CHAPTER 7. PORT PLAN

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7.1 Port Construction Site

In selecting a port construction site, study must be made from different angles: the present conditions of the area concerned and the direction of its future development, socioeconomic conditions and natural conditions.

The Casambalangan Bay has a center of inhabitants' life behind the middle part of its recesses and this area will function as the center of the district in the future as well. The housing area spreads along National Road No. 3. In the land part, mountains are close by the coast except in the middle (Fig. 7-1). The flatland consists of swamps, though with some paddy-fields. Behind the hills on the south side of the Casambalangan Bay, namely, in the area on the side of city of Gonzaga beyond the hills there is a large tract of flatland. This part will be available for land use for many purposes including factory sites. Fishery is practised in the Casambalangan Bay. In Area (I) where reefs are developed, rod-and-line fishing is in practice while in the shallow waters, fishing with water guns is practised. In Area (IV), dragnet fishing is in practice. Since this fishery caters to local consumption, the catches are small. But fishing activities by the local people will continue for some time in the future in Areas (I) and (IV), as at present. So, these areas should be preserved for fishery as much as possible.

In Area (II), there is a large pier that is already functioning. Behind it are a sugar warehouse, a molasses tank and a harbor road leading to National Road No. 3. It is important what should be the relations between these existing facilities and facilities to be constructed. Barring some special reason, it is most basically important to maintain organic relations with the existing facilities and make effective use of the past investments. So, from relations with the existing facilities Area (I) and Area (II) are eligible as the port construction site.

Let us now compare the areas for relative superiority from the view-point of natural conditions. Waves reaching into the Bay of Casambalangan prevail in the NW direction except for waves in the typhoon period. Offshore-waves directly invade into Area (III) and Area (IV) but the east side of Area (I) and the waters of Area (II) are shielded by corals and hardly affected by prevailing waves. In Area (IV), there is the Casambalangan River, the largest river that flows into the bay. Though the inflow of this river is unknown, its estuary is unstable and it seems to be the source of supply of drift sand. There is sand drifting in Area (III) and Area (IV).

As for soil conditions, they are generally satisfactory except in Area (II) as far as the results of our recent survey and the existing data are concerned. In Area (II), soil conditions are unsatisfactory. Particularly, the ground is increasingly soft in the direction toward the recesses along the face line of the existing pier. When constructing structures in this general area, foundation improvement or inventive design will be absolutely necessary. Table 7-1 compares main natural conditions. From the view-point of natural conditions, countermeasures against waves and soft ground are most important but, with appropriate investments, both counter-

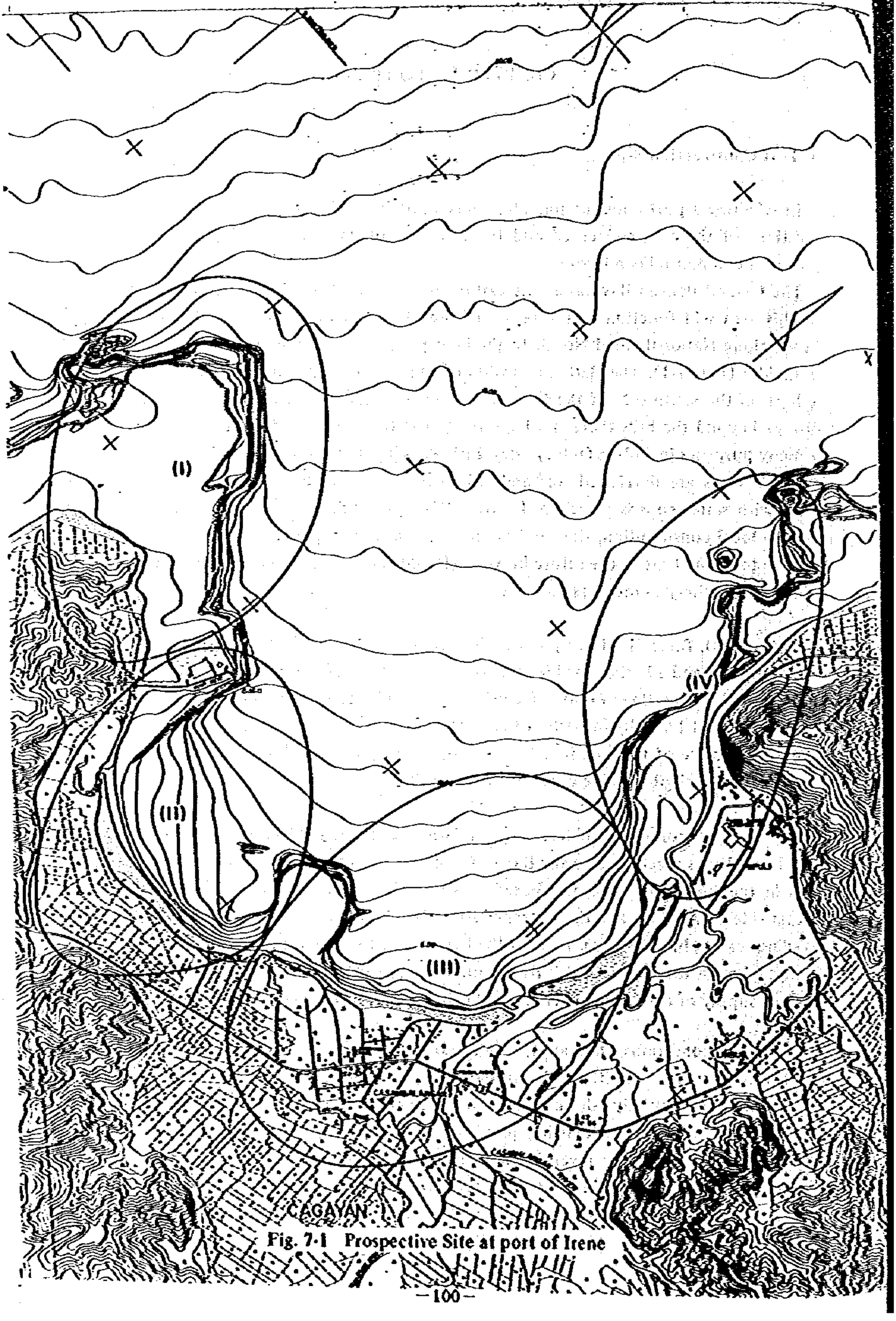


Fig. 7-1 Prospective Site at port of Irene

Table 7-1 Comparison of Natural Condition at Port of Irene

Site	(I)	(II)	(III)	(IV)
Waves	Subject to waves in N, NW and SW directions	Hardly affected	Waters with inroad of straight-advancing N and NW waves	Subject to waves in NW and SW direction
Current	–	Rather stragnant and complicated	S or SW straight current at flow tide and N or NW straight current at ebb tide	SE current at flow tide and NW river current at ebb-tide
Lottoral Drift	None (coral)	Generally stabilized	Presumed to move considerable	Presumed to move considerable in the port area (boulder seashore)
Water Depth	Steeply sloped from front of corals	There is maximum width of about 400 m between water depth of –5 m and land. Sea bottom slope: less than 1/100	There is maximum width of about 300 m between water depth of –5 m and land	Steeply sloped in front of corals. Part of this area is shallow to a great distance from shore due to river sediment
Rivers	There are small creeks	There are small rivers (only in rainy season)	There are small rivers (only in rainy season)	A large river flows into this area. It estuary is unstable
Geology	Coral layers are about 5 – 18 m thick. Underneath is an alternation of soft sandstone and shale.	Soft chayey soil exists to maximum depth of –30 Small faults are likely to exist in basement (Sandstone and shale) underneath.	Coral layers are about 15 – 20 m thick. Underneath are sandstone and basaltic breccia tuff.	Sand and detrital deposits for 2–3 m. Clayey soil is distributed at –20 m

measures are technically feasible. Since Area (II) scarcely requires countermeasures against waves, it will be an good port construction site if the construction can be so planned as to avoid use of the soft ground and its vicinity as much as possible.

At each construction site, facilities suitable for it can be constructed by taking necessary steps. But sites requiring large investments for these steps or sites where certain specialized facilities can be constructed are ineligible under the present plan aimed to construct a general commercial port. Area (II) is considered to be most suitable in view of the conditions of sea utilization, the relations to existing facilities, the influence on the life of inhabitants and the access to the National Road.

Yet, from the view-point of the future development of Port of Irene, port construction should not be concentrated only on Area (II). In the long run, the use of the entire Casambalagan Bay according to the required functions must be anticipated. If Port of Irene is require to handle large quantities of coal, black sand, etc., Area (I) and Area (IV) should be considered for this role. Also, Area (I), which is separate from the future urban district, may be used for the handling of petroleum products and other dangerous articles.

7-2 Factors Concerned with Port Planning

As for formulating a port plan, there must be assumption on the size of ships calling the port, cargo handling capacity (cargo handling methods), methods of ship entry and departure and other factors. These differ by ports and by the maturity of ports. In planning Port of Irene, mainly PMU Irene and the present conditions of the entire ports in Philippines are analyzed and necessary factors are decided.

(1) Ship Size

The ship size for the planning of port facilities is studied hereunder. The average size of ships calling port of Irene is as indicated in Table 7-2.

Table 7-2 Calling Ships at Port of Irene

Domestic/Foreign		Berth		Anchorage	
		1978	1979	1978	1979
Number of Ships	D	0	2	–	1
	F	7	8	–	7
Total Gross Register Tonnage	D	0	2,678	–	435
	F	36,770	38,176	–	77,421
Average Ship Size (Gross Register Tonnage)	D	0	1,340	–	435
	F	5,250	4,770	–	11,060

Source: 1979 Statistical yearbook PPA.

The average of ships that used the pier is 1,300 GRT for domestic trade and 5,000 GRT for foreign trade while the size of ships using the anchorage is more than 10,000 GRT for foreign trade. In the entire PMU Irene, it is 260 GRT (390 DWT) for domestic trade and 6,260 GRT (9,900 DWT) for foreign trade. The presumed reason for the small average size of domestic trade ships is the high frequency of call by 40 DWT class vessels used in short distance transportation. Fig. 7-2 shows the frequency of call by ships calling PMU Irene (excluding 40 DWT class vessels and oil barges). Ships of up to 4,000 DWT class represent 85% of all domestic trade ships. As to foreign trade ships, the number of ships of the 5,000–6,000 DWT class and the number of large ships of more than 15,000 DWT are high. Since PMU Irene has no facilities to berth large ships of more than 15,000 DWT, all are believed to have been loaded and unloaded at the anchorage. Even considering the increase of ship size in future, the use of 5,000 DWT for domestic trade ships and 15,000 DWT for foreign trade ships as target ship sizes under this plan will be sufficient.

Ship Size \ Number	Domestic Trade Vessels	Foreign Trade Vessels
1,000 DWT less	12	5
1,001 ~ 2,000	8	6
2,001 ~ 3,000	6	5
3,001 ~ 4,000	10	5
4,001 ~ 5,000	2	1
5,001 ~ 6,000	4	7
6,001 ~ 7,000		8
7,001 ~ 8,000		1
8,001 ~ 9,000		0
9,001 ~ 10,000		1
10,001 ~ 15,000		3
15,001 DWT more		13

Source: PMU IRENE 1980.

Fig. 7-2 Calling Vessels by Ship Size in PMU Irene

(2) Cargo Handling Capacity

Assuming cargo handling capacity of a port is extremely difficult because of the complex interaction of such factors as the efficiency of cargo handling equipment, the productivity of harbor workers, the size and types of ships, the types and lots of cargoes and the calmness of waters in front of the berth. Cargo handling capacity is usually either assumed from the past results at the port concerned or determined by entirely theoretical calculation. According to the Statistical Yearbook (1979, PPA), the average tonnage handled per meter run at Port of Irene is 100 t/m. Nationwide, this value can be generally divided into three groups by ports: more than

1,000 t/m, 500–600 t/m and less than 300 t/m (Table 7-3). The present low cargo handling capacity of Port of Irene result from the small volume of cargoes that is handled at the port. If the volume of cargoes increase in the future, the cargo handling capacity will greatly increase for the reasons of the relatively large lots of cargoes and the fact that, since this port is new, it can employ new cargo handling methods and so on.

In Europe and America, the average tonnage handled per meter run is 700–800 t/m. In Japan, the tonnage for large wharves catering to ships of 15,000 DWT class is 1,000–1,200 t/m at present and the target for the future is 1,000 t/m. This means that the annual handling capacity of a –10 m berth is about 200 thousand tons. These values are all in terms of general cargoes. Namely, one (1) ton of bulk cargo is counted as 0.5 ton of general cargo. If a large berth specializing in logs is constructed, it will be able to handle 400 thousand tons a year. But since no general cargo conversion is in practice in the philippines, the average handled volume per meter of berth is obtained from the relation between the total volume of cargoes handled by the berth and the length of the berth without regard for the distinction between general cargoes and the other items.

The average tonnage handled per meter run is a value resulting from the interaction of the different factors of the port concerned. The value for Port of Irene is 100 t/m, as stated already, but it does not show the actual capacity of this port. Seen in terms of handled volume per gross gang hour (to be referred to hereafter as "GGH") in accordance with the data of PMU Irene, the cargo handling productivity is as shown in Fig. 7-3.

T/GGH	Number of Case	5 10 15	Cumulative Ratio
~ 10 t less	1		2
11 ~ 20	5		12
21 ~ 30	14		40
31 ~ 40	11		62
41 ~ 50	8		78
51 ~ 60	2		82
61 ~ 70	5		92
71 ~ 80	1		94
81 ~ 90	1		96
91 ~ 100	2		100
101 more	0		

Source: Philippine Ports Authority Port Traffic Statistics

Fig. 7-3 Cargo Handling Ability by T/GGH in PMU Irene

This value must be evaluated by considering the fact that the number of samples used is small, that most of the cargoes are logs and that the cargo handling consists, mainly, of off shore. Probably, the actual value for PMU Irene is about 30 T/GGH. The target capacity of port of Tacloban for 2000 is 7.5 T/GGH (more than 501 DWT; for general cargoes) while the actual value and the future value for port of Davao are 9.57 T/GGH and 12 T/GGH, respectively. From the examples of these other ports, the value for Port of Irene seems to be slightly to high, even admitting that it cargoes are logs. If cargo handling is performed at the large berth of Port of Irene, 200 days a year and 16 hours and three gangs a day, the annual gross gang hour is 9,600 GGH. If the cargo handling capacity of the port is 20 T/GGH, a large berth can handle about 192 thousand tons. This is the capacity that corresponds to about 1,000 t/m.

Table 7-3 Tonnage Handled per Meter and Gang Hour

	Tonnage Handled per Meter Run		Tonnage Handled per Gross Gang Hour	
	1978	1979	1978	1979
Manila (North H.)	896	918	12	12
" (Pasig Bank)	368	325	13	16
Cagayan De ORO	–	–	8.2	13
Batangas	638	424	–	1.2
Cebu	540	588	–	–
Iloilo	272	352	13.4	10.1
Davao (SASA)	1,344	1,428	9.3	9.5
(STA-ANA)	1,156	1,004	8.9	9.3
Iligan	658	976	10.4	11.5
Zamboanga	639	644	14.1	14
Surigao	597	554	23.8	14.0
General Santos	1,827	1,198	8.6	8.8
San Fernando	1,877	1,423	13.6	14
Tacloban	578	598	6.2	20.8
Puerto Prinsesa	299	324	5.1	5.6
Dumaguete	547	480	15	10.6
Masao	658	955	13.2	11.8
Legaspi	297	275	14.9	19.2
IRENE (Aparri)	545	721	–	–
Jolo	138	222	7.3	6.7

Source: 1979 Statistical yearbook, PPA

Regarding cargo handling capacity in 1987, in consideration of the narrow width of apron of the existing pier, it is assumed 600 t/m. As for the proposed large berth, 850 t/m is assumed. As can be seen from Table 7-3, this value represents an average capacity in view of the capacities of ports throughout the country. To increase handling capacity, the improvement of port administration and operation for the smooth treatment of cargoes in the port area is, of course, important as well as the development of transit sheds, open storages and other related facilities. By 2000, the cargo handling capacity will have increased because the type of packing, for instance palay and fertilizer, will have changed, new cargo handling equipments will be available and domestic container transportation will be in practice. 1,000 t/m is assumed for the new foreign trade berth and 700 t/m for the domestic trade berth as the cargo handling capacity of Port of Irene in 2000 as it is expected to be nearly as large as the capacity of any of the nation's ports is at present. The present relation between the cargo handling volume and the ship staying time at PMU Irene is shown in Fig. 7-4, Fig. 7-5 and Fig. 7-6.

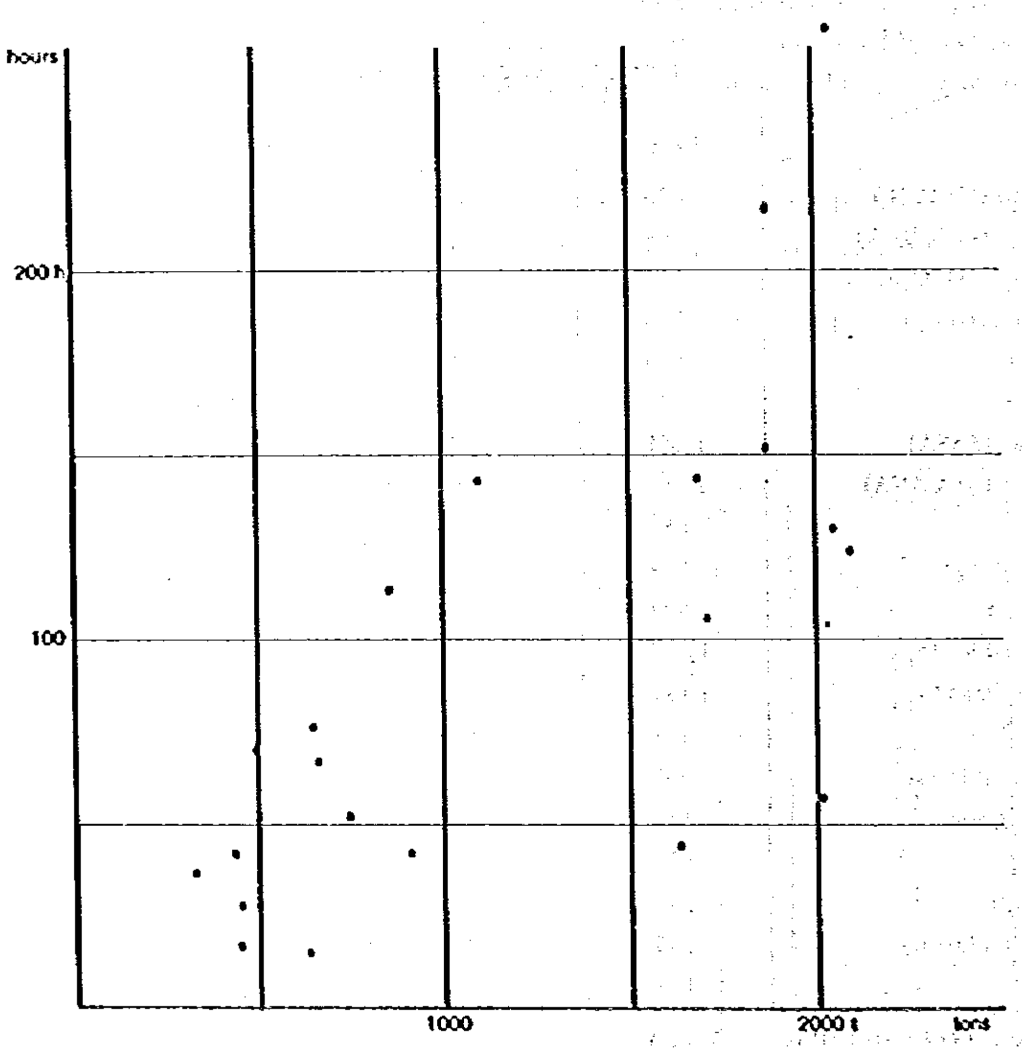


Fig. 7-4 Logs Volume Handled and Ship Staying Time in Port of Irene (Domestic)

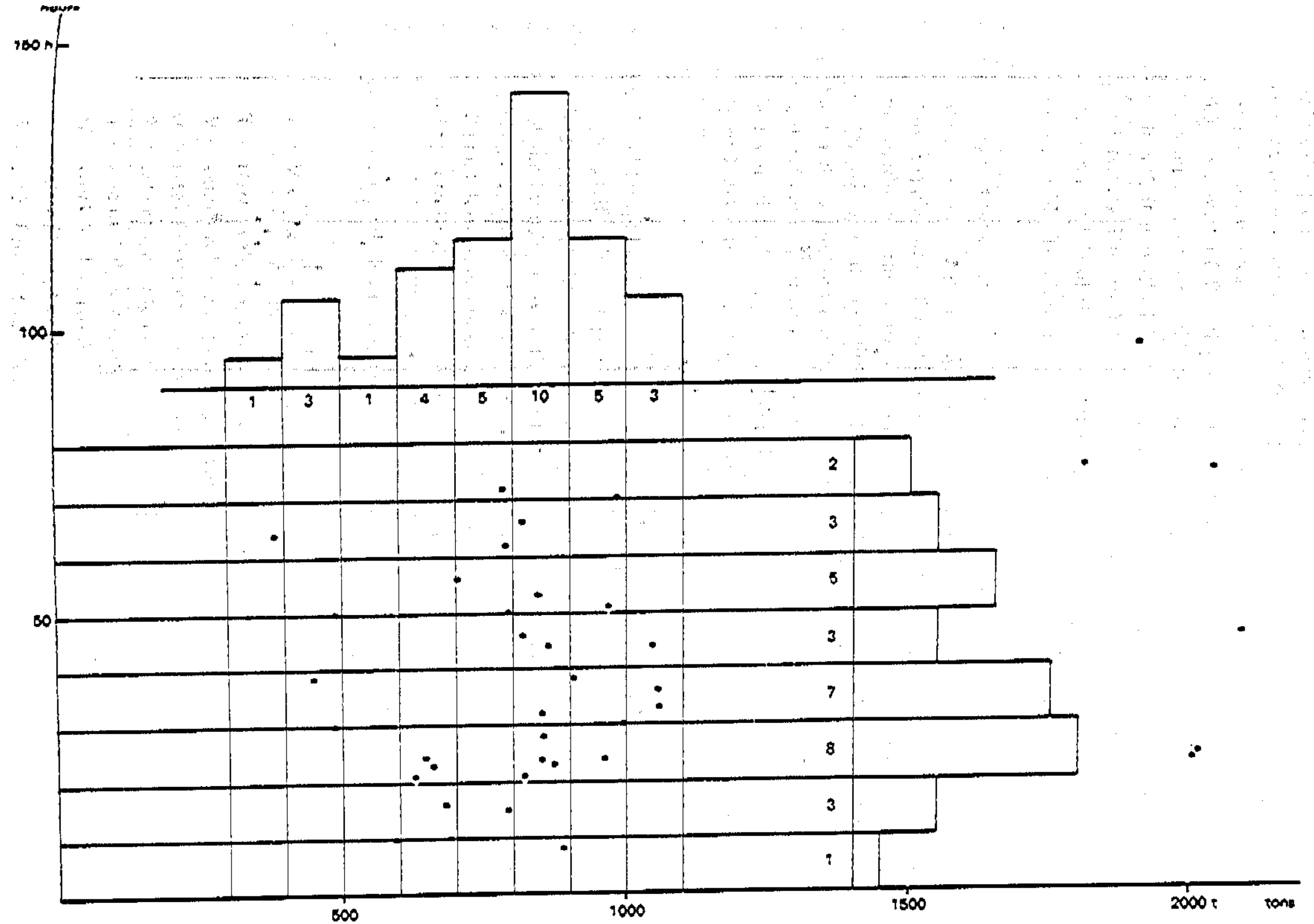


Fig. 7-5 Petroleum Products Handled and Ship Staying Time in Port of Aparri

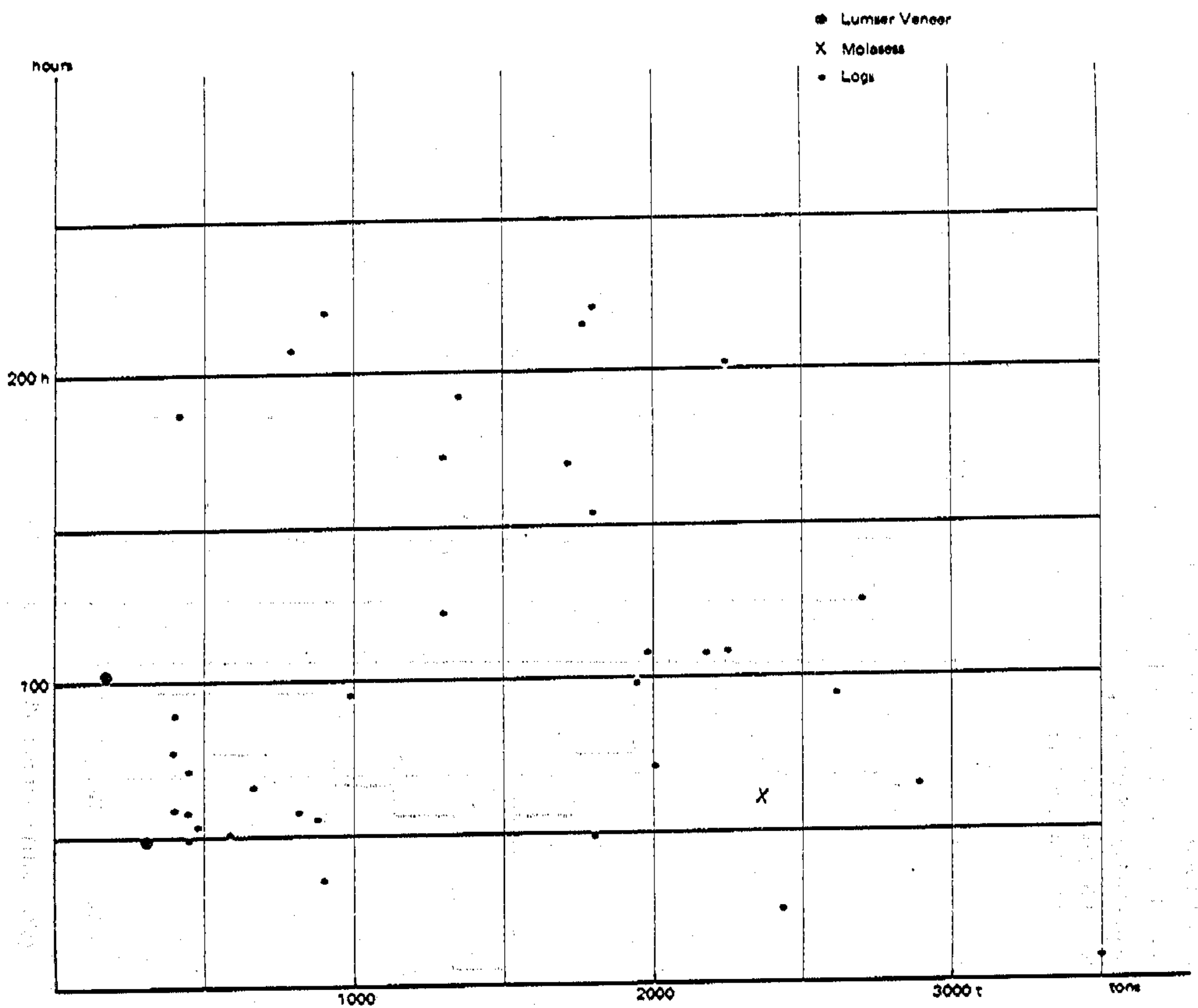


Fig. 7-6 Cargo Volume Handled and Ship Staying Time in PMU Irene (Foreign)

(3) Face Line of Berth

A ship calling Casambalagan Bay is boarded by a pilot about the interesection between the line extended approximately north from Matara point and the line extended west from Racat Beach. It proceeds toward the recesses of the bay (SE direction) from that point and enters to about 0.5 mile west of Papuli point. There, it turns to proceed toward the existing quay, maintaining an azimuth of 199°. It is usually berthed in mooring head down but, if the wind direction is SW, it is berthed in mooring head up. It is assumed that in the future, too, ships calling and leaving Port of Irene will be operated in general accordance with this principle. Therefore, the face line of the berth for large ships must be as approximate to the north-south direction as possible. This is particularly important when a tugboat is not assigned.

(4) Necessity of Breakwater

Breakwaters are not proposed in view of the marine conditions in the vicinity of Port of Irene. During typhoons or the rainy season, considerable waves may develop in the harbor. But, when the marin conditions are unfavorable, cargo handling work at the port is sometimes stopped, depending on the conditions of cargo handling of rain or wind. Though breakwaters is desirable for the safety and efficiency of the port, it would be redundant from the view-point of investment effects at port of Irene. The absence of breakwaters is considered not to affect the immediate activities of this port. The detailed analysis concerned can be found in Chapter 6. The necessity of breakwater may be studied in the future by checking to see how the port is actually used.

(5) Road and Strage Facility

As high specifications as possible are proposed for the harbor road in anticipation of the future development of the waterfront. For the present however, it is the plan to cope with the traffic volume by using part of the right of way secured. Also, improvement on transit sheds and open storages will be made and land for warehouses acquired. Port of Irene is rather distant from the origins and destinations of cargoes. So, the construction of storage facilities in the port area is proposed so as to be able to cope with the quick dispatch of ships.

The necessary number of lanes of the harbor road is determined by the following formula:

$$T = V \times \frac{\alpha}{W} \times \frac{\beta}{12} \times \frac{\gamma}{30} \times \frac{1+\delta}{\epsilon} \times \sigma$$

T = traffic volume (number of vehicles/hour)

V = annual volume of port cargoes (ton)

α = rate of share of automobiles

β = rate of monthly variation

γ = rate of daily variation

W = truck loadage (ton)

ϵ = rate of loaded vehicles

δ = rate of related vehicles

σ = rate of hourly variation

The necessary number of lanes is determined on the basis of the a lane traffic capacity of 600 vehicles/hour (actual traffic volume).

Road width is decided by traffic volume but the total width including the widths of the sidewalk and the parking strip besides the width of the roadway should, as a principle, be as follows:

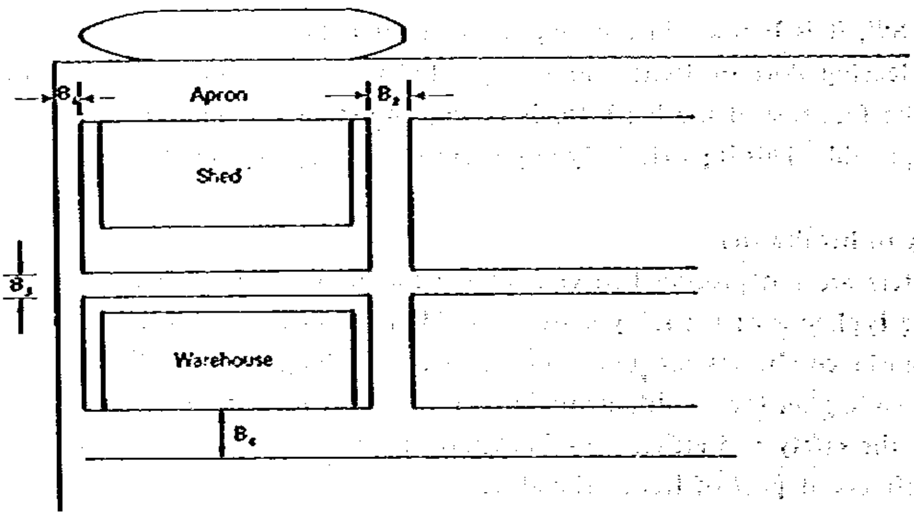


Fig. 7-7 Road Width

B_1 = roadway (3.5 m + 3.5 m) + sidewalk (3.0 m) = 10.0 m

B_2 = sidewalk (2.5 m) + parking strip (2.5 m) + roadway (7 m) + parking strip (2.5 m) + sidewalk (2.5 m) = 17 m

B_3 = parking strip (3.0 m) + roadway (7.0 m) = 10.0 m

B_4 = main harbor road = sidewalk (3.0 m) + roadway (7.0 m) + mediam strip (2.0 m) + roadway (7.0 m) + sidewalk (3.0 m) = 22.0 m

The necessary area of a transit shed is determined by the following formula:

$$S = \frac{1}{\alpha} \times \frac{1}{\omega} \times \frac{N}{R}$$

S = area of transit shed (m²)

α = effective floor ratio

ω = storing capacity

N = volume of cargoes using transit shed (ton/year)

R = rotation rate

(6) Length and Water Deply of Berth

To decide the length of a berth and the water depth of a basin, it is necessary to see their correlations with ship size (DWT), ship length (L) and full-load draft (d). According to Report of the Port and Harbour Research Institute, Ministry of Transport, Japan, Vol. 17, there is a certain relation between ship size and ship length and full-load draft.

In this report, the correlation is found by analysis for ships with age of less than 30 years from the Lloyd's Register of Ships, 1975 and the Register of Japanese Shipping, 1976. Survey results contained in the report and concerned with general cargo ships are as follows:

Table 7-4 Relation Between Ship Size and Ship Length

Tonnage category (DWT)	500–5,000	5,000–60,000
Number of data	1,786	6,501
75% regression formula	logL = 0.674 + 0.362 log (DWT)	logL = 0.970 + 0.297 log (DWT)
50% regression formula	logL = 0.654 + 0.362 log (DWT)	logL = 0.947 + 0.297 log (DWT)
Correlation coefficient	0.954	0.919

Table 7-5 Relation Between Ship Size and Full-Load Draft

Tonnage category	500–5,000	5,000–60,000
Number of data	1,786	6,568
75% regression formula	logd = –0.279 + 0.301 log (DWT)	logd = –0.154 + 0.268 log (DWT)
50% regression formula	logd = –0.305 + 0.301 log (DWT)	logd = –0.173 + 0.268 log (DWT)
Correlation coefficient	0.895	0.929

The survey results are charted in Fig. 7-8 and Fig. 7-9. The dotted line indicates the estimated value of regression. Assuming that the data are normally distributed around the regression, 75% of the total number of data is covered. From this, the length of a 15,000-DWT ship is about 160 m and its full-load draft is about 9 m. The length of a berth alongside which a 15,000-DWT ship comes is usually 185 m: ship length plus length necessary for both the bow line and the stern line. The water depth in front of the berth is usually –10 m: full-load draft plus keel clearance.

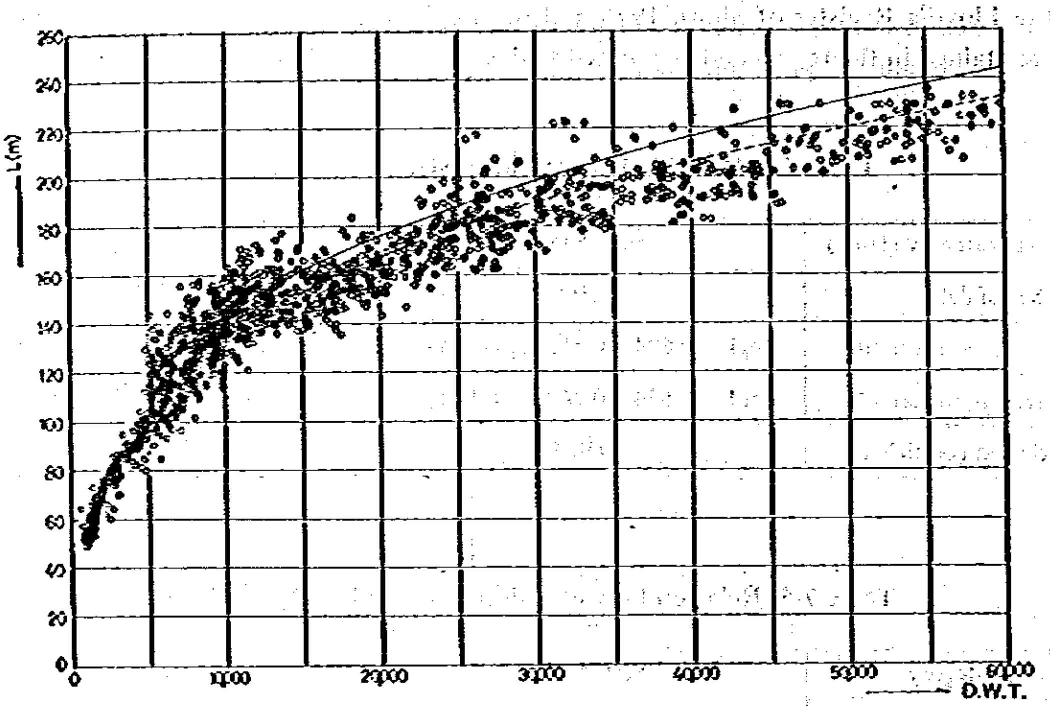


Fig. 7-8 Relation Between Deadweight Tonnage (DWT) and Length (L)

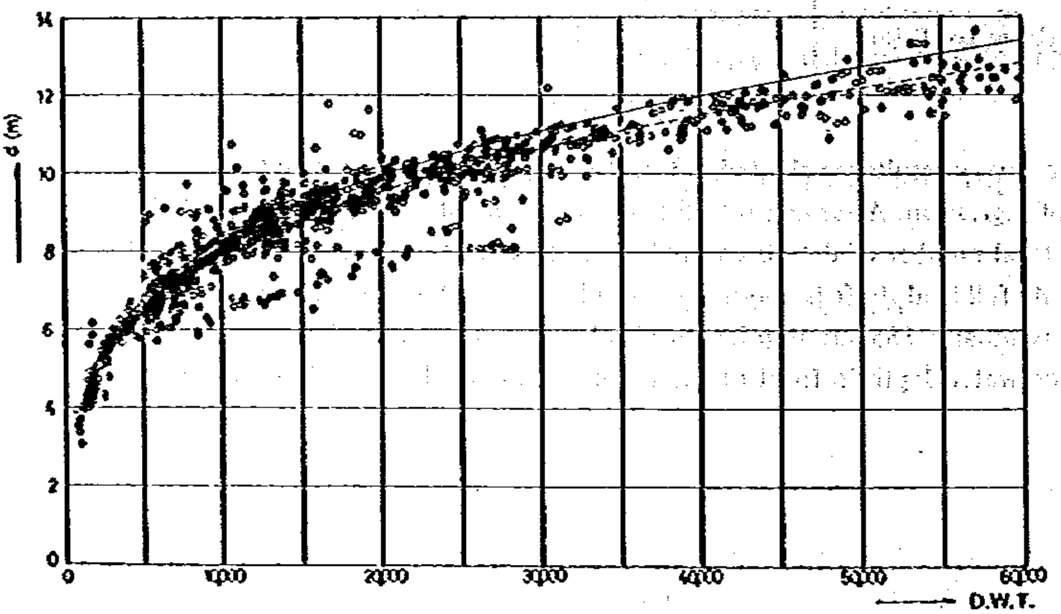


Fig. 7-9 Relation Between Deadweight Tonnage (DWT) and Full-Load Draft (d)

7-3 Master Plan 2000

(1) Basic Thinking

The cargo volume in 2000 is 450 thousand tons for foreign trade cargoes and 4000 thousand tons for domestic trade cargoes (excluding 250 thousand tons of petroleum products). If all foreign trade cargoes are to be handled by large berth, three berths are necessary for this purpose. Since the existing pier is one berth, the proposed large berth must have two berths. For domestic trade cargoes three berths are considered necessary besides one container berth.

The calculation of the number of required berths is based on the average tonnage handled per meter run found in 7-2 Factors Concerned Port Planning. The berth capacity is estimated at 200 thousand tons (average tonnage handled per meter run 1,000 tons/m) at a -10 m newly installed berth, 140 thousand tons (700 tons/m) at a -10 m existing pier; 95 thousand tons (700 tons/m) at a -7.5 m berth; and 60 thousand tons (700 tons/m) at a -5.5 m berth; and 100 thousand tons at the container berth with a water depth of 7.5 m.

The scale of Port of Irene in the year 2000 expressed in terms of cargo volume handled will be 890 thousand tons in total. At the existing large pier, both foreign trade cargo and domestic trade cargo, mostly logs, will be handled in 2000 as it is. Also, a wharf and an anchorage for handling fishery products and a pier for petroleum products are necessary. Further, a basin for the supervisory and operational boats of the PPA and other related authorities, pilot boats, etc., a harbor road and navigation aids must be planned and constructed.

To plan facilities for handling fishery products, there must be detailed data concerning the availability of fishery resources and their types as well as data about the operating conditions of fishing boats including trawling fishery, purse seine fishery and the number of days of operation. At present, these data are practically non-existent. So, in the master plan the necessary scale of facilities are determined on the assumption that a total number of 100 fishing boats, engage in trawling fishery, purse sein fishery, etc. As the necessary length of quay, a total length of 500 m is secured. About 5 thousand m^2 including space for future expansion is sufficient for freezing and cold storage. Another 5 thousand m^2 is secured as space for the likely construction of a wholesale market.

For a basin, space with a water depth of 3.5 m and an area of 18 thousand m^2 is secured for vessels of 50 GT in anticipation of a future increase in the number of smaller vessels.

The type of container vessels used in domestic trade container berth is assumed to be 5000 DWT (200 TEUs). The structure of container berth will be constructed for installing gantry cranes in the future. For a certain period of time after the construction of the container berth, loading will be carried out using ships' gears and mobile cranes. As large an area as possible will be secured for the container yard and arrangements will be made so that container handling will not be restricted by the lack of regular loading equipment.

As analyzed in 7-1 Port Construction Sites, the planned site of the Master Plan is Area (II).

The basic thinking in carrying out the Master Plan in Area (II) is as follows.

The face line of the berth is made from south to north as far as possible and calm water area is effectively used. Sufficient back-up area of the berth is secured to enable a smooth loading operation. Breakwaters will not be constructed in consideration of the frequency of waves. Effects upon the natural environment, especially, upon the surrounding marine environment, is minimized as much as possible.

From this standpoint, the following selections may be made as to the layout of the port facilities.

First is how to make effective use of soft ground areas. There are two ways; either to improve the soft ground before constructing the facilities or to avoid the soft ground and construct the facilities elsewhere.

Secondly, it is desirable that basin for small crafts be made in the southwest corner, which is where calmest waters are, and where placing of heavy structures must be avoided because of soil conditions.

Thirdly, for the domestic trade container berth, the best site selected would be the southeast corner, because construction will start late and it will be necessary to select an area with good soil conditions.

Fourthly, the facilities of the central coral area will be subject to waves from the northwest if they are developed offshore and calmness inside the port may be lost. Therefore, construction of facilities to offshore will be limited.

Fifthly, it is desirable that fishing facilities be constructed apart from commercial functions.

Area (II) has been selected after comparing waves, soil and effects upon the lives of inhabitants. However, for drafting the Master Plan, many alternatives must be studied considering the following items. A comparison will be made mostly on the ease of administration and operation, relationships with the existing facilities, future development, ease of execution of work and amount of investments, etc.

Let us now review when need will arise for developing the required facilities of these wharves. As Port of Irene already has a large pier for foreign trade, a berth for domestic trade will have to be developed first and separate use of a foreign trade pier and a domestic trade berth must be considered in general. However, in the case of Port of Irene, foreign trade cargo will increase at an initial period in comparison with domestic cargo, so the capacity of the existing pier will be filled at an earlier stage. To cope with this situation, either two berths, foreign trade and domestic trade wharves, must be developed from the start or one (1) berth must be developed for common use of foreign trade and domestic trade. The latter method may be more advisable from the standpoint of keeping initial investment as small as possible, though a little difficulty may be encountered in operation.

Fig. 7-10 shows roughly the stages of development of Port of Irene up to the year 2000, based on the above ideas.

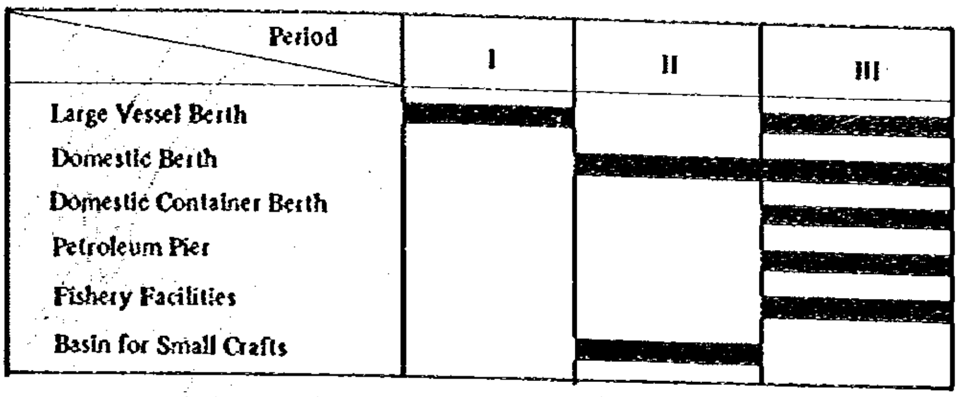


Fig. 7-10 Requiring Period of Mooring Facilities at Port of Irene

(2) Comparison of Alternative Plan

As alternate plans, three plans are proposed. The essential differences of these three plans are in the manner and extent of the use of soft ground. Plan (A) completely avoids the part with unfavorable soil conditions. Operating efficiency at the initial stage may be low because of the separation of the construction sites of the large berths from the existing pier. Further, the effect of continuous berths cannot be expected since the existing pier is independent. Plan (B) makes partial amends for the defect of Plan (A). It pursues the effect of continuous berths in spite of the increase of construction cost due to the treatment of the soft ground. Plan (C) can make all berths continuous and functionally it is best. But it requires more cost for the administration and operation of the port than any other plan. Being constructed facilities along the entire coastling, the sea condition of the harbor will be less calm than under Plan (A) or Plan (B). Also, Plan (C)'s a large berth in the central coral area will be able to flexibly cope with future cargo volumes, because the coast line in another area is arranged to sufficiently handle cargo volume in 2000.

Regarding the problem of the soft ground involved in Plan (B) and Plan (C), careful maintenance and repairs of facilities will be necessary in the future. The technical treatment of soft ground includes such physical and chemical methods as replacing soft ground soil with sand of superior quality or injecting a chemical liquid into the ground. However, treating the entire area by either method is difficult because of its treating cost and the time it requires. Thus, ground subsidence after the construction of structures is unavoidable.

Plan (C), in order to propose two large berths and as large a back area as possible, has different face line of berth from the existing pier. The construction of two large berths on the soft ground is not only costly but involves the problem of subsequent maintenance and repair and administration and operation. In Plan (C), it is difficult to construct a pier for handling petroleum inside the port and so an appropriate site must be selected offshore. In this case, the plan for breakwaters must be studied in view of safety and effective loading.

These are serious defect of Plan (C). So, this plan is unpreferable.

The same can be said of Plan (B) as far as the soft ground is concerned. However, proposed only one berth in plan (B) is to think much of the consistency of the existing pier. In this plan, the face line of berth is made to agree with that of the existing pier to facilitate ship operation. A defect of this plan is the inability to secure sufficient storage space.

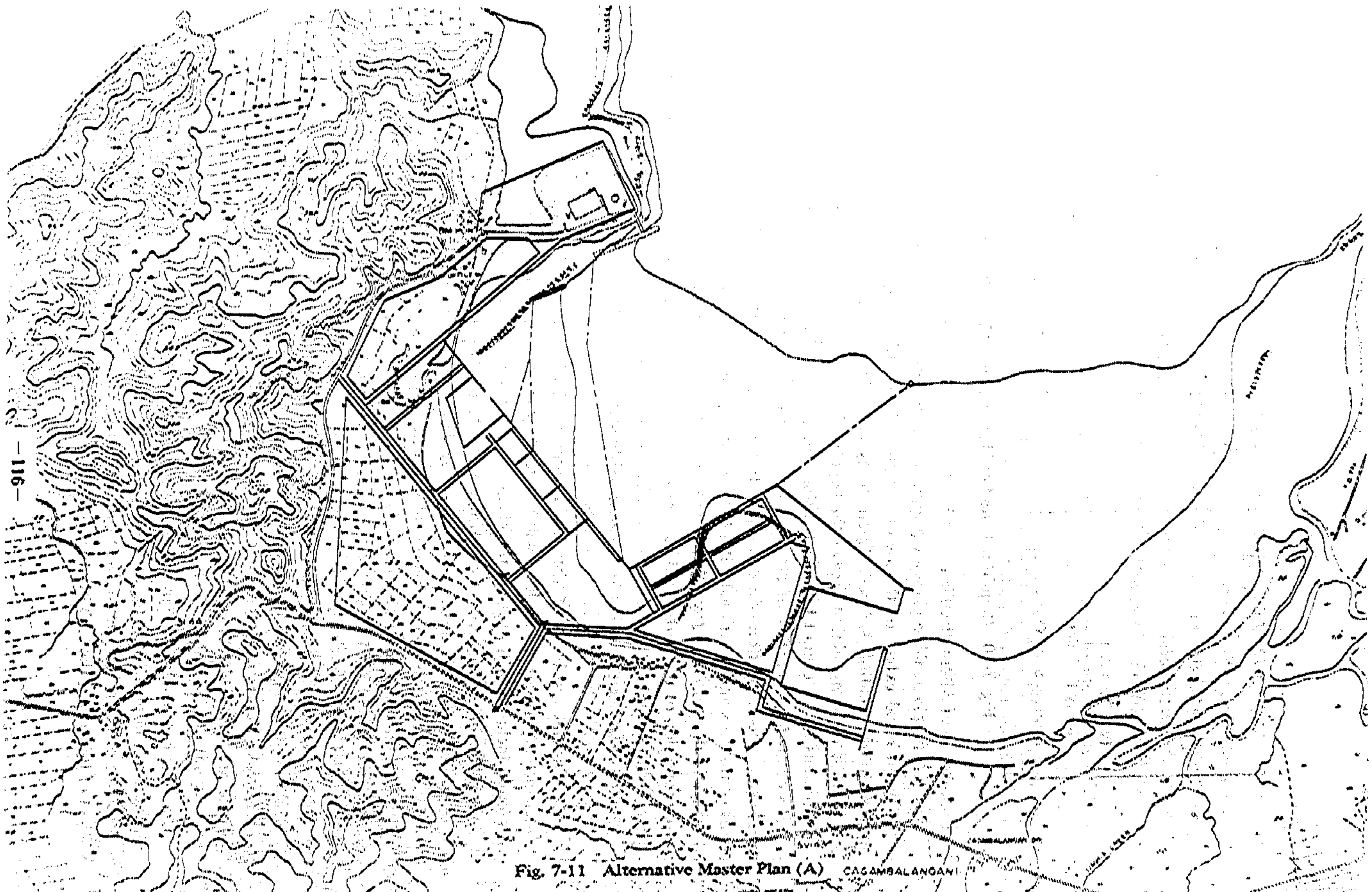


Fig. 7-11 Alternative Master Plan (A)

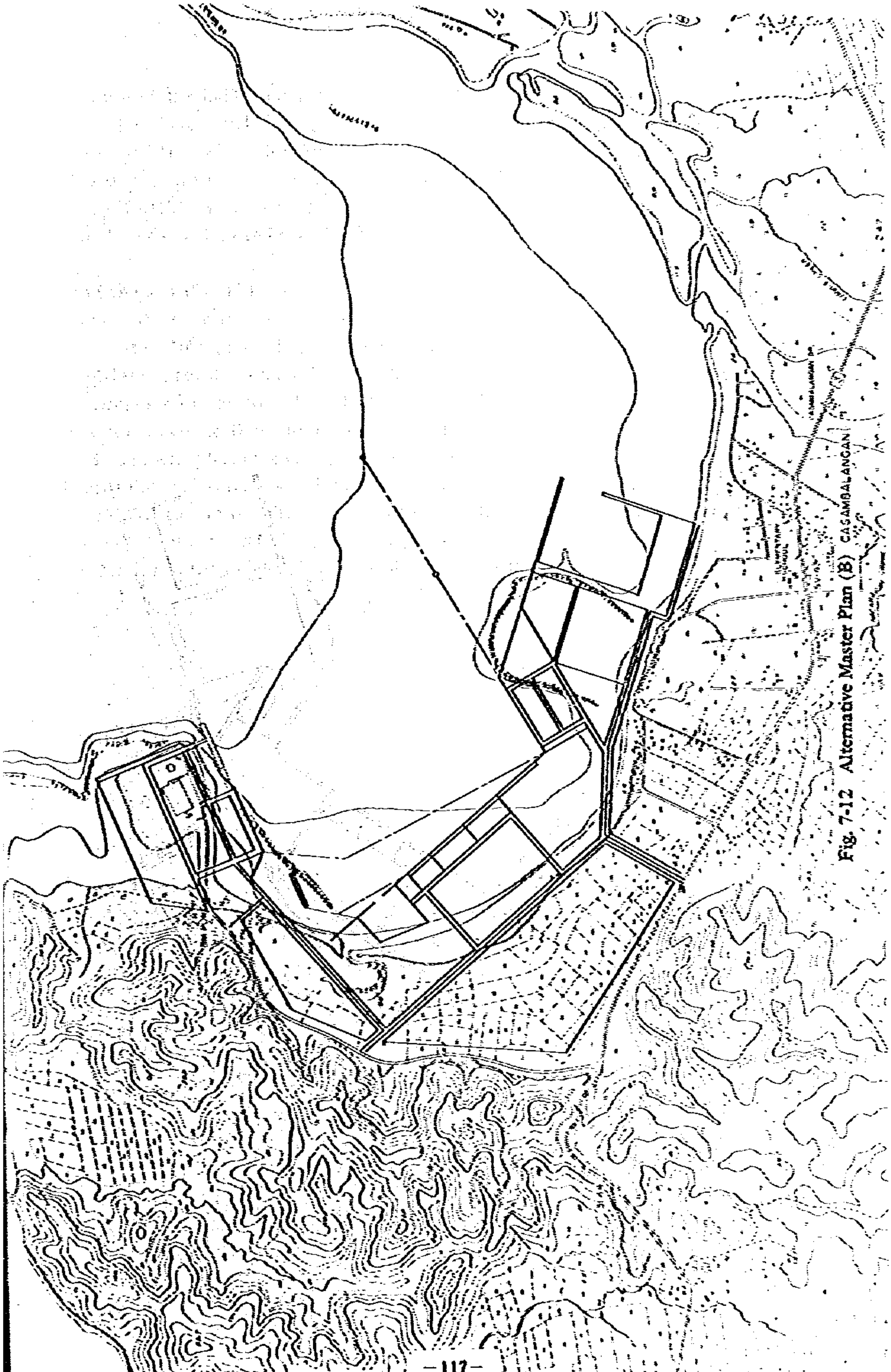


Fig. 7-12 Alternative Master Plan (B)

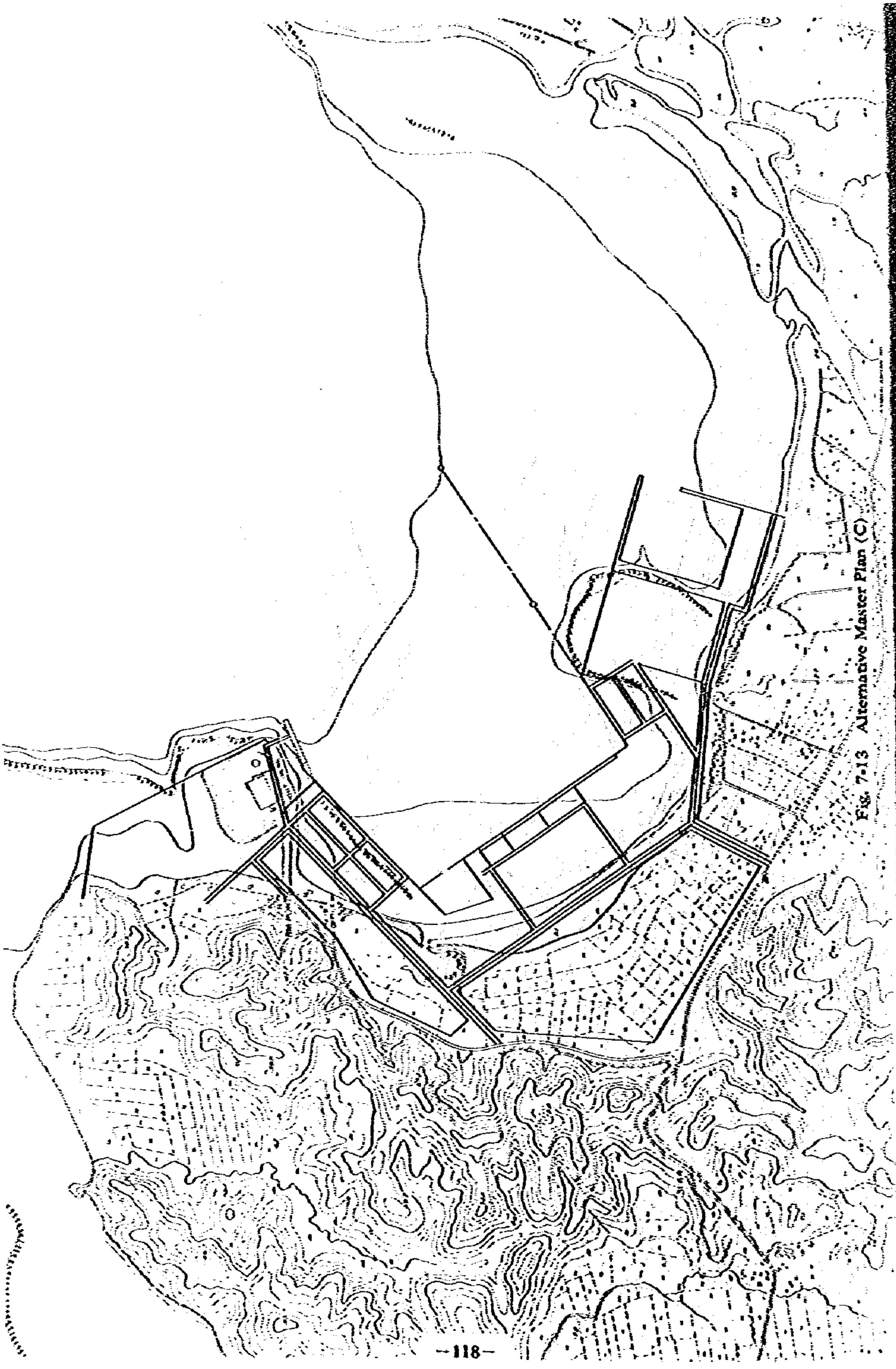


Fig. 7-13 Alternative Master Plan (C)

The use of the land behind the port is basically the same with the 3 plans. Administration buildings, green areas and parking areas are arranged around the basin for small crafts to form a central administrative area for Port of Irene. The back up area on the domestic trade berths are developed as a distribution center with storage facilities. Plots behind fishing facilities are made into sites for fishery related industries. Other land areas around the port are used mostly as industrial sites and also can be used as Export Processing Zones as required.

Plan (A) and Plan (B) have their respective problems. In selecting either plan, it is important to consider the conditions that will prevail when the construction is finally completed, but in the case of port of Irene, more importance should be attached to the initial conditions, instead. At the initial stage, construction of large berth is required in view of the volume of cargoes. Plan (A), which proposes to construct large berth at a new site, is clearly inferior to Plan (B) in view of such factors as connection with the existing pier and the construction of a new harbor road. And Plan (B) is superior from the view-point of the effective use of past investments (pier, transit shed and road) though it involves such problems as ground subsidence, as stated already. It is realistic and beneficial to improve the functions of Port of Irene for the present, making effective use of its existing facilities, and then, at a certain period, develop a new area. Hence, Plan (B) is recommended as the master plan. Table 7-6 compares the three plans. The Master Plan is shown in Fig. 7-14.

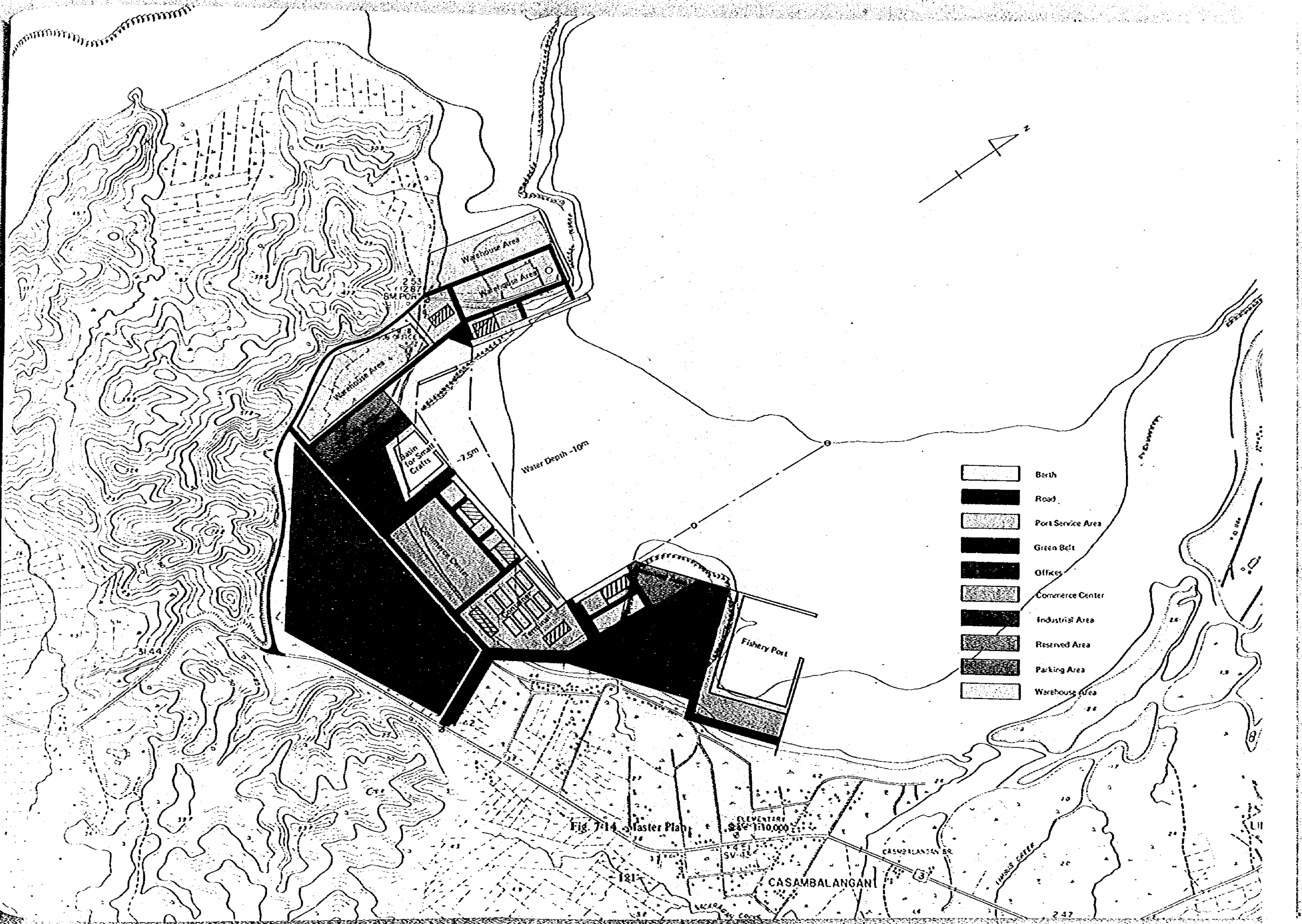


Fig. 7·14 Master Plan Scale 1:10,000

Table 7-6 Comparison of Alternative Plans

Item	Important Points of Comparison	Plan (A)	Plan (B)	Plan (C)
Maintenance of Facilities	Is it easy to maintain the constructed facilities? In this project, land subsidence is feared to pose difficult problems in maintenance.	○	△	×
Management and Utilization of Port	It is easy to manage and use the port. Comparison should be made both at an initial stage and upon completion of the project.	△	○	○
Cordination with Existing Pier	If the use of the existing pier and the new berth may be incorporated at the beginning stage, the scale merits of the facilities may be gained.	×	○	△
Utilization with Past Investment	May the existing port road and transit shed be effectively utilized?	×	○	○
Future Prospects	Is the project flexible enough to cope with new development plans after 2000?	○	○	△
Calmness within Port	Is the port sufficiently calm without breakwaters?	△	○	△
Soil Conditions	Is the site suitable for the construction of port structure?	○	△	×
Manipulation of Ships	Can the ships enter and leave the port without difficulty? Are berthing and unberthing easy?	○	○	△
Utilization of Land	Is the Port Development Plan in line with the land utilization scheme of the area? Are the storage areas and green zones in harmony with the surrounding environment?	○	△	○
Environmental Protection	Are port activities and port construction work so carried out that they are not destructive to the surrounding social and natural environment?	○	○	○
Workability	Is the construction of each facility easy? Is the gradual execution from planning to completion smooth?	△	○	△
Investment	Comparison of construction cost of basic port facilities.	○	○	×

Note: ○: Excellent △: Some Problems ×: Poor

7-4 Short-Term Port Development Plan

(1) Number of Berth

The plan for up to 1987 must be sufficient for a cargo volume of 248 thousand tons. The breakdown of the 248 thousand tons is 153 thousand tons for foreign trade and 95 thousand tons for domestic trade. Cargoes other than logs, etc. consist mostly kinds of general cargo. The cargo handling capacity of the existing pier (to be referred to hereafter as Berth No. 1) is considered only about 120 thousand a year because of its T-head type and its narrow apron. If Berth No. 1 handles foreign trade cargoes, one berth for foreign trade and one berth for domestic trade must be constructed. There must, of course, be distinction between a foreign trade berth and a domestic trade berth for such reasons as the execution of bonding work, the difference of the structure and type of port facilities, of types and prevention of troubles.

The necessary number of berths in 1987 can be estimated by the following method. But from the view-point of berth capacity, 130 thousand tons is an amount of cargoes that can well be handled by constructing one large berth. Assuming that the number of working days in a year is 200, the number of working hours in a day is 16 and the number of gangs in a day is three, the annual per-berth capacity is 9,600 GGH. Then, assuming 15 tons – which is 1/2 of the actual value – as the per-GGH capacity of Port of Irene, 16,500 GGH is necessary to handle 248 thousand tons of cargoes in 1987. Since the per-berth capacity is 9,600 GGH, the necessary number of berths of port of Irene is 1.72, which means two berths. The new berth to be constructed up to 1987, therefore, is one large berth with –10 m depth.

The time of construction of this proposed berth (to be referred to hereafter as Berth No. 2) and the time of construction of the next berth (Berth No. 3) are discussed below. Fig. 7-15 shows the tendency of increase in the cargo volume at Port of Irene. Curve (A) is based on the assumption that the cargo volume increases at an equal annual rate from the level (actual volume) in 1979 to the level (estimated volume) in 1987. Curve (B) is based on the assumption that the cargo volume increases by the same rate as the growth rate of GRDP in Region II. In other words, an imaginary value is assumed for the cargo volume in 1979 and it is assumed that this volume increases by 10 percent every year and reaches 248 thousand tons in 1987. (The assumed cargo volume in 1979 is in accordance with the economic scale in Region II).

The actual cargo volume shows different trend by such factors as the time the use of Berth No. 2 starts and the increasing maturity of the distributing system. The beginning of utilization of Berth No. 2 is presumed from the future period of detail design and other factors to be the end of 1986 or after. The cargo volume will gradually increase in the meantime without exceeding curve (A) but will rapidly increase with the start of use of Berth No. 2 and gradually approach Curve (B). It is assumed that, after 1987, a cargo volume will increase in accordance with the growth rate of GRDP in Region II. Since the capacity of Port of Irene after the completion of Berth No. 2 is about 300 thousand tons, which is the total capacity for Berth No. 1 and Berth No. 2, the cargo volume until the end of 1989 at least can be handled by the two large berths if the cargo volume increases as presumed. As for Berth No. 3, its use will be required to open in 1990 or after.

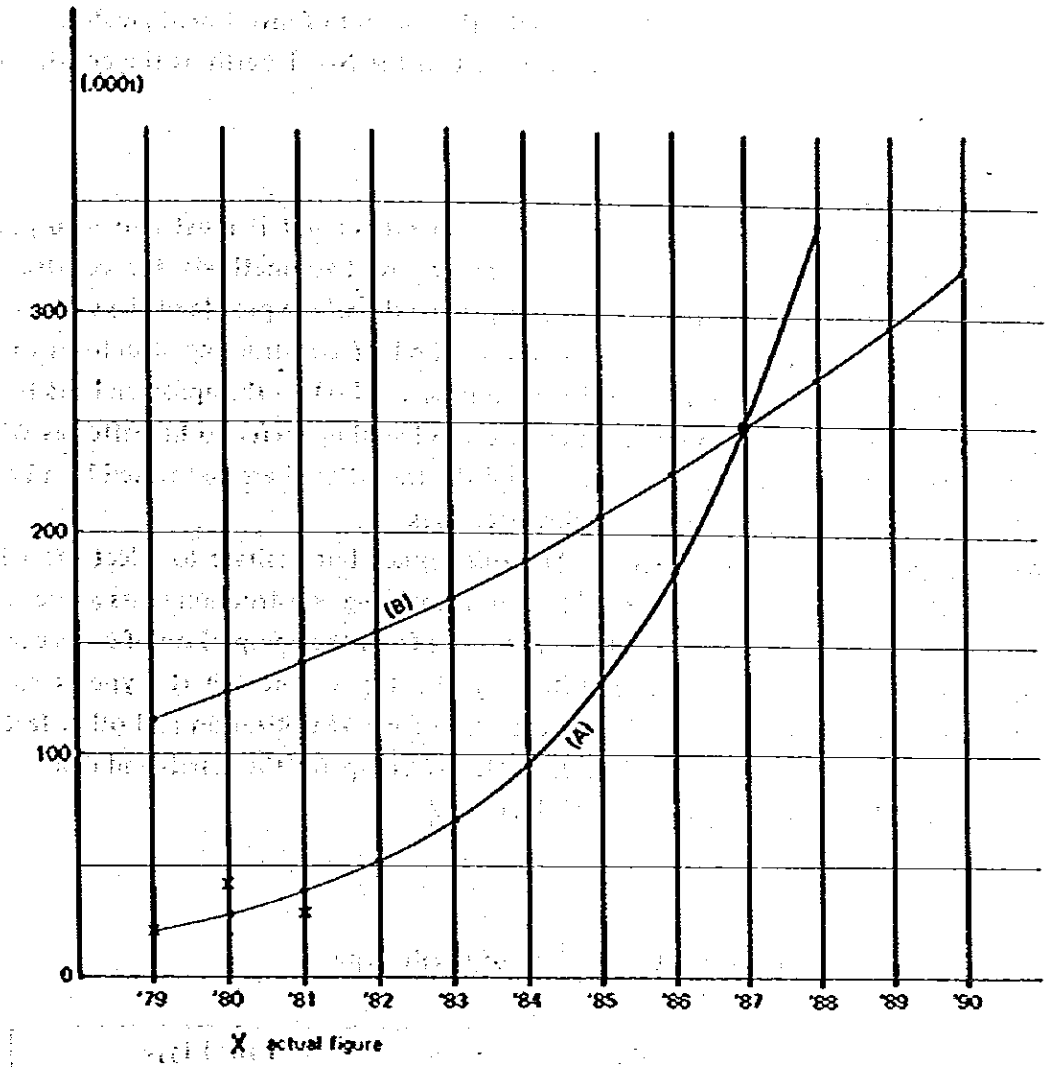


Fig. 7-15 Projection of Cargo Volume Handled in Port of Irene

(2) Construction Site for New Berth

Where to place the Short-Term Port Development Plan in the framework of the Master Plan is a very big problem. This has been given great attention during the course of the study of the Master Plan and further studies have to made. As mentioned above, in the Short-Term Port Development Plan it is necessary to develop one (1) large berth. In the Master Plan, there are two places where a large berth is proposed. One is adjacent to the existing pier (No. 1 berth) and another is the central coral area. The former has poor soil conditions and improvement of the soil and maintenance of facilities after they are developed must be taken into consideration. However, as it is adjacent to the No. 1 berth, integrated control and operation is possible and there is an advantage as far as storage of facilities. Also the existing port road can be fully utilized.

While the latter, the central coral area, has no great problems in terms of natural conditions, operation and use of the facilities are more troublesome because of distance from the No. 1 berth. Also a new port road must be developed and temporary revetments need to be constructed before the next stage of construction, which will make the amount of investment greater.

Therefore, the No. 2 berth will be located adjacent to the No. 1 berth as the construction plan for a large berth.

(3) Selection of Berth Type

The selection of the type of a berth is a technical matter but it must also incorporate consideration from the standpoint of operation. There are two methods for constructing structures at the soft ground. One is the method of replacing the whole profile of the soft ground with sand of superior quality and the other is the method of constructing structures of the T-Head Type without improving the ground. In the former method, as the apron and the transit shed are continuous, it is possible to make efficient cargo handling (refer to hereafter as Wharf Type). In the T-Head Type, meanwhile, the apron and the transit shed are connected by a bridge passage and thus cargo handling capacity inevitably decreases.

The Wharf Type costs much to construct. And one cannot but hesitate to select the Wharf Type because of the gap in construction cost. However, comparing construction costs alone could be misleading. The Wharf Type is somewhat less expensive from the comparison of costs per ton of cargoes, since cargo handling capacity differs by the types. The Wharf Type is clearly preferable from the overall assessment including the ease of wharf utilization and other factors. The Wharf Type is proposed as the Berth No. 2. Table 7-7 compares the marits and demerits of both types and Fig. 7-15 and Fig. 7-16 show their layouts.

Table 7-7 Comparison of Berth Type

	Wharf Type	T-Head Type
Cargo Handling Activity	Efficient cargo handling is possible as the operation of forklifts and other cargo handling equipment is not hampered	The passage restricts activities
Construction Cost	Approx. 103 Million Pesos	Approx. 89 Million Pesos
Cost per Ton of Cargo	Approx. 515 Pesos/Ton/Year	Approx. 524 Pesos/Ton/Year
Maintenance	Maintenance is necessary because ground subsidence is anticipated for transit shed, etc.	Same
Others	Certain turbidity occurs when removal of soft foundation is executed	It is difficult to secure open storage and warehouse areas.

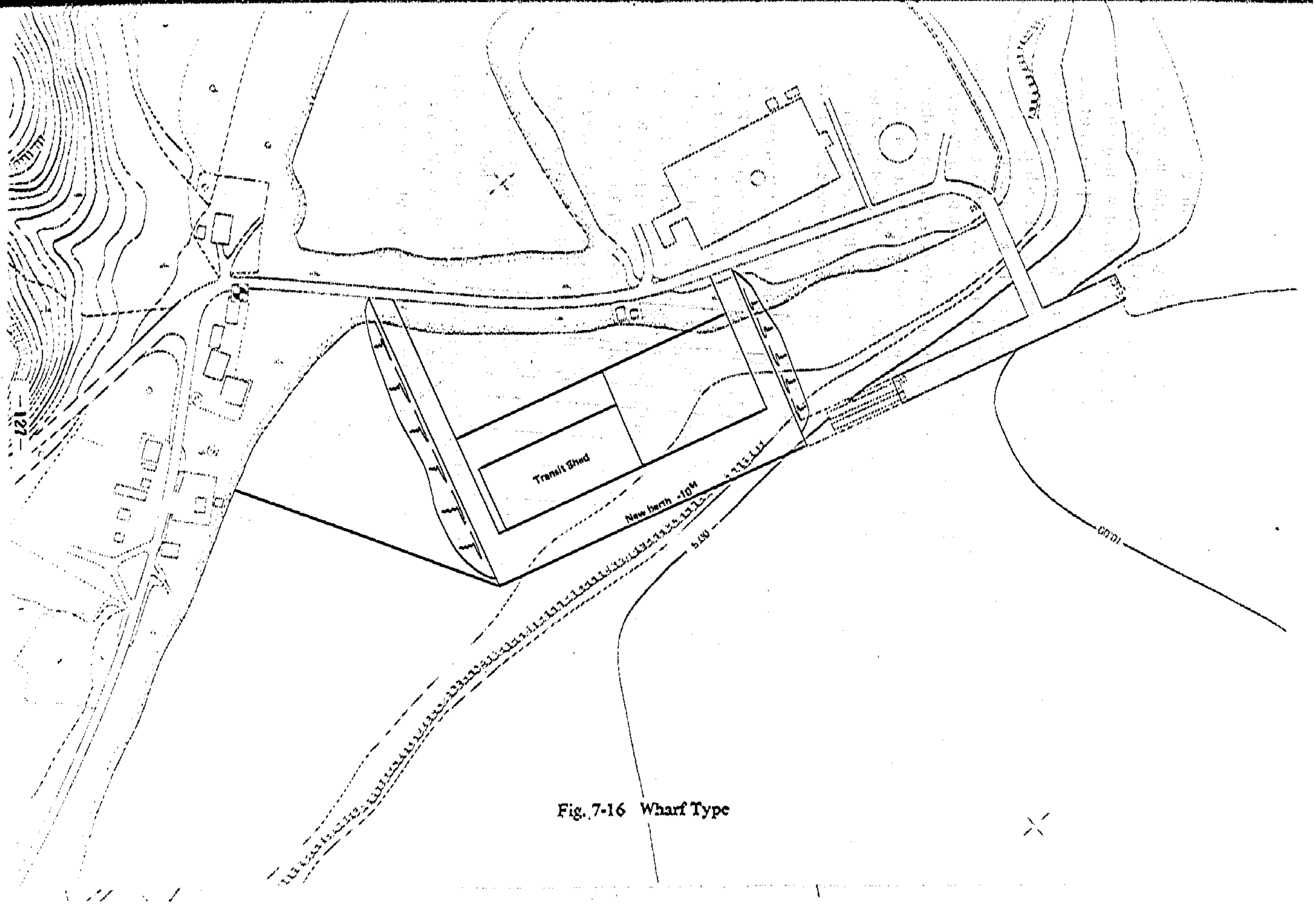


Fig. 7-16 Wharf Type

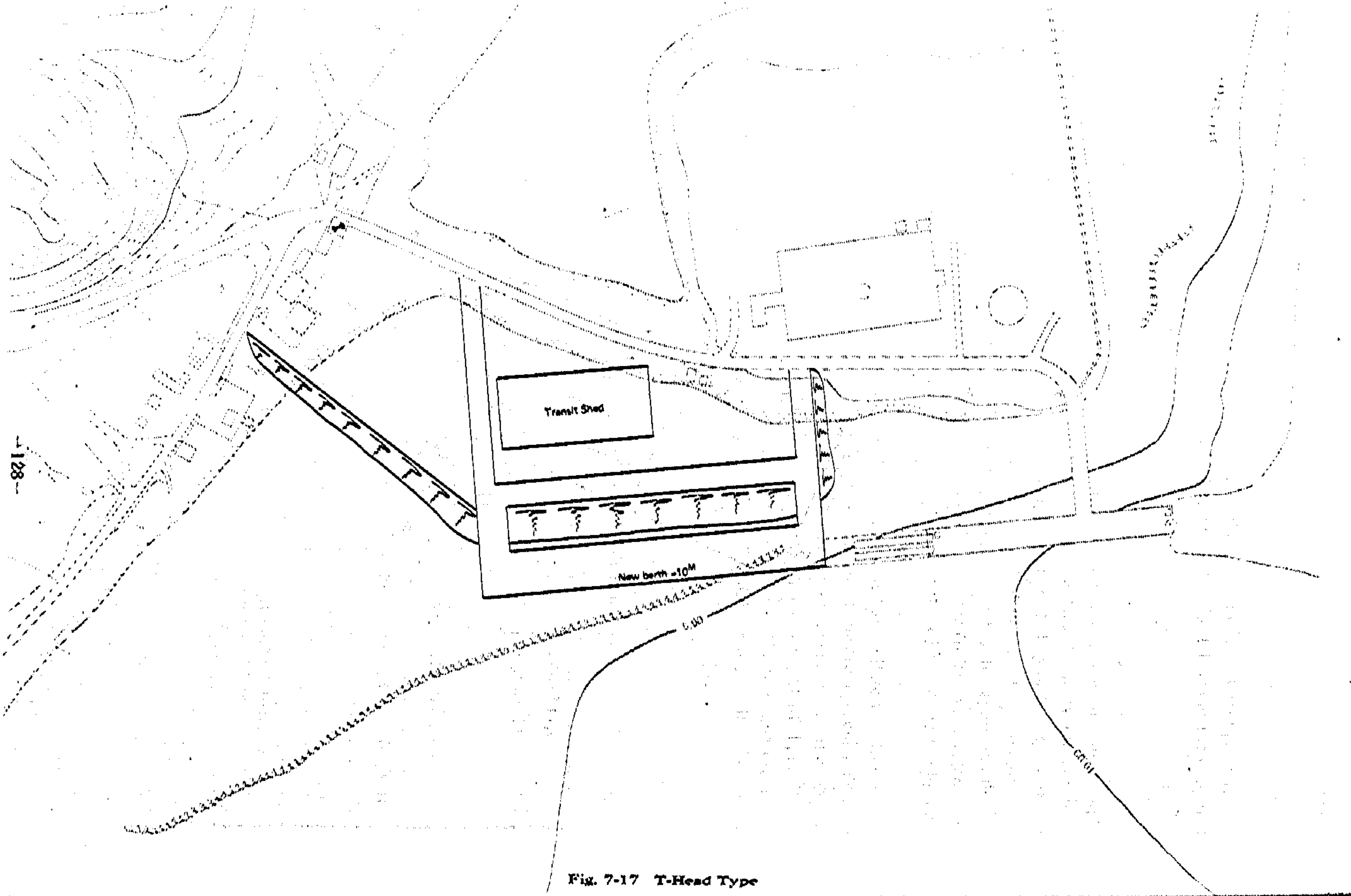


Fig. 7-17 T-Head Type

(4) Scale of New Berth

The types of ships using the No. 2 berth will be 15,000 DWT as mentioned before, considering the actual record of vessels entering PMU Irene and assuming larger type of vessels will enter the port. Water depth and the length of the berth in order to berth this type of vessel will be −10 m and 185 m respectively as standard dimensions, as analyzed in Chapter 7. In the case of Port Irene, water depth at the berth need not be changed from standard water depth but the extension of the berth needs to be made somewhat longer. This is in relation with the No. 1 berth. The No. 1 berth is a T-Head Type and there is one road leading to the pier. Under present conditions, congestion at the time of loading and unloading cannot be avoided and the efficiency of cargo handling will decrease. By connecting the No. 1 and No. 2 berths, if two roads to the No. 1 berth are secured, smooth traffic on the No. 1 berth can be achieved.

For this reason, if No. 2 berth is partly assigned of the function of No. 1 berth's road, the length of No. 2 berth is made to 200 m. This will achieve other effects also. The face line of No. 1 berth and No. 2 will be on straight line for a total length of 410 m and 3 vessels of 3,000–5,000 DWT can be berthed at the same time.

The width of the apron is made as 25 m. For other ports, the width of the apron is relatively narrow but in this project, the width is made 25 m in consideration of the track of cargo handling equipment such as forklifts, etc. A transit shed and open storage are installed on the apron. On the land side of the transit shed, a cargo sorting area is arranged in front of the transit shed to avoid congestion of vehicles on the apron coming in and out of the shed. Cargo traffic between the transit shed and the hinterland is made in and out of the transit shed through the sorting area. The ground level of the transit shed is the same as that of the apron connected to it. It is desirable to create different levels between the transit shed and the cargo sorting area to handle freely cargoes on truck with forklifts.

Size of the transit and open storage will be given the following considerations. Berth No. 1 has a transit shed for sugar, tanks for molasses and an open storage for logs. It is expected at Berth No. 1 to continue to use effectively these facilities in the future to handle mainly these cargoes. Berth No. 2 will mainly handle cargoes other than these. The following is assumed on the volume of cargoes to go through the transit shed and open storage to be constructed behind Berth No. 2.

Table 7-8 Estimation of the Volume of Cargo Using Sheds and Open Storage Yards

(,000 tons)

	Total	Transit Shed	Open Storage	Direct
Lumber	50	33		17
Plywood/Veneer	61	40		21
Cement	5	5		
Fertilizer	20	20		
Sugar	22	(22)		
Palay	40	10		30
Molasses	8	(8)		
Logs	30		30	
Others	12	12		
Total	248	120 (30)	30	68

( ) is cargo using existing facilities

The transit shed area to handle 120 thousand tons of cargoes a year is about 3,200 m². Thus, the construction of a 90 m x 40 m transit shed is proposed. As for open storage, the existing open storage should be relocated to behind the quay for the convenience of use. Its necessary area is 1,100 m².

A road width of 10 m (3.5 m x 2 for roadway and 2.5 m for parking strip) as a principle, is proposed. Area of mooring will secure a circular area of water with a radius of the length of the largest ship entering the port, on the premise that tugboats will not be available at the port. The present water depth of the area is less than −10 m and dredging for mooring area is required. Three buoys are to be installed to show the dredged mooring area is required. Three buoys are to be installed to show the dredged mooring area. The administration building will be a temporary structure.

(5) Cargo Handling

As for cargo handling equipment requirements, further study is necessary concerning cargo volume and packing methods.

Of the cargoes handled in the demand forcast in Chapter 5, molasses will be handled by a specialized apparature built by CASUCO. Thus, the volume of other cargoes handled at the port and the packing methods of these cargoes are assumed to be as follows;

Wood products	111,000 t	Mainly banded products
Cement	5,000 t	Bagged goods
Fertilizer	20,000 t	Bagged goods
Palay	40,000 t	Bagged goods
Others	12,000 t	Carton and others types
Sugar	22,000 t	Bagged goods
Logs	30,000 t	As is
Total	238,000 t	

The demand forecast for 1987 is the above volume of 238 thousand tons, excluding molasses.

From the cargo handling point of view, it can be said that though the range of goods that are handled at the port is small, the cargo (wood products, logs, etc.) is hard to handle efficiently.

However, at the same time, PPA will be requested to guide and assist arrastre companies in such a way that cargoes are handled efficiently and economically, and ships are dispatched quickly.

At the port of Irene, the nature of cargo, type of goods and packing style should facilitate efficient handling by forklift and pallet. An adequate number of forklifts and pallets can be tentatibly estimated as follows.

i) Forklift

$$F = (1 + \alpha) \cdot G \cdot N$$

Here G: number of cargo handling gangs: 6 sets
(average number per berth: 3)
N: number of forklifts per gang: 2 units
α: rate of forklift non operation: 20%

F = 15 units { 2 – 3 ton class 13 units; 5 – 8 ton class 2 units }

Cargo handling volume per forklift per annum in Philippine ports can be roughly estimated as follows:

2 – 3 ton class about 15,000 tons
5 – 10 ton class about 30,000 tons

ii) Pallets

$$P = \frac{V}{v} \cdot \frac{1}{R}$$

Here V: cargoes for which pallets are used 118,000 t
R: pallet turnover: 125 times per annum
v: per-pallet amount of cargo handled: 2 tons per time
P: 500 sheets

Fig. 7-18 and 19 show the Short-Term Port Development Plan.

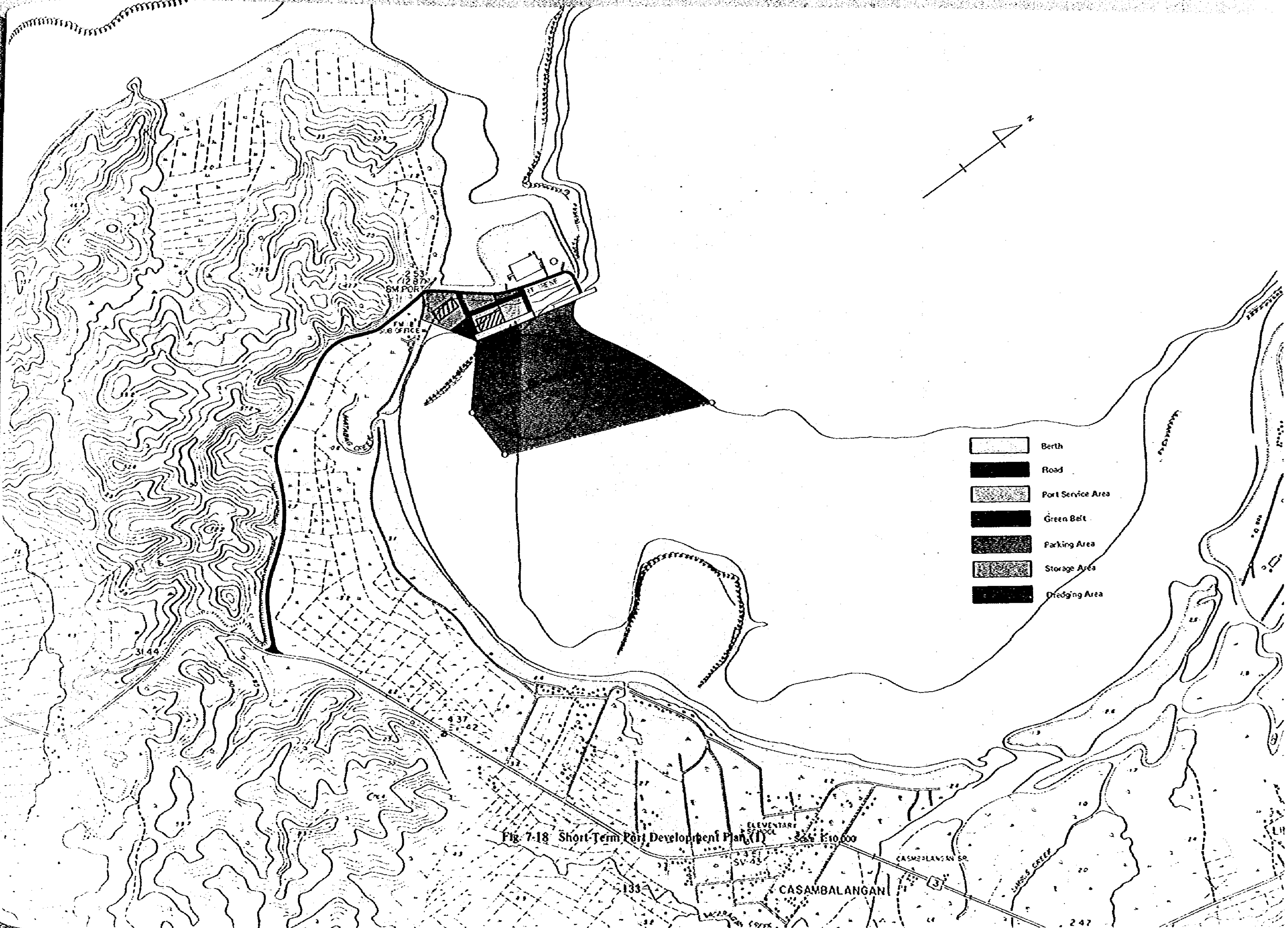


Fig. 7-18 Short-Term Port Development Plan (I) Scale 1:10,000

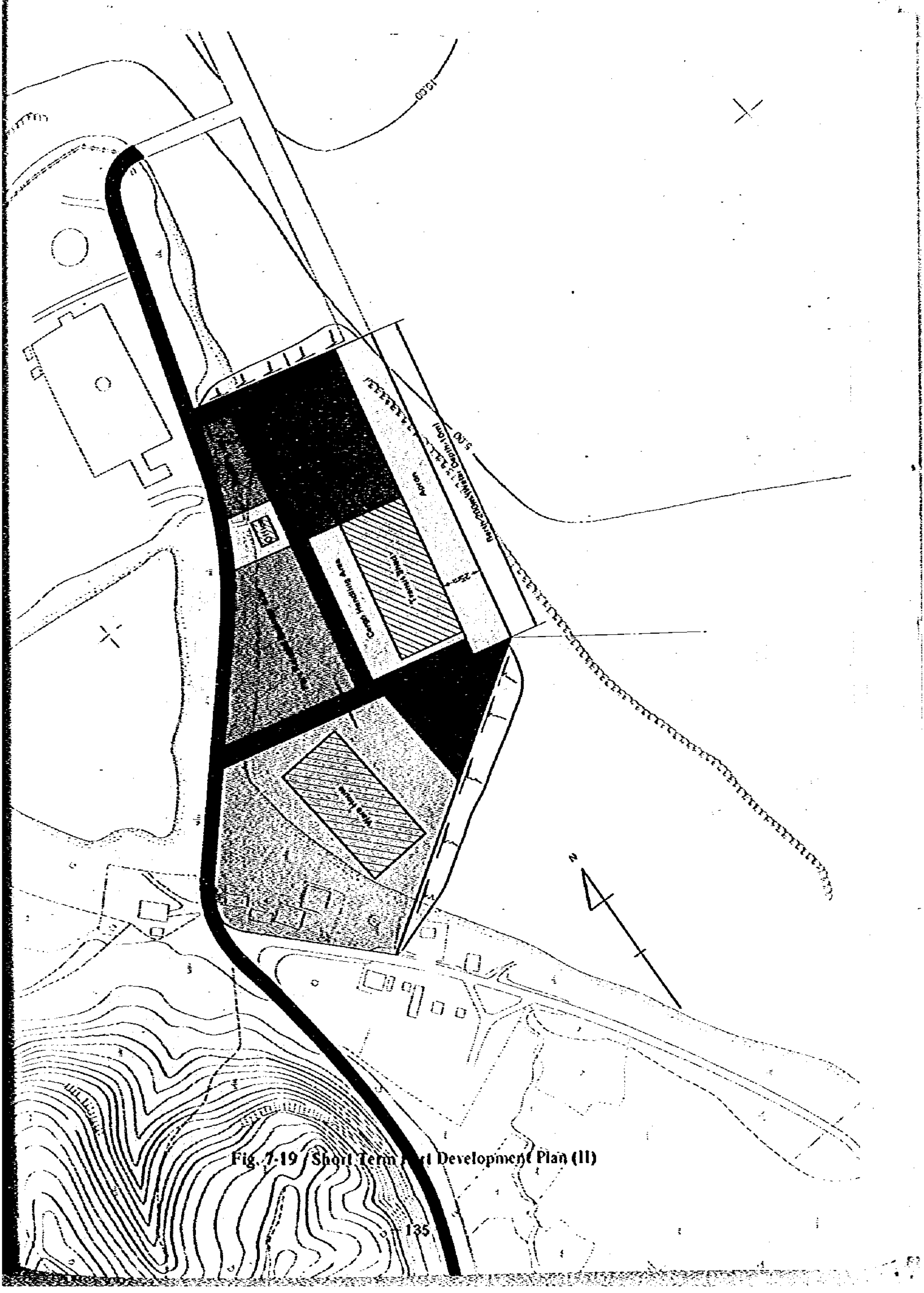


Fig. 7-19 Short Term Port Development Plan (II)

CHAPTER 8.

DESIGNING, CONSTRUCTION PLANNING AND COST ESTIMATE

CHAPTER 8. DESIGNING, CONSTRUCTION PLANNING AND COST ESTIMATE

In the previous chapter, the comparison study of the major port facilities (in the stage of both Short-Term Port Development Plan and Master Plan) has been conducted. Here in this chapter are closely described the designing, the construction planning and the cost estimate of port facilities. In the port layout study for the Master Plan, Plan (B) has been adopted. Of the Plan (B), the facilities in the Short-Term Port Development Plan has been described below.

8-1 Design Criteria

(1) General

The design criteria shall be first established for the attendant discussion of the structural dimensions and scale of port facilities. The design criteria necessary for designing the port facilities in Short-Term Port Development Plan has been tabulated in Table 8-1.

Table 8-1 Design Criteria for Short-Term Port Development Plan

Tidal levels	H.W.L.	M.L.L.W. + 1.37
	M.S.L.	M.L.L.W. + 0.58
	L.W.L.	M.L.L.W. – 0.28
Seismic disturbance	0.15 W (W: Weight of structure)	
Vessels for design	General cargo vessel – 15,000 DWT	
Water depth of berth	M.L.L.W. – 10 m	
Crest height of wharf	M.L.L.W. + 3.5 m	
Surcharge load of berth	Ordinal load condition – 2.5 t/m²	
	Particular load condition – 1.0 t/m²	
Berthing velocity of ship	0.15 m/sec.	
Design lifetime of structure	50 years	

The details of each item of design criteria are described below.

(2) Tide

The tidal elevations for designing has been established on the basis of the Tide and Current Table (1980, 1981) published by Bureau of Coast and Geodetic Survey, Ministry of National Defence. In the process of establishing the design tidal elevations, port of San Vicente has been selected as the base port. This port of San Vicente is located about 20 Km north of Port of Irene or at 18°31' N and 122°08' E.

Table 8-2 Tidal Level for Port of Irene

(cm)

H.W.L.	+1.37
M.S.L.	+0.58
L.W.L.	-0.28
M.L.L.W.	±0

(3) Soil Condition

In the vicinity of the Casambalangan bay, the Study Team has executed a total of 5 borings. Inclusive of the past boring data, soil condition on the planned site has been studied. Of five borings, BH-3 was put down nearest to the planned site. The engineering log of BH-3 shows that the upper layer is silty sand with N value of 0–5, and the medium layer is silty clay with N value of 0, and the lower layer is fine sand with N value of 10–20. This lower layer overlines the bedrock at the elevation of 32–34 m below M.L.L.W. The assumed soil profile on the proposed face line of berth for Short-Term Port Development Plan is illustrated in Fig. 8-1. This face line is located continuously just south of the existing pier.

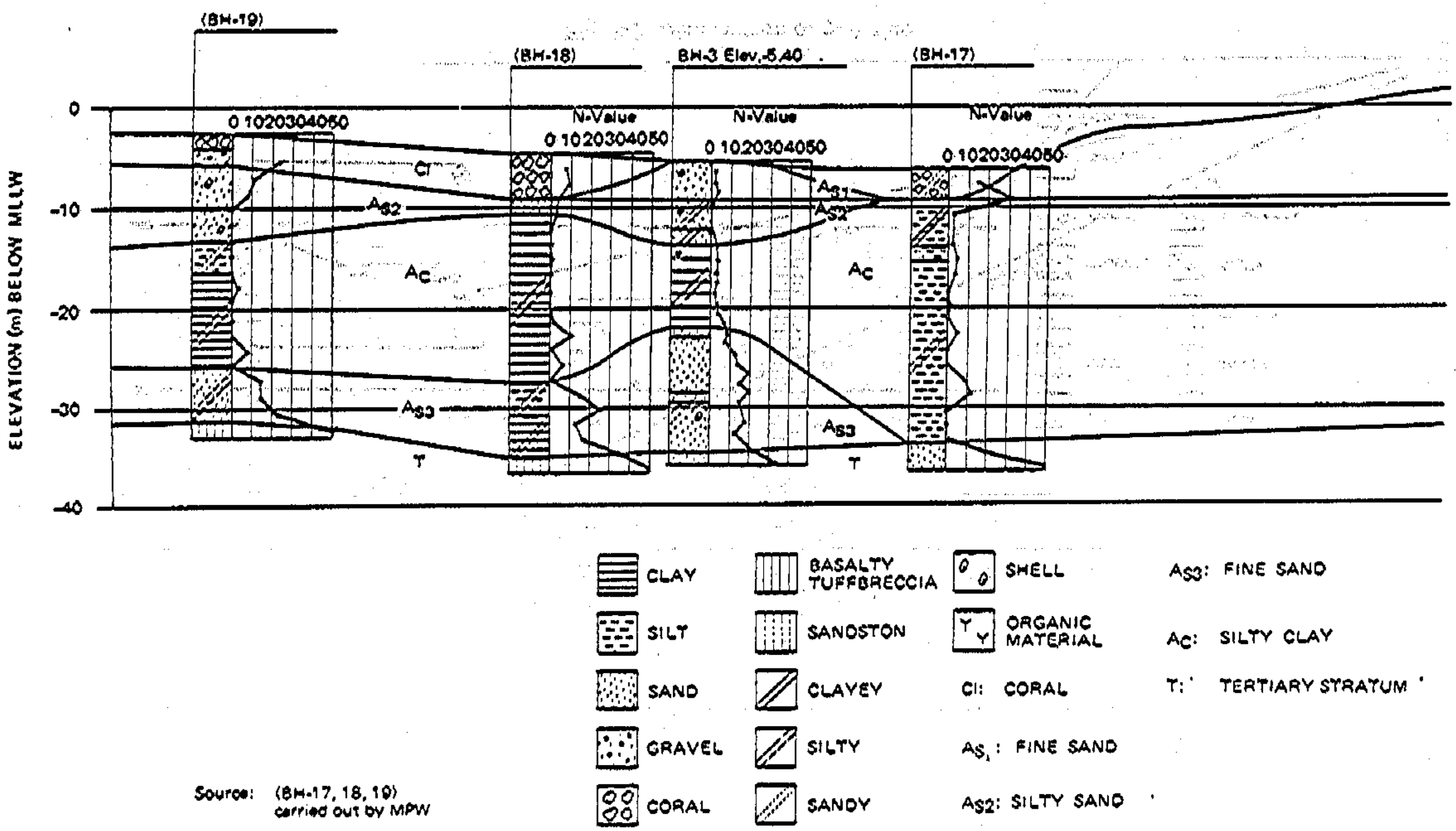
All the soil samples has been tested in Manila and site. The results of the test (wet unit weight and unconfined compression test) are shown in Fig. 8-2 and 8-3. The details of other tests are compiled in the "Natural Condition Survey Report".

The design criteria for soil condition has been assumed as follows:

Table 8-3 Soil Condition for Designing

Legend	Soil Characteristics	Elevations	Internal Friction/Cohesion	Unit Weight
Cl	Coral	MLLW − 2.0 ~ − 9.0	$\phi = 25°$	1.75 t/m³
As_2	Silty Sand	MLLW − 6.0 ~ −14.0	$\phi = 22°$	1.75
Ac	Silty Clay	MLLW −10.0 ~ −27.0	C = 0.23Z	1.65
As_3	Sand	MLLW −22.0 ~ −34.0	$\phi = 28°$	1.70

Z: depth under the sea bed



Source: (BH-17, 18, 19) carried out by MPW

Fig. 8-1 Soil Profile on Proposed Face Line of Berth

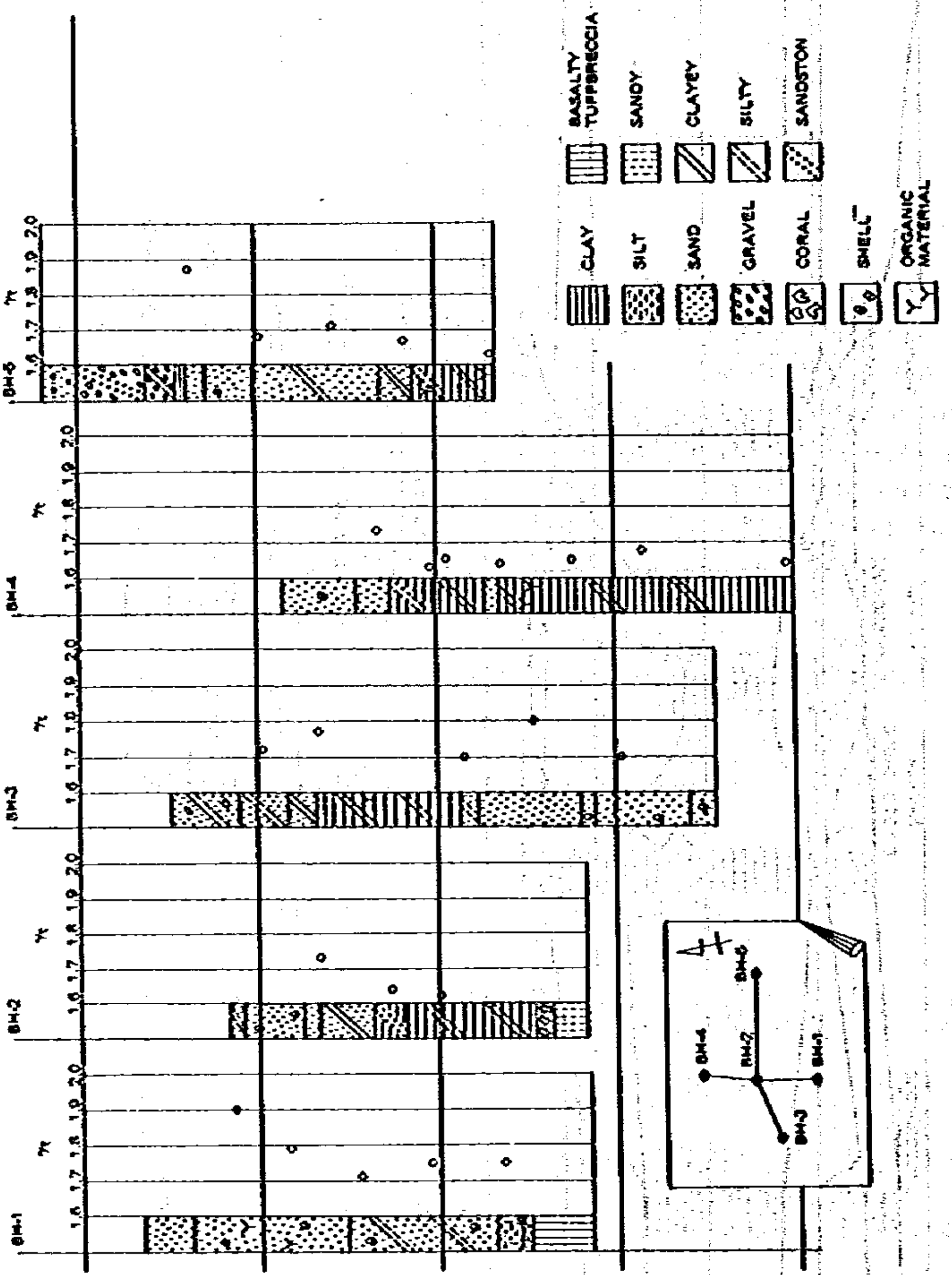
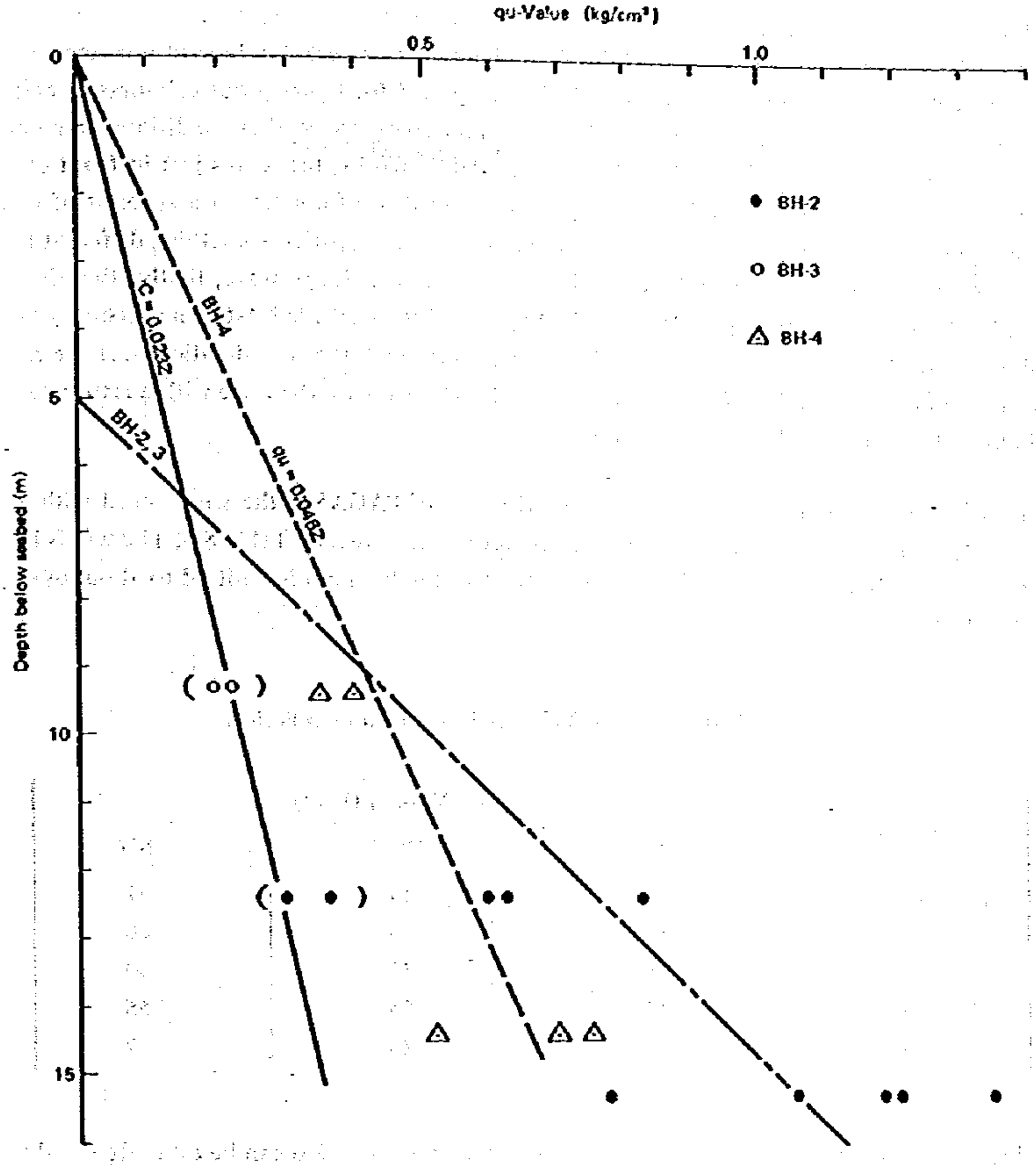


Fig. 8-2 Distribution of γ_t-Value



Note: The low qu-value in parenthesis results from the high content of sandy material in test sample.

Fig. 8-3 Distribution of qu-Value Versus Depth

(4) Design Waves

The design waves which are applied for designing structures are developed by severe storms such as typhoon, while the usual waves which are applied for figuring out calmness in certain place such as inside the port area are developed by very common weather conditions. According to the information obtained from the Ministry of Public Works, the waves just in front of the berth are a maximum of 0.5–0.8 m in height. However this information, on account of visual observation, may be little trustworthy. This wave is, in characteristics, something different from the wave with a return period of 30 years. In determining the design wave, firstly, the offshore waves has been assumed through S.M.B. method by use of the past wind data, and secondly those offshore waves has been treated into the shallow waves through the consideration over the effect of refraction and diffraction. Thirdly, of a series of highest waves, the wave with a return period of 30 years has been selected as a design wave.

Based on the past wind data from the Aparri office of PAGASA, the wind speed with each probability can be arranged through the Gumbel method as shown on Table 8-4. The winds listed on Table are daily maximum winds, since the effective fetch length is limitted to about as short as 30–60 km.

Table 8-4 Design Wind Velocity in Each Return Period

Return Period	Wind Velocity (Knot)		
	N	NNW	NW
100 years	58	69	72
50 years	52	63	66
30 years	48	58	60
20 years	45	55	56
10 years	39	48	49

By use of the design wind, the offshore wave in each return period can be estimated as shown on Table 8-5.

Table 8-5 Offshore Design Wave

Return Period	Wave Height (m)		
	N	NNW	NW
100 years	3.4	5.8	6.0
50 years	3.2	5.2	5.5
30 years	3.0	4.9	4.9
20 years	2.8	4.4	4.6
10 years	2.5	3.9	3.9

The design wave height has been defined as the wave with a return period of 30 years, and the wave heights at the strategic two points have been assumed as shown on Table 8-6.

Table 8-6 Design Wave Height at the Given Points

	Point A (m)	Point B (m)
N	1.8	1.3
NNW	3.2	2.2
NW	2.7	1.7

Direction of Offshore wave	N
Period	9.0 sec.
Coefficient of Refraction	0.77
Wave Direction in Port	N17°W

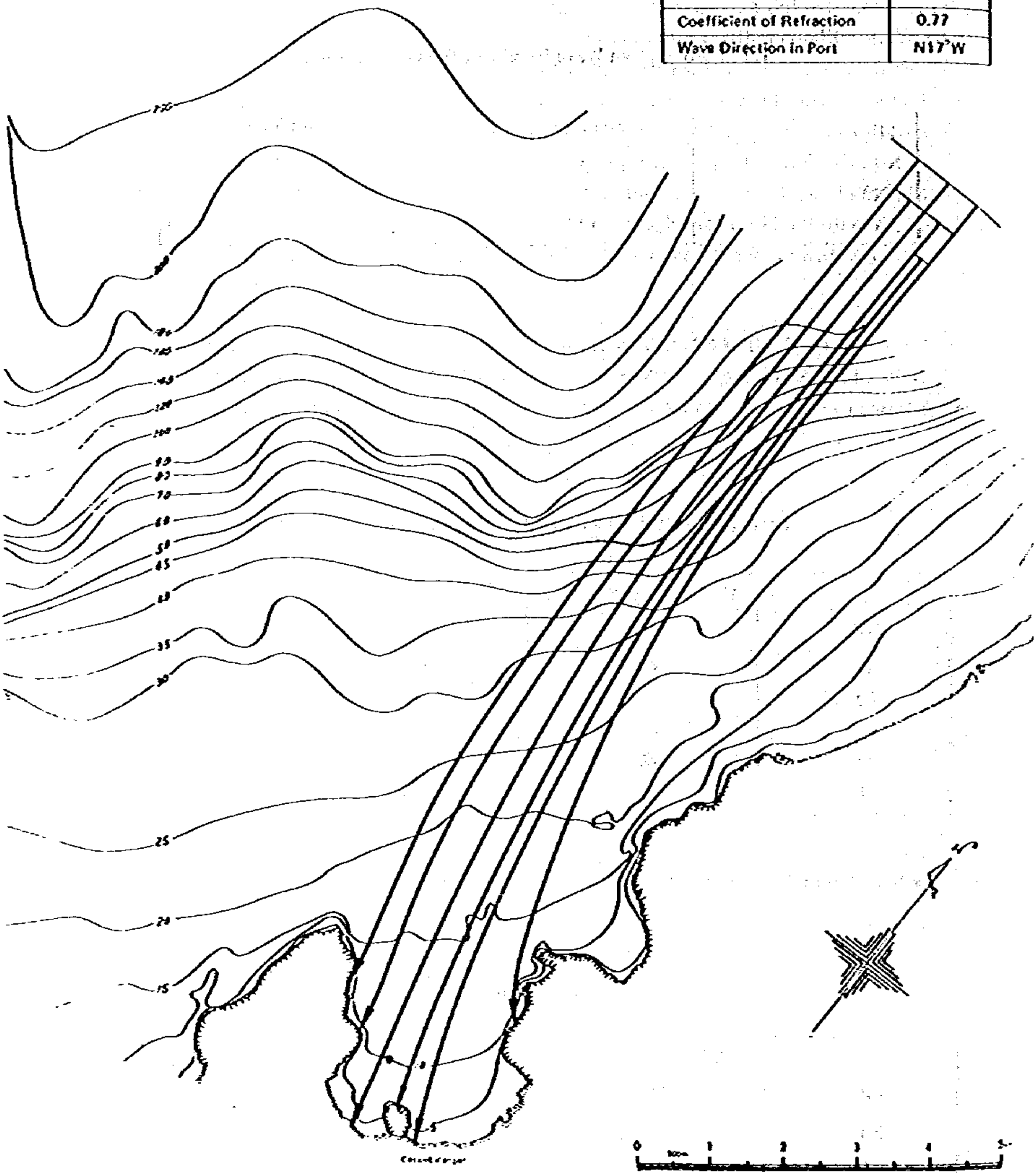


Fig. 8-4 Refraction Diagram (1)

Direction of Offshore wave	NNW
Period	9.0 sec.
Coefficient of Refraction	0.85
Wave Direction in Port	N29°W

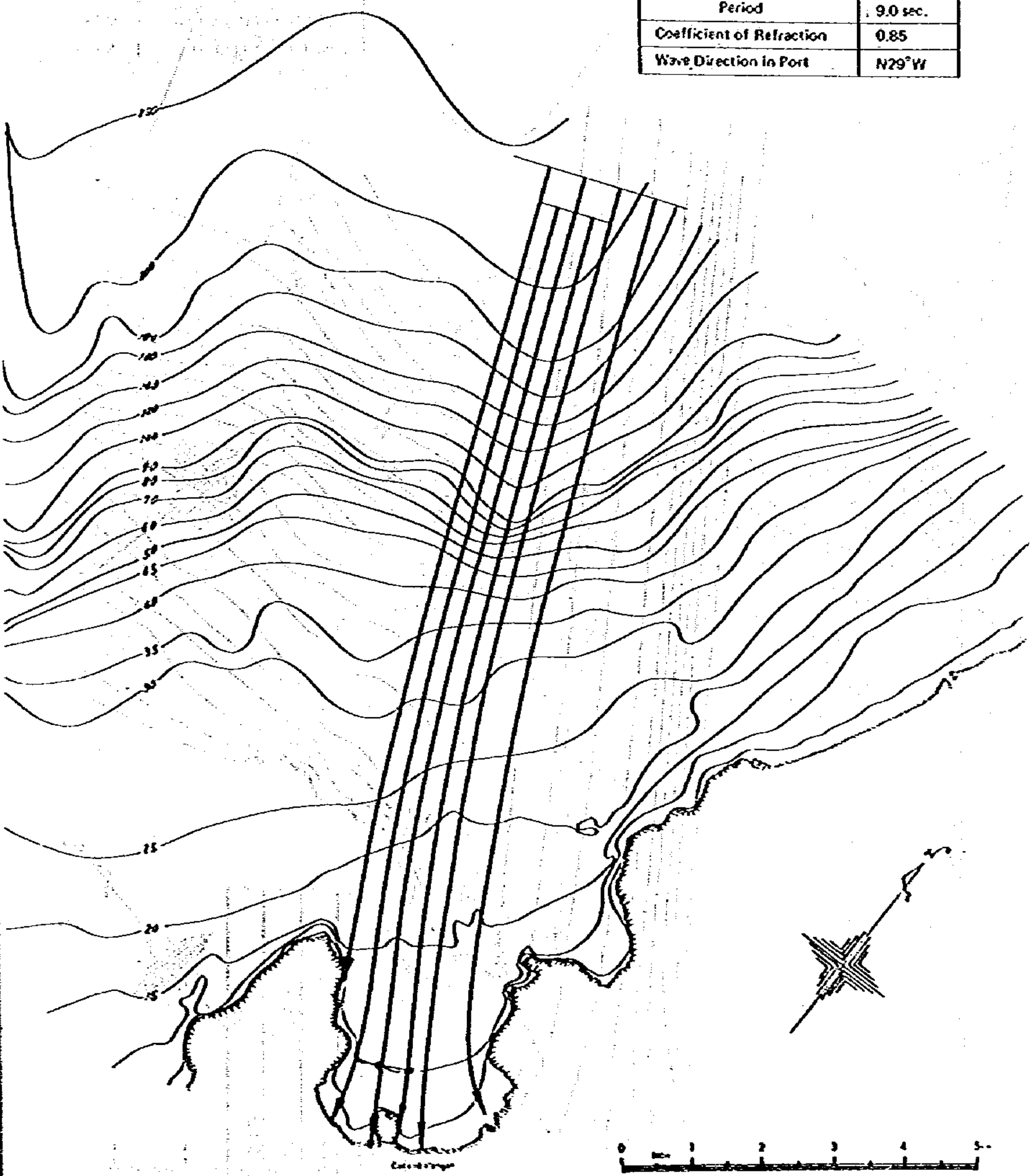


Fig. 8-5 Refraction Diagram (2)

Direction of Offshore wave	NW
Period	9.0 sec.
Coefficient of Refraction	0.73
Wave Direction in Port	N37°W

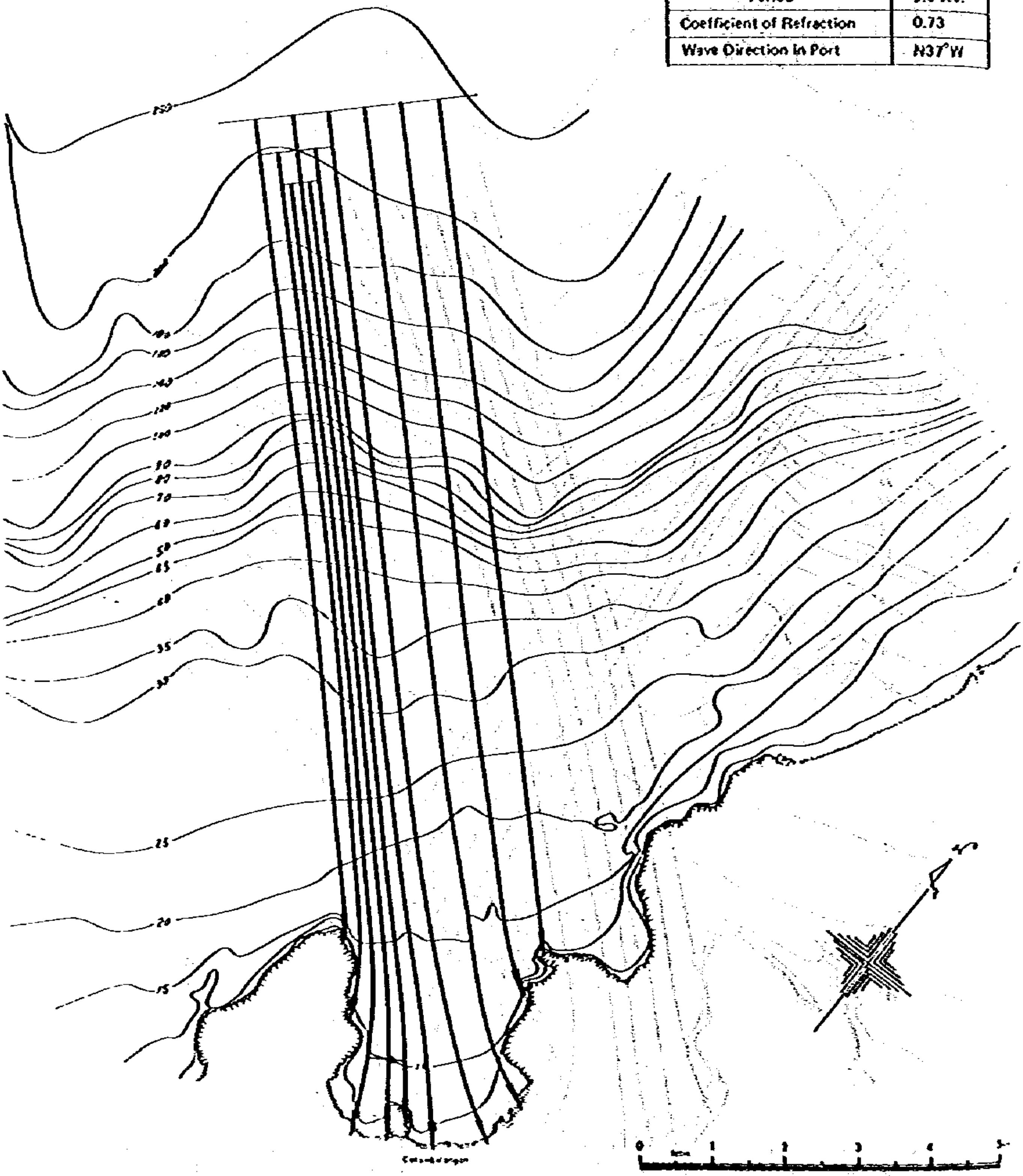
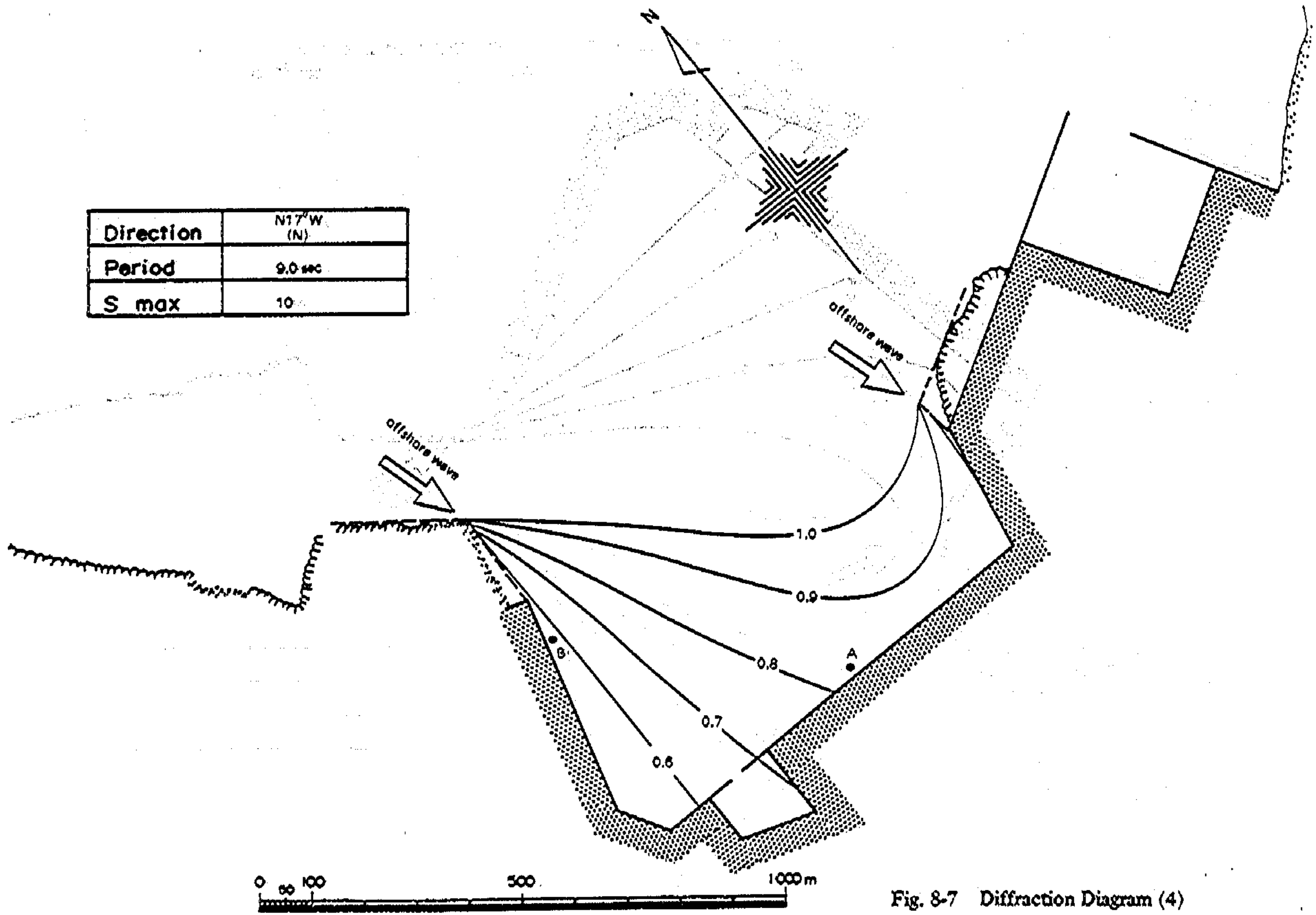


Fig. 8-6 Refraction Diagram (3)



Direction	N17°W (N)
Period	9.0 sec
S max	10

Fig. 8-7 Diffraction Diagram (4)

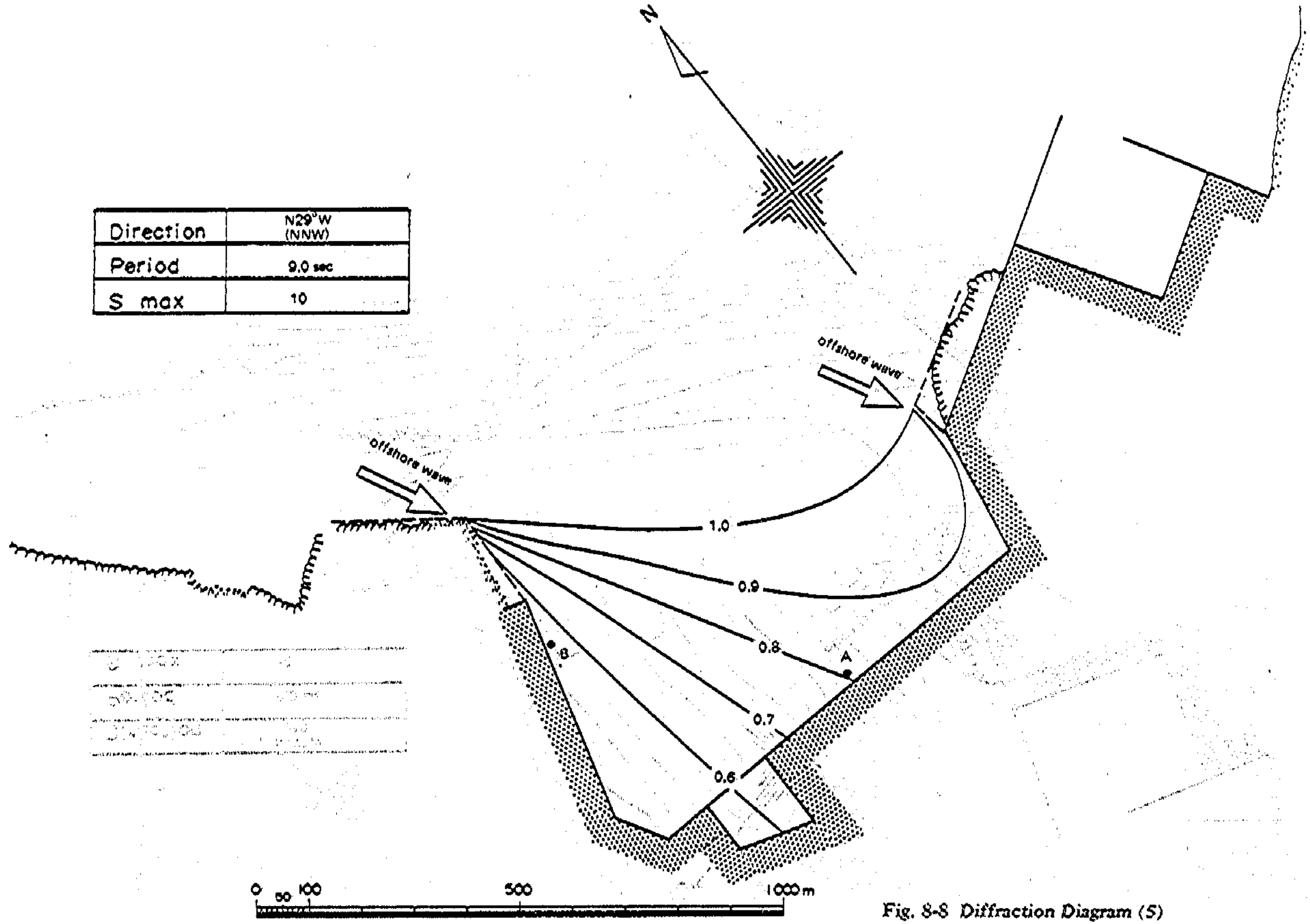


Fig. 8-8 *Diffraction Diagram (5)*

Direction	N37°W (NW)
Period	9.0 sec
S max	10

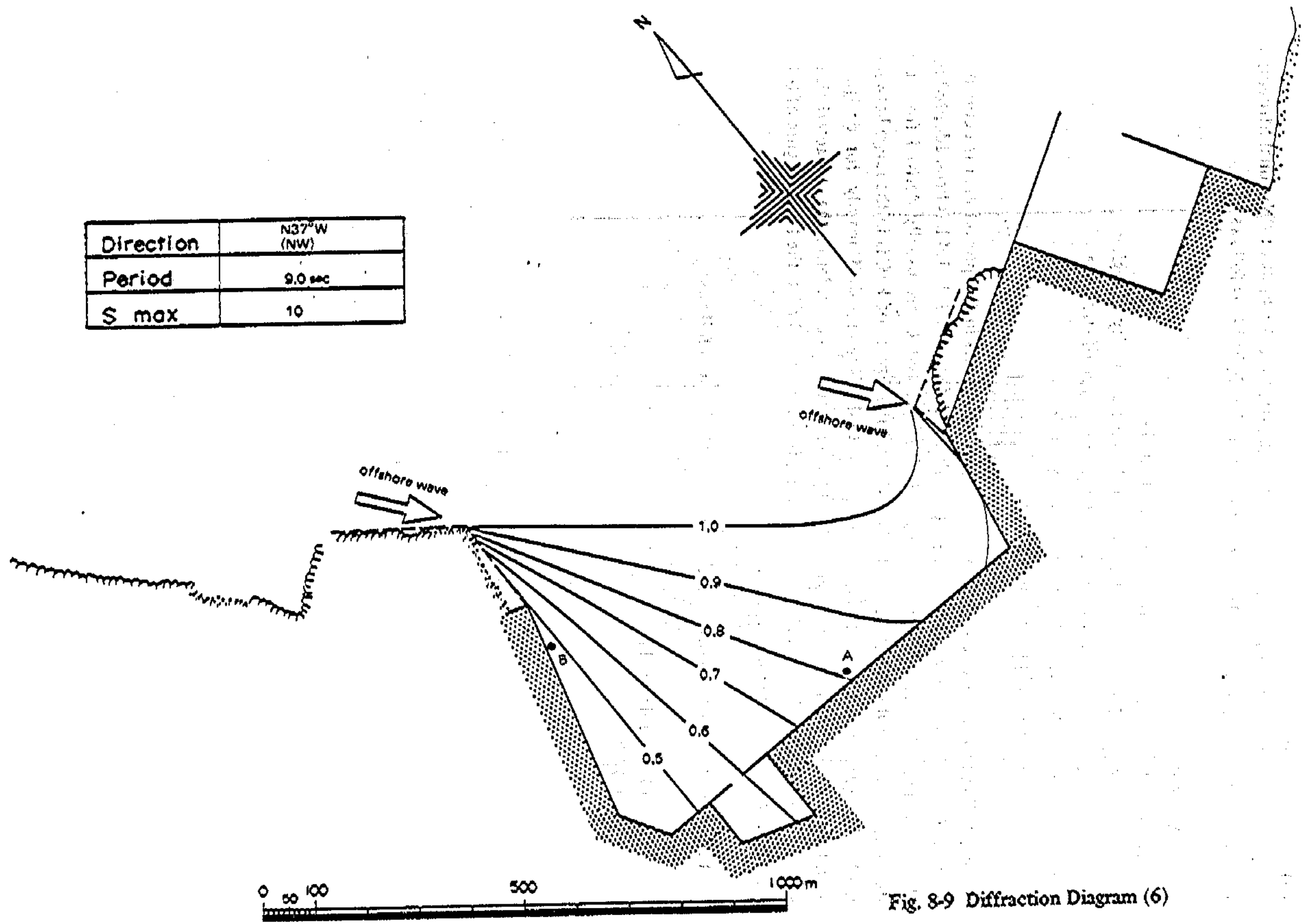


Fig. 8-9 Diffraction Diagram (6)

(5) Seismic disturbance

The seismic force due to earthquake can be calculated on the basis of "National Structural Code for Building" published by MPW. The formula to be applied is as follows:

$$V = Z \cdot K \cdot C \cdot W$$

Where V : Horizontal force due to earthquake
Z : Numerical Coefficient related to the seismicity of region
K : Numerical Coefficient related to the type of structure
C : Numerical Coefficient for base shear
W : Weight of structure

According to the above code, the numerical coefficient (Z) in the project area is defined as Zone 1. Considering the subsoil condition at the sites, the figure of 1.2–1.4 has been adopted for the design numerical coefficient. The coefficients of K and C are usually derived from the dynamic analysis of the structures, and in most cases the figures of K·C is in the range between 0.12 and 0.25. The above National Structural Code is established mainly for designing architecture rather than civil engineering structure, so that when considering the characteristic of seismic oscillation or the importance of structure, it is considered that, the lowest figure of 0.12 is sufficient for designing the berth structure.

Under these conditons, horizontal force can be calculated as follows:

$$V = (1.2 - 1.4) \times 0.12 \times W$$
$$= 0.15\ W$$

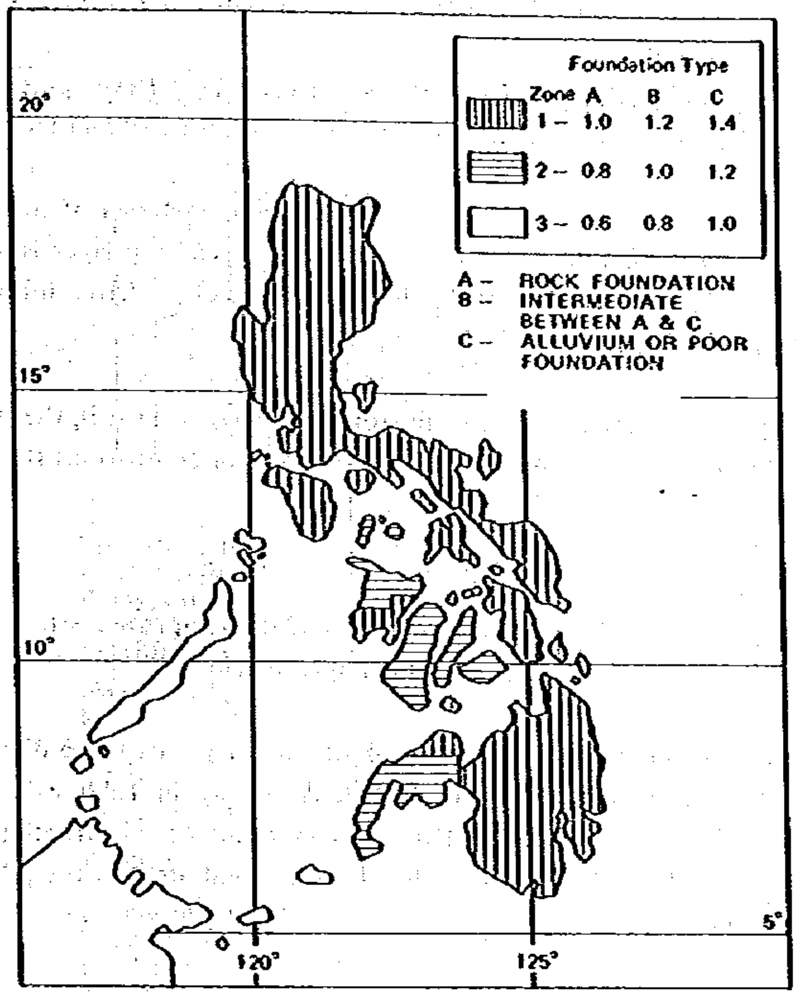


Fig. 8-10 Seismic Zones and Recommended Seismic Coefficients "Z"

8-2 Comparison Study of Berth Structure

1. Selection of the Berth Structure

Before finalizing the berth structure in the Short-Term Port Development Plan, it is quite necessary to select the prospective structural types of the berth for cost and technical comparison.

The subsoil condition is, as described before, very poor in terms of internal friction and cohesion, so that the reliable foundation cannot be assured. The top layer is partly covered by coral reef, but its thickness is so thin that the steel pile can be easily driven through this layer. As to oceanographical matter, there is no significant problem.

The notworthy point is the existence of the soft subsoil layer. That is, the steep slope will be easily collapsed due to land-slide. As the structural types for comparison study, the following three types have been selected, namely

1) piled pier type
2) steel sheet pipe pile type accompanied with foundation improvement
3) gravity type accompanied with foundation improvement

When locating these structures in the planned site, many points to be discussed have come about. These points are summarized in Table 8-7. As shown in Table 8-7, the gravity type (caisson) is apparently inferior to other structures in terms of construction procedure and construction cost, so that the further study has been concentrated on the piled pier type and steel sheet pipe pile type.

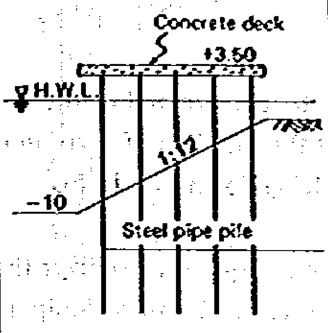
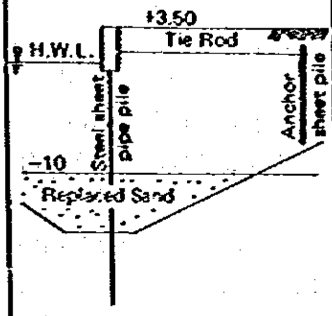
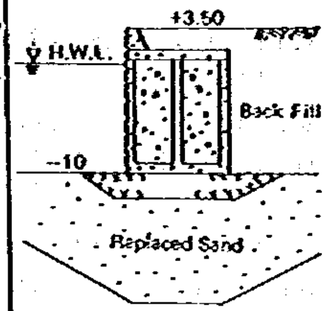
2. Preliminary Designing of the Berth

(1) Steel Sheet Pipe Pile Type (Wharf Type)

In this plan, the steel sheet pile berth will be constructed in the south of the existing pier. The entire area behind the face line of berth will be reclaimed. The soil condition along the face line is considerably poor, so that when −10 m berth is designed without any foundation improvement, any kinds of the existing steel pipe piles cannot withstand the horizontal earth pressure. Accordingly, the subsoil layer down to −20 m where passive earth pressure balances the active earth pressure shall be replaced by well compacted sand at first. Then the steel pipe piles of 914.4 mm in diameter shall be driven continuously side by side with assistance of guide-nail which is welded to the pipes. The penetration required is assumed to be −30 m. As the anchorage for steel-pipe-piled-wall, sheet pile anchorage has been employed, because this anchorage shall be installed on the sea before the work of the backfill. The steel-pipe-piled-walls and the sheet pile anchorage can be connected by high-strength steel tie-rod with a diameter of 70 mm.

The sand material for replacement will be easily obtained from the east coast of the Casamblangan Bay.

Table 8-7 Comparison on Structural Type for Port of Irene

Type of berth	Piled pier type	Sheet pipe pile type	Gravity type
General feature			
Advantage	oBeing structurally simple and flexible, this type is, indeed, suitable for poor soil characteristics. oNo technical problems concerning structure are involved. oNo problems of construction are involved.	oEfficient cargo handling is possible because the reclaimed entire area behind the quay is completely free for traffic.	oMade of concrete, this type is never corroded. oEfficient cargo handling is possible because entire area behind the quay is reclaimed.
Disadvantage	oBecause of the problem of stability of the slope under the pier, it is impossible to provide retaining wall for the pier apron so that cargo handling can not be continuous.	oThe existing soil must be replaced because of its soft soil characteristics. oConstruction and supervision are difficult because the layer requiring sand replacement is thick.	oA yard & slip or a floating dock to fabricate concrete caissons is necessary. oTo avoid subsidence of clayey soil, this layer must be replaced.
Construction speed	oFast	oNormal	oSlow

The area between the proposed face line of berth and the shoreline will be protected by the revetment of rock mound that be collected in the vicinity of the port site. The shoreside slope of the rock mound will be covered by vinyl sheet for protection of water pollution while land reclaiming.

The landreclamation will be carried out in stage development. In the first stage, land reclamation will be executed up to the level of 2 m above datum and in the next stage the landreclamation will be promoted with the assistance of land side construction machinery like bulldozers instead of barges.

At the north side of the revetment line the design wave height has been estimated about 2.5 m, so that the rock mound shall be protected by 2 ton armor rock, and intermediate portion of the rock mound and the armor rock will be filled with 300–500 kg rubble stone.

On the other hand, at the south side of the revetment line, no significant waves are expected, so that the rock mound will be filled by run-of-quarry, and no armor rock will be placed.

(2) Piled Pier Type (T-Head Type)

In this plan, the piled pier with 25 m width will be constructed in the south of the existing pier. The revetment line will be located 50 m behind the face line of berth in order to secure the stability of dredging slope which will be made by dredging down to –10 m.

The revetment will be mainly constructed with run-of-quarry. However the north side of the revetment where affected by offshore waves will be protected by wave-dissipating concrete block and the intermediate-portion will be filled with 300–500 kg rubble.

The south side of the revetment line is scarcely affected by offshore waves, resulting in requirement of only run-of-quarry filling.

The east side of the revetment which will be located between those above revetment is also scarcely affected by waves, but there is the waves running along the revetment line, so that this portion will be protected by 300–500 kg rubble.

The reclaimed land will be enclosed by these revetment on three sides, and the access to the pier will be provided by the two access bridges each with 15 m width and 25 m length.

The foundation piles of pier have been designed in the diameter of 812.8 mm, and these piles will be driven down to –30 m. The tradient of the slope under the pier has been designed at 1 : 2.5 for securing the stability of land slope.

As described before, both types have individual disadvantages: Wharf Type requires a large-scaled foundation improvement, while T-Head Type requires additional work of access bridges between main pier and reclaimed land. However these disadvantages are not critical ones. So, it is difficult to reach final choice of the berth type only from the view point of structural study. It would be desirable that the proposed berth type is determined, considering other major factor such as cargo handling efficiency and other local requirement. As to cargo handling efficiency, Wharf Type is more favorable than T-Head Type.

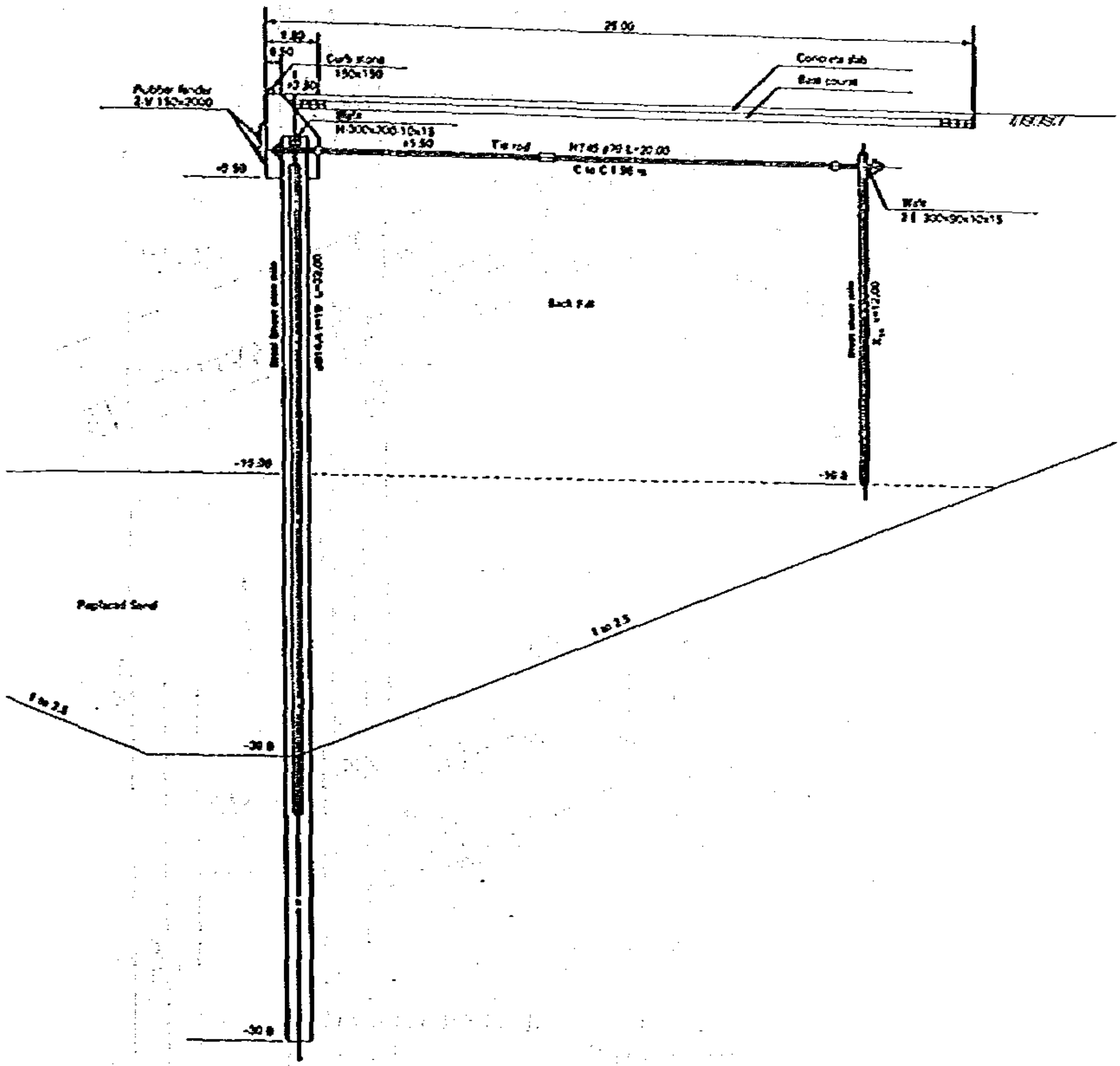
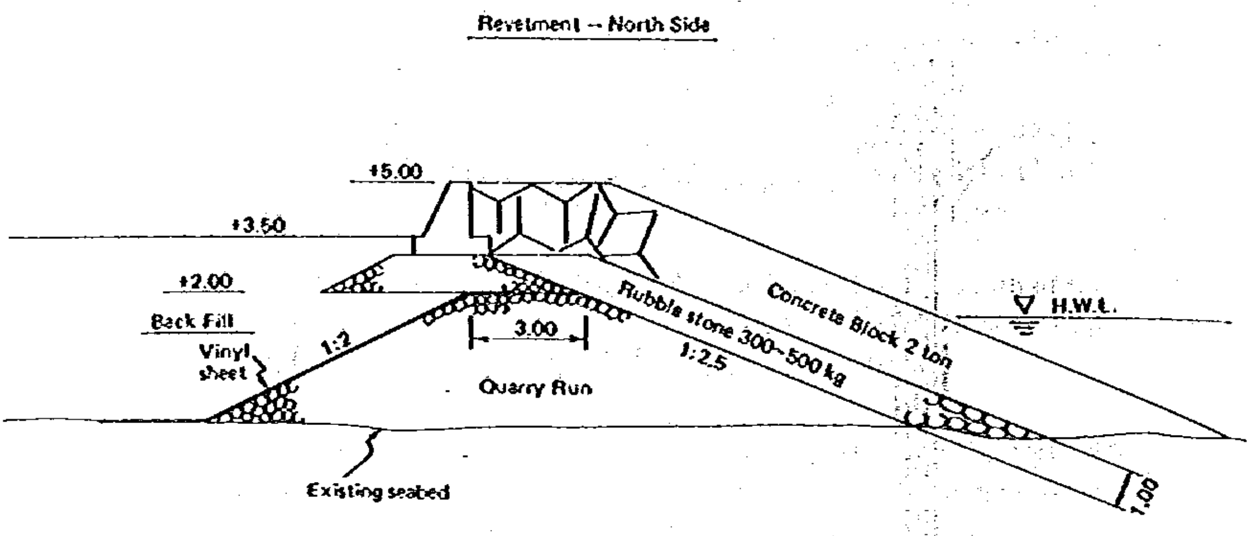


Fig. 8-11 Typical Cross Section of Berth (Wharf Type)



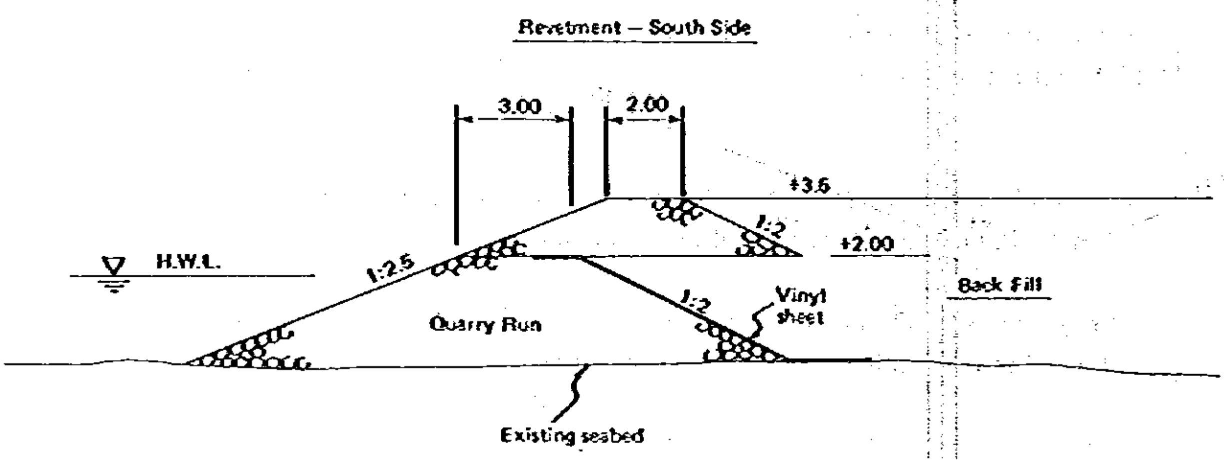


Fig. 8-12 Typical Cross Section of Revetment (Wharf Type)

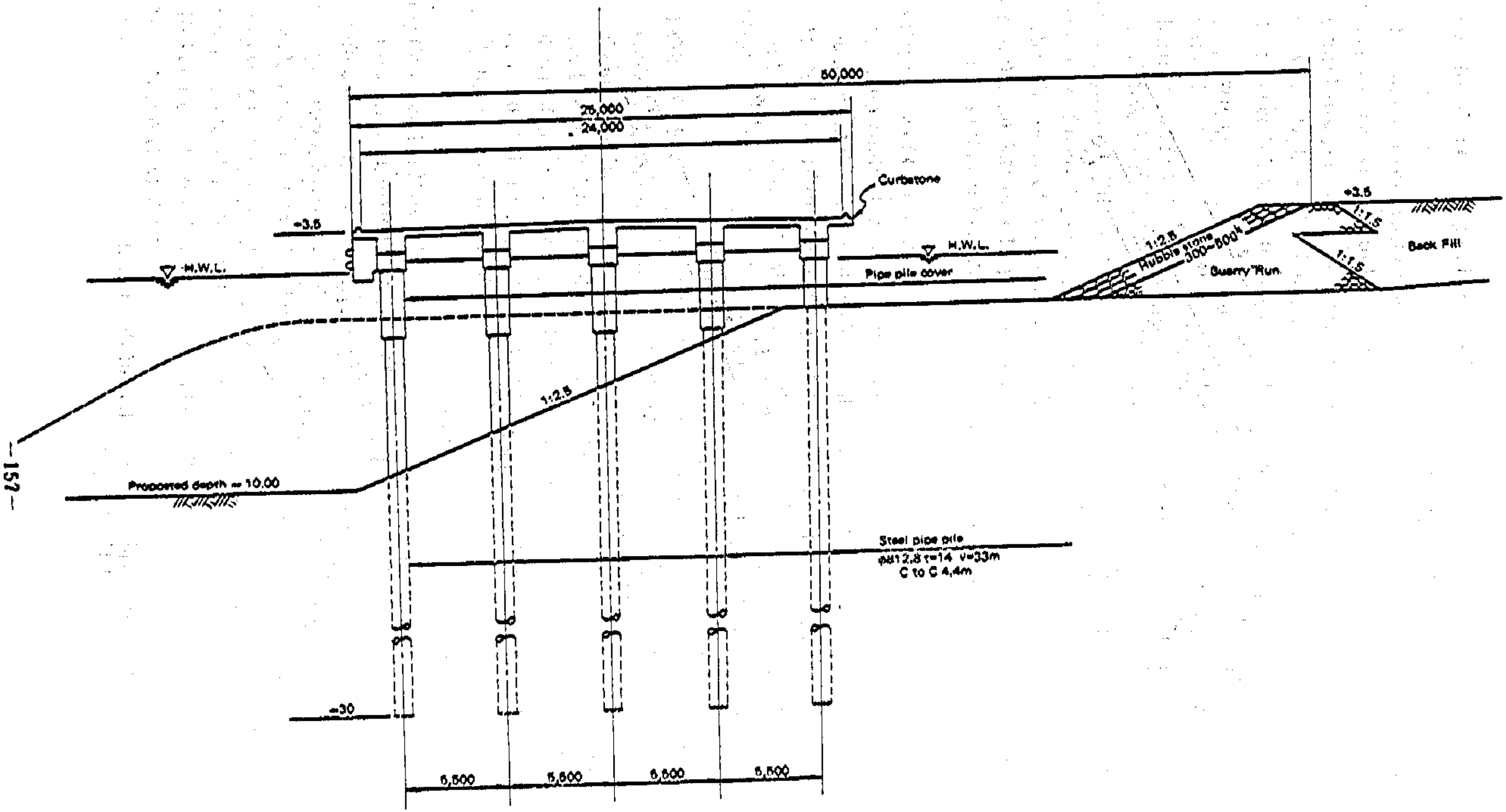
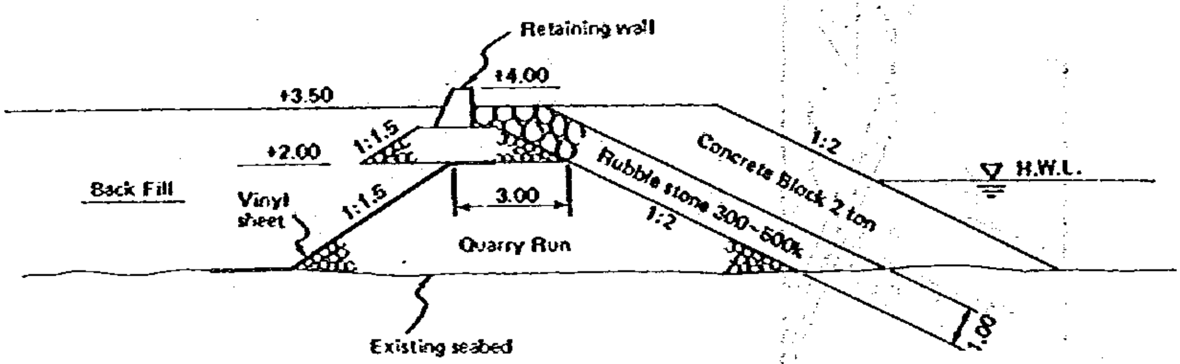
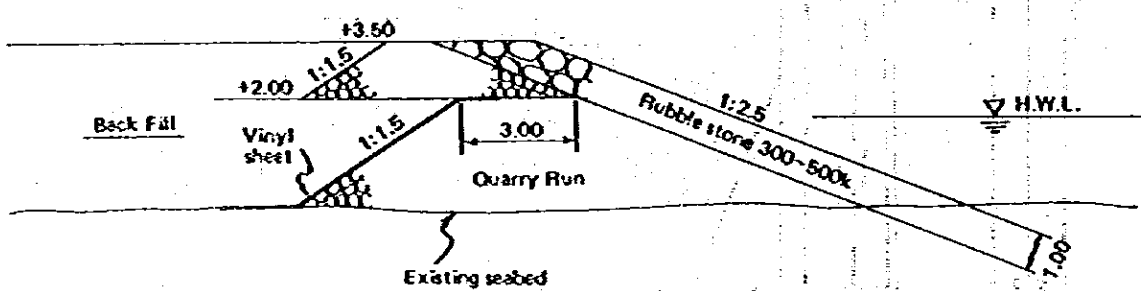


Fig. 8-13 Typical Cross Section of Berth
(T-Head Type)

Revetment – North Side



Revetment – East Side



Revetment – South Side

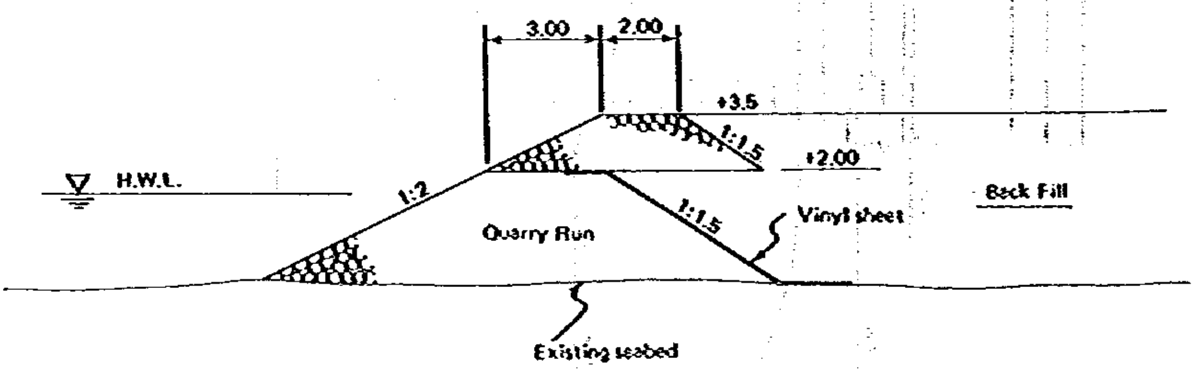


Fig. 8-14 Typical Cross Section of Revetment (T-Head Type)

8-3 Construction Planning and Cost Estimate

The proposed construction site is a comparatively favorable port surrounded by coral and cape and can be expected to be free from waves likely to hamper the offshore work of dredgers and piling barges, etc. except in times of typhoons.

Even in a typhoon, the interiors from the existing pier can be available for the refuge area of construction craft because the wave height there is relatively small.

1. General

(1) Restriction of Working Hour

According to the results of analysis of weather data from PAGASA Aparri, concerning meteorological conditions that considerably affect construction, the sea is generally rough and the number of rainy days is large during the typhoon season from June to September.

The directions of waves affecting offshore works are N and NW. From the analysis of meteorological data of a 10 year period, the average number of days available for offshore work in a month is estimated at 22.

(2) Capability of Construction

Since no contractors with sufficient capacity for the execution of this construction project can be found at the site and its vicinities, it is necessary to use contractors from outside.

Much skilled labor will be temporarily necessary at the peak of the construction but all this cannot be supplied from local sources. So, it must be supplemented from other region of Luzon Island.

(3) Construction Equipment

Grab dredgers, piling barges and other large construction craft to be used for this project are locally unavailable.

So, large grab dredger and piling barge will be mobilized from either Japan or Singapore while small grab dredger, soil transportation barges and flat barges will be mobilized from Manila. Some heavy construction equipment including bulldozers, dozer shovels and cranes can be procured locally but most must be mobilized from Manila, etc.

(4) Construction Materials

Construction materials that can be locally procured are wood, sand and stone. Cement, reinforcing bars, etc. must be brought from other region of Luzon Island. Sand from the Casambalangan River located 4 km from the site will be used as concrete fine aggregate while gravel, the course aggregate, will be collected from the Baua River located 7 km from the site. As for other stones, stones of up to 300 kg will be collected from the Pateng River located 23 km from the site while stones of more than 300 kg will be brought by sea from Palaui Island located 10 km from the site. Steel sheet pipe piles, steel sheet piles, steel shapes, tie-rods, rubber fenders, bollards and vinyl sheets will be imported from abroad and unloaded at the existing pier of the site.

2. Construction Scheme for Major Items

(1) Anchorage Dredging

The anchorage will be dredged to −10 m, using one 8 m^3 grab dredger. Dredged soil, assumed to be sandy soil, will be dumped into the sea within 4 km which is sufficiently deep but not included in fishing grounds.

Assuming 9-hour operation per working day, the dredging efficiency in terms of daily volume of dredged soil is;

$$V = 288\ m^3/h \times 0.95 \times 0.85 \times 9 = 2{,}093\ m^3/day$$

0.95: weather coefficient

0.85: soil coefficient

The composition of the dredging fleet is as follows:

Grab dredger 8 m^3 1,000 ps	1 pcs
Anchor boat 5 ton 90 ps	1 "
Hopper barge 200 m^3	3 "
Tugboat D-180 ps	1 "
Passenger boat	1 "

(2) −10 m Berth

Unsuitable soil material will be dredged up to −20 m by 8 m^3 grab dredger and sand for sand replacement will be dredged from the sea near the estuary of the Casambalangan River using one 2 m^3 grab dredger and the sand will be dumped to the correct position using soil transportation barges. After that, steel sheet pipe piles of diameter 914.4 mm, thickness 19 mm, length 32 m will be driven offshore by a piling barge equipped with a diesel pile hammer of 4 tons in ram weight. While continuing back filling, buttress steel sheet piles Z-type, length 12 m will be driven from onshore by a diesel hammer of 2 tons in ram weight mounted on a 35 ton crawler crane, after that tie-rods will be installed.

It is assumed that the piling capacity is six steel sheet pipe piles per day for the piling barge and 15 Z-type steel sheet piles per day for the crawler mounted pile driver.

The sand replacement and piling fleet is composed as follows:

Grab dredger 8 m^3 1,000 ps	1 pcs
Grab dredger 2 m^3 210 ps	1 "
Anchor boat 5 ton 90 ps	1 "
Hopper barge 200 m^3	2 "
Tugboat D-180 ps	1 "
Piling barge D-40	1 "
Flat barge 300 ton	2 "
Diver boat D-30 ps	1 "
Passenger boat	1 "

(3) Transit Shed

40 m wide x 90 m long, area: 3,600 m², will be constructed.

Being of steel frame structure, it will have a floor finished with concrete and a roof of asbestos cement slates.

(4) Land Reclamation

About 40,000 m² including the backward of the −10 m berth will be reclaimed up to +3.50 m. Reclaimed soil will be excavated from hills with superior soil located within 2 km from the site, transported by dump trucks and graded by bulldozers.

(5) Port Road

The road will be paved with concrete for a thickness of 20 cm over a base course of 30 cm in thickness. The width of road will be 10 m.

(6) Access Road

About 1.6 km temporary road from the existing national road connecting Dugo-Sanvicente to the proposed port area will be reinforced and improved. The width of road will be 7 m with concrete pavement.

(7) Drainage & Power Supply

Along the port road, drainage (700 m) and manholes (5 pcs) will be constructed. About 1.6 km transmission line will be constructed along the access road and a substation will be constructed in the port area. A branch line for lighting will be constructed from the substation to the −10 m berth, transit shed and the administration building.

(8) Navigation Aids

Three navigation buoys, one for each corner, will be installed to show the boundaries of the −10 m dreging area for the visiting ships. The buoys will be of the 24 hour type using conventional batteries.

3. Construction Schedule

The construction schedule in keeping with the Short-Term Port Development Plan is shown in Table 8-8.

Under this construction plan, a natural conditions survey and engineering study will be conducted in 1st year 2nd year anu everything up to detail design, preparation of tender documents, tender evaluation and awarding will be completed in the meantime. Actual construction will be started in 3rd year and completed until the end of 4th year; thus, the total construction period is four years.

4. Pollution Control

Sea water pollution control is necessary to prevent hindrance to fishery activities because of the proximity of the fishing grounds of fishermen of Casambalangan Village and its vicinities.

To minimize turbidity of sea water due to dreging, grab dredgers will be adopted and dredged soil will be dumped by soil transportation barges in sufficiently deep waters away from the fishing grounds. To prevent sea water pollution due to land reclamation, steel sheet pile method will be used, land reclamation will be carried out after coffering by means of steel sheet piles, thereby preventing the reclamation material from blowing out into the sea.

In revetment work, vinyl sheets will be laid on the inside of the stone revetment to prevent the outflow of land reclamation material and the penetration of sewage into the sea.

As for air pollution, no special countermeasures are considered because construction equipments emitting smoke will be hardly used.

As noise pollution, construction equipment operating during the construction period may cause noise but no special countermeasures are planned because the dwellings exist far from the construction site and because there will be no night work.

5. Cost Estimate

The detailed construction cost for wharf type under the Short-Term Port Development Plan is shown in Table 8-9.

The conditions of the cost estimate are as follows:

1) Prices are indicated in Philippine Pesos (₱) based on prices in 1981.
2) Exchange rate used: U.S.$1.0 = ₱ 7.95 = ¥239.00
3) No customs duties for imported construction materials and imported construction equipments are anticipated.
4) As for taxes, only sales tax for domestic materials is anticipated.
5) 15% is anticipated as physical contingency.
6) No price contingency is anticipated.
7) As for foreign currency, construction materials that must be imported from abroad, rentals and mobilization cost for large construction equipment difficult to procure in the Philippines, wage for foreign skilled workers with special technical capabilities and the imported raw material cost included in Philippine products are anticipated.
8) The cost of natural conditions survey and engineering study and supervision are included in the Engineering Fees.

Table 8-8 Construction Schedule for Short-Term Port Development Plan

Item				1st Year						2nd Year						3rd Year						4th Year					
No.	Description	Unit	Quantity	2	4	6	8	10	12	2	4	6	8	10	12	2	4	6	8	10	12	2	4	6	8	10	12
1	Dredging	m^3	750,000														■	■	■	■	■	■	■	■	■	■	
2	Sand Replacement	m^3	70,000															■	■	■	■	■					
3	Steel Sheet Pipe Piling	pcs	242																			■					
4	Steel Sheet Piling	pcs	667																				■				
5	Tie Rod	set	121																				■	■			
6	Concrete Work	m^3	1,030																					■	■		
7	Land Reclamation	m^3	210,000																■	■	■	■	■	■			
8	North Revetment	m	90																	■	■	■	■				
9	South Revetment	m	180																			■	■	■			
10	Transit Shed	m^2	3,600																			■	■	■	■	■	
11	Administration Building	m^2	300																					■	■	■	
12	Port Road	m^2	12,400																							■	■
13	Access Road	m^2	11,200																					■	■		
14	Drainage, Light & Fence	sum	1																							■	■
15	Fender & Bollard	sum	1																							■	■
16	Navigation Aids	sum	1																							■	
17	Mobilization/Demobilization	sum	1													■	■				■	■				■	■
18	Engineering Survey	sum	1					■	■	■	■																
19	Engineering Study	sum	1							■	■	■	■	■													
20	Engineering Supervision	sum	1													■	■	■	■	■	■	■	■	■	■	■	■

Table 8-9 Construction Cost for Short-Term Port Development Plan

Item No.	Description	Unit	Quantity	Unit Price (₱)			Amount (1,000 ₱)		
				L.C	F.C	Total	L.C	F.C	Total
1	Dredging	m^3	750,000	2.7	24.3	27	2,025	18,225	20,250
2	−10 m Wharf	m	200	39,910	113,590	153,500	7,982	22,718	30,700
3	Revetment	m	270	5,077	5,077	10,154	1,371	1,371	2,742
4	Navigation Aids	sum	1	–	–	–	250	250	500
5	Land Reclamation	m^3	147,000	10	15	25	1,470	2,205	3,675
6	Transit Shed	m^2	3,600	1,280	320	1,600	4,608	1,152	5,760
7	Administration Building	m^2	300	1,280	320	1,600	384	96	480
8	Road & Pavement	m^2	18,600	195	22	217	3,627	409	4,036
9	Open Shed	m^2	4,800	88	22	110	422	106	528
10	Vehicles	sum	1	–	–	–	0	208	208
11	Miscellaneous Works	sum	1	–	–	–	1,973	1,090	3,063
12	Mobilization/Demobilization	sum	1	–	–	–	1,086	9,776	10,862
13	Sub Total						25,198	57,606	82,804
14	Sales Tax	sum	1				1,809	0	1,809
15	Engineering (5%)	sum	1				2,034	3,052	5,086
16	Physical Contingency (15%)	sum	1				4,085	9,099	13,184
17	Grand Total						33,126	69,757	102,883

Table 8-10 Cost Distribution for Short-Term Port Development Plan

Unit: ₱1,000

Item				1st Year			2nd Year			3rd Year			4th Year			Grand Total		
No.	Description	Unit	Quantity	L.C	F.C	Total	L.C	F.C	Total	L.C	F.C	Total	L.C	F.C	Total	L.C	F.C	Total
1.	Dredging	m^3	750,000							1,013	9,112	10,125	1,012	9,113	10,125	2,025	18,225	20,250
2.	−10 m Wharf	m	200							2,912	1,122	4,034	5,070	21,596	26,666	7,982	22,718	30,700
3.	Revetment	m	270							373	373	746	998	998	1,996	1,371	1,371	2,742
4.	Navigation Aids	Sum	1										250	250	500	250	250	500
5.	Land Reclamation	m^3	147,000							735	1,102	1,837	735	1,103	1,838	1,470	2,205	3,675
6.	Transit Shed	m^2	3,600										4,608	1,152	5,760	4,608	1,152	5,760
7.	Administration Building	m^2	300										384	96	480	384	96	480
8.	Road & Pavement	m^2	18,600										3,627	409	4,036	3,627	409	4,036
9.	Open Shed	m^2	4,800										422	106	528	422	106	528
10.	Vehicle	Sum	1										0	208	208	0	208	208
11.	Miscellaneous Works	Sum	1							1,082	811	1,893	891	279	1,170	1,973	1,090	3,063
12.	Mobilization/Demobilization									760	6,843	7,603	326	2,933	3,259	1,086	9,776	10,862
13.	Sub Total									6,875	19,363	26,238	18,323	38,243	56,566	25,198	57,606	82,804
14.	Sales Tax	Sum	1							459	0	459	1,350	0	1,350	1,809	0	1,809
15.	Engineering (5%)	Sum	1	420	105	525	568	707	1,275	523	1,120	1,643	523	1,120	1,643	2,034	3,052	5,086
16.	Physical Contingency (15%)	Sum	1	63	16	79	85	106	191	1,110	3,072	4,182	2,827	5,905	8,732	4,085	9,099	13,184
17.	Grand Total			483	121	604	653	813	1,466	8,967	23,555	32,522	23,023	45,268	68,291	33,126	69,757	102,883

Table 8-11 Construction Schedule for Master Plan

No.	Item			1980												1990				
	Description	Unit	Quantity	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99
1	−10 m General Cargo Berth	m	425			■	■										■	■		
2	−7.5 m General Cargo Berth	m	260								■	■								
3	−7.5 m Container Berth	m	170																■	■
4	−5.5 m General Cargo Berth	m	90										■							
5	−3.5 m Fishers Berth & Jetty	m	1,030														■	■	■	
6	−3.5 m Small Craft Berth	m	410							■	■									
7	Petroleum Jetty	m	130																■	■
8	Revetment	m	810			■	■				■	■							■	■
9	Dredging	m^3	2,040,000			■	■				■	■					■	■		
10	Reclamation	m^3	2,500,000			■	■				■	■					■	■		
11	Transit Shed	m^2	11,100				■						■							■
12	Administration Building	m^2	750				■						■							■
13	Port Road	m^2	53,700				■						■							■
14	Engineering Survey	sum	1	■				■						■						
15	Engineering Study	sum	1		■				■						■	■				
16	Engineering Supervision	sum	1			■	■			■	■	■	■				■	■	■	■

Note:–Starting year of above construction schedule will be assumed in 1983.

Table 8-12 Construction Cost for Master Plan

Item No.	Description	Unit	Quantity	Unit Price (₱)	Amount (1,000₱)
1	−10 m Berth	m	425	153,500	65,238
2	−7.5 m Berth	m	430	100,900	43,387
3	−5.5 m Berth	m	90	67,300	6,057
4	−3.5 m Berth	m	985	56,900	56,047
5	−7.5 m Petroleum Jetty	m	130	100,900	13,117
6	Fishery Jetty	m	455	38,700	17,609
7	Breakwater	m	170	41,800	7,106
8	Revetment	m	1,110	47,300	52,503
9	Dredging	m^3	2,040,000	27	55,080
10	Reclamation	m^3	2,640,000	25	66,000
11	Transit Shed	m^2	11,100	1,600	17,760
12	Open Shed	m^2	40,000	110	4,400
13	Building	m^2	750	4,200	3,150
14	Road & Pavement	m^2	56,000	217	12,152
15	Green Area	m^2	42,000	40	1,680
16	Mobilization/Demobilization	sum	1		32,600
17	Miscellaneous Works	sum	1		18,500
	Total				472,386
	Sales Tax	sum	1		13,230
	Physical Coutingency (15%)	sum	1		70,860
	Engineering Fee (5%)	sum	1		29,324
	Grand Total				585,800

CHAPTER 9. ECONOMIC ANALYSIS

CHAPTER 9. ECONOMIC ANALYSIS

9-1 General

1. Outline

As already stated, the Region II region is currently one of the less developed area in the country in spite of its immense potentialities. It seems that one of the causes is due to lack of sufficient port facilities in the region. Since producers and consumers cannot use any nearby port they are left in a position of relying on trucking or else having to use port of Manila which is 500 km away. As a result, because producers and consumers bear excessive costs for transportation, their market competitiveness low and growth impossible, this is a primary factor hindering progress of the region.

Thus, the full-fledged development of Port of Irene aims at serving as a base for commodity flow, primarily for handling cargo within the region with the aim to realize low and efficient transportation. The second aim is to make Port of Irene a basis for growth of the region and to promote the regional development.

As a result, this project will have an immensely large impact on the development of the Region II. However, the range of quantitative economic analysis covered in this chapter is very limited as shown below. Further, although this project is formulated with 2000 as the target year for development, analysis in this chapter limits its scope to the Short-Term Port Development Plan projected on the basis of the demand forecast for 1987.

2. Comparative Alternative Plan

In conducting this analysis, various possibilities were discussed for what might be used as a comparative alternative plan, taking into consideration the trends in cargo transportation within Luzon, the relationship with port of Aparri and the situation of the road network.

Eventually, a comparative alternative plan for the case of study is that, as seen in many examples, investment is not made for this project. In other words, a cost-benefit analysis will be conducted for the difference caused by cases of "with the project" and "without it". Even in this case, however, it is assumed that the incomplete 66-m section of the existing pier and the road between Dugo and San Vicente will be completed by 1987.

Consideration must be paid that this project is not intended to simply enlarge the facilities. Even at present, Port of Irene has the best facilities in the region, but it handles only about 20,000 tons of cargo a year. One of the cause is the condition of the road between Dugo and Casambalangan. It seems, however, that the main cause is the fact that Port of Irene has only a berthing facility as a public port. That is, since Port of Irene does not have general functions as a port, the shippers or consignees of general cargo, except for specified cargo, cannot use the port at present even if they wish to do so.

Therefore, only with the implementation of this project for the full-fledged development of the port, can the port handle the potential cargoes in the region estimated from the demand forecast. In short, this project should not be regarded as one simply for the enlargement of facilities, but rather for the development of a new port substantially.

3. Cargo Volume Handled

Table 9-1 shows the volume of cargo in the cases of "with the port" and "without the port" on the basis of the above concept. The volume of cargo handled at existing ports, e.g., Aparri, Claveria, was taken into account in estimating the total volume in the table. Further, the volume of cargo is estimated to increase at an annual rate of 8.8%, reaching its limit in 1989.

Even without the implementation of this projet, since the road to Port of Irene will be complete and CASUCO's sugar shed and molasses storage and shipping facilities exist, the estimated volume of sugar, molasses and logs which is the current main item can be handled at the port. Accordingly, since no change will occur to three items, sugar, molasses and logs, either with or without the project, they will be excluded from examination below.

Table 9-1 Cargo Volume

(1,000 tons)

	Item	1987		1988		1989	
		Foreign	Domestic	Foreign	Domestic	Foreign	Domestic
Cargo Voume in with caso	Lumber	17	33	18	36	19	39
	Plywood/Veneer	29	32	32	35	35	38
	Cement	0	5	0	5	0	5
	Fertilizer	20	0	22	0	24	0
	Palay	40	0	42	0	45	0
	Others	7	5	8	7	9	9
		(113)	(75)	(122)	(83)	(132)	(91)
	Sub-total	188		205		223	
Cargo Volume in Without Case	Sugar	22	0	24	0	26	0
	Molasses	8	0	9	0	10	0
	Logs	10	20	11	21	12	22
		(40)	(20)	(44)	(21)	(48)	(22)
	Sub-total	60		65		70	
	Total	153	95	167	104	184	113
		248		270		293	

9-2 Estimate of Benefits

1. Kinds of Benefits

The purpose of the development of Port of Irene is to provide a base for commodity flow in Region II, thereby improving transport conditions and facilitating trade, ultimately serving as the core of the regional development. In more concrete terms, the following may be estimated as the main economic benefits.

1) Reduction of transportation costs

Since there are no full-fledged port facilities in the Region II, cargo transportation is mostly dependent upon relatively costly trucking. Since inexpensive marine transportation can be fully made use of with the implementation of this project, transportation costs can be reduced.

2) Effect on regional development

Firstly, those port-related businesses such as cargo handling, warehousing and transport and service industry move into the area adjacent to the port with the implementation of this project. This will be followed by the establishment of foreign trade-related industries, including the "Export Processing Zone" being planned. Further, production in agriculture, forestry and fishery will be facilitated and the exploitation of rich natural resources will be possible.

3) Effect on Increasing Opportunities of Employment and Incomes of Inhabitants

With the industrial location and the exploitation of resources resulting from the development of Port of Irene, employment opportunities for local residents will increase. Moreover, with the promotion of production in the primary industries and increases in productivity of added value due to the establishment of secondary and tertiary industries, the income of local residents will increase.

4) Promotion of trade with East and Southeast Asia

With the implementation of this project, the Region II will have closer relations with China, Korea, Japan and the countries of Southeast Asia, promoting foreign trade in the region because of the geographical superiority of Port of Irene in Luzon.

Moreover, price competitiveness of goods due to reduced transportation costs will also promote foreign trade.

5) Strengthening of regional transportation capacity and rationalizing of transport system

The development of Port of Irene will promote shipping activities capable of carrying out mass transportation to amply deal with increasing production and consumption in the region. It will also contribute to the formation of a marine transport system, which is important for an archipelago nation such as the Philippines, contributing to the realization of cheap and effective means of transportation.

Of the above items, quantitative analysis will be made below with regard to "1) Reduction of transportation costs" as measurement is possible for this item.

Table 9-2 Saw Mill Production

Point	Daily Rate Capacity (1979)	Ratio of Production Capacity	Ratio of Shipment Volume
Tuguegarao	40,000 BD. FT	26.5%	30%
Camalaniugan	11,000	73.5	70

(Source: CIADPO)

Thus Tuguegarao and Camlaniugan can be selected as origin points of wood products with the former accounting for 30% of the total shipments in Table 9-1 and the latter 70%.

ii) Cement

The volume of cement to be handled at Port of Irene in the demand forecast is based on the consumption in the limited area around the port. Therefore, Gonzaka is selected as the destination since it can function as a base for distribution, being closest to Port of Irene.

iii) Palay

Table 9-3 shows some indicators of palay production based on the data obtained. These figures show that palay is produced mainly in Isabela and Cagayan provinces in Region II. Two origin points for palay are selected for the following reasons.

1) Cagayan Province produces sufficient quantity of palay.
2) It seems that the closer the origin point is to Port of Irene, the stronger the port's attraction for the cargo will be.
3) Tuguegarao is not only the capital of Cagayan Province but is the center for the entire Region II.
4) Tuguegarao is thus to be regarded as the starting point of palay export in view of the above three factors.

However, since the above figures indicate that Isabela is the center of palay production, Ilagan, the capital of Isabela Province, is also to be added as a supplementary point.

Thus the following two points are to be the origins with the ratios.

Tuguegaro	90%
Ilagan	10%

Table 9-3 Indicators of Palay Production in Region II

Province	Farmers engage in agriculture	Farmers engage in rice production	Area devoted to rice production	Palay production
			has.	t.
Cagayan	91,455 (29%)	44,386	94,734 (22%)	311,287 (38%)
Isabela	102,181 (32%)	60,114	135,350 (31%)	–
Nueva Vizcaya	36,785	–	–	–
Kal. Apayao	18,508	–	–	–
Quirino	14,103	–	–	–
Ifugao	37,326	–	–	–
Batanes	18,127	–	–	–
Total	318,485 (100%)	–	432,600 (100%)	812,880 (100%)

Source: CIADPO (1977, 1980)

iv) Fertilizer

Since the volume of fertilizer required in Cagayan Province is to be imported throuth Port of Irene, the following two points are selected as destinations in the Province.

Tuguegarao and Aparri are located on the Pan Philippine Highway, serving as the trunk road for the Province, and are functioning as the bases for distribution. Since there are no appropriate data for ascertaining the ratio of shipment of fertilizer to each area, 50% may be set for each area, judging from the condition of distribution and the industrial structure. However, the ratios will be set according to the population ratios of the two areas.

Table 9-4 Comparison of Population in Both Cities

Tuguegarao	73,529 persons	62%
Aparri	45,047 persons	38%

Table 9-5 Comparison of Population Including Surrounding Areas

Tuguegarao Area	Tuguegarao	73,529 persons	
	Solana	46,064 persons	
	Penablanca	24,885 persons	
	Total	144,478 persons	64.4%
Aparri Area	Aparri	45,047 persons	
	Camalaniugan	15,078 persons	
	Lal-Lo	26,843 persons	
	Total	86,968 persons	37.6%

2. Benefit from reduction of transportation costs

(1) Changes in the cargo flow

As previously stated, economic activity of the Region II is largely dependent upon Manila through the Pan Philippine Highway. As a result, transportation in the region is mainly carried out by trucking on the highway. Only logs, petroleum product go through Port of Aparri, Claveria and Irene. In other words, most of the cargo in this region goes through Manila in both foreign and domestic trade.

However, with the implementation of this project, Port of Irene can be used for cargoes other than logs, resulting in reduction of transportation costs. Therefore, the implementation of this project will affect the transportation route of the cargoes in the hinterland.

Of the items in Table 9-1, the project will not affect the route for sugar, molasses and logs, since they can go through Port of Irene either with or without this project.

On the other hand, wood products (lumber, plywood/veneer), cement, fertilizer, palay and "others", which go through port of Manila without the project, can go through Port of Irene only with the project. Accordingly, the transportation route will change for these goods with the implementation of the project.

The possible changes in transportation route will be assumed on the basis of the following premises.

1) Export/import cargo goes through port of Manila without the project.

2) Manila is both the starting point and the terminus of inbound/outbound cargo.

3) As for transport routes, as a rule, those for lower transport costs are to be selected on the basis of economic principles.

4) The points of the origins and destinations of the cargo in the hinterland are to be set as below based on Chapter 5 – Demand forecast.

i) Wood products (lumber, plywood/veneer)

The volume of wood products to be handled at Port of Irene is to be confined to that produced in Cagayan Province. The points and quantities of the origins of wood products in the province can be set on the following conditions.

The main saw mills are located near Tuguegarao and Camalaniugan facing the Pan Philippine Highway with the capacity as shown below.

Thus the ratios of shipment of fertilizer to the areas can be set to be 60% for Tuguegarao and 40% for Aparri.

v) Others

For the same reasons as above, Tuguegarao and Aparri are to be destinations with the ratios of 60% and 40% respectively.

On the basis of the above conditions, the transport routes either with or without the project can be assumed as shown in Figure 9-1. The cargo volume for each transport route can also be estimated as shown in Table 9-6 from Table 9-1.

According to Figure 9-1, the distance of land transportation will be greatly reduced for foreign trade cargo by using Port of Irene.

As for domestic trade cargo, the form of transportation will change to land transportation to a combination of land and marine transportation.

(2) Estimate of the reduction in transport costs

The benefit of transportation cost reductions consists of the difference between the cost necessary for the means of transportation on the route in the "with the project" case, namely the case where this project exists, and the cost necessary in the "without it" case, namely the case where the project does not exist, as determined on the basis of Fig. 9-1 and Table 9-6 assumed in the preceding section.

Estimate of transport costs per ton of cargo is to be carried out on the basis of the data provided by NTPP, PPA, shipping and transport companies as follows.

1) Land transportation is to be provided by trucks, and the costs will be calculated on the basis of the costs per ton-kilometer by used 3-axle trucks.

2) Marine transportation is to be provided by domestic freighter, and the costs will be calculated on the basis of the costs per ton-kilometer at sea by used 3,000 DWT class freighter and ship's staying costs per ton of cargo at both ends. To these, cargo handling costs and port costs are to be added.

3) The foreign freight in both cases, i.e., with or without the project, is to be the same. The port costs and cargo handling costs per ton of cargo are also to be the same within the Philippines.

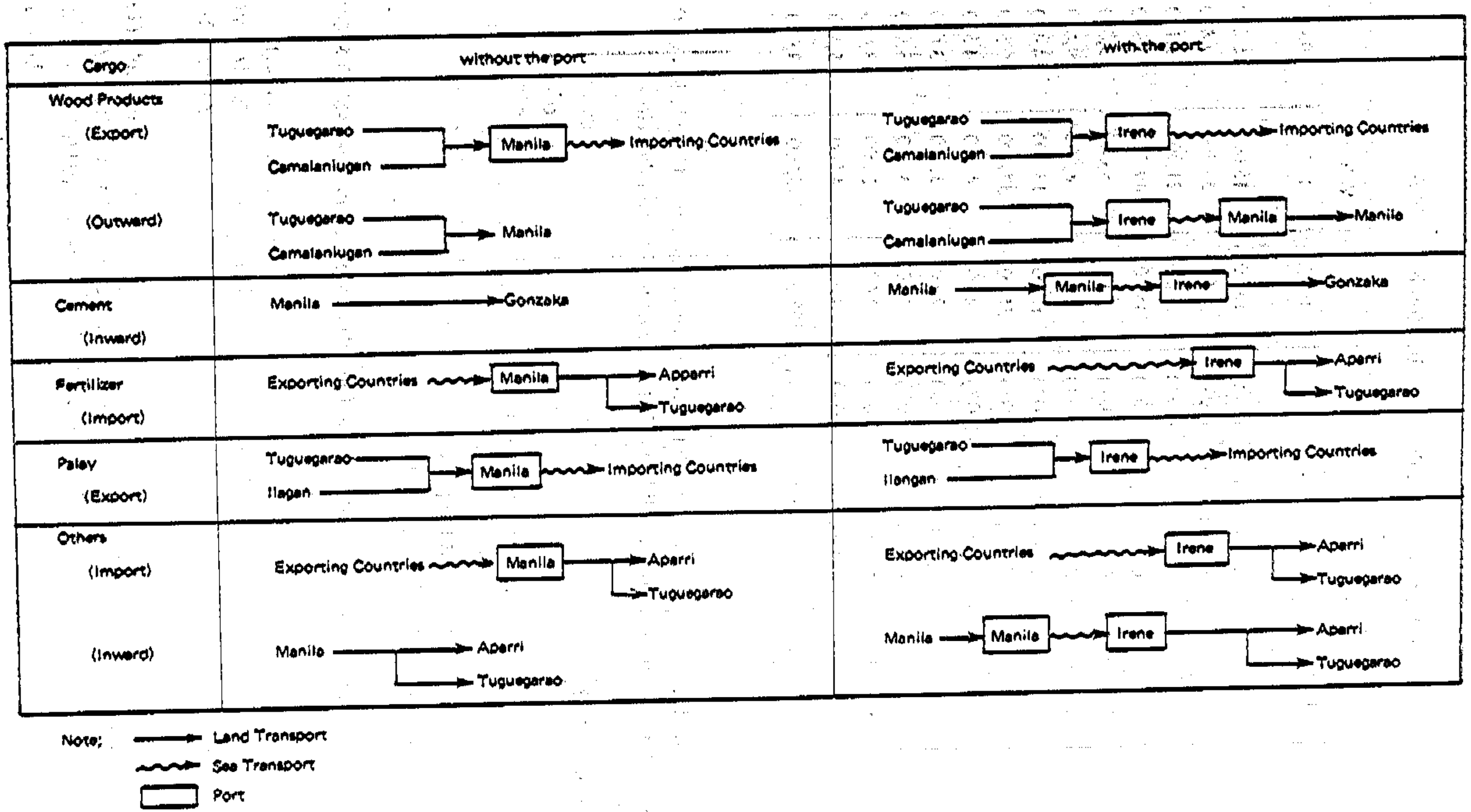


Fig. 9-1 Assumption of Cargo Transport Route

Table 9-6 Commodity Flow by Route

Cargo	Foreign or Domestic	Districts		Volume		
				1987	1988	1989
				t	t	t
Wood Products	Export	Tuguegarao	(30%)	13,800	15,000	16,200
(Lumber Plywood/Veneer)		Camalaniugan	(70%)	32,200	35,500	37,800
	Outward	Tuguegarao	(30%)	19,500	21,300	23,100
		Camalaniugan	(70%)	45,500	49,700	53,900
Cement	Inward	Gonzaka	(100%)	5,000	5,000	5,000
Fertilizer	Import	Aparri	(40%)	8,000	8,800	9,600
		Tuguegarao	(60%)	12,000	13,200	14,400
Palay	Export	Guguegarao	(90%)	36,000	37,800	40,500
		Ilagan	(100%)	4,000	4,200	4,500
Others	Import	Aparri	(40%)	2,800	3,200	3,600
		Tuguegarao	(60%)	4,200	4,800	5,400
	Inward	Aparri	(40%)	2,000	2,800	3,600
		Tuguegarao	(60%)	3,000	4,200	5,400
TOTAL				188,000	205,000	223,000

The transport costs for each section are calculated as shown in Table 9-7. Calculation of the reduction on transport costs for each route will be made according to the formula below.

$$B = V \times (C_1 - C_2)$$

Here, B = reduction of transport cost (benefit)
V = cargo volume
C_1 = transport costs without the project
C_2 = transport costs with the project

The reduction on transport costs calculated with the formula above is shown in Table 9-8.

Table 9-7 Estimate of Transportation Cost (₱/ton of Cargo)

Distance			Trucks	Cargo Ships
Tuguegarao	496 Km	Manila	298	
Camalaniugan	585	Manila	351	
Aparri	595	Manila	357	
Gonzaka	615	Manila	369	
Tugnegarao	144	Irene	86	
Camalaniugan	52	Irene	31	
Aparri	62	Irene	37	
Gonzaka	22	Irene	13	
Ilagan	220	Irene	132	
Ilagan	420	Manila	252	
Manila	10	Port of Manila	6	
Port of Irene	775	Port of Manila		203

Table 9-8 Economy of Transportation Cost

(₱1,000)

Item	1987	1988	1987
Wood Products	18,325	19,946	21,556
Cement	735	735	735
Fertilizer	5,092	5,601	6,110
Palay	8,076	8,480	9,086
Others	2,013	2,360	2,707
Total	34,241	37,122	40,204

9-3 Estimate of Cost

The costs to be analyzed here are those for the construction required by the Short-Term Port Development Plan, and those necessary for the administration, operation and maintenance of the Port.

(1) Construction costs

According to Chapter 8, the construction cost under the Short-Term Port Development Plan is estimated ₱102,883,000. Table 9-9 gives the breakdown of the costs by year for the four-year period.

Table 9-9 Construction Costs

(P1,000)

1st Year	2nd Year	3rd Year	4th Year	Total
604	1,466	32,522	68,291	102,883

(2) Administration, operation and maintenance costs

Personnel costs, administrative costs, maintenance and repair costs for Port of Irene, and directly related costs, i.e., cargo handling costs and pilotage costs, are to be added up. As regards these costs, it normally suffices to add up those corresponding to the cargo volume acruing from this project. In the present case, however, only cargo handling costs will be related to that cargo volume while the other costs for Port of Irene as a whole will be added in.

1) Personnel costs and administrative costs

Personnel costs and administrative costs for Port of Irene will be calculated according to the method described in the next chapter on financial analysis.

2) Maintenance and operation costs

Certain ratios of construction and purchase costs are to be estimated as annual maintenance and operation costs for Port of Irene as shown in Table 9-10. The total is to increase annually by 10% from the second year of operation of the project facilities in response to the increasing cargo volume.

Table 9-10 Maintenance and Operation Cost

Facilities	Rates (%)
Mooring Basin	3.0
Wharf	1.0
Revetment	0.2
Navigation Aids	3.0
Transit Shed	1.0
Administrative Bldg	3.0
Road/Pavement	1.0
Electrical Installation	2.0
Open Shed	3.0
Motor Vehicle	15.0
Access Road	1.0

3) Cargo handling costs and pilotage costs

As for cargo handling costs, ₱20 per ton of cargo handled is to be estimated. Pilotage costs consist of personnel cost and miscellaneous expenses to cover 3 pilots, 2 crew members and 1 pilot boat.

Table 9-11 Administration & Operation Cost

(₱1,000)

	1987	1988	1989
Personnel & Administrative Cost	718	832	947
Maintenance & Operation Cost	1,709	1,792	1,883
Cargo Handling & Pilotage Cost	4,079	4,419	4,479
Total	6,506	7,043	7,309

9-4 Prices

(1) 1981 prices

The costs and benefits already calculated are shown in 1981 prices as the study is conducted in that year.

(2) Economic prices

Since the above project costs are market prices, it is desirable to reevaluate them in terms of economic prices in order to carry out economic analysis. In the present analysis, however, exclusion of transfer items and partial application of shadow price will be adopted.

1) Exclusion of transfer items

Of the construction costs given in Chapter 8, the costs of imported materials and services forming the foreign currency portion do not include import duties. On the other hand, the domestic currency portion includes sales tax, which is merely a transfer item appearing without consuming resources in a national economy. Therefore, it is not necessary to include it in the project costs.

2) Shadow pricing

In general, distortion in the price mechanism of goods and service on the market in developing countries can be seen most clearly in two factors: foreign exchange rate and the price of unskilled labor. Therefore, in order to evaluate them appropriately from the viewpoint of a national economy, shadow pricing will be adopted.

i) Foreign exchange rate

The exchange rate in the Philippines does not necessarily reflect the effective rate, i.e., the effective value of foreign currencies is higher than the official rate. Therefore, if the project costs are calculated on the basis of the official rate, they will be underestimated. NEDA thus recommends the application of a shadow price about 1.15 to all foreign exchange components arising from national projects. Accordingly the foreign currency portion will be multiplied by 1.15 in this analysis to bring the figures closer to actual domestic prices.

ii) Costs of unskilled labor

Of the wages of workers included in the project costs, the market wage rate which is actually paid is applied to skilled labor, assuming that the market mechanism is functioning due to its shortage. As for unskilled labor, however, since there seems to be an excess supply of such labor, actual wage rate will exceed the opportunity cost, thus requiring the rate adjustment.

According to the guideline provided by NEDA, the economic price of unskilled labor should be within 80% of the official price. In the present analysis, therefore, the wage rate of unskilled labor will be adjusted by adopting a shadow wage rate of 0.8.

9-5 Economic Evaluation

(1) Internal Rate of Return (IRR)

There are several indices for evaluating economic returns of a project. Here, however, the economic returns are evaluated in terms of the Internal Rate of Return (IRR). The IRR is obtained by the following equation.

$$\sum_{i=0}^{n-1} \frac{Bi - Ci}{(1 + IRR)^i} = 0$$

Here, n = Period of calculation of IRR

B_i = Amount of benefit at i-th year

C_i = Amount of costs at i-th year

Assuming the project life in this case to be 20 years, the calculation period is to be from 1983, the initial year of investments, to 2002. Service life varies from facilities to facilities. Although the average service life will be 38 years if weighted by costs, the residual value will not be taken into consideration.

The result of the computation of IRR by tabulating the benefits and the costs, as in Table 9-12, in accordance with the above is 25.2%.

(2) Evaluation

There are various views concerning the percentage of IRR to make a judgement whether a project is feasible or not. The leading view is that the project is feasible if the IRR exceeds the opportunity cost of capital, which is said to be 15% in the Philippines.

According to this standard, the IRR of 25.2 is a fairly good figure, indicating that this project is feasible. However, in order to make sure, several cases will be assumed below as an attempt in sensitivity analysis.

In this chapter "without the project" was selected as the alternative plan, taking the view that "with the project" is not merely an enlargement of facilities but is almost the development of a new port. The cargo volume in both "with and without" cases was estimated as shown in Table 9-1. Moreover, changes in the flow of wood products, cement, fertilizer, Palay and "others" were supposed. As a result, it was assumed that these goods would go to Manila in the case "without the project" and only in the case "with the project" would they be handled at Port of Irene.

Only with the full-fledged development of Port Irene, can the port be used not only for specific goods but for general goods. However, since the completion of the Dugo-San Vicente road is one of the premises, this assumption may be somewhat immoderate. Therefore, if a certain proportion of those goods going to Manila in "without the project" is allocated to Port of Irene, the difference in cargo volume between the two cases is reduced. The calculation of the IRR will be made by this method below so as not to overestimate the benefits in the case with the project.

1) Second case (The preceding case is to be considered as the First case)

If the cargo volume bound for Manila in "without the project" is reduced by 10% and this 10% cargo volume is handled at Port of Irene, the IRR will be 22.4% according to Table 9-13.

2) Third case

If the cargo volume bound for Manila in "without the project" is reduced by 20% and this 20% cargo volume is handled at Port of Irene, the IRR will be 19.5% according to Table 9-14.

3) Fourth case

If the cargo volume bound for Manila in "without the project" is reduced by 30% and this 30% cargo volume is handled at Port of Irene, the IRR will be 16.5% according to Table 9-15. In this case, the total cargo volume handled at Port of Irene will approach the marginal capacity of the existing pier.

(3) Conclusion

Arranging the above four cases in Table 9-16, it shows that the IRR will be 16.5% even in the most unfavorable Fourth case with the smallest difference in cargo volume between "with and without the project". Even this figure is above the opportunity cost of capital in the Philippines. Therefore, it can be concluded that this project is feasible from the viewpoint of the national economy.

Table 9-12 Cost-Benefit Table Case 1 IRR = 25.2%

(P1,000)

No.	Year	COST (1)			BENEFIT (2)	DIFFERENCE	PRESENT VALUE
		Construction & Purchase	Operation & Maintenance	Total	Reduction of Transport Cost	(2) – (1)	Discount Rate = 25.2%
1	1983	618		618		–618	–618
2	1984	1,583		1,583		–1,583	–1,264.38
3	1985	35,551		35,551		–35,551	–22,680.01
4	1986	72,620		72,620		–72,620	–37,003.54
5	1987		6,506	6,506	34,241	27,735	11,287.84
6	1988		7,043	7,043	37,122	30,079	9,777.81
7	1989		7,309	7,309	40,204	32,895	8,540.91
8	1990		7,309	7,309	40,204	32,895	6,821.81
9	1991		7,309	7,309	40,204	32,895	5,448.73
10	1992		7,309	7,309	40,204	32,895	4,352.02
11	1993		7,309	7,309	40,204	32,895	3,476.05
12	1994		7,309	7,309	40,204	32,895	2,776.4
13	1995		7,309	7,309	40,204	32,895	2,217.57
14	1996		7,309	7,309	40,204	32,895	1,771.22
15	1997		7,309	7,309	40,204	32,895	1,414.72
16	1998		7,309	7,309	40,204	32,895	1,129.96
17	1999		7,309	7,309	40,204	32,895	902.53
18	2000		7,309	7,309	40,204	32,895	720.87
19	2001		7,309	7,309	40,204	32,895	575.77
20	2002		7,309	7,309	40,204	32,895	459.88
Total		110,372	115,875	226,247	634,219	407,972	108.16

Table 9-13 Cost-Benefit Table Case 2 IRR = 22.4%

(₱1,000)

No.	Year	COSTS (1) Construction & Purchase	COSTS (1) Operation & Maintenance	COSTS (1) Total	BENEFIT (2) Reduction of Transport Cost	DIFFERENCE (2) – (1)	PRESENT VALUE Discount Rate = 22.4%
1	1983	618		618		–618	–618
2	1984	1,583		1,583		–1,583	–1,293.3
3	1985	35,551		35,551		–35,551	–23,729.52
4	1986	72,620		72,620		–72,620	–39,601.53
5	1987		6,130	6,130	30,817	24,687	10,998.73
6	1988		6,633	6,633	33,410	26,777	9,746.64
7	1989		7,163	7,163	36,184	29,021	8,630.26
8	1990		7,163	7,163	36,184	29,021	7,050.87
9	1991		7,163	7,163	36,184	29,021	5,760.51
10	1992		7,163	7,163	36,184	29,021	4,706.3
11	1993		7,163	7,163	36,184	29,021	3,845.02
12	1994		7,163	7,163	36,184	29,021	3,141.35
14	1995		7,163	7,163	36,184	29,021	2,566.47
14	1996		7,163	7,163	36,184	29,021	2,096.79
15	1997		7,163	7,163	36,184	29,021	1,713.06
16	1998		7,163	7,163	36,184	29,021	1,399.56
17	1999		7,163	7,163	36,184	29,021	1,143.43
18	2000		7,163	7,163	36,184	29,021	934.18
19	2001		7,163	7,163	36,184	29,021	763.21
20	2002		7,163	7,163	36,184	29,021	623.54
Total		110,372	113,045	223,417	570,803	347,386	–122.43

Table 9-14 Cost-Benefit Table Case 3 IRR = 19.5%

(₱1,000)

No.	Year	COST (1) Construction & Purchase	Operation & Maintenance	Total	BENEFIT (2) Reduction of Transport Cost	DIFFERENCE (2) – (1)	PRESENT VALUE Discount Rate = 19.5%
1	1983	618		618		–618	–618
2	1984	1,583		1,583		–1,583	–1,324.69
3	1985	35,551		35,551		–35,551	–24,895.22
4	1986	72,620		72,620		–72,620	–42,555.19
5	1987		5,754	5,754	27,393	21,639	10,611.23
6	1988		6,223	6,223	29,698	23,475	9,633.1
7	1989		6,717	6,717	32,163	25,446	8,738
8	1990		6,717	6,717	32,163	25,446	7,312.13
9	1991		6,717	6,717	32,163	25,446	6,118.94
10	1992		6,717	6,717	32,163	25,446	5,120.45
11	1993		6,717	6,717	32,163	25,446	4,284.9
12	1994		6,717	6,717	32,163	25,446	3,585.69
13	1995		6,717	6,717	32,163	25,446	3,000.58
14	1996		6,717	6,717	32,163	25,446	2,510.94
15	1997		6,717	6,717	32,163	25,446	2,101.21
16	1998		6,717	6,717	32,163	25,446	1,758.33
17	1999		6,717	6,717	32,163	25,446	1,471.41
18	2000		6,717	6,717	32,163	25,446	1,231.3
19	2001		6,717	6,717	32,163	25,446	1,030.38
20	2002		6,717	6,717	32,163	25,446	862.24
Total		110,372	106,015	216,387	507,373	290,986	–22.27

Table 9-15 Cost-Benefit Table Case 4 IRR = 16.5%

(₱1,000)

No.	Year	COST (1) Construction & Purchase			BENEFIT (2) Redudion of Transport Cost	DIFFERENCE (2) – (1)	PRESENT VALUE Discount Rate = 16.5%
		Construction & Purchase	Operation & Maintenance	Total			
1	1983	618		618		–618	–618
2	1984	1,583		1,583		–1,583	–1,358.8
3	1985	35,551		35,551		–35,551	–26,193.89
4	1986	72,620		72,620		–72,620	–45,928.1
5	1987		5,378	5,378	23,969	18,591	10,092.51
6	1988		5,813	5,813	25,985	20,172	9,399.82
7	1989		6,271	6,271	28,143	21,872	8,748.49
8	1990		6,271	6,271	28,143	21,872	7,509.43
9	1991		6,271	6,271	28,143	21,872	6,445.86
10	1992		6,271	6,271	28,143	21,872	5,532.93
11	1993		6,271	6,271	28,143	21,872	4,749.3
12	1994		6,271	6,271	28,143	21,872	4,076.65
13	1995		6,271	6,271	28,143	21,872	3,499.27
14	1996		6,271	6,271	28,143	21,872	3,003.66
15	1997		6,271	6,271	28,143	21,872	2,578.25
16	1998		6,271	6,271	28,143	21,872	2,213.09
17	1999		6,271	6,271	28,143	21,872	1,899.65
18	2000		6,271	6,271	28,143	21,872	1,630.6
19	2001		6,271	6,271	28,143	21,872	1,399.66
20	2002		6,271	6,271	28,143	21,872	1,201.42
Total		110,372	98,985	209,357	443,956	234,599	–118.2

Table 9-16 Cargo Volume in 4 Cases

Case	Cargo Volume bound for Manila	Cargo Volume handled at Irene	IRR
1st Case	188,000	60,000	25.2%
2nd Case	169,200	78,800	22.4%
3rd Case	150,400	97,600	19.5%
4th Case	131,600	116,400	16.5%