hrs x 72 ships = 3,787 hrs

Berth occupancy rate per berth :

(coal berth) $$\frac{3{,}720 \text{ hrs}}{330 \text{ days} \times 24 \text{ hrs}} = 0.47$$

(Converted berth) $$\frac{3{,}787 \text{ hrs}}{330 \text{ days} \times 24 \text{ hrs}} = 0.48$$

For 25,000 DWT vessels

In the same manner,

(coal berth) 0.51

(Converted berth) 0.52

Thus, berth occupancy rate are within the permissible limit, as follows;

(coal berth) 0.44 - 0.51

(Converted berth) 0.45 - 0.52

② Computer Simulation Results

Refer to Table 11-2-1.

③ Conclusion

Assuming the improvement of the handling capacity as analyzed in Section 11-2-3, the coal berth and the converted coal berth would be sufficient for handling the projected traffic in 2005.

3) **Fertiliser/Fertiliser Raw Material**

a) Ship size/parcel size

At present, 20,000 - 30,000 DWT vessels are calling at Haldia with the maximum and average parcel size being respectively;

maximum parcel size:	fertiliser	10,917 Te
	raw material	14,852 Te
average parcel size:	fertiliser	9,976 Te
	raw material	9,461 Te

In 2005, with the remarkable increase of cargo amount, the full loaded vessels are expected to call.

Yeay	Ship size	Parcel size	Remarks
2005	20,000 - 30,000 DWT	23,000 Te	

b) Handling Productivity

Handling of fertilizer raw material and bulky fertilizer is carried out by 2 cram shell unloaders (rated capacity = 700 TPH per each). Therefore effective handling rate is assumed as follows.

$$700 \text{ TPH} \times 2 \times \overset{\eta_1}{0.6} \times \overset{\eta_2}{0.8} = 672 \text{ TPH}$$

η_1: working time efficiency

η_2: cram shell efficiency

Average loss time at berth per vessel is assumed as 1 day including required time for berthing/deberthing, preparation for unloading, documentation, waiting time for lock opening, etc.

c) Projected Traffic

Year	Commodity	Cargo Volume ('000 tons)	Parcel Size	No. of Calling Ships	
2005	Fertiliser	17*	23,000 Te	1	35,000 tons x 0.5 (for bulk type)*
	Raw Material	1,800		78	

(*) Actual ratio of bulky type to bagged type were 0.27, 0.32, 0.54, 0.42 from 83/84 to 87/88.

d) Required Number of Berthing Facilities

① Berth Occupancy Rate

Total time at berth per vessel:

23,000 Te / 672 TPH + 24 hrs = 58.2 hrs

Total berth occupying hours:

58.2 hrs x 79 ships = 4,595 hrs

Berth occupancy rate:

In the case of 2 shifts for handling

$$\frac{4{,}598 \text{ hrs}}{350 \text{ days} \times 15 \text{ hrs}} = 0.88$$

In the case of 3 shifts for handling

$$\frac{4{,}598 \text{ hrs}}{350 \text{ days} \times 22.5 \text{ hrs}} = 0.58$$

Therefore, the increase of the number of shifts to 2 shifts is imperative.

② Computer Simulation Results

Refer to Table 11-2-1.

e) Conclusions

In 2005, the increase up to 3 shifts will be required.

4) Coking Coal

a) Ship Size/Parcel Size

At present, 30,000 - 40,000 DWT vessels are calling at Haldia with the maximum and average parcel size being respectively;

maximum parcel size: 23,729 Te } in 1987/88
average parcel size: 20,542 Te }

Taking into account these as well as the draft improvement in the future, 32,000 Te in 2005 will be adopted here.

b) Handling Productivity/Loss Time at Berth per Vessel

According to Section 11-2-3, handling productivity is assumed as follows.

$$700 \text{ TPH} \times 2 \times \overset{\eta_1}{0.6} \times \overset{\eta_2}{0.8} = 672 \text{ TPH per berth for 2 circuits}$$

η_1: working time efficiency

η_2: grab bucket efficiency

1 day is assumed for non-working time per vessel.

c) Projected traffic

Year	Cargo Volume ('000 tons)	Parcel Size	No. of Calling Ships	Remarks
2005	1,800	32,000 Te	56	

d) Required Number of Berthing Facilities

① Berth Occupancy Rate

When 12 circuits are installed,

Total time at berth per vessel:

32,000 Te / 672 TPH + 24 hrs = 71.6 hrs

Total berth occupying hours:

71.6 hrs x 56 ship = 4,010 hrs

Berth occupancy rate:

$$\frac{4{,}010 \text{ hrs}}{330 \text{ days} \times 24 \text{ hrs} \times 1 \text{ berth}} = 0.51$$

② Necessity of Mechanization of Handling

As against the productivity of the mechanized system as described above, when the present handling system is continued up to 2005;

Average net handling per ship berth day (1986/87):

16,880 Te / 3.89 days = 4,339 Te per ship-day

Total time at berth per vessel:

32,000 Te / 4,339 + 0.5 day = 8.4 days

Berth occupancy rate:

8.4 days x 56 ships / 330 days = 1.43

Therefore, installation of a mechanized system is imperative.

③ Computer Simulation Results

Refer to table 11-2-1.

e) Conclusions

1 mechanized berth with 2 circuits of 700 TPH rated capacity is required.

5) Break-bulk general cargo/fertiliser (bagged)

a) Projected Traffic

Year	Commodity	Cargo Volume ('000 tons)	Parcel Size	No. of Calling Ships	Remarks
1986/87	B/Bulk	115	3,837 Te	27	Actual
	Fertiliser	44	9,976 Te	4	
2005	B/Bulk	495	5,000 Te	99	
	Fertiliser	18	11,000 Te	1.6	

(Note) i) Cargo Volume:
2005: bagged fetilser 35 x 0.5 = 18 ('000 tons)

b) Productivity

As of 1986/87. the handling rate of break-bulk cargoes at Haldia is 1,027 tons/day (Avg. parcel size/ Avg. working days per vessel = 4,259 Te/4.14 days). The gross handling productivity (including loss time for clearance and berthing-deberthing purposes) is assumed as 1,000 tons/day.

Thus,

Total time at berth per vessel:

$$\text{(B/Bulk)} \quad \frac{5{,}000 \text{ Te}}{1{,}000 \text{ tons/day}} = 5 \text{ days}$$

$$\text{(Fertiliser)} \frac{11{,}000 \text{ Te}}{1{,}000 \text{ tons/day}} = 11 \text{ days}$$

c) Required Number of Berthing Facilities

① Berth Occupancy Rate

Total occupying days p.a.

5 days x 99 ships + 11 days x 1.6 ships = 513 days

Berth Ocuupancy rate :

$$\frac{513 \text{ days}}{350 \text{ days} \times 2 \text{ berths}} = 0.78 > 0.6 \text{ (in case 2 berths are available)}$$

$$\frac{513 \text{ days}}{350 \text{ days} \times 3 \text{ berths}} = 0.52 < 0.6 \text{ (in case 3 berths are available)}$$

Therefore, 3 conventional berths or 2 conventional berths plus 1 multi-prupose berth are required to cater to break-bulk general cargo and bagged fertilizer vessels.

Assuming 60% for G/C berth and 50% for multi-purpose berth as the permissible berth occupancy rate, the remaining ship day (330 days x 0.6 x 2 berths + 330 days x 0.5 x 1 berths - 513 ship days = 48 ship days) can be provided for catering to contaienr vessels, at the multi-purpose berth.

② Computer Simulation Results

Refer to Table 11-2-1.

d) Conclusions

Conclusions will be formulated in the following container section through articulating the container berth requirement.

6) Containers

a) Average container exchange / Handling productivity

At present, the average container exchange per vessel at Haldia is 244 TEUs (loading/unloading).

In 2005, with the remarkable increase of container throughput at Haldia, the load factor and size of container vessels are expected to increase, leading to the increase of the number of container exchange per sailing.

Taking into consideration the followings:

ⓐ Feeder vessels will gradually shift form 300/400 TEU vessels to 500 TEU or more vessels in the future.

ⓑ Historical trend of the increase of the number of the average container exchange at Haldia can be expressed as follows using 1983-1987 actual data.

$$y = 111.9 + 22.6\,t \quad (r = 0.79) \qquad \begin{pmatrix} t\text{: Year} \\ y\text{: average container exchange} \end{pmatrix}$$

In 2005, y = 632 TEUs

Thus, as the average container exchange per sailing at Haldia, 600 TEUs in 2005 will be adopted here.

However as the alternative of 250 TEUs will also be examined in Alternative-1.

In the report by EIL, the handling rate of shoreside cranes was assumed 25 lifts on average as follows.

	Peak	Average
New gantry	30 lifts	15 lifts
Existing gantry	20	10
Total	50	25

The same figures will be adopted here for the multi-purpose berth using 1 existing crane and 1 new crane. As for the new berths, the handling rate at a full-fledged container berth is normally 20 - 30 boxes/crane hr; however, taking the local conditions into account, 15 boxes/crane . hr will be adopted here.

b) Projected Traffic

Assuming two different alternatives for functional allocation between Haldia and Calcutta for the year of 2005,

Year	Cargo Volume	Avg. Exchange per Vessel	No. of Calling Ships	Remarks
2005 (Alter-native-1)	TEUS 130,000	600TEUs 250	217 520	trend case
2005 (Alter-native-2)	288,000	600	480	shifting to Haldia case (recommended)

c) Required Number of Berthing Facilities

① Berth Occupancy Rate

The following premises are adopted for the estimation.

TEU/Box : 1.2 in 2005

Handling productivity : 25 boxes/hr for the multi-purpose berth using existing crane and new crane

30 boxes/hr for new full-fledged berths using new cranes

Operation hours per day : 20 hrs (3 shifts)

Non-working time at berth per vessel : 12 hrs

Working days per year : 330 days

Total time at berth per vessel:

$$\frac{600 \text{ TEUS}}{1.2 \text{ TEUS/Box} \times 30 \text{ Box/hr}} + 12 \text{ hrs} = 1.2 \text{ days}$$

(container exchange = 600 TEUs)

$$\frac{250 \text{ TEUS}}{1.2 \text{ TEUS/Box} \times 30 \text{ Box/hr}} + 12 \text{ hrs} = 0.79 \text{ days}$$

(container exchange = 600 TEUs)

Alternative-1

(container exchange = 600 TEUs)

Required ship days :

1.2 days x 217 ships = 260 ship days

Available ship days :

multi-purpose berth 48 ship dyas

container berth (1 berth) 330 days x 0.5 = 165 ship days

" (2 berths) 330 days x 0.5 x 2 berths = 330 ship days

Therefore 2 container berths are required.

Berth occupancy rate : $\frac{260 \text{ ship days} - 48 \text{ ship days}}{330 \text{ days} \times 2 \text{ berths}} = 0.32$

(Container exchange = 250 TEUs)

Required ship days :

0.79 days x 520 ships = 411 ship days

Berth Occupancy rate : assuming 2 container berths and 1 multi-purpose berth are available

$$\frac{411 \text{ ship days} - 48 \text{ ship days}}{330 \text{ days} \times 2 \text{ berths}} = 0.55$$

Therefore, it is proper to conclude 2 container berths are required in addition to 1 multi-purpose berth.

Alternative-2 (recommended)

Berth occupancy rate : assuming 3 container berths in addition to the utilization of the remaining ship days at the multi-purpose berth,

$$\frac{480 \text{ ship} \times 1.2 \text{ days} - 48 \text{ ship days}}{330 \text{ days} \times 3 \text{ berths}} = 0.53$$

Thus, 3 container berths in addition to 1 multi-purport berth are required.

d) Conclusion (handling containers as well as break-bulk general cargoes/bagged fertilizer)

The required berths are sumarrized as follows.

Alternative-1

2 exclusively general cargo berths

1 multi-purpose berth

2 exclusively container berths

Alternative-2 (recommended)

2 exclusively general cargo berths

1 multi-purpose berth

3 exclusively container berths

(2) Berth Determination for IWT Container Transport

IWT container transport demand is estimated as follows:

Year	Alternative	Estimate
2005	1	42,500 TEUs
	2	60,000

According to Dutch Report on IWT, the handling capacity of one IWT berth (75 m long) is as follows:

31,800 TEUs (1 container quay crane)

76,300 TEUs (2 container quay cranes)

Therefore, 1 IWT container berth with 2 quay cranes is required in 2005.

Table 11-2-1 Computer Simulation Results

Name of Berths	Berth Occupancy Rate	Vessels Berthed	Average Waiting Time for Berthing (tw)	Average Berth Service Time(tb)	tw/tb
Coal Berth (converted)	% 50.9	Coal	hr/vessel 7.7	hr/vessel 52.5	0.15
Coal Berth	50.9	Coal	6.9	47.3	0.15
Phosphate Berth	56.8	Fertilizer/ F.Raw Material	9.2	57.5	0.16
C/coal Berth	50.4	C/Coal	11.2	79.1	0.14
Conventional Berth (Exisr-ing + New)	% 63.9	Fertilizer/ B/Bulk	2.7 hr/veesel 3.6	229.8 hr/vessel 131.8	0.01 0.03
Multiopurpose Berth (New)	34.8	-ditto- Container	-ditto- 1.9	-ditto- 31.5	-ditto- 0.06
New container* Berth 1~3	54.7	Container	1.9	31.5	0.06

(*) Recommended alternative

(3) Determination of the Required Number of Lock Entrances

The required number of lock entrances at Haldia can be analyzed based upon queuing theory as follows.

Assuming that ship arrival follows a Poisson distribution and service time at lock entrances follows exponential distribution, using M/M/S analysis;

1) In 1986/87

Average ship arrival

$$\lambda = \frac{577 \text{ ships} - 322 \text{ ships} + 104 \text{ ships}}{365 \text{ days}} = 0.98 \text{ ship/day}$$

Here, 577 : total ship arraival to Haldia

322 : ship arrival to the oil jetty

104 : ship arrival (POL products) to the ore berth

Average ship service $\mu = 2.5 - 5$ ships/day

2.5 for one tide available per day

5 for two tides available per day (assuming night navigation)

(2 ~ 3 ships per tide is the capacity of the lock entrance per tide at present based upon the interview with CPT)

Thus,

		Night navigation (with) (without)
Average waiting ships	Lq	= 0.047 ~ 0.158 ships
Average waiting time per vessel	Wq	= 0.048 - 0.161 day/vessel
Total waiting time p.a.	TWq	= 17.2 ~ 57.8 days p.a.

2) In 2005

When the number of lock entrance is 2,

λ = 1,190 ships / 365 days = 3.26 ships/day

μ = 4 - 8 ships/day

S = 2

Thus,

Lq = 0.018 - 0.162 ships

Wq = 0.005 - 0.050 day/vessel

TWq = 6 - 59 days p.a.

Therefore, 2 lock entrances as well as productivity improvement by up grading tug fleet and berthing master number etc. will be required.

The calculation results based on queuing theory are summarized below. The calculation results for other cases such as S = 1 or 2 and the case where the handling productivity at lock entrances is improved form the present $\mu = 2.5$ per tide to $\mu = 4$ per tide through appropriate measures including the increase of tug boats and berthing masters, etc. are also presented in the table.

Year	λ	μ	S	Lq	Wq	TWq	Remarks
	ships /day	ships /day		ships	day/ship	days p.a.	
1986/87	0.98	2.5 - 5	1	0.047 - 0.158	0.048 - 0.161	17.2 - 57.8	Present
			2	0.001 - 0.008	0.001 - 0.009	0.4 - 3.2	
2005	3.26	4 - 8	1	0.280 - 3.590	0.086 - 1.1014	102.0 - 1310.0	×
			2	0.0176- 0.1623	0.0054- 0.0498	6.1 - 59.0	O

Note: The remarks show the evaluation of the calculation results based upon the comparison with the present condition in terms of waiting time for lock entrances (wq and TWq).

4) Conclusions

Up to 2005, a 2nd lock entrance will be required. In addition, productivity improvement by upgrading tug fleet and berthing masters number, etc. will also be required.

11-2-3 Required Scale of Cargo Handling Equipment

(1) Coal handling

1) Design conditions

a) The volumes to be handled at Haldia Dock System in the target years are as follows.

1994/95 4,150,000 tons

2004/05 4,150,000 tons

b) Characteristics of coal

Specific gravity

The specific gravity of coal is 0.8 - 0.9 in general.
However according to various available records from the surveyors, the actual specific gravity of the coal is between 1.032 to 1.20.
1.0 will be used for a conservative estimation of the storage capacity at the stock yard.

Angle of repose

The angle of repose of coal is 40° in general and this is used to estimate the storage capacity at the stock yard.

c) Working conditions

Working hours per year.

There are twenty (20) national holidays and local holidays at Calcutta each year. The required days for periodic maintenance and repair to maintain safety and achieve high throughput are about forty (40) days per year.

Thus, the available days per year will be maximum of 295 days. 280 days will be used to estimated the handling capacity.

d) Transport into the terminal

All the coal will be carried in to the terminal by train. The rake consists of 38 wagons with a capacity of 58t each.

2) The performance of the existing handling equipment

a) Coal berth

According to the drawings and the actual throughput , the performance of the existing handling equipment is as follows.

Tipplers (2 units) Tc

Actual	Net	626 t/h unit
	Gross	260 t/h unit

Conveyers (2 lines) Cc			
Nominal			1,500 t/h line
Stacker/Reclaimers (2 units) SRc			
Stacking Nominal (max)			1,500 t/h unit
Reclaiming Nominal (max)			1,250 t/h unit
"	Actual	Net	850 t/h unit
	"	Gross	490 t/h unit
Shiploaders (2 units) Sc			
Nominal			1,500 t/h unit

b) Ore berth

There is no data available on the actual throughput and only the nominal capacity is expressed.

Conveyers (2 lines) Co		
Nominal (for ore)		1,500 t/h line
Stacker/Reclaimers (4 units) SRo		
Stacking Nominal (for ore)		1,500 t/h unit
Reclaiming Nominal (for ore)	Average	1,250 t/h unit

3) The calculated capacity of each existing handling facility

a) Coal berth

Tippler Tc'

The nominal capacity of the tipplers is 1,500 t/h each.
However, their actual gross capacity is only 260 t/h at present because of the huge loss time.
If the large loss time is reduced by 50% because of improved maintenance, the actual gross capacity will be 360 t/h.

Reclaimer SRc'

The nominal capacity of the reclaimer is 1,250 t/h each.
However, their actual gross capacity is 490 t/h at present because of the large loss time.
If the loss time is reduced by 50% because of improved maintenance the actual gross capacity will be 610 t/h.

b) At ore berth

There is no data available for coal handling at the ore berth because the cargo which is handled at the ore berth was recently changed from ore to coal.

Thus, the capacity is calculated based on various assumptions. There are two calculation methods. The first one is based on the actual results at the coal berth and the ratio of specific gravities. The formula is expressed as follows.

$$C = Q_1 \cdot \frac{g_c}{g_o} \cdot \frac{Q_A}{Q_n} \quad (t/h) \quad \ldots\ldots\ldots\ldots\ldots (112\text{-}1)$$

C = Actual coal handling capacity at the facility for ore handling

Q_1 = Nominal ore handling capacity

g_c = Specific gravity of coal

g_o = " of ore

Q_A = Actual coal handling capacity at the coal berth

Q_n = Nominal "

The other method is based on detailed facility dimensions. For example the transportation capacity of the belt conveyer is expressed as follows.

$$V = Q_c \cdot \frac{B_o}{B_c} \cdot \frac{V_o}{V_c} \quad (t/h) \quad \ldots\ldots\ldots\ldots\ldots (112\text{-}2)$$

Q_c = Transportation capacity of coal at the belt conveyer for coal

B_o = Width of the belt conveyer for ore

B_c = " for coal

V_o = Velocity of the belt conveyer for ore

V_c = " for coal

The receiving capacity

The capacity of the receiving line depends on the tippler capacity because the belt conveyer capacity is larger than that of the tippler.

The tippler for ore can handle coal at the same rate as the tippler for coal. Thus, the receiving capacity of the ore conveyer is 360 t/h for coal.

The shipping capacity

The shipping capacity is determined by the smallest capacity among the reclaimer, belt conveyer, and ship loader.

The capacity of the reclaimer is calculated by formula 112-1 and 112-2.

By formula 112-1

$$C = 1{,}250 \cdot \frac{1.0}{3.2} \cdot \frac{610}{1{,}000} \times 2$$

$$\fallingdotseq 480 \text{ t/h}$$

By formula 112-2

$$V = 610 \cdot \frac{1{,}400}{1{,}400} \cdot \frac{2.5}{2.75} \times 2$$

$$= 555 \text{ t/h}$$

The smaller calculated capacity must be adopted.

Thus the capacity of the shipping line at the ore berth is 480 t/h.

4) The calculated capacity of the stock at the present stock yard.

According to the as-built drawing, the section of the stock-pile at the initial stage is shown in Fig. 11-2-1.

After completion the stock-pile height will be limited to below 4 m for prolonged stacking to prevent spontaneous ignition.

The section of the C.P.T is shown in Fig. 11-2-2. The volume which is estimated by C.P.T is very small.

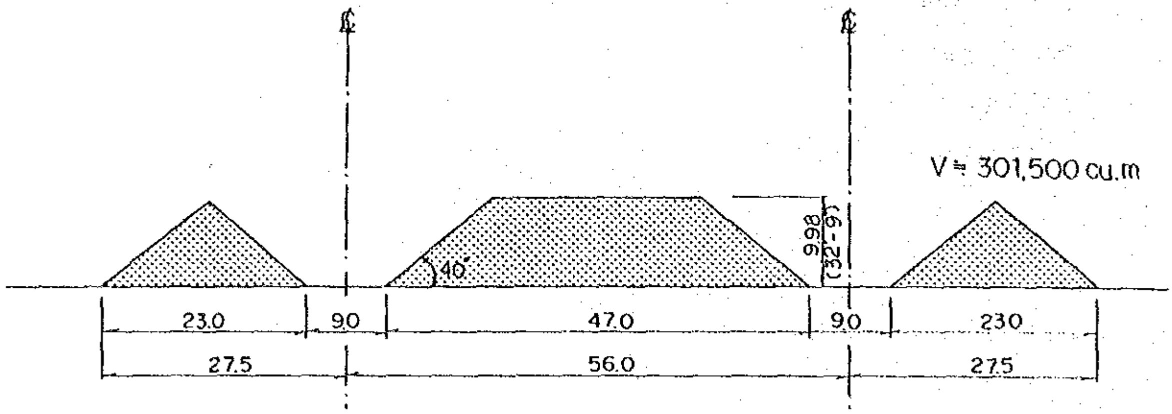


Fig. 11-2-1 C.P.T. (Design Stage for Coal)

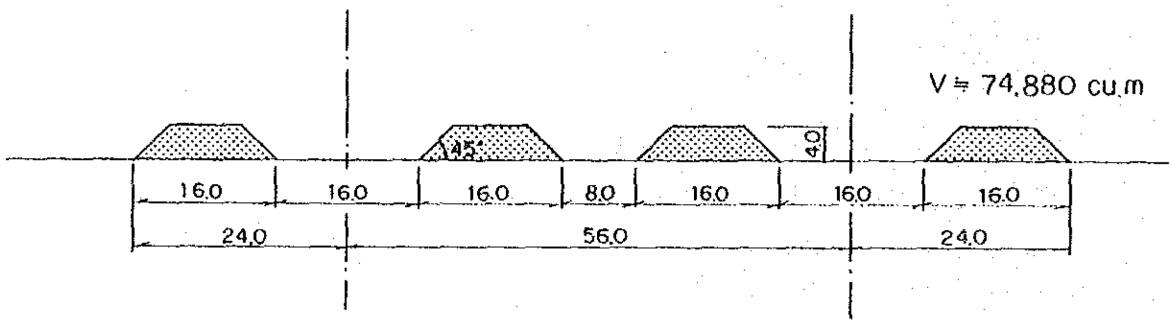


Fig. 11-2-2 C.P.T. (According to Comments for Coal)

The stock-pile height is 4 m based on the C.P.T. calculation. However, a watering facility will be provided to prevent air pollution by powdered coal in the dry season.

Thus the stock-pile can be higher than 4 m the coal temperature will be kept down by watering in the summer and the possibility of spontaneous ignition in the winter season is small.

The reasons are as follows.

i) The coal temperature will be kept down by watering in the summer.

ii) The possibility of spontaneous ignition in the winter season is small.

iii) According to the C.P.T information, the dwell days of coal at the coal stock yard is very short.

The possibility of spontaneous ignitions in this case is smaller than before.

5) Actual throughput

The actual throughput at the port terminal will be decided by the handling capacity of the facility and the stock yard capacity, whichever is smaller. The handling capacity of the facility is as follows.

At Coal berth

The capacity of the receiving lines	360 t/h
" shipping lines	610 t/h
The total working hours per year	6,720 h/y
the capacity to be handled is	3,042,720 t/y

At Ore berth

The capacity of the receiving lines	360 t/h
" shipping lines	480 t/h
The total working hours per year	6,720 h/y
the capacity to be handled is	2,764,800 t/y

The required stock yard

The required stock yard will be decided by the following factors.

① The volume to be handled
② The ship size and the ship size distribution
③ The ship arrival distribution
④ The wagon size and the arrival distribution
⑤ the maximum transportation capacity by rail
⑥ Others

The required volume to be stocked at the port is 7% ~ 10% of the total volume to be handled per year in general.

The volume will be determined by the results of a simulation at the detailed design stage. On the other hand, according to C.P.T informations.

① The dwell days of coal at the coal stock yard to very short
② The transport capacity of the coal on the rail is larger than that of required
③ The reliability of the rail transport is large
④ The coal carriers at sea are just

Transportation between two ports. Thus the handling capacity does not be tied up with the stowage capacity. the coal stock will be zero in rare case and the carriers have to wait for the arrival of coal to begin boading.

6) Conclusion

a) At the coal berth, the losstime of the tippler will be reduced by 50% because of improved maintenance.

b) At the ore berth, a boulder removal equipment will be provided.

c) After the above items are realized, the port will have sufficient facilities to smoothly handle the forecast cargo volume (4,150,000 t/y).

7) In case of a handling volume increase to 6,000,000 t/y

a) Handling capacity of the facilities

The handling capacity of the facilities are as follows:

At coal berth	3,042,720 t/y
At ore berth	2,764,800 t/y
Total	5,807,520 t/y

However, the actual throughput at the port terminal should be decided by the handling capacity of the facility and the stock yard capacity.

b) Stock yard capacity

At the present stock yard, the calculated stock volume is only 4% for 6,000,000 t/y.

This figure is too small to excute smooth coal handling.

Additionally, when the number of coal kinds to be handled will be increased, stock yard capacity should be enlarged.

c) Conclusion

In case of a handling volume increase to 6,000,000 t/y and/or an increase in the number of coal kinds, the stock yard has to be improved. Additional conveyer-line and stacker/reclaimer will be required to enlarge the stock yard. Fig. 11-2-5 shows the layout of coal stock yard.

A new additional stacker/reclaimer will also back up the existing units.

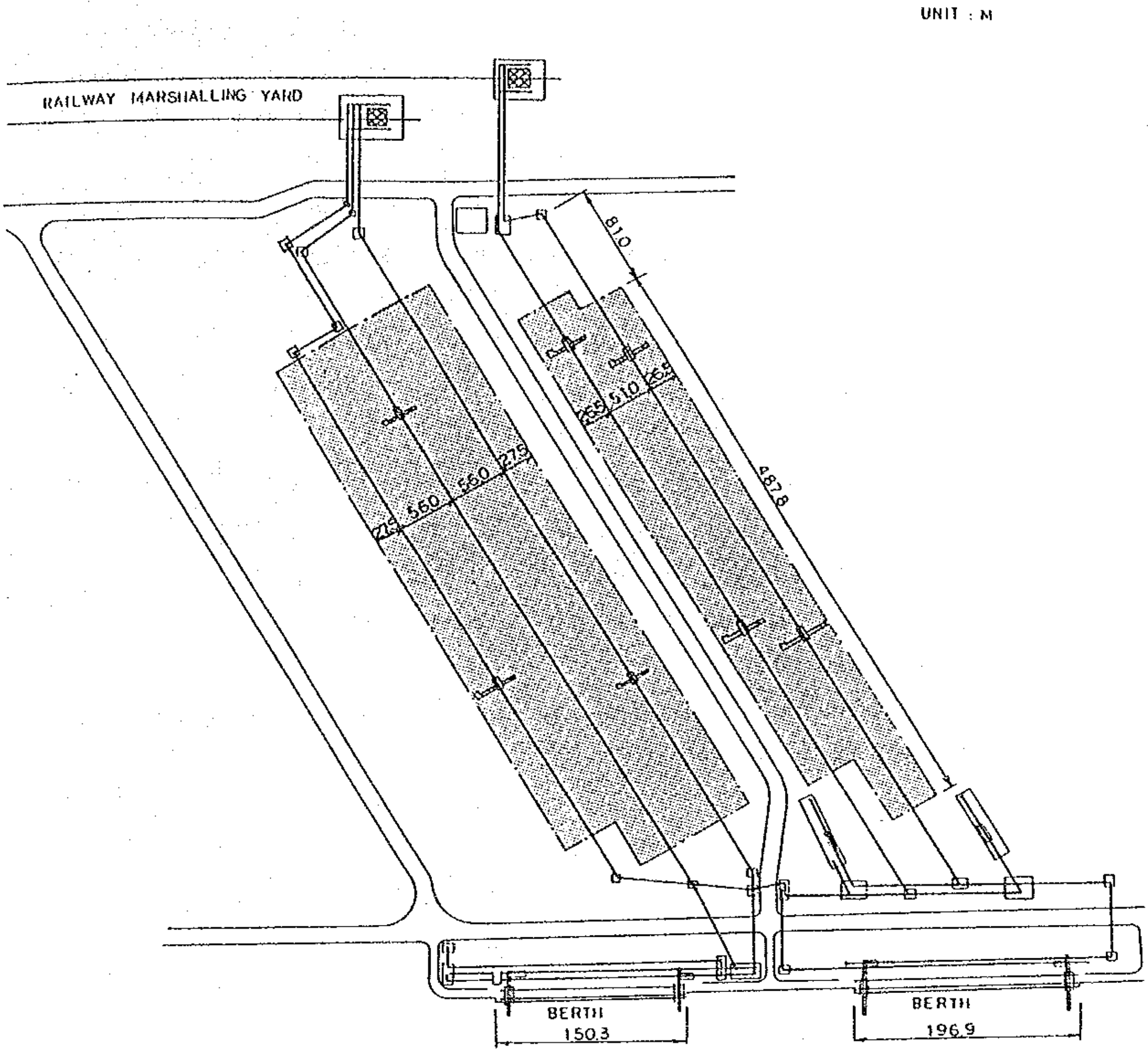


Fig. 11-2-3 Layout of Coal Handling Plant
(6,000,000 t/yar)

5) Actual throughput

The actual throughput at the port terminal will be decided by the handling capacity of the facility and the stock yard capacity, whichever is smaller. The handling capacity of the facility is as follows.

At Coal berth

The capacity of the receiving lines	360 t/h
" shipping lines	610 t/h
The total working hours per year	6,720 h/y
the capacity to be handled is	3,042,720 t/y

At Ore berth

The capacity of the receiving lines	360 t/h
" shipping lines	480 t/h
The total working hours per year	6,720 h/y
the capacity to be handled is	2,764,800 t/y

The required stock yard

The required stock yard will be decided by the following factors.

① The volume to be handled

② The ship size and the ship size distribution

③ The ship arrival distribution

④ The wagon size and the arrival distribution

⑤ the maximum transportation capacity by rail

⑥ Others

The required volume to be stocked at the port is 7% 10% of the total volume to be handled per year in general.

The volume will be determined by the results of a simulation at the detailed design stage. On the other hand, according to C.P.T comments, the handling capacity should not be tied up with the stowage capacity.

However, the coal stock was sometimes zero according to certain data. This means that vessels had to wait for the arrival of coal to begin loading.

Thus the maximum throughput is tied to the stowage capacity.

6) Conclusion

a) At the coal berth, the losstime of the tippler will be reduced by 50% because of improved maintenance.

The ratio of the containers via the C.F.S in assumed as 50% (20%) in the target years.

$$NG = \frac{NL \times 1.3 \times 2}{350 \times 24 \times 0.6}$$

Nc = Required number of chassis

NG = Number of gangs

NL = Number of containers via the C.F.S 50% (20%)

= 28,000 (57,600)

NG = 15 (30)

Nc = 23 (45)

Total 43 (85) *(including 10% spares)*

c) Truck-Tractors

For shipping

NT = Ns = 16 (32)

For C.F.S

NT' = 0.1 N

= 3 (5)

Total 20 (37) (including 10% spares)

d) Fork lift trucks

For C.F.S 1.5t

NF = NG + 1 = 16 (31)

For C.F.S Truck or wagon 3.0t

NF = 1/2 NF + 1 = 9 (17)

For Empty 5t

$$NE = \frac{CE \times 1.3}{30{,}240\ (350 \times 24 \times 0.6 \times 6)}$$

CE = Number of empty containers at the terminal.

= 20,000 (118,000)

NE = 1 (5)

For General services 45t

NG = 1 (1)

4) Container yards

a) For loaded containers

The required size of the container yard for loaded containers will be calculated exactly after the detailed yard layout is set. According to the calculation in a model layout, the number of slots per 10,000

(2) Coking coal

1) The volumes to be handled in the target years are as follows.

1994/95	1,800,000 t/y
2004/05	1,800,000 t/y

2) Handling systems

There are various possible handling systems.

a) From ship (Unloader)

Continuous type

Grab Bucket type

Gantry crane

Level Luffing crane

b) At terminal

Gantry crane

Stacker/Reclaimer

Stacker/Shovel loader

Dump truck/Shovel loader

3) Recommended handling system

The most suitable handling systems at the terminal are decided by examining various factors, including:

- Cargo volume to be handled
- Available stowage yard (shape, size etc.)
- Land side transportation method
- Site condition

The recommended handling system is a level luffing unloader stacker/reclaimer system.

4) Outline of the proposed handling equipment

- Unloader

  Type: Luffing crane with grab bucket.

  No. of unloaders:

In the final stage, 2 units

Capacity

$$C = \frac{Q}{350 \times 24 \times Bo \times \eta_1 \times \eta_2 \times \eta_3 \times 2}$$

Q = Cargo volume to be handled (t/y)

B_0 = Berth occupation

η_1 = Operation efficiency

η_2 = Working time efficiency (macro)

η_3 = Grab bucket efficiency

The values below are used in the above formula

Q = 1,800,000 t/y $\quad$ B_0 = 0.6

η_1 = 0.6 $\quad$ η_2 = 0.6 $\quad$ η_3 = 0.8

C = 620

1st stage 700 t/h 2 unit

. Belt conveyer 1,400 t/h

. Stacker/Reclaimer

1st stage; 2 unit,

. Storage yard

Capacity

The average dwell days of the cargo is assumed as 30 days

$$Q = \frac{1,800,000}{12} \fallingdotseq 150,000$$

The layout is shown in Fig. 11-2-6.

(3) Containers at Haldia

1) Number of containers, berths and quay-side cranes

	1994/95	2004/05 (A1-2)
Containers	56,000	288,000
Berths	1	3
Cranes	2 + 1 = 3	3 x 2 + 1 = 7

2) Handling system

a) From/To ship

Two different handling systems will be used to and from container ships: the roll-on, roll-off method and the lift-on, lift-off method.

However, the roll-on, roll-off method will be used only in special cases.

The lift-on, lift-off method will basically be adopted at the port.

The handling from/to ships will use a quay-side crane system for the following reasons:

- It is the most popular
- One quay-side crane has been introduced already at the existing container berth
- It is the most expensive system. However it can get the highest throughput

b) At terminal

There are many handling methods at container terminals throughout the world including the transfer crane system (rail, rubber tyred), chassis system, straddle carrier system, forklift system, front loader system, mobile crane system, and others.

The most suitable handling system for the terminal will be adopted.

The items to be considered are as follows:

a) The size and shape of the available container yard.

b) The estimated cargo volume.

c) Flexibility of the adopted handling system.

d) Cost (initial cost, running cost, maintenance cost).

e) Operation system and number of operators at the container terminal.

f) Others

The consultant recommends the rubber tyred transfer crane system for Haldia. The reasons are as follows.

The rail mounted transfer crane system is already used for handling containers on railway flat-cars.

The size of the available container yard is limited.

The handling system provides great flexibility to expand the handling equipment.

The initial investment is lower than that of the rail transfer crane system.

3) Required minor handling equipment

The cost of the minor handling equipment is lower than that for the quayside container cranes.

The required minor handling equipment will be prepared to support the smooth operation of the quayside container cranes.

Mostly the number of minor handling equipment will depend on the number of quay-side container cranes. Figures in parentheses indicate the values in 2004/05 (alternative-2).

a) Rubber tyred transfer cranes

The required number of transfer crane is usually calculated by the following expression.

$NT = 2N + 1$ or 2

NT = Required number of rubber tyred transfer cranes

N = Number of quay-side contaienr cranes

NT = 9 (17)

b) Chassis

For shipping

The required number of chassis for shipping is calculated by the following formula.

$Ns = T_1 / T_2 \times N_Q$

Ns = Required number of chassis

NQ = Number of quay-side container cranes

T_1 = Average calculated cycle time of the chassis

T_2 = Minimum cycle time of the quay-side container cranes

The following values are adopted

T_1 = 8 min T_2 = 2 min Ns = 8/2 NQ

Ns = 16 (32)

For CFS

The required number of chassis for the CFS is usually calculated by the number of gangs stuffing and unstuffing cargoes at the C.F.S.

Nc = 1.5 x NG

The containers which are stuffed/unstuffed within the port area are L.C.L container only and F.C.L containers are not moved through the C.F.S in general. Some F.C.L containers are stuffed/unstuffed because of the special local conditions at the port at present. However, this is not desirable.

The volume of the F.C.L cargo which will pass through the C.F.S will decreased to Zero in 2004/05.

m^2 for a tyred-transfer crane system is 180 TEU

$$A\ max = \frac{N \times K_1 \times K_2}{365 \times 180 \times 2.5}$$

A max = Required area for loaded containers (0'000 m^2)

N = Number of loaded containers 36,000 (170,000)

K_1 = Average dwell days (10 days)

K_2 = Peak ratio (1.3)

A max = 3.0 (13.5)

b) Empty containers

The empty containers will be block stacked. the roughly estimated number of empty containers which can be stacked per 10,000 m^2 is about 490 slots.

$$A\ max = \frac{NE \times K_1 \times K_2}{365 \times 490 \times 3}$$

A max = Required area for loaded containers

N = Number of loaded containers 20,000 (118,000)

K_1 = Average dwell days (20 days)

K_2 = Peak ratio (1.3)

A max = 0.9 (5.8)

c) Others

In addition, space for reefer containers, the maintenance shop, vehicle pool, and buildings for administration, operation, canteen, etc. will be needed.

d) Total

The total required area is as follows

	1994/95	2004/05 (A1-2)
Loaded containers	3.0	13.5
Empty containers	0.9	5.8
Buildings	1.2	2.0
Others	0.5	1.0
Total	56,000m^2	223,000 m^2

The layout is shown in Fig. 11-2-11.

5) Maintenance shop

A maintenance shop to repair handling equipment and containers is required at the container terminal.

The required area will be about 800m². A welder, an air compressor, gas cutting equipment, a steam boiler, a battery charger, some machine tools and so on will also be required.

6) Container handling facility for barges (Alternative-2)

a) Estimated cargo volume

year	Dock	TEUs
1994/95	Calcutta	20,200
	Haldia	18,420
2004/05 (1)	Calcutta	44,700
	Haldia	42,800
" (2)	Calcutta	62,000
	Haldia	60,000

b) Planned barge

Capacity	42 TEUs x 2
Dimensions of Barge	65.0 x 10.0 x 2.9 m
Speed	5.4 kt

c) Average number of transported containers per navigation.

NA 50 TEUs (84 x 0.8 x 1/1.3 = 51.7)

d) Navigation hours

H = 10 hours

e) Number of navigations per year

1994/95 404

2004/05 1,240

f) Navigation model

1994/95 Two (2) barge system two (2) fleets

Handling 10 hours

Navigation 10 hours

Others 4 hours

2004/05 Two (2) barge system three (3) fleets

1 cycle time

Handling 4 x 2 = 8 hours

Navigation 10 x 2 = 20 hours

Others 2 x 2 = 4 hours

g) Required number of Quay-side cranes for barge

in 1994/95   Calcutta, (Floating crane) 1 unit

in 2004/05   Calcutta, Haldia   each 2 units

(4) Raw Material for Fertilizer

1) The volumes to be handled in the target years are as follows

1994/95   530,000 tons

2004/05   1,800,000 tons

2) Capacity of the existing handling facility

There is one berth and one set of handling equipment for raw materials for fertilizer. The capacity of the existing facility is 1,600,000 ~ 1,900,000 t/Y. Thus the cargo volume (1,800,000) which will be handled in the target year can be handled.

3) Conclusion

No additional handling facility will be required and the existing facility will handle the cargo.

Table 11-2-2 List of Minor Handling Equipment at Haldia

	Exist	For General Cargo						For Container						Total Procurement	
		1994 / 1995			2004 / 2005			1994 / 1995			2004 / 2005				
		Required	Procu (Initial)	Procu (Replace)	Required	Procu (Initial)	Procu (Replace)	Required	Procu (Initial)	Procu (Replace)	Required	Procu (Initial)	Procu (Replace)	94/95	04/05
Transfer crane(rail)	1	0	0	0	0	0	0	1	0	0	2	1	0	0	1
Transfer crane(rubber)	0	0	0	0	0	0	0	9	9	0	17	8	0	9	8
Fork-lift 2.0 t	0	0	0	0	0	0	0	18	18	0	31	15	32	18	47
3.0 t	8	5	5	0	8	3	10	9	1	8	17	8	18	14	39
5.0 t	0	0	0	0	0	0	0	1	1	0	5	4	2	1	6
10.0 t	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45.0 t	0	0	0	0	0	0	0	1	1	0	1	0	2	1	2
Mobile crane 10.0 t	3	3	0	1	3	0	2	0	0	0	0	0	0	1	2
16.0 t	0	1	1	0	1	0	0	0	0	0	0	0	0	1	0
30.0 t	0	1	1	0	1	0	0	0	0	0	0	0	0	1	0
Chassis	5	0	0	0	0	0	0	43	38	5	85	42	86	43	128
Tractor	4	0	0	0	0	0	0	20	16	4	37	17	40	20	57
Truck-scale	0	0	0	0	0	0	0	2	2	0	4	2	0	2	2

Table 11-2-3 Replacement of Minor Handling Equipment (Haldia)

Description	Capa.	Require at 94/95	Existing Equipment No.	Existing Equipment M.Y.	Existing Equipment End Y.	No. of Replacement 90/91	91/92	92/93	93/94	94/95	Remarks
Fork-lift working life-time; 5 Y.	3 t	14	4 4	1977 1982	1982(89) 1987(89)	4 4					
		total	8			8					8
		Initial Procu. 14- 8= 6						6			6
											14 (Total Procurement)
Mobile crane working life-time; 15 Y.	10 t	3	1 2	1977 1982	1992 1997			1			1
		total	3					1			1 (Total Procurement)
Chassis working life-time; 5 Y.		43	5	-	-	5					
		total	5			5					5
		Initial Procu. 43- 5= 38				10				28	38
											43 (Total Procurement)
Tractor working life-time; 5 Y.		20	4	-	-	4					
		total	4			4					4
		Initial Procu. 20-4=16				3				13	16
											20 (Total Procurement)

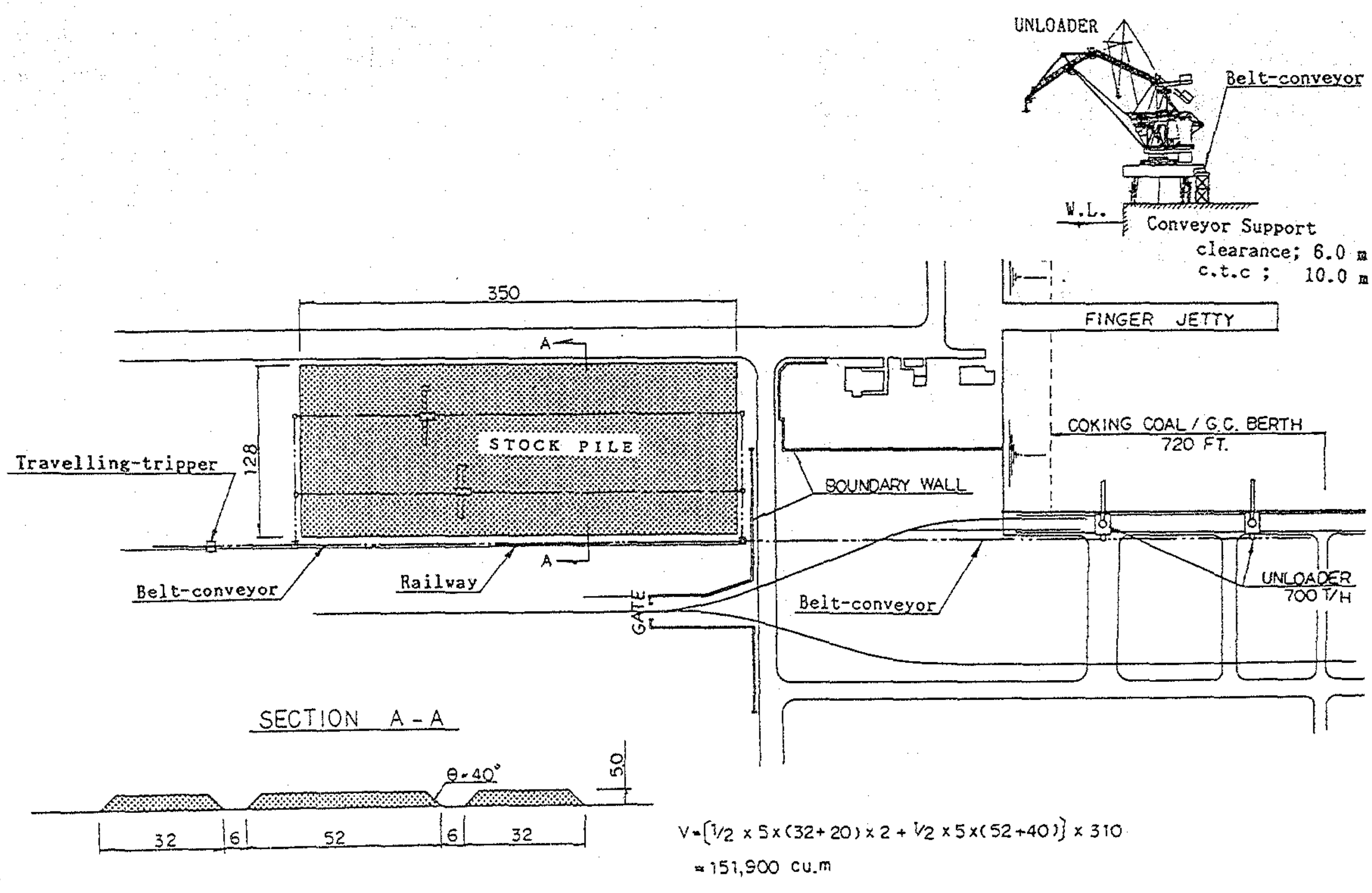


Fig. 11-2-4 Layout of Coking Coal Handling Plant

11-2-4 Port Traffic facilities

1) Container terminal

Container movement in Haldia is expected to increase after completion of the new ICDs and expansion of Guwahati ICD. Future container facilities for rail shall be examined considering the present bottlenecks and the necessary requirements corresponding to the cargo volume estimated in Chapter 8. At present, due to the shortage of track length, full container rakes have to be divided into two rakes and there is no engine escape line.

The required number of reception tracks, departure tracks and loading/unloading tracks in 1995 and 2005 are calculated in the same way as for the Calcutta container terminal and presented in Table 11-2-5.

Fig. 11-2-7 shows the conceptual plan of the container terminal to be located behind the container berths in 1995 and 2005. In 1995, the rakes have to be split up into two part at the terminal.

Table 11-2-5

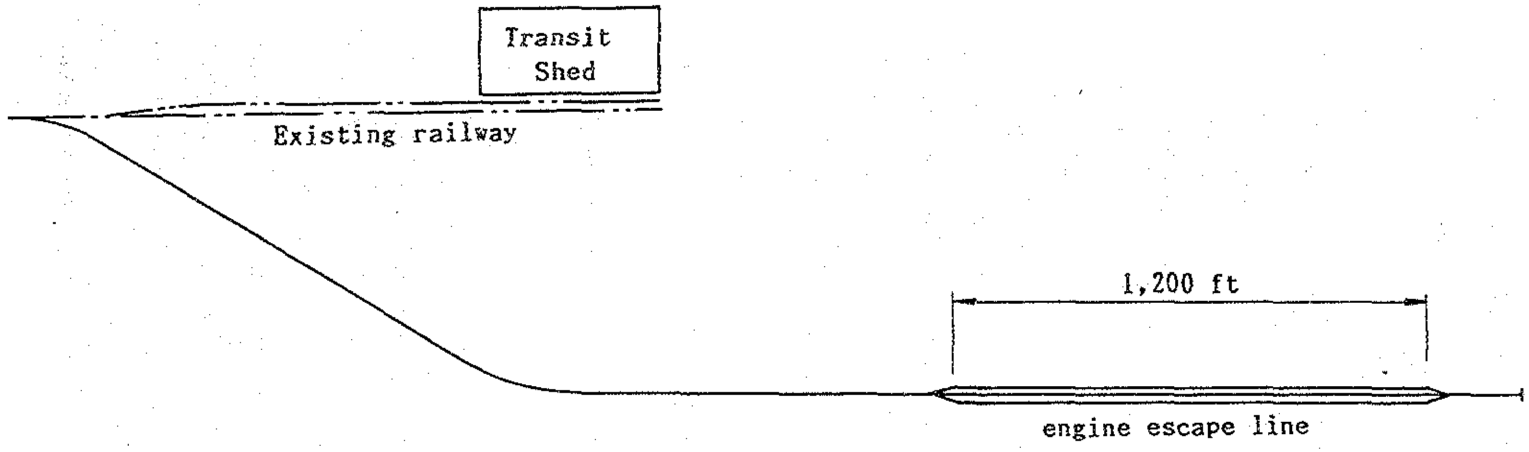
	Handling Volume A (TEUs)	λ	μ	Required Number of Tracks		
				Reception	Loading/Unloading	Departure
1995	11,200	0.240	8 (Reception) 1.33 (Loading/Unloading) 2.67 (Departure)	1 1 -	- 1 -	- - 1
2005 (Alternative-1)	19,000	0.4071	8 (Reception) 1.33 (Loading/Unloading) 2.67 (Departure)	1 1 -	- 1 -	- - 1
2005 (Alternative-2)	69,500	1.4893	8 (Reception) 1.33 (Loading/Unloading) 2.67 (Departure)	1 1 -	- 3 -	- - 2

2) Coal rake terminal

The number of reception and departure tracks in BH yard shall be examined considering the tippler efficiency and the locomotive availability.

At present. the net tippler rate (number of wagons) per hour is 5.8 wagons/hour/tippler.

However, the present tippling capacity (μ) which is affected by idle time due to plant breakdown, maintenance etc. is 5.16 wagons/



Loading/unloading Tracks in 1995

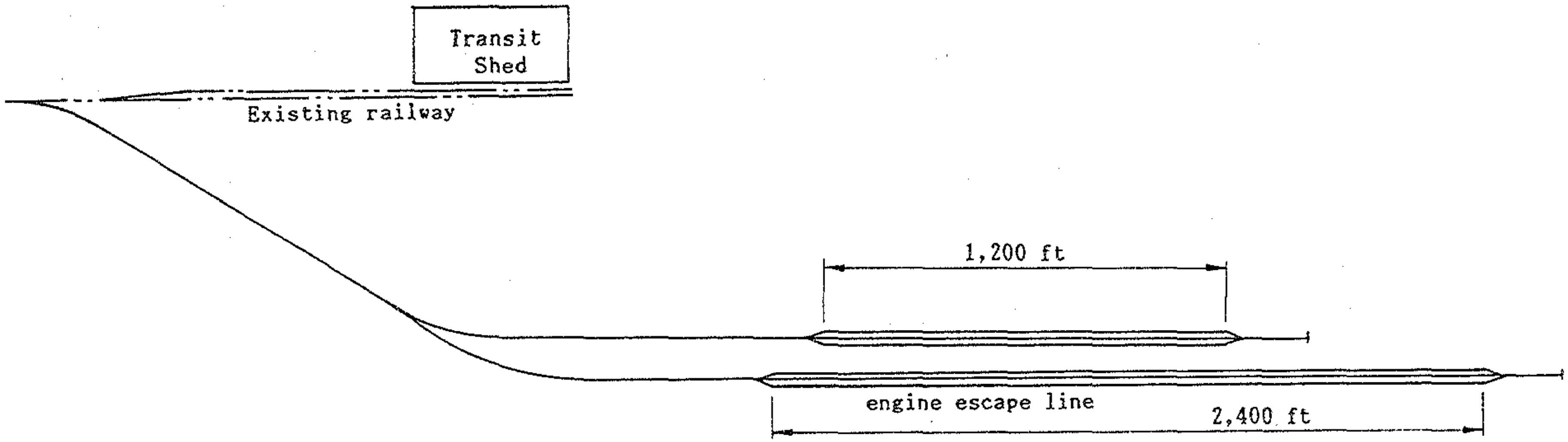


Fig. 11-2-7 Conceptual Layout of the Container Terminal in 1995, 2005

hour/tippler.

The average number of arrival rakes per day (λ) is calculated by the following equation.

$$\lambda = (\frac{A}{T} x \frac{1}{v} x\ k\ x\ p)/t$$

where, A : Cargo handling volume per year

T : Working days per year

v : Actual wagon loading volume (tonnes/wagon)

k : Empty wagon rate

p : Peak rate

t : Average number of wagons per rake

For the above coefficients, the following values are used.

T = 365 days, v = 58.5 tonnes, k = 1.0, p = 1.3

t = 44 wagons, then $t \times v \fallingdotseq 2,600$ tonnes.

The average number of arrival rakes (λ) at present is 4.2 rakes/day and the figures in 1995 and 2005 are calculated as follows.

	(rakes/day)	A (tonnes)
1987/88	4.21	2,540,000
1994/95	5.685	4,150,000
2004/05	5.685	4,150,000

The average staying periods of coal rakes at each of the tracks at Haldia are as follows as shown in Chapter 4.

Reception Tracks : 4.5 hrs (5.33 rakes/day)

Tippler, forming tracks, other : 19 hrs (1.26 rakes/day)

Departure Tracks : 12 hrs (2 rakes/day)

The required number of reception tracks shall be examined considering that waiting of incoming rakes at the trunk line should be strictly avoided and the required number of reception tracks depends on the tippling efficiency. Present tippling efficiency is 3.345 rakes/day.

Using the present operational efficiency at the reception tracks, tippler and departure tracks, the required number of reception tracks, tippler and departure tracks are calculated as shown in Table 11-2-6.

Table 11-2-6

	1987/88	1994/95	2004/05
Reception Tracks	3	4	4
No. of Tipplers	3	4	4
Departure Tracks Departure (improved)	6 (5)	7 (5)	7 (5)

According to the above results, it is clear that tippling efficiency and examination/clearance efficiency at the departure tracks should be improved.

It seems that it will be possible to reduce examination and clearance time through coordination between CPT and S.E.

Tippler efficiency will also be improved by increasing the number of tipplers and/or reinforcing the capacity (ref. Chapter. 3-3).

Assuming the examination/clearance time will be reduced by half, the required numbers of departure tracks will be reduced to the numbers in Parenthese in Table 11-2-6

3) P.O.L

At present, the average staying periods of P.O.L rakes at Haldia rail system are as follows, as mentioned in Chapter 4.

Reception tracks : 10 hrs (2.4 rakes/day)

Departure tracks : 15 hrs (1.6 rakes/day)

Using the above operational efficiency, the required numbers of reception tracks and departure tracks are calculated in the same way as for the other cases.

The arrival rate is calculated by the equation below.

$$\lambda = (\frac{A}{T} x \frac{1}{v} x\ k\ x\ p)/t$$

where,

T = 350 days

v = 20 tonnes

t = 70 wagons/rake

k = 1.0

p = 1.0

Table 11-2-7

	Handling volume (tonnes)	λ	μ	Required number of Tracks		
				Reception	IOC	Departure
1955	1,280,000	2.612	2.4 (4.8) :Reception 1.6 (3.2) :Departure	4 (2) -	- *	- 5 (3)
2005	1,775,000	3.622	2.4 (4.8) :Reception 1.6 (3.2) :Departure	5 (3) -	- *	- 6 (4)

* Depend upon IOC's siding efficiency

According to the above results, it is clear that the operational efficiency at the reception tracks and departure tracks should be improved.

Assuming the operational efficiency will be doubled, the required numbers of departure tracks will be reduced to the numbers in Parentheses in Table 11-2-7.

4) Coking coal

At present, the average staying periods of coking coal rakes at the loading tracks and the departure tracks at G.M yard are as follows.

Reception tracks : 9 hrs (2.67 rakes/day)

Departure tracks : 15 hrs (1.60 rakes/day)

If a mechanical loading facility of coking/coal to wagons is developed by the target year 1995, the loading efficiency will improved as shown below (ref. chapter. 4).

Loading efficiency : 4.930 rakes/day/line.

Using this improved efficiency, the required number of tracks (2 tracks/line) is calculated as shown in Table 11-2-8.

The arrival rate is calculated by the equation below.

$$\lambda = (\frac{A}{T} \times \frac{1}{v} \times k \times p)/t$$

where,

$T = 365$ days

$v \times t = 2,600$ tonnes

$k = 1.0$

$p = 1.0$

Table 11-2-8

	Handling volume (tonnes)	λ	μ	Required number of Tracks	
				Loading	Departure at G.M
1955 2005	1,800,000	1.897	4.930 :Loading 1.6 (3.2) :Departure	1 -	- 4 (2)

If the operational efficiency at the departure tracks, namely, examination of tracks and clearance, is doubled, the required numbers of tracks will be reduced to the numbers in parentheses in Table 11-2-8.

A direct link line shall be developed between the coal departure trucks and the coking coal loading terminal as shown in Fig. 11-2-8 .

5) *Required number of tracks at Haldia*

The required number of reception tracks and departure tracks at G.M yard and BH yard are summarized in Table 11-2-9 below. The required number of sorting yards will be eight in 1995, and ten in 2005.

Table 11-2-9

		Reception tracks		Departure tracks	
GM yard	1995	1 for containers 4 (2) for POL 1 for General cargo	6 (2)	1 for containers 5 (3) for POL 4 (2) for coking coal 1 for General cargo no truck for general cargo	11 (5)
GM yard	2005	1 for containers 5 (3) for POL 1 for General cargo	7 (3)	2 for containers 6 (4) for POL 4 (2) for coking coal 1 for General cargo no truck for general cargo	12 (6)
BH yard	1995	4 for coal	4	7 (5) for coal	7 (5)
BH yard	2005	4 for coal	4	7 (5) for coal	7 (5)

( ) : assuming a 100 % improvement of operational efficiency (examination/clearance)

6) General improvement plan of Haldia railway system

Fig. 11-2-8 shows the general plan of Haldia railway system in 1995. Through 2005, the number of departure tracks and reception tracks at GM yard will increase as shown in Table 11-2-9.

The number of sorting tracks at GM yard shall also increase.

At BH yard, the number of reception tracks and departure tracks shall increase through 2005 as shown in Table 11-2-9.

Sufficient coking coal loading tracks to accommodate the cargo volume in 2005 shall be developed by 1995.

Two 1,200 feet container loading tracks shall be developed behind the container berth to accomodate the cargo volume to be handled in 1995 and in 2005 (alternative -1). In the case of alternative-2, two full rake loading tracks and two 1,200 feet tracks (for one rake) shall be developed, by 2005.

As noted in Chapter-4, Haldia railway system has many serious problems including lack of locomotives, frequent derailment, shortage of staff, and inefficient operations for the commercial/industrial sidings. Especially, the following problems need to be improved urgently.

a) Reducing the examination period through coordination between CPT and SE.
b) Thorough maintenance of the tracks in order to avoid derailment and to improve efficiency.
c) Increasing the number of locomotives.
d) Installing speed arresters (Car Reterder) at the post tippling zone to avoid damage to wagons.
e) Installing wagon pushers in place of beetles to minimize breakdown caused by the unavailability of beetles to low chassis coal wagons.
f) Construction of one loco maintenance shed with a crane to augment the maintenance facilities to accommodate the future increase of locomotives.

Concerning the operation for the industrial sidings, it seems reasonable to entrust this operation to the Indian Railway.

It would be much better to transfer rakes directly from Indian Railway especially for HFC sidings and IOC sidings without passing through port railway yards considering the sufficient traffic volume to form rakes.

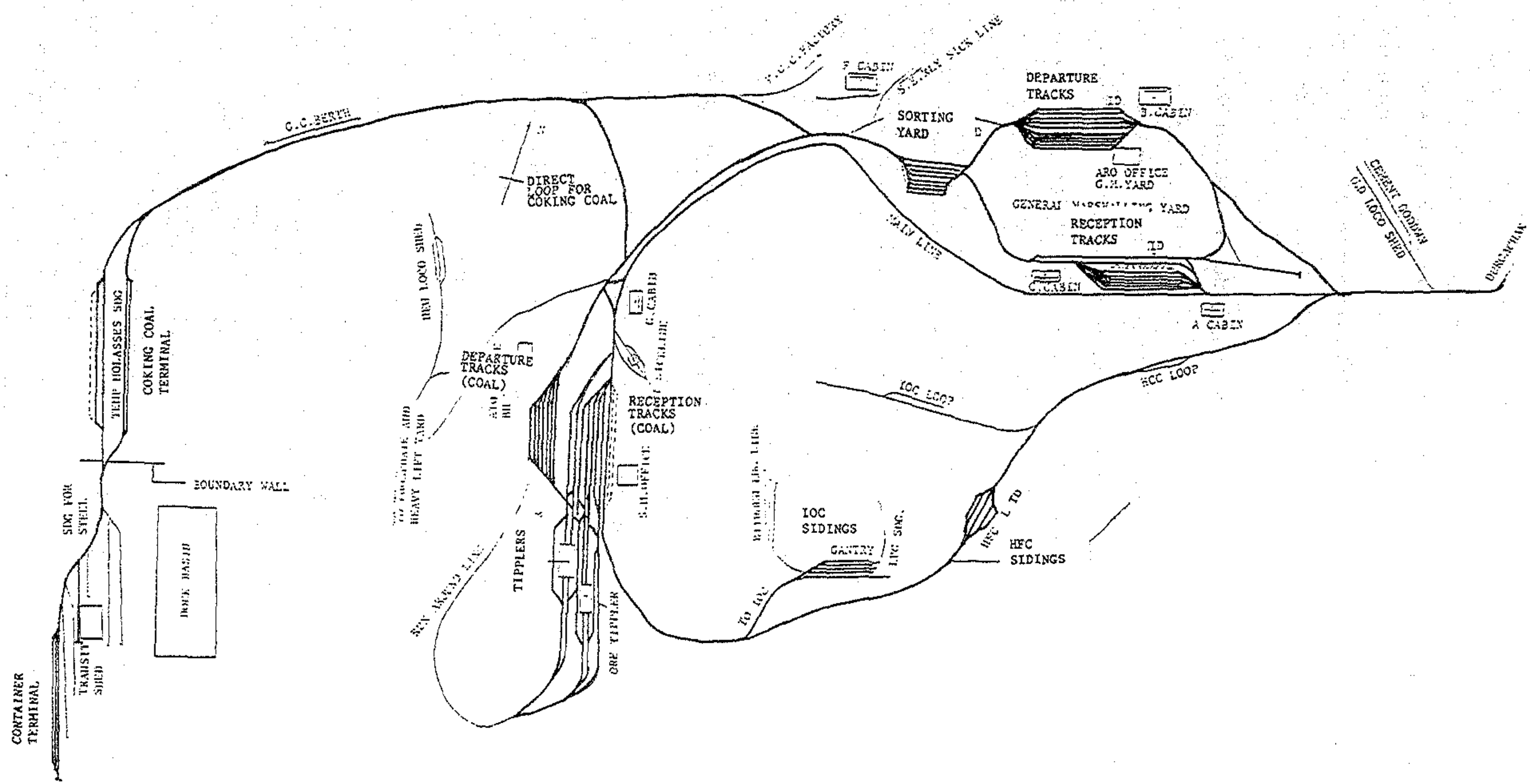


Fig. 11-2-8 General Plan of Haldia Railway System (1995)

11-2-5 Proposed Layout Plan

Based on the required scale of the port facilities as analyzed in the foregoing sections, a layout for the Master Plan is prepared as shown in Fig. 11-2-9, For reference, the layout for Alternative-1 is also presented in Fig. 11-2-10.

(1) The dimensions of newly constructed berths are determined as follows.

Taking into consideration that :

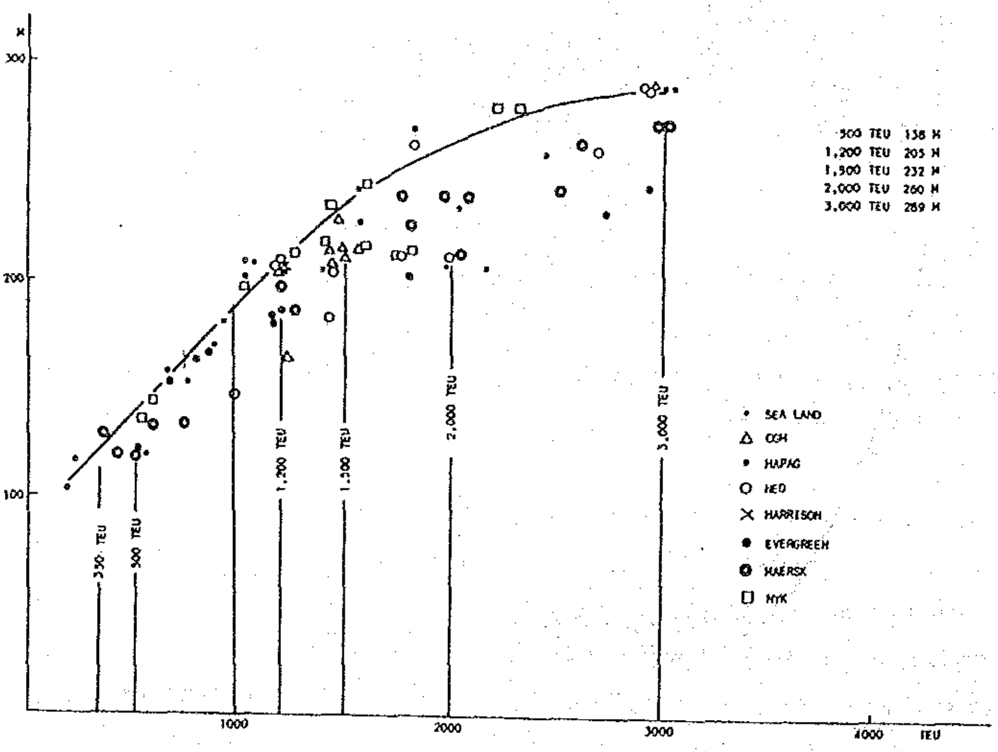
i) the berth of the existing berth is 220 m

ii) the study by EIL on the augmentation of container handling facilities at Haldia assumed the length of 220 m for the new multi-purpose berth.

iii) as regards container vessels in future upto 2005 :

			LOA
300-400	TEU vessel	presently most of the calling vessels	125 m
500	TEU vessel	increase the share	160 m
1000	TEU vessel	Black Sea Shipping, etc	190 m
7/800	TEU vessel	SCI etc may deploy in future	210 m

Thus, adding berthing gap (15-30m), 200 m of berth length will be sufficient for 500 TEU loaders.



Relationship Between LOA and TEU

vi) as regards conventional vessels :

Present calling vessels are less than 20,000 DWT (1986) and the appreciable increase of ship size of the conventional vessel is not expected.

Also, 15,000 DWT ~ 20,000 DWT conventional vessels calling at Haldia/Calcutta occupies 12 % in 1986. Respective berth length = 180 m - 210 m.

v) all berth are continuous, thefore the contiguous berths can be utilized when required.

Thus, the following berth length will be adopted here,

Multi purpose berth : l = 220 m /berth

Container berth : l = 200 m /berth

Conventional berth : l = 200 m /berth

(2) Berth allocation for container and break-bulk G/C vessels

As examined in the Section 11-2-2, the berth requirement for catering to container and break-bulk G/C and bagged fertilizer vessels is as follows.

2 exclusively general cargo berths

1 multi-purpose berth

3 exclusively container berths

In determining the berth location, the followings should be considered.

(i) The same kind of berths should be continuous.
This is particularly the case for container berths.

(ii) Conventional berths can be easily converted to container berths in future when the future demand requires so.
On the other hand, the conversion of container berths to conventional berths is not proper from the economic point of view due to the capital intensive nature of container berths.

(iii) The existing multi-purpose berth is not suitable for handling containers due to the shortage of the space between the quay front and the exsisting shed.

(iv) IWT berth should be in such a location as to enable efficient horizontal container flow between IWT berth and oceangoing container berths.

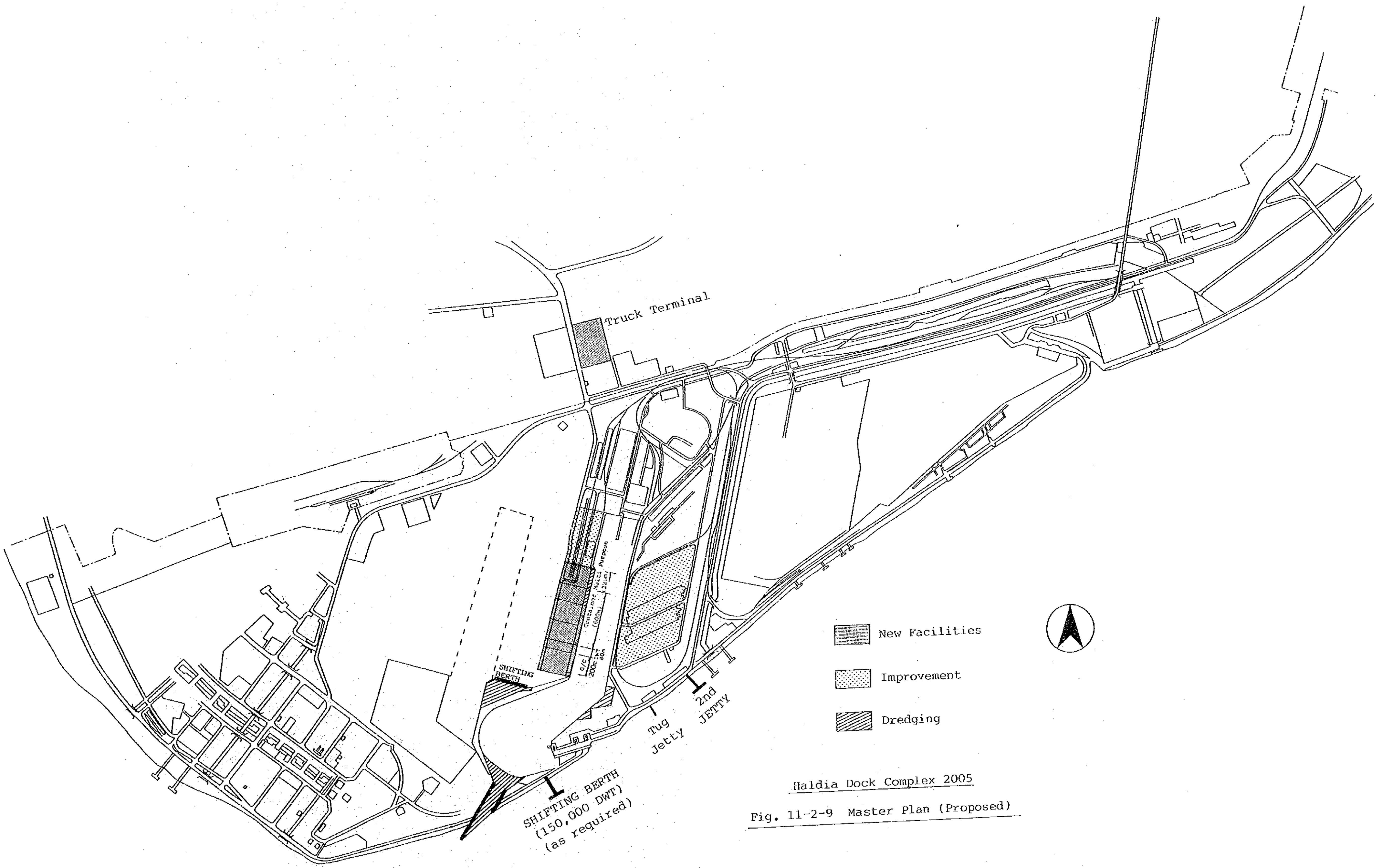
(v) Appreciable investment has been already made in the container yard next to the existing multi-purpose berth.
Also, the study on the augmentation of container handling facilities at Haldia by EIL has been carried out.

(vi) Smoothly development of the facilities from the existing level, via 1995 to the year of 2005 according to the increase of traffic demand should be ensured.

Taking these factors into account, the following allocation is likely the best for the berth allocation.

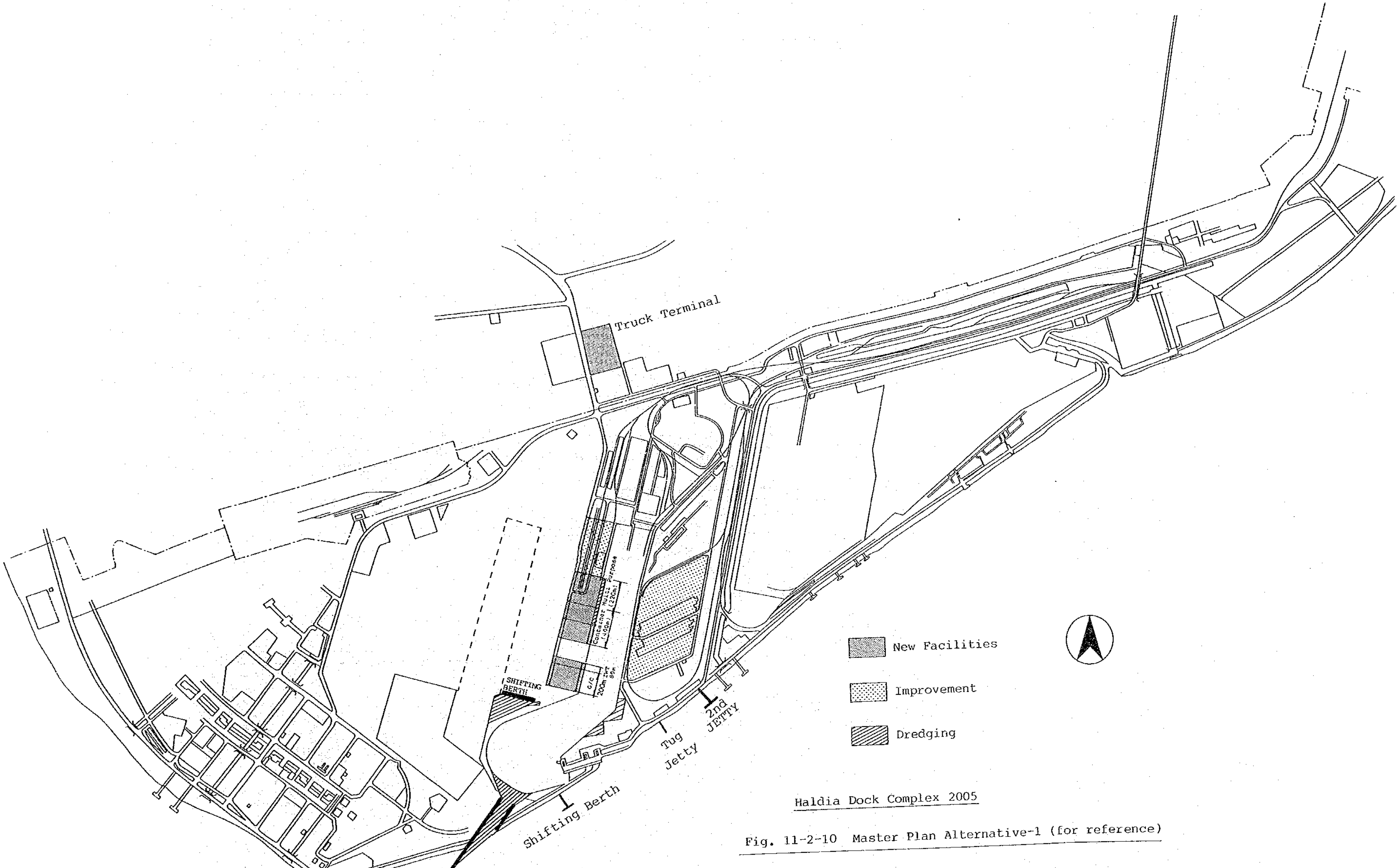
From the finger jetty side,

	①	②	③	④	⑤	⑥	⑦	⑧
(existing) :	G/C	Multi	-	-	-	-	-	-
(1995) :	C/Coal	G/C	Multi (IWT)	con	-	-	-	-
(2005, Al-1) :	C/Coal	G/C	Multi	con	con	-	IWT	G/C
(2005, Al-2) :	C/Coal	G/C	Multi	con	con	con	IWT	G/C



Haldia Dock Complex 2005

Fig. 11-2-9 Master Plan (Proposed)



Haldia Dock Complex 2005

Fig. 11-2-10 Master Plan Alternative-1 (for reference)

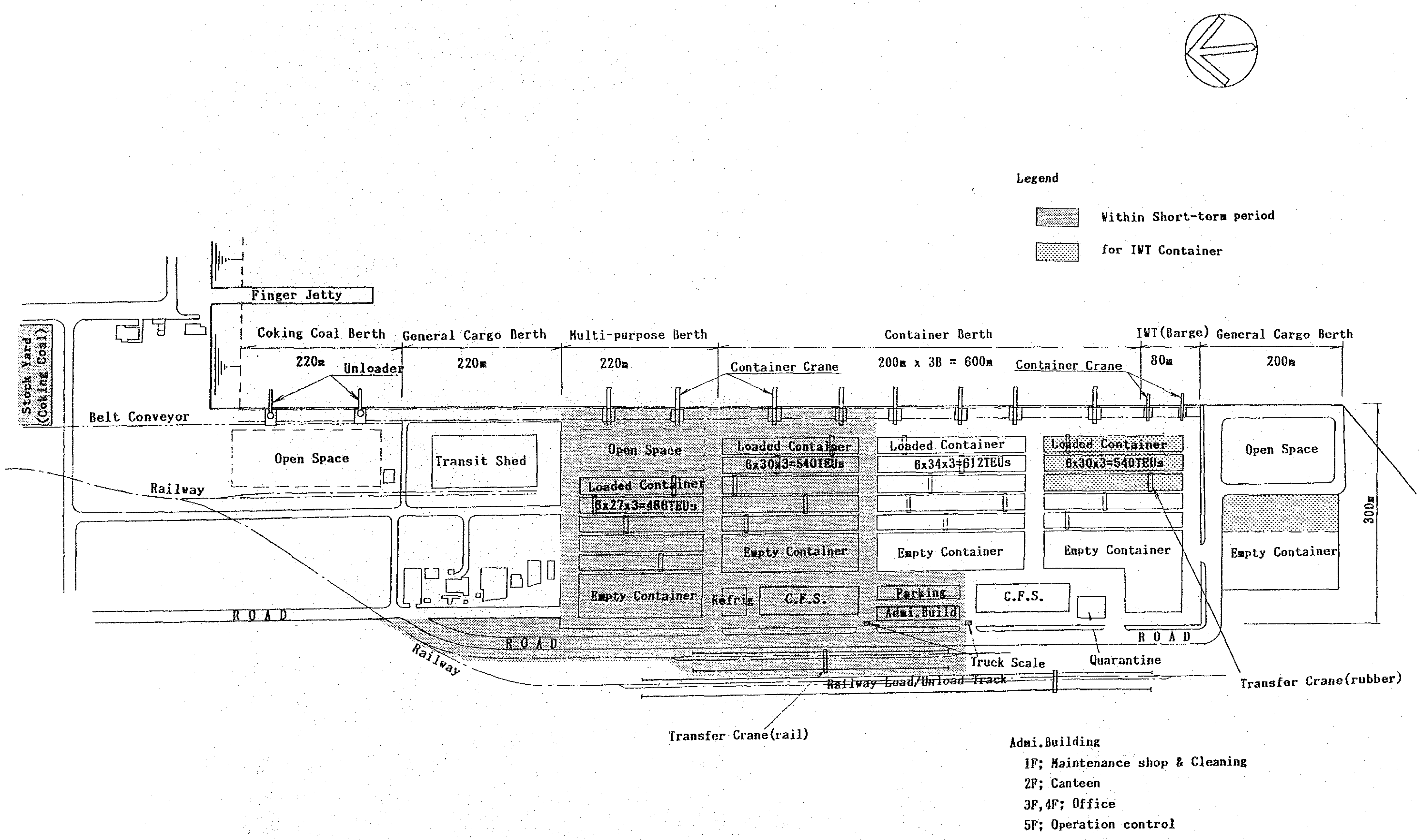


Fig. 11-2-11 Layout Plan of Container Terminal at Haldia

11-2-6 Others

(1) Pollution caused by sulphur handling by clam shell unloaders

There are certain anti-pollution systems available as follows.

1) For the cargo which can be washed

(Ore, Coal)

a) Watering

Water curtain

Water nozzle

b) Hopper with window protection plate

2) For the cargo which must be kept dry

a) Anti-pollution equipment (Air vacuum system)

b) Hopper with window protection plate

c) Preparation of a new type unloader

3) Conclusion

A hopper with window protection plates has been introduced already. If it is necessary to reduce the air pollution further, measures will be decided based on the balance between pollution prevention and cost.

(2) Bulk Fertilizer Handling

1) There are some factors preventing the free flow of fertilizer

1) Angle of the hopper side plate

In general Plate 60°

Cone 55°

2) Caked fertilizer adheres to the hopper plate (insufficient cleaning after handling)

3) Rusted hopper side plates

4) Hopper plates with projections

5) Damp cargo

2) Plans to improve the handling efficiency

1) Reconstruction of the hopper

2) Cleaning

3) Removal of the projections

4) Preparation of vibrators

5) Lining the hopper with smooth surface plate

3) Conclusion

The best method will be decided after detailed investigations and discussions.

11-3 Craft/Vessels

11-3-1 The Existing Craft/Vessels

The existing craft/vessels for port services in Calcutta Port Trust are shown in the Table 11-3-1. There are about eighty (80) craft/vessels belonging to the C.P.T. Their average ages are about 22 years old and 14 of the vessels were built before 1960. Generally the port vessels are old. The working results for the past three years are shown in Table 11-3-2. From the table, the following points are clear:

(1) The number of usable days is very short.

The figure varies by ship type. The best group is the tug boats, which are available 236 days per year on average. The worst group is the hopper dredgers with 145 days per year on average. The grand average availability is only 180 days per year. This figure is far too low.

(2) The number days vessels cannot be used due to breakdown and other reasons is very high

The average number of days that all types of vessels cannot be used due to breakdown and other reasons is about 54 days per year. This figure is very high and it should be reduced by improving the maintenance and repair system.

(3) The number of days for inspection and overhaul is also far too high.

The average number of days for vessel inspection and overhaul is about 120 days per year. This figure seems extremely high. Standard figures are as follows:

- large ships: about 60 days
- small ships: about 20 days

(4) Net working days per year

Judging from the available days, the average net actual working days per year may be less than about 150 days. This figure should be increased. Thus the management, control and maintenance systems will have to be reviewed in an effort to increase productivity.

Table 11-3-1 Floating Equipment

Port	No.	Type of Vessel	Name	Built year	Main Dimensions L	Main Dimensions B	Main Dimensions D		Scrap M/P	Scrap S/T	Built M/P	Built S/T	Final	Remarks
	1	Dredger (River)	Mahaganga	'78	140.0	22.0	9.5	4,700 m^3 1,910psX4					0	Finally Large,Middle,Small three Dredgers
	2	〃 〃	Mohana	'85	123.6	18.7	8.2	2,800 m^3 4,900ps	X		0		0	(5,000 3,000 1,700 m^3)
	3	〃 〃	Churni	'81	113.4	18.9	7.3	1,700 m^3 5,352ps	X	X	0	0	0	
	4	〃 〃	Subarnarekha	'88	93.8	15.2	5.8	1,274 m^3 2,080ps	X	X				
	5	〃 (Port)	Ajoy (Bucket)	'81	56.4	14.0	5.4	No Hopper 1,500ps	X	X				
C	6	〃 〃	Grab Dredg.No.1	'84	68.3	13.7	5.4	1,910ps	X	X	0	0	0	750 m^3
	7	〃 〃	Grab Dredg.No.2	'87	68.3	13.7	5.4	1,910ps	X					
	8	Tug/Despatch	Nadia	'51	73.1	11.3	4.1	B.P 18t 2,153ps	X	X				→ Multi.
	9	〃	Seva	'83	73.8	12.2	3.88	20t 2,200ps	X					Average 86days Navi.per year
C	10	Tug boat (River)	Shaktiman	'84	33.0	9.0	4.5	22t 750psX2					0	
	11	〃 〃	Stalvart	'73	38.7	9.8	4.3	10t 1,000ps	X					
C	12	〃 (Dock)	Champa	'54	28.9	8.2	3.8	10t 800ps	X	X	0	0	0	* 7 tugs are available usually
C	13	〃 〃	Chameli	'55	28.9	8.2	3.8	10t 800ps	X	X	0	0	0	* (5 tugs within 11 tugs were not available
	14	〃 〃	Malati	'58	26.1	7.8	3.7	9.6t 776ps	X	X				at same time)
C	15	〃 〃	Galap	'87	28.9	7.9	3.7	11.5t 950ps	X		0		0	#
C	16	〃 〃	Tagar	'67	26.9	7.9	3.7	11.6t 950ps	X		0		0	*
C	17	〃 〃	Hena	'87	27.4	7.9	3.7	13.6t 950ps	X		0		0	#
C	18	〃 〃	Bakul	'68	27.4	7.9	3.7	13.7t 950ps	X		0		0	#
C	19	〃 〃	Juin	'85	27.5	8.6	3.7	950ps					0	* : 2,500ps
C	20	〃 〃	M.O.T.Tug-1	'67	28.4	8.2	3.1	12t 950ps	X		0		0	# # : 750ps x 2
	21	Pilot Vessel	Saugor	'64	83.5	13.3	7.2	1,500ps	X	X				
	22	〃	Sandra	'64	83.5	13.3	7.2	1,500ps	X					
	23	River Survey Ve.	Haddia	'81	44.1	7.8	3.6	600ps	X	X				→ Multi. Alternately Work
	24	〃	Tribeni	'65	60.1	10.8	5.2	1,200ps	X					
	25	River Survey Laun.	Ram	'80	20.4	4.6	2.2	120ps	X	X	0	0	0	
	26	〃	Laksman	'80	20.4	4.6	2.2	120ps	X	X				
	27	〃	Bharat	'80	20.4	4.6	2.2	120ps	X	X	0	0	0	based at Hugli point,Falta,Moyapur,Baj Baj,
	28	〃	Topsee					240ps					0	Akre & Fairfields.
	29	〃	Lava	'84	20.4	4.6	2.2	160ps	X	X				
	30	〃												
	31	〃	Kanshalya	'68	20.4	4.6	2.2	182ps	X		0		0	
	32	〃	Kaikeyee	'68	20.4	4.6	2.2	182ps	X		0		0	
	33	〃	Kopoi	'70	17.9	4.9	1.7	218psX2					0	
	34	Pil/Har/Dock Laun.	Parijat	'57	23.8	5.2	2.4	380ps	X	X	0	0	0	]-Transport officer & man
	35	〃	Parul	'51	22.8	5.2	2.4	380ps	X	X	0	0	0	between shore point and ship
	36	〃	Keya	'63	15.4	3.9	1.8	190ps	X	X				
	37	〃	Karabi	'63	15.4	3.9	1.8	190ps	X	X	0	0	0	
	38	〃	Ketaki	'63	15.4	3.9	1.8	190ps	X	X				
	39	〃	Mahua	'72	15.1	4.2	2.1	93ps	X		0		0	
	40	〃	Mandar	'72	15.1	4.2	2.1	83ps	X					
	41	〃	Madhabi	'76	22.3	4.6	2.2	190ps					0	]-are stationed at Baj Baj
	42	〃	Mallika	'77	21.9	4.8	2.2	190ps					0	alternately
	43	〃	Srobana	'78	20.8	5.0	2.6	372ps					0	]-Towage work for small
	44	〃	Sarmistha	'79	20.8	5.0	2.6	372ps					0	ships
	45	〃	Sutapa	'79	20.8	5.0	2.6	372ps					0	
	46	〃	Shilabati	'79	23.3	5.2	2.5	174ps					0	Transport personnel
	47	Lighting Launch	Jyoti	'58	26.9	5.0	2.6	380ps						→ Multi.
	48	〃	Dasarath	'68	30.4	6.9	3.7	358psX2						
	49	Water Barge	Jaladhi	'63	39.4	9.4	2.8	200t water	X		0		0	
	50	〃	Baridhi	'63	38.4	9.4	2.8		X		0		0	
	51	Anchor Vessel	Deepak	'65	20.7	7.0	3.5		X					
	52	〃	Arjum	'81	37.1	8.8	4.4		X		0		0	Average 86days Navi.per year
	53	Light Vessel	Deepak	'65	20.7	7.0	3.5		X					
	54	〃	Pradip	'73	27.4	7.3	4.4		X					}-No crew
	55	〃	Planet	'17	20.1	5.8	2.7		X	X				
	56	〃	Torch	'51	40.8	7.9	4.6		X	X				
	57	〃	Flame	'55	40.8	7.9	4.6		X	X				}-with crews
	58	〃	Candle	'57	40.8	7.9	4.6		X					
	59	Research Vessel	Anusandhani	'62	43.9	9.9	4.6	1,500ps	X					→ Multi.
	60	Barge (Hopper)	No.3	'84	67.1	12.2	4.9	840psX2	X	X				O/O/C since '87
	61	〃	No.4	'64	55.1	10.9	3.8	692 m^3 1,000ps	X	X				
	62	〃	No.5	'68	55.1	10.9	3.8	710 m^3 1,000ps	X	X				Private Co.
	63	〃	No.7	'67	67.1	11.9	4.9	791 m^3 1,780ps	X	X				
	64	House Boat	Blue-Wing	'52	24.7	5.3	1.5		X	X				
C	65	Multi-purpose ship									0	0	0	
C	66	〃									0	0	0	
H	67	〃									0	0	0	
C	68	Floating Crane	Atlas	'23	54.4	17.3	3.8	60t, 842ps,10 kt	X	X	0	0	0	60t
C	69	〃	Mahabahu	'63	24.7	17.4	4.3	60t, 1100ps, 9.5kt	X	X	0		0	150t
	70	〃	Virbau	'63	46.0	14.9	3.8	30t, 777ps,10 kt	X	X				
H	71	〃	New ship								0	0	0	60t
C	72	General S.B.	New ship								0		0	
H	73	〃	New ship								0		0	
H	74	Dredger	Grab No.3	'87	66.9	11.8	4.9		X	X	0	0	0	750 m^3
H	75	Tug boat	Ahalya 39.5	'72	39.5	9.7	4.9	B.P 24t 780psX2	X		0		0	#
H	76	〃	Draupadi	'74	39.8	9.7	4.9	B.P 24t 780psX2	X		0		0	#
H	77	〃	Kunti	'75	39.5	9.7	4.9	B.P 24t 780psX2					0	
H	78	〃	Tara	'76	39.5	9.7	4.9	B.P 24t 780psX2					0	
H	79	〃	Mandodari	'77	39.5	9.7	4.9	B.P 24t 780psX2					0	
H	80	〃	New ship								0	0	0	*
H	81	〃	〃								0	0	0	*
H	82	〃	〃								0	0	0	* * : 2,500ps # : 750ps x 2
H	83	Mooring boat	Sntapa	'83	20.8	5.2	2.4		X					
H	84	〃	Jwan						X		0		0	
H	85	〃	No.1						X					
H	86	〃	No.2						X		0		0	

Table 11-3-2 Vessel Availability

Name	No. of			Days in Commission (1)				Days Down River (2)				Days out of Commission (3)				Due to Breakdown and other reasons (4)				Undergoing Survey/Overhaul (5)				Annual output of the Vessel				Ratio		Remarks
	Officers	Crew	Total	85/86	88/87	87/88	Average	85/86	86/87	87/88	Average	85/86	86/87	87/88	Average	85/86	86/87	87/88	Average	85/86	86/87	87/88	Average	85/86	86/87	87/88	Average	(2) 365	(3) 385	
MAHAGANGA	20	71	91	146	278	28	150	128	230	23	127	219	87	340	215	81	87	5	58	138	–	335	158	3,040	2,656	230	1,975	34.8	59.0	
MOHANA	19	95	114	138	130	72	113	115	109	63	96	229	235	50	171	23	94	50	56	206	141	–	116	2,777	2,099	871	1,915	28.2	46.9	
CHURNI	16	95	111	147	96	93	112	128	81	78	95	218	269	273	253	218	58	–	93	–	211	273	161	430	269	229	309	28.0	69.3	
SUBARNAREKHA	16	46	62	176	284	148	203 (145)	145	238	124	169 (122)	189	81	218	163 (201)	24	37	35	32 (60)	165	44	183	131 (142)	420	673	466 (000m³)	520 (4,669)	46.3 (33.3)	44.8 (55.0)	
No. 1 (Grab)	2	42	44	243	153	–	132	79	20	–	33	122	212	366	233	122	33	–	52	–	179	366	182	421	206	–	209	9.0	83.9	
No. 2 (Grab)	2	42	44	229	263	311	268	54	66	90	70	136	102	54	93	40	102	54	65	96	–	–	32	355	488	540	461	19.2	25.5	
AJOY (Bucket)	3	52	55	139	59	329	176 (192)	–	–	–	–	226	306	37	190 (172)	8	4	37	16 (44)	218	306	37	187 (134)	213	102	409 (000m³)	241 911	–	52.1 (47.2)	
TRIBENI	5	32	37	230	109	185	175	127	55	112	98	135	256	181	191	26	15	112	51	109	241	59	140	4,749	2,365	3,371	3,495	26.8	52.3	
HALDIA	4	25	29	198	213	108	173 (174)	87	93	45	75 (87)	167	152	258	192 (192)	49	26	32	36 (44)	118	126	226	157 (149)	1,141	2,393	1,044 (km)	1,526	20.5	52.6 (52.4)	
NADIA	5	59	64	325	87	260	224	–	–	–	–	40	278	106	141	23	–	17	13	17	278	89	128						38.6	
SEVA	6	62	68	9	292	72	124 (174)	–	–	–	–	356	73	294	241 (191)	52	32	19	34 (24)	304	41	275	207 (168)						66.0 (52.3)	
SHAKTIMAN (R)		21		319	205	206	243	–	–	–	–	46	160	160	122	36	27	46	36	10	133	114	88	694	478	510	561		33.4	
STAWART (R)		23		187	192	76	152 (198)	–	–	–	–	178	173	290	214 (168)	36	41	42	40 (38)	142	132	248	174 (130)	163	262	118	181		58.6 (46.0)	
CHAMPA (D)		16		226	177	156	186					139	188	210	179	44	58	55	52	85	130	155	123	721	667	541	643		49.0	
CHAMELI (D)		14		145	136	50	110					220	229	316	255	154	73	197	141	66	156	119	114	577	300	118	332		69.9	
MALATI (D)		14		215	75	73	121					150	290	293	244	125	55	58	79	25	235	235	165	677	179	221	359		66.9	
GOLAP (D)		14		184	116	240	180					181	248	126	185	71	22	66	53	110	227	60	132	668	499	891	688		50.8	
TAGAR		14		123	348	209	227					242	17	157	139	24	17	17	19	218	–	140	119	373	1,215	797	795		38.0	
HENA		14		120	210	283	234					155	155	83	131	72	20	17	36	83	135	66	95	1,129	667	1,082	959		35.9	
BAKUL		14		199	138	337	225					166	227	29	141	168	8	26	67	0	219	3	74	782	871	1,211	955		38.6	
JUIN		14		61	204	60	108					45	161	306	171	45	31	151	76	0	130	155	95	221	660	192	358		46.8	
M.O.T. TUG-1		14		122	245	123	163 (173)					243	120	243	202 (183)	243	120	243	202 (81)	0	0	0	0 (102)	98	697	426	407		55.3 (50.1)	
DRAUPADI	2	34	38	167	313	305	262					198	52	60	103	5	12	17	11	178	5	3	62	421	798	726	648		28.2	
KUNTI	2	39	41	337	138	238	238					28	227	128	128	8	1	0	3	7	114	104	75	866	354	535	585		35.1	
TARA	2	33	35	113	193	319	208 (236)					253	171	46	157 (129)	8	–	–	2 (5)	247	147	10	135 (91)	223	449	771	481		43.0 (35.4)	
JYOTI	1	13	14	267	110	153	177					98	255	212	188	61	50	129	80	37	205	83	108						51.5	
DASARATH	1	14	15																											Laid up since 3 '84
							(%) 49.4												(%) 14.8				(%) 33.3						(%) 48.9	

11-3-2 Planning of Craft/Vessels

(1) Planning premises

The major planning premises adopted here for the planning of floating craft/vessels for Calcutta/Haldia up to 2005 AD are as follows.

1) The existing craft/vessels which are not superannuated will be retained.

2) Some of the works which are presently carried out by C.P.T. will be given to contractors in the target year.

3) The repair period of the craft/vessels will be shortened, mostly by stocking sufficient spare parts and materials..

4) The breakdown time will be reduced by improving the periodic maintenance and repair system

5) Multi-purpose vessels will be introduced.

6) Port vessels will be berthed near their work sites.

7) The system for managing the port vessels will be reviewed and revised as necessary to realize efficient, economical operations.

8) Average service life in years 30 years

(2) Master plan

The master plan is shown in Table 11-3-1. The number of working vessels will eventually be reduced from 76 to 51. Out of the exiting 76 ships, 16 ships will remain unchanged and 60 ships will be scrapped. 37 ships will be newly build. The details for each kind of ship are as follows.

1) Hopper dredgers

CPT has five hopper dredgers, and three of them are presently being used. Their total dredging capacity is about 7.77 million cu.m/year.

On the other hand, the required dredging volume will be 23 Million cu.m/year in the future. Thus it will be impossible to execute all the dredging using only C.P.T. dredgers. The balance will be dredged by Contractors. The proposed dredging fleet consist of three hopper dredgers:

5,000 m^3 class, 3,000 m^3 class, and 1,700 m^3 class

The main dimensions and construction schedule are shown in Table 11-3-3.

Table 11-3-3 Existing Hopper Dredgers

Name	Hopper Capacity	Main dimensions Lbp	B	D	d	Speed	Year Built	Dredging Capacity	Remarks
	(m^3)	(m)	(m)	(m)	(m)	(kt)		(m^3/Y)	
MAHAGANGA	4,740	131.0	20.0	9.5	6.30	12.0	1978	5.87 M	
MOHANA	2,906	117.5	18.9	6.2	5.94	12.0	1965	-	Condemned since 1.8.'87
CHURNI	1,700	108.9	18.9	7.3	5.33	11.0	1961	1.06 M	
BHAGIRATHI	1,700	108.9	18.9	7.3	5.18	12.5	1957	?	
SUBARNAREKHA	1,274	89.9	15.2	5.8	4.45	11.0	1996	9.70	
M.O.T. OR - V									

Future Hopper Dredgers

Name	Hopper Capacity	Lbp	B	D	d	Speed	Year Built	Dredging Capacity	Remarks
MAHAGANGA	4,710	131.0	20.0	9.5	6.30	12.0	1978	5.87 M	
NEW	3,000	110.0	18.0	7.5	5.80	12.0	M/P	(4.5 M)	
NEW	1,700	84.0	16.0	7.2	5.60	12.0	S/T	(2.5 M)	

2) Other Dredgers

There are presently two grab dredgers and one bucket dredger. They are used mainly for maintenance dredging at the inner dock and near the dock gates. The proposed plan is as follows.

a These dredgers will be used until the end of their service lives.

b They will be disposed of at the end of their service lives.

c Two self-propelles grab dredgers with hoppers will be built.

3) Tug/Despatch

CPT has two (2) tug/despatch ships at present. However one of them is kept as a spare so both of them are not required to work at the same time. Most of their works will be done by multi-purpose ships in the future and the existing vessels will be disposed of.

4) Tug boats at Calcutta Dock System

There are two kinds of tug boats (river and Dock) at Calcutta at present.

There are no major differences between the river tugs and the dock tugs except for the number of their crew. They will be used as a pool in the proposed plan. The total required number of tug boats will be reduced from 11 to 9 by increasing the number of working days. Nine (9) tug boats will be disposed of and seven (7) tug boats which consists of 1,500 ps (4) and 2,500 ps (3) will be built.

5) Tug boats at Haldia Dock System

There are five (5) boats at Haldia port at present. Two (2) tug boats will be disposed of and five (5) tug boats which consists of 1,500 ps (2) and 2,500 (3) will be built. Eight (8) tug boats other than procured by OECF loan will work at Haldia in the target year.

360 degree steerable nozzle propeller (4 blade fixed pitch) unit is suitable for get high bollard pull and good maneuverability.

6) River survey vessels

CPT owns two (2) river survey vessels at present. Their works will be carried out by multi-purpose ships in the future and the existing ships will be disposed of.

7) Pilot launches

CPT has thirteen launches at present. Seven (7) launches will be disposed of and four(4) launches will be built.

8) Survey launches

CPT has eight (8) launches, at present. They are located at different districts. Six (6) launches will be disposed of and four (4) launches will be built.

9) Light vessels and lighting launches

There are three vessels with crew and three vessels without crew. All of them will be disposed of in target year because they are very old. However it is not yet decided whether they will be replaced or not. It is possible that fixed towers or platforms may be used instead of the existing light vessels and lighting launches. The required number of lighting launches will be decided based upon a comprehensive review of the costs of various alternative plans.

10) Research vessel

CPT has one research vessel at present. Research works will be carried out by multi-purpose ships in the future and the present research vessel will be disposed of.

11) Water barges

CPT has two (2) water barges at present. They will be disposed of and two (2) new barges will be built.

12) Anchor vessels

CPT has two (2) anchor vessels at present. They will be disposed of and one (1) new vessel will be built.

13) House boat

CPT has one house boat at present. She will be disposed of and most of her work will be excuted by survey launches.

14) Barges

There are four (4) barges used to carry the spoil dredged by the bucket dredger. They will be disposed of when the bucket dredger is scrapped.

15) Multi-purpose ships

Three (3) new multi-purpose ships will be introduced. Their work will include:

a Most of the river survey vessels' work
b Some of the tug/despatch vessels' work
c Some of the lighting launches' work
d Most of the research vessels' work

16) General service boats

Port sales are an important component of modern port management. It is recommended to have a high speed boat for port sales at both dock systems. These boats will also be used for supervision of port construction, reconstruction and maintenance works.

17) Floating Cranes at Calcutta Dock System

CPT has three (3) floating cranes at present. One of them is very old (built 1923) and the other two are old (built 1963). They are used mainly for handling heavy cargo and repairing port facilities/equipment. Ore (1) non-propulsion fix type floating crane and one (1) self-propulsion swing type floating crane 60t and 150t respectively, will be procured as replacements. All the existing floating cranes are self-propulsion type because the floating cranes are required to work at Haldia also. But as described below, one new floating crane will be provided at Haldia.

18) Floating Crane at Haldia Dock System

For handling heavy cargo and maintenance of Locks, shiploaders, etc., an exclusives floating crane at Haldia is also necessary. One (1) non-propulsion fix type floating crane with a lifting capacity of 60t will be procured.

19) Mooring boat

There are four (4) mooring boats to handle the line of ships. All of them will be disposed of and two (2) new boats will be built.

(3) Improvement plan

1) To increase the available hours on each ship

a To reduce breakdown time

Breakdown time is very large at the port (See Table 11-3-2.) Vessels must be repaired and inspected or examined periodically. If they are maintained properly, they will work properly throughout the year. Even with proper inspection and maintenance, there will still be some break downs, but it is necessary to minimize the number of days vessels are not available due to breakdowns.

b To decrease the repair period

According to the collected data, the repair time is too long. Efforts must be made to decrease the repair time and vessels must be repaired at proper ship yards in a timely manner. Periodic repairs and maintenance should include:

* Yearly repair

  Yearly repairs done at a ship yard or maintenance yard. The required time depends on the work required. However, the repairs generally take about 4 weeks for smaller vessels and 10 weeks for larger vessels.

* Monthly maintenance

  Monthly maintenance should be carried out by the crew at berth or at an offshore mooring. The required time is one day

* Daily maintenance

  Daily maintenance should be carried out by the crew at berth or at an offshore mooring and before and after work and during waiting time.

  Plans to speed up repairs include the following.

  o To make out a yearly repair plan for all ships.

  o To keep in stock all spare parts which are required frequently every year and/or used for many ships.

  o To procure in advance all required parts and/or components which are not available locally

  o To conduct regular inspections of all vessels

  Annual repairs and maintenance should be scheduled to take advantage of times when the vessels are not too busy.

c To ensure sufficient crew

The number of crew at the port is probably sufficient. Judging from the present number of crew, the ships have enough crew to maintain safety and to perform regular works even if some crew are on leave. In order to avoid non operation due to a crew shortage, each ship has to have extra workers and officers. On the other hand, the present crews are large compared with those in other countries. When new ships are planned and designed, they should be modernized to reduce the number of crew.

d To decrease the incidental time waste

One way to increase efficiency is to berth all vessels near their regular working areas. Especially the ships (such as despatch vessels, river survey vessels, dredgers, etc.) which are working at Haldia and/or downstream should berth at Haldia dock to minimize time loss and to reduce expenses.

2) Organization

There are many organizations including the Harbour Master (R), Harbour Master (D), Dredging & Despatch service, Chief Hydraulic Engineering Dept, River Survey Sec, Marine Engineering Sec, and Chief Mechanical Engineering which control and manage port vessels at present. The existing organizations have various demerits as follows.

a The decentralized control makes it difficult to introduce multi-purpose ships and/or combined ships.

b They limit the flexibility in ship distribution and operation.
The organizational structure will be reviewed to maintain economical ship operation. Yearly distribution plans and yearly repair plans should be worked out by the concerned organizations. The plans should be approved by relation sections. Long-range plans for the procurement and scrapping of vessels must be made out by C.P.T.

3) Others

CPT's craft/vessels fleet has a long history and there are many officers and crews of these craft/vessels. The timing of the disposal of craft/vessels should be worked out considering the following points, and should be executed step by step.

a Rearrangement of officers and crew.

b The age of the vessels which are scrapped.

c The timing of the construction of new ships.

Table 11-3-4 Procurement List of Port Service Vessels (Master Plan)

Port	Type of Vessel	Main Dimensions			Performance	Remarks
		L	B	D		
H	Hopper Dredger	110.0	18.0	7.5	3,000 m³	
H	〃	84.0	16.0	7.2	1,700 m³	
C	Grab Dredger	60.0	12.0	5.0	750 m³	with hopper
H	〃	〃	〃	〃	〃	〃
C	Tug-Boat	39.5	9.7	4.9	1,250ps × 2	
C	〃	〃	〃	〃	〃	
C	〃	〃	〃	〃	〃	
C	〃	〃	〃	〃	750ps × 2	
C	〃	〃	〃	〃	〃	
C	〃	〃	〃	〃	〃	
C	〃	〃	〃	〃	〃	
H	Tug-Boat	〃	〃	〃	1,250ps × 2	
H	〃	〃	〃	〃	〃	
H	〃	〃	〃	〃	〃	
H	〃	〃	〃	〃	750ps × 2	
H	〃	〃	〃	〃	〃	
C	River Survey Launch	20.4	4.6	2.2		
C	〃	〃	〃	〃		
C	〃	〃	〃	〃		
C	〃	〃	〃	〃		
C	Pilot/Harb./Dock Launch	20.8	5.0	0.6		
C	〃	〃	〃	〃		
C	〃	〃	〃	〃		
C	〃	〃	〃	〃		
C	Anchor Vessel	36.0	8.8	4.4		
C	Floating Crane	45.0	24.0	3.5	60t	Self-propulsion
C	〃	45.0	22.0	4.0	150t	Non-propulsion
H	〃	40.0	18.0	3.5	60	〃
C	Multi-Purpose	45.0	12.0	5.5	1,000ps × 2	
C	〃	〃	〃	〃	〃	
H	〃	〃	〃	〃	〃	
C	General Service	16.0	4.4	2.0	380ps × 2	
H	〃	〃	〃	〃	〃	
C	Water Barge	39.4	9.4	2.8	200t water	
H	〃	〃	〃	〃	〃	
H	Mooring Boat	20.8	5.2	2.4		
H	〃	〃	〃	〃		

Chapter 12 Formulation of Short-term Development Plan

12-1 Calcutta Dock System (Including Budge Budge District)

12-1-1 Planning Premises

(1) Project Cargo Volume

The project commoditywise cargo volume in 1994/95 is as follows.

① Liquid Bulk Cargo

	in 1994/95	
Import POL (Products)	900	x 1,000 Tons
Export POL (Products)	90	
Total POL (Products)	990	
Import Edible Oil	190	
Other Liquid Cargo	30	
Grand Total	1,210	

② Dry Bulk Cargo

Import Food Grains	200	
Export Fertilizer	20	
Import Raw Materials for Fertilizer	380	
Import Salt	10	
Grand Total	610	

③ Container Cargo

Grand Total	1,110	
Import Containers	87	x 1,000 TEUs
Export Containers	23	
Total Containers	110	

④ Other General Cargo

Import Other General Cargo	1,780	x 1,000 Tons
Export Other General Cargo	430	
Grand Total	2,210	

(2) Projected Vessel Size

The current vessel size and dimension of respective cargo types is as follows.

	Length over all	Bredth	Maximum Draft
① Liquid Bulk Cargo			
6,717 GRT ≑ 10,258 DWT	136.9 m	17.9 m	7.9 m
② Dry Bulk Cargo			
6,917 GRT ≑ 10,288 DWT	136.9	17.7	7.9
③ Container Cargo			
3,786 GRT ≑ 5,560 DWT	110.9	17.7	6.3
④ Other General Cargo			
5,961 GRT ≑ 9,361 DWT	133.8	18.2	7.8

The maximum size of vessels which will be accessible to in full load in 1994/95 is as follows.

	Length over all	Bredth	Maximum Draft
① Liquid Bulk Carriers			
8,077 DWT	127 m	16.3 m	7.4 m
② Dry Bulk Carriers			
7,686 DWT	126	16.0	7.4
③ Container Vessels			
9,130 DWT	134	20.5	7.4
④ General Cargo Vessels			
7,743 DWT	126	17.3	7.4

The average vessel size calling the Calcutta Dock System is greater than the maximum size of vessels which will be accessible to in full load in 1994/95 except container vessels. So the vessels except container vessels will not be able to be in full load even if the draft is improved up to 7.4 m. Therefore, the average vessel size except container vessels will not change so much. On the other hand, the average vessel size of container vessels at present is less than the maximum vessel size of vessels which will be accessible to in full load in 1994/95. And the maximum draft of present calling container vessels is less than the accessible draft in 1986/87 by 0.5 m. So the average container vessels seemed to be in full load, and the average vessel size in 1994/95 will increase to some extent by improving the accessible draft. If we assume the draft of the average container vessel is less than 0.5 m from the accessible draft in 1994/95, then the average container vessel size and its dimension may be estimated as follows.

Average Container Vessel Size Dimension in 1994/95

	Length over all	Bredth	Maximum Draft
7,400 DWT	123.7 m	19.2 m	6.9 m

(3) Projected Parcel Size

The projected parcel size for respective cargo types is as follows.

	Project Parcel Size
① Liquid Bulk Cargo	6,405 tons/ship
② Dry Bulk Cargo	8,024 tons/ship
③ Container Cargo	3,885 tons/ship
	385 TEUs/ship
④ General Cargo	4,785 tons/ship

12-1-2 Alternative Formulation

From the calculation results in Appendix 11-1-11, the relationship between the number of berths and the lost cost in 1994/95 would be as follows.

① In 1994/95

ⓐ Dry bulk cargo

(i) Using the Indian average productivity per total time at berth (1,150 tons/day)

No. of berths	6	5	4	3	2
Lost cost (MY)	1	5	30	168	1,246

ⓑ Container cargo

(i) Using the productivity of 10 TEUs/hour

No. of berths	4	3	2
Lost cost (MY)	23	124	1,015

(ii) Using the productivity of 15 TEUs/hour

No. of berths	4	3	2
Lost cost (MY)	3	24	173

ⓒ General cargo

(i) Using the Indian average productivity (492 tons/day)

No. of berths	23	22	21	20	19	18	17	16	15
Lost cost (MY)	7	15	31	64	129	259	515	1,039	2,188

The following table shows the combination of respective cargo berths and the total lost cost.

① Container : 4 berths

Productivity	15 TEUs/hour	10 TEUs/hour
Lost cost (MY)	3	23

Dry bulk berth		General cargo berth		Both	Total lost cost	
No. of berths	Lost cost (MY)	No. of berths	Lost cost (MY)	Lost cost (MY)	(15TEUs)	(10TEUs)
6	1	16	1,039	1,040	1,403	1,063
5	8	17	515	523	526	546
4	42	18	259	301	304	324
3	225	19	129	354	357	377
2	1,767	20	64	1,831	1,834	1,854

② Container : 3 berths

Productivity	15 TEUs/hour	10 TEUs/hour
Lost cost (MY)	24	124

Dry bulk berth		General cargo berth		Both	Total lost cost	
No. of berths	Lost cost (MY)	No. of berths	Lost cost (MY)	Lost cost (MY)	(15TEUs)	(10TEUs)
6	1	17	515	516	540	640
5	8	18	259	267	291	391
4	42	19	129	171	195	295
3	225	20	64	289	213	413
2	1,767	21	31	1,798	1,822	1,922

③ Container : 2 berths

	15 TEUs/hour	10 TEUs/hour
Productivity	15 TEUs/hour	10 TEUs/hour
Lost cost (MY)	173	1,015

Dry bulk berth		General cargo berth		Both	Total lost cost	
No. of berths	Lost cost (MY)	No. of berths	Lost cost (MY)	Lost cost (MY)	(15TEUs)	(10TEUs)
6	1	18	259	260	433	1,275
5	8	19	129	137	310	1,152
4	42	20	64	106	279	1,121
3	225	21	31	256	429	1,271
2	1,767	22	15	1,782	1,955	2,797

The althernatives of berth combination are as follows.

In 1994/95 (Conservative Plan)

	Container Berth			Dry Bulk Berth			General Cargo Berth			Lost Cost due to vessel waiting
Cargo Volume	x 1,000 tons 1,110			x 1,000 tons 610			x 1,000 tons 2,210			
No. of Vessel	(110 x 1,000 TEUs) 286			vessels 76			vessels 462			
λ	0.784			0.208			1.266			
	No. of B	Prod. TEUs/hour	$\overline{Wg}$ day	No. of B	Prod. tons/hour	$\overline{Wg}$ day	No. of B	Prod. tons/day	$\overline{Wg}$ day	
Alternative 1	4	15	0.02	4	1,150	0.6	18	492	0.6	304 △
2	4	10	0.13	4	"	"	18	"	"	324
3	4	15	0.02	3	"	3.2	19	"	0.3	357 } Long Waiting Time for Dry Bulk Carriers
4	4	10	0.13	3	"	"	19	"	"	377 }
5	3	15	0.1	4	"	0.6	19	"	"	195 ◎
6	3	10	0.7	4	"	"	19	"	"	295 ◎
7	2	15	0.9	4	"	"	20	"	0.14	279 △

The average waiting time of dry bulk carriers of alternatives 3 and 4 seems to be too long.

If it is possible to improve the productivity of container cargo up to 15 TEUs/hour, the best allotment is alternative 5. If it is not possible to improve the productivity of container cargo up to 15 TEUs/hour but it is possible up to 10 TEUs/hour, the best allotment is alternative 6. Therefore, the number of respective type berths is as follows.

Container berth	3 berth	
Dry bulk cargo berth	4 berth	
General cargo berth	19 berth	
Liquid cargo berth	1 berth	(Excluding 5 berth at BB)
Total	27 berth	

The berth allottment is summarized as follows.

① Container Berth

			Productivity
In 1994/95	110 x 10^3 TEUs	3B	10 TEUs/hour or
	286 vessels		15

② Dry Bulk Cargo Berth

In 1994/95	610 x 10^3 TEUs	4B	1,150 tons/day
	76 vessels		Present Indian Average (per total time at berth)

③ General Cargo Berth

In 1994/95	2,210 x 10^3 TEUs	19B	492 tons/day
	462 vessels		Present Indian Average

④ Liquid Cargo Berth

In 1994/95	119 x 10^3 TEUs	1B	1,924.5 tons/day
	19 vessels		(per total time at berth)

The berths shall be allotted taking into consideration the present berth utilization as follows.

At present, the liquid bulk cargo is handled at No. C berth of NSD. As the necessary number of berths is one, No. C berth of NSD will continue to be used for liquid bulk in 1994/95.

No. A berth of NSD is now frequently used for dry bulk cargo, so No. A berth of NSD will be used for dry bulk cargo in 1994/95. And No. 23 of KPD2 is now alloteed to food grains so it will be used for dry bulk cargo in the future. Other nessesary berths, 2 berths in 1994-95, should be allocated to B of NSD and 6 KPD1 in accordance with the principal of berth allotment in Master Plan.

For container cargoes, No. D berth should be used. The other 2 necessary berths should be located in NSD or KPD2 by considering the availability of land use.

IWT container transport demand is estimated as follows:

(Unit: TEUs)

Year	Alternative	Estimate	Dutch Estimate
1994/95	-	20,200	24,200

According to the Dutch Report on IWT, the handling capacity of one IWT berth (75m long) is as follows.

31,800 TEUs (1 container quay crane)
76,300 TEUs (2 container quay crane)

Therefore, the demand in 1994/95 seems to be less than the cargo volume which need to construct a independent IWT terminal in 1994/95.

In 1994/95, we formulate the following Short-term Development Plans.

ⓐ Alternative 1 (Fig. 12-1-1)

①	Liquid Bulk Cargo	1B	1,925 tons/days	at C of NSD
②	Dry Bulk Cargo	4B	1,150 tons/day	at A, B of NSD and 6 of KPD1 and 23 of KPD2
③	International Container Cargo	3B	10 - 15 TEUs/hour	at D, 28 and 29 of KPD
④	Inland Water Way Container Cargo	1B		at D of NSD
⑤	General Cargo	19B	600 tons/day	at other berths

ⓑ Alternative 2 (Fig. 12-1-2)

①	Liquid Bulk Cargo	1B	1,925 tons/days	at C of NSD

②	Dry Bulk Cargo	4B	1,150 tons/day	at A, B of NSD and 6 of KPD1 and 23 of KPD2
③	International Container Cargo	3B	10 - 15 TEUs/hour	at D, 5 and 4 of NSD
④	Inland Water Way Container Cargo	1B		at D of NSD
⑤	General Cargo	19B	600 tons/day	at other berths

As for the alternative Short-term Development Plans, alternative 2 is recommendable.

Fig. 12-1-1 Alternative 1 of Berth Allocation in 1995

Fig. 12-1-2 Alternative 2 of Berth Allocation in 1995

12-1-3 Required Scale of Cargo Handling Equipment

Refer to 11-5-1.

12-1-4 Required Scale of Storage Facilities

The classification of commodity wise cargoes by storage facilities is as follows.

(Unit: 1,000 tons)

	Sheds Use	Yards Use	Container
Import	729.2	1,050.8	580.0
Export	160.2	128.8	530.0
Total	889.4	1,179.6	1,110.0

The above cargoes are allocated to the respective districts as follows.

(Unit: tons)

District		Sheds Use	Yards Use	Container
NSD	Import	115,105	165,916	580,000
	Export	25,295	20,337	530,000
	Total	140,432	186,253	1,100,000
West side of KPD1	Import	153,516	221,221	
	Export	33,726	27,116	
	Total	187,242	248,337	
East side of KPD1	Import	191,895	276,526	
	Export	42,157	33,895	
	Total	234,052	310,421	
KPD2	Import	268,653	387,137	
	Export	59,021	47,452	
	Total	327,674	434,589	

The required area to handle the above volume of cargoes is as follows.

(Unit: m^2)

District	Shed	Yard	Total	Container Yard
NSD	8,933	10,470	19,403	1859 slots
KPD1	26,799	31,409	58,208	
	(152)	(1,982)		
West side	11,914	13,959	25,873	
East side	14,893	17,450	32,343	
KPD2	20,849	26,955	47,804	
Total	56,589	73,486	130,075	

Note:( ) shows the required area for fertilizer and raw materials for fertilizer

At the respective districts, the following measures shall be recommended to implement.

(1) KPD2 District

① To convert the Pie shed to the open storage yard.

(2) KPD1 East side District

① To demolish the existing railway and rearrange the existing road arrangement.

(3) KPD1 West side District

① To demolish the sheds 4 and B and convert them to the open storage yard.

(4) NSD

① To expand the dock area at the back of berth 4 and 5.

② To construct the new CFS at the back of berth 4 and 5.

By taking the above measures, the respective storage area will be as follows.

(Unit: m^2)

District	Shed	Yard	Total	Container	CFS
NSD	11,838	17,200	29,038	1923 slots	18,080m^2+5,919m^2
KPD1	39,646	40,750	80,396		
West side	16,723	23,300	40,023		
East side	22,923	17,450	40,373		
KPD2	33,223.5	26,080+875	60,178.5		
Total	84,707.5	84,905	169,612		

12-1-5 Port Traffic Facilities

(1) Railway System in Calcutta Port

At present, GCD subsidiary yard has 21 tracks. It seems necessary to reduce the size of this yard because of the decline of the cargo volume handled at the quay side lines. The required number of tracks at present may be 10 - 12 tracks.

As the cargo volume to and from quay side lines is forecast to remain stable through 1995, 10 - 12 tracks at GCD yard shall remain through 1995.

It is also necessary to remove tracks at EJC yard, which presently has 50 tracks. Of those, 7 fully electrified arrival tracks, 7 top electrified departure tracks, 3 sorting tracks, and 2 tracks for loco movement shall remain through 1995.

1) Block Rake Loading Terminal

The required number of reception tracks and loading tracks depends on the loading operational efficiency. The relation between $\frac{1}{\mu}$ and Lq, Wq are as shown in Table 12-1-1 for the short-term plan in 1995.

A = 200,000 tonnes

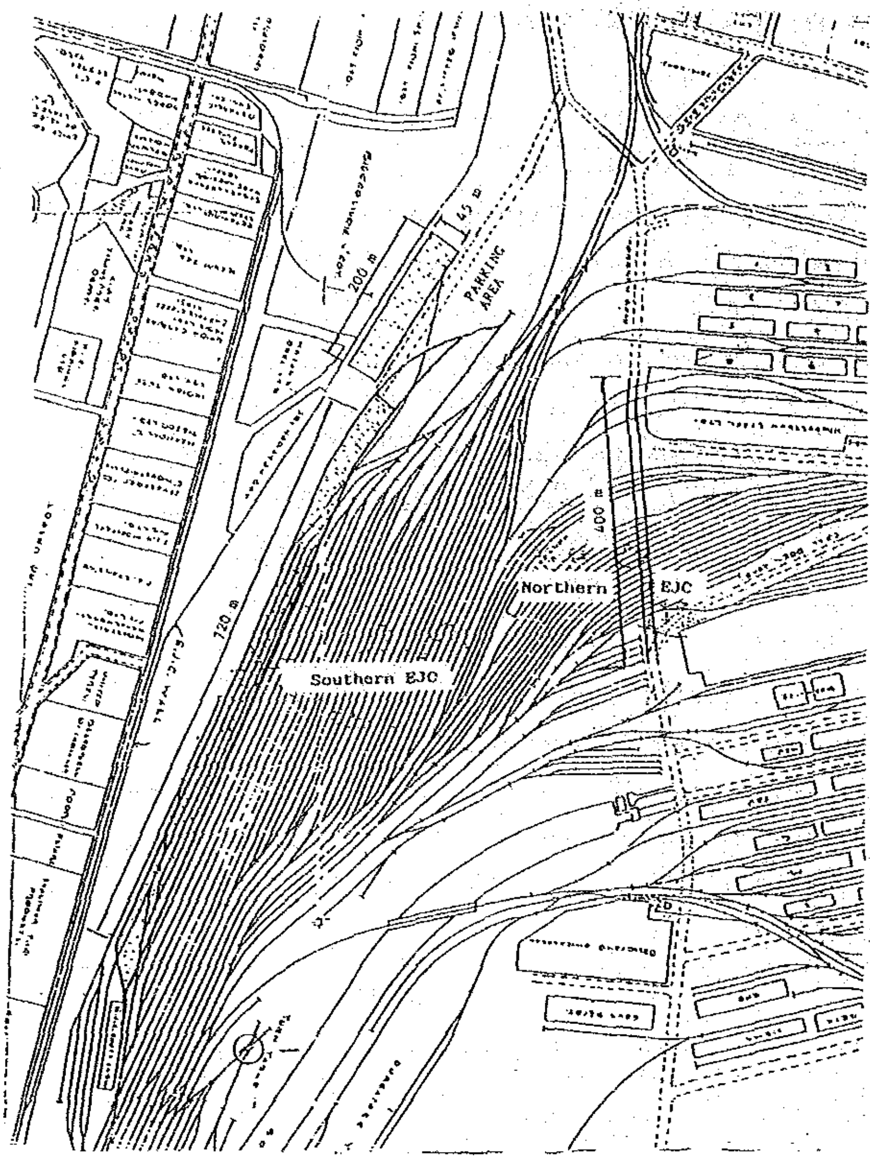
$\lambda = 0.2857$

Table 12-1-1

$^1/_\mu$ (hrs)	No. of loading/unloading tracks	ρ	Lq	Wq	Required No. of reception tracks
24	1	0.2857	0.114	0.400	1
36	1	0.4286	0.322	1.125	1
48	2	0.2857	0.051	0.178	1

As shown in Table 12-1-1, two loading/unloading tracks will be necessary through 1995 at over 90% reliability. In addition, one reception track will be used for the block rakes.

Fig. 12-1-3 show the conceptual plan of the block rake loading terminal to be located at EJC yard in 1995.



SHORT TERM PLAN (1995)

Fig. 12-1-3 Block Rake Loading Terminal

2) Container Terminal

a) NSD Container Terminal

The required number of reception tracks, departure tracks and loading/unloading tracks in 1995 are calculated on the condition that all railborne containers will be handled at the NSD container terminal, and area presented in Table 12-1-2.

Table 12-1-2

	Handling Volume A (TEUs)	λ	μ	Required Number of Tracks		
				Reception	Loading/ unloading	Departure
1995	22,000	0.4714	8 (Reception)	1	-	-
			1.33 (loading/ unloading)	1	1	-
			2.67 (Departure)	-	-	1

3) Required number of locomotives

In 1995, at least 8 locomotives will be necessary. The details are as follows.

1 for block rake loading terminal

2 for EJC

2 for container (NSD), GCD

1 for CESC (Coal)

2 for sidings

It is recommended to replace four old locomotives with two locomotives of 5,000 ton capacity and two of smaller capacity for 9th plan.

4) General improvement plan of Calcutta railway system

Fig. 12-1-4 shows the general plan of Calcutta railway system in 1995. Through 1995, most quayside tracks shall be eliminated. On the other hand, the container terminal at NSD and the block rake terminal at EJC shall be developed and the quay side tracks at KPD-2 and NSD A, B would remain.

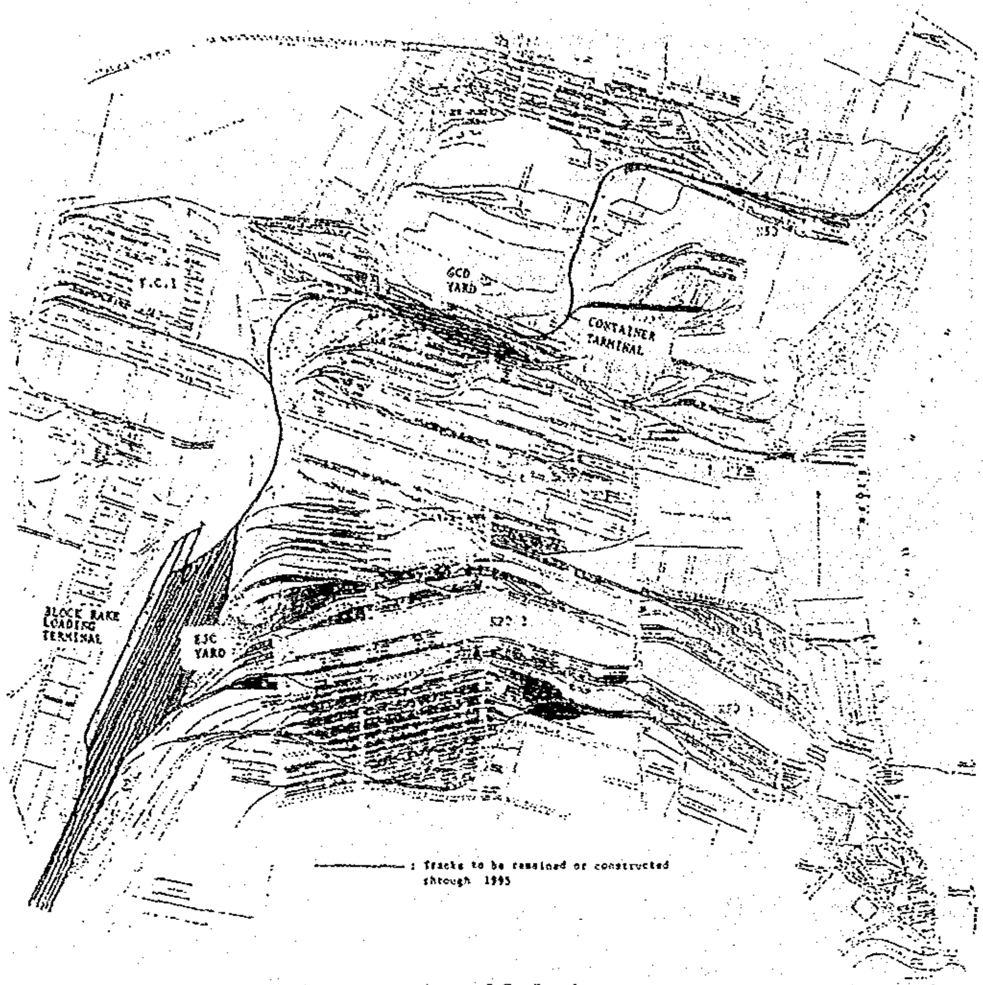


Fig. 12-1-4

(2) Road System in Calcutta

1) Traffic volume

The traffic volumes (loaded) generated from each dock in 1995 are calculated from the cargo volume and presented in Table 12-1-3.

Table 12-1-3 Estimated Number of Trucks Per Day (in 1995)

Dock	Commodity	Cargo Volume by truck (,000 tonnes, TEU)		Loaded Traffic Volume (No. of trucks)	
		Import	Export	Import	Export
KPD-1 (East)	General Cargo	428	72	127	21
KPD-1 (West)	Dry Bulk General Cargo	257 257	- 43	76 76	- 13
KPD-2	Dry Bulk General Cargo	129 599	- 101	38 178	- 30
KSD	Dry Bulk General Cargo Container	129 634 12,510	- 213 12,510	38 189 33	- 63 33
GRJ	Container General Cargo	3,055 32	3,055 30	8 10	8 9

Note: (1) Yearly working days = 350
(2) Loaded Traffic Volume = Cargo Volume by truck/Average load (9.6t)
(3) Conversion factor for container = 1.1

2) Parking space at the exit gates

Parking spaces for the trucks waiting for entry should be provided outside the gates.

Table 12-1-4 Number of Queueing Trucks at the Exit Gates (in 1995)

Gate	Arrival rate	Service rate per gate	Average number of trucks queueing	Required No. of parking spaces in terms of truck No. at over 90% reliability	Number of gates
KPD-1 Gate 3	38	50	1	2	2
KPD-1 Gate 4	43	50	1	2	2
KPD-2 Gates	64	50	1 1	6 1	2 3

3) Projected traffic volume

According to Fig. 12-1-5, with only the present network the hourly traffic volume on Circular garden Reach Road would be over 300 trucks per hour even in 1995. Even with the present level of road traffic, Calcutta Port, Circular Garden Reach road and especially Bascule Bridge, Kidderpore intersection and Kidderpore Bridge are very congested. As shown in Fig. 4-

3-5, not only port related trucks but also buses and cars run on Bascule Bridge. At around 300 trucks/hour the bridge is at a standstill due to the traffic jam at Kidderpore intersection.

In order to ease the congestion on Circular garden Reach Road, three measures are proposed, namely,

a) In order to reroute some heavy vehicles from Circular Garden Reach Road to Garden Reach Road, Swing Bridge should be replaced or reinforced and opened to heavy vehicles. Hasting Bridge on Garden Reach Road should also be expanded.

b) In order to avoid passing through Diamond Harbour road and Kidderpore intersection and reroute the cargo traffic on Diamond Harbour Road from the industrial/commercial area in the port, Kantapukur Road, Eastern Boundary Road and Satya Doctor road Should be improved.

c) In order to reroute the traffic on Circular Garden Reach Road from NSD dock, Remount Road and Sonapore Road should be linked.

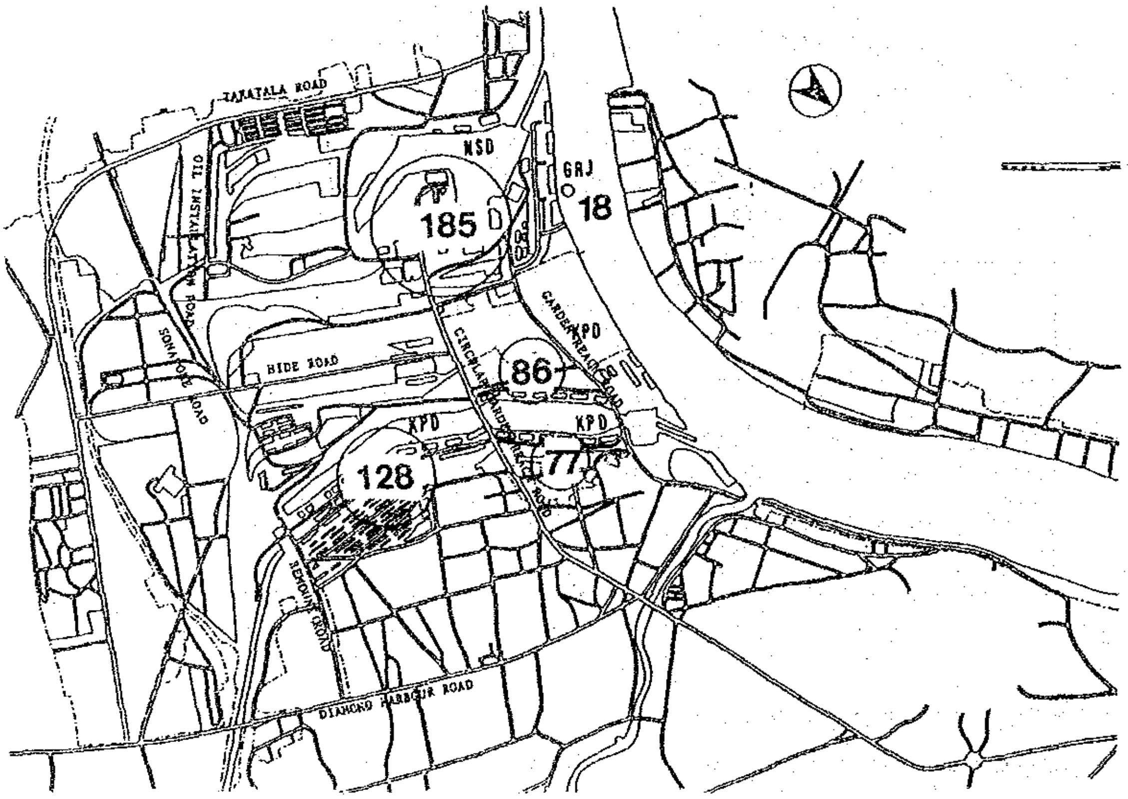


Fig. 12-1-5 Hourly Traffic Volume in 1995

4) General improvement plan of Calcutta port road system

a) Major roads to be improved (ref. Fig. 12-1-6)

In order to ease the congestion on the roads, especially on Circular Garden Reach Road, we propose following improvement.

Up to 1995 : New roads

1) Linkage between NSD (conversion of the C.G.R.R) and Sonapore Road

2) Linkage between Sonapore Road and Remount Road

: Widening/improvement

1) Swing Bridge on Garden Reach Road

2) Hasting Bridge on Garden Reach Road

3) Sonapore Road and Hoboken Road

4) Hide Bridge

b) Parking facilities and road network within the docks

As mentioned in 2), queueing trucks on the road within the docks and around the gates cause traffic congestion.

The general layout of parking facilities and the road nework within the docks is planned so as to improve the cargo handling efficiency as shown in Fig. 12-1-7.

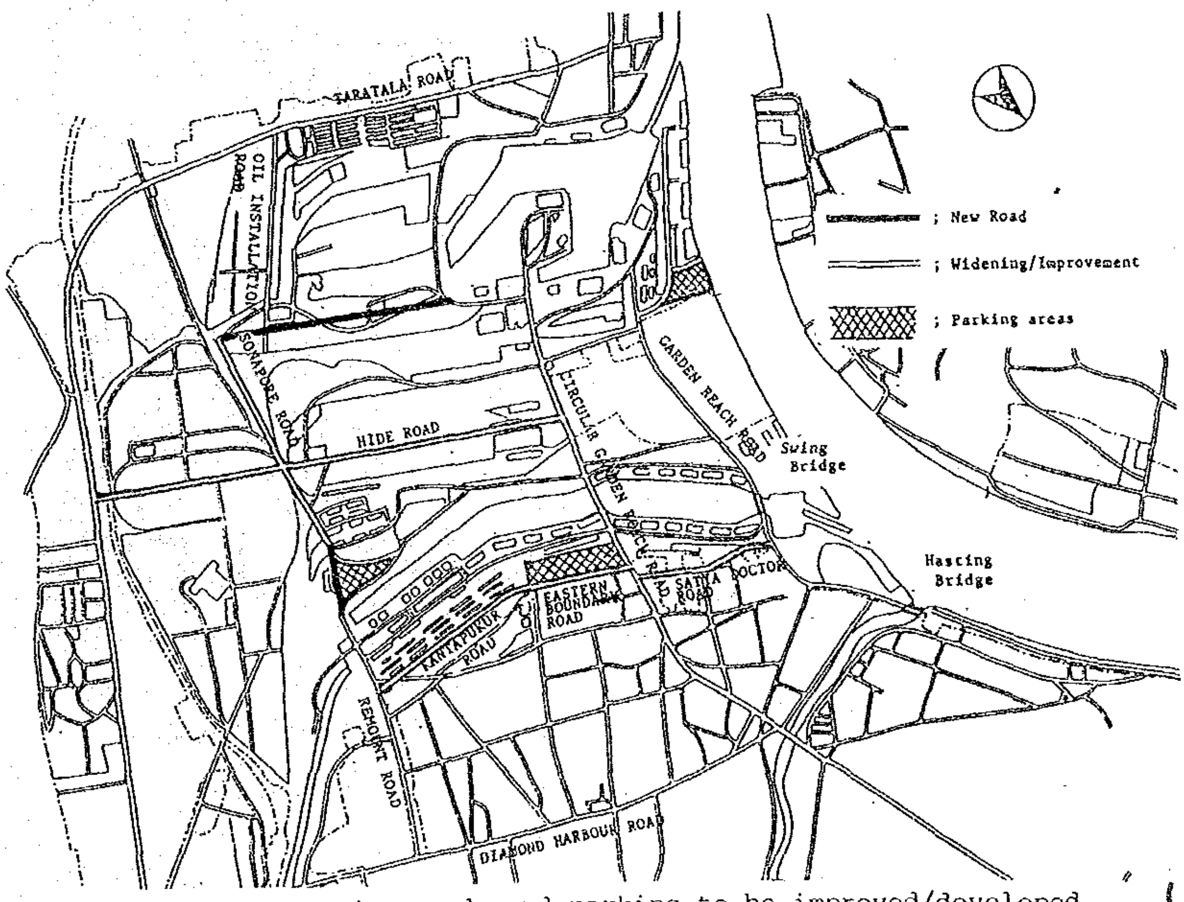
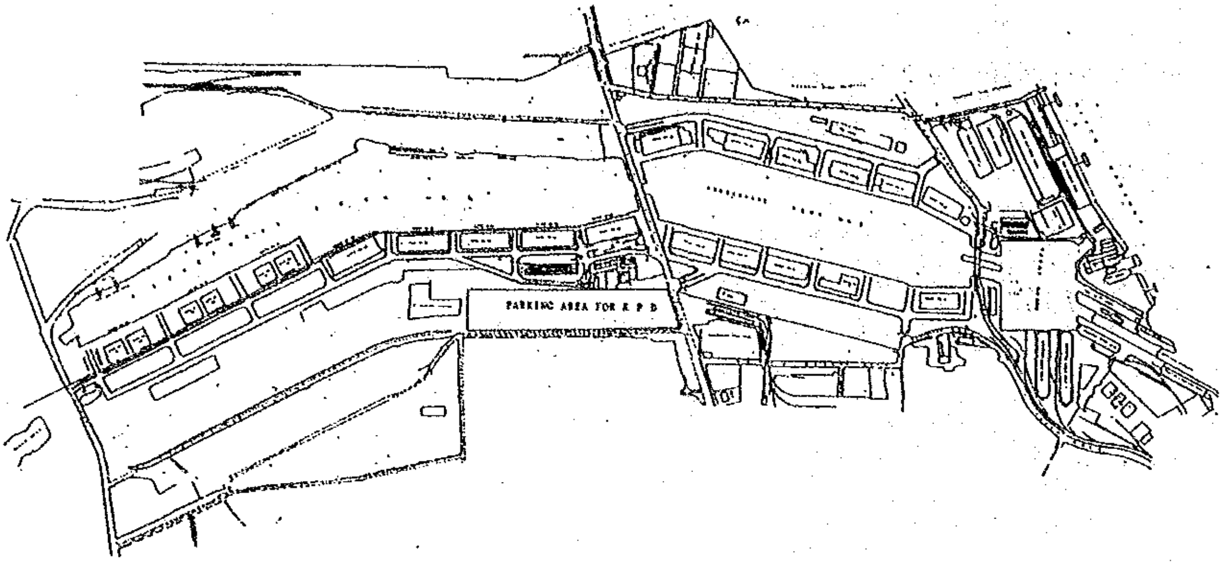


Fig. 12-1-6 Major roads and parking to be improved/developed



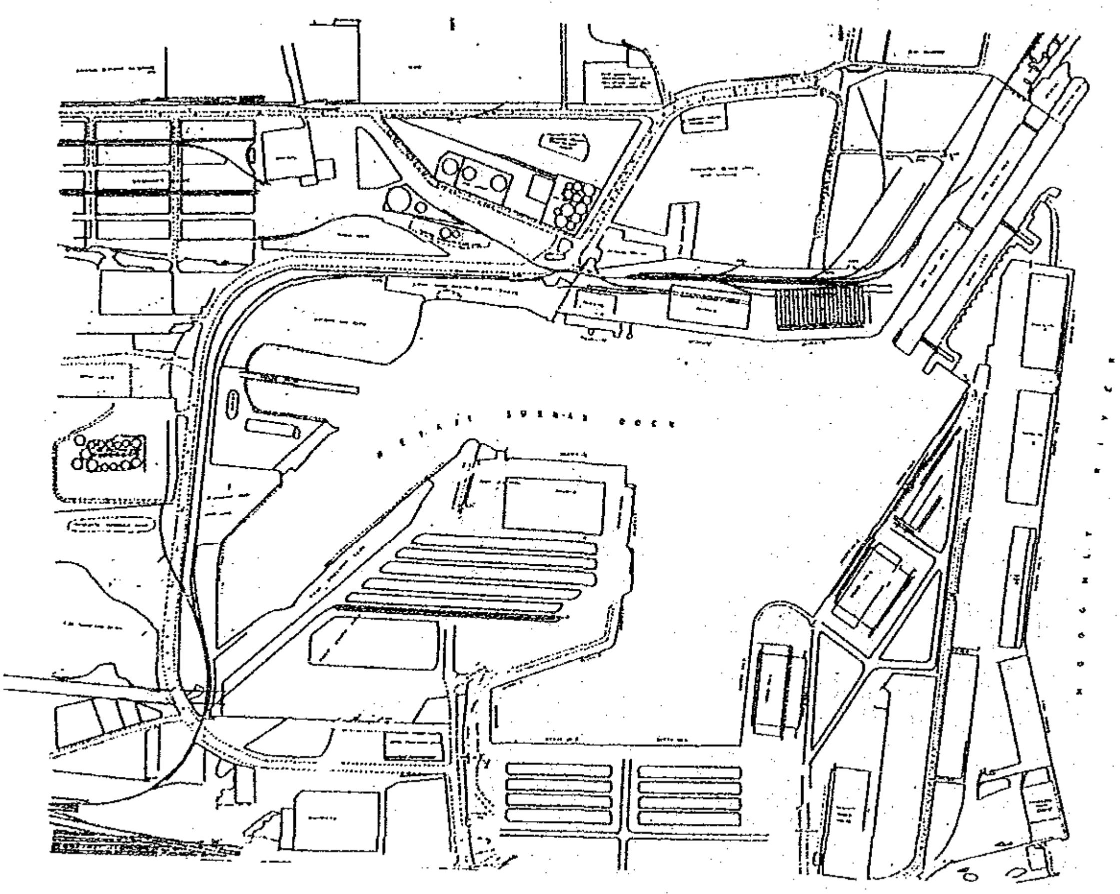


Fig. 12-1-7   General Layout of Road Network Around Docks

c) Parking facilities for trucks in the port area.

The required space for these parking area in 1995 is presented in Table 12-1-5. *In addition, we propose the provision of refreshment* stalls, rest rooms etc. at each truck parking area.

Table 12-1-5 Required space for parking areas

	Arrival rate (trucks/hour)	Service rate (trucks/hour)	Required capacity (No. of trucks)	Required space (m^2)
K P D	146 (1995)	1.11	150	15,000
N S D	102 (1995)	1.11	105	10,500