4-2 Required Facilities and Scale

(1) Estimate of type and number of vessels entering the port

A. Type of vessel entering the port

1. The conditions of harbors in northern area (Tables 4-421, 4-422)

If the results of analysis made of Callao Port which is a representative port for handling general cargoes and other harbors in northern region are summarized:

a) Vessel type at Callao Port

For Callao Port with great amount of general cargo handling throughout the year, the average vessel size for the years 1970 to 1973 was 4,310 G/T to 5,510 G/T showing a slight increase in size of vessel.

b) Annual volume of cargo handled per ship at Callao Port

A favourable increase in cargo volume of 2,425 ton in 1970 to 3,925 ton in 1973 is seen.

The volume of cargo handled by one vessel compared to the increase in vessel size shows a great increase.

$$\frac{2,425 \text{ ton}}{4,310 \text{ G/T}} = 56\% \quad \ldots\ldots\ldots\ldots\ldots\ldots 1970$$

$$\frac{3,925 \text{ ton}}{5,511 \text{ G/T}} = 71\% \quad \ldots\ldots\ldots\ldots\ldots\ldots 1973$$

c) Peruvian vessels entering Callao Port

Many foreign country registered vessels enter Callao Port, and the percentage of Peruvian registered vessels entering this port during this period increased steadily from 19 % to 26 %.

d) Type difference between domestic and foreign vessel (Table 4-422)

In the case of Callao Port, almost no difference in type of vessel between domestic and foreign vessel can be observed.

e) Type of vessel and volume of cargo handled at Salaverry Port

Salaverry and Chimbote Ports are representative Peruvian port handling dry cargos.

Depending on the year, the change in vessel type is great; but as at Callao Port only a slight change in foreign vessel type can be confirmed.

In 1973 the percentage of volume of cargo handled per vessel to the size of vessel is :

$$\frac{\text{Average tonnage of cargo handled per vessel}}{\text{Average registered tonnage per vessel}}$$

$$= \frac{3,557}{4,395} = 81\ \%$$

which is higher than for Callao Port. The reason for this is believed to be due to high proportion of annual cargo tonnage occupied by bulk sugar and oil carried by execusive vessels.

f) Situation at Chimbote Port

The harbor statistic for this port shows that, recently, a sudden change in average vessel tonnage and cargo tonnage is taking place. This is due to the trend in fishmeal export and import of raw materials for steel manufacturing.

g) Situation at small and medium ports in northern Peru.

Following points common to Pacasmayo Port, Chicama Port, Eten Port and private port of Pimentel can be seen.

1. (Natural condition) Calm mooring area protected by breakwater or cape is not available.
2. (Offshore cargo handling) Not having harbor facility for wharf handling of cargo, lighters are used for offshore cargo handling.
3. (Foreign & domestic trade) Largely export and import cargos with almost no cargo for domestic trade excepting movement of petroleum at Pimentel Port.
4. (Export & import) Handling of export and import cargo is extremely low (Table 4.423)
5. (Domestic cargo movement) There is no intracoastal flow of domestic goods excepting for petroleum handling at Pimentel Port. However, records show that large volume of export and import cargo was handled formerly. (Table 4.424)

6. (Vessel type) In 1973, large domestic vessels entered Pacasmayo and Chicama Ports but the number of vessel making port entry is decreasing. If the reason for placing large vessel in service is to facilitate offshore cargo handling during swell action, this phenomenon is believed to be of temporary nature.

h) Intracoastal shipping activity along northern coast of the Pacific is not brisk at present

It is correct to assume that general cargos from foreign countries are unloaded at Callao and Salaverry Ports and then hauled to northern region by inland transportation.

Goods for export are also believed to go through the same process.

2. Study of vessel type

a) (Promotion of national merchant fleet) The 13,780 DWT cargo vessel constructed in line with the policy of Peruvian Government in latter part of 1960 for promotion of national merchant fleet is in service as mainstay of the National Maritime Board's merchant fleet.

b) (Vessels for transpacific service) It is correct to assume that scheduled and non scheduled vessels of 10,000 DWT and larger are in service for the transpacific route.

c) (Average vessel tonnage is 5,000 D/W) If vessels entering commercial ports are assumed to be of

5,500 - 5,800 G/T class (8,250 - 8,700 D/W) it can be assumed that many shall and medium size ships entering a port will consist of 3,000 D/W to 5,000,and 7,000 D/W class as can be seen from Callos Port that handles mainly general cargo.

d) (Exclusive ore carrier) According to data on Michiquillay Mine Industry, it is planned to ship out 367,000 short tons of copper concentrates annually in dry state. If 8 % moisture is added the annual tonnage will be 408,000 short tons or 370,000 M.T/year if converted to metric ton. If 2 vessels enter the port monthly to load copper concentrates, each ore carrier must be able to load at least 15,000 metric tons.

e) (Tanker) To be able to transport petroleum constantly even during relatively high wave period from May to July, port entry of tankers larger than in normal season must be taken into consideration.

3. Estimate of vessel type

From above studies, following types of vessel were assumed.

- o Exclusive ore carrier 18,800 D/W
- o Tanker (from domestic refinery) 10,000 D/W
- o Transpacific general cargo ship (Europe, Asia, North America) 15,000 D/W
- o Ships for trade with 5 Andean countries 10,000 D/W
- o Ships for intracoastal cargo 3,000 D/W

However, tankers much smaller than indicated above will also be used for hauling petroleum or 300 - 400 D/W cargo ships for Andean route and intracoastal shipping.

Table 4-421 Comparison of Average Tonnage of Vessel Making Port Entry and Average Tonnage of Cargo per Vessel

(Figure in ( ) is average cargo tonnage per vessel)

Port	1970			1971			1972			1973		
	No. of Vessel	Total Tonnage of Vessels Entering Port (Registered tonnage)	Cargo Tonnage (Ton)	No. of Vessel	Total Tonnage of Vessels Entering Port	Cargo Tonnage	No. of Vessel	Total Tonnage of Vessels Entering Port	Cargo Tonnage	No. of Vessel	Total Tonnage of Vessels Entering Port	Cargo Tonnage
Pacasmayo	58	246,573 (4,251)	49,110 (845)	48	236,645 (4,930)	26,676 (556)	48	266,509 (5,552)	27,832 (579)	37	202,025 (5,460)	62,676 (1,694)
Chicama	22	89,734 (4,079)	50,911 (2,314)	29	60,507 (2,086)	91,884 (3,168)	16	85,759 (5,360)	58,413 (3,651)	4	18,154 (4,539)	10,414 (2,604)
Salaverry	280	1,027,153 (3,668)	726,357 (2,594)	252	827,032 (3,282)	879,775 (3,491)	280	822,660 (2,938)	904,312 (3,230)	247	1,085,569 (4,395)	878,577 (3,557)
Chimbote	459	1,687,472 (3,676)	1,335,806 (2,910)	301	1,026,142 (3,409)	1,198,333 (3,981)	234	1,125,103 (4,808)	1,144,308 (4,890)	190	1,279,232 (6,733)	917,681 (4,830)
Callao	1,608	6,931,262 (4,310)	3,899,026 (2,425)	1,404	6,255,045 (4,455)	4,232,164 (3,014)	1,309	6,315,113 (4,824)	4,448,403 (3,169)	1,049	5,780,605 (5,511)	4,117,053 (3,923)
Paita	296	734,977 (2,483)	143,907 (486)	499	940,820 (1,885)	147,265 (295)	714	857,430 (1,201)	140,680 (197)		N.A.	160,283
Talara	379	1,303,200 (3,438)	2,825,440 (7,455)	405	1,348,899 (3,331)	2,789,765 (6,885)	385	1,351,646 (3,511)	2,891,307 (7,510)		N.A.	3,224,678
Eten	28	99,663 (3,559)	77,991 (2,785)	16	107,255 (6,703)	89,909 (5,619)	16	82,759 (5,172)	81,342 (5,084)		N.A.	74,103

Prepared from ENAPU information

Table 4 - 422 Number of Vessels Making Port Entry and Tonnage
- Peruvian - Foreign Vessel -

(Registered Tonnage)

	Nationality	1970			1971			1972			1973		
		No. of Vessel	Total Tonnage of Vessel Making Entry (N.R.T.)	Average Tonnage per Vessel (N.R.T./Vessel)	No. of Vessel	Total Tonnage of Vessel Making Entry (N.R.T.)	Average Tonnage per Vessel (N.R.T./Vessel)	No. of Vessel	Total Tonnage of Vessel Making Entry (N.R.T.)	Average Tonnage per Vessel (N.R.T./Vessel)	No. of Vessel	Total Tonnage of Vessel Making Entry (N.R.T.)	Average Tonnage per Vessel (N.R.T./Vessel)
Paracamayo	Domestic	7	31,108	4,444	17	94,831	5,578	18	85,753	4,764	6	83,085	13,848
	Foreign	51	215,485	4,225	31	141,814	4,575	30	180,756	6,025	31	118,940	3,837
Chicama	Domestic	3	13,815	4,605	6	13,815	2,303	3	13,632	4,544	1	9,571	9,571
	Foreign	19	75,919	3,996	13	46,692	3,592	13	72,127	5,548	3	8,583	2,861
Salaverry	Domestic	136	387,951	2,853	145	301,943	2,082	175	175,573	1,003	119	420,102	3,530
	Foreign	144	639,202	4,439	107	525,089	4,907	105	647,087	6,162	128	665,467	5,199
Chimbote	Domestic	174	413,471	2,376	151	348,406	2,307	96	364,214	3,794	91	349,959	3,846
	Foreign	265	1,274,001	4,470	150	677,737	4,518	138	760,889	5,514	99	929,273	9,387
Callao	Domestic	309	1,338,170	4,331	321	1,420,965	4,427	204	994,990	4,877	272	1,580,144	5,809
	Foreign	1,299	5,593,092	4,306	1,083	4,834,080	4,464	1,105	5,320,123	4,815	777	4,200,461	5,406
San Nicolas	Domestic										18	141,374	7,854
	Foreign										155	3,043,250	19,634
Paita	Domestic	78	150,140	1,925	283	204,441	722	428	181,302	423		N.A.	
	Foreign	218	584,837	2,683	216	736,379	3,409	286	676,128	2,364		N.A.	
Talara	Domestic	268	1,092,039	4,075	297	1,165,057	3,923	275	1,106,320	4,023		N.A.	
	Foreign	111	211,161	1,902	108	185,842	1,702	110	245,326	2,230		N.A.	
Eten	Domestic	10	29,305	2,931	5	26,010	5,202	4	17,013	4,253		N.A.	
	Foreign	18	70,358	3,909	11	81,245	7,295	12	65,141	5,428		N.A.	

Prepared from ENAPU information

Table 4-423 Volume of Cargo Handled at Neighboring Ports

(Ton)

Port		1971	1972	1973	1974
Chicama	Export	90,726	57,851	10,414	22,024
	Import	0	0	0	0
	Domestic	1,158	562	0	0
	Total	91,884	58,413	10,414	22,024
Pacasmayo	Export	6,942	12,094	39,928	8,786
	Import	19,734	15,288	22,748	18,027
	Domestic	0	450	0	0
	Total	26,676	27,832	62,676	26,813
Eten	Export	87,857	76,700	67,943	75,378
	Import	2,052	2,005	6,160	45
	Domestic	0	2,637	0	9
	Total	89,909	81,342	74,103	75,432
Pimentel (for reference)	Export	97,143	85,385	113,503	91,800
	Import	33,085	33,250	35,575	25,866
	Domestic	Dry Cargo 130,228 Petroleum 186,871	Dry Cargo 119,311 Petroleum 183,736	Petroleum 183,165	Petroleum 206,587
	Total	447,326	421,682	332,243	324,253

Prepared from ENAPU Information

Table 4-424 Volume of Domestic Trade at Medium and Small Ports in Northern Peru

Unit : Metric Ton

		1960	1965	1970
Chicama Port	Sugar	35,040	13,761	-
	Guano	10,484	7,692	-
	General	2	-	-
	Petroleum Petroleum Product	6,845	13,627	-
	Sub-Total	53,371	35,090	-
Pacasmayo Port	Sugar	30,628	10,118	-
	Guano	9,698	5,792	-
	General	457	817	495
	Petroleum Petroleum Product	-	-	-
	Sub-Total	40,983	16,727	495
Eten Port	Fertlizer	-	-	2,250
	Rice 2,463 M.T. in 1972			
	Hemp Sack 676 M.T. in 1969			
	General 174 M.T. in 1972			
	(Note) : Domestic Trade up to 1972			
Pimentel Port	Rice	27,840	8,738	-
	Sugar	22,916	8,006	-
	Guano	-	3,750	-
	General	14,078	2,375	2
	Petroleum and Petroleum Product	-	136,142	166,930

Prepared from ENAPU Information

B. Estimate of annual number of vessels entering port

1. Annual number of vessels entering port

It is assumed that only copper concentrates and petroleums will be handled as bulk cargo while other cargoes in containers, boxes, bags, cans or other types of packages would be handled as general cargo.

However, bulk cargoes for small cargo crafts used for short distance intracoastal shipping can be easily loaded at the small quaywall with a small pneumatic type load handling equipment having relatively high movability so in this plan bulk cargoes for small cargo crafts were considered as general cargoes.

These general cargoes were assumed to be transported with scheduled cargo vessels and the tonnage of cargo handled for one vessel at Pacasmayo Port was assumed as 4,000 - 5,000 tons for 15,000 D/W vessel, 3,000 - 4,000 tons for 10,000 D/W vessel and 2,000 tons for 3,000 D/W vessel.

It is assumed that a 3,000 D/W class vessel will be used in shipment of cargo by small cargo crafts.

If vessel types shown in Table 4-425 are assumed, annually, 138 vessels could be estimated to enter the port; but actually, it is believed that a greater number of ships smaller than sizes assumed would enter the port, so there would be the possibility of further increase in the number of vessels entering the port annually.

2. Form of cargo handling

Copper concentrates will be moved from mine company's stock yard with belt conveyor and loaded onto the ore carrier with travelling loader installed at the wharf.

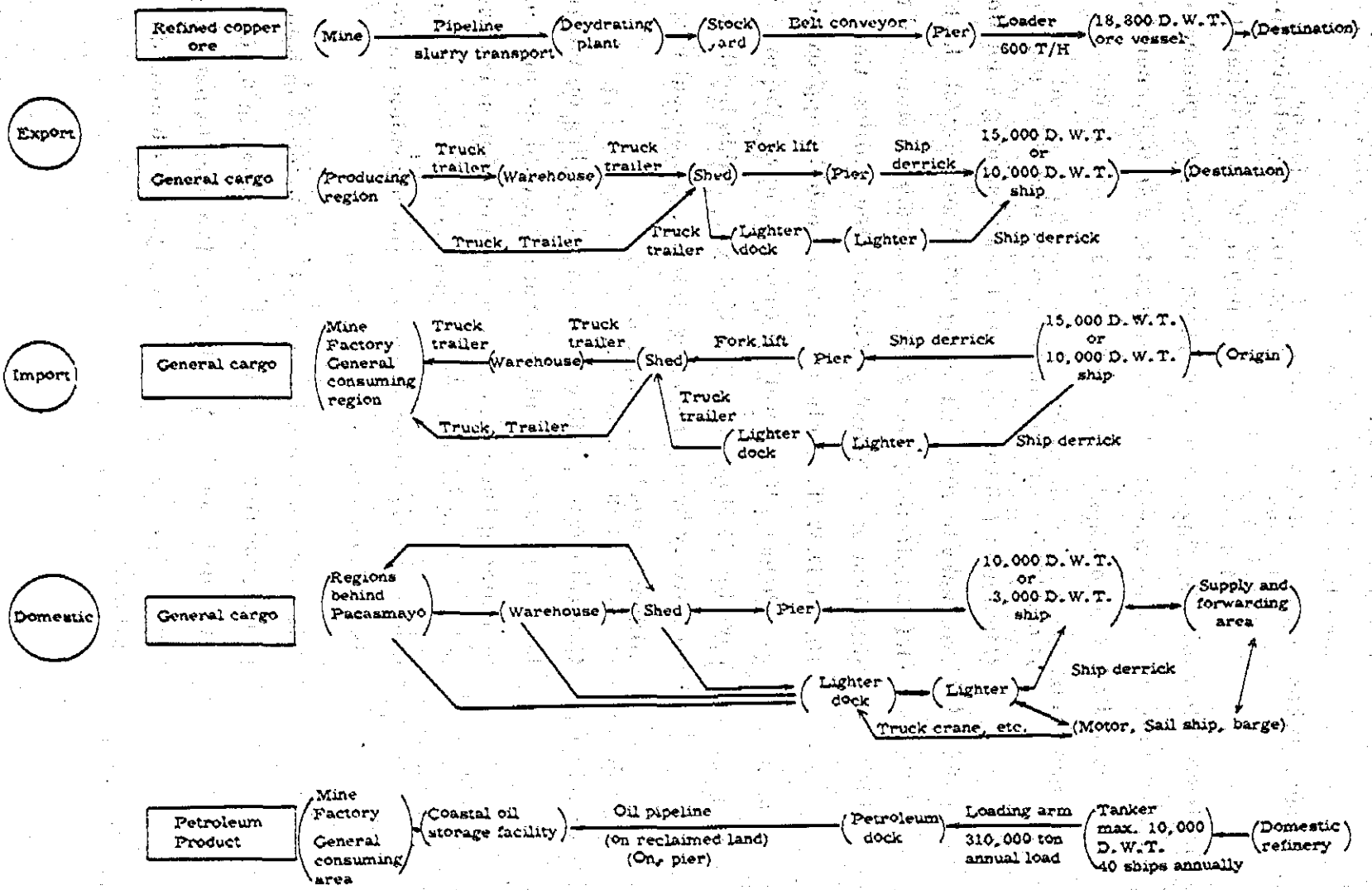
Petroleums will be unloaded from tanker with loading arm provided at petroleum unloading wharf and then pumped through pipeline to oil storage tank located within the port terminal.

General cargoes will be handled at wharf or offshore; but in both cases it will be necessary to properly lay-out forklifts, pallets, and modern transit shed.

Table 4-425 Estimated Number of Vessels During One Operating Year

	Cargo	Volume ton	Main Destination and Source	Vessel Type	Tons per Vessel	No. of Vessel Annually	Remarks
Export	Refined copper ore	370,000	Asia	18,800 D.W.T.	15,700 Ton	23.6 ships	
	Sugar (in bag)	79,000	North America, Europe, Middle East	15,000	5,000	15.8	
Import	Mining material and equipment	20,000	Asia	15,000	4,000	5	
	General cargo (Machinery, etc.)	10,000	Europe, Asia, North America	15,000	4,000	2.5	
Domestic	Rice (bag)	105,000	Callao	10,000	4,000	26.3	Outgoing
	Fruit	14,000	Callao	3,000	2,000	7	
	Fertilizer (bag)	25,000	Talara, Bayovar	3,000	2,000	12.5	Incoming
	Cement (bag)	50,000	Northern ports	3,000	2,000	25	Outgoing
	Other general cargo	7,000	Domestic ports	3,000	2,000	3.5	Out + Incoming
	Petroleum and Petroleum product	311,000	Talara	4,600 - 10,000	3,300 - 13,800	40	Incoming
Total		991,000		Over 15,000 D.W.T. 10,000 3,000 Tanker (4,600 - 10,000)	Excepting refined copper ore and petroleum. Tons of cargo handled per ship 3,267 ton/ship	Over 15,000 46.9 ship Total 10,000 26.3 ship 162 ships/year 3,000 ton 48 ship Tanker 40 ship	

FIG. 4-421 CARGO HANDLING DIAGRAM



(2) Estimate of scale of required berth

The number vessels entering the port of Pacasmayo annually is estimated as:

24 ships	18,000 D.W.T exclusive for ore
24 ships	15,000 D.W.T for general cargo
27 ships	10,000 D.W.T for general cargo
48 ships	3,000 D.W.T for general cargo
40 ships	Tankers

If ore loader with nominal capacity of 600 ton per hour (Maximum 720 ton/hr) is used and assuming a loading efficiency of 70 % and taking into consideration the berthing and castoff time, port entry and departure time and temporary interruption in middle of night, the waiting time for a 10,000 D.W.T. exclusive vessel would be approximately 37.4 hours. If the waiting time is 2 days, the total waiting days for 24 ships would be 48 days. If this berth is used exclusively by ore carrying vessels, the annual rate of berth utilization would be only 13.15 %.

General cargo handling capacity, depending on the grade of laborers and day or night handling, would not necessarily be uniform; but one gang composed of 15 men is assumed to be capable of loading 25 tons per hour of rice, sugar and cement in bags from the dock. The unloading capacity is also assumed as 25 tons per hour.

It is assumed that 4 hatches out of 6 hatches in both 10,000 and 15,000 D.W.T. ship and all 3 hatches in 3,000 D.W.T. ship will be used. At Salaverry Port, night handling is done when necessary; but for Pacasmayo Port 8 hour day was assumed.

From these conditions, the result of computation for annual number of waiting days for both onshore and offshore cargo handling is shown in Table 4-426.

The relationship between berth utilization type and the annual rate of utilization is shown in Figure 4-422.

From results of this study, one ore berth with water depth of -10.5 meters, one general cargo berth with -10 meter depth, one petroleum berth and 120 meters long quaywall with -4 meter depth for lighter and small freighter of 300 gross ton class were planned as shown in Figure 4-422.

At relatively shallow depth below sea bed a gravel layer is observed and below this is a layer of conglomerate, so a water depth of -10.5 meters is planned for general cargo berth.

Quaywall with length of 120 meters and water depth of -4 meters would provide 4 berths for 200 D/W lighters or 3 berths for 300 gross ton crafts.

The annual volume of cargo handled per meter of berth is:
(converted volume of cargo handled for entire port (excluding petroleum))

Copper concentrates 370,000 tons x 1/2 =		185,000 tons
General cargo		310,000 tons (+
Sub-Total		495,000 tons ...(A)

(converted berth length)

Ore berth		195 meters
General cargo berth		185 meters
Small craft berth (-4 m quaywall)	120 m x 2/3 =	80 meters (+
Sub-Total		460 meters ....(B)

(Annual volume of cargo handled per meter of berth)

$$\frac{A}{B} = 1,076 \text{ tons/one meter of berth}$$

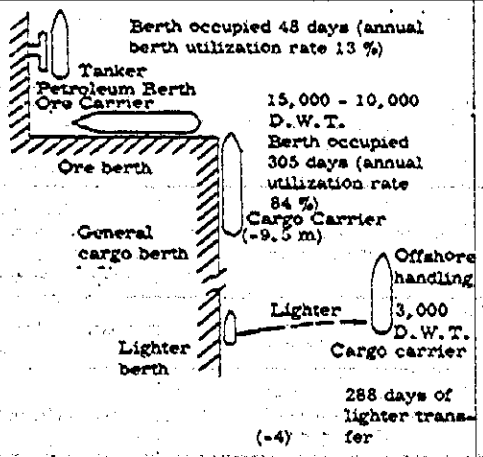
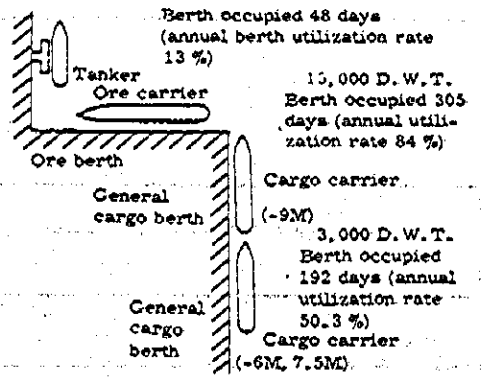
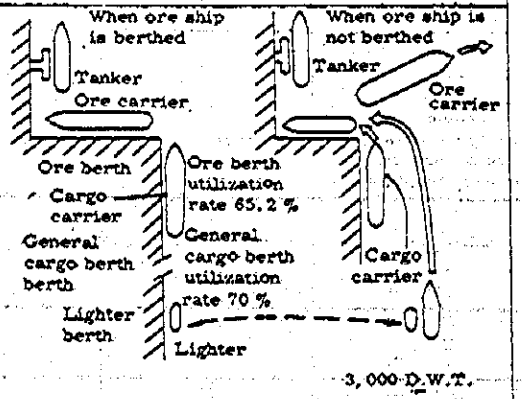
If sheds and freight handling facilities are properly laid out, berth of this scale is believed to be adequate.

Table 4-426 Cargo Handling Time

	Vessel Type	No. of Hatch (note.1)	Type of Cargo	Capacity	Cargo Handling Capacity per Day (8 hrs/day)	Average Tonnage of Cargo per Vessel	Cargo Handling Time	Cargo Handling Days	No. of Days in Port	No. of Vessel Annual	Total Number of Days in Port	
	18,800 D.W.T. (Ore Vessel)		Refined copper ore	420 ton/hr (=600x0.7)		15,700 ton	37.4 hr		2 days	24 ships	48 days	
	15,000 D.W.T.	4 (6)	General cargo (mining equipment, sugar)	25	800 ton/ship	5,000 4,000		6.3 days 5	7 5.5	16 8	112 44	Total of 545 days (with 2 berths Berth utilization rate is 74.7 %)
	10,000 D.W.T.	4 (6)	General cargo (Rice, sundry)	25	800	4,000		5	5.5	27	149	
	3,000 D.W.T.	3	General cargo (fertilizer, cement, fruit)	25	600	2,000		3.3	4	48	192	
	Tanker (Max. 10,000D.W.T.)		Petroleum	1,000 Kl/hr			10 hr		1	40	40	
In case of offshore cargo handling for 3,000 D.W.T. ship, the number of days in port for the ship		3	General cargo (Fertilizer, cement, fruit, etc.)	15 ton/hr	360 ton/ship	2,000 ton		5.6 days	6 days	48 ships	Total 288 days	
In case of offshore cargo handling for 10,000 D.W.T. ship, the number of days in port for the ship		4 (6)	General cargo (Rice, sundry)	15	480	4,000		8.3	9	(27)	* In case cargo handling is offshore for all 10,000 D.W.T. ships, the total number of days in port for this type of ship is 243 days. (9 x 27)	

NOTE 1. In column for "Hatch" the numbers 4,(6) indicate 4 hatches used, out of 6 hatches

FIG. 4-422 TYPES OF BERTH UTILIZATION AND ANNUAL RATE OF UTILIZATION

In Case of Petroleum Berth x 1, General Cargo Berth x 1, Ore Berth x 1, and Lighter Transfer	In case of Ore Berth x 1, General Cargo Berth x 2, Petroleum Berth x 1	In case of Ore Berth x 1 (If vacant use this Berth for General Cargo), General Cargo Berth x 1, Petroleum Berth x 1
 I	 II	 III
(1) In order to handle 3,000 D.W.T. cargo ship with lighters, one offshore cargo handling anchorage will cause congestion. (2) The volume cargo to be handled in case of 3,000 D.W.T. ship will be 96,000 tons and to handle this tonnage with lighters, it is necessary to maintain and keep an organization and system for some times after opening of port. (3) Ore berth will be used for only 13 % of the year. (4) Utilization rate for -9.5 m deep general cargo berth is 84 %, so considerable number of anchored ship can be anticipated. Actually, it would be difficult to handle 10,000 - 15,000 D.W.T. ship cargo only with this berth.	(1) Utilization rate for -6 to -7.5 m deep 3,000 D.W.T. berth is 50.3 %, so construction of exclusive berth for this type of ship is premature. (2) -9.5 m deep berth is same as (4) in I. (3) Ore berth is same as (3) in I. (4) From construction cost, providing an extra berth is not advantageous. From over all viewpoint, the existence at same time of unbalance in congested berth and unoccupied berth was confirmed.	(1) If 60 % of 317 unoccupied days (365 - 48) of ore berth or 190 days can be used for general cargo berth, this number of days will almost take care of dock handling for 3,000 D.W.T. class cargo ship, so without using lighters cargo handling is possible according to calculation. (2) However, moving 10,000 - 15,000 D.W.T. general cargo ship moored at general cargo berth to ore berth is more appropriate. So, by holding the general cargo berth to annual use rate of 70 % and in order to occupy the berth for 255 days only, cargo ship can be moved to ore berth for 50 days (305 - 255 days). 3,000 D.W.T. cargo vessel can also occupy the ore berth for 140 days (190 days (1) -50 days). (3) Therefore, in case of utilization as in (2), by calculation, annually approximately 80 days of cargo handling with lighters is necessary. $(192 - 140 \times \frac{288}{192})$

(3) Scale of cargo storage facilities and port terminal facilities

A. Scale of shed

In order to handle 10,000 - 15,000 D/W general cargo vessel at unoccupied ore berth, a rapid and efficient berthing and cargo handling would be necessary. For this it would be necessary to provide the cargo handling gang with sufficient number and capacity of fork lifts and at the same time, especially in this case, a shed of sufficient scale to permit smooth handling of freights must be provided. In the past, several computation formulas or recommended values have been published for estimating the required scale of sheds for ports in advanced countries; but in the case of Pacasmayo Port, from the contents of cargo to be handled, it is believed that in the planning of ports for developing countries the adoption of computation method recommended by Mr. Bohdan Nagorski, port specialist at U.N. would be more appropriate, storage floor area obtained with this method is shown below:

Average volume of general cargo handled in sheds	2,000 tons
Sugar, rice, etc. in bags	1,000 tons
Floor area for storage under shed	
- For general cargo in small lots 2 m^2/ton assumed	4,000 m^2
- For sugar, etc in bag 2 ton/m^2 assumed	500 m^2
Space to allow free movement of handling equipment	1,500 m^2
Space to allow easy access to each lot	
Space for custom clearance	
	6,000 m^2

The figure of 6,000 m^2 obtained is slightly larger than for sheds in the past; but storage shed of this scale should be

able to cope with the lag of port transporation firms advancing into warehouse business.

B. Scale of open storage yard

Vehicles, tractors, machineries, steels, lubricating oil in drums, acids, etc. are to be stored for short period in open storage yard located behind the shed.

Following equation is used to obtain the area of open storage yard:

$$W = \frac{N}{R} = wA$$

where : W = cargo storage capacity (t)

N = required tonnage of cargo handled annually (t)

R = rate of turnover (times/year)

A = required area of open storage yard (m^2)

w = cargo storage tonnage per unit area (t/m^2)

= rate of utilization

In this case, assuming a turnover rate of 12 times/year, utilization rate of 0.7, cargo storage tonnage per unit area of 0.5 t/m^2, and required tonnage of cargo handled annually as 100,000 tons :

$$W = \frac{100,000}{12} = 8,400 \text{ tons}$$

The required area of open storage yard:

$$A = \frac{8,400}{0.7 \times 0.5} = 24,000 \ m^2$$

With this value as basis, the location of open storage yard will be determined after the flow of freight is considered.

C. Port transporation facility

Assuming :

Port cargo tonnage 600,000 ton/in year 1990

Monthly fluctuation rate 1.3

Incoming-outgoing cargo 300 days/year
(Excepting Saturday, Sunday and Holiday)

Truck loading capacity 3.6 tons/truck

$$\text{The number of loaded trucks} = 600,000 \times 1.3 \times \frac{1}{3.6} \times \frac{1}{300}$$

$$= 723 \text{ trucks/day}$$

If the number of empty trucks is assumed as 30 % increase over loaded trucks:

The number of empty truck = 723 x 1.3 = 940 trucks/day

Therefore : The daily volume of truck traffic

= 723 + 940 = 1,663 trucks/day

If 80 % is assumed as peak rate per hour, the volume of truck traffic will be 665 trucks/hour, so initially 2 lane road will be sufficient, but with anticipated increase in cargo load per truck in the future, widening of the roads will be necessary.

D. Warehouse

After imported goods are custom cleared in transit shed the goods must be discharged and stored for a fairly long period, so a warehouse must be provided within the port terminal.

Warehouse must also be provided in the port terminal or in the vicinity to store domestic cargo such as fertilizer in bags coming into the port in sizeable amount before distribution to consumers and consumer group with inland transportation and distribution system.

These warehouses are assumed to be constructed and operated by port transport firms or warehouse firms on sites prepared and furnished by Port Administration Agency.

The operation of warehouses by above mentioned type of firms is desirable in increasing the turn-over rate of cargo in transit.

Warehouse space is obtained by following equation:

$$W = \frac{N}{R} = wA$$

Where : W = cargo storage capacity (ton)

N = annual tonnage of cargo handled (ton)

R = Turn-over rate (times/year)

A = area of warehouse (m^2)

w = cargo storage tonnage per unit area (t/m^2)

= rate of cargo storage

In this case, if warehouse turn-over rate of 12 times per year, annual tonnage of cargo handled as 1/2 of 310,000 tons or 155,000 tons stored in warehouse, cargo storage tonnage per unit area of 2.5 tons per square meter and turn-over rate of 0.7 are assumed, the required warehouse area is:

$$A = \frac{W}{w} = \frac{N/R}{w} = \frac{155,000 \div 12}{0.7 \times 2.5} = 7,381 \text{ m}^2$$

Warehouse itself is a private investment; but land for the warehouse is assumed to require an area that is 3 times the size of the warehouse.

Required land area = $7,381 \times 3 = 22,143 \text{ m}^2$

E. Land for oil storage tank yard

It has been assumed that handling, storage and shipment of petroleum would be a responsibility of petroleum related enterprises. In this report it was assumed that site for oil storage yard would be provided within the port terminal.

In 1982, the total volume of petroleum and petroleum products to be unloaded at this port was assumed as 310,000 tons and from wave observation data annual port entry of 40 times was anticipated for tankers. In this case, tankers were classified according to type of oil carried; and as a result oil storage tanks of following capacity were determined to be necessary.

Diesel oil storage tank	18,700 kiloliters x 1 tank
Kerosene storage tank	15,000 kiloliters x 1 tank
Gasoline storage tank	5,300 kiloliters x 1 tank
"B" heavy oil storage tank	10,000 kiloliters x 1 tank

If pump stations, oil dikes, office, tank lorry loading yard, drum filling yard, fire fighting facility, etc. are provided within the tank yard, the required land area for oil storage tank yard will be :

$$A = 150 \text{ meters} \times 125 \text{ meters} = 18,750 \text{ m}^2$$

4-3 Construction Phases for Pacasmayo Port

Construction of Pacasmayo Port should be executed in stages according to the anticipated volume of cargo handling for this port.

Construction of all port terminal facilities based on volume of cargo anticipated for very distant future and on low probability of the forecast would be wasteful. If the volume and items of cargo change drastically from the anticipated and actual volume of cargo, confusion may occur in utilization of the facilities. However, if necessary facilities are constructed each time based on relatively short range forecast, the expanded facilities from overall viewpoint would not necessarily become efficient as many examples show.

Since this construction program for Pacamayo Port, especially, is based on the switch over of inland freight transportation structure to sea transportation structure and on the great growth anticipated for

norther region from the regional development program, great change in volume and contents of cargo must be anticipated.

Another big point of problem facing Pacasmayo Port program is the existence of extensive bedrock in shallow area of Pacasmayo Port and continuous invasion of this coast by long period swells which must be overcome before construction of port terminal facilities. Due to continuous invasion by long period swells, great limitation will be placed upon construction crafts, equipments and method and the existence of bedrock will influence the type of structure to be built on this bedrock so port terminal facilities will require a special foundation. These factors will surely make construction comparatively high priced; and for this reason it would be advisable not to construct too many structure at initial stage of port opening.

However, if the development program for northern region proceeds favourably and the percentage occupied by marine transporation in the transporation structure also progresses satisfactorily, the second phase of construction must be started at relatively early period continuing from first phase construction.

The most important point in carrying forward the program for Pacasmayo Port is to prevent beforehand the increase of waiting vessels due to lowered efficiency in utilization of the very few berths constructed initially by the execution of 2nd and 3rd phase construction according to the favourable transition of cargo volume. If cargoes passing through this port cannot be handled efficiently resulting in fairly long waiting period and causing temporary transfer of cargo to overland transporation with trucks, the development of this port cannot be called a success. It is very important for this port to fulfil the demand for transporting goods by prompt cargo handling for vessels waiting will be a great obstacle to the growth of this port.

With a situation of not having an appropriate substitute port near Pacasmayo Port, this vessels waiting would also greatly affect the growth

of marine transportation in northern regions. For this reason, in the planning of this port following stages of expansion are considered with importance placed on execution of expansion work without affecting, even temporarily, the function of the port terminal facilities already established.

It is believed that the layout and construction phases indicated in Figure 4-412 can fully cope with any change in regional development program or resulting change in volume and contents of cargo which are prerequisites of this overall port program. Of importance is the adequate study of the timing for the start of next construction phase and necessary preparation.

(1) Preparation stage (for 15 month period beginning at 5 years before start of port operation)

In order to be able to provide services of a public wharf and to ship out copper concentrates from the start of operation as commercial port, the design work, construction estimate and construction contract must be completed in March, 4 years before start of port operation. At present, in order to go into basic design work, investigation of sea conditions based on continuous observations and soil investigation based on full scale sea boring are lacking. These investigations will be conducted according to plan during this stage of preparation so that informations can be made available at time of design work. Also, at this time, the completion of by-pass from the north to detour Pacasmayo City, relocation of lighthouse and model tests of principal structures will be conducted.

(2) First phase (For 45 month period beginning in 4th month of 4 years before start of port operation)

The target at completion of this phase is to open the port as public wharf to handle 310,000 tons of general cargo, 370,000 tons of copper concentrates and petroleum. During this period importance will be placed on the construction of basic facilities such as seawall and breakwater.

The breakwater will extend out for 1,200 meters where the depth of water is more than -10.5 meters. Shore end 800 meters of the breakwater will act as seawall during the progress of reclamation work. By the completion of breakwater, a calm mooring basin would be provided on north side of breakwater.

For berthing facility, 2 berths with water depth of -10.5 meters and -10 meters will be constructed at location nearest to offshore side of the port terminal site reclaimed at north side of the breakwater to be utilized as wharf for handling ore and general cargo.

Behind the berth, one transit shed with floor area of 6,000 m^2 will be constructed to provide a smooth freight handling function.

Tanker dolphin will be constructed alongside the breakwater but taking into consideration the increase in future demand for petroleum a dolphin capable of mooring 10,000 D.W. tanker will be constructed initially.

With the completion of Pacasmayo Port, small cargo vessels plying between Salaverry Port, Chimbote Port and Pacasmayo Port could be anticipated. These small cargo vessels are believed more appropriate than inland trucks and trailers, so a small quaywall with water depth of -4 meters to

facilitate handling of cargo for 200 - 300 ton class vessels will be provided.

At this stage, for handling 310,000 tons of cargo it will be necessary for offshore handling utilizing present offshore handling system and lighters to go together with dock handling operation. For this reason, the above mentioned -4 meter quaywall will be constructed so that lighters can also utilize this berth.

Fishing port for use by local fishermen or processing firms centered around fishing boats presently moored to existing pier will be established after the following phase, but at this phase these fishing crafts, are to be moored adjacent to the -4 meters quaywall.

Channel and turning basin will be dredged to provide water depth of -11 meters while front of the berths will be dredged to -10.5 and -10 meters depth.

(3) Second phase (For 2 year period after 1 year of mine operation)

For smooth handling of the volume of cargo anticipated for 3rd year of port operation, the area adjacent to -10 meter general cargo berth will be reclaimed and two general cargo berths with depth of -7.5 meter and -6 meters will be constructed.

These berths will be used by 3,000 - 5,000 D.W.T. general cargo vessels for at this stage growth in intracoastal trade especially is expected and many vessels of this type would be entering port.

At this phase, construction of extension to -4 meter quaywall for berthing small cargo ship is possible if demand calls for

more berth space, but any plan for construction of additional facility should be flexible and according to transition in port growth. Establishment of fishing port should also be treated in similar manner.

(4) Third phase (For 2 year period from 6th year of mine operation)

For the same reason as in second phase, the area adjacent to north side of the land reclaimed in second phase will be reclaimed in shape of L. In this case also, the location was determined so that construction work would not interfere with normal port operation.

At this reclaimed land, 2 berths of -6 meter and -7.5 meter depth for intracoastal trade vessels will be established; but it is possible with this flexible plan to extend the reclaimed land approximately 200 meters offshore which would provide a berth with water depth of -9 to -10 meters if the number of vessels larger than 10,000 DWT making port entry increases more than expected. However, in this case it will be necessary to increase the width of the wharf to facilitate cargo handling.

During this third phase, one transit shed with floor space of 6,000 m^2 will be constructed.

(5) Fourth phase and after (From 8th year of mine operation)

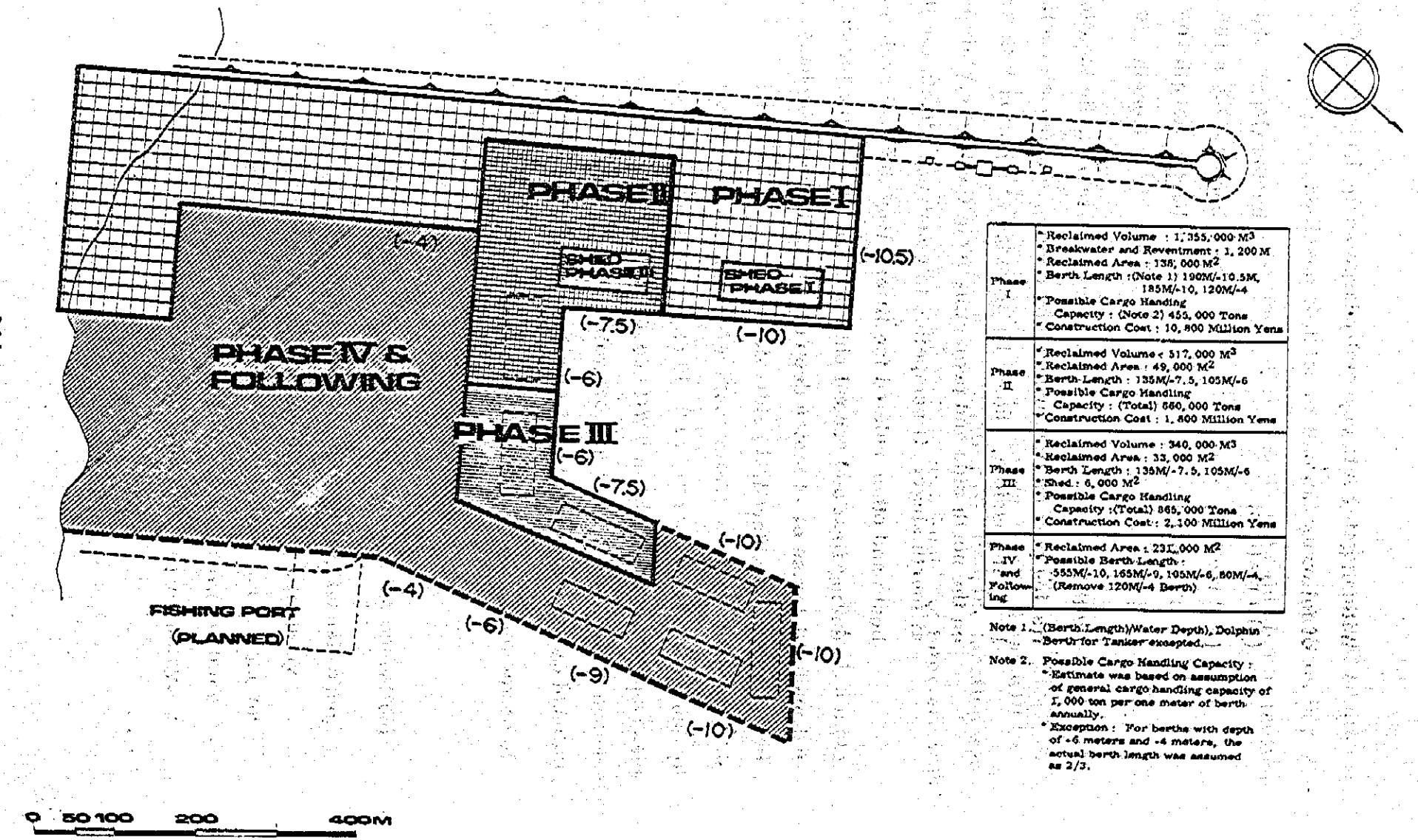
It is possible to construct mooring facility, transit shed, warehouse and distribution and processing center by reclaiming the area adjacent to reclaimed land in one or several phases according to transition of cargo volume handled and changes in vessel type making port entry.

Without going into especially large scale dredging, construction of following number of berth is possible:

(-10 meters)	3 berths (length 555 meters)
(- 9 meters)	1 berths (length 165 meters)
(- 6 meters)	1 berths (length 105 meters)
(- 4 meters)	(length 80 meters)

By this phase, if it is necessary to establish the location of fishing port or fish processing center, a separate reclaimed land, if possible, should be provided at location with water on the north side and projecting from the land reclaimed at fourth stage. If compelled to construct a basin for fishing boats and other related facilities along the land reclaimed during first and second phase, relocation in the future, as in the case of -4 meter deep quaywall in the first phase, should be considered.

FIG. 4-431 CONSTRUCTION PHASES AND SCALE OF WORKS



Phase I	* Reclaimed Volume : 1,355,000 M^3 * Breakwater and Revetment : 1,200 M * Reclaimed Area : 138,000 M^2 * Berth Length :(Note 1) 190M/-10.5M, 185M/-10, 120M/-4 * Possible Cargo Handing Capacity : (Note 2) 455,000 Tons * Construction Cost : 10,800 Million Yens
Phase II	* Reclaimed Volume : 517,000 M^3 * Reclaimed Area : 49,000 M^2 * Berth Length : 135M/-7.5, 105M/-6 * Possible Cargo Handling Capacity : (Total) 660,000 Tons * Construction Cost : 1,800 Million Yens
Phase III	* Reclaimed Volume : 340,000 M^3 * Reclaimed Area : 33,000 M^2 * Berth Length : 135M/-7.5, 105M/-6 * Shed : 6,000 M^2 * Possible Cargo Handling Capacity :(Total) 865,000 Tons * Construction Cost : 2,100 Million Yens
Phase IV and Following	* Reclaimed Area : 231,000 M^2 * Possible Berth Length : 555M/-10, 165M/-9, 105M/-6, 80M/-4, (Remove 120M/-4 Berth)

Note 1. (Berth Length)/Water Depth), Dolphin Berth for Tanker excepted.

Note 2. Possible Cargo Handling Capacity :
* Estimate was based on assumption of general cargo handling capacity of 1,000 ton per one meter of berth annually.
* Exception : For berths with depth of -6 meters and -4 meters, the actual berth length was assumed as 2/3.

4-4 Planning of Breakwater

(1) Layout of breakwater

The entire coastline of the proposed site for new port is affected by swells coming from the ocean, so it would be necessary to protect this proposed sea area with breakwater.

The swells coming to this area are generated by subtropical high atmospheric pressure over south Pacific and the predominant wave direction is overwhelmingly SSW followed by SW direction while 56 % of the wind is from southwesterly direction and 41.6 % from southerly direction. The breakwater was located to prevent invasion of waves from these directions.

Since a calm anchorage is required for offshore cargo handling and the water depth in the harbor is not sufficiently deep for anchorage a long breakwater required to protect the water area and mooring facilities are planned for this port by year 1990.

For this reason, Pacasmayo Bay will be utilized as much as possible by extending the breakwater from vicinity of the existing lighthouse at Pacasmayo Cape on south side of Pacasmayo Bay. As result of study of wave diffraction in a harbor with breakwater constructed for predominant wave, with period of 6 - 15 seconds and direction from SSE to SW, it was decided to construct the breakwater in a straight line in N 37°30'W direction. In the case of breakwater with length of 1,200 meters, water depth at extreme end of the breakwater arm will be -10.7 meters; and the transport of sea bed sediment at this location is believed to be small so invasion by littoral drift should not be great.

The coefficient of wave diffraction in the harbor, in the case of swell from SW and SSW, is shown in Figures 4-441 and 4-442. It is judged that sufficient calm will be obtained at pier location.

In the case of predominant wave direction of SSW and wave period of 15 seconds and attacking wave from SW with wave period of 15 seconds having the greatest effect inside the harbor, the comparison of offshore wave and wave direction at various points in the harbor is shown in Table 4-441. According to this table, for a wave height of 4.90 meters and 50 year probability and 70 % safety factor, sufficient calm within the harbor can be secured.

FIG.4-441 DIFFRACTION DIAGRAM FOR INSIDE OF PORT (SW16SEC)

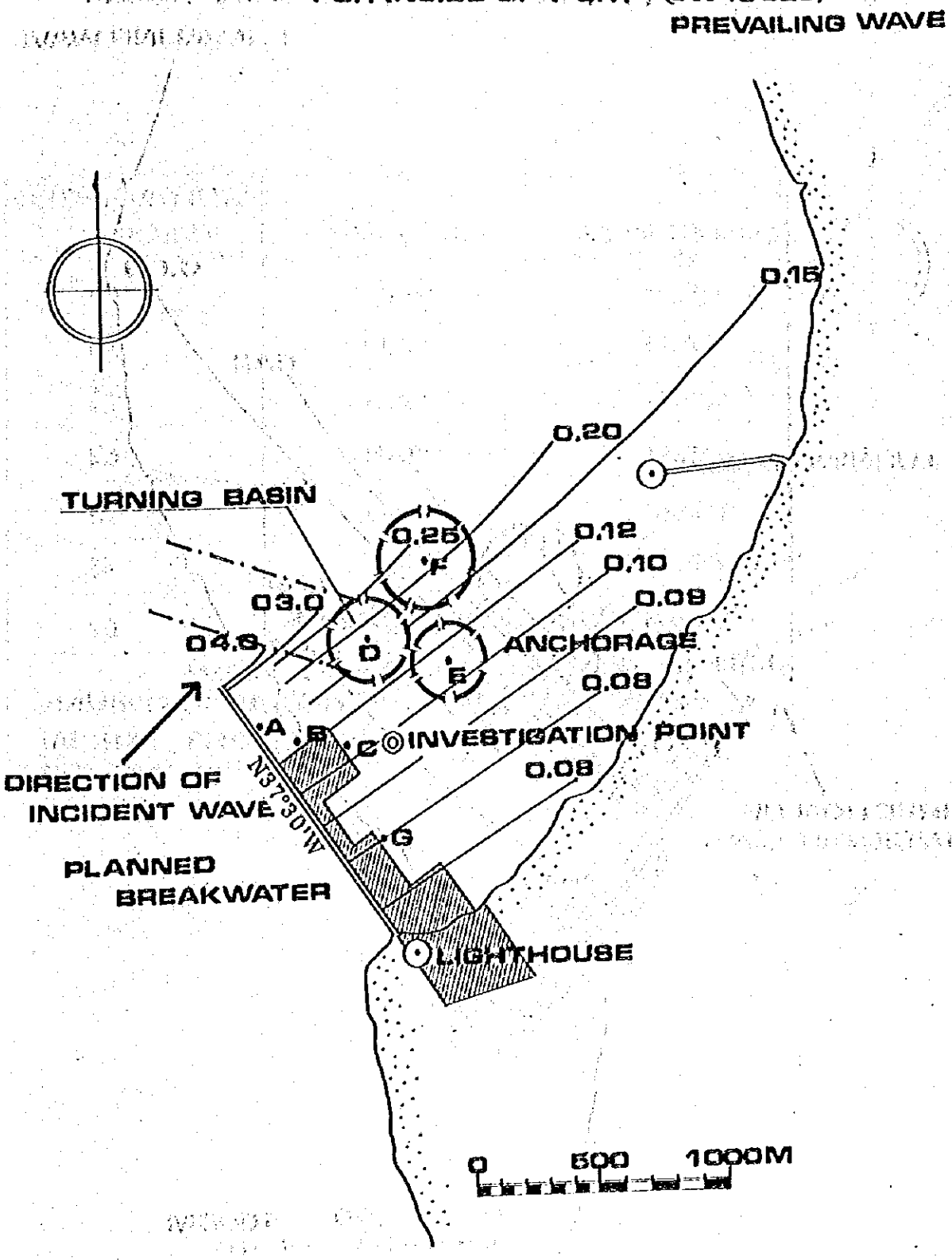


FIG.4-442 DIFFRACTION DIAGRAM FOR INSIDE OF PORT (SSW 15SEC)

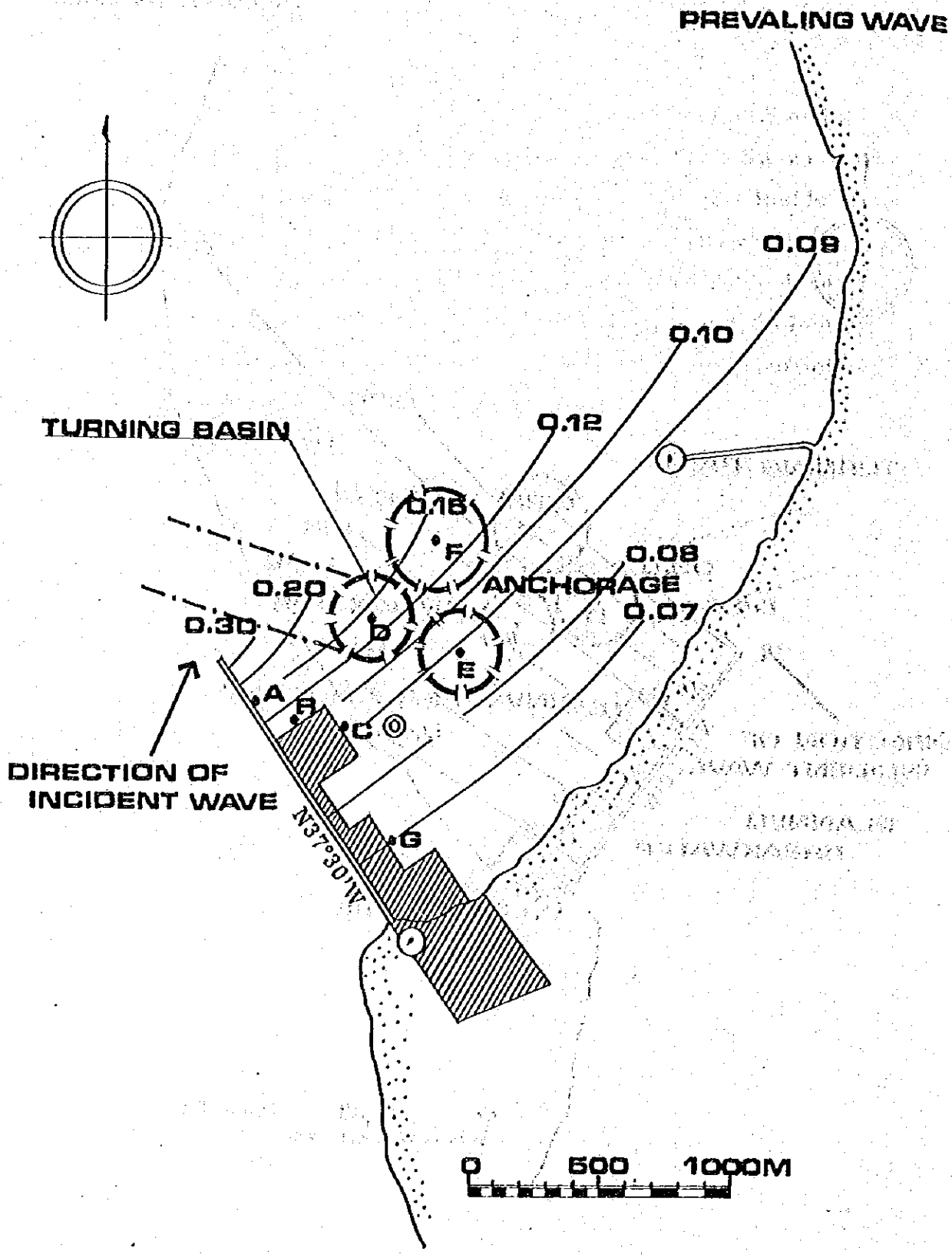


Table 4-441 Comparison of Offshore Wave and Wave Height at Various Points Inside The Port

OBSERVATION POINT	SW15 SEC	SSW15 SEC
A	0.16	0.15
B	0.13	0.11
C	0.11	0.085
D	0.17	0.14
E	0.11	0.09
F	0.22	0.14
G	0.08	0.075
WAVE DIRECTION HAVING GREATEST EFFECT INSIDE THE PORT		DIRECTION OF PREVAILING WAVE

(2) Breakwater structure type

From following 6 reasons, rubble mound type breakwater structure was adopted.

1. Suitable land for caisson fabricating yard is not available.
2. In vicinity of Pacasmayo and at least to Salaverry 130 km south, there is no basin for anchoring construction craft for caisson work.
3. This entire seashore is a shallow beach and a breaker zone, so the section that construction craft cannot operate in is very long.
4. Although the haul distance may be long, a suitable quarry for armor stone can be secured.
5. Rubble stone for core of the breakwater may be slightly small in size but the stones are available at shore end of the breakwater.
6. The sea bed is not a soft clay layer, so there will be almost no fear of sliding even in the case of end-on system of breakwater construction.

However, since the distance to quarry is 15 km it will not be economical to obtain and haul all armor stones for the breakwater from this quarry. For this reason the secondary armor stones required from mid-point to extreme end of the breakwater will be made of concrete blocks weighing from 12.5 tons to 25 tons. For rocks below this secondary armor, materials from the quarry or near the breakwater will be used.

The area in the north and towards shallow water from point 400 meters from extreme end of the 1,200 meter long breakwater will be reclaimed as site for port terminal facilities

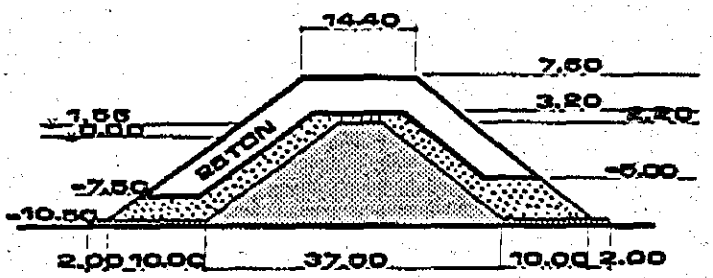
and this section of the breakwater will be used as seawall.

Typical section of breakwater and seawall is shown in Figure 4-443. Wave height of 4,90 meters was used for design purpose. Breakwater section must be determined with the assumption that wave overtopping will not be allowed. If C-stone of sufficient size indicated in Figure 4-443 is not available near the breakwater, these stones must be obtained from a quarry.

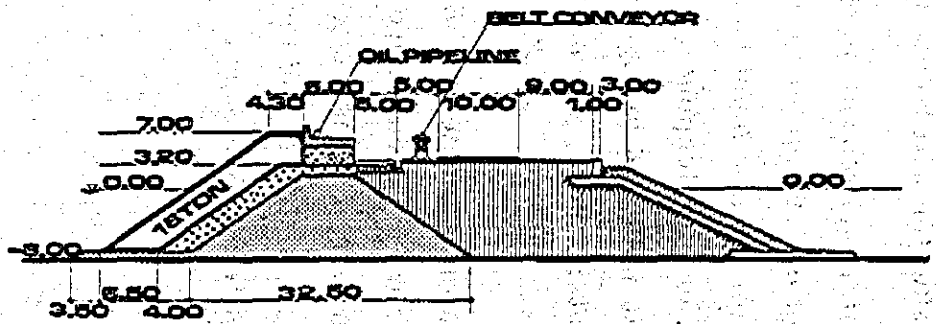
The section of the breakwater was determined to permit construction of breakwater wholly from shore end and from top of the breakwater, however, for inspection work, diving operation and works at extreme end the use of construction craft would become necessary.

FIG.4-443 TYPICAL SECTION OF BREAKWATER AND REVETMENT(1)

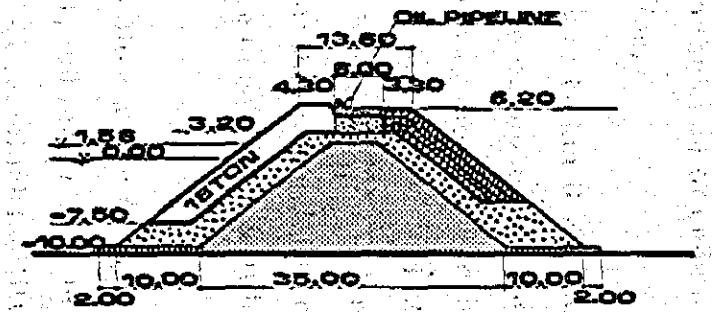
A-A SECTION EXTREME END



C-C SECTION L=320M



B-B SECTION L=400M



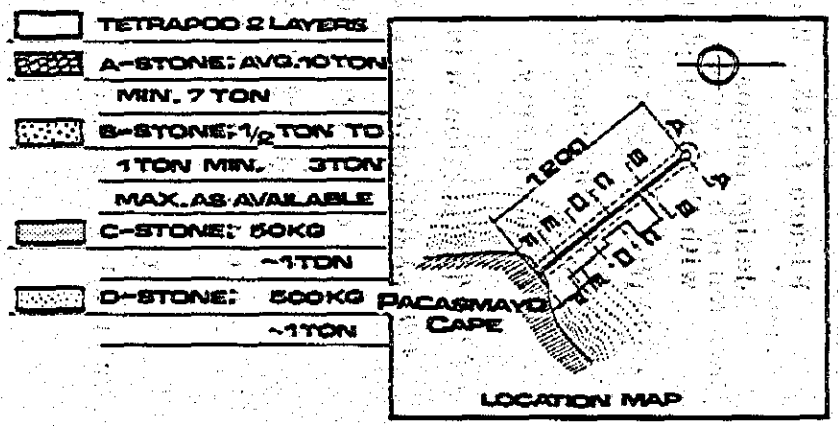
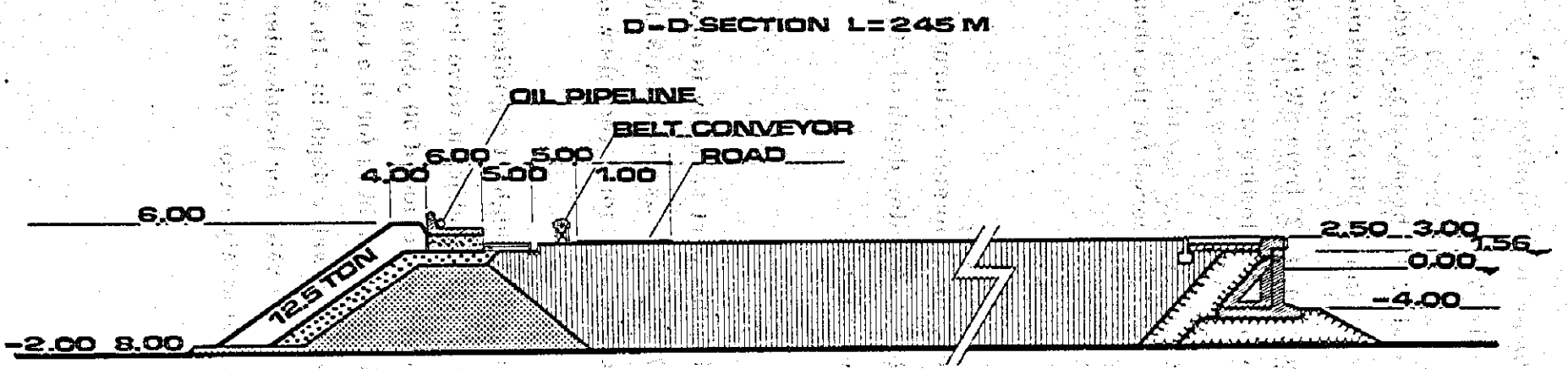
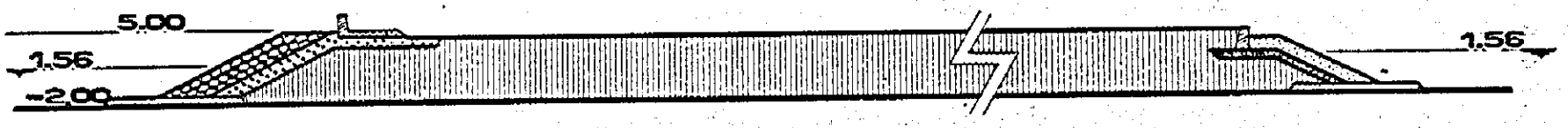


FIG.4-443 TYPCAL SECTION OF BREAKWATER AND REVETMENT(2)





4-5 Planning of Channel and Anchorage

(1) Channel (Figure 4-451)

Wave direction at extreme end of the breakwater predominantly from SSW with SW direction is slightly confirmed.

Channel was laid out in direction of 52° from SW in order to avoid bad control of ship due to following of sea during port entry at low speed.

Water depth of -11 meters will be secured for the channel with a width of 300 meters.

(2) Ship turning basin

Based on the use of tug boats, the diameter of turning basin was established as 330 meters. A water depth of -11 meters will be secured for the turning basin.

(3) Anchorage area

The number of ships utilizing this port annually is about 140 ships and of this number 97 ships are assumed as 3,000 to 10,000 DWT class so anchorage area for 2 vessels was provided.

From extreme probability of annual highest significant wave height shown in Figure 4-453, the significant wave height will be 4.90 meters when a return period of 50 years is assumed. The value of this wave height is for the extreme point of the breakwater where the water depth is -10.5 meters and this value is the same as the value for breakwater when life expectancy of 50 years and safety factor of 70 % are assumed.

If direction of this significant wave with height of 4.90 meters is from SW with wave period of 15 seconds, from the wave height in wave diffraction diagram shown in Figure 4-441.

At location F' for 10,000 DWT ship :
The wave height = 4.9 m x 0.22 = 1.08 m < 1.5 m

This wave height can be assumed to be within the limit of wave height for anchorage area.

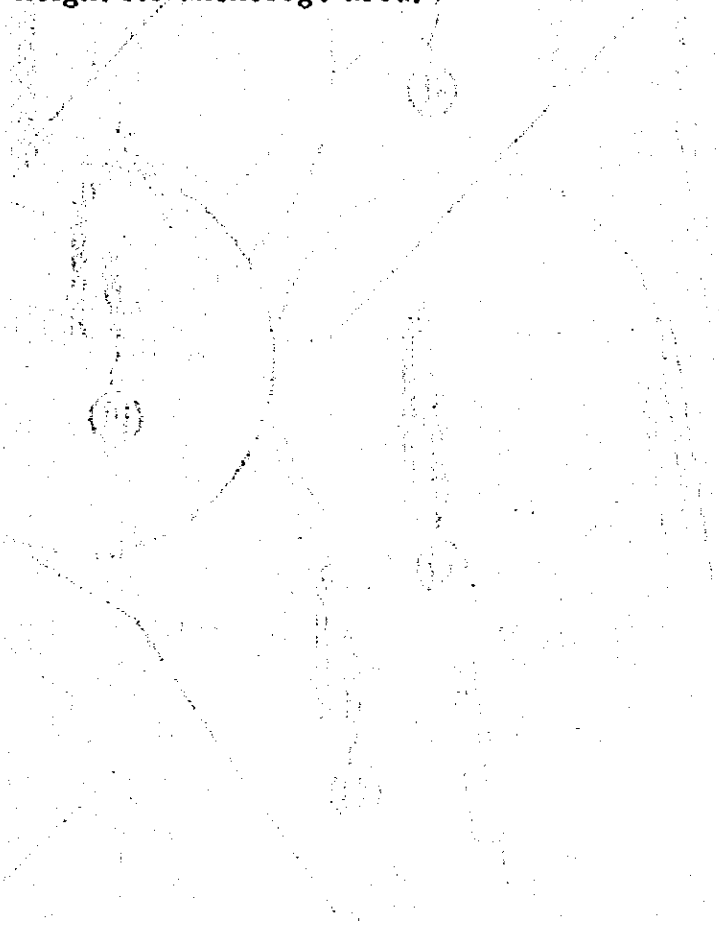


FIG.4-451 DREDGING PLAN

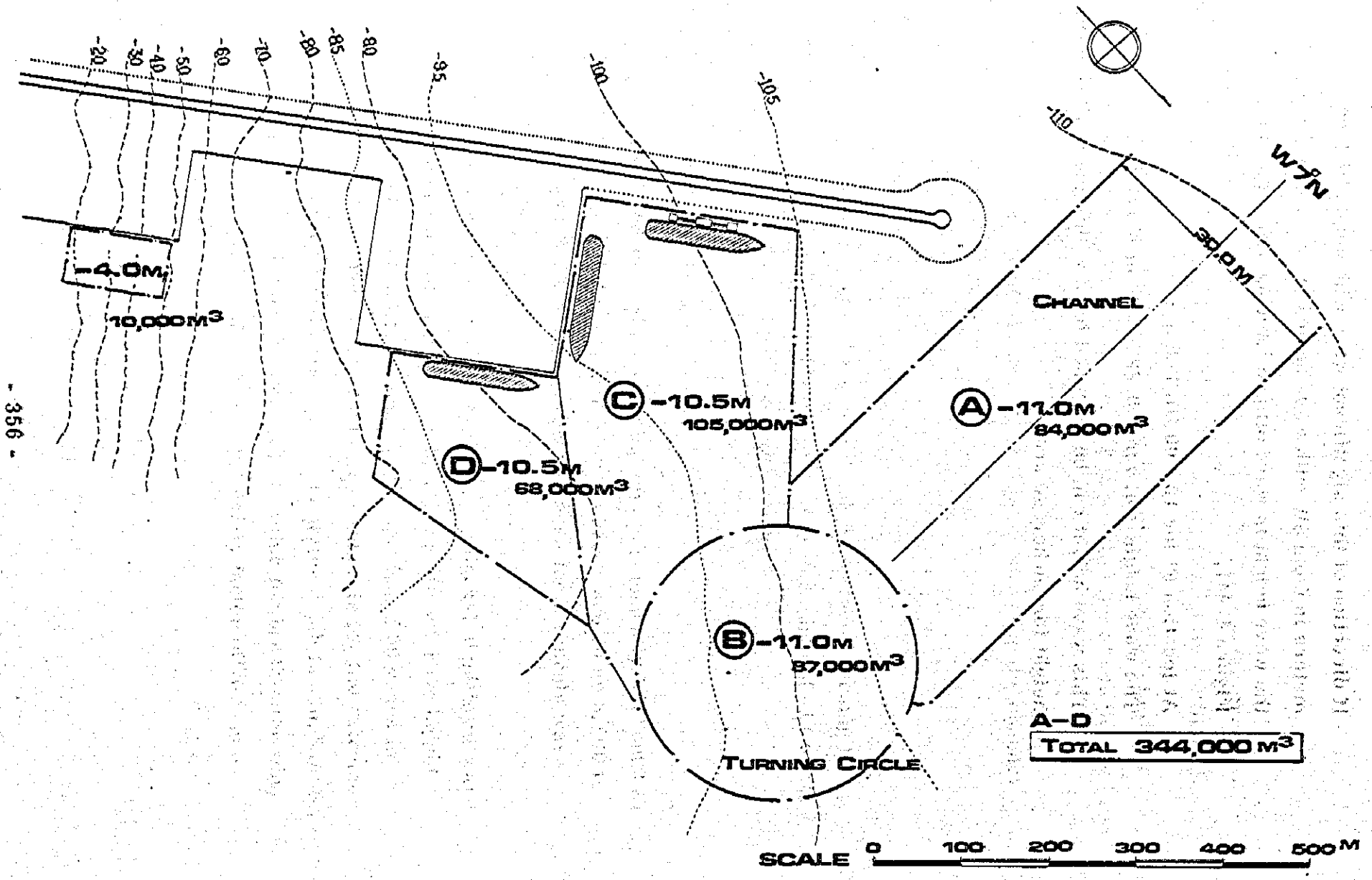


FIG.4-452 ANCHORAGE PLAN

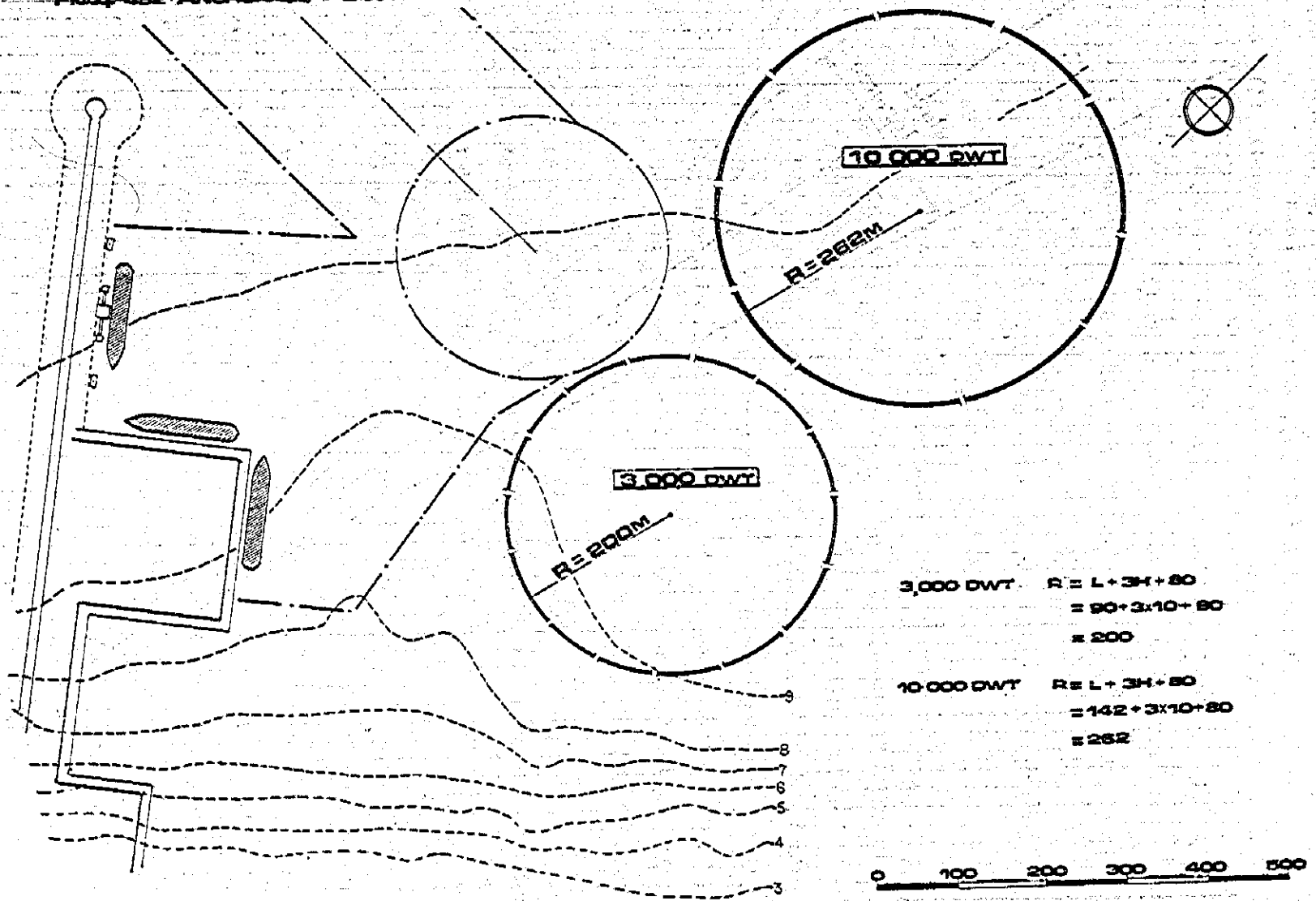
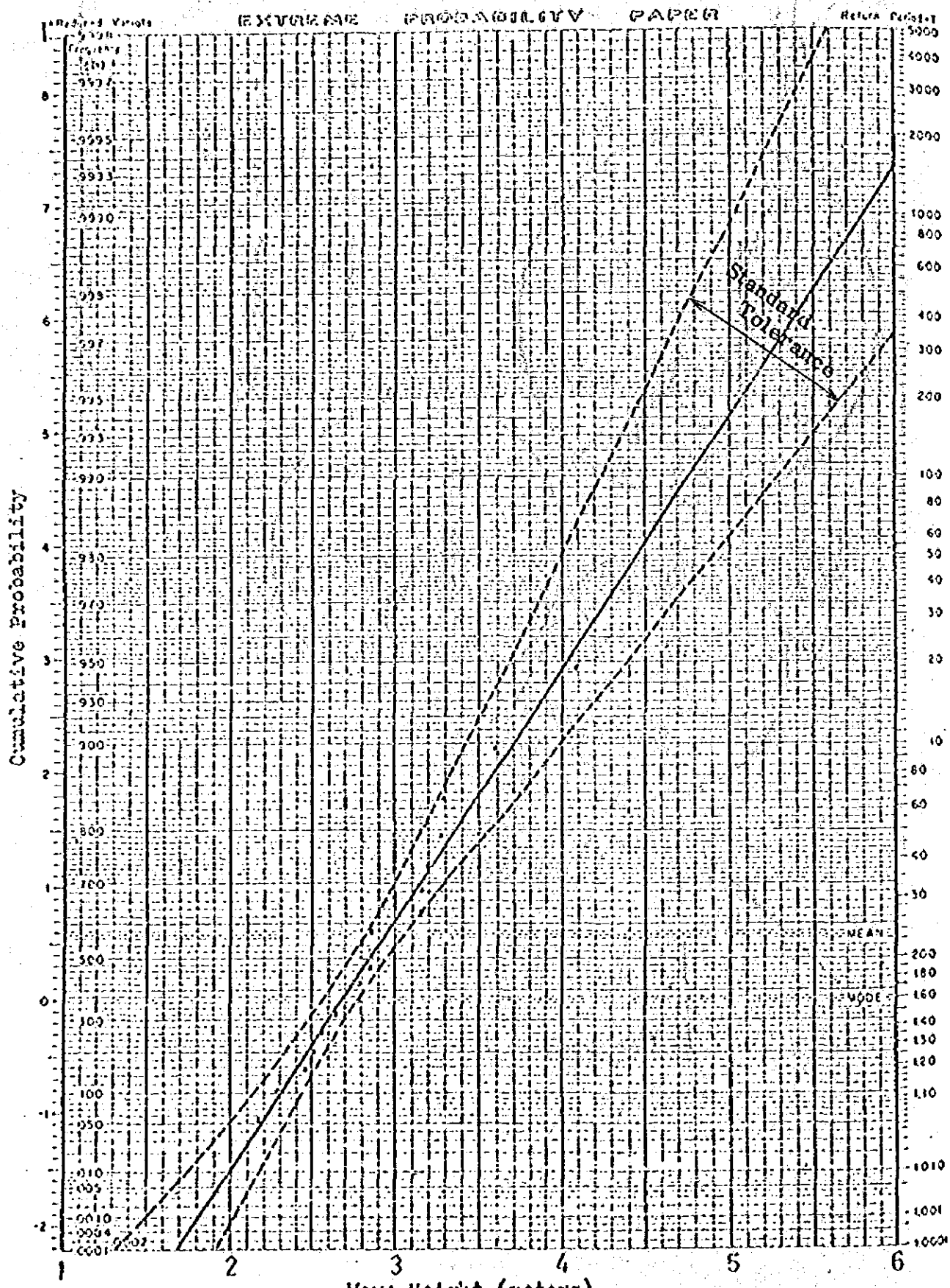


FIG. 4-453 DISTRIBUTION OF ANNUAL HIGHEST SIGNIFICANT WAVE HEIGHT

at Point A (-10.5m), Pacasmayo, Peru



4-6 Planning of Mooring Facilities

(1) General cargo wharf and ore wharf

As can be seen in wave diffraction diagram shown in Figure 4-441, the wave height ratio is 0.11 and 0.13 at locations for 15,000 DWT general cargo ship and ore ship berth respectively, so it is judged that water would be calm enough at these locations to permit cargo handling at all times while the ships are moored.

Below the sea bed at location for mooring facilities, and at relatively shallow place, a layer of gravel and layer of bedrock directly below exist, so a gravity type wharf structure using caisson would be the best method; but from construction schedule the construction of wharf must go together with breakwater construction so an open-type wharf on pile using self elevating platform was selected which would permit construction even under action of waves.

In the case of pile, it was judged that driving pile into this bedrock would be impossible, so a method of grouting cement milk around wharf piles lowered into holes drilled with 950 mm diameter rock bit after pitching casings of 1,100 mm diameter from self elevating platform was adopted. The depth of pile embedment must be determined after obtaining detailed data for this bedrock; but at this point, types of wharf shown in Figure 4-461 and 4-462 were considered.

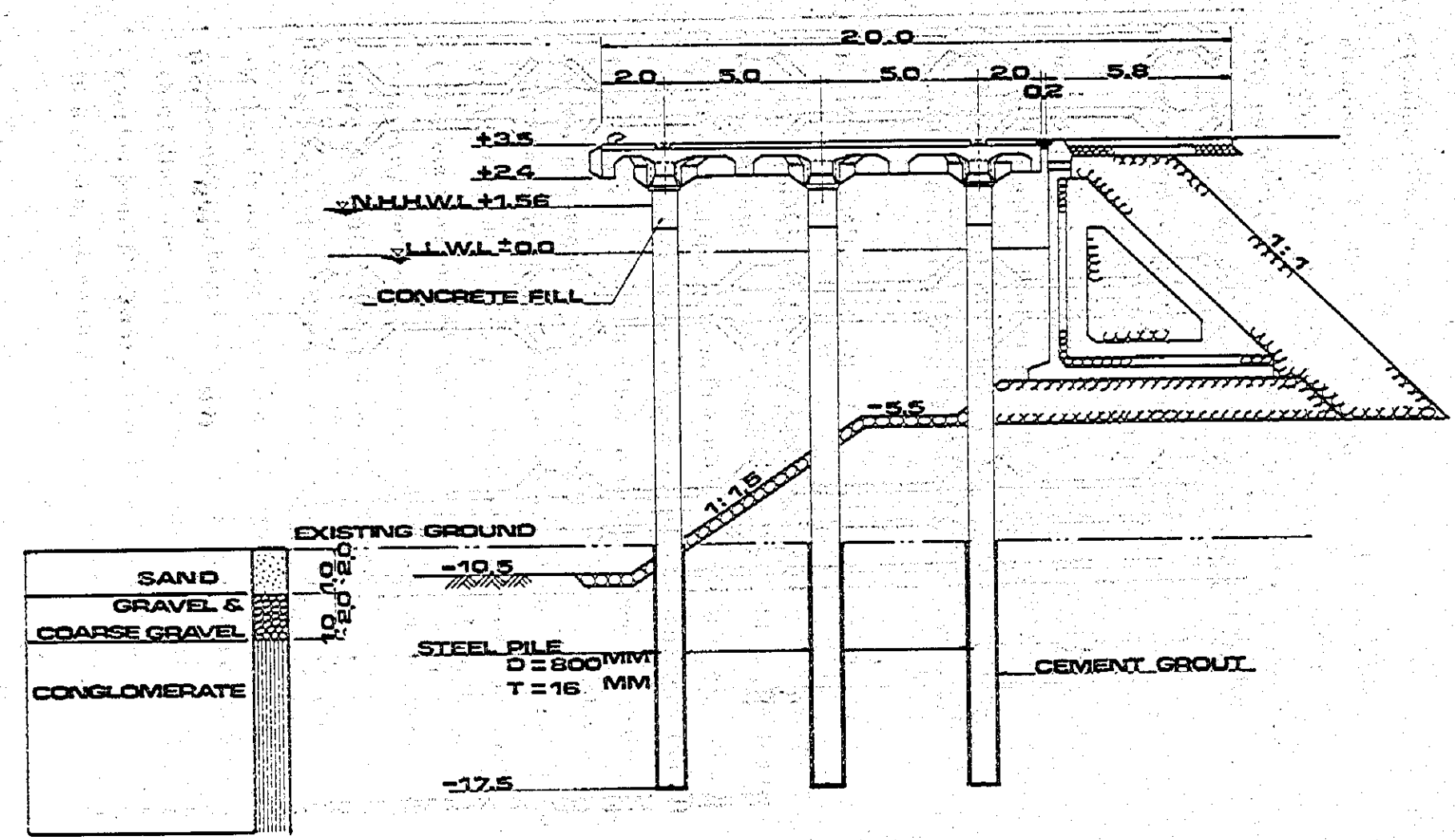
The retaining wall portion of this wharf will be of gravity type structure using L shaped concrete blocks.

Considering the layers of gravel and bedrock below the sea bed, the berth water depth was made 50 cm deeper than normal depth; but the wharf structure for both -10 meter

deep general cargo berth and -10.5 meter deep ore berth will be of same type.

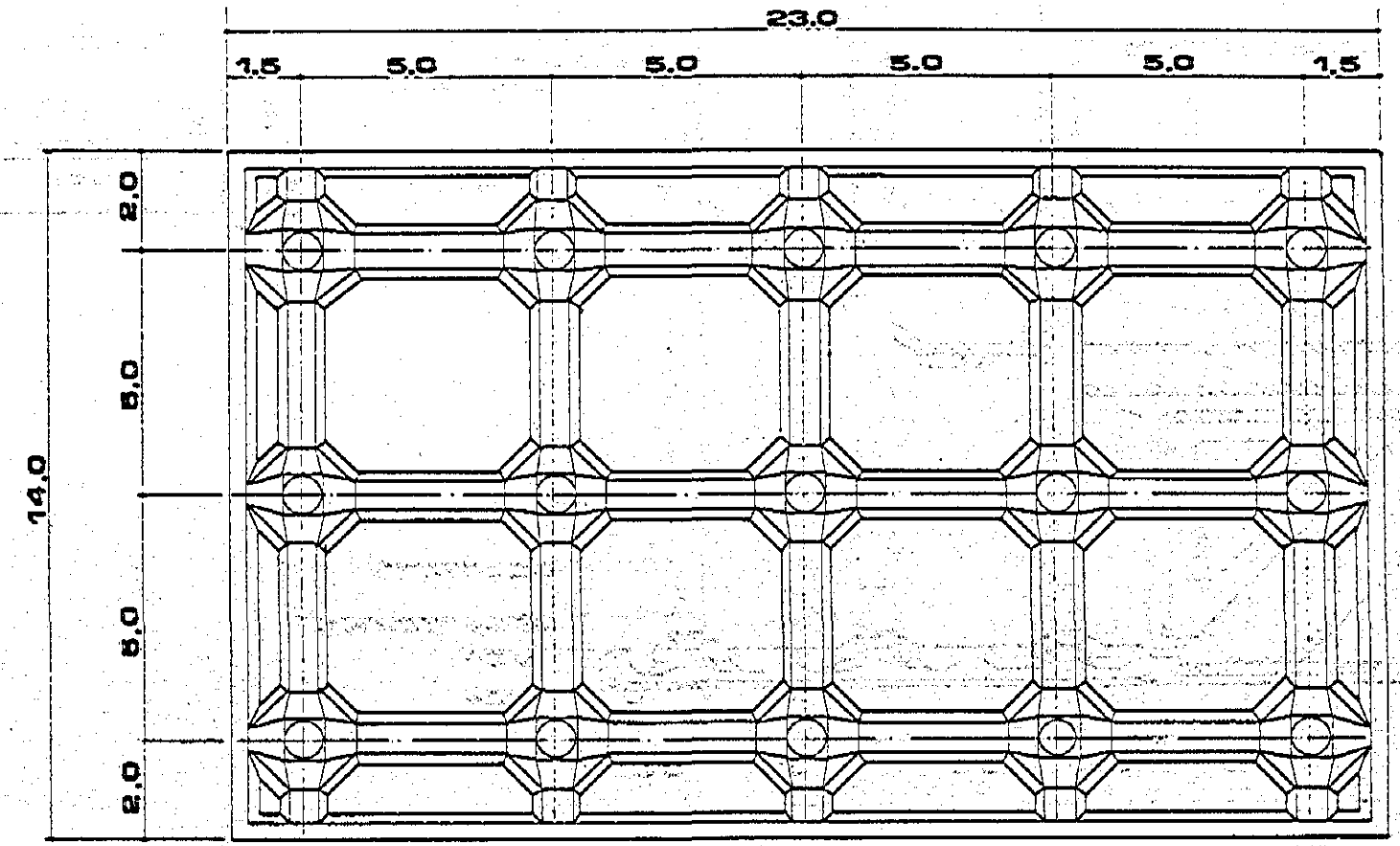
Pile diameter will also be determined after obtaining necessary informations on the bedrock condition.

FIG.4-461 (-10.5) TYPCAL SECTION OF PIER (1)



B TYPCAL SECTION

FIG.4-462 TYPICAL SECTN OF-10.5M PIER (2)



B PLAN

(2) Planning of small quaywall

Frequent port entry by small cargo vessel is anticipated and since these vessels will be handling necessities of life, perishables and raw materials needed by small local industries, a small quaywall for these ships is provided.

Berth for small cargo vessel and lighter :

-4 meters x 120 meters

Depending on the changes in scale and structure of each related industry, the berth, location and water depth were selected with possible rearrangement of berth utilization becoming necessary after the second phase of construction.

A. Berth for small cargo vessel

In planning of berth for small cargo vessel, it was assumed that half of the cargo for domestic trade would be carried by 3,000 DWT ships and handled offshore with lighters; and since the distance from Pacasmayo Port to Salaverry Port is a relatively short 66 miles, it is highly possible that a certain percentage of intracoastal trade between Salaverry and Pacasmayo Port after completion of calm anchorage area would be handled by cargo vessels of 3,000 DWT or smaller. Chimbote Port located approximately 58 miles south of Salaverry Port is alo favored with an excellent harbor, so there is a sufficient basis for increasing the activities of these classes of cargo vessel between these ports.

If there is no sizable volume of freight it would not be economical to haul this very small amount of freight for a short distance; and so it would be difficult to attract freights carried presently by trucks and trailers to this port. For this reason, although the future method of transportation

may be by car ferry, at this present stage, transportation of cargo would surely be mainly with small cargo vessel, so a quaywall for berthing small cargo vessel was planned. A 300 G/T cargo vessel was selected as the type of ship berthing at this quaywall after taking into consideration that goods carried presently by trucks and trailers will be hauled by a small ship after sizeable volume has accumulated.

If cargoes for 2 - 300 G/T ship are handled simultaneously, a 80 meter long (2 x 40 m) berth will be required. Remaining 40 meters is to be used by lighters; but water depth of -4 meters was provided to permit use of this berth by 300 G/T craft also.

Gravity type structure for quaywall was selected due to anticipation of coarse gravel bedrock foundation. Since there will be almost no effect of differential settlement and if the use of large crane for setting large deformed block is possible, quaywall structure will be constructed of large L type concrete blocks.

The location of the quaywall was determined with the rule of not deepening the present water depth to great extent.

B. Quaywall for lighters

In this plan a portion of cargoes carried by 3,000 DWT and 10,000 DWT vessels is to be handled offshore by lighters; but when -10 m and -10.5 m berths are not occupied it is possible to handle cargoes for these vessels whiled berthed, so there should not be a great deal of total offshore handling; but at initial stage offshore handling cannot be disregarded in clearing the anchored ships during time of congestion. For 200 DWT lighter, a berth with water depth of -2 meters

would be sufficient; but it is planned to allow berthing of small cargo vessel as well.

For unloading lighters, the existing pier crane, depending on its condition, can be relocated and used at this quaywall.

C. Mooring facility for fishing craft

At present, consolidation of modern fishing port having a fish processing factory is progressing in the country, especially in northern Peru, so it is believed that at this stage Pacasmayo region is not considered as base for exporting animal protein feed or processed sea food or base for supplying protein to the people of Peru. However, besides the principal fishing ports, each port is in its own way taking active part as source of supply for low priced foodstuffs and this activity must be continued into the future.

During of investigation in March 1976, tens of small fishing craft were moored at existing pier in Pacasmayo Port. These crafts consisted of around 70 G/T anchovy boats to 10 G/T boats that fished several miles offcoast of Pacasmayo from night to early morning and the hauls were sold to the residents at open market located at base of the pier.

Although a small scale business, the activity of this small scale market that is responsible for supplying the daily requirements of protein to the people of Pacasmayo City should be able to cover a greater sphere of consuming area if favored with appropriate facility and means of transportation.

Access to existing pier from the fishing boat is by a weak step that cannot be claimed to be stable and safe in case of high wave. After fish haul is unloaded from fishing boat with ENAPU owned 1 - 3 ton crane, the haul is loaded onto

rail truck and hauled to open market at base of the pier. Quantitively, the fish haul is insignificant and considering the 6 family members on a 10 ton boat and engine maintenance and fuel cost, a measure for stabilizing the basis of livelihood must be considered.

If,during construction of a new port, a small craft basin is provided for safe mooring of these small fishing crafts, some question will remain as to possibility of attracting these crafts to the small craft basin for the existing pier is close to center of Pacasmayo City; and although the distance is slight, it would be difficult for the fishers and people to leave the existing pier.

By the construction of new breakwater, the wave height may become smaller at existing pier so it will become even more difficult for fishermen to leave this pier, but even if the fishing crafts are moved to small craft basin in the new port to avoid high maintenance and repair cost of this old facility, basin for small fishing craft adjacent to lighter berth in the new port was planned after fully considering means of increasing the fishermen's actual income by securing well adjusted organization and adequate transportation system at same time.

It is considered not necessary to provide a quaywall especially at this stage; but consideration must be given to facilitate movement of fisherman from boat to pier or boat to boat and maintenance of crafts.

Since fish hauls are unloaded in short time during early morning hours and from the small number of crafts, the use of the portion of -4 meter deep quaywall is recommended where crane used for handling lighter cargo can be utilized.

When the number fishing crafts entering port and fish haul increase, construction of suitable wharf in line with this berth should be considered; but if this area is to be reclaimed, a facility with scale corresponding to size of fish haul should be planned.

When seafood processing factory and fish market become necessary, it would be desirable, in principle, to construct a permanent fishing port along the planned revetment for 4th phase of construction as shown in Figure 4-431 no matter how the reclamation work for the commercial port is progressing.

In any case, plan must be made and carried out with flexibility in accordance with regional demand for marine products.

4-7 Planning of Cargo Handling and Port Terminal Transportation Facilities

(1) Cargo handling facility

Layout plan of facilities in terminal area behind of ore and general cargo berths was determined as shown in Figure 4-471. In order to handle cargoes speedily, transit shed No. 1 is provided with enough floor space of 6,000 square meters. Open storage yard is located behind this shed and motor pool for cargo handling forklifts and cranes, repair shop, dining room and shower room for cargo handlers are also planned in this area. Administration office for transit shed will be located on 2 floors in the shed.

As can be seen in section plan shown in Figure 4-472 the shed entrance is given sufficient height and width for easy loading of trucks and trailers.

The apron in front of the shed is 30 meters wide with consideration given to facilitate movement of freights directly from the shed with truck or trailer. This is very important for small intracoastal ships are planned to be handled at this wharf.

At ore loading berth, a travelling loader and a belt conveyor to move copper concentrates to the loader are to be installed. Both are assumed to be of 600 ton/hr capacity, but when ore carrier is not moored at this berth a general cargo vessel will utilize this berth, so in order to handle cargoes swiftly and smoothly a wharf with sufficient area to permit a maximum use of wharf space must be considered; but a restudy of location and height of belt conveyor must be conducted when determining the type of ore carrier.

FIG.4-47 WHARF FACILITY

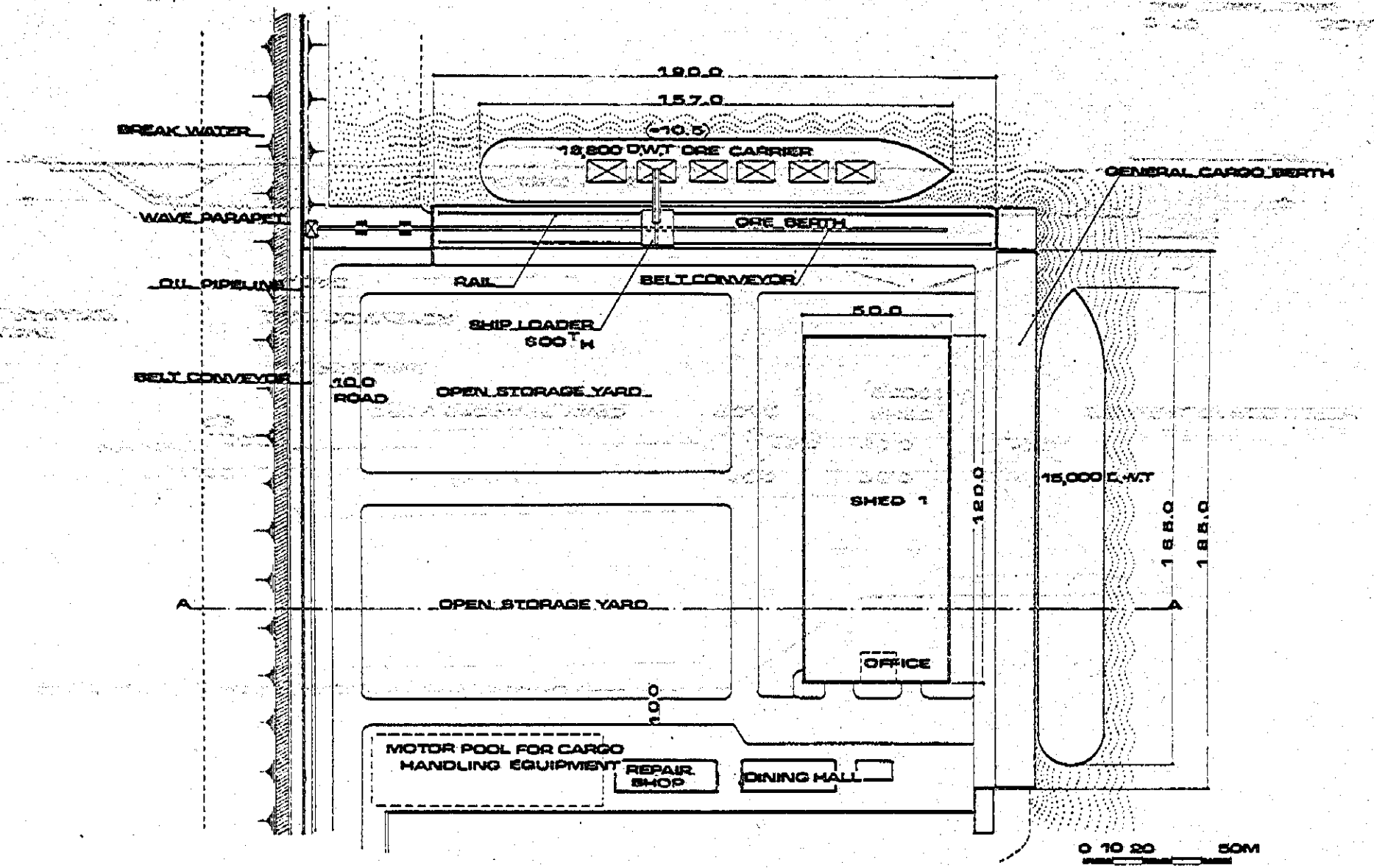


FIG.4-472 WHARF FACILITY (A—A SECTION)

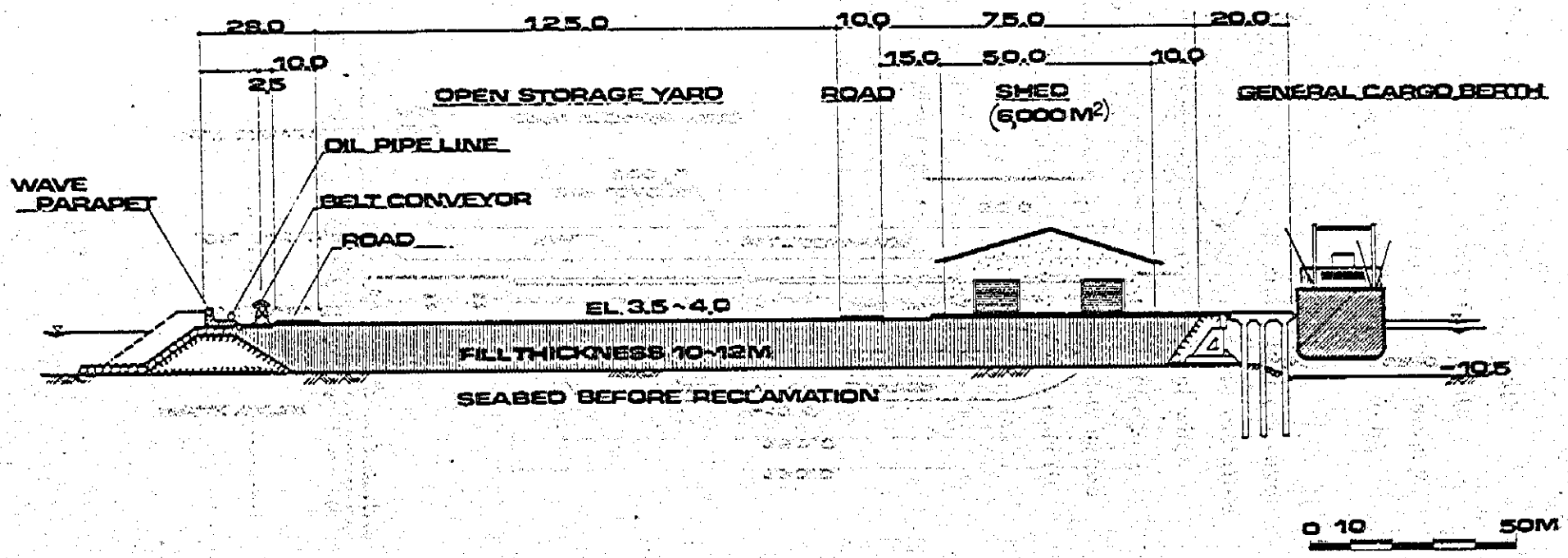
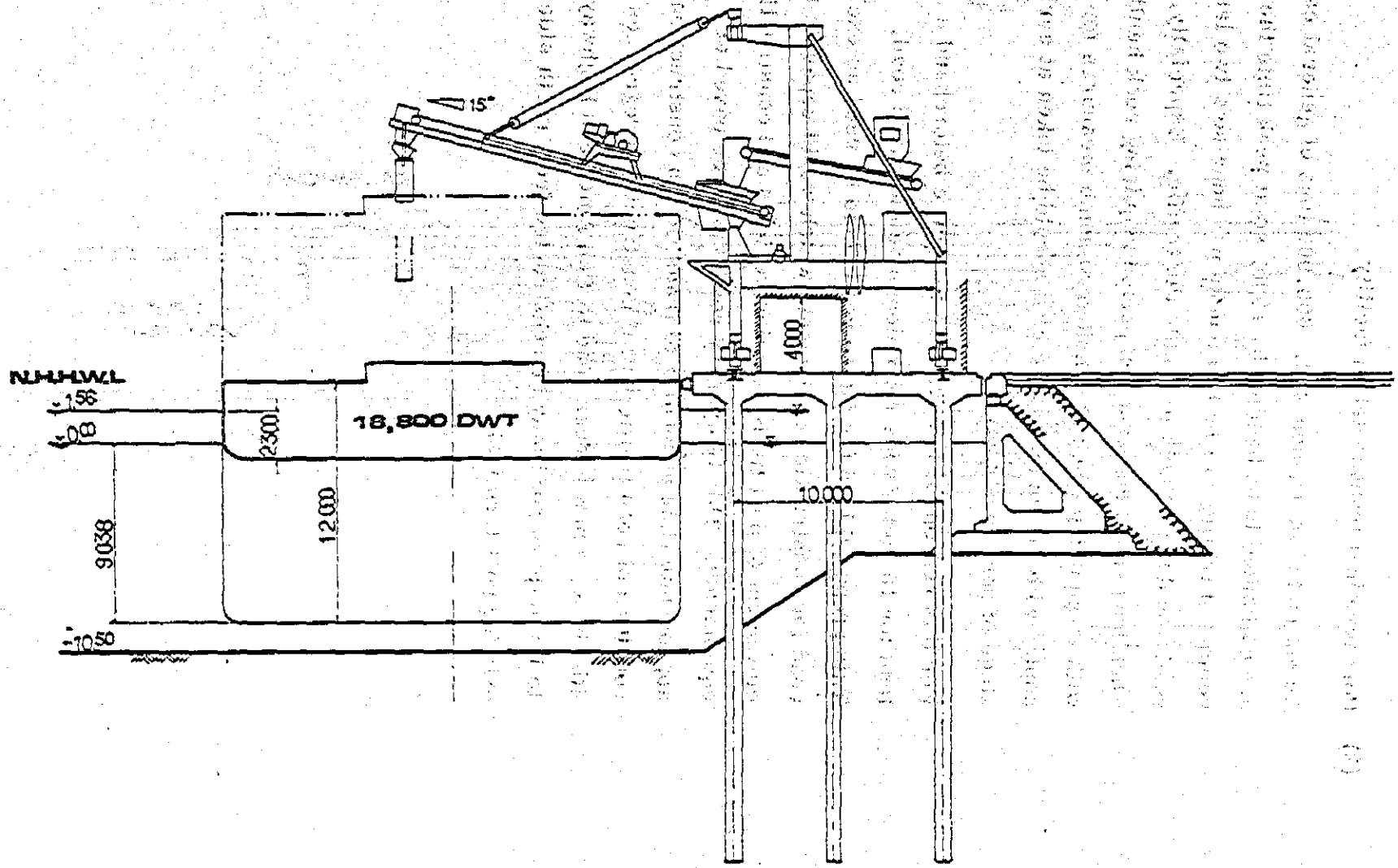


FIG. 4-473 COPPER ORE LOADER 600 T/HR

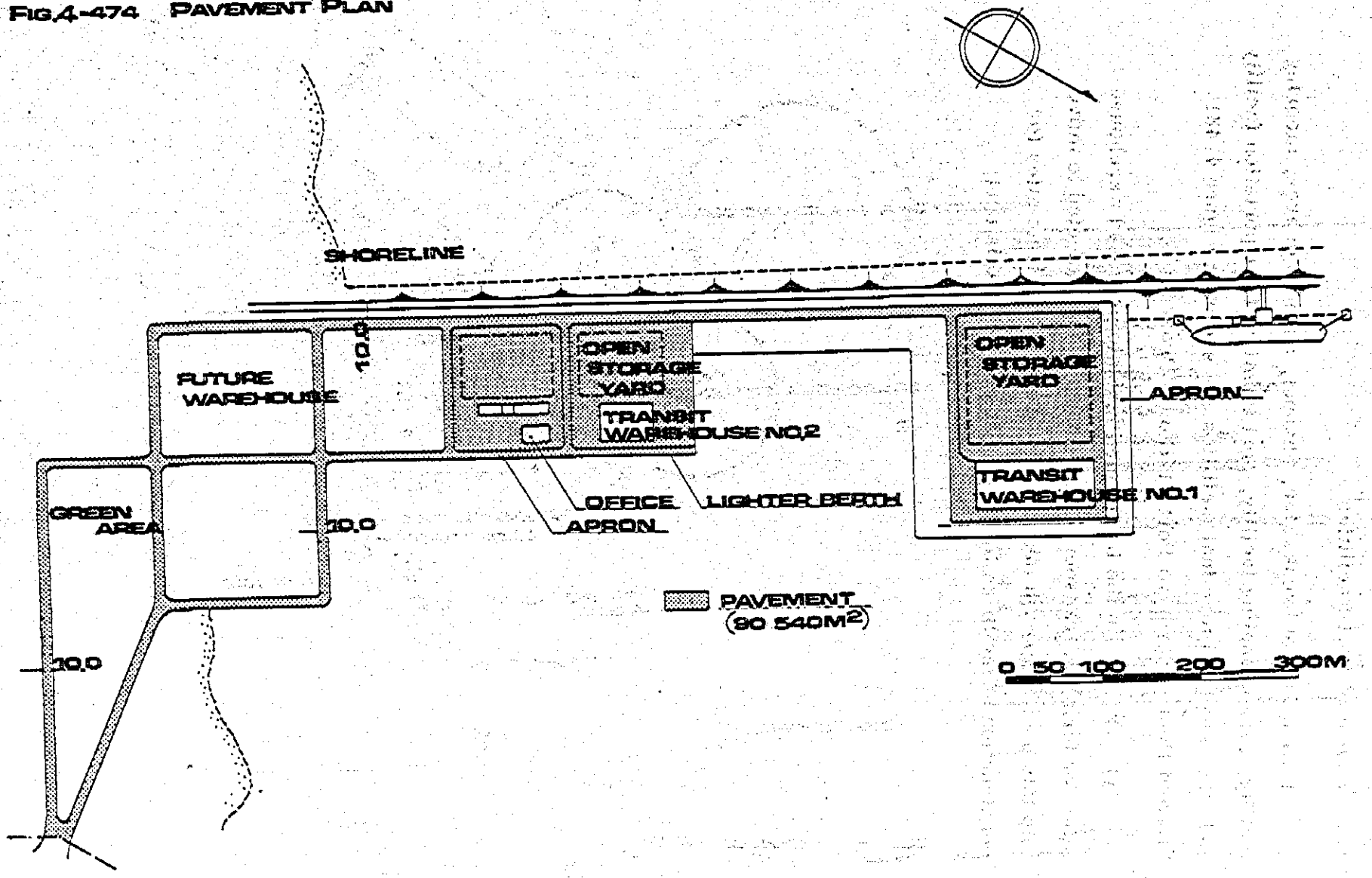


(2) Port terminal transportation facility

As estimated in Clause 4-2, 600,000 tons of general cargo are estimated to be handled by 1990, so at peak time the volume of traffic will be 665 trucks per hour so a two lane road would not be able to handle the traffic. Especially, when long range construction period requiring rock hauling with large dump truck is considered some measures for coping with the future traffic load should be taken at early stage of port construction.

For this reason, it is advisable to secure beforehand a land for 10 meter wide road alongside the paved road. This proposed land for future road could be used as exclusive road for construction equipments which would separate the movement of port transportation vehicles and construction equipments. This temporary road should be paved at appropriate time according to transition in construction and condition of road traffic; but if construction progresses to 4th phase, a new access road to Pan American Highway or to its by-pass road may be constructed from north side of existing port terminal.

FIG.4-474 PAVEMENT PLAN

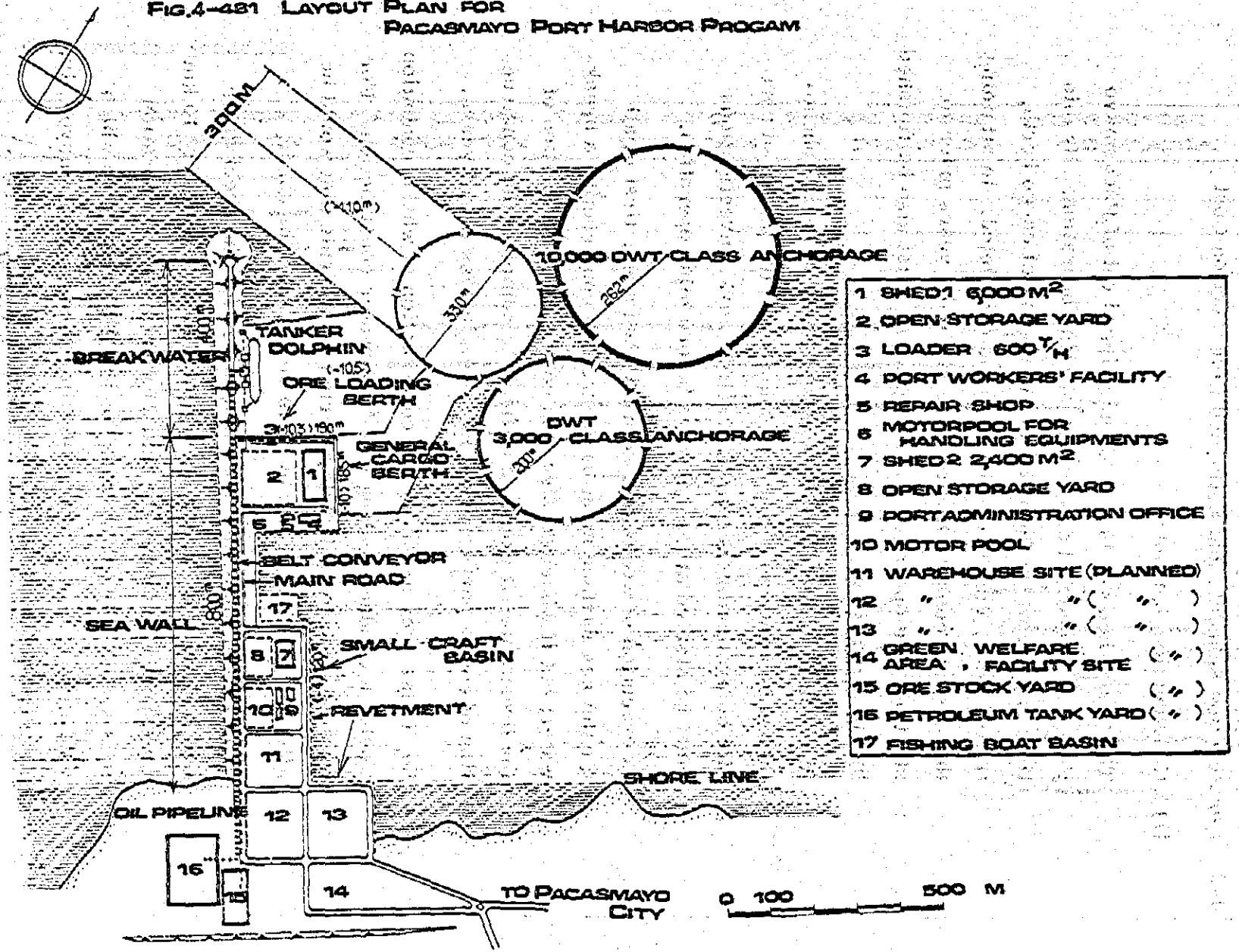


4-8 Layout of Port Facilities

Layout plan of breakwater, channel, anchorage area, mooring facility, cargo handling facility, port terminal transportation facility and other required terminal facilities are shown in Figure 4-481 "Layout Plan Pacasmayo Port Harbour Program".

11 12 13 in the layout plan indicate proposed warehouse sites for terminal transportation firms that are expected to move into this port as growth takes place. 15 16 indicate sites for construction of facilities by enterprises utilizing this port.

FIG.4-481 LAYOUT PLAN FOR PACASMAYO PORT HARBOR PROGAM



4-9 Construction Schedule and Estimated Construction Cost

(1) Construction schedule

The year when ore is loaded and shipped out of Pacasmayo Port was scheduled as the year of mine operation. By this time, public wharf facilities such as general cargo berth, transit shed, etc. are assumed to be completed. In attaining this target, construction must be started 4 years prior to start of mine operation and design work must also be finished by the same time.

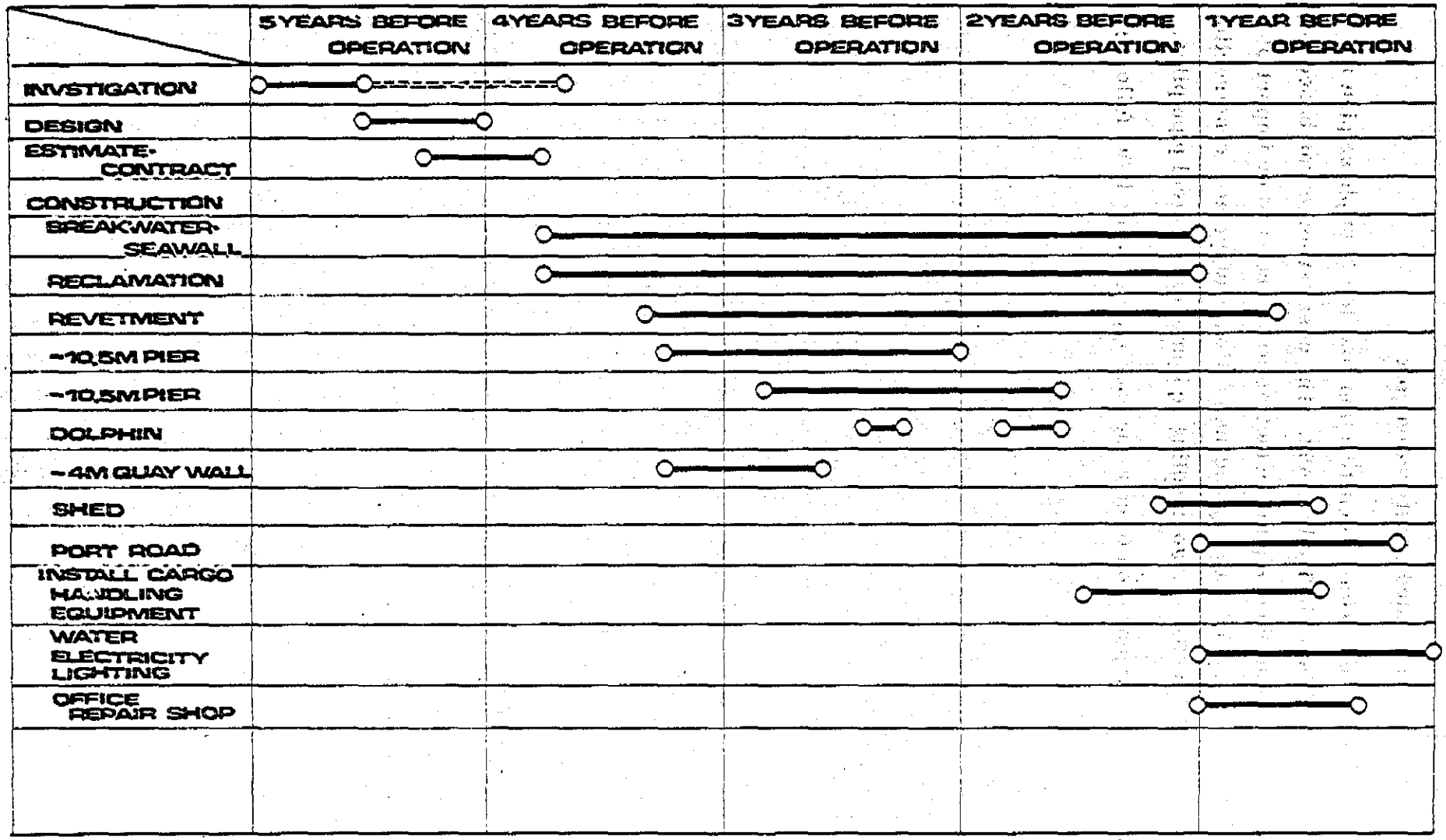
In order to obtain continuous data related to marine phenomenon and data on bedrock in sea area of the proposed port site before commencing construction work, investigations must be started at least 5 years before mine operation.

In execution of works on sea in this sea area, first of all a calm sea surface must be secured by constructing a breakwater; but if wharf construction comes after completion of the breakwater, it would be difficult to complete the construction of entire port terminal facilities in less than 4 years.

So, it has been assumed that construction of wharf foundation would be conducted along with breakwater construction. For this construction schedule, marine equipments that would be affected relatively little by wave action must be used.

A portion of the armor stones required for the breakwater will be hauled in from a quarry located approximately 15 km from port site and by the time of starting haul operation it is assumed that a by-pass road will be completed which will allow trucks to avoid travelling through Pacasmayo City.

Table 4-491 Construction Schedule



(2) Estimated construction cost

Approximate construction cost for first phase plan is shown in Table 4-492. The cost estimate was based on outline design of principal structures and or import of special large type construction equipments, construction crafts, cargo handling equipments and steel pipe piles.

Explanation of cost for each type of work is as follows:

Table 4-492 Construction Cost

(Unit : 1,000 yen)

Work			Reclaimed Material (Including C-Stone)	A.B.D. Stone		Precast Concrete Armour Units	Concrete Parapet	Pile Work	Concrete for Pier	Revetment Behind Pier	Fender Bitt, Bollard	L.S.	Total	Remark
		Unit Cost / Quantity	785 Yen/m^3	Material 2,087 Yen/m^3	Laying Cost 2,770 Yen/m^2	38,035 Yen/m^3	20,000 Yen/m^3	419,000 Yen/m	82,120 Yen/m^3	1,660,000 Yen/m	79,000,000 Yen/LS			
Breakwater	Breakwater	(1,200 m) 400 m	(11,000 m^3) 8,635	(94,900 m^3) 197,013	(50,800 m^2) 140,716	(21,200 m^3) 806,342	(7,200 m^3) 144,000						1,296,706	3,242 thousand yen/m
	Seawall	800 m	Included (In reclamation work)	(36,900 m^3) 77,011	(31,400 m^2) 86,978	(24,100 m^3) 916,644	(9,900 m^3) 198,000						1,278,633	1,598 thousand yen/m
Dock Facility	-10.5 m. Pier	190 m						(2,562 m) 1,073,478	(3,920 m^3) 321,910	(210 m) 388,810	35,550		1,779,748	9,367 thousand yen/m
	-10 m Pier	185 m						(2,478 m) 1,038,282	(3,724 m^3) 305,815	(200 m) 332,000	31,600		1,707,697	9,231 thousand yen/m
	-4 m. Quay Wall	120 m @950,000 Yen/m										114,000	114,000	950 thousand yen/m
	-10 m. Dolphin	1 set						(735 m) 307,965	(570 m^3) 46,808		11,850		366,623	(/1 set) Equip. and pipe not included
Site Grading	Revetment	1,140 m			(22,200 m^2) 61,494		(2,900 m^3) 58,000						119,494	104.8 thousand yen/m
	Reclamation	138,000 m^3	(1,244,000 m^3) 976,540										976,540	7,076 yen/m^2, 785 yen/m^3
Road, Open Storage Yard, Pavement		90,540 m^2 @7,500 Yen/m^2										679,050	679,050	
Shed		8,400 m^2 @50,000 Yen/m^2										420,000	420,000	
Office, Repair Shop, Warehouse, Dining hall, Shower Room		4,800 m^2 L.S.										272,000	272,000	
Cargo Handling Equipment, Tug, Fork lift, Crane		L.S.										802,000	802,000	Loader + Belt Conveyor
Utilities		L.S.										400,000	400,000	Fence, Electricity, Water, Drainage, Street Light, Telephone
Dredging		350,000 m^3 @600 Yen/m^3										212,400	212,400	
Design and Project Supervision		3.6 %										375,109	375,109	
Total	Amount		985,175	274,024	289,188	1,722,986	400,000	2,419,725	674,533	680,810	79,000	3,274,559	10,800,000 thousand yen	
	Quantity)		(1,255,000 m^3)	(131,300 m^3)	(104,400 m^2)	(45,300 m^3)	(20,000 m^3)	(5,775 m)	(8,214 m^3)	(410 m)	(L.S.)	(L.S.)		

A. Reclamation work

Along the coastline of the proposed port site a 10 meter high terrace formed of conglomerate spreads out and this conglomerate will be blasted and hauled as fill material. The required volume of fill material is 1,355,000 cubic meters and includes 110,000 cubic meters of C-stone for breakwater construction.

If converted to natural ground and when swell and shrinkage percentage of C = 1.15 is assumed:

The volume of borrow excavation = $1,355,000 \div 1.15$
$\fallingdotseq 1,180,000\ m^3$

(Estimating conditions)

a) Actual working hour — 10 hours daily

b) Average haul distance — 700 meters

c) Equipments used:

For blasting .....Drill ϕ115 mm
Pushing .....D-9 bulldozer
Loading .....Wheel loader CAT 992
Hauling .....CAT 796 B
Spreading ..... CAT D-8

Unit price for each type of work was assumed as follows:

Blasting	270 yen per m^3
Pushing	41 yen per m^3
Loading	162 yen per m^3
Hauling	270 yen per m^3
Spreading	41 yen per m^3
Temporary facility	118 yen per m^3
Total	902 yen per m^3

If this unit cost of 902 yen/m^3 is converted to unit cost of reclaimed volume:

Unit cost = 785 yen per m^3

B. Armor stone

One to ten ton size armor stone will be obtained from quarry located 15 km northeast of Pacasmayo Cape by blasting hard rocks.

Required volume of A-stone
with average weight 10 ton/stone 36,100 m^3

Required volume of B-stone
with weight of 1/2 - 3 ton/stone 92,200 m^3

Total 130,300 m^3

If converted to natural ground and when swell and shrinkage percentage of C = 1.40 is assumed:

The volume of borrow excavation = 130,300 ÷ 1.4 93,100 m^3

If volume of required stone is assumed as 1/2 of quarried volume the volume of blasted material will be double or 186,000 m^3.

Blasting	186,000 m^3 x @270	= 50,220,000 yen
Pushing & Selecting	186,000 m^3 x @70	= 13,020,000 yen
Loading	93,100 m^3 x @162	= 15,082,200 yen
Hauling (15 km)	93,100 m^3 x @1,620	= 150,822,000 yen
Spreading	93,100 m^3 x @135	= 12,568,500 yen
Temporary facility	10 %	= 24,700,000 yen
	Total	271,871,300 yen

Therefore: Unit cost of completed volume = 271,871,300 ÷ 130,300 m^3 = 2,087 yen/m^3

C. Rubble bed levelling work

Since the south side of the breakwater is a long breaker zone it would be difficult for divers to conduct fine underwater work during the construction of extension to breakwater or seawall. Due to the type of material for breakwater construction, high degree of accuracy in slope levelling would not be required. Accordingly, it would be necessary to level the slope in stable shape only so that armor stones or blocks could be set in approximate location as quickly as possible.

For this rapid setting operation, one crawler crane with hoisting capacity of 50 ton and 2 divers forming the main work party are planned to be located near the extreme end of the breakwater at all times for conducting breakwater extension work. The cost of this work is approximately:

a) Working party - 2 parties (1 party each for breakwater and revetment works)

b) Total working days - 48 months

c) Cost per month - 6,000,000 yen/party

(b) x (c) = 288,000,000 yen

If the area of breakwater extension is assumed as 104,000 m^2 :

The unit cost = 2,770 yen/m^2

D. Wave-breaker block work

a) Tetrapod of 3 sizes, 12.5 ton, 16 ton and 25 ton are planned to be used for this work.

(Quantity) 25 ton x 220 each
16 ton x 5,530 each
12,5 ton x 1,650 each

b) The amount of concrete required for the tetrapod is 45,300 m^3.

c) A 120 meter x 300 meter fabricating yard will be located in the reclaimed.

A 25 ton x 16 meter jib-crane will be used at this yard.

d) Principal equipments for hauling and setting tetrapods.

50 ton capacity trailer truck 2 truck

275 ton hoisting capacity crawler crane 1 crane

e) (Schedule)

Number of fabricating days 7,400 tetrapods ÷ 20/day

= 370 days

If monthly working day is assumed as 20 days

Time required for casting 7,400 tetrapods

7,400 tetrapods ÷ 400 pcs/month = 18.5 months

Time required for setting 7,400 tetrabods and 10 ton "A" stone

7,400 tetrapods + 4,200 "A" stone

= 11,600 pcs/months = 27 months

Construction Cost

a) (Fabrication)

Equipment cost	77,000,000 yen
Fuel cost	2,000,000 yen
Material cost	590,000,000 yen
Form cost	185,000,000 yen
Patent fee	
Labor cost	20,000,000 yen
Sub-total	874,000,000 yen

b) (Fabricating yard)

360,000 m2, water, rail, repair, included	L.S.	62,000,000 yen

c) (Hauling, Setting)

Equipment cost	624,000,000 yen
Labor cost	87,000,000 yen
Underwater work cost	33,000,000 yen
Material cost	18,000,000 yen
Sub-total	762,000,000 yen

d) (Equipment Transportation Cost

	L.S.	25,000,000 yen

275 ton crawler crane is to be procured locally so this is excluded. Round trip cost to site only is estimated.

Total cost of wave-breaker block work is :

a + b + c + d = 1,723,000,000 yen

E. Pile work

(Basis of estimate)

a) A self-elevating platform method (SEP) will be used to drive piles in location where swell would occur without the breakwater.

b) SEP, anchor boat and 2 platform craft will be shipped from Japan.

c) Round trip only is considered for shipping cost.

d) In order to deliver 21 meter long steel pipe pile directly to site from sea, use of 12,000 DWT ocean-going barge was considered.

e) Wharf foundation pile is erected in holes drilled into bedrock and cement milk injected into space between the hole and pile. Construction equipments appropriate for this work will be provided.

f) Required quantity of piles

For -10.5 meter wharf	117 piles
For -10 meter wharf	114 piles
For others	9 piles
For petroleum dolphin	35 piles
Total	275 piles

Pile length was assumed as 21 meters.

g) Two shifts were considered for crew member and working party in order to secure 12 hours of actual working hour.

h) Total working days = 275 piles ÷ 1 pile/day ÷ 25days/month
= 11 months = 330 days

Construction cost

a) Pile driving cost

1 Equipment rental and labor cost

SEP Large diameter borer Bit cost 2,600 PS tug boat Anchor boat, work platform boat Slurry pump Cement dissolving pump Vibro-hammer Labor cost	L.S.	1,130,000,000 yen

2 Construction craft shipping cost

Equipping cost Tugging cost Shipping rental cost Shipping insurance Shipping overhead cost	L.S.	690,000,000 yen

3 Material cost

Steel pipe pile (including shipping cost) Cement (including admixture) Casing Fuel Other materials	L.S.	600,000,000 yen

Total cost for pile work 2,420,000,000 yen
(cost per meter of pile 419,000 yen)

F. Wharf, Superstructure work

For one square meter of wharf area, 1.4 cubic meters of concrete is estimated to be required.

Concrete volume is :

For -10.5 meter wharf	7,600 m^3
-10 meter wharf	
For petroleum dolphin	570 m^3
Total	8,220 m^3

Concrete cost Concrete placing cost	L.S.	436,000,000 yen
Formwork cost Timbering cost		
Reinforcing steel work	L.S.	239,000,000 yen
Total		675,000,000 yen

Cost breakdown

Per 1 meter of wharf		1,675,000 yen
For petroleum berth	L.S.	47,000,000 yen
Cost of wharf superstructure per cubic meter of concrete		82,120 yen

G. Construction of revetment behind wharf

L shaped concrete block weighing 20 ton with width of 4.5 meters will be used for revetment behind wharf. The concrete block will be set -4.3 meters below water surface.

The cost of revetment per one meter length of wharf including cost of divers for levelling slope between piles and rock setting work was estimated as 1,660,000 yen.

H. -4 meter quaywall construction

Twenty ton concrete L shaped blocks with width of 4.5 meters will be used in construction of quaywall. It was assumed that hard rocks would be encountered during excavation of foundation for setting concrete blocks. The unit cost of quaywall construction was estimated as 950,000 yen per meter.

I. Dredging work

The volume of dredging work for channel, turning basin and in front of pier is 344,000 m^3 and from the measurements of water depth taken in April 1976, greater part of dredging would be less than 1 meter deep with maximum depth under 2 meters. Dredging operation will not specially affect construction work; but it is desirable for dredging work to commence after the completion of breakwater.

Including the 10,000 m^3 of dredge material in front of -4 meter quaywall, nearly all of the 354,000 m^3 of dredge material is

seen to consist of sand or silt. From this point, it is advisable for ENAPU to conduct dredging work under direct management with its own dredger to avoid the expense of bringing in dredger from long distance.

Information from ENAPU showed that dredging cost for Salaverry Port in the year 1974 was 85,000,000 Soles, so if a dredge volume of 1,000,000 m^3 is assumed for this year the unit cost of dredging work would be 85 Soles/m^3. With this as reference, unit cost of 600 yen/m^3 was assumed for dredging work (Figure 4-451).

J. Concrete cap and parapet for breakwater

The total volume of concrete required for breakwater cap and parapet is estimated as 20,000 m^3 and this volume is broken down to :

For breakwater portion	7,200 m^3
For seawall portion	9,900 m^3
For north side revetment	2,900 m^3

Average unit cost for this work was assumed as 20,000 yen/m^3. (see Figure 4-443).

K. Pavement

The total pavement area for road, open storage yard and motor is Phase 1 construction is 90,540 m^3 and the unit cost of pavement construction was estimated as 7,500 yen/m^2. (see Figure 4-474).

L. Fender and bit

Lump sum 79,000,000 yen

M. Transit shed

Transit shed No. 1	6,000 m^2 x 50,000 yen/m^2
Transit shed No. 2	2,400 m^2 x 50,000 yen/m^2

N. Office, repair shop, equipment & material warehouse, welfare facility for workers, dining room, shower,

Total floor area	4,800 m^2	L.S.	272,000,000 yen

O. Utilities

The lump sum cost of fence, storm and sewer drain system, water supply system, electrical system, street lighting system, open storage yard lighting system, telephone system within port terminal boundary was estimated as 400,000,000 yen.

P. Ship loader

Estimate for 1 set of 600 ton per hour capacity belt conveyor and travelling ship loader is shown below:

FOB price	290,000,000 yen
Freight	60,000,000 yen
Marine insurance	1,400,000 yen
Other miscellaneous costs	35,000,000 yen
Sub-total	390,000,000 yen
Rails, wiring, etc. for above (15 % of 1 set)	59,000,000 yen
Sub-total	449,000,000 yen
Erection cost (530 tons x 100,000 yen/ton)	53,000,000 yen
Total	502,000,000 yen

Q. Navigation aids

It would be necessary to relocate the existing lighthouse before starting port construction works.

Other lighthouse, lightbuoys, etc. that are required by law and regulation will be provided; but the cost of these navigation aids are not included in this estimate.

R. Tugs, fork-lifts, cranes

The cost of these items is estimated as 300,000,000 yen, and this breakdown is as follows:

Fork-lift (10-15 ton capacity) 10 sets at 12,000,000 yen/set	120,000,000 yen
Truck crane (25 ton hoist capacity 2 sets at 40,000,000 yen/set	80,000,000 yen
Tug boat (1000 PS) 1 boat	100,000,000 yen
Total	300,000,000 yen

SECTION 5. DEVELOPMENT EFFECTS

5-1 Economic Effects in Distribution

(1) Reduction in transportation cost and related expenses

Nearly all of the raw materials and industrial products which are necessary for various industrial operations as well as for daily life of the people in this area are supplied from outside except agricultural products and yields available in this area.

At the same time, quite a few of mineral products and agricultural products in this area are either exported to overseas markets or supplied to relevant consuming markets. The transportation of those products with less unit quantity is done by means of the land transport while those of variegated small quantity are shipped by marine transport via port of Salaverry which is nearest to the area. Included in such products are copper zinc, lead and other mineral products from the Province of Pacasmayo and neighbouring Department of Cajamarca as well as various agricultural products such as rice, fruit etc. in addition to sugar and cement which are the main industrial products in this area. Apart from these exported or outgoing products, those which are either imported or incoming are fertilizers, general consumer products, petrochemicals, ball liner, gunpowder required for the operation of mines. These products and materials are closely connected with land features in the area for both demand and supply which are relatively stable unless there occur some drastic changes on natural or geographical conditions,

position on resources or alterations on industrial policy and so on. Therefore, as far as cargo distribution is concerned, a system with shorter transportation distance particularly with the port which is able to handle mass volume of cargoes would bring a considerable cost saving and reduction in transport expenses. Furthermore, all of these products and materials belong to the industrial segments which are given much importance by the Government that is presently aiming at export drive to increase foreign exchange holdings as well as develop export industry continuously for the future in addition to the Government's policy to improve self-sufficiency of food supply in the country and the stable supply of basic raw materials for the promotion of local developments. Thus, the development of this stable supply and distribution facility will bring great national and economic significance.

Besides, thanks to the stable functioning of the distribution facility which is able to mass handle those incoming and outgoing cargoes, the overloading of other harbours and transport means can be lightened and thereby traffic and cargo congestions can be relieved and spaces of stored goods disposing facility can also be reduced which consequently will lead to the curtailment in investments. Furthermore, operating rate of vessels which are currently not so active in the coastal trade can also be improved.

The total amount of cost-saving out of whole transport expenses at the time of opening of the port is estimated at about 110 Mio. soles (2,400 thousand dollars) at least.

(2) Improvement of distribution efficiency

Except the port of Salaverry, all ports in neighbouring three States were constructed in 19th century and loading and

unloading of cargoes are carried out by barges because of those wharfs' structural features. Upon completion of related projects under way in those neighbouring districts, the volume of cargoes produced there would presumably increase to a great extent.

The main projects which are presently under way are; agriculture in Jequetepeque-Zaña districts, development of Michiquillay Mine, industrial developments mainly for chemical industries in Chiclayo and construction thereof, large scale equipment expansion at Pacasmayo plant for the production increase of cement which is indispensable for the construction of dams and roads. For smooth developments of these various industrial operations, the prerequisite is stable distribution of products and yields as well as procurement of raw materials and parts.

In case of port of Salaverry that is currently taking a role of a distribution base in the area has some technical problems such as sand drifting and backland and thereby further expansion of the facility now looks to be difficult and on the other hand the land transportation system is also encountered with some restrictive conditions, i.e., traffic jams and road congestions, suspension due to seasonal and natural influence, difficulty to cope with the increasing cargo volume caused by the shortage of related distribution facilities in the area etc. Therefore, the development of the port of Pacasmayo will possibly share the forthcoming structural changes in the distribution configuration in the area, i.e., substituting the functions which the area has so far been depending as well as playing a role as a distribution facility for the increasing yields from those neighbouring districts. That is to say, the port of

Salaverry will in future meet with the change of cargo structure in such a way that the export of agricultural products mainly sugar and import of sundry goods will be switched to handling of various materials related to the machinery industries as well as wheat and other general consumer goods and also shipping of machinery and paper products. Furthermore, those proposed port facilities and operating system in the development project are expected to drastically improve the existing efficiency in loading and unloading work, which will indirectly relieve the congestion of land traffic between Pacasmayo and Trujillo as well as lighten the burden of investments in land transportation.

5-2 Contribution to Industrial Operations

(1) Contribution to expansion of existing industries

As already described, those industries which depend on the distribution facility of the port of Pacasmayo are mines, cement, sugar and agriculture. In case of mining industry in Cajamarca area which belongs to the service range of this port, some ten and odd thousand tons of copper, zinc and lead are produced by various small and medium mines every year out of which approximately 80 % had been shipped from the port of Pacasmayo until 1965 while it dropped to only about 20 % in 1970 and none in recent years. By the proposed port development, it is possible to reduce the inland freight between Pacasmayo and Trujillo but above all the largest one is Michiquillay mine which is planned to produce some 370,000 tons of copper concentrates per year. Besides, there are 10 mines which are presently under prospecting in Cajamarca area and are expected to be

developed in near future and in this respect the reduction in cost will favour the realization of such projects and plans and a series of effects such as utilization of undeveloped resources, impacts to the development of surrounding area as well as earning foreign exchange from those export products.

Secondly, this development project will bring considerable merit to Pacasmayo cement plant which is located almost adjacent to the port of Pacasmayo and supplying the cement to all northern areas from Chimbote. The northern area is now highlighted as an important district for the activation of the industrial developments as well as acceleration of local integration and huge amount of public investment is being planned for construction and development of various roads as well as basic infra-structures such as dams, irrigations and canals and also for industrial activation and social developments and under such circumstances, the demand of cement as a basic material is greatly anticipated so that the production capacity of 320,000 ton in 1975 is going to be drastically increased to 1 Mio. ton per year in 1978. This trend in demand is expected to further continue at fairly high level, though no drastic increase is foreseen.

In order to cope with this steadily increasing demand, it is feared that dependence on existing exclusive vehicles would not assure smooth supply in the future and consequently it seems inevitable that marine transport must be depended upon partly in the future. This will also solve the problems on urea fertilizers supplied from Talara and phosphoric fertilizers from Bayovar and apart from overall effect, the following cost-saving effects can be anticipated compared to land transport:-

Reduction in transport cost thanks to bulk shipments. Cost reduction brought by cost-saving of heavy oil on transport which occupies a fairly large portion in the production costs. Reduction in the expenses of storing facility and lightening in the stock investment thanks to well arranged systematic arrival of cargoes.

Thirdly, the contribution to agriculture which is the main industry in this area is greatly expected. That is, first of all the increasing yield of rice has to be highlighted. The rice has been taken up as one of the future prospective export cargoes in line with the worldwide deterioration in its demand and supply situation and the agricultural project for Jequetepeque-Zana clearly specifies the powerful promotion of rice export substituting the import.

The project is aimed at improving the unit harvest and yield by switching to IRR plant breeding which will be realized by mass fertilization coupled with the construction of water treating facility by better irrigations.

On the other hand, though the consumption of fertilizers will increase due to this project, it is also expected that the transportation expenses will be reduced by approximately 2 % - 3 % of the direct production costs excepting personnel cost comparing with those expenses incurred in case of existing transport via Salaverry or land transport, but above all the biggest effect will be securing of stable mass distribution and handling thereof to cope with the seasonal concentrated rush of demand. Furthermore, as far as rice is concerned, it will be possible to mass transport to Lima and Arequipa area which are the largest rice consuming areas and thereby the stable supply of rice can be secured for those areas and at the same time the

problem of one-sided cargoes of coastal trades will also be solved.

Regarding sugar industry, a plant producing approximately 25 % - 30 % of the country's output is located at point a bit beyond midway to Trujillo. Though the merit from the transportation expenses is not much when compared with those of the port of Salaverry, sugar cane pulps can be supplied to paper mills in Trujillo and thereby overall transport power including the change of cargoes in the port of Salaverry can be standardized. In view of quality-wise stability of sugar as a merchandise, systematic storage and adjustable despatch and shipments are now possible and thereby the port can play a vital role as buffer in compliance with seasonal fluctuations in volume.

Anyway, the sugar industry is a promising one in the neighbouring area with sugar canes which provide high added value like fruit and alfalfa and thanks to this project the final outlet of sugar cane growing can be assured and in addition due to the recent development of sucrose industry the sugar cane is now being high lighted as a raw material for organic chemical industries and in view of demand of times to secure foodstuffs resources, the sugar cane demand in the world is quite promising. In this respect, the project will provide a motivation to those related industries in this area for further production increase and consequently it will contribute to the local development and progress as well as improvement of nation's economy.

In addition to the above main agricultural products, there is a Jequetepeque project targetting at expanding the existing palto pear acreage by 10 times. In Cajamarca district, 77 % of whole outgoing quantity was shipped

to Lima in 1973 and in view of keeping the freshness of this fruit, the preparation of mass transportation means will contribute to its sound development. Consequently, a basis for fruit growing can be prepared so as to reach optimum income per hectare and thereby selection of kinds, preservation and processing, quality-wise upgrading for packings and production of canned fruit would materialize. This will further lead to rural development and improvement of welfare standard by higher income for farmers. Likewise, such as tomato, cucumber and eggplant generally called hortalizas are also evaluated to have the same possibility and can be expected to provide similar effects. Particularly in case of Zaña area, the site is said to be suitable for tomato growing and it is expected that the additive value for this vegetable can be further enhanced by preparing the related processing facility in the harbour for commercialization.

Besides the above industries, those dwindling service industries such as restaurants, hotels etc. are expected to revive with the reconstruction of the harbour and increase in the volume of cargoes which activates the function of the port once again.

The number of trucks, related vehicles and other consumer goods carrying vehicles entering into the town in line with the operations of the port of Pacasmayo is totally estimated at about 1,200 - 1,500 cars per day while the number of calling vessels and boats is surely anticipated as 140 per year and the service business for those crews as well as automotive personnel is estimated at about 95 million Soles per year.

With this new service business as a motive, the demand for vegetables, fruit and sea food which were not commercialized will increase and thereby the income for farmers and fisherman will also increase, the total turnover of which is estimated at 14 Mio. soles out of which approximately 1/3 will favour the surrounding fishermen whose population and income are relatively low and thus their income will be considerably improved.

(2) Role for promoting new industries

The backland of Pacasmayo port consists of solid gravel layer which is topographically level and therefore this backland can be used for providing sands and soils required for the construction of the harbour facility and at the same time the land can also be utilized as an industrial zone. In line with the opening of the port, a series of transport service industries such as warehouse, cargo collection and packing etc. will be presumably arranged at the site. Furthermore, new industries such as automobile tyres and repair shops for land transportation vehicles will also come in.

On the other hand, apart from above new service industries, the food processing industries for selection, washing, freshness preservation of various agricultural products including before mentioned fruit and vegetables will also be needed. Further, new industries for packing, wrapping and secondary processing of food products are also presumably required and all these new industries are quite promising in this area. Besides, other promising industries are butchery industry in Cajamarca district,

preservation industry such as chilled processing, preservation of tuberous roots in Selva district by means of isotope application. Bagazo which is a pulp of sugar canes can be used for the raw material of cardboard manufacture while the high molecular chemical industry in Chiclayo can also supply raw materials for packing materials according to necessity.

Furthermore, wood and logs carried through Cajamarca or Marañon river can also be taken into consideration for processing in view of utilization of resources and availability of the nearby distribution facility.

The expansion of trade brought by the increasing volume of cargoes will organize some 7,500 craftsmen and secure their sales channels who have been making a scanty living by making the traditional pre-Inca artistic handicrafts which have a bright future for export from this port and in addition, setting up of retail and wholesale shops is also anticipated.

After some time in future, the development of automotive industries in Trujillo will possibly bring related manufacturing industries as well as assembly type industries such as electric industry in view of the advantageous locality of this area as a key base for both marine and land transport in addition to its relatively high labour standard (non-illiteracy rate is 85.8 %).

Besides, it is also well conceivable that the future development of copper mines in Cajamarca district will bring the refining industry to this area and as result the establishment of the fertilizer industry will be strongly promoted because of its locality being close to consuming areas.

Anyway, giving consideration to the local traffic, land, water, electric power, manpower etc. in this area, it can be said that the area has sufficient aptitude as an industrial zone with remarkably high potential and the opening of new Pacasmayo harbour will possibly initiate the coming of new industries.

5-3 Effects to Local Society and Inhabitants

(1) Increase in income

The surrounding districts of this area comprise a lot of farmers and reductions in distribution costs for fertilizers, rice, fruit and general sundries are considerably big and further their income can also be improved by the direct commercialization of those fruit and vegetables together with increasing demand for the neighbouring harbour service industries. In other words, thanks to the development of port facilities for the distribution centre in this area, those neighbouring remote places will suddenly convert to suburban farm villages while the area around Pacasmayo will be reconstructed as key distribution center.

Under such consideration, it is presumed that the increase in income brought by the opening of the harbour will be 13,000 soles/year per households in average in the country of Pacasmayo and approximately 1,000 soles/year in Cajamarca district.

(2) Strengthening of social integration and improvements of administrative efficiency

Thanks to an increase in related demands and new employment in line with the opening of the new port facility, a population of 6,725 which drained out from the Province of

Pacasmayo during 1964 - 1972 will gradually return to this area and such a population drain will not occur so much in future and thereby the country's cultural characteristic of friendliness and companionship will be strengthened resulting in social stability.

SECTION 6. FINANCIAL ANALYSIS

6-1 Income and Expenditure of Project

(1) Development of Investment for Harbour Construction

in 1,000 Dollars

Year	77	78	79	80	81
Basic port facilities	1,200	7,000	9,000	9,000	5,000
Machinery equipments				1,000	1,700
Buildings				1,000	1,300
Total	1,200	7,000	9,000	11,000	8,000

Amount of Investment for Port Expansion

in 1,000 Dollars

Year	83	84		88	89
Basic port facilities	5,850	5,850		10,970	10,970
Machinery equipments					
Buildings					
Total	5,850	5,850		10,970	10,970

(2) The life-span of harbour facility and equipment

Estimated life-span of harbour facilities and structures is shown below:

Unit : Year

Basic port facilities	50
Machinery equipments	30
Buildings	30

For those portions which are expanded, the basic facility is subject to a 50-year depreciation from 4th year (first expansion) and 9th year (second expansion) respectively.

The method of depreciation :

Flat rate method with residual book value of 10 %.

(3) Loan repayment plan

The loan arrangements will be made by the Government of Peru, international organ and foreign country. Specially, the short term loan is to be arranged by Peruvian Government while the rest is to be the long term loan. The relevant rates of interest and repayment methods are assumed as follows:-

Financing organs	Percentage of loan	Interest of loan
Peruvian government	40 %	11 %
International monetary institutions	30 %	8 %
Foreign countries	30 %	5 %

Repayment methods : For Peruvian Government, free formula will be applied while for both international organ

and foreign country, 5-year unredeemable period is applied with 20-year repayments and interest to be paid during the unredeemable period and the principal is to be even repayment.

(4) Annual maintenance and management expense

These are personnel cost for the management of the port, maintenance expense, material cost and other expenditure. In this stage of income and expenditure planning, the sliding rate is assumed so as to estimate a pattern for each year.

in 1,000 US Dollars

Expenditures	First year	Sliding assumption
Personal expense	644	15 % increase every year
Maintenance	451	5 % increase every two years
Power expense	24	5 % increase every three years
Miscellaneous	13	10 % increase every year
Materials	11	10 % increase every year

EXPLANATION OF ITEMS OF EXPENDITURE

Labor Cost :

Since Pacasmayo will be a newly developed port, it would be necessary for all port terminal workers to undergo training in their respective duties prior to opening of the port. With the effect of this training upon efficiency considered, it has been assumed that the number of personnel estimated to be required in 1985 would be ready

at time of port opening in 1983.

In computation of unit labor cost, the financial data for Salaverry Port furnished by Salaverry Port Authority was used as reference and a labor cost of 100,000 Soles per man per year in 1983 was assumed.

Of the cargoes handled, general cargo, especially, which has a high proportion of labor cost was assumed to increase at an annual rate of 7 % during 1985 to 1990 and also taken into consideration the size of vessel and form of cargo handling, the number of port terminal workers required including office workers was assumed as 290 men in 1983 and 440 men in 1990 which is an annual increase of 6 %.

The forecasting of the increase in labor cost per man would be difficult at this stage but if increase of 8 % annually is assumed:

$$(1.08)^7 = 1,714$$

Therefore, in 1990 the labor cost per man would be approximately 170,000 Soles.

From these assumptions, the labor cost at time of port opening in 1983 would be :

290 men x 100,000 Soles/yr. = **29,000,000 Soles/year**

Also, the labor cost in 1990 would be:

440 men x 170,000 Soles/yr. = **74,800,000 Soles/year**

Increase in labor cost from 1983 to 1990 would be :

$$74,800,000 \div 29,000,000 = 2,5793$$

$$= (1 + x)^7$$

$$0.14 < x < 0.15$$

Therefore, the annual rate of increase in labor cost for Pacasmayo Port was assumed as 15 % and this rate of increase was also assumed for years following 1990.

Depreciation Cost

Computation of this depreciation cost is separately made so this cost is omitted.

Parts and Maintenance Cost

Annual cost for parts and maintenance was considered as follows:

Approximately 30 % of civil work cost	4,000,000 Soles
Approximately 5 % of equipment cost	4,300,000 Soles
Dredging - 150,000 m^3/year x 80 Soles/m^3 (Note 1)	12,000,000 Soles
Total	20,300,000 Soles

However, Pacasmayo Port is fortunate in having natural condition that does not include typhoon or cyclone winds. The same type of rubble mound breakwater planned for Pacasmayo Port which was constructed more than 10 years ago at neighboring Salaverry Port has not required any maintenance work. (Excluding extension portion)

If proper consideration at time of contracting cargo handling equipments is taken, large expenditures for parts and maintenances of cargo handling equipments should not be necessary, actually, at initial stage of port operation. From these points, cost increase of 5% every 2 years was considered.

Note 1 : Dredging cost of Salaverry Port furnished by ENAPU was used as reference data.

Electricity and Water Cost

o Electric power cost ;

o Assuming an annual electric power demand of 1,000,000 KWH and unit cost of 1.00 Sole/KWH :

Annual electric power cost = 1,000,000 Soles (A)

o Water supply cost ;

Annual tonnage of water supply to vessel	100,000 tons
Annual tonnage of water supply within terminal	150,000 tons
Total	250,000 tons

If unit cost of 0.4 Soles/ton is assumed:

The annual water supply cost = 100,000 Soles (B)

Therefore : Electricity and water cost = 1,100,000 Soles/year (A) + (B)

At this stage, since the route for power transmission, water volume at the source and location of related plants are not yet determined, approximate unit cost was assumed. Cost increase is also probably believed to be of policy cost nature, so a rough figure of 5 % increase every 3 years was assumed.

The amount of electricity and water used should not increase greatly seen from the form of usage.

Office Overhead

A monthly overhead expense of 50,000 Soles was assumed which would be 600,000 Soles/year.

Overhead expense was assumed to increase 10 % annually by taking into consideration cost and cargo tonnage increases.

Material Cost

Annual material cost of 500,000 Soles was assumed with annual increase of 10 %.

(5) Annual revenue to harbour

in 1,000 US Dollars

Revenue	First year	Sliding assumption
Copper concentrates	115	12 % per year up to 9th year 23 % increase per year from 10 year
Agricultural products	1,213	19 % per year up to 4th year 14 % per year from 5th year to 9th year 12 % increase per year from 10th year
Cement	212	32 % increase per year up to 4th year 25 % per year from 5th year to 9th year 23 % per year from 10th year
Fertilizer	168	25 % increase per year up to 4th year 28 % per year from 5th year to 9th year 18 % year from 10th year
Oil	746	14 % increase per every year

The opening of Pacasmayo Port would reduce the freight of land transportation to Salaverry Ports. This profit has been given in comparison between this reduction and the cost of the land transportation replaceable by the marine, and estimated by forecasting the transportation form and quantity per item.

The sliding rate has been set by multiplying the increasing rate of cargo, substitutable rate for land transportation and increasing rate of the reducible unit price produced by rising of freight level.

Table 4-613 and Table 4-614 shows trial calculations on long term revenue and expenditure figures according to the assumed basic items required for the above revenue and expenditure plan.
(Table 4-613 does not include those portions for expansion.)
Profit will appear at 8th year ($377,000) and dissolution of accumulative loss is for 13th year ($7,431,000) while the completion of short term loan repayments is for the 14th year and thus fairly highly efficient payability is anticipated.

Table 4-614 shows the estimates including those portions of expansion. In this case, profit will appear at 13th year ($1,393,000) and dissolution of accumulative loss is for 18th year ($19,642,000) while the completion of short term loan repayments is for 25th year.

Table 4-611 Time of Profit Occurrence and Other Times in Case of Fluctuating the Loan Interest

Case	Assumed loan interest			Excluding those portions of expansion (year)				Including those portions of expansion (year)			
	Peruvian Government	International organ	Foreign country	Gains for fiscal term	Dissolution of accumulative loss	Occurrence of surplus money	Completion of short term loan repayments	Gains for fiscal term	Dissolution of accumulative loss	Occurrence of surplus money	Completion of short term loan repayments
1	11 %	8 %	5 %	8	13	14	14	13	18	19	19
2	11 %	9 %	8 %	9	14	15	15	14	19	20	20
3	11 %	10 %	10 %	10	15	16	16	14	20	21	21
4	12 %	8 %	5 %	9	13	15	15	14	19	20	20
5	12 %	9 %	8 %	10	15	16	16	15	20	21	21
6	12 %	10 %	10 %	11	16	17	17	15	21	22	22

Table 4-612 Balance of Loan and its Peak in Case of Fluctuating the Loan Interest

in 1,000 Dollars

Case	During construction period			(Excluding those portions of expansion) at the time of peak	(Including those portions of expansion) at the time of peak
	Peruvian Government	International organ	Foreign country		
1	16,407	12,303	12,303	27,431 (8th year)	80,293 (12th year)
2	16,702	12,525	12,525	34,637 (9th year)	93,178 (13th year)
3	16,932	12,692	12,692	40,962 (9th year)	104,272 (13th year)
4	16,509	12,375	12,375	30,473 (8th year)	91,170 (13th year)
5	16,805	12,598	12,598	38,767 (9th year)	107,330 (14th year)
6	17,029	12,770	12,770	46,297 (10th year)	121,034 (14th year)

Note : Peak means the balance of loan from short term financing organ (Peruvian Government)

Table 4-613 Long Term Income and Expenditure and Cash Flow-Tables (Excluding those portion of expansion)

Item	** (77)	** (78)	** (79)	** (80)	** (81)	1 (82)	2 (83)	3 (84)	4 (85)
(1) Income (condensed copper)	0	0	0	0	0	115	129	144	161
(2) " (agricultural products)	0	0	0	0	0	1213	1443	1717	2043
(3) " (cement)	0	0	0	0	0	212	280	370	488
(4) " (fertilizer)	0	0	0	0	0	168	210	263	329
(5) " (oil)	0	0	0	0	0	746	850	969	1105
Total	0	0	0	0	0	2454	2912	3463	4126
(1) Expenditure (personal expense)	0	0	0	0	0	644	741	852	980
(2) " (maintenance)	0	0	0	0	0	451	451	474	474
(3) " (power expense)	0	0	0	0	0	24	24	24	25
(4) " (miscellaneous)	0	0	0	0	0	13	14	15	17
(5) " (materials)	0	0	0	0	0	11	12	13	14
Sub-total	0	0	0	0	0	1143	1242	1378	1510
Depreciation 1 (fundamental equipments)	0	0	0	0	0	561	561	561	561
" 2 (machinery equipments)	0	0	0	0	0	81	81	81	81
" 3 (buildings)	0	0	0	0	0	69	69	69	69
Sub-total	0	0	0	0	0	711	711	711	711
Interest 1 (Peruvian government)	0	53	365	792	1341	1805	2035	2251	2445
" 2 (international monetary institutions)	0	29	199	432	732	984	984	984	984
" 3 (foreign countries)	0	18	125	270	457	615	615	615	615
Sub-total	0	100	689	1494	2530	3404	3634	3850	4044
Total	0	100	689	1494	2530	5258	5587	5939	6265
Profit before deduction of income taxes	0	-100	-689	-1494	-2530	-2804	-2675	-2476	-2139
Accumulated profit	0	-100	-789	-2283	-4813	-7617	-10292	-12768	-14907
Taxes	0	0	0	0	0	0	0	0	0
Profit for the current term	0	0	0	0	0	0	0	0	0
Profit carried from previous term	0	0	0	0	0	0	0	0	0
Profit for the current term	0	-100	-689	-1494	-2530	-2804	-2675	-2476	-2139
Depreciation (Add back)	0	0	0	0	0	711	711	711	711
Borrowing 1 (peruvian government)	480	2840	3877	4998	4212	2093	1964	1765	1428
" 2 (international monetary institutions)	360	2130	2906	3748	3159	0	0	0	0
" 3 (foreign countries)	360	2130	2906	3748	3159	0	0	0	0
Total income	1200	7000	9000	11000	8000	0	0	0	0
Investment 1 (fundamental equipments)	1200	7000	9000	9000	5000	0	0	0	0
" 2 (machinery equipments)	0	0	0	1000	1700	0	0	0	0
" 3 (buildings)	0	0	0	1000	1300	0	0	0	0
Sub-total	1200	7000	9000	11000	8000	0	0	0	0
Repayment 1 (Peruvian government)	0	0	0	0	0	0	0	0	0
" 2 (international monetary institutions)	0	0	0	0	0	0	0	0	0
" 3 (foreign countries)	0	0	0	0	0	0	0	0	0
Total expenditure	1200	7000	9000	11000	8000	0	0	0	0
Balance	0	0	0	0	0	0	0	0	0
Outstanding amount of borrowing (Peruvian government)	480	3320	7197	12195	16407	18500	20464	22229	23657	
" (international monetary institutions)	360	2490	5396	9144	12303	12303	12303	12303	12303	
" (foreign countries)	360	2490	5396	9144	12303	12303	12303	12303	12303	
Total	1200	8300	17989	30483	41013	43106	45070	46835	48263	
Scrap value (fundamental equipments)	0	0	0	0	31200	30639	30078	29517	28956	
" (machinery equipments)	0	0	0	0	2700	2619	2538	2457	2376	
" (buildings)	0	0	0	0	2300	2231	2162	2093	2024	

Long Term Income and Expenditure and Cash Flow-Tables

Item	5 (86)	6 (87)	7 (88)	8 (89)	9 (90)	10 (91)	11 (92)	12 (93)	13 (94)
(1) Income (condensed copper)	180	202	226	253	283	317	390	480	590
(2) " (agricultural products)	2431	2771	3159	3601	4105	4680	5242	5871	6576
(3) " (cement)	644	805	1006	1258	1573	1966	2418	2974	3658
(4) " (fertilizer)	411	526	673	861	1102	1411	1665	1965	2319
(5) " (oil)	1260	1436	1637	1866	2127	2425	2765	3152	3593
Total	4926	5740	6701	7839	9190	10799	12480	14442	16736
(1) Expenditure (personal expense)	1127	1296	1490	1714	1971	2267	2607	2998	3448
(2) " (maintenance)	498	498	523	523	549	549	576	576	605
(3) " (power expense)	25	25	26	26	26	27	27	27	28
(4) " (miscellaneous)	19	21	23	25	28	31	34	37	41
(5) " (materials)	15	17	19	21	23	25	28	31	34
Sub-total	1684	1857	2081	2309	2597	2899	3272	3669	4156
Depreciation 1 (fundamental equipments)	561	561	561	561	561	561	561	561	561
" 2 (machinery equipments)	81	81	81	81	81	81	81	81	81
" 3 (buildings)	69	69	69	69	69	69	69	69	69
Sub-total	711	711	711	711	711	711	711	711	711
Interest 1 (Peruvian government)	2602	2708	2890	3002	3117	2999	2636	2180	1493
" 2 (international monetary institutions)	984	984	935	886	837	787	738	689	640
" 3 (foreign countries)	615	615	584	554	523	492	461	431	400
Sub-total	4201	4307	4409	4442	4377	4188	3835	3300	2533
Total	6596	6875	7201	7462	7685	7798	7818	7680	7400
Profit before deduction of income taxes	-1670	-1135	-560	377	1505	3001	4662	6762	9336
Accumulated profit	-16577	-17712	-18272	-17835	-16330	-13329	-8667	-1905	7431
Taxes	0	0	0	0	0	0	0	0	0
Profit for the current term	0	0	0	377	1505	3001	4662	6762	9336
Profit carried from previous term	0	0	0	0	0	0	0	0	0
Profit for the current term	-1670	-1135	-560	377	1505	3001	4662	6762	9336
Depreciation (Add back)	711	711	711	711	711	711	711	711	711
Borrowing 1 (peruvian government)	959	1654	1019	142	0	0	0	0	0
" 2 (international monetary institutions)	0	0	0	0	0	0	0	0	0
" 3 (foreign countries)	0	0	0	0	0	0	0	0	0
Total income	0	1230	1230	1230	2216	3712	5373	7473	10047
Investment 1 (fundamental equipments)	0	0	0	0	0	0	0	0	0
" 2 (machinery equipments)	0	0	0	0	0	0	0	0	0
" 3 (buildings)	0	0	0	0	0	0	0	0	0
Sub-total	0	0	0	0	0	0	0	0	0
Repayment 1 (Peruvian government)	0	0	0	0	986	2482	4143	6243	8817
" 2 (international monetary institutions)	0	615	615	615	615	615	615	615	615
" 3 (foreign countries)	0	615	615	615	615	615	615	615	615
Total expenditure	0	1230	1230	1230	2216	3712	5373	7473	10047
Balance	0	0	0	0	0	0	0	0	0
Outstanding amount of borrowing (Peruvian government)	24616	26270	27289	27431	26445	23963	19820	13577	4760
" (international monetary institutions)	12303	11648	11073	10458	9843	9228	8613	7998	7383
" (foreign countries)	12303	11688	11073	10458	9843	9228	8613	7998	7383
Total	49222	49606	49435	48347	46131	42419	37046	29573	19526
Scrap value (fundamental equipments)	28395	27834	27273	26712	26151	25590	25029	24468	23907
" (machinery equipments)	2295	2214	2133	2052	1971	1890	1809	1728	1647
" (buildings)	1955	1886	1817	1748	1679	1610	1541	1472	1403

Long Term Income and Expenditure and Cash Flow-Tables

Item	14 (95)	15 (96)	16 (97)	17 (98)	18 (99)	19 (100)	20 (101)	21 (102)	22 (103)
(1) Income (condensed copper)	726	893	1098	1351	1662	2044	2514	3092	3803
(2) " (agricultural products)	7365	8249	9239	10348	11590	12981	14539	16284	18238
(3) " (cement)	4499	5534	6807	8373	10299	12668	15582	19166	23574
(4) " (fertilizer)	2736	3228	3809	4495	5304	6259	7386	8715	10284
(5) " (oil)	4096	4669	5323	6068	6918	7887	8991	10250	11685
Total	19422	22573	26276	30635	35773	41839	49012	57507	67584
(1) Expenditure (personal expense)	3965	4560	5244	6031	6936	7976	9172	10548	12130
(2) " (maintenance)	605	635	667	700	735	772	811	852	895
(3) " (power expense)	28	28	29	29	30	30	30	30	32
(4) " (miscellaneous)	45	50	55	61	67	74	81	89	98
(5) " (materials)	37	41	45	50	55	61	67	74	81
Sub-total	4680	5314	6008	6838	7754	8841	10056	11476	13076
Depreciation 1 (fundamental equipments)	561	561	561	561	561	561	561	561	561	561
" " 2 (machinery equipments)	81	81	81	81	81	81	81	81	81
" " 3 (buildings)	69	69	69	69	69	69	69	69	69
Sub-total	711	711	711	711	711	711	711	711	711
Interest 1 (Peruvian government)	524	0	0	0	0	0	0	0	0
" 2 (international monetary institutions)	591	541	492	443	394	345	295	246	197
" 3 (foreign countries)	369	338	308	277	246	215	185	154	123
Sub-total	1484	879	800	720	640	560	480	400	320
Total	6875	6904	7519	8269	9105	10112	11247	12587	14107
Profit before deduction of income taxes	12547	15669	18757	22366	26668	31727	37771	44920	53477
Accumulated profit	19978	35647	54404	76770	103438	135165	172936	217856	271333
Taxes	0	0	0	0	0	0	0	0	0
Profit for the current term	12547	15669	18757	22366	26668	31727	37771	44920	53477
Profit carried from previous term	0	7268	22418	40656	62503	88652	119860	157112	201513
Profit for the current term	12547	15669	18757	22366	26668	31727	37771	44920	53477
Depreciation (Add back)	711	711	711	711	711	711	711	711	721
Borrowing 1 (peruvian government)	0	0	0	0	0	0	0	0	0
" 2 (international monetary institutions)	0	0	0	0	0	0	0	0	0
" 3 (foreign countries)	0	0	0	0	0	0	0	0	0
Total income	13258	23648	41886	63733	89882	121090	158342	202743	255701
Investment 1 (fundamental equipments)	0	0	0	0	0	0	0	0	0
" 2 (machinery equipments)	0	0	0	0	0	0	0	0	0
" 3 (buildings)	0	0	0	0	0	0	0	0	0
Sub-total	0	0	0	0	0	0	0	0	0
Repayment 1 (Peruvian government)	4760	0	0	0	0	0	0	0	0
" 2 (international monetary institutions)	615	615	615	615	615	615	615	615	615
" 3 (foreign countries)	615	615	615	615	615	615	615	615	615
Total expenditure	5990	1230	1230	1230	1230	1230	1230	1230	1230
Balance	7268	22418	40656	62503	88652	119860	157112	201513	254471
Outstanding amount of borrowing (Peruvian government)	0	0	0	0	0	0	0	0	0
" (international monetary institutions)	6768	6153	5538	4923	4308	3693	3078	2463	1848
" (foreign countries)	6768	6153	5538	4923	4308	3693	3078	2463	1848
Total	13536	12306	11076	9846	8616	7386	6156	4926	3696
Scrap value (fundamental equipments)	23346	22785	22224	21663	21102	20541	19980	19419	18858
" (machinery equipments)	1566	1485	1404	1323	1242	1161	1080	999	918
" (buildings)	1334	1265	1196	1127	1058	989	920	851	782

Long Term Income and Expenditure and Cash Flow-Tables

Item	23 (104)	24 (105)	25 (106)	26 (107)	27 (108)	28 (109)	29 (110)	30 (111)
(1) Income (condensed copper)	4678	5754	7077	8705	10707	13170	16199	19925
(2) " (agricultural products)	20427	22878	25623	28698	32142	35999	40319	45157
(3) " (cement)	28996	35665	43868	53958	66368	81633	100409	123503
(4) " (fertilizer)	12135	14319	16896	19937	23526	27761	32758	38654
(5) " (oil)	13321	15186	17312	19736	22499	25649	29240	33334
Total	79557	93802	110776	131034	155242	184212	218925	260573
(1) Expenditure (personal expense)	13950	16043	18449	21216	24398	28058	32267	37107
(2) " (maintenance)	772	772	811	811	852	852	895	895
(3) " (power expense)	32	32	34	34	34	36	36	36
(4) " (miscellaneous)	108	119	131	144	158	174	191	210
(5) " (materials)	89	98	108	119	131	144	158	174
Sub-total	14951	17064	19533	22324	25573	29264	33547	38422
Depreciation 1 (fundamental equipments)	561	561	561	561	561	561	561	561	561
" 2 (machinery equipments)	81	81	81	81	81	81	81	81
" 3 (buildings)	69	69	69	69	69	69	69	69
Sub-total	711	711	711	711	711	711	711	711
Interest 1 (Peruvian government)	0	0	0	0	0	0	0	0
" 2 (international monetary institutions)	148	99	49	0	0	0	0	0
" 3 (foreign countries)	92	62	31	0	0	0	0	0
Sub-total	240	161	80	0	0	0	0	0
Total	15902	17936	20324	23035	26284	29975	34258	39133
Profit before deduction of income taxes	63655	75866	90452	107999	128958	154237	184667	221440
Accumulated profit	334588	410454	501306	609305	738263	892500	1077167	1298607
Taxes	0	0	0	0	0	0	0	0
Profit for the current term	63655	75866	90452	107999	128958	154237	184667	221440
Profit carried from previous term	254471	317607	392954	482881	591591	721260	876208	1061586
Profit for the current term	63655	75866	90452	107999	128958	154237	184667	221440
Depreciation (Add back)	711	711	711	711	711	711	711	711
Borrowing 1 (peruvian government)	0	0	0	0	0	0	0	0
" 2 (international monetary institutions)	0	0	0	0	0	0	0	0
" 3 (foreign countries)	0	0	0	0	0	0	0	0
Total income	318837	394184	484117	591591	721260	876208	1061586	1283737
Investment 1 (fundamental equipments)	0	0	0	0	0	0	0	0
" 2 (machinery equipments)	0	0	0	0	0	0	0	0
" 3 (buildings)	0	0	0	0	0	0	0	0
Sub-total	0	0	0	0	0	0	0	0
Repayment 1 (Peruvian government)	0	0	0	0	0	0	0	0
" 2 (international monetary institutions)	615	615	618	0	0	0	0	0
" 3 (foreign countries)	615	615	618	0	0	0	0	0
Total expenditure	1230	1230	1236	0	0	0	0	0
Balance	317607	392954	482881	591591	721260	876208	1061586	1283737
Outstanding amount of borrowing (Peruvian government)	0	0	0	0	0	0	0	0
" (international monetary institutions)	1233	618	0	0	0	0	0	0
" (foreign countries)	1233	618	0	0	0	0	0	0
Total	2466	1236	0	0	0	0	0	0
Scrap value (fundamental equipments)	18297	17736	17175	16614	16053	15492	14931	14370
" (machinery equipments)	837	756	675	594	513	432	351	270
" (buildings)	713	644	575	506	437	368	299	230

Table 4-614 Long Term Income and Expenditure and Cash Flow-Tables (Including those portion of expansion)

Item	** (77)	** (78)	** (79)	** (80)	** (81)	1 (82)	2 (83)	3 (84)	4 (85)
(1) Income (condensed copper)	0	0	0	0	0	115	129	144	161
(2) " (agricultural products)	0	0	0	0	0	1213	1443	1717	2043
(3) " (cement)	0	0	0	0	0	212	280	370	488
(4) " (fertilizer)	0	0	0	0	0	168	210	263	329
(5) " (oil)	0	0	0	0	0	746	850	969	1105
Total	0	0	0	0	0	2454	2912	3463	4126
(1) Expenditure (personal expense)	0	0	0	0	0	644	741	852	980
(2) " (maintenance)	0	0	0	0	0	451	451	474	474
(3) " (power expense)	0	0	0	0	0	24	24	24	25
(4) " (miscellaneous)	0	0	0	0	0	13	14	15	17
(5) " (materials)	0	0	0	0	0	11	12	13	14
Sub-total	0	0	0	0	0	1143	1242	1378	1510
Depreciation 1 (fundamental equipments)	0	0	0	0	0	561	561	561	771
" 2 (machinery equipments)	0	0	0	0	0	81	81	81	81
" 3 (buildings)	0	0	0	0	0	69	69	69	69
Sub-total	0	0	0	0	0	711	711	711	921
Interest 1 (Peruvian government)	0	53	365	792	1341	1805	2035	2895	3803
" 2 (international monetary institutions)	0	29	199	432	732	984	984	984	984
" 3 (foreign countries)	0	18	125	270	457	615	615	615	615
Sub-total	0	100	689	1494	2530	3404	3634	4494	5402
Total	0	100	689	1494	2530	5258	5587	6583	7833
Profit before deduction of income taxes	0	-100	-689	-1494	-2530	-2804	-2675	-3120	-3707
Accumulated profit	0	-100	-789	-2283	-4813	-7617	-10292	-13412	-17119
Taxes	0	0	0	0	0	0	0	0	0
Profit for the current term	0	0	0	0	0	0	0	0	0
Profit carried from previous term	0	0	0	0	0	0	0	0	0
Profit for the current term	0	-100	-689	-1494	-2530	-2804	-2675	-3120	-3707
Depreciation (Add back)	0	0	0	0	0	711	711	711	921
Borrowing 1 (peruvian government)	480	2840	3877	4998	4212	2093	7814	8259	2786
" 2 (international monetary institutions)	360	2130	2906	3748	3159	0	0	0	0
" 3 (foreign countries)	360	2130	2906	3748	3159	0	0	0	0
Total income	1200	7000	9000	11000	8000	0	5850	5850	0
Investment 1 (fundamental equipments)	1200	7000	9000	9000	5000	0	5850	5850	0
" 2 (machinery equipments)	0	0	0	1000	1700	0	0	0	0
" 3 (buildings)	0	0	0	1000	1300	0	0	0	0
Sub-total	1200	7000	9000	11000	8000	0	5850	5850	0
Repayment 1 (Peruvian government)	0	0	0	0	0	0	0	0	0
" 2 (international monetary institutions)	0	0	0	0	0	0	0	0	0
" 3 (foreign countries)	0	0	0	0	0	0	0	0	0
Total expenditure	1200	7000	9000	11000	8000	0	5850	5850	0
Balance	0	0	0	0	0	0	0	0	0
Outstanding amount of borrowing (Peruvian government)	480	3320	7197	12195	16407	18500	26314	34573	37359
" (international monetary institutions)	360	2490	5396	9144	12303	12303	12303	12303	12303
" (foreign countries)	360	2490	5396	9144	12303	12303	12303	12303	12303
Total	1200	8300	17989	30483	41013	43106	50920	59179	61965
Scrap value (fundamental equipments)	0	0	0	0	31200	30639	30078	41217	40446
" (machinery equipments)	0	0	0	0	2700	2615	2538	2457	2376
" (buildings)	0	0	0	0	2300	2231	2162	2093	2024

Long Term Income and Expenditure and Cash Flow-Tables

Item	5 (86)	6 (87)	7 (88)	8 (89)	9 (90)	10 (91)	11 (92)	12 (93)	13 (94)
(1) Income (condensed copper)	180	202	226	253	283	317	390	480	590
(2) " (agricultural products)	2431	2771	3159	3601	4105	4680	5242	5871	6576
(3) " (cement)	644	805	1006	1258	1573	1966	2418	2974	3658
(4) " (fertilizer)	411	526	673	861	1102	1411	1465	1965	2319
(5) " (oil)	1260	1436	1637	1866	2127	2425	2765	3152	3593
Total	4926	5740	6701	7839	9190	10799	12480	14442	16736
(1) Expenditure (personal expense)	1127	1296	1490	1714	1971	2267	2607	2998	3448
(2) " (maintenance)	498	498	523	523	549	549	576	576	605
(3) " (power expense)	25	25	26	26	26	27	27	27	28
(4) " (miscellaneous)	19	21	23	25	28	31	34	37	41
(5) " (materials)	15	17	19	21	23	25	28	31	34
Sub-total	1684	1857	2081	2309	2597	2899	3272	3669	4156
Depreciation 1 (fundamental equipments)	771	771	771	771	1165	1165	1165	1165	1165
" 2 (machinery equipments)	81	81	81	81	81	81	81	81	81
" 3 (buildings)	69	69	69	69	69	69	69	69	69
Sub-total	921	921	921	921	1315	1315	1315	1315	1315
Interest 1 (Peruvian government)	4106	4381	4747	6276	7852	8275	8592	8742	8832
" 2 (international monetary institutions)	984	984	935	886	837	787	738	689	640
" 3 (foreign countries)	615	615	584	554	523	492	461	431	400
Sub-total	5708	5980	6266	7716	9212	9554	9791	9912	9872
Total	8313	8758	9268	10940	13124	13768	14378	14896	15343
Profit before deduction of income taxes	-3387	-3018	-2567	-3101	-3934	-2969	-1898	-454	1393
Accumulated profit	-20506	-23524	-26091	-29192	-33126	-36095	-37993	-38447	-37054
Taxes	0	0	0	0	0	0	0	0	0
Profit for the current term	0	0	0	0	0	0	0	0	1393
Profit carried from previous term	0	0	0	0	0	0	0	0	0
Profit for the current term	-3387	-3018	-2567	-3101	-3934	-2969	-1898	-454	1393
Depreciation (Add back)	921	921	921	921	1315	1315	1315	1315	1315
Borrowing 1 (peruvian government)	2466	3327	13846	14380	3849	2884	1813	369	0
" 2 (international monetary institutions)	0	0	0	0	0	0	0	0	0
" 3 (foreign countries)	0	0	0	0	0	0	0	0	0
Total income	0	1230	12200	12200	1230	1230	1230	1230	2708
Investment 1 (fundamental equipments)	0	0	10970	10970	0	0	0	0	0
" 2 (machinery equipments)	0	0	0	0	0	0	0	0	0
" 3 (buildings)	0	0	0	0	0	0	0	0	0
Sub-total	0	0	10970	10970	0	0	0	0	1478
Repayment 1 (Peruvian government)	0	615	615	615	615	615	615	615	615
" 2 (international monetary institutions)	0	615	615	615	615	615	615	615	615
" 3 (foreign countries)	0	0	0	0	0	0	0	0	0
Total expenditure	0	1230	12200	12200	1230	1230	1230	1230	2708
Balance	0	0	0	0	0	0	0	0	0
Outstanding amount of borrowing (Peruvian government)	39825	43152	56998	71378	75227	78111	79924	80293	78815
" (international monetary institutions)	12303	11688	11073	10458	9843	9228	8613	7998	7383
" (foreign countries)	12303	11688	11073	10458	9843	9228	8613	7998	7383
Total	64431	66528	79144	92294	94913	96567	97150	96289	93581
Scrap value (fundamental equipments)	39675	38904	38133	59302	58137	56972	55807	54642	53477
" (machinery equipments)	2295	2214	2133	2052	1971	1890	1809	1728	1647
(buildings)	1955	1886	1817	1748	1679	1610	1541	1472	1403

Long Term Income and Expenditure and Cash Flow-Tables

Item	14 (95)	15 (96)	16 (97)	17 (98)	18 (99)	19 (100)	20 (101)	21 (102)	22 (103)
(1) Income (condensed copper)	726	893	893	893	893	893	893	893	893
(2) " (agricultural products)	7365	8249	9239	10348	11590	12981	14539	16284	18238
(3) " (cement)	4499	5534	6807	8373	10299	12668	15582	19166	23574
(4) " (fertiliser)	2736	3228	3809	4495	5304	6259	7386	8715	10284
(5) " (oil)	4096	4669	5323	6068	6918	7887	8991	10250	11685
Total	19422	22573	26071	30177	35004	40688	47391	55308	64674
(1) Expenditure (personal expense)	3965	4560	5244	6031	6936	7976	9172	10548	12130
(2) " (maintenance)	605	635	635	667	667	700	700	735	735
(3) " (power expense)	28	28	29	29	29	30	30	30	32
(4) " (miscellaneous)	45	50	55	61	67	74	81	89	98
(5) " (materials)	37	41	45	50	55	61	67	74	81
Sub-total	4680	5314	6008	6838	7754	8841	10050	11476	13076
Depreciation 1 (fundamental equipments)	1165	1165	1165	1165	1165	1165	1165	1165	1165
" 2 (machinery equipments)	81	81	81	81	81	81	81	81	81
" 3 (buildings)	69	69	69	69	69	69	69	69	69
Sub-total	1315	1315	1315	1315	1315	1315	1315	1315	1315
Interest 1 (Peruvian government)	8670	8243	7483	6322	4665	2386	0	0	0
" 2 (international monetary institutions)	591	541	492	443	394	345	295	246	197
" 3 (foreign countries)	369	338	308	277	246	215	185	154	123
Sub-total	9630	9122	8283	7042	5305	2946	480	400	320
Total	15625	15751	15606	15195	14374	13102	11845	13191	14711
Profit before deduction of income taxes	3797	6822	10465	14982	20630	27586	35546	42117	49663
Accumulated profit	-33257	-26435	-15970	-988	19642	47228	82774	124891	174854
Taxes	0	0	0	0	0	0	0	0	0
Profit for the current term	3797	6822	10465	14982	20630	27586	35546	42117	49663
Profit carried from previous term	0	0	0	0	0	0	5977	41608	83810
Profit for the current term	3797	6822	10465	14982	20630	27586	35546	42117	49663
Depreciation (Add back)	1315	1315	1315	1315	1315	1315	1315	1315	1315
Borrowing 1 (peruvian government)	0	0	0	0	0	0	0	0	0
" 2 (international monetary institutions)	0	0	0	0	0	0	0	0	0
" 3 (foreign countries)	0	0	0	0	0	0	0	0	0
Total income	5112	8137	11780	16297	21945	28901	42838	85040	135088
Investment 1 (fundamental equipments)	0	0	0	0	0	0	0	0	0
" 2 (machinery equipments)	0	0	0	0	0	0	0	0	0
" 3 (buildings)	0	0	0	0	0	0	0	0	0
Sub-total	0	0	0	0	0	0	0	0	0
Repayment 1 (Peruvian government)	3882	6907	10550	15067	20715	21694	0	0	0
" 2 (international monetary institutions)	615	615	615	615	615	615	615	615	615
" 3 (foreign countries)	615	615	615	615	615	615	615	615	615
Total expenditure	5112	8137	11780	16297	21945	22924	1230	1230	1230
Balance	0	0	0	0	0	5977	41608	83810	133858
Outstanding amount of borrowing (Peruvian government)	74533	68726	57476	42409	21694	0	0	0	0
" (international monetary institutions)	6768	6153	5538	4923	4308	3693	3078	2463	1848
" (foreign countries)	6768	6153	5538	4923	4308	3693	3078	2463	1848
Total	88069	81032	68552	52255	30310	7386	6156	4926	3696
Scrap value (fundamental equipments)	52212	51147	49982	48817	47652	46487	45322	44157	42992
" (machinery equipments)	1566	1485	1404	1323	1242	1161	1080	999	918
" (buildings)	1334	1265	1196	1127	1058	989	920	851	782

Long Term Income and Expenditure and Cash-Flow-Tables

Item	23 (104)	24 (105)	25 (106)	26 (107)	27 (108)	28 (109)	29 (110)	30 (111)
(1) Income (condensed copper)	893	893	893	893	893	1298	1351	1662
(2) " (agricultural products)	20427	22878	25623	28698	32142	35999	40319	45157
(3) " (cement)	28996	35665	43868	53958	66368	81633	100429	123503
(4) " (fertiliser)	12135	14345	16956	19937	23526	27761	32758	38654
(5) " (oil)	13321	15180	17312	19736	22499	25649	29240	33334
Total	75772	88961	104592	123222	145428	172140	204077	242310
(1) Expenditure (personal expense)	13656	16043	18449	21216	24398	28058	32267	37107
(2) " (maintenance)	772	772	811	811	852	852	895	895
(3) " (power expense)	32	32	34	34	34	36	36	36
(4) " (miscellaneous)	178	115	131	144	158	174	191	210
(5) " (materials)	89	98	108	119	131	144	158	174
Sub-total	14951	17264	19533	22324	25573	29264	33547	38422
Depreciation 1 (fundamental equipments)	1165	1165	1165	1165	1165	1165	1165	1165
" 2 (machinery equipments)	81	81	81	81	81	81	81	81
" 3 (buildings)	69	69	69	69	69	69	69	69
Sub-total	1315	1315	1315	1315	1315	1315	1315	1315
Interest 1 (Peruvian government)	0	0	0	0	0	0	0	0
" 2 (international monetary institutions)	148	99	49	0	0	0	0	0
" 3 (foreign countries)	92	62	31	0	0	0	0	0
Sub-total	240	161	80	0	0	0	0	0
Total	16506	18540	20928	23639	26888	30579	34862	39737
Profit before deduction of income taxes	59266	70401	83664	99583	118540	141561	169215	202573
Accumulated profit	234120	304521	388185	487768	606308	747869	917084	1119657
Taxes	0	0	0	0	0	0	0	0
Profit for the current term	59266	70401	83664	99583	118540	141561	169215	202573
Profit carried from previous term	133858	193209	263695	347438	448336	568191	711067	881597
Profit for the current term	59266	70401	83664	99583	118540	141561	169215	202573
Depreciation (Add back)	1315	1315	1315	1315	1315	1315	1315	1315
Borrowing 1 (peruvian government)	0	0	0	0	0	0	0	0
" 2 (international monetary institutions)	0	0	0	0	0	0	0	0
" 3 (foreign countries)	0	0	0	0	0	0	0	0
Total income	194439	264925	348674	448336	568191	711067	881597	1085485
Investment 1 (fundamental equipments)	0	0	0	0	0	0	0	0
" 2. (machinery equipments)	0	0	0	0	0	0	0	0
" 3 (buildings)	0	0	0	0	0	0	0	0
Sub-total	0	0	0	0	0	0	0	0
Repayment 1 (Peruvian government)	0	0	0	0	0	0	0	0
" 2 (international monetary institutions)	615	615	618	0	0	0	0	0
" 3 (foreign countries)	615	615	618	0	0	0	0	0
Total expenditure	1230	1230	1236	0	0	0	0	0
Balance	193209	263695	347438	448336	568191	711067	881597	1085485
Outstanding amount of borrowing (Peruvian government)	0	0	0	0	0	0	0	0
" (international monetary institutions)	1233	618	0	0	0	0	0	0
" (foreign countries)	1233	618	0	0	0	0	0	0
Total	2466	1236	0	0	0	0	0	0
Scrap value (fundamental equipments)	41827	40662	39497	38332	37167	36002	34837	33672
" (machinery equipments)	837	756	675	594	513	432	351	270
" (buildings)	713	644	575	506	437	368	299	230

6-2 Profit Index and Internal Profitability

The annual profit index against the harbour investment is expressed as the increased part of gains brought after the execution of the investment project and the expenditure is also computed as before mentioned.

The evaluation for the investment is being made based on these profit and expenditure. (in this case, loan and related interest are not taken into consideration.)

All profit index is expressed in the form of "cash flow". The discount rate that equalize the current value against whole capital investments and the current value of a series of time-lagged cash inflow is regarded as internal profitability. This discount rate stands for the profitability against whole capital investments in the project and expresses interests of investment project itself. The rate obtained from dividing the net present value with its capital investments (N.P.V.) is a scale to measure the amount of N.P.V. per investment unit and also a character index to judge the profitability of the project. This profitability index is also a scale to measure the investment profitability of the profit index.

Table 4-623 shows the result of calculation assuming the discount rate of N.P.V. as 10 % and 12 % respectively. The P.V. index is 2.69 in case of 10 % and 1.49 in case of 12 %.

The internal profitability of whole project is indicating 15.58 % from which it can be evaluated that the project is well payable. However, the trial calculation for the project is based on 35 years including construction and investment period and when calculating the same according to 25-year basis, the internal profitability is 11.31 % but the P.V. index is 0.54 in case of 10 % and 0.19 in case of 12 %.

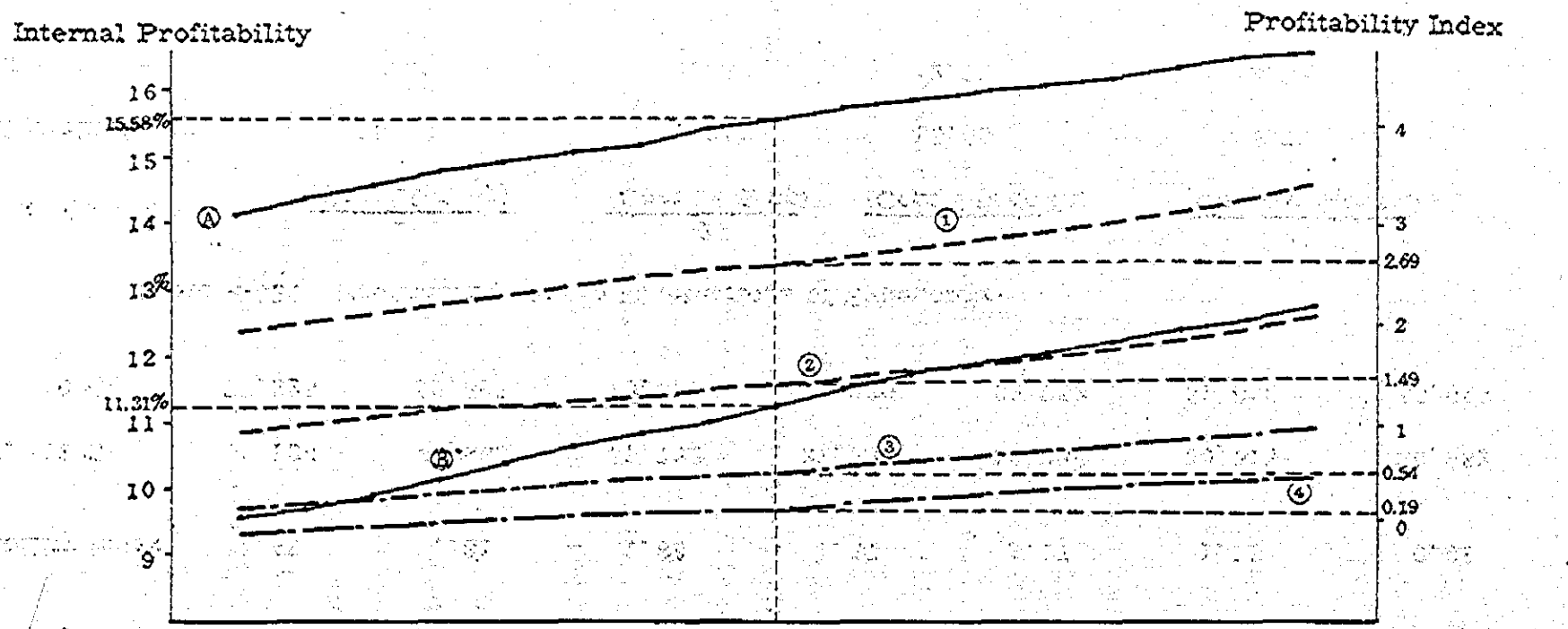
Table 4-621 Profitability due to Fluctuations of Income

Sensitivity Case 1	Base	1 (Income 10 % up)	2 (Income 12 % up)	3 (Income 4 % down	4 (Income 10 % down)	5 (Income 12 % down)	6 (Income 16 % down)
Internal profitability	15.58 %	16.32 %	16.46 %	15.26 %	14.76 %	14.60 %	14.23 %
Profitability index (10 %)	2.69	3.16	3.25	2.50	2.22	2.13	1.94
Profitability index (12 %)	1.49	1.81	1.88	1.37	1.17	1.11	0.98
N.P.V. (12 %)	41,126	49,965	51,733	37,590	32,286	30,518	26,982
N.P.V. (10 %)	77,225	90,697	93,391	71,830	63,752	61,058	55,669

Table 4-622 Profitability due to Fluctuations of Expenditure

Sensitivity Case 2	1 (Cost 10 % up)	2 (Cost 14 % up)	3 (Cost 6 % down)	4 (Cost 10 % down)
Internal profitability	15.39	15.31	15.69	15.76
Profitability index (10 %)	2.59	2.55	2.75	2.79
Profitability index (12 %)	1.42	1.39	1.54	1.57
N.P.V. (12 %)	39,152	38,363	42,309	43,008
N.P.V. (10 %)	74,348	73,197	78,951	80,101

FIG. 4-621 TRANSITION OF PROFIT INDEX IN CASE OF VARIATION OF ± 15% OF HARBOR INCOME



Internal Profitability

Ⓐ: Profitable Period - 30 years

Ⓑ: Profitable Period - 20 years

Profitability Index - 30 years

①: Internal Profitability - 10 %

②: Internal Profitability - 12 %

Profitability Index - 20 years

③: Internal Profitability - 10 %

④: Internal Profitability - 12 %

Table 4-623 Expense for Benefit and Internal Rate of Profit -1

YEAR	CASH IN	CASH OUT INVESTMENT	PERSONAL EXPENSE	MAINTE-NANCE	POWER EXPENSE	MISCEL-LANEOUS	MATERIALS	CASH FLOW	D.C.F.RATE 10%	D.C.F.RATE 12%
1977	[illegible]	12000.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-12000.00	-12000.00	-12000.00
1978	[illegible]	7000.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-7000.00	-6363.64	-6250.00
1979	[illegible]	9000.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-9000.00	-7438.03	-7174.75
1980	[illegible]	11000.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-11000.00	-8264.48	-7829.59
1981	[illegible]	8000.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-8000.00	-5464.13	-5084.15
1982	2454.00	[illegible]	644.[illegible]	451.[illegible]	24.[illegible]	13.[illegible]	11.[illegible]	1311.00	814.53	743.90
1983	2912.00	[illegible]	74[illegible]	451.[illegible]	24.[illegible]	14.[illegible]	12.[illegible]	1471.00	942.68	846.08
1984	3463.00	[illegible]	851.69	473.55	24.[illegible]	15.73	13.31	2084.72	1069.80	943.02
1985	4126.00	[illegible]	979.44	473.55	25.20	17.30	14.64	2615.86	1220.33	1056.51
1986	4920.00	[illegible]	1126.36	497.23	25.20	19.03	16.11	3242.07	1374.97	1169.13
1987	5741.00	[illegible]	1295.31	497.23	25.20	20.94	17.72	3883.60	1497.31	1250.42
1988	6731.00	[illegible]	1485.61	522.10	26.46	23.03	19.49	4662.32	1619.41	1328.24
1989	7839.00	[illegible]	1713.35	522.10	26.46	25.33	21.44	5530.67	1762.24	1419.58
1990	9196.00	[illegible]	1971.11	548.19	26.46	27.87	23.58	6593.88	1910.63	1511.16
1991	10799.00	[illegible]	2265.51	548.19	27.78	30.65	25.94	7900.91	2064.58	1616.69
1992	12481.00	[illegible]	2605.34	575.60	27.78	33.72	28.53	9239.02	2204.60	1682.46
1993	14442.00	[illegible]	2990.14	575.60	27.78	37.09	31.38	10773.99	2344.77	1757.48
1994	16736.00	[illegible]	3445.56	604.38	29.17	40.80	34.52	12581.56	2489.23	1832.45
1995	19422.00	[illegible]	3962.39	604.38	29.17	44.88	37.97	14749.19	2651.73	1917.21
1996	22573.00	[illegible]	4550.75	634.60	29.17	49.37	41.77	17261.34	2822.41	2004.17
1997	26276.00	[illegible]	5240.28	634.60	30.63	54.30	45.95	20277.25	3013.10	2101.37
1998	30635.00	[illegible]	6026.29	666.33	30.63	59.73	50.54	23851.46	3216.36	2203.07
1999	35773.00	[illegible]	6939.23	666.33	30.63	65.71	55.60	28024.45	3442.76	2316.03
2000	41839.00	[illegible]	7969.77	699.65	32.16	72.28	61.16	33013.98	3685.90	2435.32
2001	49014.00	[illegible]	9165.23	699.65	32.16	79.51	67.27	38968.18	3956.35	2567.33
2002	57519.00	[illegible]	1054[illegible]	734.63	32.16	87.46	74.00	46038.75	4249.28	2708.18
2003	67586.00	[illegible]	12121.[illegible]	734.63	33.77	96.20	81.40	54516.98	4574.38	2863.31
2004	79557.00	[illegible]	13939.16	771.36	33.77	105.82	89.54	64617.31	4928.98	3030.17
2005	93802.00	[illegible]	16030.[illegible]	771.36	33.77	116.41	98.50	76751.81	5322.36	3213.58
2006	110776.00	[illegible]	18434.53	809.93	35.46	128.05	108.35	91259.50	5753.09	3411.62
2007	131014.00	[illegible]	21199.72	809.93	35.46	140.85	119.18	108728.75	6221.25	3629.18
2008	155242.00	[illegible]	24379.66	850.43	35.46	154.94	131.10	129690.31	6756.88	3865.05
2009	184212.00	[illegible]	28036.66	862.44	37.23	170.43	144.21	154973.00	7340.11	4123.68
2010	218965.00	[illegible]	32242.[illegible]	892.95	37.23	187.47	158.63	185406.44	7983.23	4404.90
2011	260573.00	0.00	37078.40	892.95	37.23	206.22	174.49	222183.56	8697.09	4713.08
N.P.V									77224.94	41125.90

PAYOUT YEAR= 14.41

PROFITABILITY INDEX (10) = 2.69
PROFITABILITY INDEX (12) = 1.49

INTEREST RETURN PERIOD = 15.58

DISCOUNT BREAK EVEN POINT (10) = 23.39
DISCOUNT BREAK EVEN POINT (12) = 22.89

Table 4-624 Expense for Benefit and Internal Rate of Profit - 2

YEAR	CASH IN	CASH OUT INVESTMENT	PERSONAL EXPENSE	MAINTE-NANCE	POWER EXPENSE	MISCEL-LANEOUS	MATERIALS	CASH FLOW	D.C.F.RATE 10%	D.C.F.RATE 12%
1977	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-1200.00	-1200.00	-1200.00
1978	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-7000.00	-6363.64	-6250.00
1979	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-9000.00	-7438.03	-7174.75
1980	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-11000.00	-8264.46	-7829.59
1981	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-8000.00	-5464.13	-5084.15
1982	2454.00	[illegible]	644.00	451.00	24.00	13.00	11.00	1311.00	814.03	743.90
1983	2912.00	[illegible]	746.64	451.00	24.00	14.30	12.10	1671.00	942.68	846.08
1984	3463.00	[illegible]	851.69	473.55	24.96	15.73	13.31	2084.72	1069.80	943.02
1985	4126.00	[illegible]	979.44	473.55	25.71	17.30	14.64	2619.86	1220.33	1056.51
1986	4926.00	[illegible]	1126.46	497.23	25.71	19.03	16.11	3242.47	1374.97	1169.13
1987	5746.00	[illegible]	1295.31	497.23	25.20	20.94	17.72	3883.60	1497.31	1290.42
1988	6701.00	[illegible]	1489.61	522.09	26.46	23.03	19.49	4607.32	1619.41	1328.24
1989	7839.00	[illegible]	1713.05	522.09	26.46	25.33	21.44	5333.62	1762.24	1419.58
1990	9190.00	[illegible]	1970.01	548.19	26.46	27.87	23.58	6593.88	1916.03	1511.16
1991	10799.00	[illegible]	2265.51	548.19	27.78	30.65	25.94	7900.91	2080.58	1616.69
1992	12488.00	[illegible]	2605.34	575.60	27.78	33.72	28.53	9209.02	2204.60	1682.46
1993	14442.00	[illegible]	2996.14	575.60	27.78	37.09	31.38	10773.99	2344.77	1757.48
1994	16736.00	[illegible]	3445.56	604.38	29.17	40.80	34.52	12581.56	2489.23	1832.45
1995	19422.00	[illegible]	3962.39	604.38	29.17	44.88	37.97	14743.19	2651.73	1917.21
1996	22573.00	[illegible]	4556.75	634.60	29.17	49.37	41.77	17261.34	2822.41	2004.17
1997	26276.00	[illegible]	5240.26	634.60	30.63	54.31	45.95	20227.25	3014.10	2101.37
1998	30635.00	[illegible]	6026.29	666.33	30.63	59.73	50.54	23807.46	3216.26	2203.07
1999	35773.00	[illegible]	6931.23	666.33	30.63	65.71	55.60	28024.49	3442.76	2316.03
2000	41839.00	[illegible]	7969.77	699.65	32.16	72.28	61.16	33048.98	3685.92	2435.32
2001	49012.00	[illegible]	9165.23	699.65	32.16	79.51	67.27	38968.18	3956.35	2567.33
N.P.V									15388.34	5163.16

PAYOUT YEAR= 14.41

PROFITABILITY INDEX (10) = [illegible].54
PROFITABILITY INDEX (12) = [illegible].19

INTEREST RETURN PERIOD = 11.31

DISCOUNT BREAK EVEN POINT (10) = 20.36
DISCOUNT BREAK EVEN POINT (12) = 22.07

6-3 Recovery of Investment and Risk Analysis

In the before-mentioned trial calculations on investment profitability of the profitability index the loan and related interest were not taken into consideration and in this calculation the investment profitability is being sought based on the initial income and expenditure plan.

	Excluding those portion of expansion	Including those portion of expansion
Investment profitability after paying the interest (Return = profit after tax + depreciation)	13.53 %	10.76 %
Investment profitability with reimbursement of the interest (Return = profit after tax + depreciation + long term and short term loan interest)	17.33 %	15.47 %
Period of recovery of investment	20.6 year	25.1 year

Though the loan interest is being assumed as 11 %, 8 % and 5 % respectively in the income and expenditure plan, the project is evaluated as fairly feasible investment profitability even comparing with the profitability in case of giving consideration to additional investment.

Next, the item of port revenue and expenditure is being extracted from the revenue and expenditure plan and sensitivity and risk analysis is given by providing a certain margin to said item.

Since those items of revenue and expenditure are based on uncertain factors which require a certain spot assumption inevitably, the sensitivity analysis expresses the profitability as a relative frequency in case of fluctuating by ± 5 % every year.

In case of the risk analysis, the probability calculation is being made by giving a margin of ± 10 % every year without uniformly fluctuating both port revenue and expenditure like the sensitivity analysis. The following is a summary of results obtained from the sensitivity and risk analysis from which it is noticed that the average profitability stays around 15 % and 17 % roughly with normal distribution. (See graph.)

Table 4-631 Results of Sensitivity and Risk Analysis 1
(excluding those portion of expansion)

Fluctuation of sensitivity analysis	Port Revenue		Port Expenditure	
Interest of investment recovery	Type I	Type II	Type I	Type II
Simulation case	A	B	C	D
Average profitability	13.5287 %	17.3258 %	13.5254 %	17.3276 %
Variance	0.0146	0.0093	0.0011	0.0007
Standard deviation	0.1209	0.0963	0.0333	0.0272
95 % reliable range (2)	13.2869 % -- 13.7705 %	17.1332 % -- 17.5184 %	13.4589 % -- 13.5920 %	17.2732 % -- 17.3819 %

Type I means the investment profitability during construction after paying the interest while Type II the one during construction with the reimbursement of the interest.

Table 4-632 Results of Sensitivity and Risk Analysis 2
(Including those portion of expansion)

Fluctuation of sensitivity analysis	Port Revenue		Port Expenditure	
Interest of investment recovery	Type I	Type II	Type I	Type II
Simulation case	E	F	G	H
Average profitability	10.7528 %	15.4762 %	10.7597 %	15.4728 %
Variance	0.0229	0.0088	0.0014	0.0006
Standard deviation	0.1512	0.0937	0.0371	0.0235
95 % reliable range (2)	10.4504 % -- 11.0552 %	15.2887 % -- 15.6637 %	10.6855 % -- 10.8338 %	15.4257 % -- 15.5198 %

Table 4-633 Rate of Profit Graph Case-B
(Fluctuation of Port Revenue)

	FROM		TO	FREQUENCY	0 . . . . 5 . . . . 10 . . . . 15 . . . . 20 . . . . 25 30
1)		<-->	16.9554	(0) :	
2)	16.9554	<-->	16.9919	(1) : *	
3)	16.9919	<-->	17.0284	(0) :	
4)	17.0284	<-->	17.0649	(0) :	
5)	17.0649	<-->	17.1015	(3) : *	
6)	17.1015	<-->	17.1380	(10) : *	
7)	17.1380	<-->	17.1745	(15) : *	
8)	17.1745	<-->	17.2111	(25) : *	
9)	17.2111	<-->	17.2476	(48) : *	
10)	17.2476	<-->	17.2841	(64) : *	
11)	17.2841	<-->	17.3207	(74) : *	
12)	17.3207	<-->	17.3572	(78) : *	
13)	17.3572	<-->	17.3937	(56) : *	
14)	17.3937	<-->	17.4302	(46) : *	
15)	17.4302	<-->	17.4668	(48) : *	
16)	17.4668	<-->	17.5033	(16) : *	
17)	17.5033	<-->	17.5398	(8) : *	
18)	17.5398	<-->	17.5764	(6) : *	
19)	17.5764	<-->	17.6129	(2) : *	
20)	17.6129	<-->		(0) :	
	TOTAL			500	

Table 4-634 Rate of Profit Graph Case F
(Fluctuation of Port Revenue - Including Those Portion of Expansion)

	FROM		TO	FREQUENCY	0 . . . . 5 . . . . 10 . . . . 15 . . . . 20 . . . . 25 30
1)		<-->	15.1765	(0) :	
2)	15.1765	<-->	15.2073	(1) : *	
3)	15.2073	<-->	15.2381	(3) : *	
4)	15.2381	<-->	15.2689	(1) : *	
5)	15.2689	<-->	15.2996	(7) : *	
6)	15.2996	<-->	15.3304	(19) : *	
7)	15.3304	<-->	15.3612	(24) : *	
8)	15.3612	<-->	15.3920	(42) : *	
9)	15.3920	<-->	15.4228	(47) : *	
10)	15.4228	<-->	15.4535	(56) : *	
11)	15.4535	<-->	15.4843	(59) : *	
12)	15.4843	<-->	15.5151	(77) : *	
13)	15.5151	<-->	15.5459	(53) : *	
14)	15.5459	<-->	15.5767	(38) : *	
15)	15.5767	<-->	15.6075	(36) : *	
16)	15.6075	<-->	15.6382	(13) : *	
17)	15.6382	<-->	15.6690	(12) : *	
18)	15.6690	<-->	15.6998	(7) : *	
19)	15.6998	<-->	15.7306	(5) : *	
20)	15.7306	<-->		(0) :	
	TOTAL			500	

Table 4-635 Sensitivity Analysis (Case B)
(Fluctuation of Port Revenue)

Fluctuation Ratio	Profitability Ratio	Relative Ratio	Period of Recovery (Year)
-20.00 %	15.40477 %	(88.90 %)	24.0
-15.00 %	15.92223 %	(91.89 %)	23.0
-10.00 %	16.41298 %	(94.72 %)	22.1
-5.00 %	16.88044 %	(97.42 %)	21.3
.00 %	17.32738 %	(100.00 %)	20.6
5.00 %	17.75612 %	(102.47 %)	20.0
10.00 %	18.16860 %	(104.85 %)	19.4
15.00 %	18.56644 %	(107.15 %)	18.9
20.00 %	18.95105 %	(109.37 %)	18.4

Table 4-636 Sensitivity Analysis (Case F)
(Fluctuation of Port Revenue - Portion of Expansion)

Fluctuation Ratio	Profitability Ratio	Relative Ratio	Period of Recovery (Year)
-20.00 %	13.54474 %	(87.54 %)	29.1
-15.00 %	14.06439 %	(90.90 %)	28.0
-10.00 %	14.55662 %	(94.08 %)	26.9
-5.00 %	15.02497 %	(97.11 %)	26.0
.00 %	15.47231 %	(100.00 %)	25.1
5.00 %	15.90105 %	(102.77 %)	24.3
10.00 %	16.31317 %	(105.43 %)	23.6
15.00 %	16.71037 %	(108.00 %)	22.9
20.00 %	17.09409 %	(110.48 %)	22.3