INTRODUCTION

INTRODUCTION

CHAPTER 1 OUTLINE OF THE STUDY

1-1 Background and Progress

In response to the request of the Government of Sri Lanka, for technical cooperation for the port sector, the Government of Japan decided to perform study on the port improvement scheme, and a preliminary survey team was dispatched by the Japan International Cooperation Agency to the site in Sri Lanka for a period of 16 days in October 1978 in order to get a firm grasp on the key project concerned.

As a result of this study, it was recommended that the containerization of the Queen Elizabeth Quay of the Port of Colombo and the introduction of new cargo handling equipment should be urgently performed. In response to this, Mr. H. Wickramasinghe, the Additional Secretary to the Ministry of Trade and Shipping, visited Japan in May 1979 and a final agreement was made on the scope of work of this study between him and the Japan International Cooperation Agency.

Immediately after this, a survey team consisting of 9 members, 8 specialists and an officer representing the Japan International Cooperation Agency was organized, and conducted an in situ investigation for a period of one month from June to July in 1979. In consequence, the Sri Lankan side requested the team to submit a provisional report for the following reasons:

1) With respect to the cargo handling equipment to be introduced newly, it is desired that its outline is notified as soon as possible.

2) A Ports Authority is going to be organized newly on August 1st, 1979, and thus, exchange of views with the new organization is desirable.

3) So many organizations are related to or involved in the Colombo Port development that some adjustment is needed before the final preparation of the report.

Therefore, the original survey schedule was revised and a mission for the provisional report consisting of four survey members was dispatched for a period of 13 days from October to November 1979.

Also, since there were few data available on the soil properties for the areas in front of the Coaling Jetties and the Queen Elizabeth Quay of which modification to a container berth was proposed, it was determined that the Sri Lankan side would perform the soil exploration immediately. In respect to the soil exploration, Sri Lanka side also requested to the Japanese team to cooperate particularly in determining the points of exploration at the site. Accordingly, the team revised part of its original schedule, and two specialists from the team were dispatched to the site from November to December.

1-2 Objective and Outline of the Study

Objective and outline of the study prescribed in the S/W are indicated hereinafter.

1-2-1 Objective

The objective of the study is to carry out a study on the following items of the Port of Colombo.

(1) Urgent Improvement Plan (Short-term)

a. Adaptation of the Queen Elizabeth Quay to containerization.
b. Addition of urgently needed equipment/items.

(2) Master Plan (Long-term)

This plan will be made on a long term basis to secure the better utilization of the present port premises and to solve several problems of the existing Port.

1-2-2 Outline of the Study

(1) Urgent Improvement Plan

a. Forecast of cargo traffic including containerized cargoes based on the various economic development plans of Sri Lanka.
b. Determination of the scale of the container wharf.
c. Layout of facilities including cargo handling equipment on the container wharf.
d. Determination of number and type of additional cargo handling equipment for conventional type general cargo which are urgently needed to make good use of the existing port facilities.
e. Determination of any other equipment/items
f. Cost Estimates.
g. Economic and financial analyses of the items listed in 1-2-1, (1).

(2) Master Plan

a. Formulation of basic principles of the development of the Port.
b. Forecast of cargo traffic.
c. Determination of the development scale and layout of basic port facilities.
d. Formulation of the Master Plan with particular reference to the redevelopment of the Port including possibility of establishment of a new tanker berth and replacement of the present 17 midstream berths in Colombo Port by alongside quays/ finger piers.
e. Rough cost estimates.

1-3 Field Investigation

1-3-1 Methods of Investigation

Methods of investigation are generally classified into verbal, field observation and collection of informative materials. Names of the authorities and organizations visited by the team for hearing and collecting informative materials are listed below.

Ministry of Trade and Shipping
Ministry of Mahaweli Development
Ministry of Defence
Colombo Port Commission
Port (Cargo) Corporation
Division of Merchant Shipping
Ceylon Petroleum Corporation
Ceylon Shipping Corporation
Greater Colombo Economic Commission
Urban Development Authority
Central Freight Bureau of Sri Lanka
Ceylon Cement Corporation
Federation of Chambers of Commerce
Colombo Dockyard Ltd.
Prima Flour Mill Factory
Ceylon Association of Steamer Agents
Central Bank of Ceylon
Asian Development Bank (at Manila)

Field observation was conducted at the following places:
Port of Colombo
Port of Galle
Port of Trincomalee
Petroleum refinery

1-3-2 Survey Team

(1) Field investigation

The field investigation was conducted for a period of about one month from June 9th to July 8th, 1979. The members of the team are as follows:

Mr. Masao OHNO (Head)
Excecutive Director
The Overseas Coastal Area Development Institute of Japan (OCDI)

Mr. Ikuhiko YAMASHITA (Deputy Head)
Port Planning
Civil Engineer, OCDI

Mr. Kouki ZEN
Structural Design
Civil Engineer, OCDI

Mr. Kenichi SASAKI
Cost Estimates and Construction
Civil Engineer, OCDI

Mr. Katsuyoshi NABETA
Cargo Handling Equipment
Mechanical Engineer, OCDI

Mr. Hisanori KATO
Tanker Berth
Civil Engineer, OCDI

Mr. Tomoo ISHIWATA
Economic Analysis
Traffic Engineer, OCDI

Mr. Shoji KAZAMA
Financial Analysis and Port Operation
Financialist, OCDI

Mr. Takao KAIBARA
Co-ordinator to the Team
The Japan International Cooperation Agency (JICA)

One of the members, Mr. Kaibara returned to Japan on June 25th. In addition, Mr. Ohno, head of the team, and Mr. Yamashita visited the Asian Development Bank in Manila on their way home, were advised about the oil berths, collected information and returned to Japan on July 10th.

(2) Interim report

For the Interim report, a team was dispatched to Sri Lanka 13 days from October 22th to November 3rd in 1979. The members of the team are as follows:

Mr. Masao OHNO (Head)
Excecutive Director
The Overseas Coastal Area Development Institute of Japan (OCDI)

Mr. Ikuhiko YAMASHITA
Port Planning
Civil Engineer, OCDI

Mr. Katsuyoshi NABETA
Cargo Handling Equipment
Mechanical Engineer, OCDI

Mr. Takao KAIBARA
Co-ordinator to the Team
The Japan International Cooperation Agency (JICA)

(3) Soil exploration

Soil exploration was started on November 15th. One Japanese specialist joined from November 29th and another specialist from December 6th who then returned to Japan on 24th December. These two specialists are;

Mr. Ikuhiko YAMASHITA
Port Planning
Civil Engineer, OCDI

Mr. Kouki ZEN
Structural Design
Civil Engineer, OCDI

1-3-3 Counterparts

The Sri Lanka counterparts are shown below.

COLOMBO PORT COMMISSION	
Mr. D.L.I. Paktsun	Chief Engineer (Ports)
Capt. G.O. Henricus	Master Attendant
Mr. M. Ramanayake	Deputy Civil Engineer (Planning)
Mr. R.W. Wickramage	Deputy Chief Engineer (Mechanical)
Mr. E.A. Wijegunawardhana	Deputy Chief Engineer (Civil)
Mr. G.P. Weerasinghe	Supdt., Civil Engineer (Planning)
Mr. L.R. de Lanerolle	Supdt. Civil Engineer
PORT (CARGO) CORPORATION	
Mr. K.W. Dias	General Manager
Mr. C.D. Chinnakone	Chief Operations Manager
Mr. Kingsley Fernando	Engineering Manager
PETROLEUM CORPORATION	
Mr. P. Sivalingam	Deputy General Manager
Mr. Chandra de Silva	Operations Manager (Oil Facilities, Bunkering & Aviation)

1-3-4 Progress of Investigation

The progress of field investigation is as follows:

09th June (Sat.)	Tokyo to Colombo.
10th June (Sun.)	
11th June (Mon.)	Courtesy call at the Embassy of Japan. Courtesy call at the Ministry of Trade & Shipping. Starting-point-discussion with nine counterparts on the inception report and the schedule during the Team's stay in Sri Lanka.

12th June (Tue.) Courtesy call at and interview to the Federation of Chambers of Commerce & Industry.
Courtesy call at and interview to the Ministry of Finance & Planning.
Courtesy call at the Ministry of Defence.

13th June (Wed.) Courtesy call at and interview to the Urban Development Authority, Ministry of Local Government, Housing & Construction.
Port & East Lake Tour.
Discussion with Urban Development Authority officers on the urban area development problem mainly from the traffic point of view.

14th June (Thu.) Interview to the Ceylon Petroleum Corporation, Oil Dock.
Interview to the Ceylon Petroleum Corporation, Refinery at Sapugaskanda and Kolonnava Depot.

15th June (Fri.)

1. Planning Members (Mr. Ohno, Mr. Yamashita, Mr. Ishiwata & Mr. Kaibara)
   Courtesy call at and interview to the Greater Colombo Economic Commission.
   Courtesy call at and interview to the Ministry of Mahaweli Development.
2. Operation/finance Members (Mr. Nabeta and Mr. Kazama)
   Interview with Mr. Chinnakone, Chief Operation Manager P(C)C
3. Engineering members (Mr. Sasaki and Mr. Zen)
   Interview with Mr. Wijegunawardhana, Deputy Chief Engineer, CPC.
4. Tanker berth member (Mr. Kato)
   Interview with Mr. D. Mutucumarana, Chief Hydrographic Surveyor, CPC and to Mr. S.K. Malaviarachchi, Engineer Maritime, CPC.
   Interview with Mr. W.H. de Silva, Operation Manager, Ceylon Petroleum Corporation.

16th June (Sat.) Interview to the Colombo Dockyard Limited.

17th June (Sun.) Colombo to Trincomalee

18th June (Mon.) Trincomalee Port tour and interview to the Prima Flour Mill Factory (under construction)

19th June (Tue.) Trincomalee to Colombo.

20th June (Wed.)

1. Planning members (Mr. Ohno, Mr. Yamashita, Mr. Ishiwata and Mr. Kaibara)
   Interview to the Central Freight Bureau of Sri Lanka, Ministry of Trade & Shipping.

Interview to the Ceylon Shipping Corporation, Ministry of Trade & Shipping.
Interview to the Ceylon Association of Steamer Agents.
Interview to the Division of Merchant Shipping, Ministry of Trade & Shipping.

2. Operation/Finance Members (Mr. Nabeta and Mr. Kazama)
Interview with Mr. M.A. Nanayakkara, Assist. Supdt. and Mr. H.W. de Zoysa, Head Clerk Statistics, P(C)C.
Interview with Mr. A. Devagiri, Chief Financial Manager, P(C)C

3. Engineering Members (Mr. Sasaki and Mr. Zen)
Interview with Mr. Wijegunawardhana, Deputy Chief Engineer, CPC.
Visit to a quarry at Mahara.

4. Tanker berth member (Mr. Kato)
Interview with Mr. G.K. Paul, CPC
Interview with Mr. S. Kumarasive, Ceylon Petroleum Corporation.

21st June (Thu.) One day tour to the Port of Galle.

22nd June (Fri.)

1. Planning/finance members (Mr. Yamashita, Mr. Ishiwata and Mr. Kazama)
Interview to the Ceylon Cement Corporation.
Interview with Mr. A. Devagiri, Chief Financial Manager, P(C)C

2. Operation/tanker berth members (Mr. Nabeta and Mr. Kato)
Interview with Capt. G.O. Henricus, Master Attendant, CPC.

3. Operation member (Mr. Nabeta)
Interview with Mr. H.W. de Zoysa, Head Clerk Statistics, P(C)C

4. Tanker berth member (Mr. Kato)
Interview with Mr. J.A. Dias, Supdt. Civil Engineer, CPC

5. Engineering members (Mr. Sasaki and Mr. Zen)
Interview with Mr. Wijegunawardhana, Deputy Chief Engineer, CPC

6. Administrative members (Mr. Ohno, Mr. Yamashita, Mr. Ishiwata and Kaibara)
Report on the Study situation to the Embassy of Japan.

23rd June (Sat.) Data analyses and discussion in the Team.

24th June (Sun.) Mr. Kaibara left for Tokyo.

25th June (Mon.)

1. Planning/finance members (Mr. Yamashita and Mr. Kazama)
Interview with Mr. A. Devagiri, Chief Financial Manager, P(C)C

2. Planning/operation members (Mr. Ishiwata and Mr. Nabeta)
Interview with Mr. H.W. de Zoysa, Head Clerk Statistics, P(C)C

3. Planning/operation/finance members (Mr. Yamashita, Mr. Ishiwata, Mr. Nabeta and Mr. Kazama)
Discussion on the port tour on the 26th, 27th June with counterparts.

4. Engineering members (Mr. Sasaki and Mr. Zen)
   Preparation for the port tour on the 26th/27th June.
5. Tanker berth member (Mr. Kato)
   Interview with Mr. J.A. Dias, Supdt. Civil Engineer, CPC.
   Interview with Mr. Sivasundaram, Deputy General Manager Ceylon Petroleum Corporation.
6. Planning/finance members (Mr. Yamashita, Mr. Ishiwata and Mr. Kazama)
   Interview with Mr. D.R.L.Y. Paktsun, Chief Engineer Ports, CPC

26th June (Tue.)	Port tour 1. Road/railway (Mr. Ishiwata & Mr. Kato) 2. W/H/equipment (Mr. Yamashita, Mr. Nabeta and Mr. Kazama) 3. Structure (Mr. Sasaki and Mr. Zen) 4. General (Mr. Ohno)
27th June (Wed.)	– ditto –
	Port tour by a launch
28th June (Thu.)	Preparing Provisional Report
29th June (Fri.)	– ditto –
30th June (Sat.)	– ditto –
31st July (Sun.)	– ditto –
02nd July (Mon.)	– ditto –
03rd July (Tue.)	Discussion on the provisional report (draft) with the counterparts. Review and revision of the provisional report.
04th July (Wed.)	Review and revision of the provisional report. Explanation of the revised provisional report to the Embassy of Japan
05th July (Thu.)	Submitting the revised provisional report to the Ministry of Trade and Shipping.
06th July (Fri.)	Courtesy call to the Ambassador of Japan
07th July (Sat.)	Leaving Colombo (SQ 49)
08th July (Sun.)	Travelling
09th July (Mon.)	Data collection at the ADB
10th July (Tue.)	Arrival at Tokyo

CHAPTER 2 A BRIEF SKETCH OF SRI LANKA

2-1 General Aspects

2-1-1 Geography and Topography

Sri Lanka, an island in the Indian Ocean, is situated East-Southeast of the Southern tip of the Indian Continent. Sri Lanka faces the Indian Continent across the Palk Strait to the North, and the Gulf of Manner to the South, less than 30 km separates the countries at Adam's Bridge. The Sri Lanka is situated from latitude 5°55' to 9°50'N, and from longitude 79°40' to 81°55' E. (Refer to the coloured map on the title page.) Northeastern side of the island faces the Bay of Bengal.

South from the center of the country, a table land called the Hill Country, more than 1,000 meters above the sea level, extends over the Central and Sabaragamuwa Provinces, and Badulla District in the Province of Uva. There are peaks rising over 2,000 meters in and near the Nuwara Eliya District, located in the central part of Hill Country. The land space of Sri Lanka is 65,000 km^2, approximately 18% that of Japan.

2-1-2 Climate

Sri Lanka located Southwest of the Asian monsoon zone has two monsoon periods, that is the Southwestern monsoon period from May till October in the summer and the Northeastern monsoon period in the winter.

In the plainland, the maximum temperature is around 30–32°C, and the minimum temperature around 23–25°C. The mean annual rainfall exceeded 1,000 mm in the 30 years from 1931–60. The reinfall is relatively light in the North, from Jaffna through Anuradhapura, varying around 1,350–1,450 mm. Hambantota, located at the South end of the island, records the country's minimum rainfall at around 1,100 mm. From Colombo to the Hill Country rainfall is heavy exceeding 2,000 mm, while Ratnapura, located in the Southern part of Hill Country, receives nearly 4,000 mm of rainfall.

2-1-3 Culture, Society, Population and Social Indicators.

According to a 1978 mid-year estimate, the population of Sri Lanka is 14,181,000 people, with a population density of 219 people/km^2. The greatest population density is in the Colombo District with nearly 1,500 people/km^2. Adjacent to it is the Kandy District, with a population density of 550 people/km^2. Other districts in the area, and to the south of Colombo, have population density of 400 – 500 people/km^2. The 76% of Sri Lankans reside in the 40% of the country which covers the Northwestern Province, the Western Province, the Central Province, the Sabaragamuwa Province, and the Southern Province.

The population of Sri Lanka is increasing presently, with a rate of 21.9 persons per 1,000 persons recorded in 1978. Its birth rate has shown a gradual decrease from 30.4 persons in 1971 to 28.5 persons in 1978 (estimate). On the other hand, the death rate has fluctuated from 7.7 persons in 1971 to 9.1 in 1974, but then it gradually decreased after 1974 to 6.6 persons in 1978

(estimate). As a result, the rate of population increase per 1,000 persons changed from 22.7 persons in 1971 to 18.5 persons in 1974, but after 1974 it gradually increased up to 21.9 persons in 1978 (estimate).

The 76% of Sri Lankas are of Sinhalese descent, the 19% are Tamil and the 7% are Moor. The 1971' statistics indicated the predominate religion to be Buddhism, the remainder Hindus at 18% Islam at 7%, and Christians at 8%.

Despite low economic indicators such as income per capita, social indicators including education and medical care, are high in Sri Lanka. For example, the average longevity was 65 years in 1967, the population per hospital bed in 1973 was 333 persons, and the literacy rate in 1971 was 78.5%. These figures are the best of any developing country in Asia. Several social indicators, including the above, are listed in Table-2.1.

2-1-4 Transportation and Traffic

The total network of roads is approximately 27,000 km. In the Southwest the developed roads are centered around Colombo. From central to Southeast Sri Lanka, Colombo is the hub of the road network. And in the Northern part, Anuradhapura is the center of the road system. (Refer to the coloured map on the title page.) The public bus transportation operated by the Ceylon Transport Board, and others, offered services to 1,744,000,000 passengers in 1978.

The total service length of railroads is 1,453 km. The routes connecting Colombo with other ports include:

Colombo – Anuradhapura – Jaffna – Kankesanturai, Colombo – Galewela – Trincomalee and Colombo – Galle – Matara. (Refer to the coloured map on the title page). Passengers transported in 1978 totalled 80,000,000, and the volume of freight for the same year was 1,892,000 metric tons (estimate) and 246,000 ton km (estimate).

The conveyance volume of freight by road is unknown. However, roads appear to constitute the main source of domestic transportation, as indicated by the ratio of road to rail service lengths.

2-1-5 Economy

(1) General Condition

The economic operations of Sri Lanka made a radical change after the political turnover in July 1977. Since then, Sri Lanka has been agressively promoting the growth of the national economy by taking the following measures: attainment of self-sufficiency in food production by advancing the Mahaweli Development Scheme; increasing the electric supply to avoid dependence on oil; inviting domestic and foreign capital investment by establishing a free trade zone; and modifying the tax system, aiding the urban development of the Colombo region and radically relieving the restrictions on imports, and so on.

The basic plan of the Mahaweli Development Scheme, drafted by the UNDP/FAO Team in 1965–1968, intends to develop self-sufficiency in food production through increase of irrigation to the northeastern low lands for paddy production. It also shall increase the hydroelectric power generation (970 MW) of Sri Lanka. New irrigation land shall be 263,000 ha, and improved land 101,000 ha. Part of this basic plan called the Accelerated Mahaweli Development Program, has

started already. The planned completion date is in the year of 1984, with a total capital investment of 110–120 hundred million Rupees (net). Its targets are: the creation of 144,000 ha of new irrigation land, 10,500 ha of improved land and hydroelectric power sources. The World Bank has made the overall arrangement for this program at the request of the Government of Sri Lanka, and financial help is being offered by Japan, America, England, Canada, West Germany, Holland and Sweden, besides ADB.

A region extending nearly 180 miles² at the north of Colombo has been appointed as a free trade zone. The Greater Colombo has been appointed as a free trade zone. The Greater Colombo Economic Commission has been founded in order to establish several Investment Promotion Zones (IPZ), to develop the economic organization of those zones to stimulate industries to export by granting special tax benefits, and to increase employment opportunities within Sri Lanka. At present, an Investment Promotion Zone of 500 acres has been created next to the Katunayake International Airport, with 122 million Rupees of the preparation funds out of 622 million Rupees earmarked for the 1979 budget. Approximately 30 industries have already selected this zone.

The city development program of the Colombo region aims at shifting the central function of the capital from Colombo to Kotte, located about 5 km Southeast of Colombo, and constructing 100,000 houses in that area. This is because Colombo, located in a low and damp area, has little land left for expansion, due to poor past investments and overcrowding, it has a very limited water supply and an inadequate sewer system. The Urban Development Authority (UDA) has been founded for implementation of the transfer, with the relocation of the National Assembly Building already underway. The major part of this program is expected to be completed by 1983, at an estimated total cost of 1,300 million Rupees.

By radically limiting the import licensing system, it has been planned to increase the importation of food, fertilizers, precious metals, and luxury goods (the import licensing system has eliminated 957 out of 1,096 items of the Brussels Tariff Nomenclature).

These reforms are now in progress. The FEEC system (the dual exchange rate system of foreign currency) was abolished with a 85% currency devaluation on November 15th, 1977.

(2) National Income Statistics

The GNP in 1978 was $2.3 billion USD, or $163 USD per capita. This ranks as the lower group in Asian countries. The growth rate of the GNP, at 3–4% for several years, has held at 8.5% since 1968. Among the various industries of Sri Lanka, agriculture has the greatest share at over 30%, but its growth rate has been as low at 4.2%. Construction, mining & stone-quarrying and wholesale & retail trades all have high growth rates, these are the industries responsible for pushing up the overall growth rate. Several factors in the national income statistics are offered in Table-2.2 to Table-2.5.

(3) Production

The principal products of Sri Lanka consist of tea, rubber, coconut and rice. The changes in the production volume, etc. of tea, rubber, coconut and paddy are shown in Table-2.6.

The changes in the production value of the industrial products are indicated in Table-2.7.

(4) Trade

The trends of the total amount of import/export, balance of trade, etc. are shown in Table-2.8. The export by commodity are shown in Table-2.9. The import by commodity are given in Table-2.10.

(5) Production and Consumption of Energy

Almost all electricity is provided by hydroelectric power at present, and production shall be further increased by the Mahaweli Development Scheme. However, hydroelectric generation supplies around 10% of the total energy consumed by the nation. Thus, though the increase of hydroelectric power is anticipated, to accompany future economic development, dependency on oil is likely to become large. Tables-2.11 and 2.12 show the production and consumption of energy.

2-1-6 Labor, Wages and Prices

(1) Employment Condition

There are hardly ever available statistical data in this field. Table-2.13 offers the extracts from various sources.

(2) Trade Unions

The changes in the number of trade unions and the number of union members are shown in Table-2.14.

(3) Strikes

The number of strikes is shown in Table-2.15. The table offers the data upto the year of 1977. Labour and management relations have been good since 1978.

(4) Wages

The increase in the minimum wage is shown in Table-2.16.

(5) Prices

The trend of the consumers' price index at Colombo is presented in Table-2.17. The increase in the consumers' price index of 12.1% in 1978 indicates a radical change with that of 1.2–1.3% in 1976-1977.

2-2 Ports

The Sri Lanka Ports Authority, inaugurated on August 1, 1979, has jurisdiction over three ports, i.e. the Port of Colombo, the Port of Galle on the south coast and the Port of Trincomalee on the east coast. In addition, Sri Lanka has the Port of Kankesanturai located at its Northern end.

The Port of Colombo will be described in detail in the following chapters. The Port of Galle and the Port of Trincomalee described here.

2-2-1 Port of Galle

The Port of Galle is located about 120 km south of Colombo along the west coast at the latitude 6° N and longitude 80°E. The Bay of Galle is surrounded by the two capes and faces south. A connecting road was built on reclaimed land up to an islet in the center of the Bay and from this islet towards the west a breakwater is extended to protect the harbour zone.

A quay about 400 meters long with the water depth of 9 meters serves cargo vessels. However, dredging work has not yet been completed, large cargo vessels can enter the Port and approach the quay only after unloading part of their cargo in the bay. The sea conditions during the southwestern monsoon period in the summer are very severe. The volume of cargo handled was over 70,000 tons in 1978, consisting mainly of rice imported from China. The share of this Port in the total tonnage of cargo handled in the country is 1.4 percent. The Port plays a role of relieving the bottleneck to some extent, resulting from having to handle an excessive amount of food imports at the Port of Colombo. The tonnage of cargo handled is shown in Table-2.18, and the number of calling vessels is presented in Table-1.19.

2-2-2 Port of Trincomalee

The Port of Trincomalee, on the east coast, lies opposite to the Bay of Bengal. It is situated at latitude 8°30' N. and longitude 81°10' E. The Port consists of three harbours divided by four capes, and is an excellent natural deep water port. Among the three harbours, the Port is located in the Inner Harbour. However, it presently has no facilities for the vessels to come alongside the pier, thus it can serve only as a lighter port.

A flour mill, with an annual production capacity of 500,000 ton is under construction at the Malay Cave on the west coast of the Inner Harbour. And after its completion, an unloading berth can accomodate for 60,000 DWT vessels.

The food imports and tea exports constitute the main tonnage of cargo handled, amounting to approximately 120,000 tons in 1978. Its share in the total tonnage of cargo handled in all the ports in the country is 2 percent. The Port of Trincomalee plays a role of serving as an auxiliary port for the Port of Colombo. The tonnage of cargo handled is shown in Table-2.20, and the number of vessels calling the Port of Trincomalee is presented in Table-2.21.

Table – 2.1 Social Indicators

Life Expectancy at Birth	Males 64.2 Females 67.1	1971, Statistical Pocket Book 1979 Dept. Census and Statistics
Literacy Rate	78.5 %	1971, – do –
Persons per Bed	352	1978, – do –
Persons per Physician	6,369	1978, – do –
Calories Intake per Day per Capita	2,077 Cal.	1976, ADB
Protein Intake per Day per Capita	41.8 Gram	1976, ADB

Table – 2.2 National Product, Income and Population – 1959 - 1978

Year	GNP at Current Factor Cost Prices		GDP at Constant (1959) Factor Cost Prices		GNP at Constant (1959) Factor Cost Prices		Mid Year Population		GNP Per Capita	
	Amount Rs. Mn.	Growth Rate %	Amount Rs. Mn.	Growth Rate %	Amount Rs. Mn.	Growth Rate %	Amount 1000	Growth Rate %	Amount Rupees	Growth Rate %
1959	5,893	–	5,930	–	5,893	–	9,625	–	612	–
1960	6,287	6.7	6,332	6.8	6,289	6.7	9,896	2.8	635	3.8
1961	6,313	0.4	6,465	2.1	6,425	2.2	10,168	2.7	632	-0.5
1962	6,503	3.0	6,760	4.6	6,710	4.4	10,443	2.7	643	1.7
1963	6,797	4.5	6,951	2.8	6,900	2.8	10,646	1.9	648	0.8
1964	7,291	7.3	7,397	6.4	7,363	6.7	10,903	2.4	675	4.2
1965	7,484	2.6	7,565	2.3	7,551	2.6	11,164	2.4	676	–
1966	7,705	3.0	7,854	3.8	7,818	3.5	11,440	2.5	683	1.0
1967	8,265	7.3	8,255	5.1	8,210	5.0	11,703	2.3	702	3.8
1968	9,876	19.5	8,937	8.3	8,901	8.4	11,992	2.5	742	5.7
1969	10,725	8.6	9,369	4.8	9,301	4.5	12,252	2.2	759	2.3
1970	11,636	8.5	9,828	4.9	9,743	4.8	12,514	2.1	779	2.0
1971	11,860	1.9	9,836	...	9,769	0.3	12,699	1.5	769	-1.0
1972	12,710	7.2	10,146	3.2	10,085	3.2	12,951	2.0	779	1.2
1973	15,274	20.2	10,514	3.6	10,470	3.8	13,091	1.1	800	2.7
1974	19,858	30.0	10,892	3.6	10,867	3.8	13,284	1.5	818	2.3
1975	22,067	11.1	11,194	2.8	11,167	2.8	13,514	1.7	826	1.0
1976*	24,215	9.7	12,542	3.1	11,506	3.0	13,730	1.6	838	1.4
1977*	29,271	20.9	12,042	4.3	12,016	4.4	13,971	1.7	860	2.6
1978*	36,139	23.5	13,043	8.3	13,002	8.2	14,184	1.7	917	6.4

* Provisional.

Source: 1978 Annual Report, Central Bank of Ceylon

Table – 2.3 Sectoral Composition of Gross National Product at Constant (1959) Factor Cost Prices

Sectors	1959		1974		1975		1976		1977		1978		Percentage Increase 1978 over 1977
	Amount Rs. Mn.	Percentage	Amount Rs. Mn.	Percentage	Amount Rs. Mn.	Percentage	Amount Rs. Mn.	Percentage	Amount Rs. Mn.	Percentage	Amount Rs. Mn.	Percentage	
1. Agriculture, Forestry, Hunting & Fishing	2,302	39.1	3,582	32.9	3,596	32.2	3,568	31.0	3,828	31.9	3,990	30.7	4.2
1.1 Agriculture	2,148	36.5	3,328	30.6	3,352	30.0	3,308	28.8	3,568	29.7	3,690	28.4	3.4
1.1.1 Tea	(642)	(10.9)	(699)	(6.4)	(733)	(6.6)	(674)	(5.9)	(715)	(6.0)	(682)	(5.2)	(-4.6)
1.1.2 Rubber	(183)	(3.1)	(259)	(2.4)	(295)	(2.6)	(299)	(2.6)	(296)	(2.5)	(315)	(2.4)	(6.4)
1.1.3 Coconut	(404)	(6.9)	(387)	(3.6)	(419)	(3.7)	(365)	(3.2)	(332)	(2.7)	(385)	(3.0)	(16.0)
1.1.4 Paddy	(312)	(5.3)	(656)	(6.0)	(479)	(4.3)	(513)	(4.4)	(687)	(5.7)	(775)	(6.0)	(12.8)
1.1.5 Other	(453)	(7.7)	(1,327)	(12.2)	(1,426)	(12.8)	(1,457)	(12.7)	(1,538)	(12.8)	(1,533)	(11.8)	(-0.3)
1.2 Forestry	93	1.6	120	1.1	114	1.0	120	1.0	112	0.9	133	1.0	18.8
1.3 Fishing	61	1.0	134	1.2	137	1.2	140	1.2	148	1.2	167	1.3	12.8
2. Mining & Quarrying	31	0.5	191	1.7	248	2.2	354	3.1	311	2.6	411	3.2	32.2
3. Manufacturing	682	11.6	1,420	13.1	1,462	13.1	1,489	12.9	1,505	12.5	1,632	12.6	8.4
3.1 Export processing	373	6.3	546	5.0	460	4.1	432	3.7	435	3.6	446	3.4	2.5
3.2 Factory Industry	263	4.5	770	7.1	832	7.4	871	7.6	881	7.3	987	7.6	12.0
3.3 Small Industry	46	7.8	104	1.0	171	1.5	185	1.6	189	1.6	200	1.5	5.8
4. Construction	283	4.8	553	5.1	503	4.5	531	4.6	480	4.0	629	4.8	31.0
5. Electricity, Gas, Water Sanitary Services	9	0.1	84	0.8	91	0.8	99	0.9	102	0.8	123	0.9	20.6
6. Transport, Storage and Communications	541	9.2	1,054	9.7	1,100	9.8	1,143	9.9	1,198	10.0	1,285	9.9	7.3
7. Wholesale & Retail Trade	801	13.6	1,450	13.3	1,501	13.4	1,545	13.4	1,623	13.5	1,780	13.6	9.7
7.1 Imports	139	2.3	161	1.5	125	1.1	146	1.3	147	1.2	261	2.0	77.5
7.2 Exports	104	1.8	123	1.1	171	1.5	126	1.1	243	2.0	277	2.1	14.0
7.3 Domestic	558	9.5	1,166	10.7	1,205	10.8	1,273	11.0	1,233	10.3	1,242	9.5	0.7
8. Banking, Insurance and Real Estate	51	0.9	166	1.5	184	1.6	191	1.7	229	1.9	263	2.0	14.8
9. Ownership of Dwellings	201	3.4	344	3.2	350	3.1	353	3.1	360	3.0	374	2.9	3.9
10. Public Administration and Defence	301	5.1	609	5.6	646	5.8	676	5.9	703	5.8	760	5.8	8.1
11. Services n.e.s.*	728	12.3	1,441	13.3	1,513	13.5	1,593	13.8	1,704	14.2	1,797	13.8	5.5
12. Gross Domestic product	5,930	100.6	10,892	100.2	11,194	100.2	11,543	100.3	12,042	100.2	13,043	100.3	8.3
13. Net factor Income from abroad	- 37	- 0.6	- 25	- 0.2	- 27	- 0.2	- 37	- 0.3	- 25	- 0.2	- 41	- 0.3	–
14. Gross National Product	5,893	100.0	10,867	100.0	11,167	100.0	11,506	100.0	12,016	100.0	13,001.9	100.0	8.2

* not elsewhere specified

Source: 1978 Annual Report, Central Bank of Ceylon

Table – 2.4 Composition and Utilization of Resources 1977–78

Category	1977		1978		1978 at 1977 prices		Percentage increases 1978/77
	Amount Rs. Mn.	%	Amount Rs. Mn.	%	Amount Rs. Mn.	%	
1. Total Resources	37,860	100	53,900	100	42,197	100	11.5
1.1 Gross Domestic Product at Market Prices	31,352	83	38,850	72	33,954	80	8.3
1.2 Imports of goods and non-factor services	6,508	17	15,350	28	8,243	20	26.7
2. Utilization	37,860	100	53,900	100	42,197	100	11.5
2.1 Consumption	25,306	67	32,381	60	28,084	66	11.0
2.2 Gross Domestic Capital Formation	5,035	14	8,280	15	6,233	15	23.8
(a) Government	(1,542)	(4)	(3,077)	(6)	(2,049)	(6)	(32.8)
(b) Public Corporations	(861)	(3)	(1,815)	(3)	(1,066)	(3)	(23.8)
(c) Private Sector	(2,632)	(7)	(3,388)	(6)	(3,158)	(6)	(20.0)
2.3 Stocks	159	–	33	–	27	–	–
2.4 Exports of goods and non-factor Services	7,360	19	13,207	25	7,853	18	6.7

Source: 1978 Annual Report, Central Bank of Ceylon.

Table – 2.5 Domestic Savings

Category	1974*	1975*	1976*	1977*	1978
1. Gross Domestic Product at Market Prices	21,701	24,183	26,443	31,352	38,392
2. External Resources (Net imports of goods and non-factor services)	1,040	1,203	427	- 852	1,867
3. Investment	3,139	3,909	4,193	5,194	8,313
4. Domestic Savings (3 – 2)	2,099	2,706	3,766	6,046	6,446
5. Savings Ratio (4 as % of 1)	9.7	11.2	14.2	19.3	16.8

Source: 1978 Annual Report, Central Bank of Ceylon.

Table – 2.6 Production and Other Key Indicators of Principal Agricultural Crops – 1969–1978

Category	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978 (Provisional)
1. Tea										
1.1 Production (Mn. lbs.)	484	468	480	471	466	450	471	433	460	439
1.2 Total Acreage	556,514	597,499	597,171	597,645	598,740	598,466	597,691	594,481	598,024	603,464
1.3 Yield per acre (lbs.)	811	811	833	816	805	882	920	839	899	838
1.4 Cost of Production (Rs./lb.)	1.51	1.52	1.54	1.60	2.03	2.52	3.04	3.37	3.54	4.76
1.5 Average Price (Rs./lb.)										
– Colombo net	1.53	1.63	1.81	1.90	1.92	2.67	2.79	3.54	6.10	5.28
– Export f.o.b.	2.39	2.44	2.50	2.77	2.78	3.52	4.12	4.76	8.55	15.07
1.6 Replanted annual (acres)	6,500	6,857	6,640	6,418	5,953	4,282	4,356	2,756	3,067	5,811
1.7 Replanted cumulative (acres)	33,428	40,285	46,925	53,343	59,296	63,578	67,934	70,690	73,757	79,568
2. Rubber										
2.1 Production (Mn. lbs.)	333	351	312	309	341	291	328	335	322	343
2.2 Total Acreage	563,633	568,900	567,994	567,060	565,000	563,406	562,494	560,872	559,850	559,257
2.3 Area under tapping (Acres)	493,712	496,210	494,355	491,324	475,529	475,165	477,110	474,626	466,401	456,434
2.4 Yield per acre (lbs.)	674	707	657	658	694	634	691	705	690	753
2.5 Cost of Production (Rs./lb.)	0.71	0.69	0.76	0.75	0.85	1.12	1.25	1.49	1.70	2.20
2.6 Average Price (Rs/lb.)										
– Colombo RSS. I	1.04	0.91	0.79	0.81	1.17	1.28	1.13	197	2.05	3.14
– Export f.o.b.	1.37	1.24	1.08	0.93	1.67	2.61	1.84	2.95	3.11	6.76
2.7 Replanted annual (Acres)	12,084	10,239	8,477	8,742	7,276	7,076	7,980	6,299	6,464	7,968
2.8 Replanted cumulative (Acres)	276,132	286,371	294,848	303,590	310,866	317,942	325,922	332,221	338,685	346,653
3. Coconut										
3.1 Production (Mn. nuts)	2,440	2,510	2,610	2,963	1,935	2,031	2,398	2,330	1,821	2,207
3.2 Cost of Production (Rs./nut)	0.07	0.08	0.08	0.08	0.10	0.10	0.11	0.16	0.21	0.25
3.3 Average Price (Rs./nut)										
– Colombo	n. a	n.a.	n.a.	0.14	0.25	0.56	0.32	0.45	0.92	0.85
– Export f.o.b.*1	0.25	0.27	0.27	0.21	0.34	0.86	0.46	0.47	1.19	1.85
4. Paddy										
4.1 Production (Mn. bushels)	65.8	77.5	66.9	62.9	62.9	76.8	55.3	60.0	80.4	90.6
4.2 Acreage										
– Sown ('000)	1,709	1,876	1,794	1,795	1,792	2,038	1,719	1,789	2,046	2,162
– Harvested ('000)	1,539	1,776	1,714	1,579	1,660	1,969	1,476	1,570	1,933	2,074
– Under improved varieties ('000)	1,108	1,325	1,204	1,252	1,284	1,647	1,285	1,381	1,710	1,692*2
4.3 Yield per acre (Bushels)	50.33	51.30	45.91	46.87	44.58	45.65	44.04	44.91	48.92	50.70
4.4 Guaranteed Price (Rs./bushel)	14.00	14.00	14.00	14.00	18.00	33.00	33.00	33.00	33.00	40.00
4.5 Purchases under Guaranteed Price Scheme (Mn. bushels)	13.7	26.2	32.4	26.4	22.9	20.9	11.3	12.8	24.6	32.0

*1 Average price of nut equivalent of exports.
*2 Excluding figures for the districts of Batticaloa, Ratnapura and Jaffna for Yala 1978.

Source: 1978 Annual Report, Central Bank of Ceylon.

Table – 2.7 Industrial Production 1976–1978

Industrial Group	Value of Production (Rs. Mn.)		
	1976	1977	1978
1. Food, Beverages and Tobacco	1,715	2,294	2,609
2. Textiles, Wearing Apparel and Leather Products	680	698	1,008
3. Wood and Wood Products, including Furniture	129	127	124
4. Paper and Paper Products	203	270	376
5. Chemicals, Petroleum, Coal, Rubber and Plastic Products	2,336	2,469	3,279
6. Non-metallic Mineral Products, except Petroleum and Coal	360	411	592
7. Basic Metal Products	138	132	219
8. Fabricated Metal Products, Machinery and Transport Equipment	474	571	590
9. Products not elsewhere specified	26	34	55
Total	6,061	7,004	8,851
Real Rate of Growth (%)	1.2	1.3	10.6

Source: 1978 Annual Report, Central Bank of Ceylon.

Table – 2.8 Foreign Trade – 1969–78

Period	Rupees Million			Index Number 1967 = 100				Terms of Trade *2
				Volume		Prices		
	Exports*1 (f.o.b.)	Imports (c.i.f.)	Balance of Trade	All Exports	All Imports	All Exports	All Imports	
1967	1,690	1,738	– 48	100	100	100	100	100
1968	2,035	2,173	– 138	103	101	117	126	93
1969	1,916	2,543	– 627	98	108	117	134	83
1970	2,033	2,313	– 280	102	102	118	140	84
1971	1,947	1,986	– 39	99	90	117	150	78
1972	2,029	2,064	– 55	97	88	118	157	75
1973	2,617	2,715	– 98	98	79	137	209	65
1974	3,471	4,554	–1,082	85	56	217	370	58
1975	3,933	5,251	–1,318	102	69	199	433	46
1976	4,815	4,645	+ 170	97	75	239	383	62
1977	6,638	6,007	+ 631	89	97	382	471	81
1978	13,206	14,662	–1,456	95	132	698	877	80

*1 Including re-exports.

*2 Terms of Trade = $\frac{\text{Export Price Index}}{\text{Import Price Index}} \times 100$

Sources: 1978 Annual Report, Central Bank of Ceylon.

Table – 2.9 Composition of Exports 1976–1978

Category	Value Rs. Million SDR Million in brackets			Percentage of Total Exports		
	1976	1977	1978	1976	1977	1978
Tea	2,100 (216)	3,503 (355)	6,401 (327)	44	53	48
Rubber	890 (91)	931 (93)	2,021 (103)	18	14	15
Coconut	382 (39)	335 (32)	972 (50)	8	5	8
Minor Agricultural crops*	231 (24)	378 (38)	658 (33)	5	6	5
Gems	261 (27)	298 (30)	531 (27)	5	4	4
Industrial Exports*	782 (80)	919 (86)	1,891 (97)	16	14	14
Other Exports	170 (18)	275 (26)	733 (38)	4	4	6
Total Exports	4,815 (495)	6,638 (659)	13,206 (676)	100	100	100

* Selected Items

Source: 1978 Annual Report, Central Bank of Ceylon.

Table – 2.10 Expenditure on Imports 1976–1978

Category	Value						Percentage of Total Imports		
	Rs. Million			SDR Million					
	1976	1977	1978*1	1976	1977	1978*1	1976	1977	1978
1. Consumer goods	1,689	2,534	5,593	174	270	287	36	42	38
1.1 Food and drinks	1,491	2,181	4,103	153	224	210	32	36	28
(i) Rice	602	917	689	62	94	35	13	15	8
(ii) Flour	683	925	2,274	70	96	117	15	15	16
(iii) Sugar	64	197	514	7	19	26	1	3	4
1.2 Textiles & clothing	49	150	531	5	15	27	1	3	4
1.3 Other	149	203	959	16	31	50			
2. Intermediate goods	2,259	2,648	5,591	232	262	287	49	44	38
2.1 Petroleum	1,164	1,441	2,402	120	141	123	25	24	16
2.2 Fertilizer	99	51	252	10	6	13	2	1	2
2.3 Chemicals	906	1,036	2,491	9	100	128			
3. Investment goods	641	746	3,367	66	73	173	14	12	23
3.1 Machinery & equipment	364	286	1,845	37	33	95	8	5	13
3.2 Transport equipment	175	232	988	18	24	51	4	4	7
3.3 Building materials	104	129	150	11	9	8	2	2	1
4. Unclassified	54	79	110	6	25*2	29*2	1	1	1
5. Total	4,645	6,007	14,662	477	630	774	100	100	100

*1 Provisional
*2 Includes adjustments for transactions effected after November 15, 1977 at rates prevailing prior to that date.

Source: 1978 Annual Report, Central Bank of Ceylon.

Table – 2.11 Production and Consumption of Energy

(Unit: Million Metric Tons of Coal Equivalent)

	1970	1975	1976
Production	0.09	0.14	0.14
Consumption	1.87	1.60	1.45

Source: Statistical Yearbook 1977, UN

Table – 2.12 Consumption of Energy (1976)

Source of Energy		
Solid Fuel	Consumption (Thousand metric tons of coal equivalent)	4
	Per capita consumption (Kg)	0
Petroleum	Consumption (Thousand metric tons)	857
	Per capita consumption (Kg)	63
Electricity	Consumption (Million KWH)	1,202
	Per capita (KWH)	88

Source: Statistical Yearbook 1977, UN

Table – 2.13 Labour Force

	1971	1973*3	1978*3
Labour Force ('000)	4,488	5,960 (4,500)	5,600
Employed ('000)	3,649*1	5,167 (3,500)	4,500
Unemployed ('000)	839*2	793 (1,000)	900
Unemployment rate (%)	18.7	13.3 (22.2%)	16.1

*1 Statistical Pocket Book 1979, Dept. Census and Statistics.
*2 1978 Annual Report, Central Bank of Ceylon.
*3 ADB estimates
Figures in Parentheses: same as *2

Table – 2.14 Trade Unions

Item	1973	1974	1975	1976	1977
No. of Trade Unions	1,644	1,592	1,565	1,578	1,636
Total membership	1,217,740	398,446	1,266,271	1,066,429	1,397,893

Source: Statistical Pocket Book 1979, Dept. of Census and Statistics.

Table – 2.15 Strikes, Workers Involved and Man-Days Lost (Number)

Year	TOTAL		
	Strikes	Workers involved	Man-days lost
1967	230	89,851	699,345
1968	197	77,217	988,417
1969	189	573,178	464,165
1970	340	149,018	1,314,562
1971	157	90,802	513,294
1972	187	55,037	298,898
1973	238	93,656	390,739
1974	91	27,073	105,924
1975	69	21,897	79,224
1976	157	55,995	161,182
1977	119	38,667	210,470
1978	–	–	–

Source: Statistical Pocket Book 1979, Dept. of Census and Statistics.

Table – 2.16 Minimum Average Daily Rate of Wages
(Base: 1952 = 100)

Class of Workers		1972	1973	1974	1975	1976	1977	1978
Workers in agriculture	R	2.91	3.29	4.11	5.14	6.03	6.30	8.84
	I	148.47	168.07	209.91	262.45	307.51	321.43	451.02
Workers in trade other	R	5.30	5.83	6.68	8.04	5.17	8.96	11.03
than agriculture	I	181.48	199.74	235.81	275.20	282.30	306.90	377.74
Combined rate	R	3.10	3.49	4.33	5.36	6.25	6.51	9.02
	I	151.88	171.24	212.38	263.20	306.25	319.12	442.16

R – Wage Rate in Rs. I – Index Number.
Source: Statistical Pocket Book 1978 and 1979, Dept. of Census and Statistics.

Table – 2.17 Colombo Consumers' Price Index (1952 = 100)

Item	1970	1971	1972	1973	1974	1975	1976	1977	1978
Commodity-wise									
Food	136.6	139.1	147.5	164.8	189.7	204.3	202.1	203.3	237.5
Clothing	137.3	145.0	163.4	186.1	204.6	208.2	211.7	223.8	226.2
Fuel & Light	136.1	140.8	145.9	164.4	221.0	237.1	265.2	257.5	262.1
Rent	109.8	109.8	109.8	109.8	109.8	109.8	109.8	109.8	109.8
Miscellaneous	153.2	159.5	169.4	170.0	178.3	191.9	203.8	208.4	224.8
All Items	138.2	141.9	150.8	165.4	185.8	198.3	200.7	203.2	227.8
Growth Rate	5.9	2.7	6.3	9.7	12.3	6.7	1.2	1.3	12.1
Sector-wise									
Domestic	142.9	148.9	161.6	167.8	176.1	189.5	195.5	200.6	228.8
Import	129.3	129.7	136.1	162.5	195.7	213.5	209.2	195.6	243.8
Export	157.3	157.9	140.6	171.9	251.4	214.5	219.8	317.5	358.2

Source: Economic and Social Statistics of Sri Lanka, Central Bank of Ceylon.

Table – 2.18 Yearly Tonnage of Dry Cargo Handled (Port of Galle)

(Unit: Freight Tons)

Year	Food Cargo	General Cargo	Total Imports	Tea	Rubber	Coconut Products	Others	Total Exports	Total Imports and Exports
1960	53,343	2,637	55,980	84,228	8,682	1,578	7,807	102,295	158,275
1961	41,683	3,566	45,249	87,108	7,889	655	8,972	104,624	149,873
1962	69,961	1,642	71,603	85,398	10,047	–	11,635	107,080	178,683
1963	79,594	2,847	82,441	81,442	7,023	–	3,962	92,427	174,868
1964	58,301	571	58,872	N/A	N/A	N/A	N/A	89,737	148,609
1965	68,106	4,795	72,901	19,582	10,654	2,022	898	33,156	106,057
1966	29,931	5,500	35,431	1,568	10,762	529	233	13,092	48,523
1967	41,367	310	41,677	2,281	9,295	1,691	43	13,310	54,987
1968	39,443	8,159	47,602	2,571	12,087	1,914	35	16,607	64,209
1969	12,477	6,424	18,901	11	10,383	399	7	10,800	29,701
1970	66,905	3,726	70,631	166	13,960	1,132	250	15,508	86,139
1971	34,045	259	34,304	–	11,849	–	–	11,849	46,153
1972	13,262	–	13,262	–	12,994	–	–	12,994	26,256
1973	22,555	–	22,553	–	11,563	–	81	11,644	34,197
1974	4,584	–	4,584	–	10,212	–	–	10,212	14,796
1975	43,644	–	43,644	–	8,748	–	–	8,748	52,392
1976	44,320	–	44,320	–	8,360	–	324	8,684	53,004
1977	99,423	2,505	101,928	–	7,342	–	–	7,342	109,270
1978	59,054	–	59,054	–	12,773	–	–	12,773	71,827

N/A: Not available

Source: P (C) C

Table – 2.19 No. of Vessels Called
(Port of Galle)

Year	Dischargers	Loaders	Total
1970	18	13	31
1971	10	10	20
1972	3	11	14
1973	4	10	14
1974	2	8	10
1975	13	8	21
1976	8	9	17
1977	22	6	23
1978	16	5	21

Source: P(C)C

Table – 2.20 Yearly Tonnage of Dry Cargo Handled
(Port of Trincomalee)

(Unit: Freight Tons)

Year	Food Cargo	General Cargo	Total Imports	Tea	Rubber	Coconut Produce	Other	Total Exports	Total Imports and Exports
1960	82,647	45,626	128,273	151,298	–	–	2,634	153,932	282,205
1961	138,554	133,685	272,239	216,124	504	234	910	217,772	490,011
1962	151,895	213,616	365,511	253,296	343	178	556	254,373	619,884
1963	131,076	231,039	362,115	274,360	892	61	10,521	285,834	647,949
1964	110,520	336,684	447,204	240,022	598	1,083	34,620	276,323	723,527
1965	N/A	N/A	484,079	229,392	5,777	691	13,570	249,430	733,509
1966	79,619	213,350	292,969	162,020	84	314	33,951	196,369	489,338
1967	90,829	182,013	272,842	138,530	48	291	128	138,997	411,839
1968	21,465	65,105	86,570	173,552	221	522	686	174,981	261,551
1969	29,513	56,682	86,195	140,359	135	219	1,968	142,681	228,876
1970	71,693	9,713	81,406	177,627	32	243	1,872	179,774	261,180
1971	66,994	5,390	72,384	121,437	–	200	731	122,368	194,752
1972	52,283	7,027	59,310	104,940	32	28	2,991	107,991	167,301
1973	62,564	164	62,728	93,489	25	–	1,981	95,495	158,223
1974	29,507	158	29,665	81,869	–	–	307	82,176	111,841
1975	64,472	15	84,487	75,296	–	–	5,555	80,851	145,338
1976	65,802	–	65,802	59,592	–	5	1,629	61,226	127,028
1977	83,310	13,518	96,828	37,845	–	–	198	38,043	134,871
1978	55,171	20,167	75,338	47,333	–	–	2	47,335	122,673

N/A: Not available

Source: P(C)C

Table – 2.21 No. of Vessels Called
(Port of Trincomalee)

Year	Dischargers	Loaders	Total
1970	15	139	154
1971	11	103	114
1972	16	109	125
1973	10	108	118
1974	4	83	87
1975	8	85	93
1976	5	67	72
1977	13	50	63
1978	17	56	73

Source: P. (C) C

PART I
LOCATION OF THE PORT OF COLOMBO

PART I LOCATION OF THE PORT OF COLOMBO

CHAPTER 1 GEOGRAPHICAL CONDITIONS

The Port of Colombo is located at the center of the Indian Ocean and it can be said a keystone for many ocean routes. Near the Port of Colombo are located the Port of Cochin (India) on the Indian Ocean and the Port of Bombay (India) and Port of Karachi (Pakistan) on the Arabian Sea. On the side of the Bay of Bengal, nearest is the Port of Madras (India), and deep in the Bay of Bengal are located the Port of Calcutta (India), Port of Chittagong (Bangladesh) and Port of Rangoon (Burma).

Historically, when the Suez Canal was opened in 1869, a good port was sought in this vicinity, and the Bay of Galle was once used as a port, but finally the Port of Colombo was constructed by the hand of British. It was in 1875 that the construction of the South-West Breakwater, now the revetment along the rear of the Queen Elizabeth Quay, was started.

As a typical example indicating the geographically favorable location of the Port, it may be cited that there are a number of ships visiting the Port for bunkering. In 1978, 382 ships visited the Port for bunkering, and this figure represents 22.6% of all ships calling the Port. There was a record that the fuel supply at the Port doubled immediately after the closure of the Suez Canal in 1967.

All of the international sea routes connecting the Europe, Mediterranean Sea and the Middle East with the Australia, Southeast Asia and Far East pass near the Port of Colombo. Thus, while the Indian ports in the vicinity are being developed and improved, the Port of Colombo still maintains the locational advantage in the sea transport.

The Port of Colombo has its northwest direction sheltered by the Indian Subcontinent. From west to southwest, the Maldive Islands are extending south to north about 800 km off in the Indian Ocean.

CHAPTER 2 NATURAL CONDITIONS

The east coast of Sri Lanka faces the Bay of Bengal, and about 100 km off in the east, there are located the Andamans and Nicobars (Fig.-1.2.1). The west coast faces the Indian Ocean, and about 200 km to the west across the Palk Strait and Gulf of Mannar is situated the southern end of the Indian Penisula, and further south about 600 km west are located the Maldives. The coast of the island is characterized generally as rock on the east coast, sand on the west coast and coral reef on the south coast, and its total extension is about 900 miles.

The natural conditions in Colombo will be discussed in detail in the following.

2-1 Wind

In this paragraph, the wind characteristics in the vicinity of the Port of Colombo will be discussed. The design conditions of structures or operating conditions of work vessels are directly affected by wind. Further, the wind characteristics were used as the fundamental data for forecasting wave dimensions, as described in the subsequent paragraph.

2-1-1 Observation Record

Observation records used in analysis are as follows.

(1) Wind Log (1963-1975)*

Place of observation: Pilot Station, South-West Breakwater in the Port of Colombo.

Equipment: Dines pressure type.

Equipment height: 80 ft above sea surface.

The data include the durations of wind by direction and the maximum wind velocity during the respective durations but don't include hourly wind velocity and direction. However, this record includes the data over longer period, and therefore in this report wind characteristics were analyzed mainly upon this data.

(2) Wind Record 1977–1978**

Place of observation: Near the extreme end of South-West Breakwater, the Port of Colombo.

The observation is carried out by CPC, after the observation(1) conducted by the Department of Meteorology, approximately at the same place. The data remained unprocessed, so they were analysed for this study and used to supplement the data(1).

(3) Annual Reports of Meteorology 1966-1970 by Department of Meteorology, Sri Lanka.***

The data are the Annual Reports of the Department of Meteorology during the observation period(1).

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* Wind Statistics; C.P.C.

** Wind Record, C.P.C.

*** Report of the Department of Meteorology; Department of Meteorology

2-1-2 Results of Analysis

The results of analysis are given in Tables-I.2.1 through I.2.4 and Figs.-I.2.2 through-I.2.5.

(1) Strong Wind Record

Strong winds of 50 mile/hour (22 m/sec) or over taken from the records in 1963–77 are shown in Table-I.2.1. As seen, strong winds occur at an average rate of about 3 times/year although the frequency differs from year to year. Further, about 80% of the strong winds occurs in the SW monsoon season of June to September and the SSW-NNW wind prevails 70 percent of the time due partly to the fact that the SW monsoon is generally more predominant over the NE monsoon and partly to the geographical conditions of the observatory station. The strong winds occur 48 times in total, those of 60 ~ and 70 ~ mile/hour 9 and 3 times respectively and the maximum wind observed is 74 mile/hour (33m/sec) (1964. 7. 4. WSW). Table-I.2.1(d) shows the annual maximum wind velocities.

(2) Frequency of Occurrence by Wind Direction and Velocity

Wind occurrence characteristics by direction and velocity are shown in Tables I.2.2 through I.2.4 and Figs.-I.2.2 through I.2.4 (Here, for the data of 1976–77, the method of observation is different so that they are shown separately from the previous records.) For the directional characteristic of wind throughout the period of observation, the sea winds from the W sector are prevailing, with the SW direction having a high rate of occurrence, as shown in Fig.-I.2.2. For the strong winds of 10 m/sec or over, those from N, W, and SW directions are of nearly equal frequencies of occurrence, and thus they show a rather different characteristic from those of the winds of 0~ m/sec and of 5~ m/sec, which are of higher rate of strong wind from N and W. For the directional characteristic of wind by month, the effect of biannual monsoon seasons is noted. Fig.-I.2.4 shows the wind direction by month of winds of 10 m/sec or over which are of great influence upon the port plan. According to the figure, N-NE winds prevail in December to February, and SW-W winds in June to September, while the periods of March to May and October to November form a transitional period of two monsoon seasons. With respect to the annual change of wind directions, in January winds of N sector blow predominantly, but they shift to W gradually in February to April, with decreasing frequency of occurrence. In May, W wind begins to blow, and the SW monsoon season comes from June to September. During this period, the wind direction changes counterclockwise from WSW to SW. October is the period in which the SW monsoon retreats, and in November, NE winds begin to blow, although SW winds are seen. And in December, the NE monsoon season sets in to form an annual cycle. In General, the N wind in January and W-SW wind in June to September are distinguished.

(3) Probability of Strong Wind

The probability of strong winds was calculated from the wind records over 1963–1977 according to the Weibull's formula. The results are shown in Fig.-I.2.5. According to the figure the maximum wind velocity of 74 miles/hour in the past is of about 16 year probability, and the wind velocities of 30 year and 50 year probabilities are 81 mile/hour (36 m/sec) and 85 mile/hour (38 m/sec) respectively.

2-2 Wave

In this paragraph, the results of analysis of the waves affecting the Port of Colombo will be described. For a port plan, records of wave observation over about 10 years are usually required. Where observation records are not available, wind data can be used for forecasting wave dimensions. With respect to the waves near the Port of Colombo, no data in the past are available. Thus, the wave dimensions were forecasted by the wind data described in the preceding paragraph.

2-2-1 Method of forecast

Wave characteristics were analyzed from the wind data according to the SMB method. For forecasting, the data of 1963–77 were used. But the wind velocities and directions were not recorded hourly in the 1963–75 data. Thus, by using the raw data during this period and data of 1976–77, their characteristics of hourly change were approximated and this was used. Further, for strong winds, the wind data were often not complete so that the hourly change is assumed to be of similar characteristics as conjectured by the raw data. Further, in consideration of the 1976–77 data being incomplete, with a high rate of measurement missing and of a different observation method from that up to 1975, and being very low in the frequency of occurrence of strong winds, wave dimensions were forecasted mainly from the 1963–75 data.

2-2-2 Results of Forecast

Forecasts were made of waves of direction between SSW-NNW and a height of 0.5 m or greater in consideration of the geographical condition of the Port of Colombo.

(1) High Waves

Dimensions of the maximum wave ($H_{1/3}$) in each year from 1963–77 estimated from the records of strong winds are shown in Table-I.2.5. As shown, waves of 4m or greater occur only 3 times during the period of 15 years, and the waves range largely within 3-4m, with the mean value at about 3.5m. The period of waves falls within the range of 6–9 sec, with the mean value about 6.9 sec. The wave directions are: WSW, 4 times, and W, 3 times, these two being about one half of total followed by SW and NW, each 2 times, the WSW direction having a rather higher frequency of occurrence when taken against the directional characteristic of strong winds discussed previously. 75 percent of the waves occur from June to the first half of July, or the pre-SW-monsoon period, and 25 percent in the second half of September to October. Thus, the high waves concentrate at the beginning and retreating seasons of the monsoon when the climate is unstable.

(2) Wave Direction-Height Characteristics

The frequencies of wave occurrence by direction of 0.5m and 1.0m or higher in 1963–75 are shown in Fig.-I.2.6 and Table-I.2.6. According to the figure, the wave directions show a similar characteristic to that of wind directions mentioned previously, and the W-SW waves are prevailing. These waves show a different trend of direction from that of the high waves of which the frequency of WSW direction is lower than that of SW direction.

Fig.-I.2.7 shows the monthly wave direction characteristics of the wave heights of 0.5m and 1.0m or greater. According to the figure, waves of NW-NNW directions prevail in January, but they recede in February, and in March and April, then comes a calm period with no appreciable waves. In May, W waves begin to occur, and SW-W waves prevail in the SW monsoon season of June to September but they retreat in October. It is relatively calm in November, and in December, NNW waves occur at a low frequency, and continue through to January. In general, occurrence of waves is maximum from June to September which corresponds to the SW monsoon season, and it is calm from October to May.

Table-I.2.7 and Fig.-I.2.8 show the frequencies of occurrence by wave height and month. As shown, a clear contrast is seen in the wave occurrence of 0.5m or higher between the SW monsoon season and the period of other months, being about 50 percent in the former and about 25 percent in the latter.

(3) Probability of Occurrence

The probabilities of occurrence of high waves were obtained similarly as that of winds. The results are shown in Fig.-I.2.9. According to the figure, it is known that the maximum wave $H_{1/3}$ =6.1m occurred July 4, 1964, is of an approximately 25 year return period. Further, the 5 and 10 year wave heights are about 4m and 5m respectively.

(4) Examination of the Results

Observation of waves occurring off the Port of Colombo is being planned by the Coastal Conservation Department (CPC) with ultrasonic wave recorders. There is no record of measurement in the past. However, for the waves occurring far off the coast of Sri Lanka, two records of observation*,** are available. Here, the forecast results will be compared with these values of observation.

1) Maximum wave Dimensions

In both of these two data, the waves prevail in the SW monsoon season, in W direction. Maximum waves occur in this period and their dimensions are as follows.

Climatic Atlas *

Wave height H = 6–7.5m.
Period T = 6–7 secs.
Wave direction, W.

Wave Statistics**

Wave height H = 5.5–6.5m.
Period T = 8–9 secs.
Wave direction, W.

The results of the forecast, H=6.1m, T=9.1 sec and wave direction WSW, are very close to the above results.

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* U.S. Navy Marine Climatic Atlas of the World; Naval Weather Service Detachment, Scheville, N.C.

** Ocean Wave Statistics; Ministry of Technology Natural Physics Laboratory, London

2) Wave Characteristics

With respect to the annual wave occurrence and wave direction characteristics, good agreement is seen between the values of observation and the results of forecast. However, for the wave period, swells exceeding 13 secs are observed of the waves less than 6.0m.

(5) Incident Wave Dimensions

Now, as the result of the foregoing analysis, there were obtained the dimensions of waves off the Port of Colombo. Deep water waves have their dimensions changed by the effects of refraction, shoaling and bottom friction as they propagate onto shallow water areas. Thus, in consideration of these, the dimensions of the incident waves near the entrance to the Port of Colombo will be calculated.

1) Shoaling Effect

When a wave having a height H_0 in deep water area enters a shallow water area, its wave height H changes as expressed by the following formula

$$\frac{H}{H_0} = \sqrt{\frac{1}{2n}\frac{C_0}{C}} = K_S$$

$$n = \frac{1}{2}\left(1 + \frac{4\pi h/L}{\sinh(4\pi h/L)}\right)$$

where C_0 and C represent the wave velocities in the deep water and shallow water areas respectively.

2) Bottom Friction Effect

When a wave propagates in a water area of depth h for a distance Δx, its height decreases at rate K_f as expressed

$$K_f = H_2/H_1 = \left(1+64/3\,\pi^3/g^2\,\frac{f H_1 \Delta x}{h^3}\,(h/T^2)^2\,\frac{Ks^2}{\sinh^3(2\pi h/L)}\right)^{-1}$$

where H_1 represents the initial wave height, H_2 the wave height after propagation for Δx, and f the friction coefficient (0.01 – 0.02).

3) Refraction effect

The incident wave changes its direction caused by the velocity change in a shallow water region. In Fig. -1.2.10 are shown the refractions of waves off the Port of Colombo.

From the foregoing, the incident wave height is calculated as below (T=10 sec, h=12m),

$$H = K_S \cdot K_f \cdot K_r \cdot H_0 = 0.95 \times 0.96 \times 1.0 \times H_0 = 0.91 \times H_0$$

2-3 Tidal Planes

According to the Indian Tide Table,* the tidal plans in the Port of Colombo are as below.

Mean Lower Low Water Springs	+0.02 m
Mean Low Water Springs	+0.06

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* Indian Tide Tables; Geodetic and Research Branch, India

Mean Low Water Neaps	+0.30
Mean Sea Level	+0.38
Mean High Water Neaps	+0.48
Mean High Water Springs	+0.72

Further, the highest high water level during 1953--1972 is **

Highest High Water Level (Dec. 9, 1958)	+1.14 m (M.S.L. +2.5 ft)

2-4 Soil Conditions

Several soil explorations were conducted in the past in the Port of Colombo; (1) soil exploration performed in 1923, (2) soil exploration conducted in association with the construction project of the South-West Breakwater Pier, and (3) soil investigation conducted for the Colombo Dry Dock Project in 1977. In the early stage of the current study, it was carried out by making reference to the results of explorations (1), (2) and (3) stated above but the necessity for more fully understanding the soil conditions became clear as the study progressed. Thus a (4) fourth soil exploration was conducted at the Queen Elizabeth Quays No. 4 and No. 5 and in the water area in front of the Coaling Jetties.

2-4-1 Results of Soil Exploration Conducted in 1923

This exploration was conducted at each intersection of grid lines within the region encircled by solid lines shown in Fig.-I.2.11. The soil boring log at each point indicates the types of soil such as clay, sand, mud or rock, colors and the consistency of clay. Though the method of boring and the datum level of the depth are not available, rough information on the soil can be obtained from the results of this exploration. Sections A-A, B-B and C-C shown in Fig. -I.2.11 indicate the locations for construction of a new container terminal, widening work of the North Quay and construction of a oil berth, respectively.

Figs. -I.2.12 to I.2.14 show the soil profiles for sections A-A, B-B and C-C. As shown in Figs.-I.2.12 to I.2.14, the stratums below the seabed consist of mud, sand, clay and rock stratums in the order beginning from the surface of the seabed. The mud stratum is seen only at a few points and its thickness is small. The physical characteristics of sand, clay and rock stratums are not available from the results of this exploration.

Fig.-I.2.15 shows the depths of rock stratum which were judged to be rock by this exploration. The rock stratum tends to incline toward offshore, but it likely that more than half of the area surveyed may have the rock stratum deeper than −15m. Since the datum level is not clear as stated above, it seems that the depths shown may include a maximum error of about 0.72m which is equivalent to the difference in tidal range of the Port of Colombo.

** Tide Observation Data; CPC

2-4-2 Results of Soil Exploration for Construction Project of the South-West Breakwater Pier

According to the location map, borings were carried out at the 15 points as shown in Fig.-I.2.16 in this exploration. In the soil boring log for each point shown in Figs.-I.2.17 to I.2.19, soil properties are shown in slightly more detail compared to these of exploration stated in the section 2-4-1. Concerning clay stratum that may offer certain problems for the construction of structures, the presence of thin stratums of white sandy clay, blue sandy clay, white yellow clay is definitely indicated.

2-4-3 Results of Soil Investigation for the Colombo Dry Dock Project

The results of soil investigation conducted at the sites shown in Fig.-I.2.20 are indicated in Figs-I.2.21 to I.2.23 as soil profiles.

The seabed slightly off the shoteline within this explored area consists roughly of, beginning from the surface of the seabed, extremely soft clay (N-value: 1 to 2, maximum stratum thickness: approximately 4 m at borehole No. D1, fine to medium sand (N-value: 12 to 40, maximum thickness: 6.5m), weathered rock stratum (stratum thickness: 2 m), and rock stratum. And each stratum inclines down toward offshore. Table-I.2.1 shows the depths of rock in reference to the low water of ordinary spring tide (LWOST). As apparent from Fig.-I.2.21 to I.2.23 and Table-I.2.1, the depth of rock stratum gradually increases as it runs from north to south and also from east to west.

2-4-4 Results of Soil Investigation Conducted for the Study on the Development Project of the Port of Colombo

This soil investigation was conducted by a private soil survey firm authorized by the Sri Lanka Ports Authority. Two members of this study team from the Government of Japan joined to the field survey. Survey points and method were determined after exchanging views between persons in charge for both Governments.

(1) Method of Investigation

Percussion boring was conducted for the soil above the bed rock. However, rock was sampled by core tube (casing size: NX; core size: TNX) in order to confirm the bad rock below the weathered rock stratum. At least one standard penetration test was conducted in each stratum, as a rule, and investigation at each borehole was completed only after confirming the bed rock. Marine boring was conducted by using a pontoon for boreholes No. 1, No. 2A, No. 3A, No. 4 and No. 5. On the other hand, on-land boring was conducted for boreholes No. 2 and No. 3.

(2) Locations of Investigation

The location of the soil survey is shown in Fig.-I.2.24. In addition, the location of the investigation of the Queen Elizabeth Quay is shown in detail in Fig.-I.2.25. The quaywall of the Queen Elizabeth Quay No. 5 was constructed by using 24 cylindrical concrete caissons with 8.1 m diameter (this will be called the "cylinder" hereinafter). Borehole No. 1 is located in the seabed 6.9 m (23') off the cylinder No. 24, borehole No. 2 is located inside the cylinder No. 13,

borehole No. 2A is in the seabed 10.1 m away from the quaywall and 16.3 m away from the borehole No. 2, borehole No. 3 is on land behind the concrete block quaywall which is 22.5m from the edge of the cylinder No. 1 and is 12m away from the face of this quaywall, and borehole No. 3A is in the seabed 10.5 m away from the face of the quaywall in front of the borehole No. 3.

(3) Soil boring logs and profiles

Soil boring logs are shown in Figs.-I.2.26 to I.2.30 and soil profiles in Fig.-I.2.31 and I.2.32 respectively which were obtained at the Queen Elizabeth Quays No. 4 and No. 5. By examining Figs.-I.2.26 to I.2.32, the types of soil layers below seabed in this vicinity can be classified as follows, below beginning from the surface of the seabed:

1st layer: Soft clay with a stratum thickness of 0 to 3 m near the surface of seabed.
2nd layer: Fine to coarse sand with stratum thickness of 2.7m to 5.7m.
3rd layer: Clear grey or white clayey sand with N-value of 9 to 14 and stratum thickness of 0.4 m to 1.5 m.
4th layer: Weathered gneiss with N-value of 27 to 5 0
5th layer: Rock stratum of gneiss with N-value of more than 50.

In Figs. -I.2.31 and I.2.32, the depth (-15.60 m) of the bottom surface of the cylinder of the Queen Elizabeth Quay No. 5 below LWOST is shown with broken lines. As apparent from Figs.-I.2.31 and I.2.32, the bottom of the existing cylinders is located in the 3rd layer having N-Value of 9 to 14, or in a shallower layer.

Soil boring logs and profiles for the sea area in front of the Coaling Jetties are shown in Figs.-I.2.33, I.2.34, I.2.35 and I.2.36. By examining these soil profiles, the rock stratum is found at a depth of −14.40m to −16.10m in section L-L, and it also appears at a depth of −14.40m for borehole No. 4 and of -19.50m for borehole No. D11 in section M-M. The depth of the bed rock increases as it runs offshore from east to west.

(4) Results of Physical Tests

Physical tests such as a specific gravity test, mechanical analysis, liquid limit test, and plastic limit test were conducted for some of specimens sampled through borings and standard penetration tests. The results are tabulated and shown in Table-I.2.2. Fig.-I.2.37, Fig.-I.2.38 and Fig.-I.2.39 show the plasticity chart, soil classification and grain size accumulation curve.

2-5 Water Depth in the Port

Water depth in the Port of Colombo is shown in Fig.-I.2.40. The depth shown in this figure were obtained from the sounding map of the Port of Colombo prepared by the Sri Lanka Ports Authority.

2-6 Rainfall, etc.*

2-6-1 Rainfall

Rainfall at Colombo concentrates in April-May and October-November which are the transitional seasons of monsoons, with the precipitation at 260–350 mm and the number of days of rainfall at about 20. In the other seasons, the rainfall is relatively small at about 90mm, and no great difference is seen throughout the year.

2-6-2 Temperature

There is no great seasonal change, and the daily mean highest and lowest temperatures are 30.0°C and 23.9°C respectively.

2-6-3 Humidity

The humidity is relatively high in the NW monsoon season, but no sharp seasonal change is observed.

2-6-4 Tidal Current

The tidal current off the Port of Colombo scarcely exceeds 0.5 knot.

2-6-5 Cyclones

Cyclones in the Bay of Bengal take a course in the NW direction so that they have a great influence on the east coast of Sri Lanka but little on the west coast.

2-6-6 Earthquake

Very weak earthquakes are observed often, but there are no earthquakes that may cause damage to structures.

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* Weather Statistics Department of Meteorology, Colombo

Table – I.2.1 (a) Strong Wind Record (MPH)

(-) ..... Max. Wind Velocity
-- ..... Duration (h'r)

Year	Month	Date	N	NNW	NW	WNW	W	WSW	SW	SSW	S	SSE	SE	ESE	E	ENE	NE	NNE
1963	1	10	–	–	–	–	–	–	–	3	1	1	(65) 1	–	–	–	1	–
	6	5	–	–	–	–	–	–	(55) 1	13	–	–	--	–	–	--	–	–
		6							(56) 6	14	4							
		20	–	–	–	–	–	–	–	3	12	7	2	–	–	–	–	–
		22	–	–	–	--	–	–	14	(57) 6	4	–	–	–	–	--	–	–
	9	23	–	–	–	1	–	(518) 12	4	4	–	–	–	–	–	–	–	–
		15	–	–	–	–	–	–	5	6	(53) 1	–	–	–	–	–	–	–
		17	–	–	–	–	2	3	2	7	3	7	–	–	–	–	–	–
		18	–	–	–	–	–	(58) 2	–	–	–	–	4	–	–	–	–	–
	11	2	–	–	–	–	–	–	–	–	–	–	(69) 8	–	–	–	–	1
		6	–	–	–	–	–	–	–	–	–	(51) 1	–	–	1	–	–	–
		15	–	–	(69) 6	–	–	–	–	–	–	–	–	–	–	–	–	–
1964	1	7	10	–	–	–	–	–	–	–	–	–	–	–	--	–	(51) 10	–
	2	26	–	–	–	–	–	–	–	–	–	–	--	–	(66) 1	2	3	–
	6	16	–	–	–	–	–	–	–	(56) 6	5	–	–	–	–	–	–	–
	7	1	–	–	–	–	–	17	3	–	–	–	–	–	–	–	–	–
		5	–	–	–	–	–	3	(51) 11	–	–	–	--	–	–	–	–	–

Table – I.2.1 (b) Strong Wind Record (MPH)

Year	Month	Date	N	NNW	NW	WNW	W	WSW	SW	SSW	S	SSE	SE	ESE	E	ENE	NE	NNE
1964	7	8	–	–	–	–	–	7	(35) 1	–	–	–	–	–	–	–	–	–
		9	–	–	–	–	–	(55) 8	16	–	–	–	–	–	–	–	–	–
		11	–	–	–	–	1	10	(52) 13	–	–	–	–	–	–	–	–	–
		13	–	–	–	–	(52) 9	7	4	4	–	–	–	–	–	–	–	–
1966	4	30	–	–	–	–	–	–	–	–	(50) 10	2	9	1	1	1	–	–
	7	12	–	–	–	–	(51) 16	3	4 (17) 2	16	–	–	–	–	–	–	–	–
	10	20	–	–	–	–	6	(56) 5	2	–	–	–	–	–	–	–	–	–
	12	5	5	(50) 16	–	–	–	–	–	–	–	–	–	–	–	–	–	–
		6	1	(59) 6	7	10	–	–	–	–	–	–	–	–	–	–	–	–
1968	5	6	–	–	–	–	(59) 3	21	–	–	–	–	–	–	–	–	–	–
	7	2	–	1	1	1	(56) 5	8	6	–	–	1	–	–	–	–	–	–
		17	–	–	–	–	(52) 6	1	5	9	–	–	–	–	–	–	–	–
		18	–	–	1	(60) 3	3	3	3	1	2	1	1	–	–	–	–	–
1971	8	12	–	3	2	(50) 1	–	–	–	–	–	–	–	–	–	–	–	–
	9	21	–	–	–	–	(50) 6	15	3	–	–	–	–	–	–	–	–	–
		22	–	–	–	–	8	(68) 12	1	–	–	–	–	–	–	–	–	–
		23	–	–	–	1	–	(55) 11	6	–	–	–	–	–	–	–	–	–

Table – I.2.1 (c) Strong Wind Record (MPH)

Year	Month	Date	N	NNW	NW	WNW	W	WSW	SW	SSW	S	SSE	SE	ESE	E	ENE	NE	NNE	
1973	7	3	–	2	(50) 20	2	–	–	–	–	–	–	–	–	–	–	–	–	
1974	5	29	–	–	(50) 2	–	27	–	5	–	–	–	–	–	–	–	–	–	
	7	25	–	–	–	–	(50) 9	–	–	–	–	–	–	–	–	–	–	–	
	8	12	–	–	–	–	–	–	(50) 2	22	–	–	–	–	–	–	–	–	
	6	6	(50) 24	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	
1975		15	20	–	–	–	–	–	–	–	–	–	–	–	–	–	4	–	
		18	–	–	–	–	–	–	–	–	–	–	–	–	(54) 4	–	20	–	
		21	–	–	–	–	–	–	–	–	–	–	–	–	–	(52) 1	3	20	
	7	11	–	–	–	–	–	–	–	–	–	–	(50) 1	–	18	–	–	–	
		12	–	–	–	–	–	–	–	–	–	–	–	–	(54) 24	–	–	–	
	5	13	–	–	–	–	–	–	–	–	–	–	–	–	–	–	(58) 15	9	
1955	10	20					2	2	(41) 16										
1969							2	(43) 12	19										
1970					(45) 19	10													
1972					4	(44) 16	4												
1976	5	26					(51)												
1977	7	20					(40)												

Table – I.2.1 (d) Strong Wind Record (MPH)

Year	Month	Date	N	NNW	NW	WNW	W	WSW	SW	SSW	S	SSE	SE	ESE	E	ENE	NE	NNE
1963	9	17	–	–	–	–	2	3	2	(70) 7	3	7	–	–	–	–	–	–
1964	7	1	–	–	–	–	–	(14) 17	5	–	–	–	–	–	–	–	–	–
1965	10	23	–	–	–	–	–	–	–	–	(48) 1	–	9	1	6	–	–	–
1966	1	30	–	–	–	–	–	–	–	–	(50) 10	2	9	1	1	1	–	–
1967	7	12	–	–	–	–	(54) 15	3	2	–	–	–	–	–	–	–	–	–
1968	7	18	–	–	1	(60) 3	3	3	3	1	2	1	1	–	–	–	–	–
1969	12	19	–	–	–	(49) 2	1	1	1		3	3	–	–	–	–	–	–
1970	5	15	–	–	(48) 19	10	3	–	–	–	–	–	–	–	–	–	–	–
1971	9	22	–	–	–	–	8	(58) 12	1	–	–	–	–	–	–	–	–	–
1972	9	8	–	–	–	–	(48) 10	1	10	–	–	–	–	–	–	–	–	–
1973	7	3	–	2	(53) 29	2	–	–	–	–	–	–	–	–	–	–	–	–
1974	7	25	–	–	–	–	(56) 9	–	–	–	–	–	–	–	–	–	–	–
1975	6	15	20	–	–	–	–	–	–	–	–	–	–	–	–	–	(78) 6	–
1976	6	26					(52)											
1977	7	20					(40)											
1978																		
1979																		

Table – I.2.2 (a) Wind Occurrence (U>0m/sec) (1963~75)
(No. of Observation)

	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	% of Observation
1963	15	14	6	3	2	3	3	13	21	19	21	10	3	9	5	15	862
1964	23	3	5	0	3	0	0	3	12	22	36	16	5	5	12	8	151
1965	20	5	1	0	2	2	3	13	30	35	38	20	8	6	14	5	205
1966	32	2	6	3	7	1	17	25	52	16	65	17	7	12	27	2	294
1967	20	10	16	1	11	1	12	1	21	21	55	39	18	19	23	16	315
1968	24	6	6	1	2	3	2	2	4	9	44	58	61	30	32	11	301
1969	16	1	10	2	3	0	3	0	6	5	38	63	41	29	20	15	233
1970	1	17	26	2	3	0	4	0	2	6	39	20	26	20	13	5	175
1971	2	5	11	5	1	2	1	0	0	1	22	13	17	8	13	3	107
1972	10	6	15	1	9	0	3	7	9	1	29	22	26	22	18	11	190
1973	17	3	3	0	3	3	3	0	1	0	3	0	11	20	33	25	128
1974	17	15	8	8	10	1	5	7	11	11	25	11	30	15	31	6	214
1975	51	18	29	1	13	3	12	1	6	0	1	7	7	5	15	5	180
1976																	
1977																	
Total	248	105	140	33	69	22	68	72	175	156	409	276	293	200	255	133	2655

Table – I.2.2 (b) Wind Occurrence (U>5m/sec)
(No. of Observation)

	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	% of Observation
1963	12	14	5	2	0	3	3	13	21	18	29	9	3	8	5	11	147
1964	23	3	5	0	1	0	0	1	12	22	31	16	5	3	7	5	136
1965	19	1	1	0	2	1	3	9	22	39	28	16	5	3	11	5	165
1966	27	0	1	1	1	1	10	17	35	8	53	9	1	1	26	2	207
1967	18	9	13	1	9	0	1	0	11	62	37	26	36	10	16	15	222
1968	16	6	1	1	2	1	1	0	3	1	23	35	49	16	35	11	202
1969	12	1	8	2	3	0	1	0	3	3	21	22	14	12	1	11	117
1970	0	11	15	0	2	1	1	0	1	5	11	11	18	13	9	1	105
1971	2	5	9	5	1	1	0	0	0	1	17	9	11	8	11	3	86
1972	10	6	9	1	9	0	3	3	6	2	10	5	17	11	12	11	124
1973	17	3	3	0	3	3	3	0	1	0	1	9	9	13	23	22	103
1974	17	11	7	8	8	1	1	3	7	13	19	9	28	11	30	6	185
1975	11	15	26	1	12	3	8	1	3	0	1	7	1	1	11	5	151
1976																	
1977																	
Total	219	85	111	30	58	15	41	67	129	118	284	178	208	119	188	114	1943

Table – I.2.2 (c) Wind Occurrence (U>10m/sec)
(No. of Observation)

	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	% of Occurrence
1963	7	10	4	2	0	1	2	7	16	13	16	7	1	4	3	4	97
1964	18	1	4	0	3	0	0	0	3	9	14	8	5	1	0	1	67
1965	3	2	2	0	1	1	1	2	5	7	5	3	2	2	2	1	39
1966	8	0	1	1	1	1	1	1	14	5	10	2	0	0	7	2	54
1967	1	2	3	1	1	0	0	2	0	1	13	11	17	1	8	9	76
1968	1	1	0	0	0	0	0	5	1	1	7	7	26	1	7	3	66
1969	7	1	2	2	0	0	0	0	0	0	5	5	1	2	0	2	39
1970	0	1	0	0	0	1	0	0	0	3	3	3	5	2	1	2	24
1971	0	3	3	0	1	0	0	0	0	1	7	1	6	3	3	1	32
1972	2	2	3	1	6	0	0	0	0	0	0	2	2	3	5	6	32
1973	10	3	3	0	0	1	1	0	0	0	0	0	1	2	1	3	31
1974	3	1	1	0	2	1	2	0	0	3	1	3	11	3	9	1	48
1975	15	6	5	2	5	0	2	0	2	0	1	2	1	0	1	0	51
1976																	
1977																	
Total	57	33	34	13	20	6	9	12	31	43	85	57	86	30	55	35	617

Table – I.2.3 (a) Wind Occurrence (1976) (U>O Knot)
(No. of Observation)

Month \ Direction	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW		e. s.	% of Occurrence
1																			
2																			
3																			
4																			
5						3	3		21	110	113	35	4				24×31	155	289
6	5					22	15	2	58	157	219	89	13		1		24×30	119	691
7					1	2	2	1	5	2	24	83	14	5	2	2	24×31	641	103
8																			
9																			
10																			
11	23	7	3	5	4	1	5	22	29	10	3	13	12	5	3	4	28×30	521	149
12																			
Total	31	7	3	5	5	28	25	25	133	219	339	121	43	10	6	8	2928	1786	1182

Table – I.2.3 (b) (U>15 Knot)
(No. of Observation)

Direction / Month	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW		n. o.	No. of Observation
1																			
2																			
3																			
4																			
5										2	8	3	2				15	0	15
6	1										2	7	6				17	1	16
7											1	6	7				14	0	14
8																			
9																			
10																			
11							1		3	1							6	1	5
12																			
Total	1						1		3	3	11	16	15				52	2	50

Table – I.2.3 (c) (U>20 Knot)
(No. of Observation)

Direction / Month	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW		n. o.	No. of Observation
1																			
2																			
3																			
4																			
5													1				1	0	1
6											1	2	6				9	0	9
7													6				6	0	6
8																			
9																			
10																			
11																			
12																			
Total											1	2	13				16	0	16

Table – I.2.3 (d) Wind Occurrence (1977) (V>O Knot)
(No. of Observation)

Direction / Month	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW		a.a.	% of Observation
1	2	6	4	36	69	62	109	49								5	24×31	422	322
2	52	18	50	20	36	29	5	10	1	6	3	8	16	23	45	72	24×30	294	626
3	6	6	18	22	35	88	18	7	3	9	13	35	18	19	24	24	24×31	358	386
4																			
5					1	4	3	7	11	34	61	47	4				24×31	569	375
6						1		1	9	41	172	263	92	5			24×30	136	584
7	3	1	1		1	9	8		4	59	127	125	134	27	5	2	24×31	262	502
8						4	6	5	19	281	127	32	2				24×31	338	406
9					1	4	1		8	59	143	35		1			24×30	697	223
10	21		4	3	33	35	17	19	10	13	26	22	5	6	5	3	24×31	519	225
11	10	5	3	7	16	28	14	11	8	13	9	21	25	10	8	33	24×30	496	226
12					2	16	36	11									24×31	611	30
Total	93	66	80	88	239	283	210	120	107	668	684	574	296	93	87	136	8088	4,565	3543

Table – I.2.3 (e) Wind Occurrence (V>15 Knot)
(No. of Observation)

Direction / Month	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total	a.a.	% of Observation
1				2	11	23	65	22								5	156	18	136
2	11	4		1			1							3	5	8	35	0	35
3	1		1	2	1	1		1	2		2	9	2	2	1		31	6	25
4																			
5					1	1			3	10	5	9					41	12	29
6									1	2	20	88	38				183	2	181
7	1	1								1	1	11	43	16	2		79	3	76
8										6	6	19	2				32	8	24
9											1			1			8	6	2
10					1						1			1			3	0	3
11	1				1		3		2		2	3	11	2		4	29	0	29
12					3	12	29	1									64	16	48
Total	13	5	1	5	21	37	98	32	8	19	38	122	96	25	8	17	620	11	549

Table – I.2.3 (f) Wind Occurrence (V>20 Knot)
(No. of Observation)

Direc-tion / Month	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total	n.o.	% of Occurrence
1							14	7								2	23	0	23
2	2	1					1									1	5	0	5
3			1			1		1				1	1				5	0	5
4																			
5					1					2							3	0	3
6										1	2	6	6				15	0	15
7		1										2	10	4			17	0	17
8										1	1	1					3	0	3
9														1			2	1	1
10					1									1			2	0	2
11												1					1	0	1
12							1										1	0	1
Total	2	2	1	0	2	1	16	8	0	4	3	11	17	6	0	3			16

Table – I.2.4 (a) Monthly Wind Occurrence (1963-75) (V>10m/sec) Jan.
(No. of Observation)

	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	% of Occurrence
1963	3	3															6
1964	14	1	3													1	19
1965					1												1
1966	6														2	1	9
1967	1		1													3	5
1968	2	1														1	4
1969	3		2	2												2	9
1970															1		1
1971		1															1
1972	1	2	1												3	1	11
1973	1		2			1											4
1974	2												1	2	2		7
1975		2	1		1							2	1		3		10
1976																	
1977																	
Total	36	10	10	2	2	1	0	0	0	0	0	2	2	2	11	11	99

Table – I.2.4 (b) Feb.
(No. of Observation)

	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	% of Observatio
1963	1	5									1			2	1	1	11
1964	1		1		2												7
1965																	0
1966				1											4	1	6
1967	2														4	2	8
1968	1														2	1	4
1969	1																1
1970																	0
1971																	0
1972	1														1		2
1973		3	1														4
1974							1						1	1	1		4
1975	1										1						2
1976																	
1977																	
Total	11	8	2	1	2	0	1	0	0	0	2	0	1	3	13	5	49

Table – I.2.4 (c) Mar.
(No. of Observation)

	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	% of Observatio
1963	1		1	1		1								2			6
1964					1				1		1		3				6
1965																	0
1966												1					1
1967					1						1						2
1968													2		2	1	5
1969																	0
1970						1											1
1971					1												1
1972																	0
1973																	0
1974																	0
1975									2								2
1976																	
1977																	
Total	1	0	1	1	3	2	0	0	3	0	2	1	5	2	2	1	21

Table – I.2.4 (d) Apr.
(No. of Observation)

	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	% of Occurrence
1963	1	1					1	1	1				1		1		7
1964																	0
1965																	0
1966	1				1				1	3	1						7
1967													1				1
1968												1	2		1		4
1969																	0
1970																	0
1971																	0
1972																	0
1973																	0
1974																	0
1975																	0
1976																	
1977																	
Total	2	1	0	0	1	0	1	1	2	3	1	1	4	0	2	0	19

Table – I.2.4 (e) May
(No. of Observation)

	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	% of Occurrence
1963				1													1
1964																	0
1965												1					1
1965							1	1	2	1							5
1967								2		1	2		1				6
1968											1		4				5
1969											2	1					3
1970										1							1
1971													1				1
1972				1								2	1	3	1		8
1973							1						3				4
1974												1					1
1975	3																3
1976																	
1977																	
Total	3	0	0	2	0	0	2	3	2	3	5	5	10	3	1	0	39

Table – I.2.4 (f) Jun.
(No. of Observation)

	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	No. of Observation
1963								1	5	3	1						10
1964									1	5	4	1					11
1965									1	4		1	1	1			8
1966									3		3	1					7
1967											1		2				3
1968										1	4		8	1			14
1969												3	1				4
1970											1		3	1	2		7
1971										1	4	1		1			7
1972																	0
1973																	0
1974		1													3		4
1975	7		3	2	1												13
1976																	
1977																	
Total	7	1	3	2	1	0	0	1	10	14	21	7	15	4	5	0	91

Table – I.2.4 (g) Jul.
(No. of Observation)

	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	No. of Observation
1963								1	1	1		1					4
1964									1	1	4	4	1				11
1965										1	3						4
1966						1				1	1						3
1967											1	1	8		2		12
1968									1		2	3	5	3	1		15
1969																	0
1970										2	2	3					7
1971												1	2				3
1972																	0
1973	4														4		8
1974												1	4		3		8
1975	2				2		2										6
1976																	
1977																	
Total	6	0	0	0	2	1	2	1	3	5	13	14	20	3		0	81

Table – I.2.4 (h) Aug.
(No. of Observation)

	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	% of Observation
1963								2	2	3	10	2					19
1964										1							1
1965												1					1
1966											3						3
1967											1	4	4				9
1968												3	2	1			6
1969											2		2	1			5
1970													1				1
1971														1	2		3
1972																	0
1973	5															3	8
1974										1	2		5				8
1975	5	4	4		2										6		15
1976																	
1977																	
Total	10	4	4	0	1	0	0	2	2	5	18	10	14	3	3	3	79

Table – I.2.4 (i) Sep.
(No. of Observation)

	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	% of Observation
1963			1					1	7	6		3					18
1964										1	2	1					4
1965								2	2	1							5
1966									7		2						9
1967											5	2					7
1968													4	2			6
1969																	0
1970														1			1
1971											3	2	3	1			9
1972													1				1
1973																	0
1974										2	1						3
1975																	0
1976																	
1977																	
Total	0	0	1	0	0	0	0	3	16	10	13	8	8	4	0	0	63

Table – I.2.4 (j) Oct.
(No. of Observation)

	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	% of Occurrence
1963											1						1
1964											1						1
1965							1		2		1			1			5
1966	1								1								2
1967											2	1	1		1		5
1968													1		1		2
1969													1	1			2
1970													1		1	2	4
1971																	0
1972																	0
1973													1	2			3
1974											1	1					2
1975																	0
1976																	
1977																	
Total	1	0	0	0	0	0	1	0	3	0	6	5	5	4	3	2	30

Table – I.2.4 (k) Nov.
(No. of Observation)

	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	% of Occurrence
1963		1	2				1	1				1			1	3	10
1964											2	2	1	1			6
1965	1	2	2			1							1		1		8
1966																	0
1967	1	1		1										1	1	1	6
1968																	0
1969											1	1					2
1970																	0
1971			1														1
1972																	0
1973																	0
1974	1				1	1											3
1975																	0
1976																	
1977																	
Total	3	4	5	1	1	2	1	1	0	0	3	4	2	2	3	4	36

Table – I.2.4 (I) Dec.
(No. of Observation)

	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	% of Occurrence
1963	1																1
1964										1							1
1965	2									3	1				1	1	6
1966			1												1		2
1967		1	2													3	6
1968	1																1
1969	3	1															4
1970		1															1
1971		2	2												1	1	6
1972			2		4											2	10
1973																	0
1974			1	1	1		1									1	5
1975																	0
1976																	
1977																	
Total	7	5	6	1	7	0	1	0	0	2	1	0	0	0	3	8	46

Table – I.2.5 Strong Wave

	Date	H 1/3 m	T sec	Direction	V m/h
1	1968 2 4	61	91	WSW	74
2	1971 9 22	53	85	WSW	68
3	1963 9 17	48	79	SSW	70
4	1967 10 10	37	72	WSW	54
5	1968 1 2	34	68	W	56
6	1976 4 26	33	69	W	53
7	1973 1 3	32	68	NW	50
8	1974 8 12	32	68	SW	50
9	1975 6 6	32	68	N	50
10	1970 6 15	29	66	NW	48
11	1966 1 30	28	63	S	50
12	1972 5 13	28	63	WNW	44
13	1969 6 28	25	61	WSW	43
14	1965 10 20	25	60	SW	44
15	1972 6 19	23	58	W	40
	Average	35	69		

Table – I.2.6 Wave Occurrence – Direction

Direction / Month	(H>0.5m) SSW	SW	WSW	W	WNW	NW	NNW	(H>1.0m) SSW	SW	WSW	W	WNW	NW	NNW
1		6	6	7	9	28	33			3	6	4	11	14
2	3	2	7	4	6	27	14		1			2	12	5
3	3	5	1	7	9	12	2			1	1	2	1	1
4	3	11	6	5	4	3		3	1	2	3		1	
5	4	14	13	16	5	3		4	6	6	14	4	1	
6	24	50	21	25	10	10		21	37	17	16	6	5	2
7	15	34	31	41	17	16	4	8	20	17	27	5	10	2
8	21	51	25	31	8	12	15	11	34	13	18	6	9	6
9	21	30	22	23	10	6	8	15	19	13	14	8	1	
10	3	20	10	12	11	10	3		10	6	9	5	5	2
11		7	6	3	6	5	7		3	3	1	3	3	1
12	2	2	4	3	2	16	17	1	1				1	8
Total	102	232	144	177	97	148	103	63	132	81	107	45	69	61

Table – I.2.7 Wave Occurrence (1963~1975) (%)

Wave Height(m) \ Month	1	2	3	4	5	6	7	8	9	10	11	12
0 ~ 0.49	69	73	78	79	72	69	63	62	68	58	78	79
0.5 ~ 0.99	18	18	19	14	10	13	25	26	22	19	13	16
1.0 ~ 1.49	12	8	3	4	10	17	13	18	16	12	2	2
1.5 ~ 1.99	1			1	4	7	8	9	5	1	3	2
2.0 ~ 2.49		1		1	3	6	5	4	4	2	3	
2.5 ~ 2.99					1	5	2	2	2	1	1	1
3.0 ~				1		3	4		3	1		

Table – I.2.8 Depth of Bed Rock

B. Nos.	Depth of Bed Rock	
D1	-47'2"	-14.15m
D2	-51'1"	-15.325
D3	-29'3"	- 8.775
D4	-20'10"	- 6.25
D5	-15'10"	- 4.75
D6	-56'4"	-16.90
D6A	-48'11"	-14.675
D7	-42'0"	-12.60
D8	-22'6"	- 6.75
D9	- 6'8"	- 2.00
D10	-17'9"	- 5.325
D11	-65'0"	-19.50
D12	-54'9"	-16.425
D12A	-50'3"	-15.075
D13	-34'4'	-10.30
D14	-30'4"	- 9.10
D15	-35'10"	-10.75

Table – I.2.9 Result of Soil Testing

Site: Colombo Port

Sample number			BH1 12	BH1 14	BH1 16	BH1 18	BH2 5	BH2 6	BH2 7	BH2 8	BH2A 6	BH2A 7	BH2A 8	BH2A 9	BH2A 11	BH4 6
Specific gravity		Gs	2.77	2.83	2.71	2.72	2.71	2.70	2.68	2.82	2.68	2.68	2.67	2.65	2.71	2.82
Consistency	Liquid limit	W_L (%)		50.2			91.7							36.7	49.7	
	Plastic limit	W_P (%)	N.P.	30.5	N.P.	N.P.	38.7	N.P.	N.P.	N.P.	N.P.	N.P.	N.P.	21.3	20.9	N.P.
	Plasticity index	I_P		19.7			53.0							15.4	28.8	
	Classification			MH			CH							CL	CL	
Texture	Gravel	Gravel(%)	9.2	0.1	0.7	0.1	0.3	3.4	3.3	1.4	1.1	3.2	5.9	0.8	7.2	79.3
	Sand	Sand (%)	44.1	42.9	43.5	40.5	5.7	74.8	71.5	70.4	74.9	76.0	77.5	50.3	46.8	13.6
	Silt	Silt (%)	16.4	17.3	30.3	33.4	54.2	12.3	4.2	16.2	2.0	0.3	2.1	12.9	18.2	3.3
	Clay	Clay (%)	30.3	39.7	25.5	26.0	39.8	9.5	21.0	12.0	22.0	20.5	14.5	36.0	27.8	3.8
	Classification		sand Clay	sand Clay	clay Sand	clay Sand	silt Clay	silt Sand	clay Sand	silt Sand	clay Sand	clay Sand	Sand	sand Clay	clay Sand	Sand

Remarks: CL : Clay with low plasticity
CH : Clay with high plasticity
MH : Silt with high plasticity

Fig. – I.2.1 Location of Sri Lanka

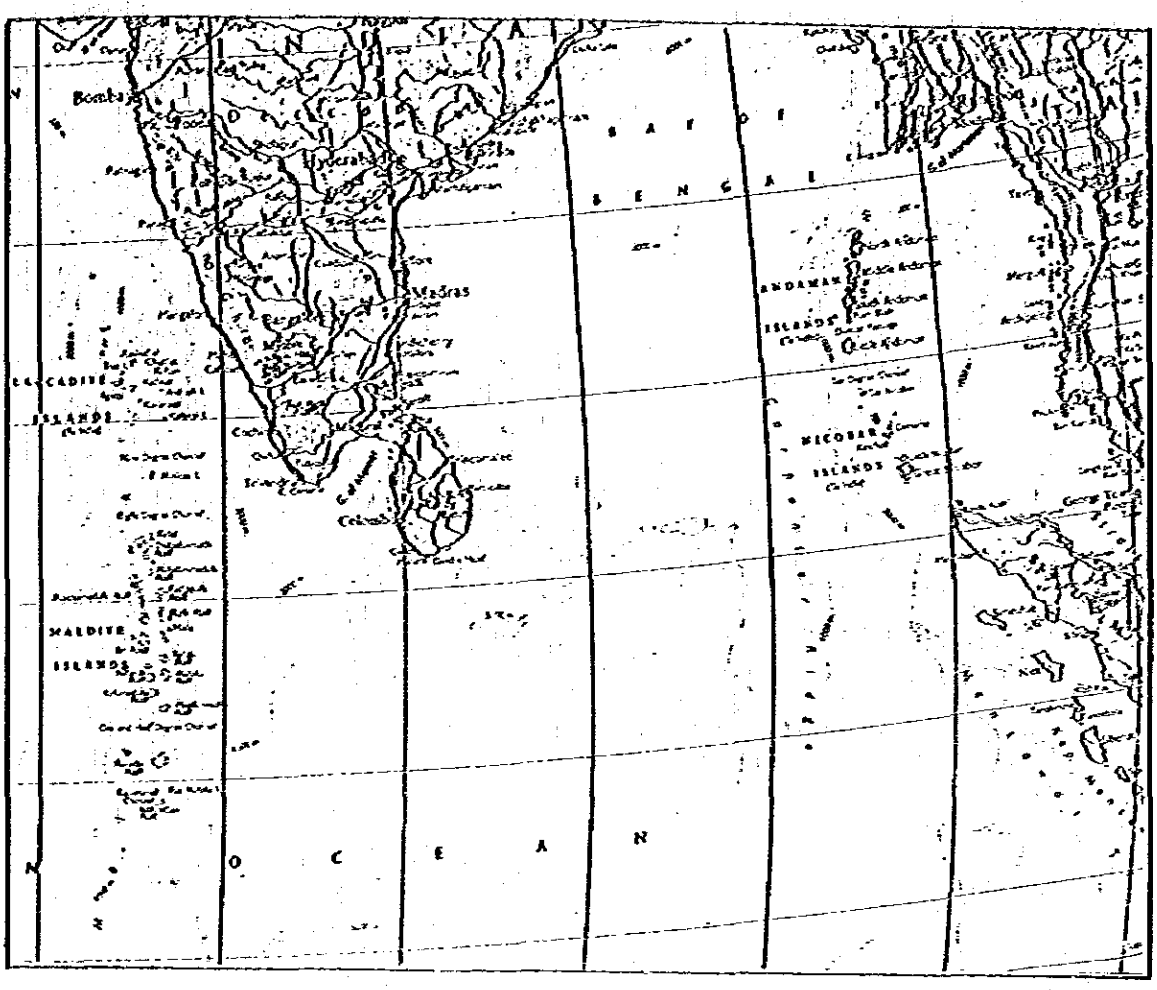


Fig. – I.2.2 Wind Rose

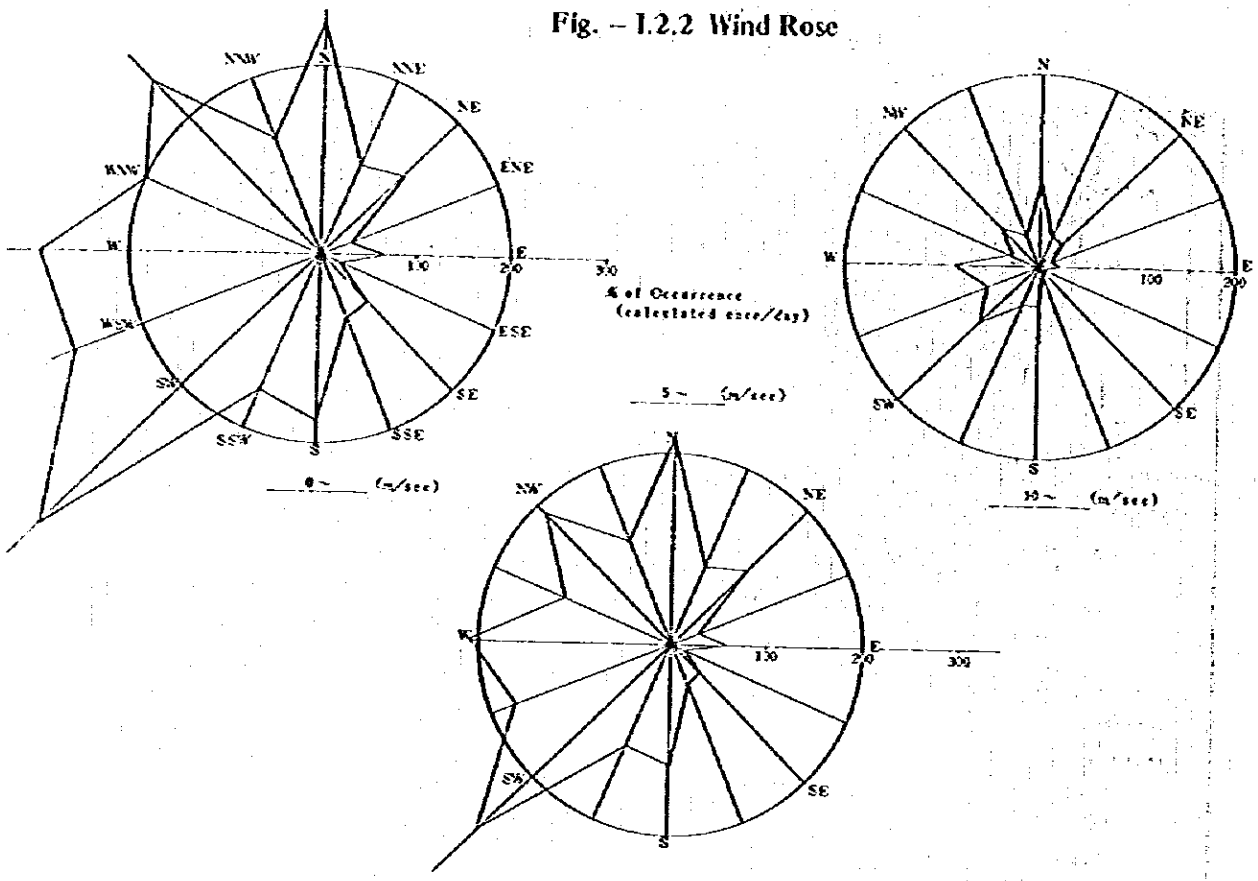


Fig. – I.2.3 (a) Wind Rose (1976)

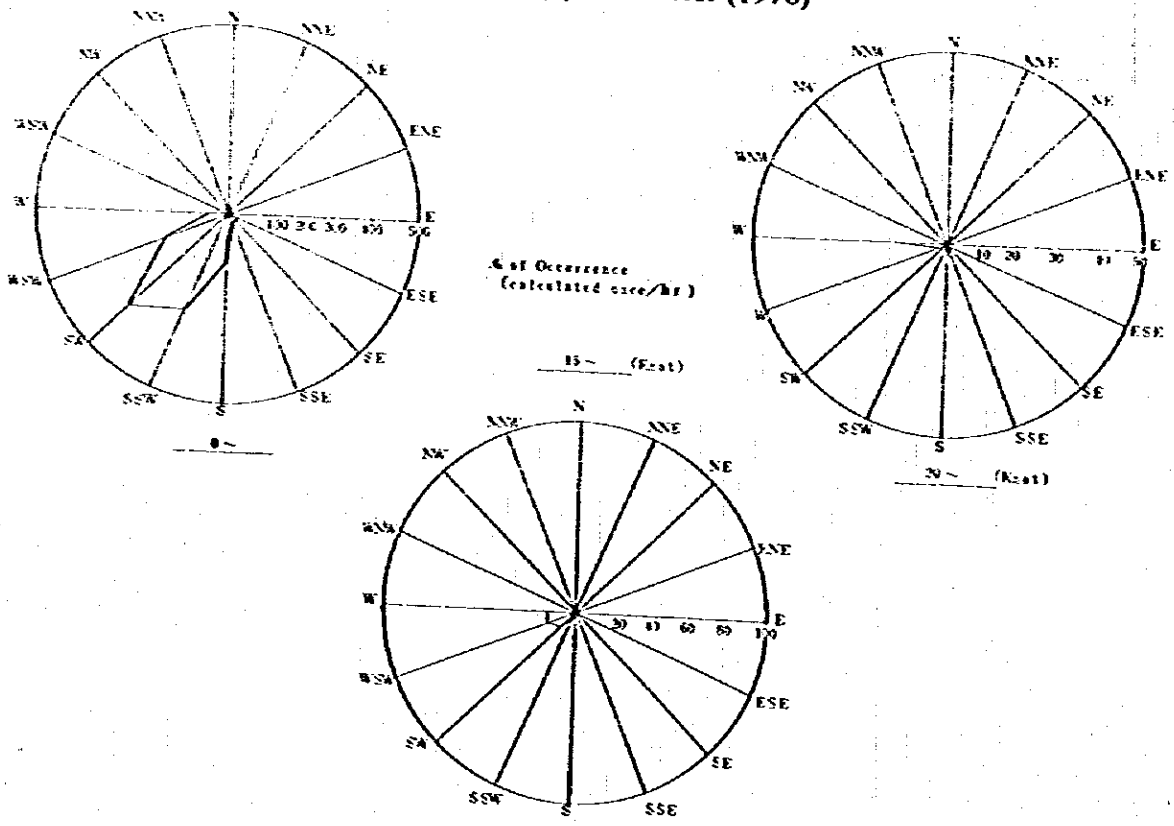


Fig. – I.2.3 (b) Wind Rose (1977)

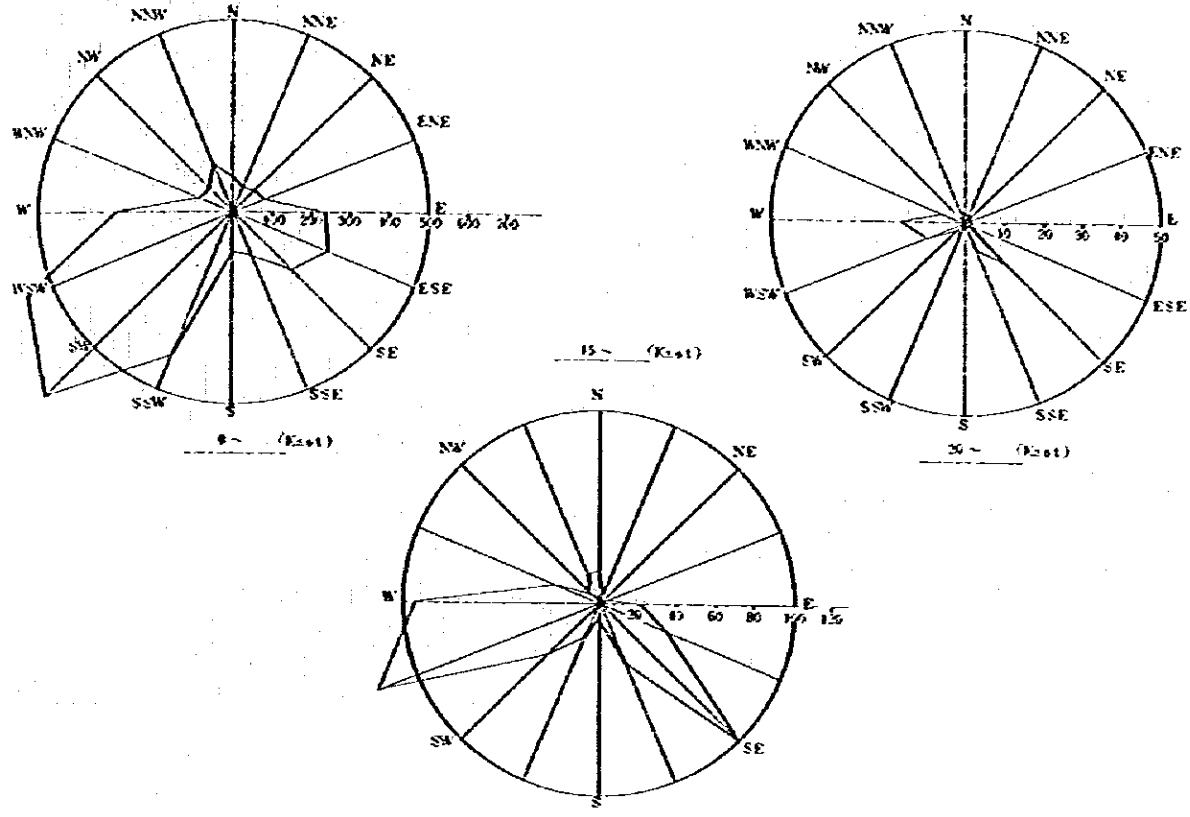


Fig. – I.2.4 (a) Wind Rose (1963~1975)
(U>10m/sec)

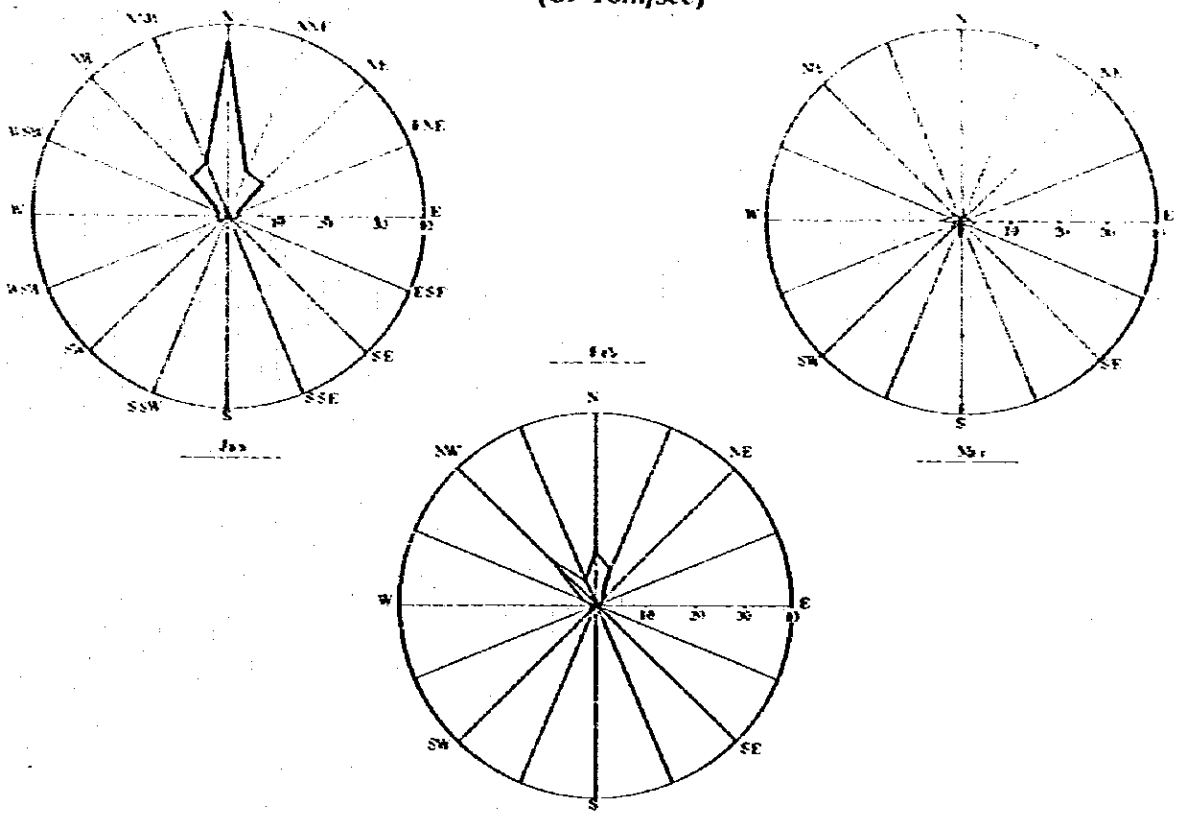


Fig. – I.2.4 (b) Wind Rose (1963~75)

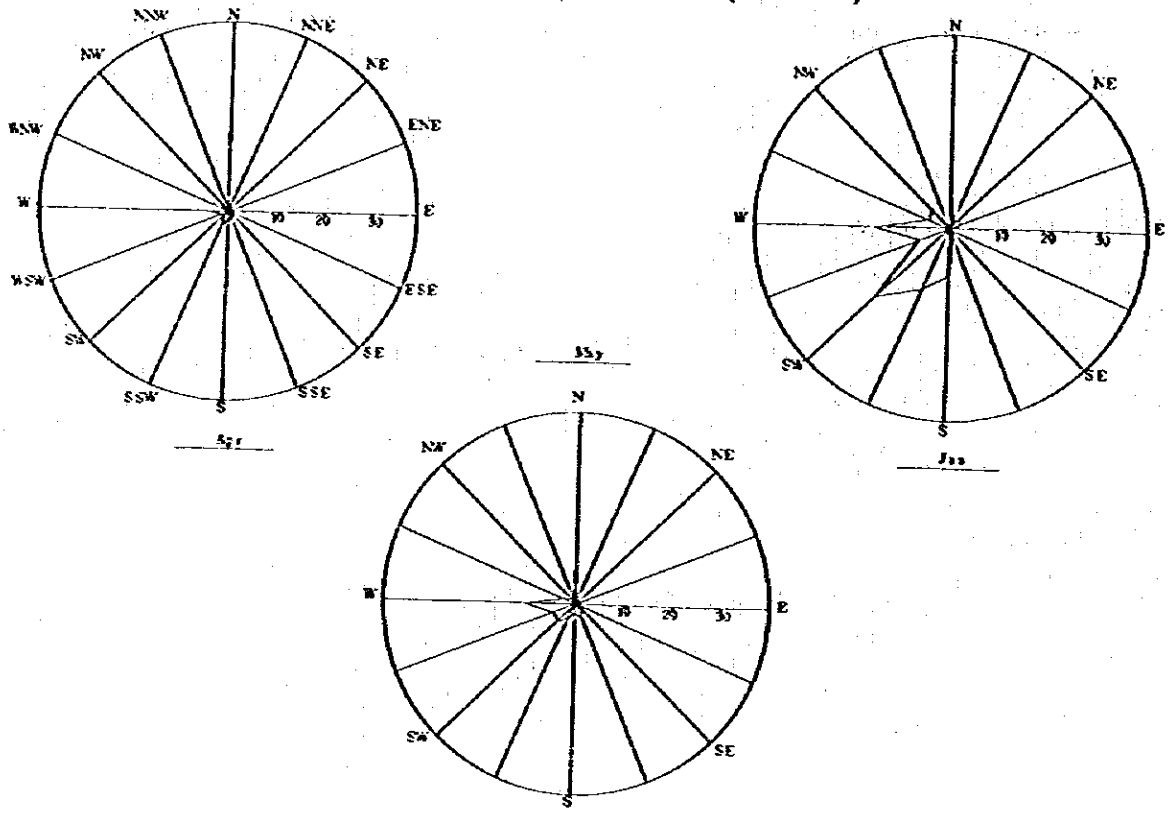


Fig. – I.2.4 (c) Wind Rose (1963~75)

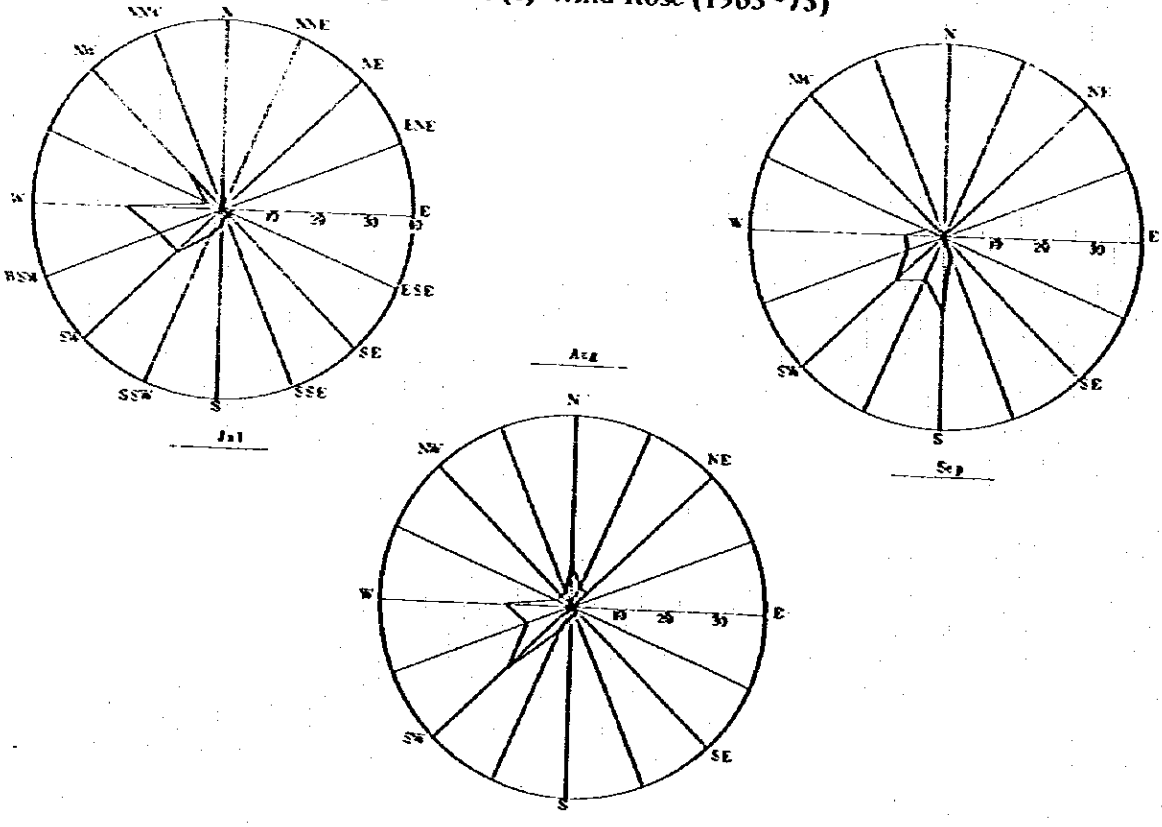


Fig. – I.2.4 (d) Wind Rose (1963~75)

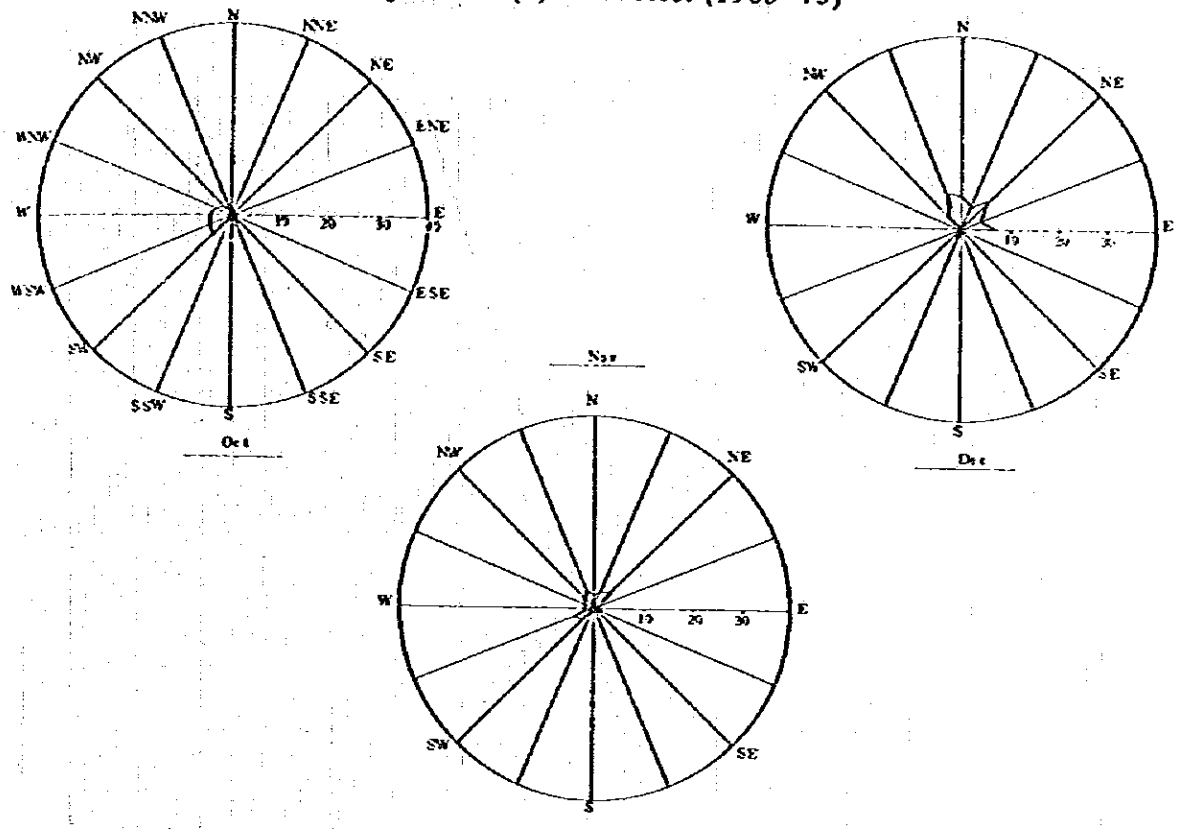


Fig. 1.2.5 Return Period, Wind

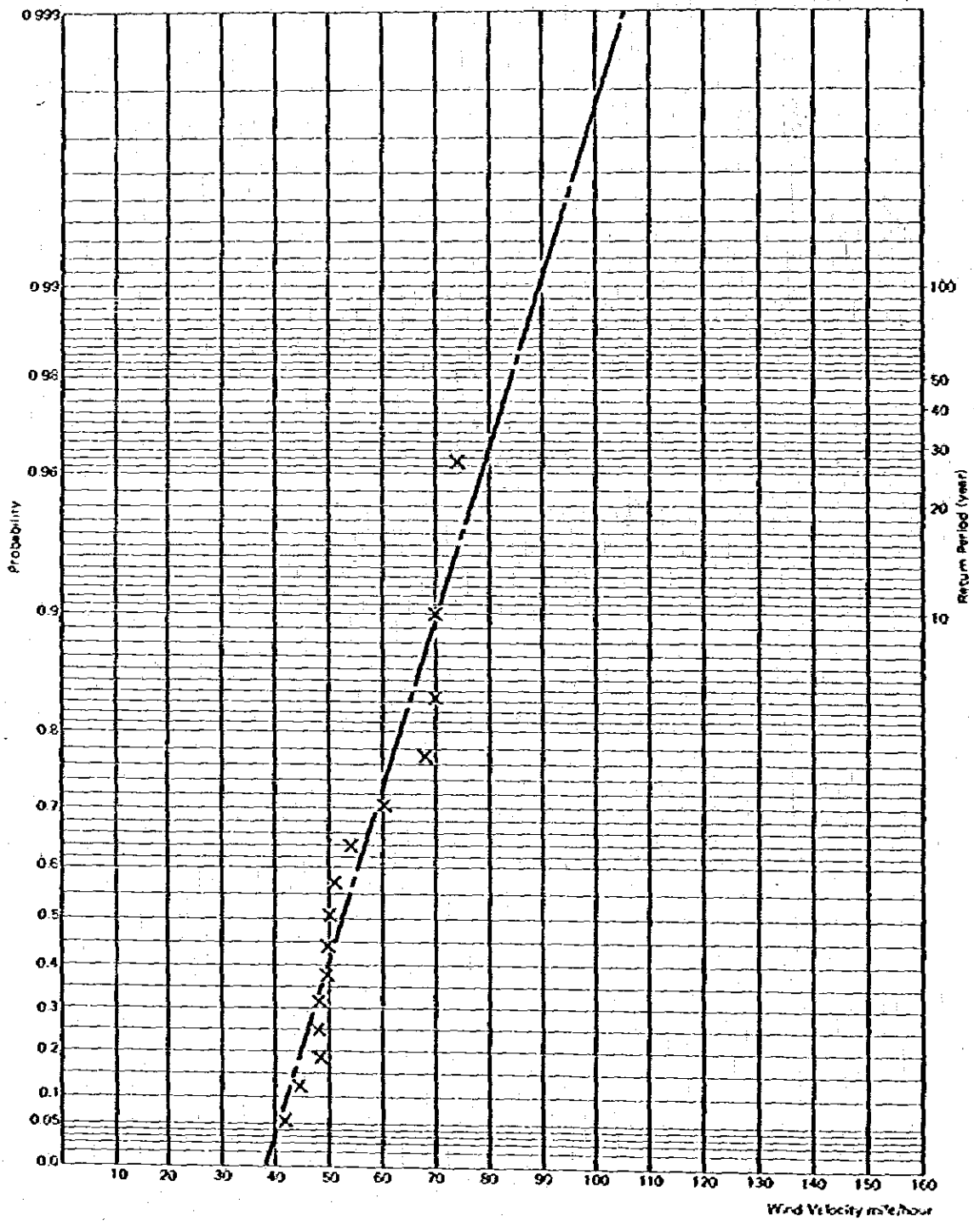


Fig. – I.2.6 Wave Occurrence

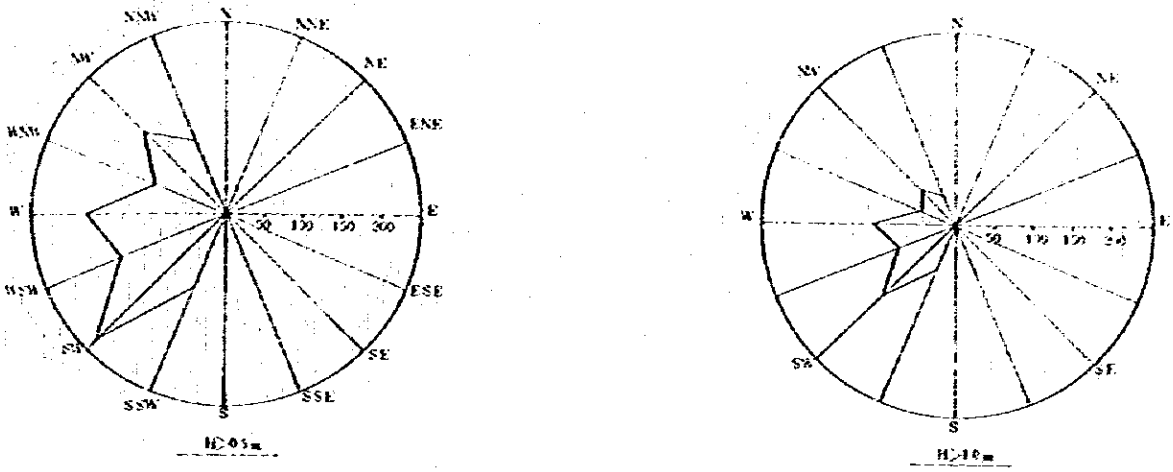


Fig. – I.2.7 (a) Monthly Wave Occurrence
(H>0.5m)

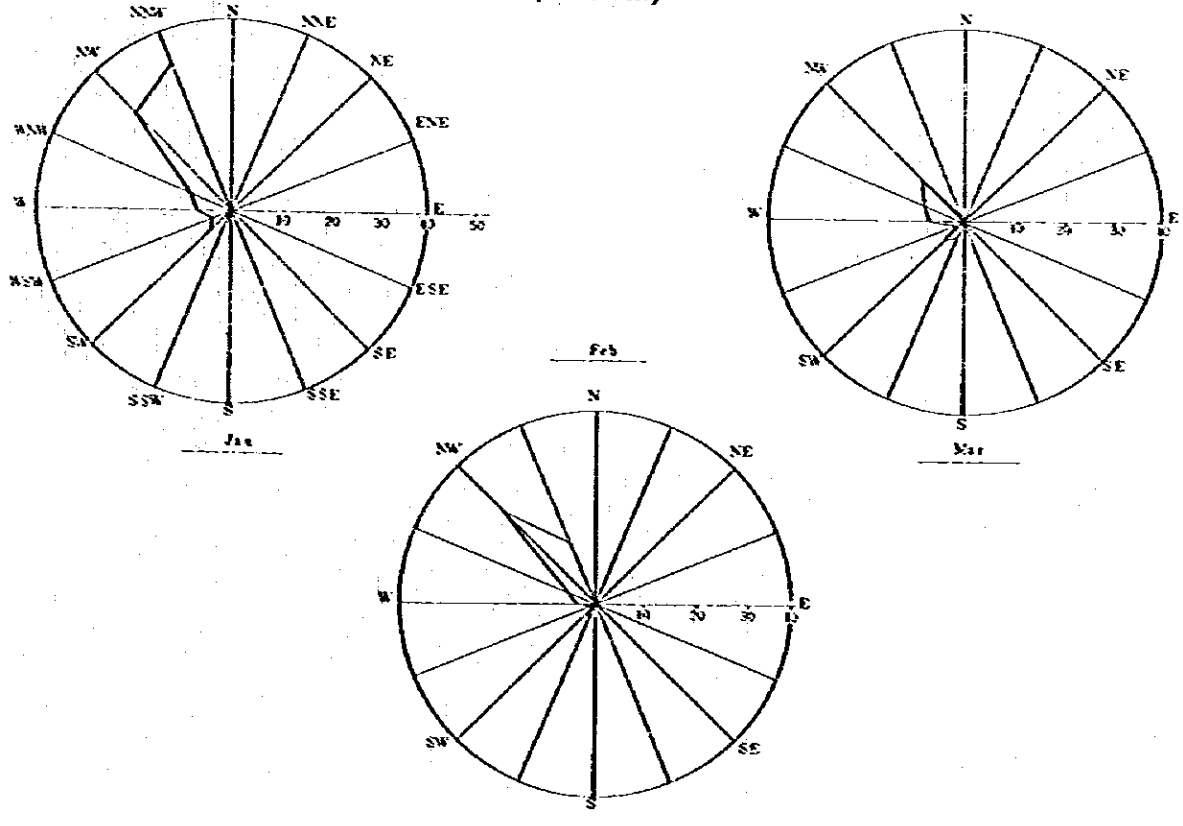


Fig. – I.2.7 (b) Monthly Wave Occurrence

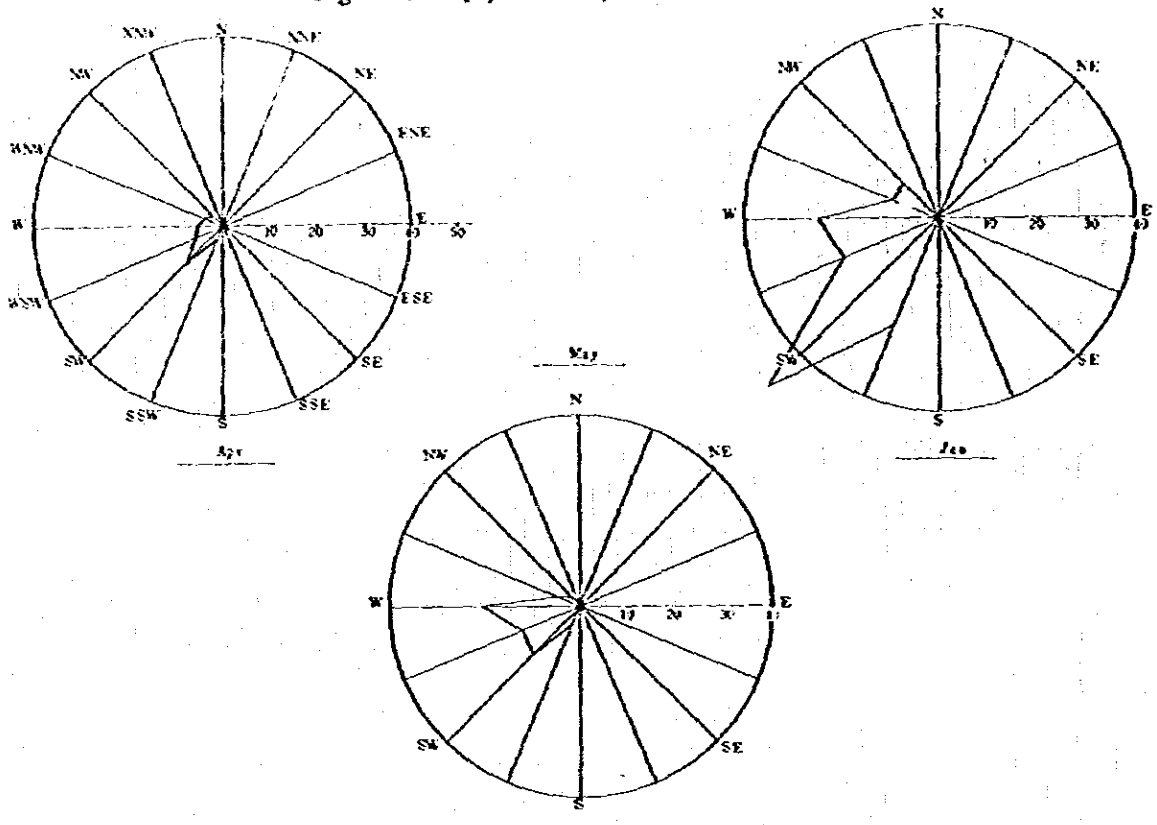


Fig. – I.2.7 (c) Monthly Wave Occurrence

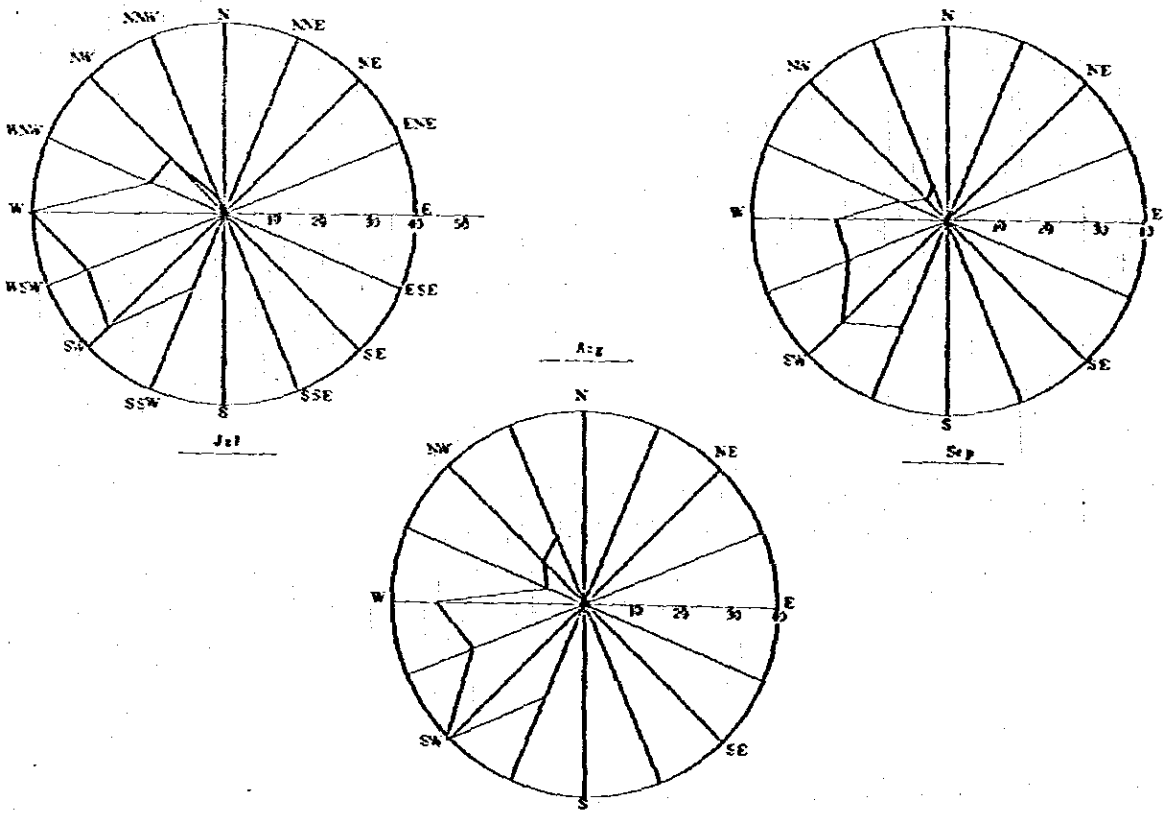


Fig. – I.2.7 (d) Monthly Wave Occurrence

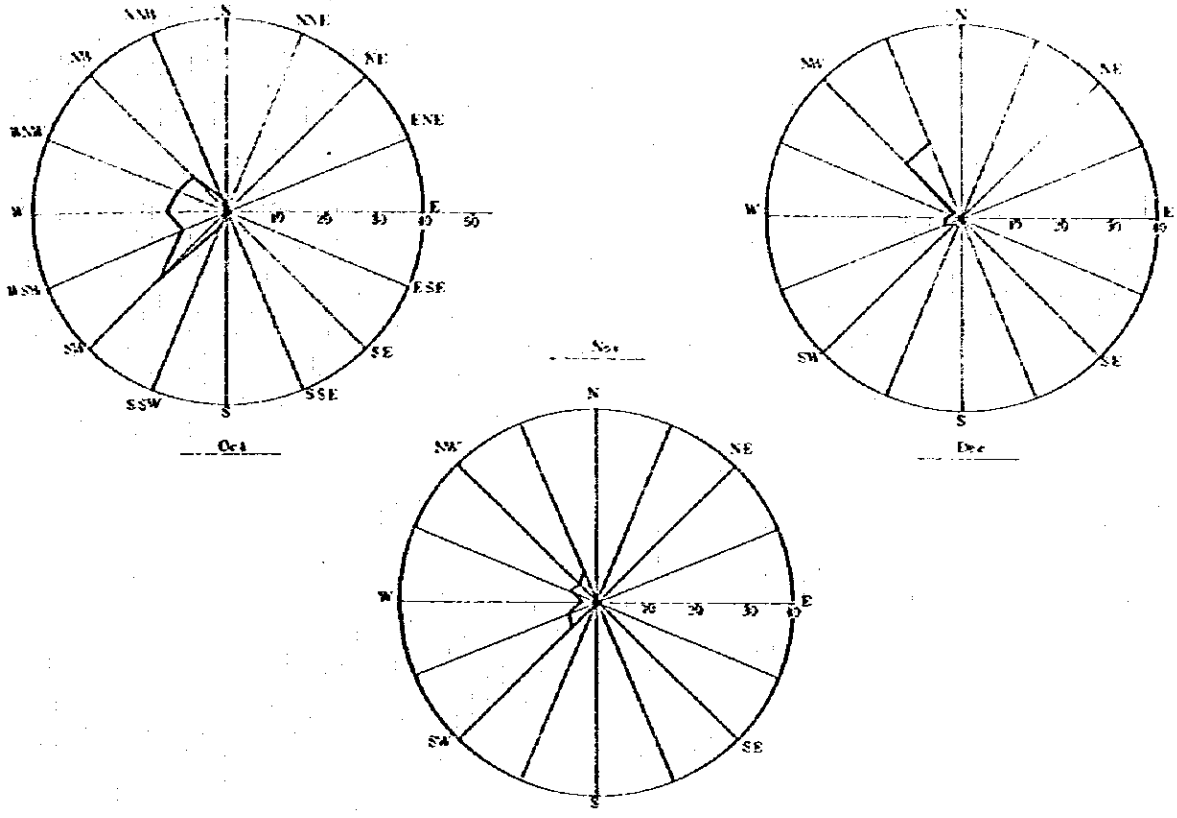


Fig. – I.2.7 (e) Monthly Wave Occurrence
(H>1.0m)

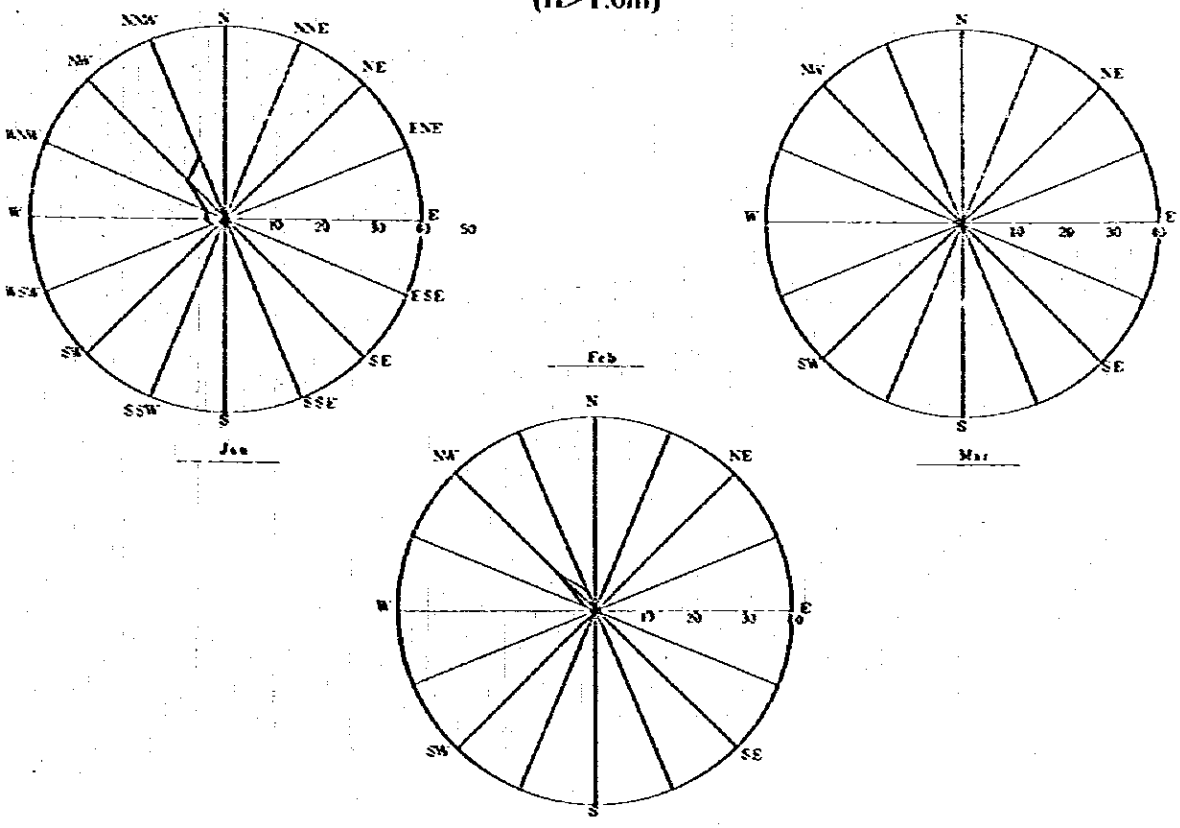


Fig. – I.2.7 (f) Monthly Wave Occurrence
(H>1.0m)

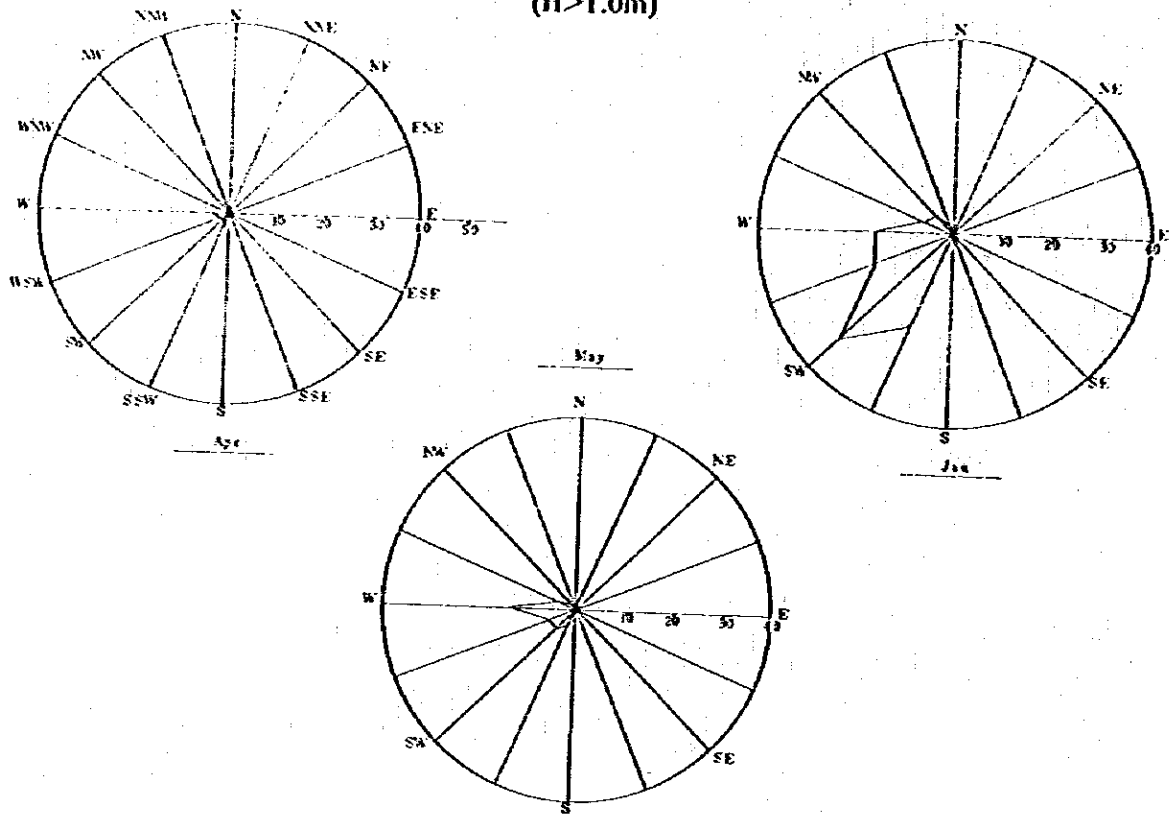


Fig. – I.2.7 (g) Monthly Wave Occurrence

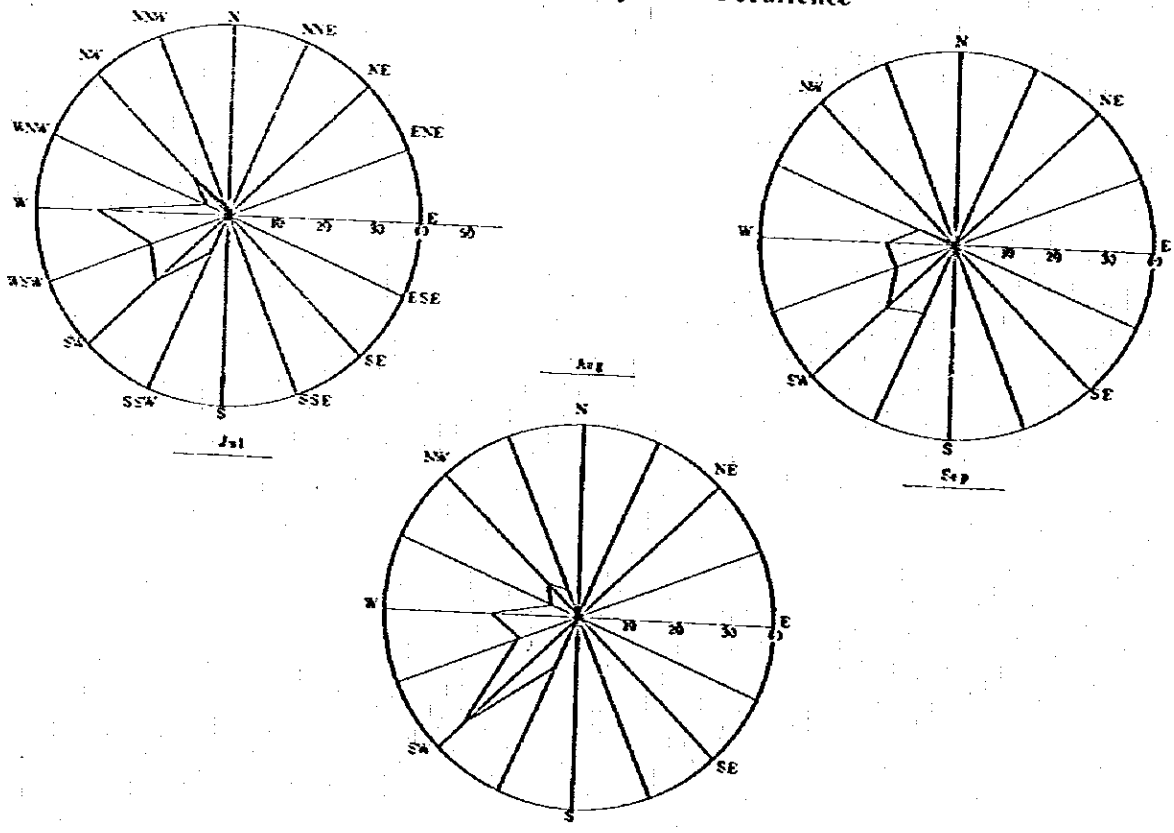


Fig. – I.2.7 (h) Monthly Wave Occurrence

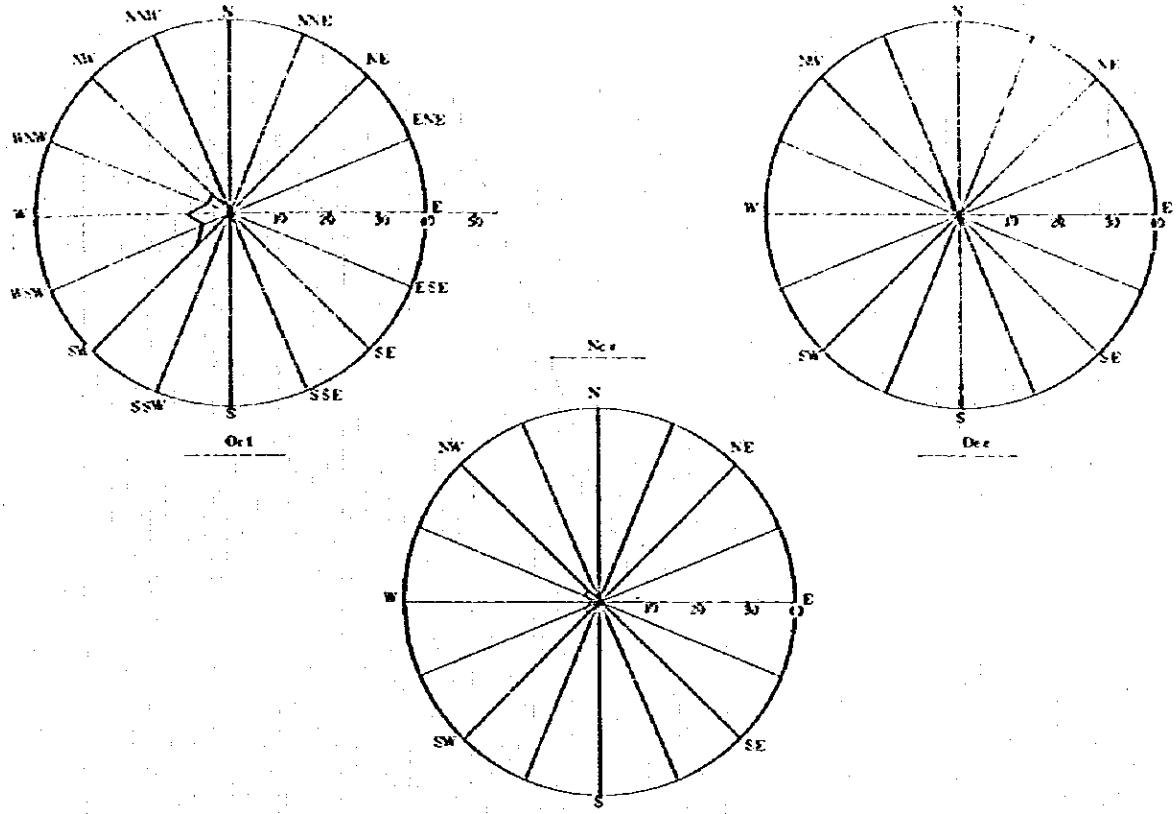


Fig. – I.2.8 Monthly Wave Occurrence

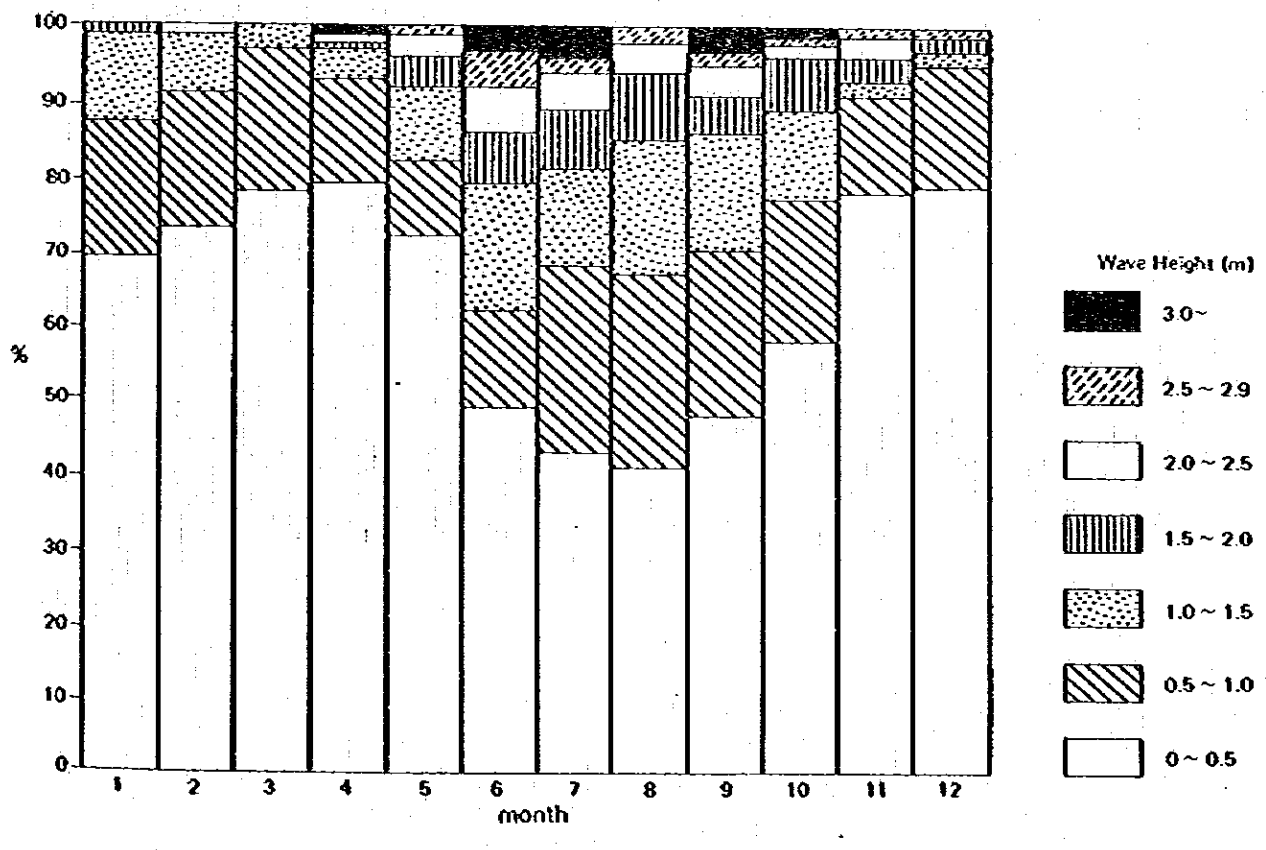


Fig. – I.2.9 Return Period, Wave

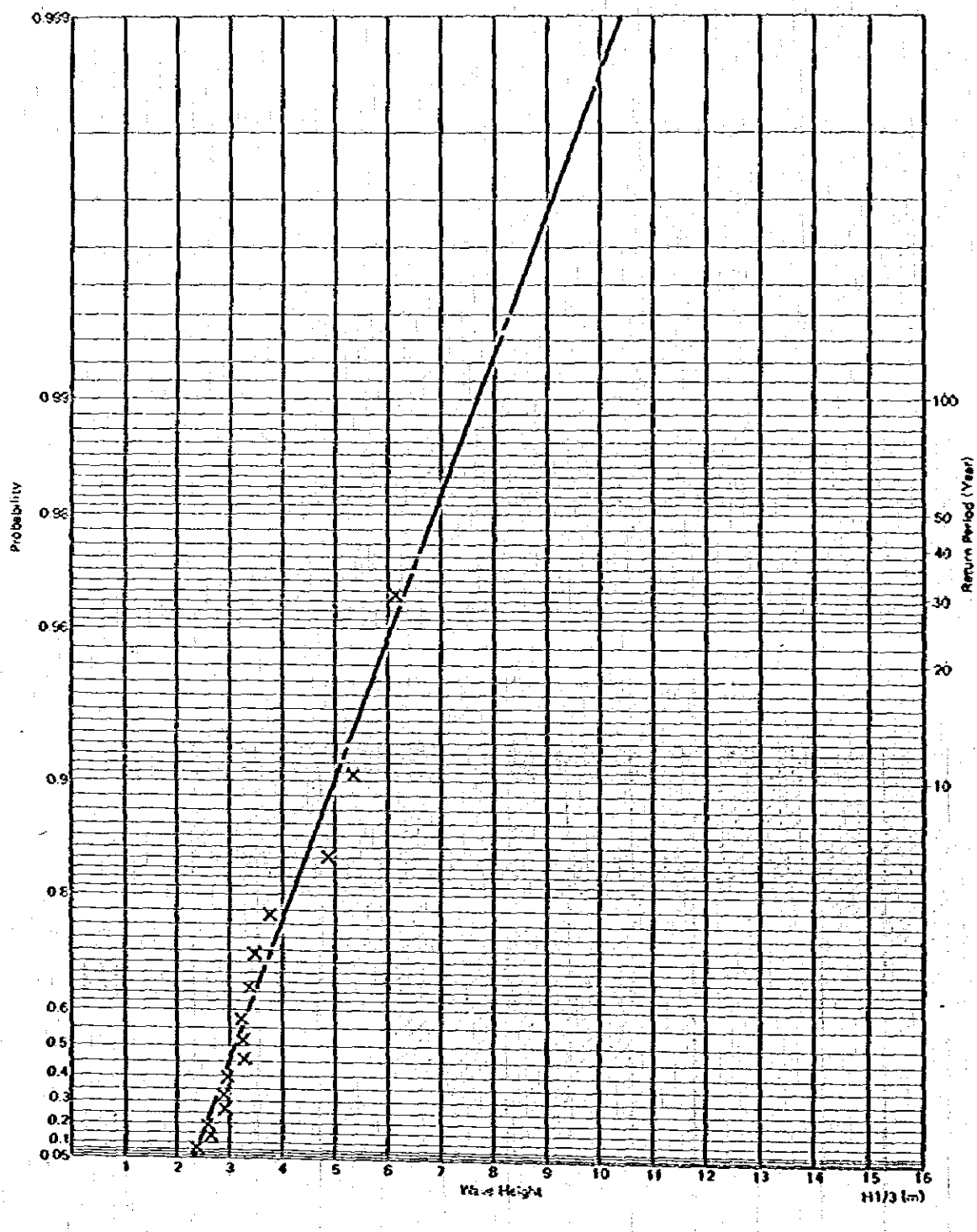


Fig. – I.2.10 (a) Refraction Diagram

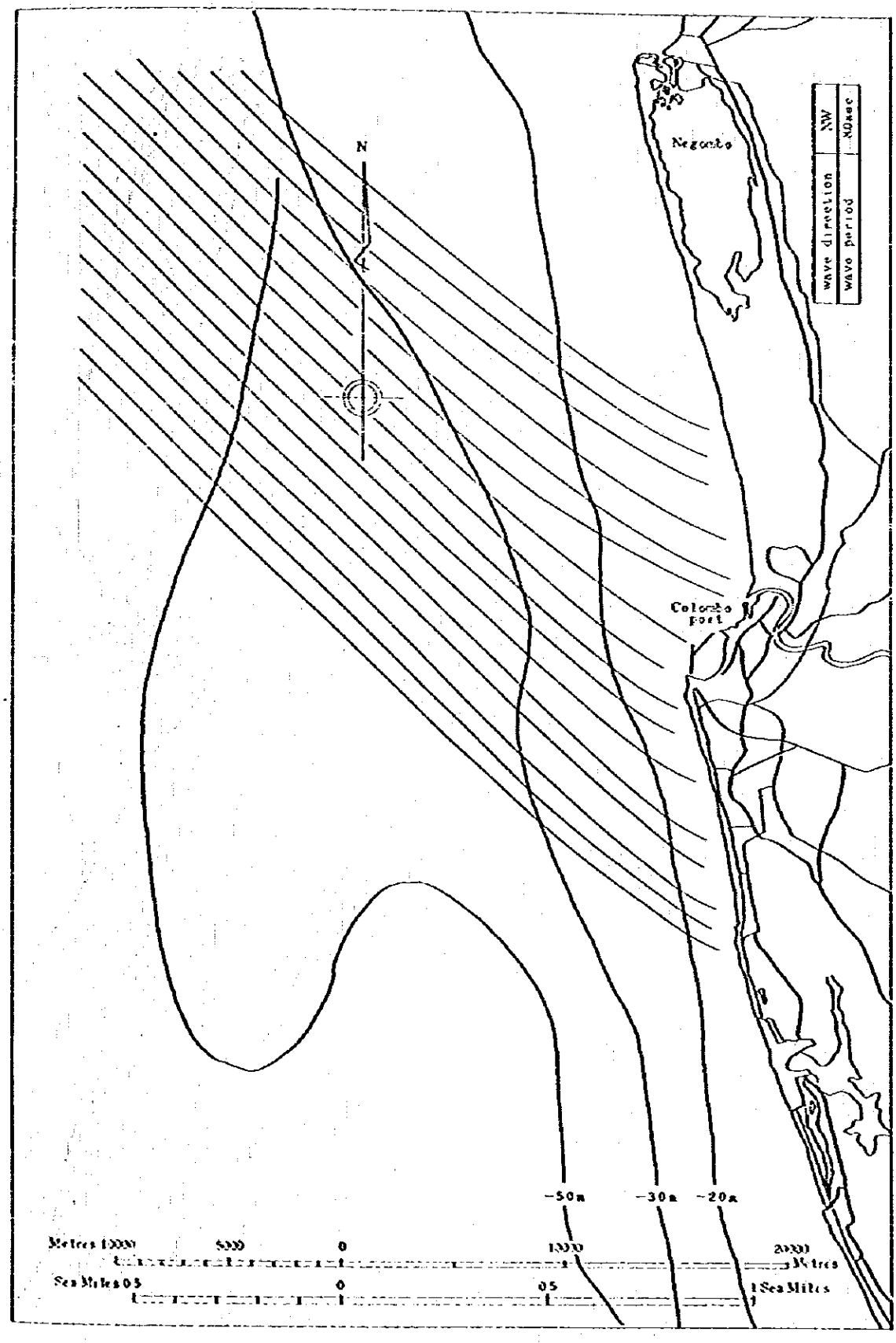


Fig. – I.2.10 (b) Refraction Diagram

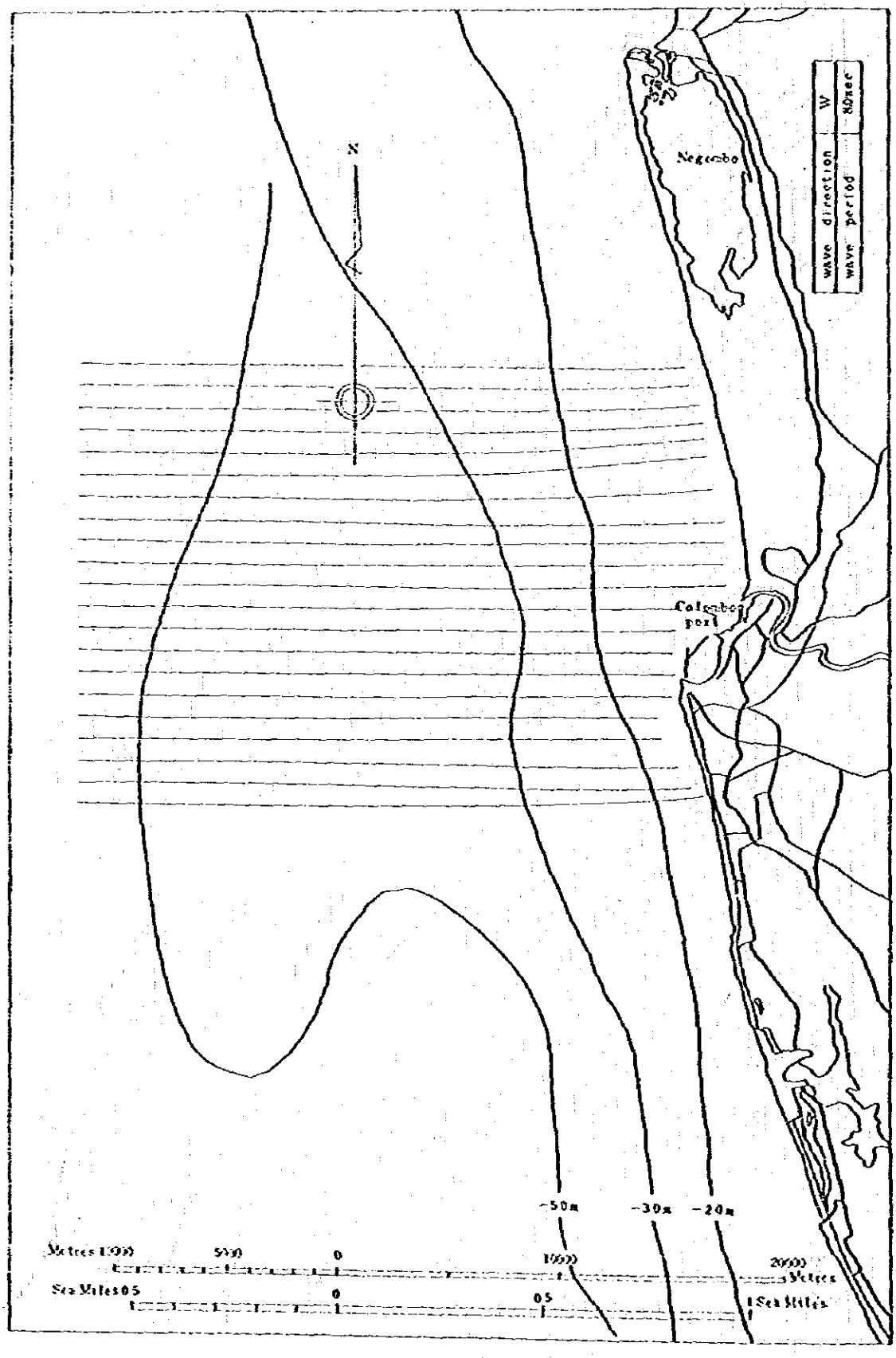


Fig. I.2.10 (c) Refraction Diagram

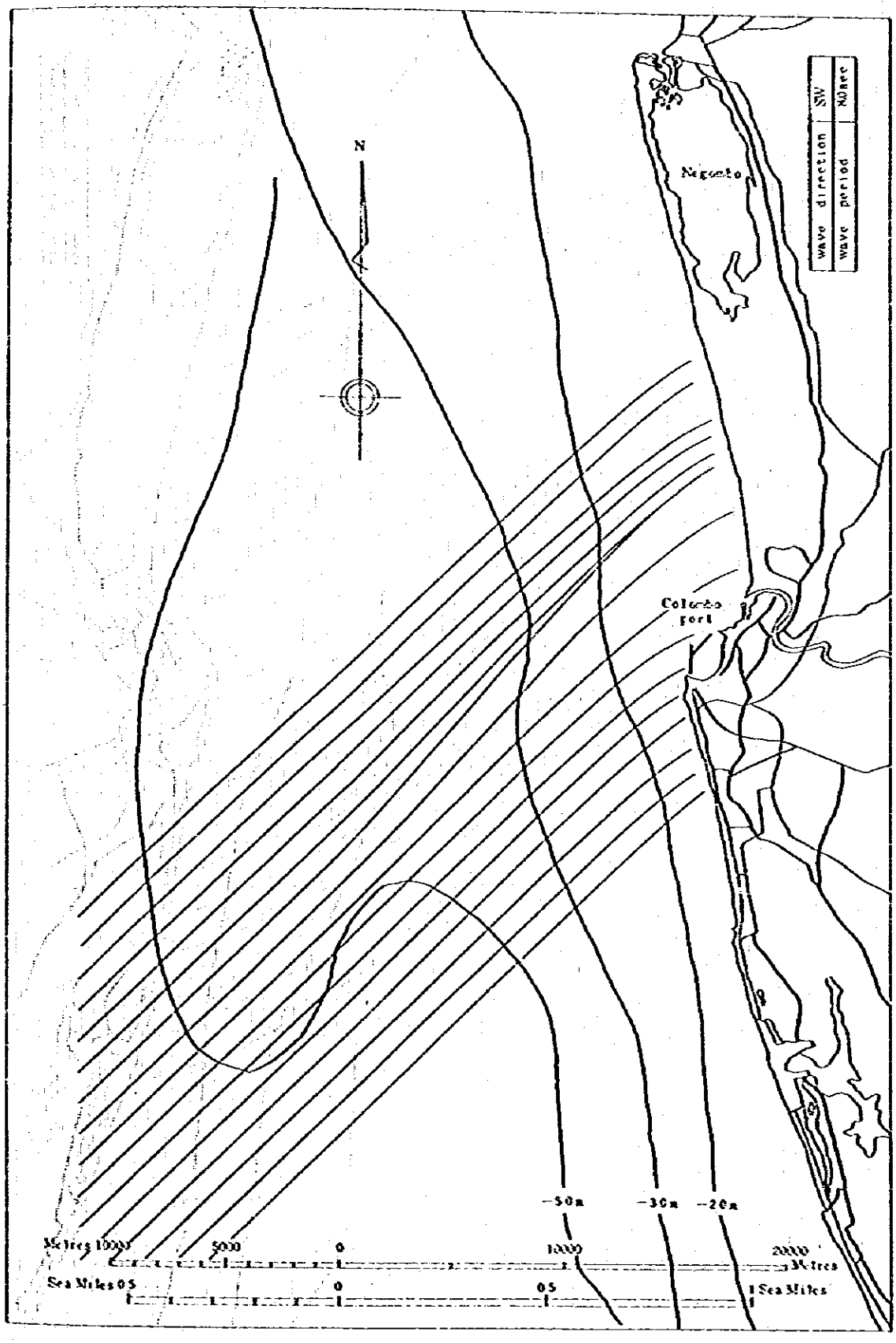


Fig. - I.2.10(d) Refraction Diagram

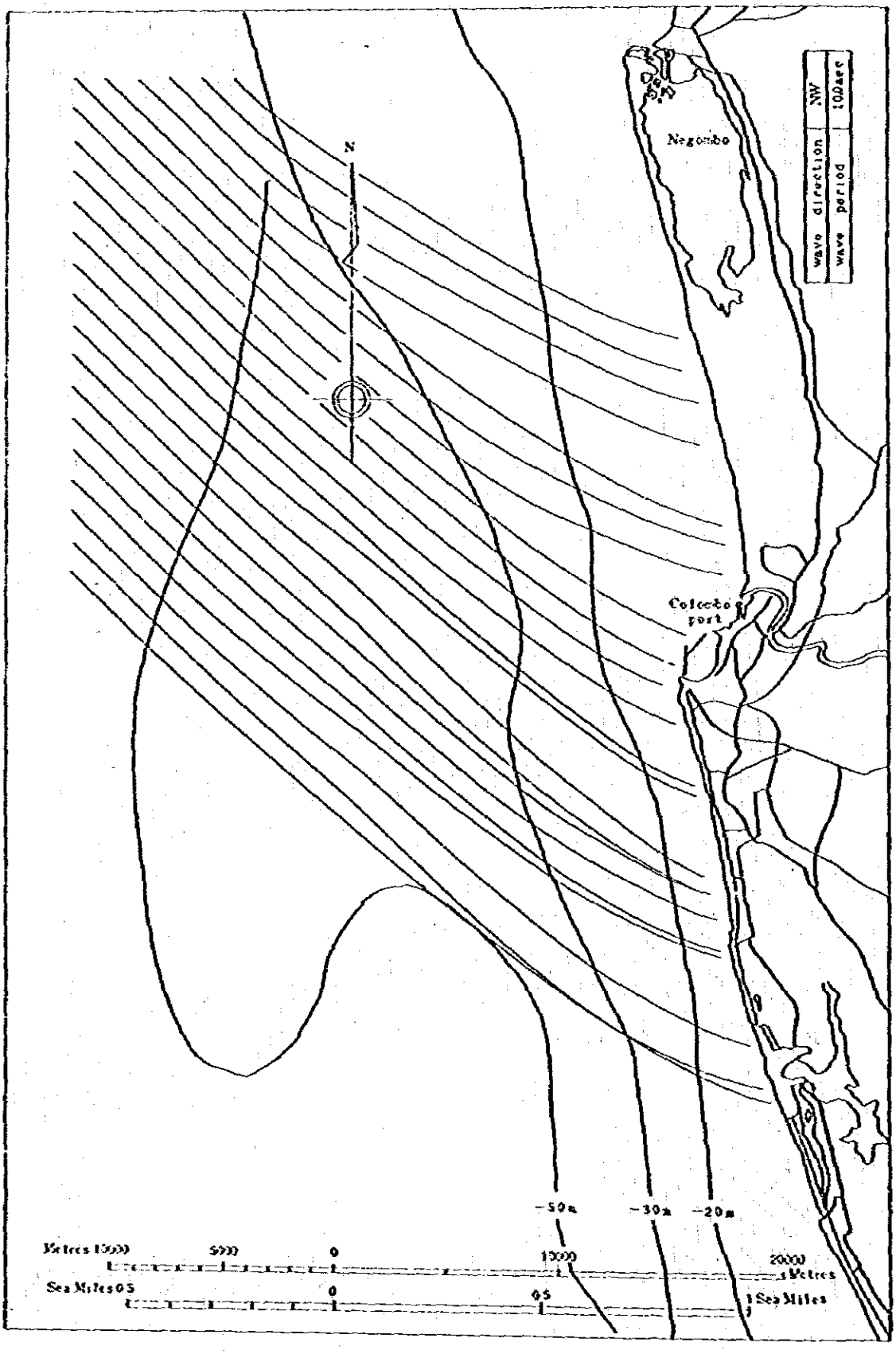


Fig. – I.2.10 (e) Refraction Diagram

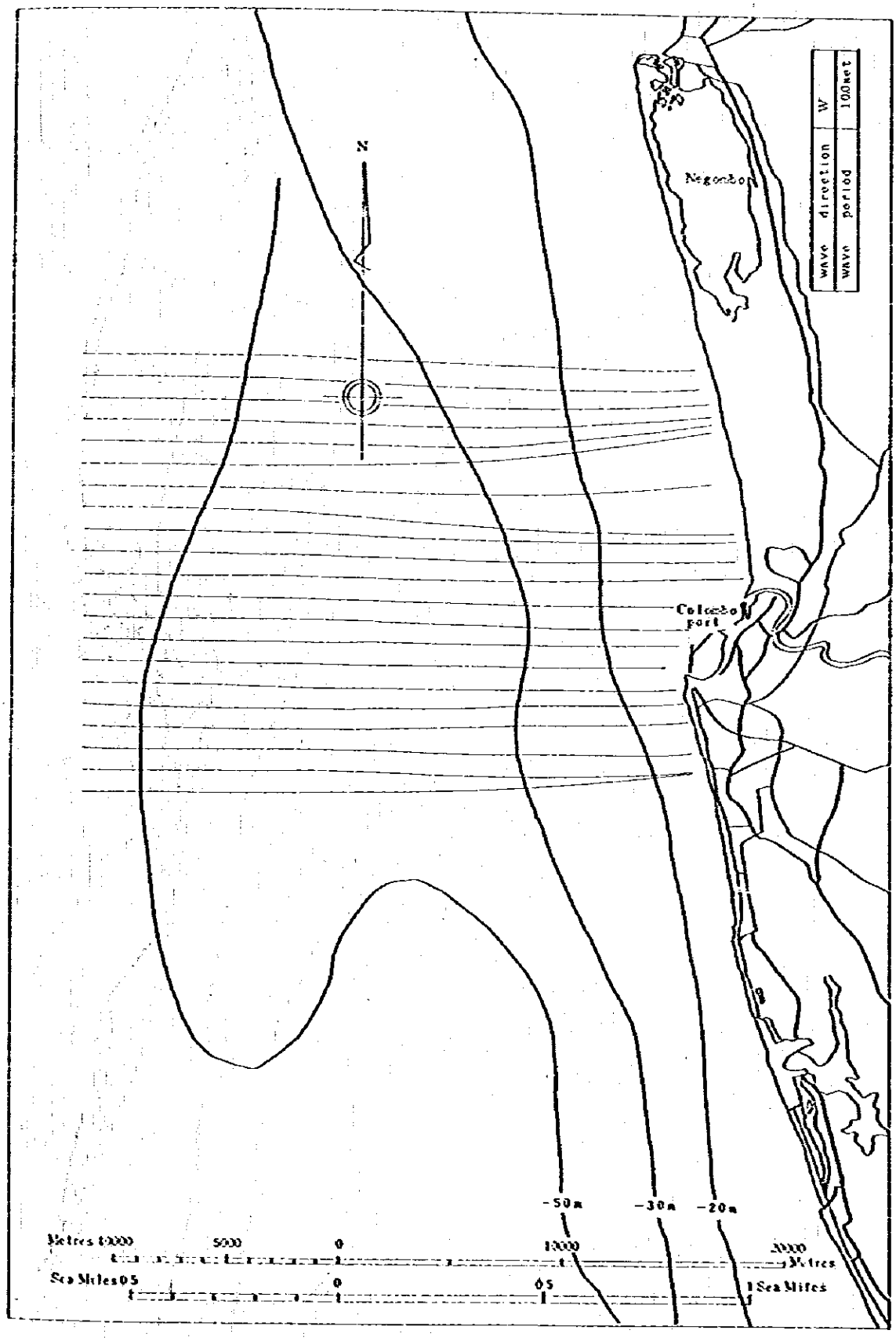
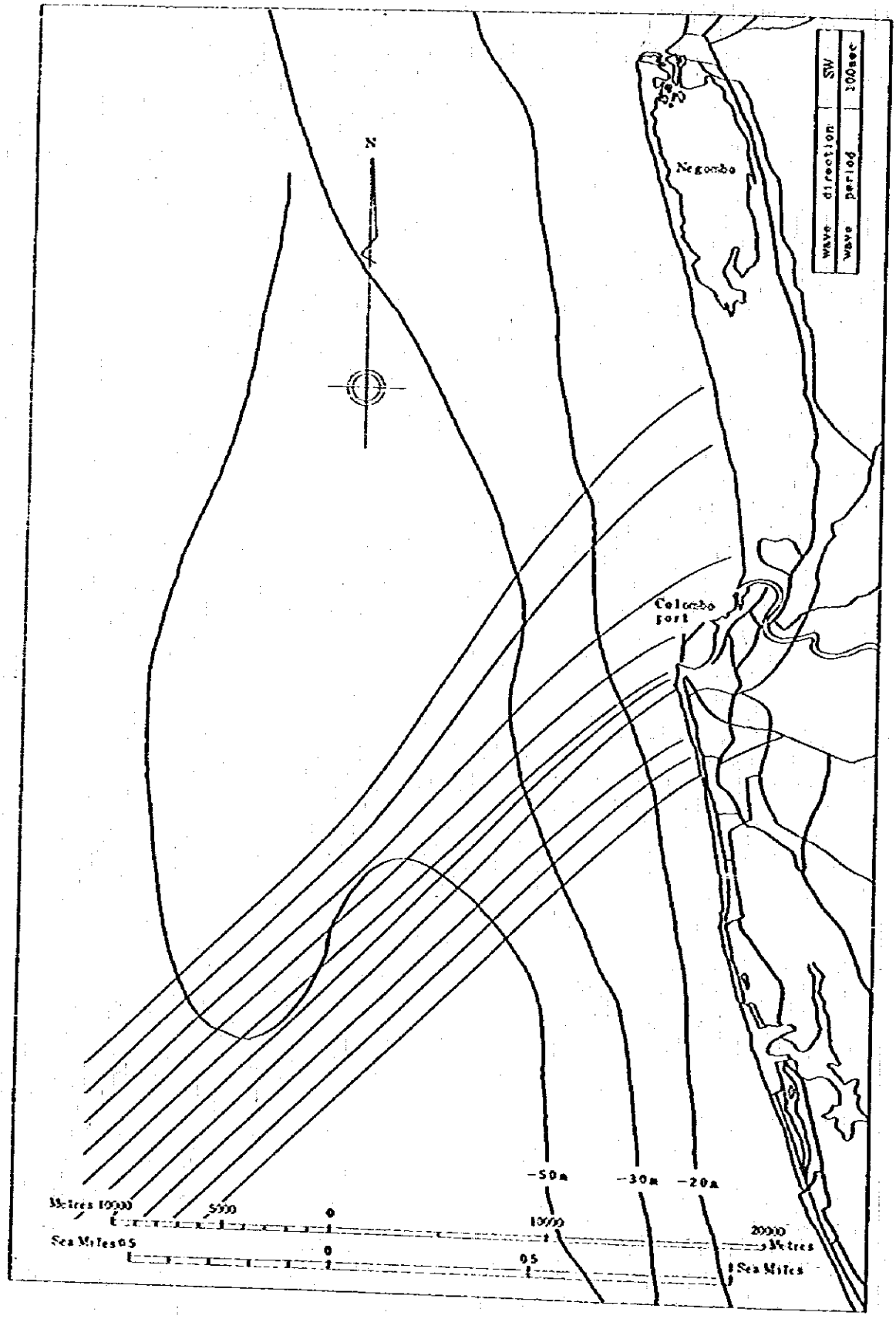


Fig. – I.2.10 (f) Refraction Diagram



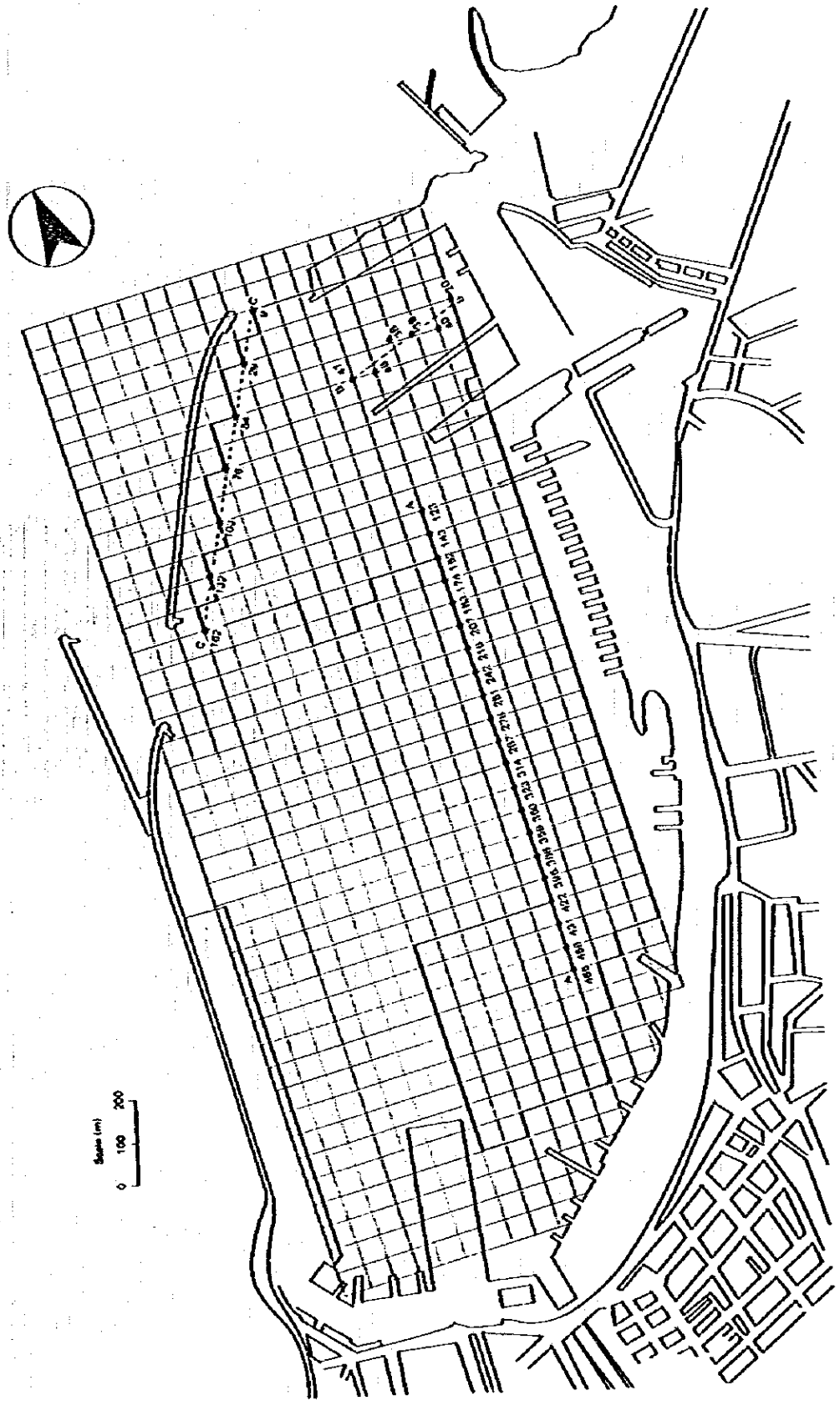


Fig. – 1.2.11 Location of Soil Exploration

Fig. – I.2.12 Soil Profile (Section A-A)

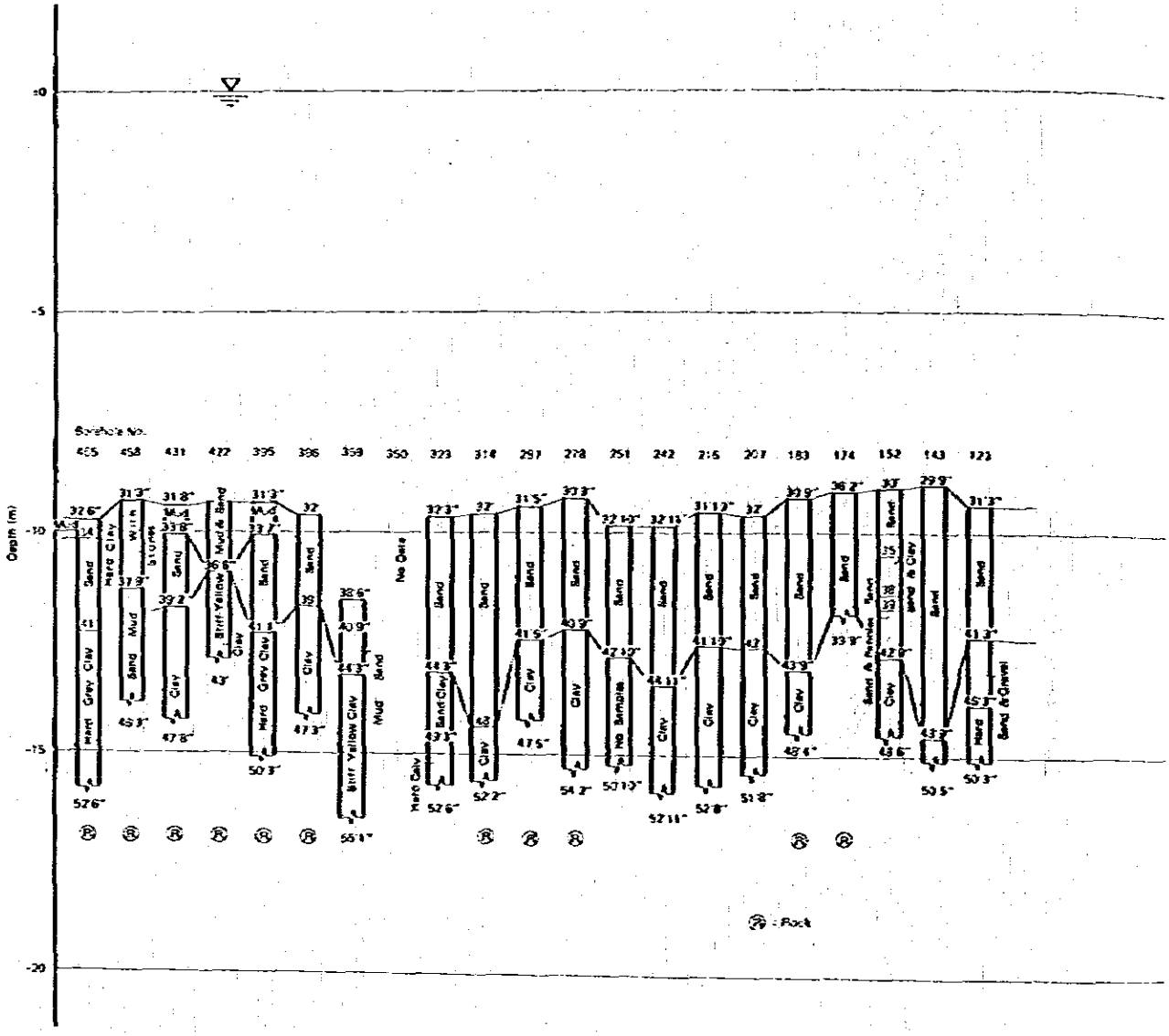


Fig. – I.2.13 Soil Profile (Section B-B)

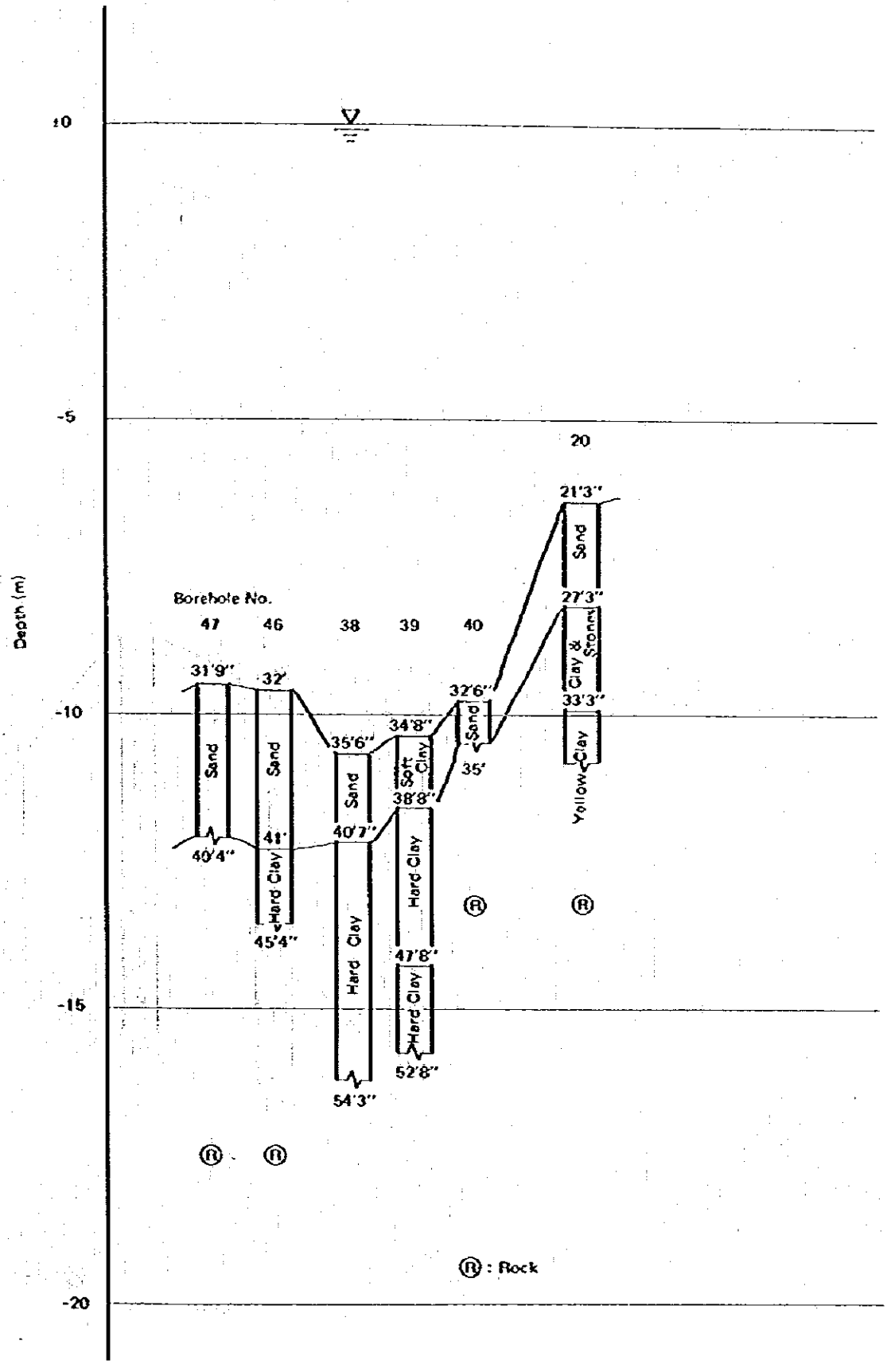


Fig. – I.2.14 Soil Profile (Section C-C)

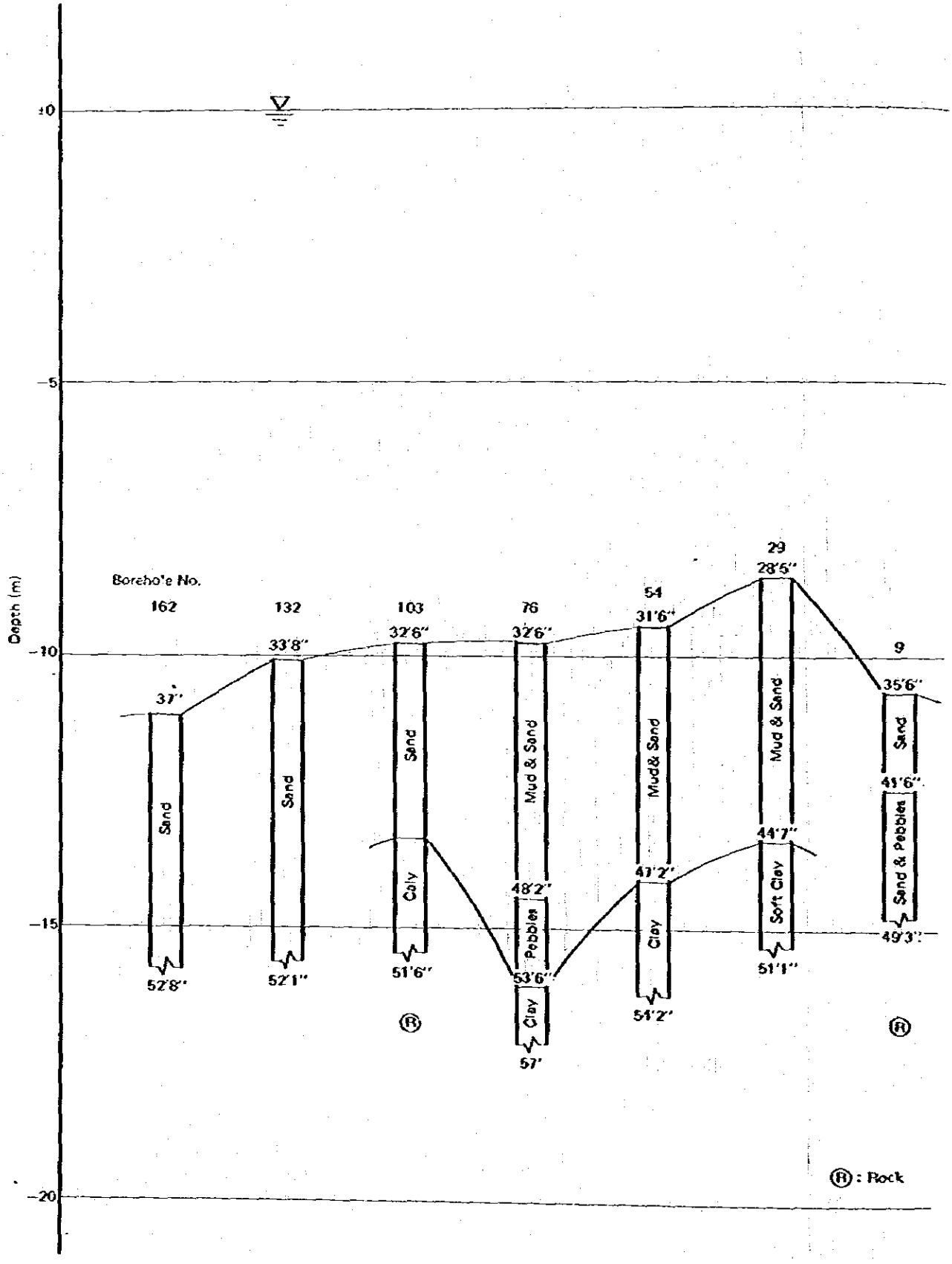


Fig. – I.2.15 Depth of Rock

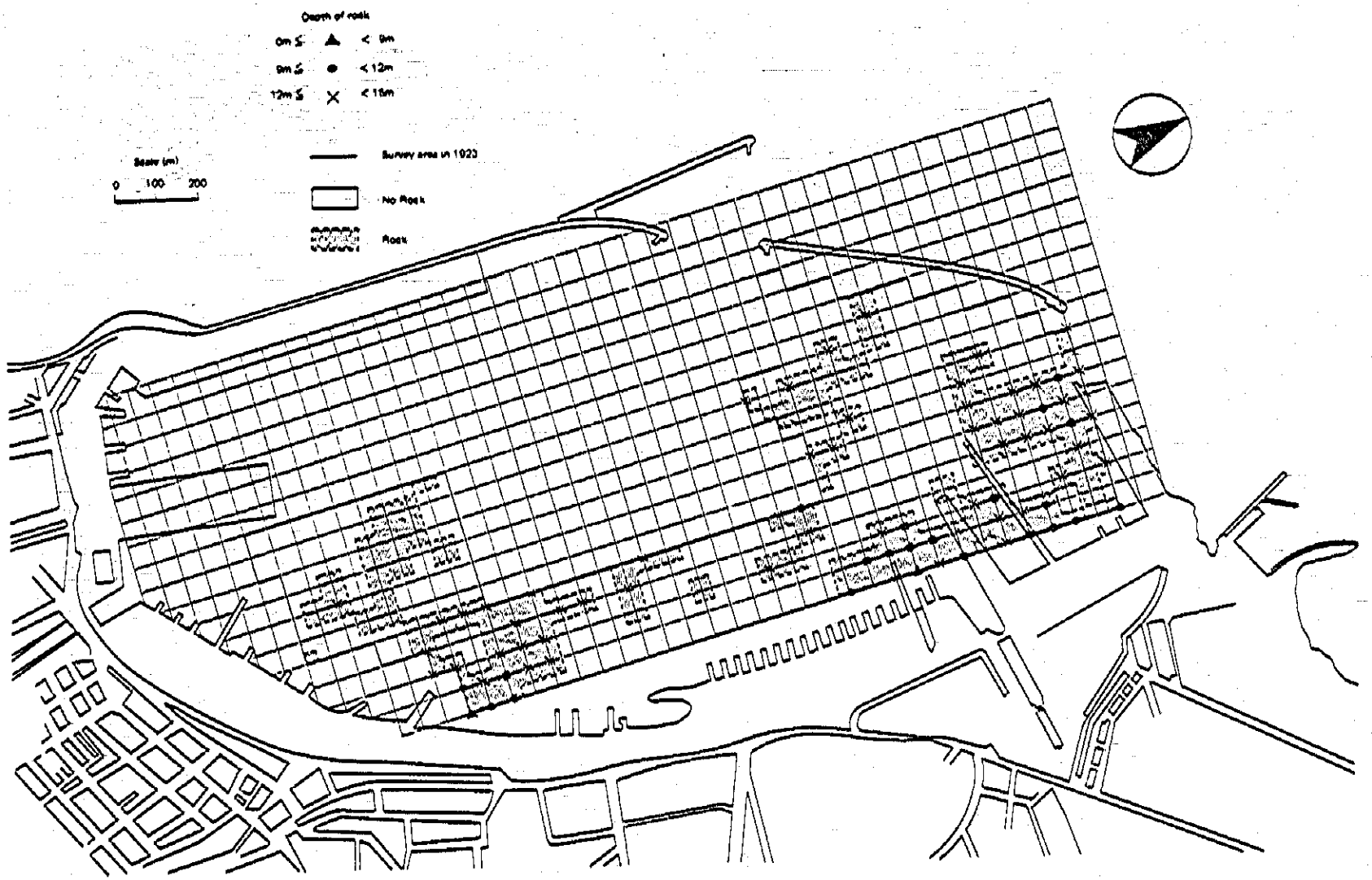


Fig. – I.2.16 Location of Soil Exploration

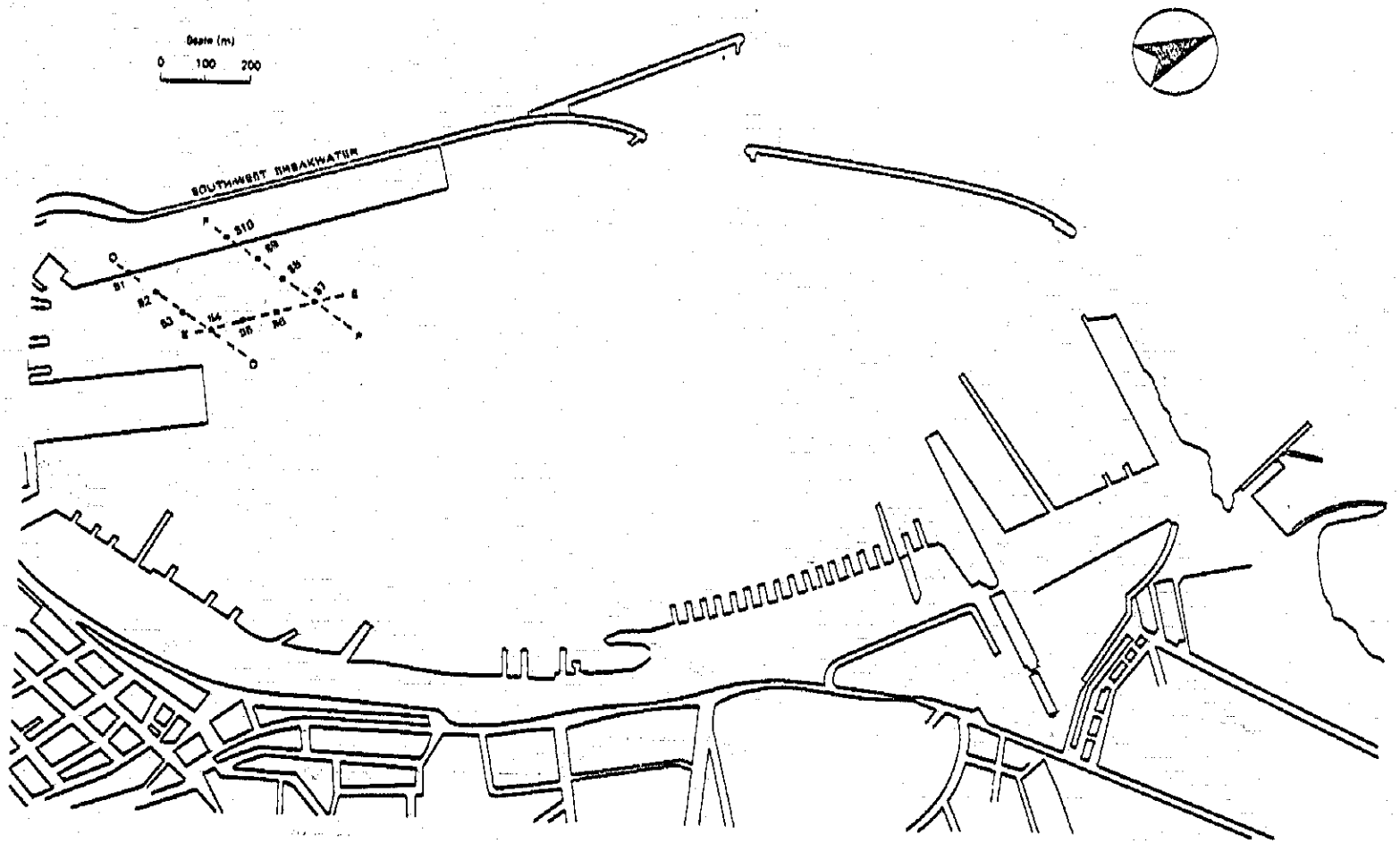


Fig. – 1.2.17 Soil Profile (Section D-D)

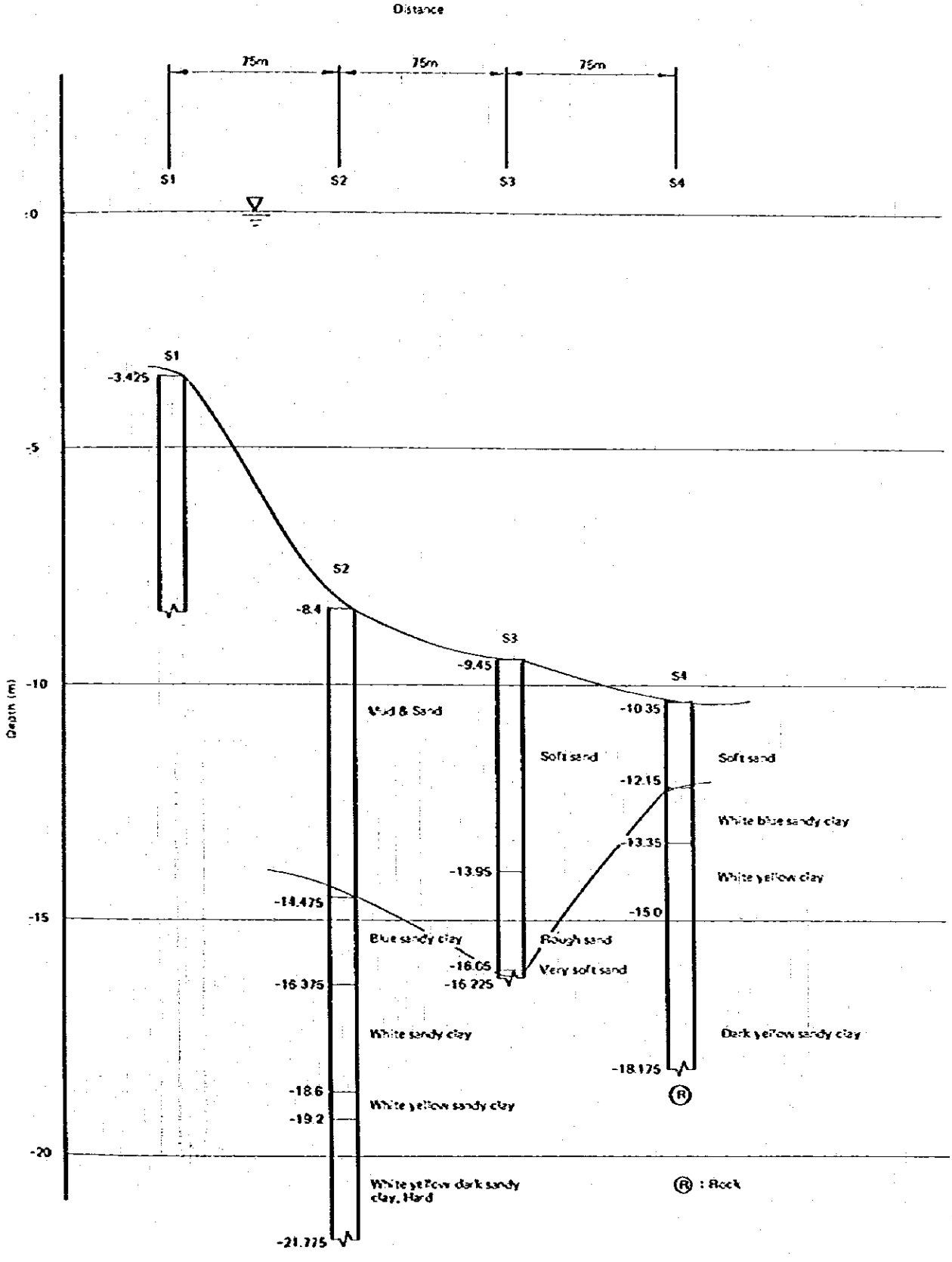


Fig. – I.2.18 Soil Profile (Section E-E)

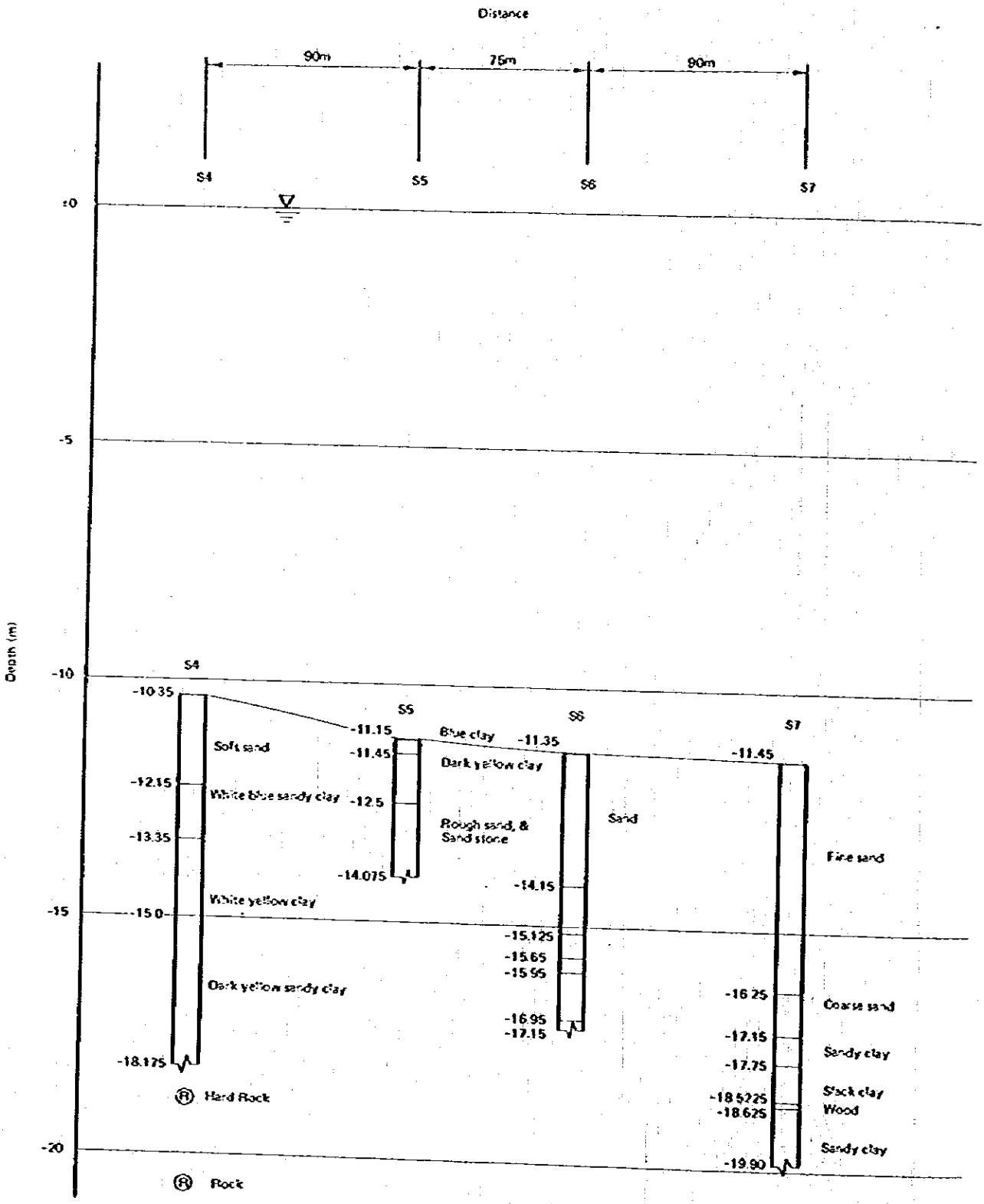


Fig. – I.2.19 Soil Profile (Section F-F)

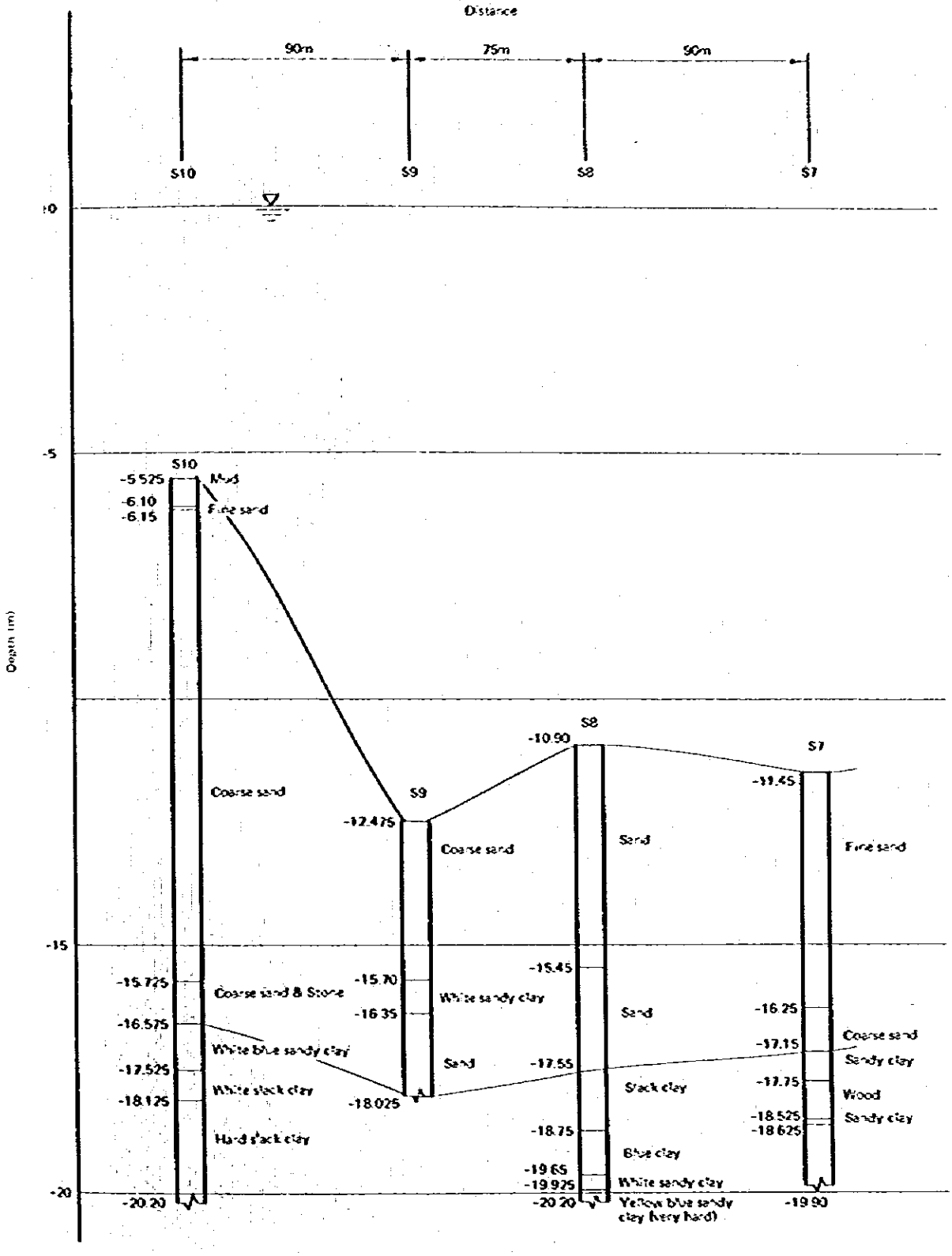


Fig. – I.2.20 Location of Soil Investigation

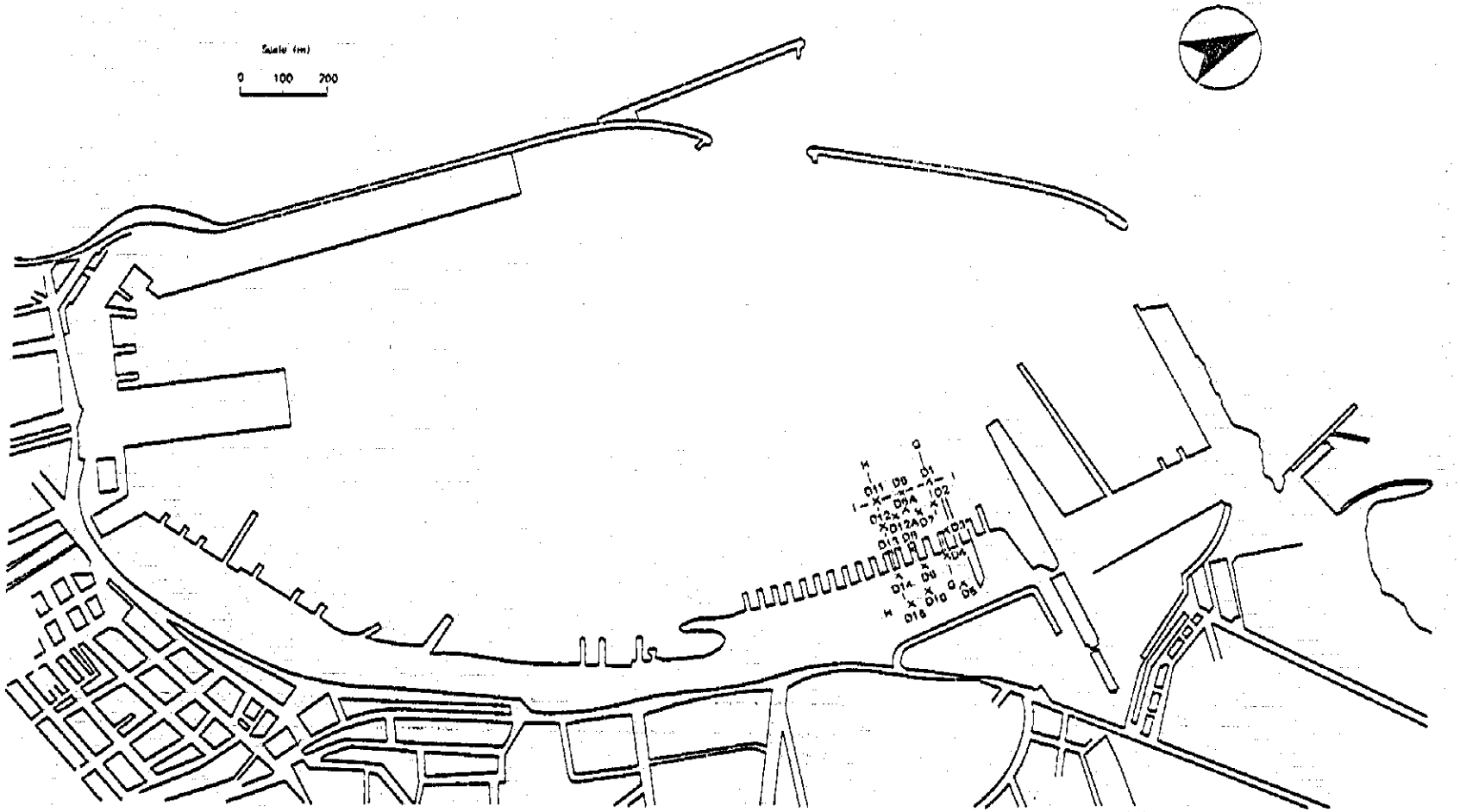


Fig. – I.2.21 Soil Profile (Section G-G)

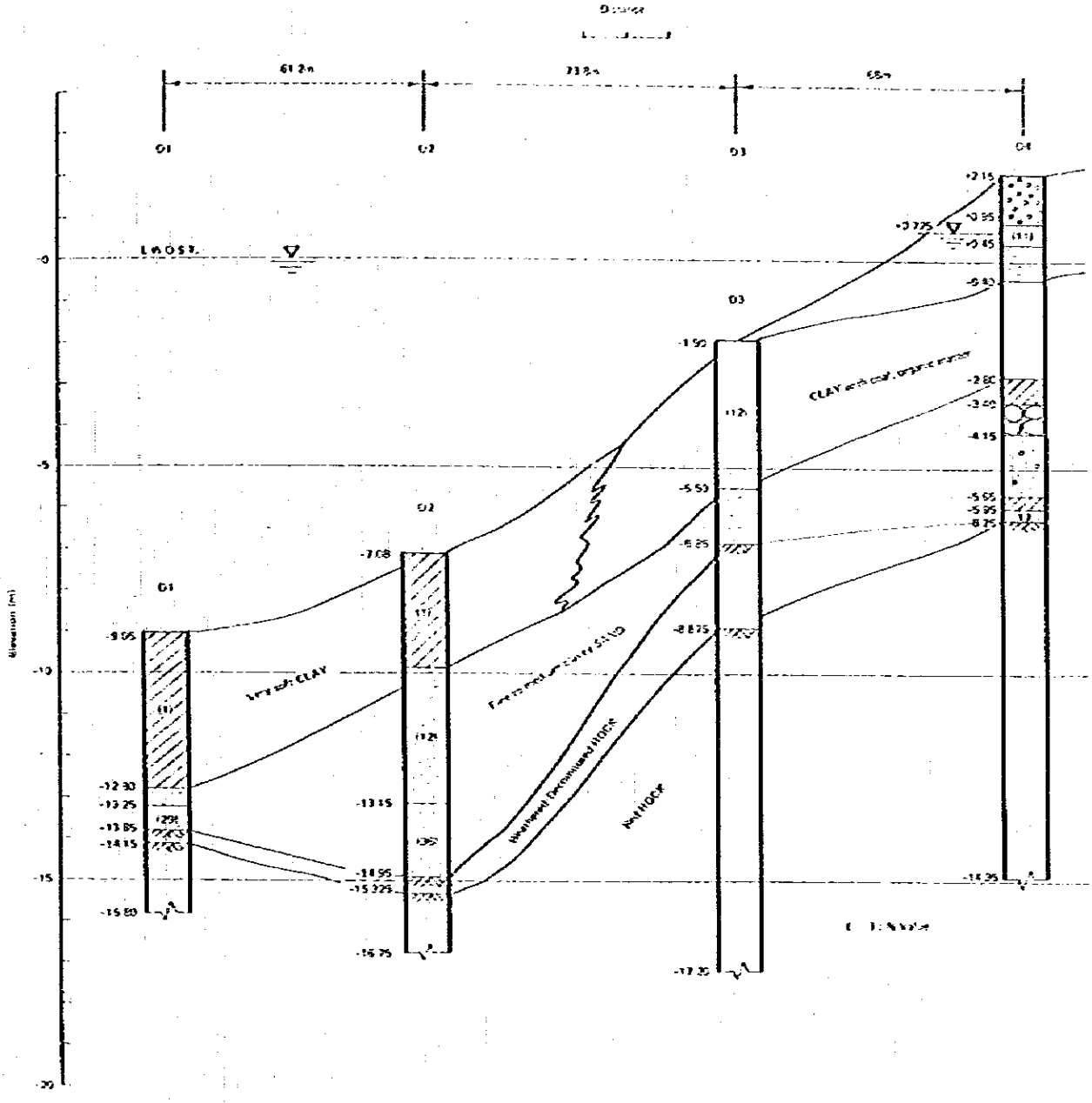


Fig. – I.2.22 Soil Profile (Section H-H)

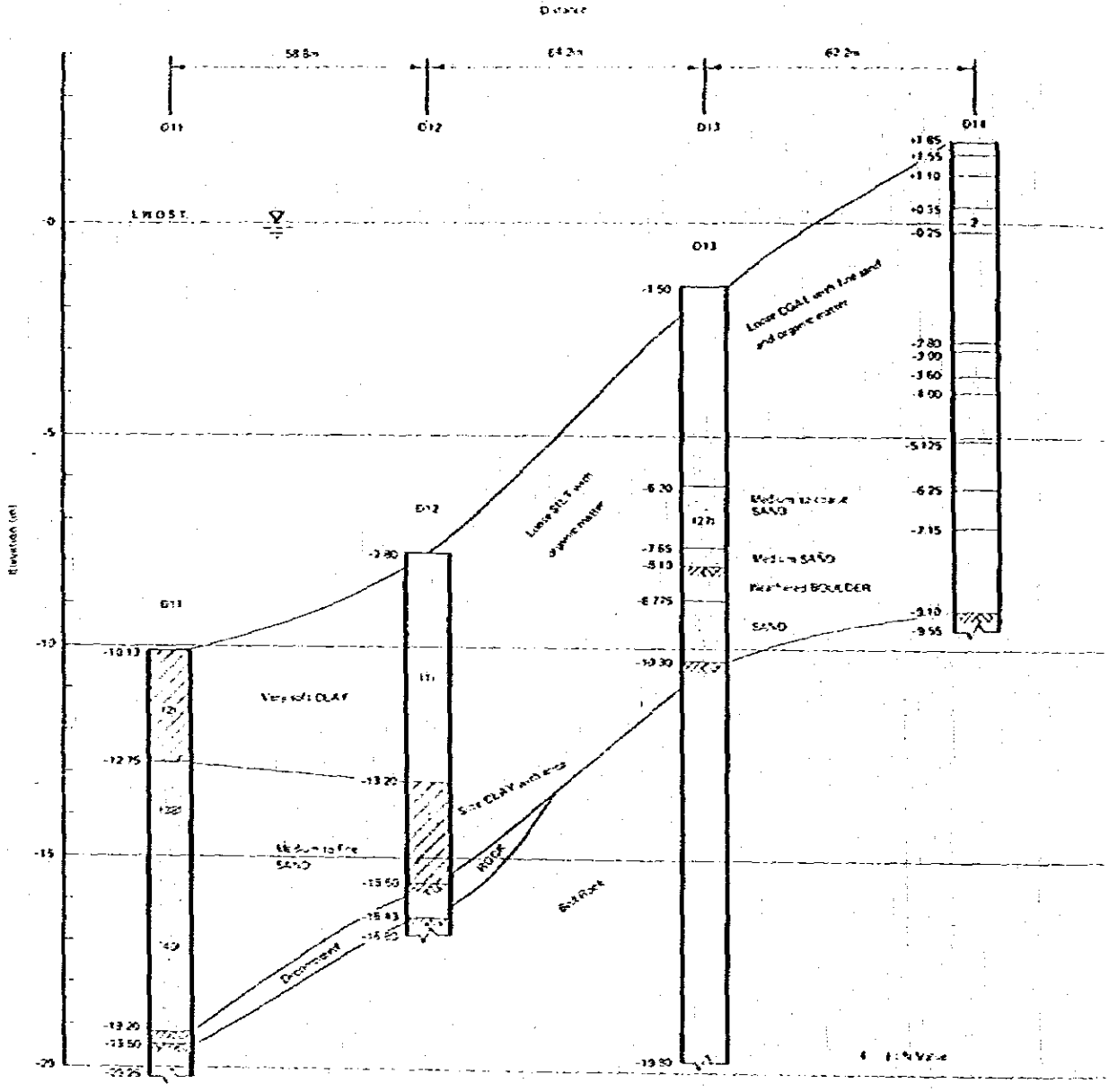


Fig. -- I.2.23 Soil Profile (Section I-I)

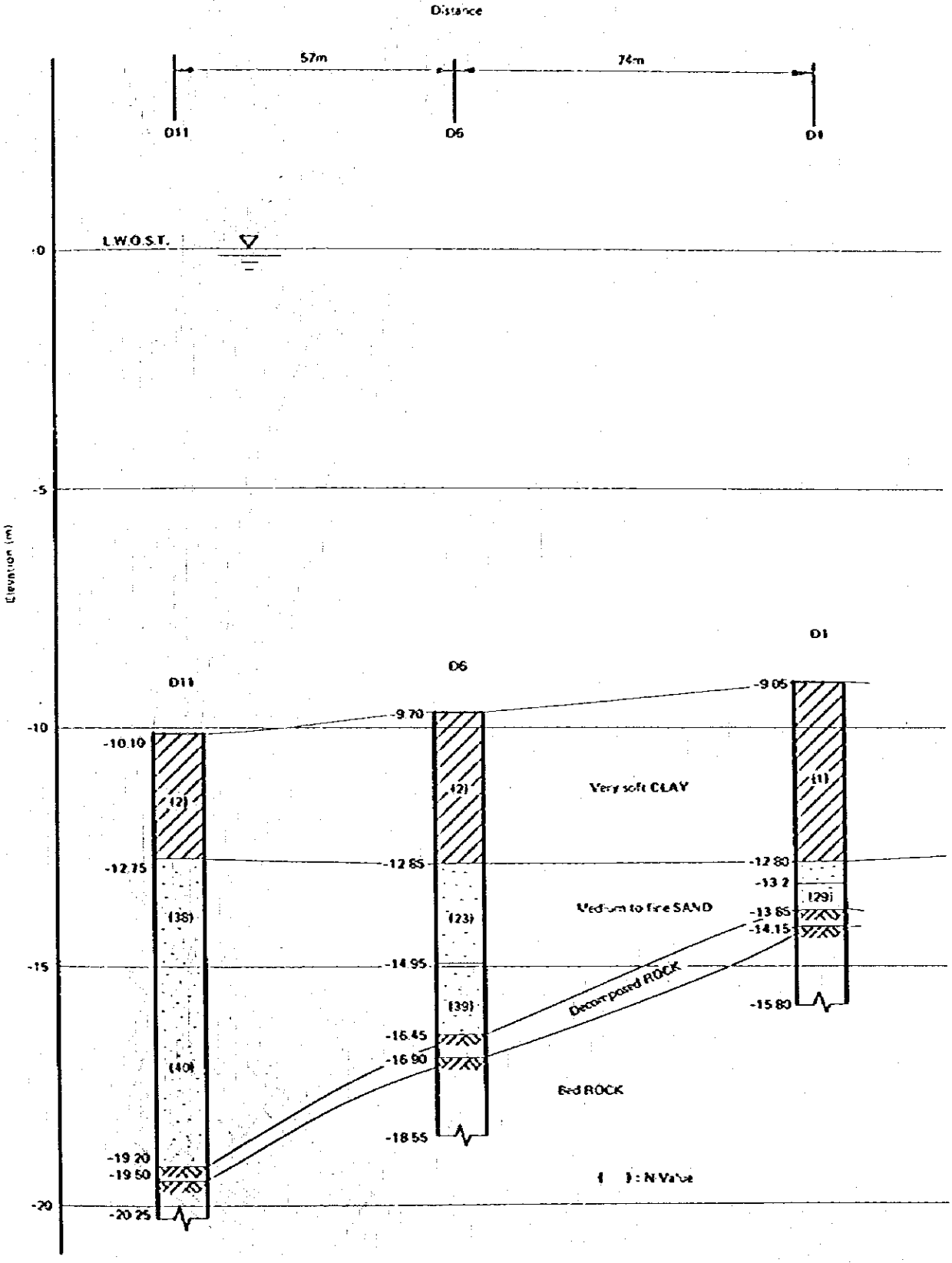


Fig. – I.2.24 Location of Soil Investigation

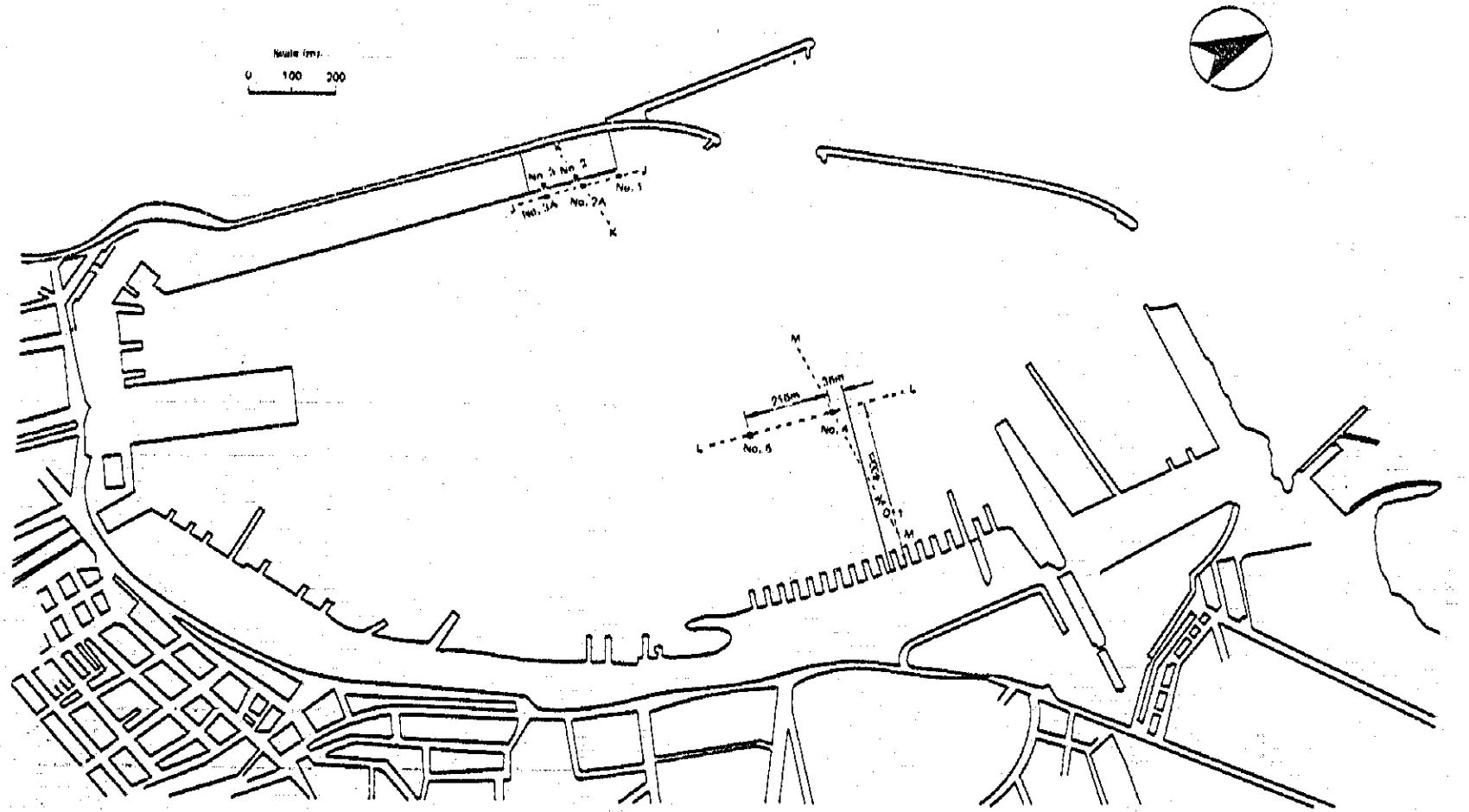


Fig. – I.2.25 Detailed Location of Soil Investigation for QEQ

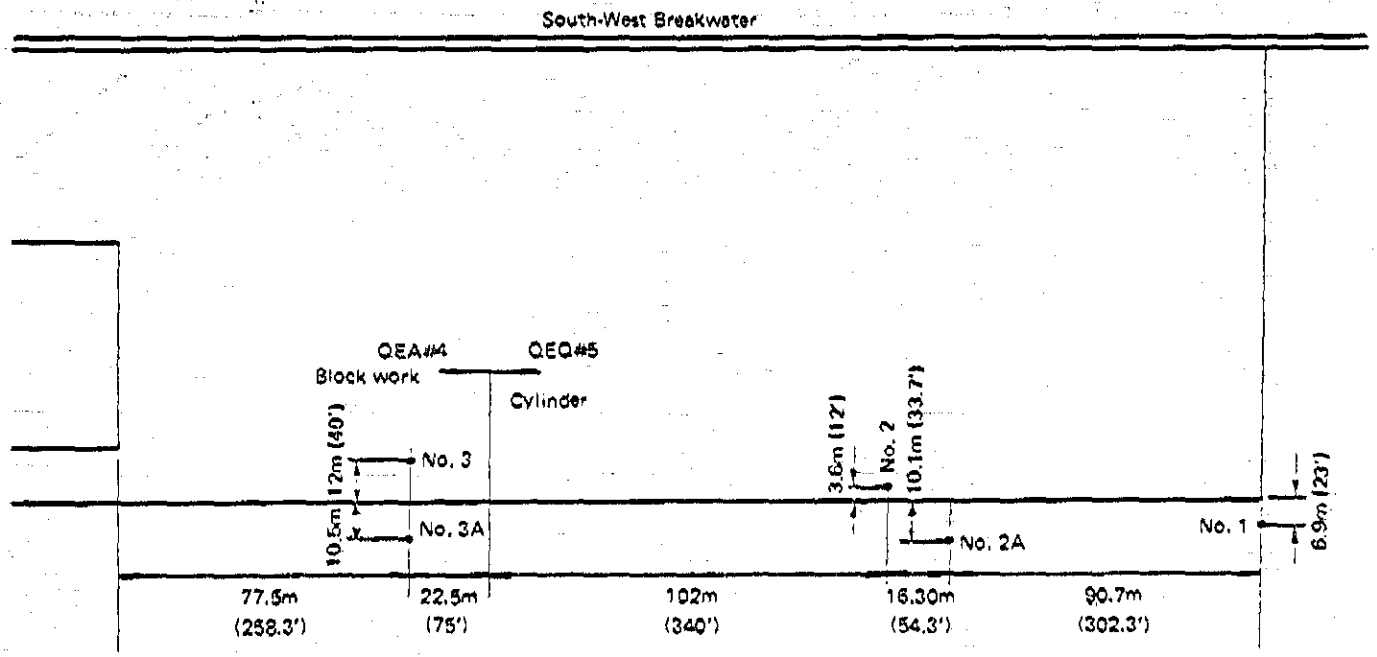


Fig. – I.2.26 Site Boring Log (Borehole No. 1)

SITE BORING LOG

Borehole No.: 1

Date: Nov., 18th to 20th, 1979

Location: COLOMBO PORT, OEQ=5

Depth of sea bed below LWOST: -7.40m

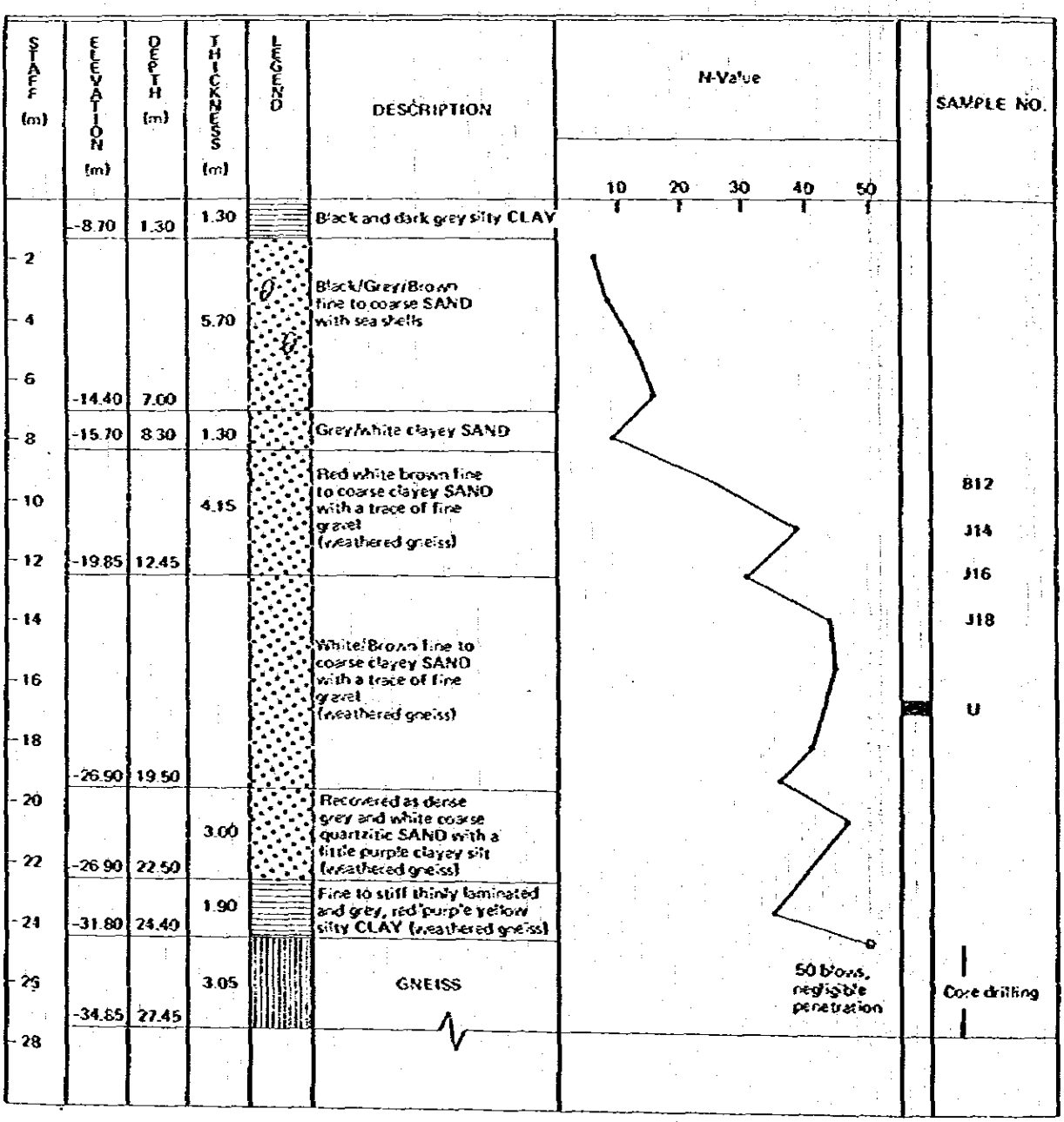


Fig. – I.2.27 Site Boring Log (Borehole No. 2)

SITE BORING LOG

Borehole No.: 2

Date: Dec. 10th to 20th, 1979

Location: COLOMBO PORT, OEO&5

Ground Level above LWOST: +2.7m

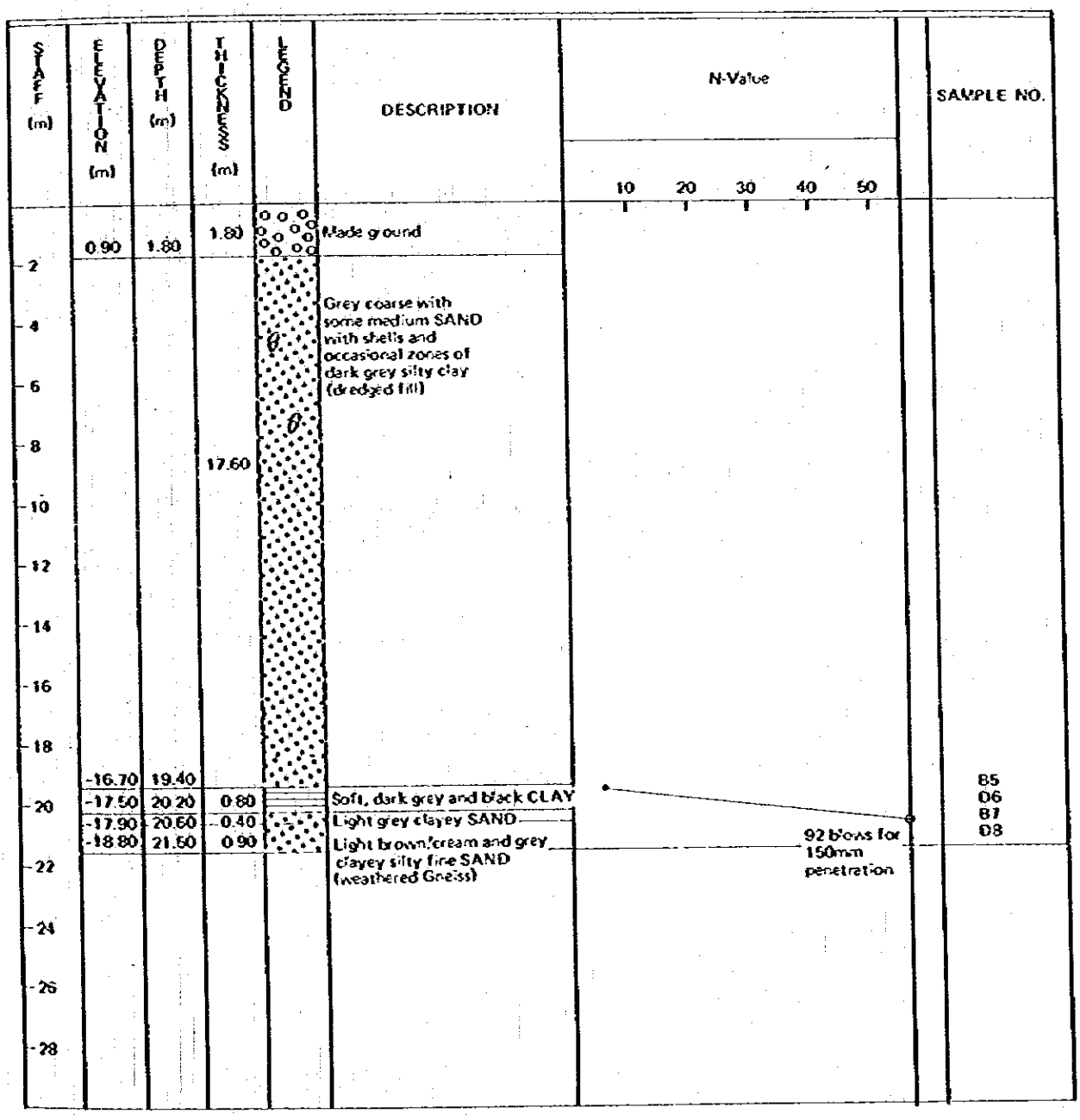


Fig. – I.2.28 Site Boring Log (Borehole No. 2A)

SITE BORING LOG

Borehole No.: 2A

Date: Dec. 16th to 20th, 1979

Location: COLOMBO PORT, QEQ#5

Depth of Seabed below LWOST: -7.80m*

STAFF (m)	ELEVATION (m)	DEPTH (m)	THICKNESS (m)	LEGEND	DESCRIPTION	N-Value 10 20 30 40 50	SAMPLE NO.
2	-10.80	3.00	3.00		Black probably organic CLAY		
4			5.30		Dark grey brown and grey brown fine and medium with some coarse SAND		
6							
8	-16.10	8.30					D6
	-17.60	9.80	1.50		Grey/white clayey SAND		D7
10	-18.30	10.50	0.70		Dark brown clayey, silty SAND		D8
			1.60		Weathered GNEISS		D9
12	-19.90	12.10					D11
14						* Estimation from Crown Height + 2.7m (9') LWOST	
16							
18							
20							
22							
24							
26							
28							

Fig. – I.2.29 Site Boring Log (Borehole No. 3)

SITE BORING LOG

Borehole No.: 3

Date: Dec. 9th to 19th, 1979

Location: COLOMBO PORT, OEO#4

Ground Level above LWOST: +2.70m

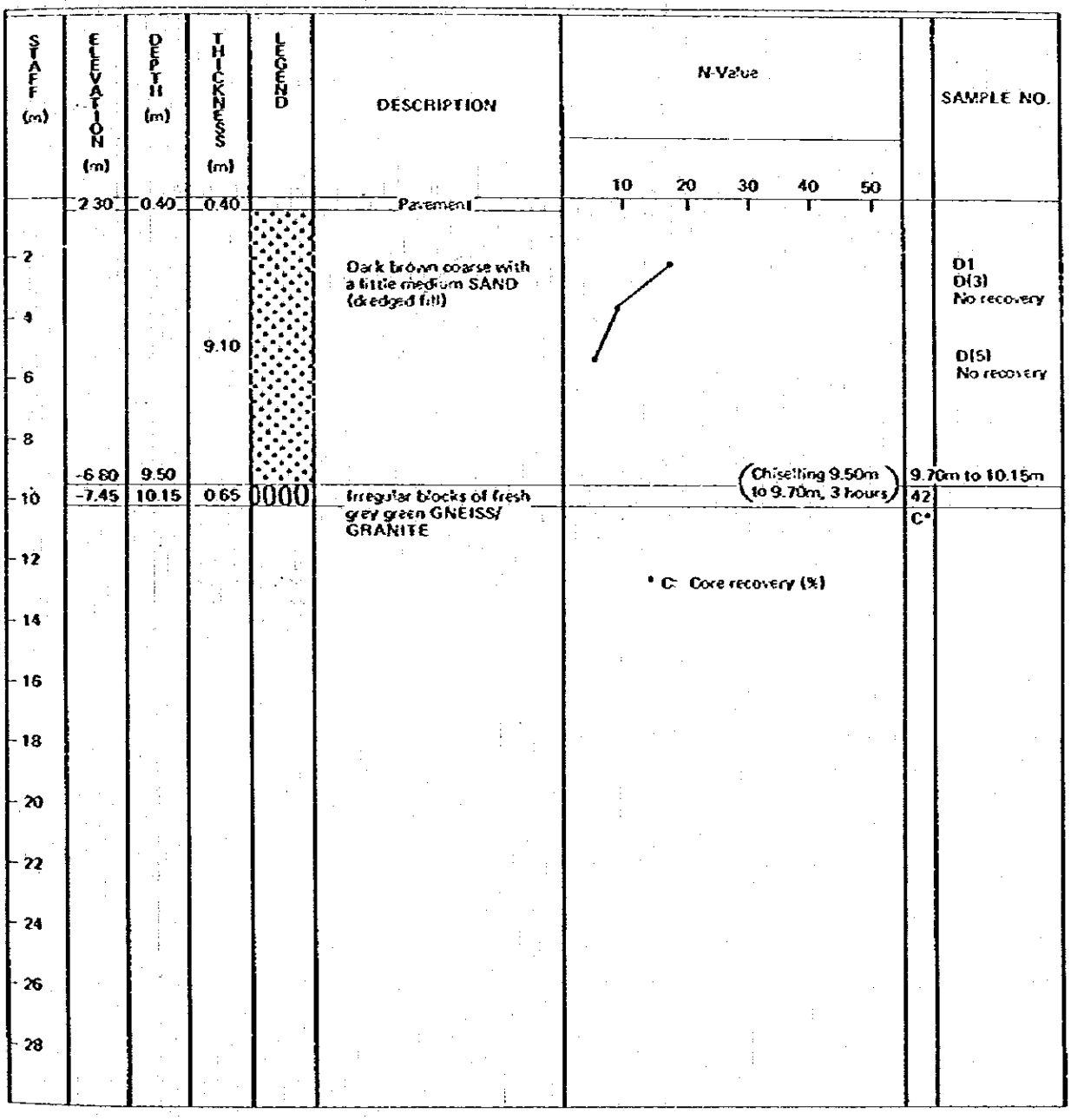


Fig. – I.2.30 Site Boring Log (Borehole No. 3A)

SITE BOREING LOG

Borehole No.: 3A

Date; Jan. 1980

Location; Colombo Port OEQ#4

Depth of sea bed below LWOST; -11.7m

STAFF (m)	ELEVATION (m)	DEPTH (m)	THICKNESS (m)	LEGEND	DESCRIPTION	N-Value	Sample No.
	-12.80	1.10	1.10		Dark grey very silty fine to coarse SAND		
-2			2.70		Loose to medium dense, medium and coarse grey clean SAND		
	-15.50	3.80					
-4	-16.60	4.90	1.10		Medium dense light grey clayey SAND with occasional zones of grey and light brown sandy clay		
-6			3.10		Grey and mottled reddish brown silty CLAY becoming clayey sand in parts		
-8	-19.70	8.00					
			2.00		Dense light grey and white laminated clayey SILT (weathered GNEISS)		
-10	-21.70	10.00					
	-23.20	11.50	1.50		Dense light grey and white clayey SILT (weathered GNEISS)		
-12							
-14							
-16							
-18							
-20							
-22							
-24							
-26							
-28							

N-Value: 10 20 30 40 50

145mm Initial penetration only 60 blows, rod bounding after initial 10 blows

Fig. – I.2.31 Soil Profile (Section J-J)

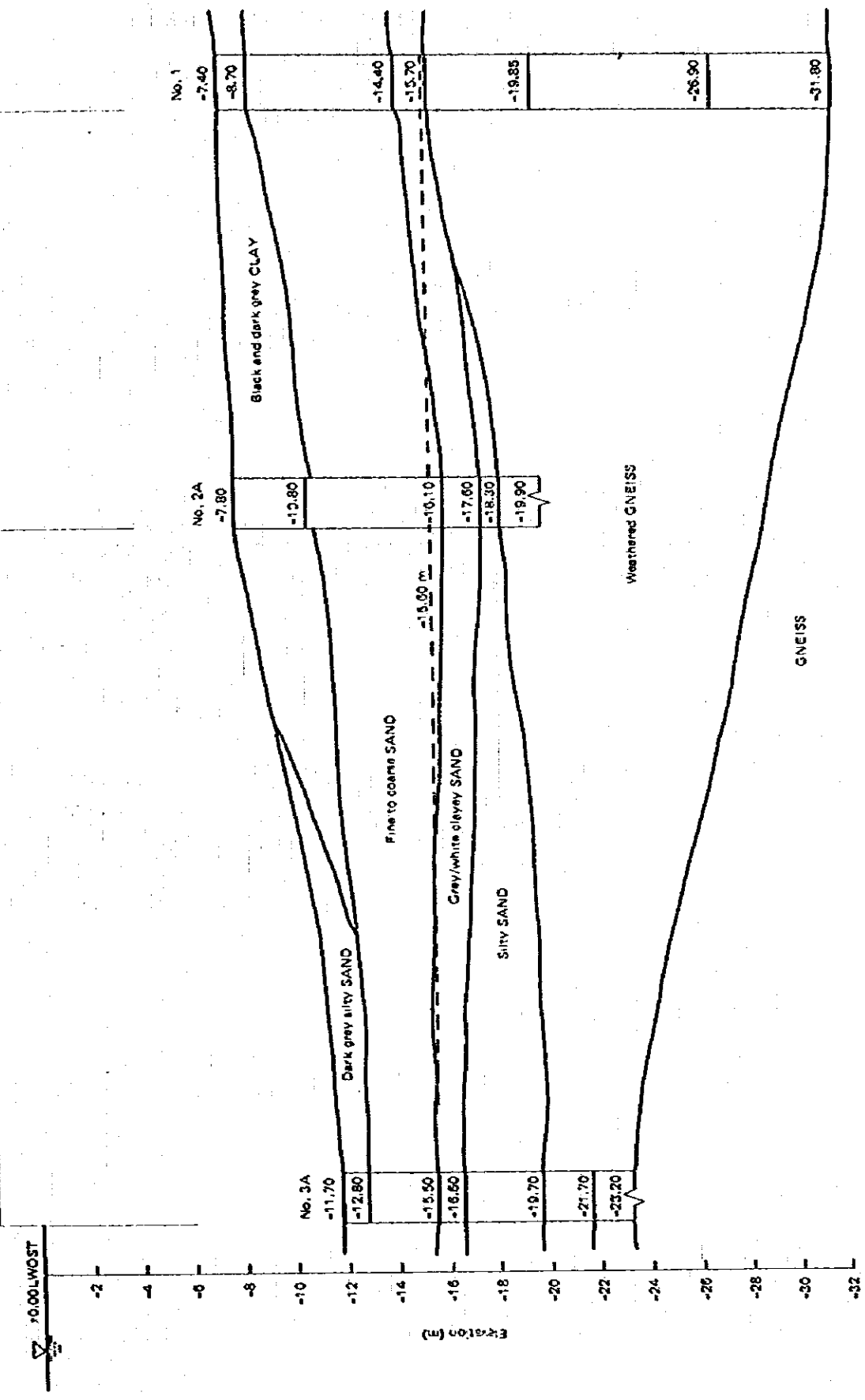


Fig. – I.2.32 Soil Profile (Section K-K)

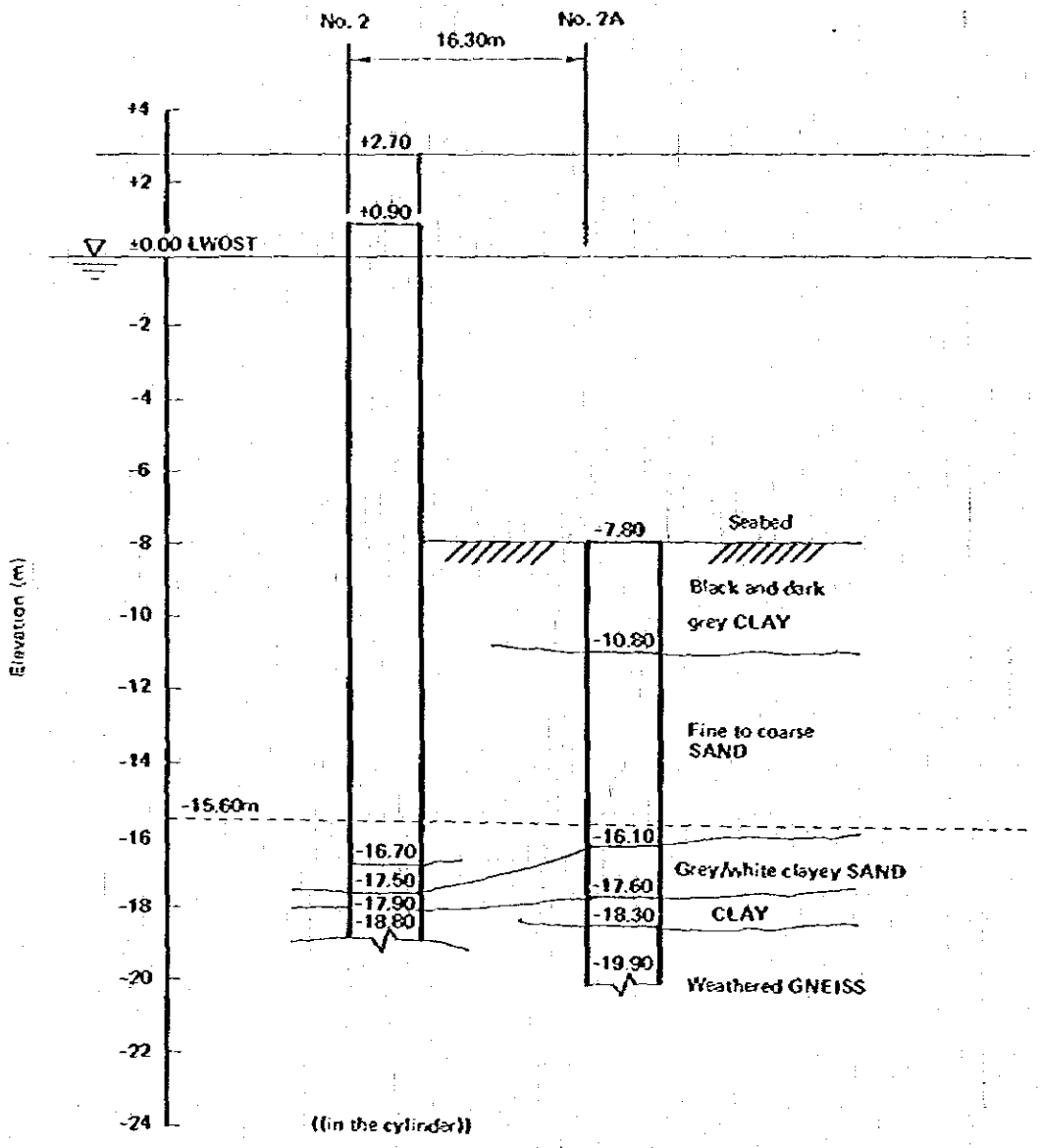


Fig. – I.2.33 Site Boring Log (Borchole No. 4)

SITE BORING LOG

Borehole No.: 4

Date: Nov. 23rd to 24th, 1979

Location: COLOMBO PORT

Depth of Seabed below LWOST: -9.4m

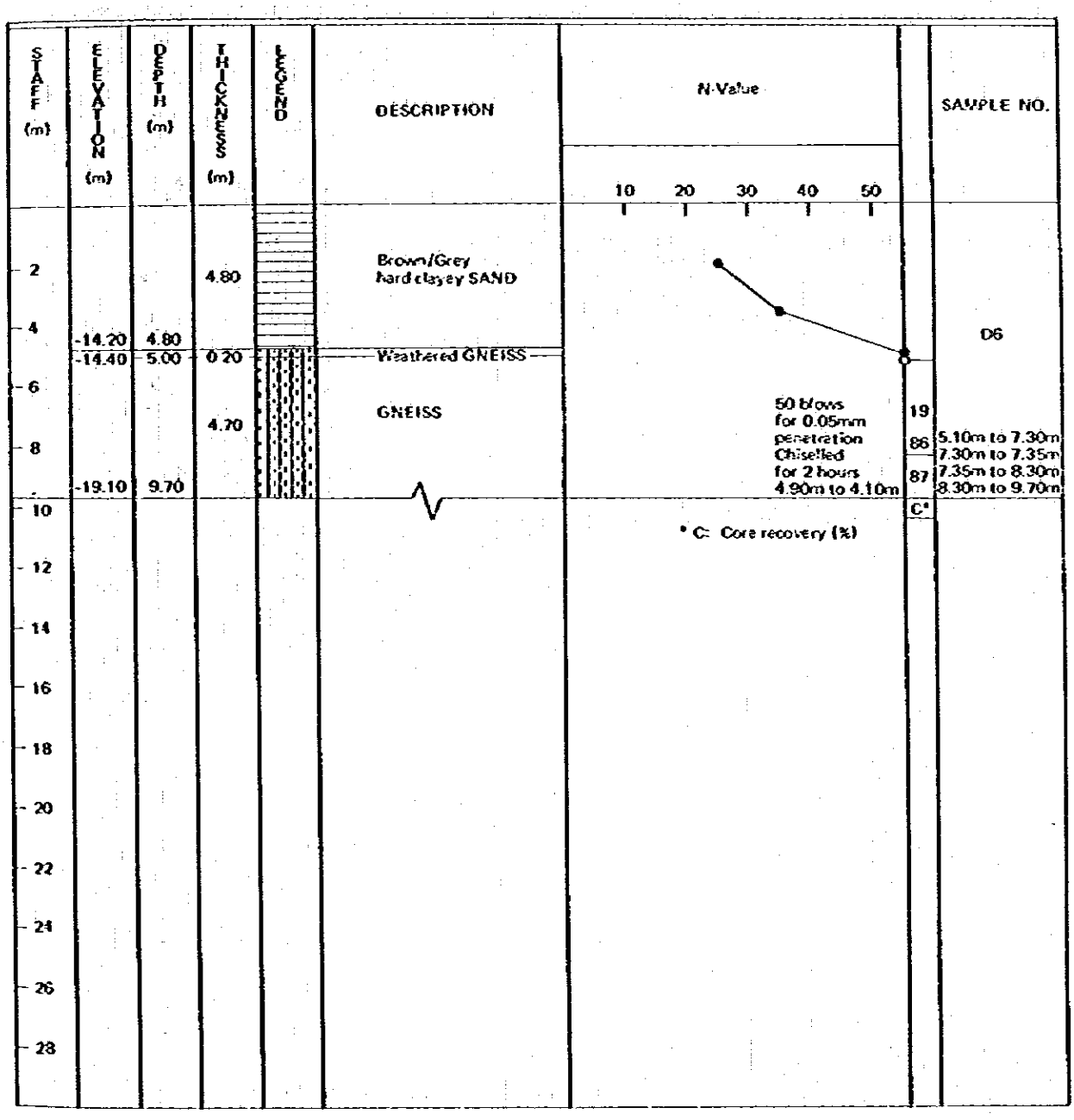


Fig. – I.2.34 Site Boring Log (Borehole No. 5)

SITE BORING LOG

Borehole No.: 5 Date: Nov. 28th, 1978

Location: COLOMBO PORT

Depth of sea bed below LWOST: -9.70m

STAFF (m)	ELEVATION (m)	DEPTH (m)	THICKNESS (m)	LEGEND	DESCRIPTION	N-Value 10 20 30 40 50	SAMPLE NO.
	-10.70	1.00	1.00		Dark grey SILT		
2	-11.70	2.00	1.00		Coarse SAND with fine gravel		
	-12.10	2.40	0.40		Black to dark grey sandy SILT		2.50 U5 2.95
4			4.00		White and light grey clayey SAND with a little fine gravel (a completely weathered gneiss)		4.50 (U7) 4.95
6	-16.10	6.40					No recovery
8			3.10		Moderately weathered moderately strong GNEISS	75 blow for 100mm penetration chiselling 6.40m to 7.00m 1 hour	D10
	-19.20	9.50					
10	-21.00	11.30	1.80		Slightly weathered GNEISS		
12							
14							
16							
18							
20							
24							
22							
26							
28							

Fig. – I.2.35 Soil Profile (Section L-L)

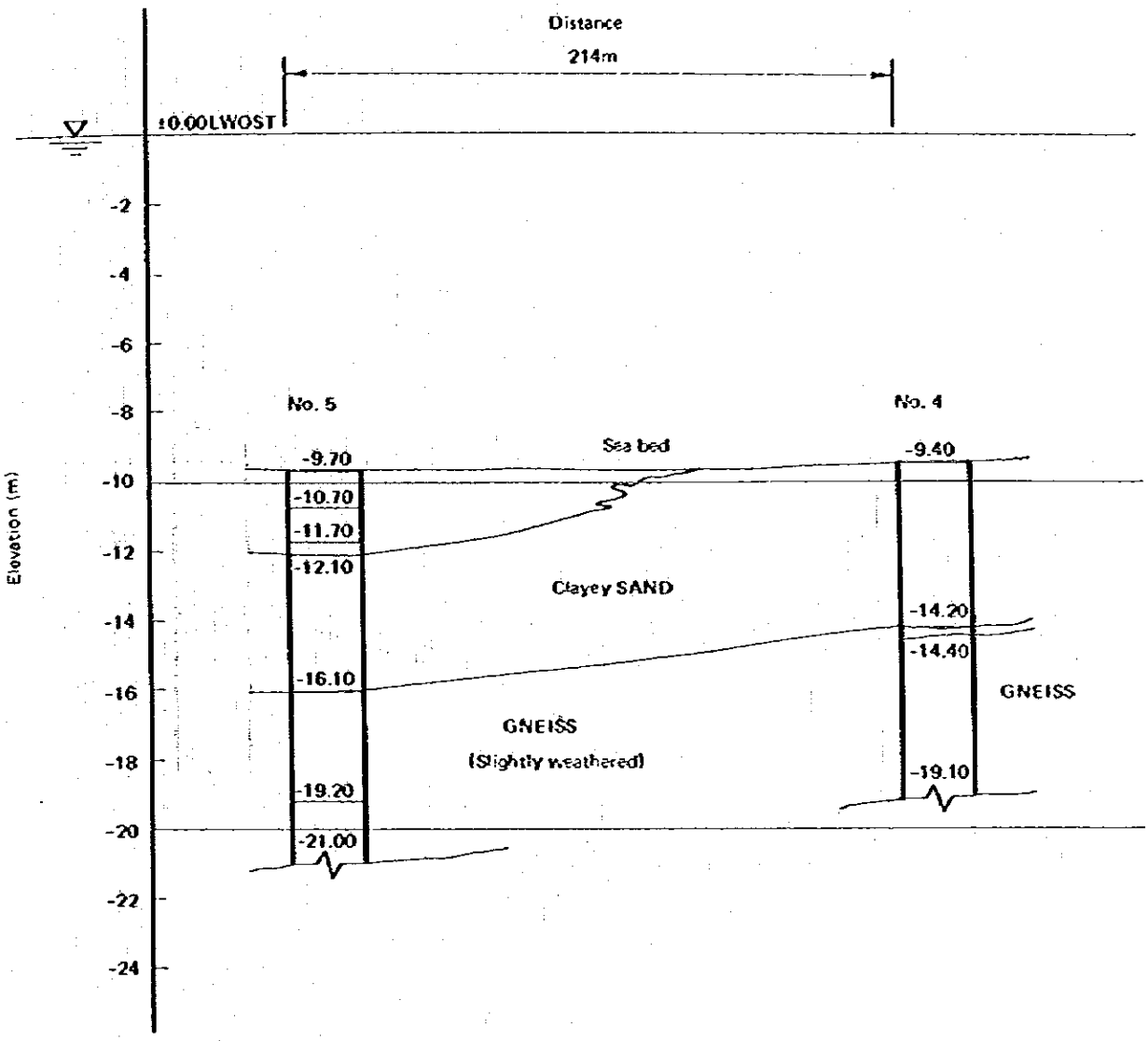


Fig. – I.2.36 Soil Profile (Section M-M)

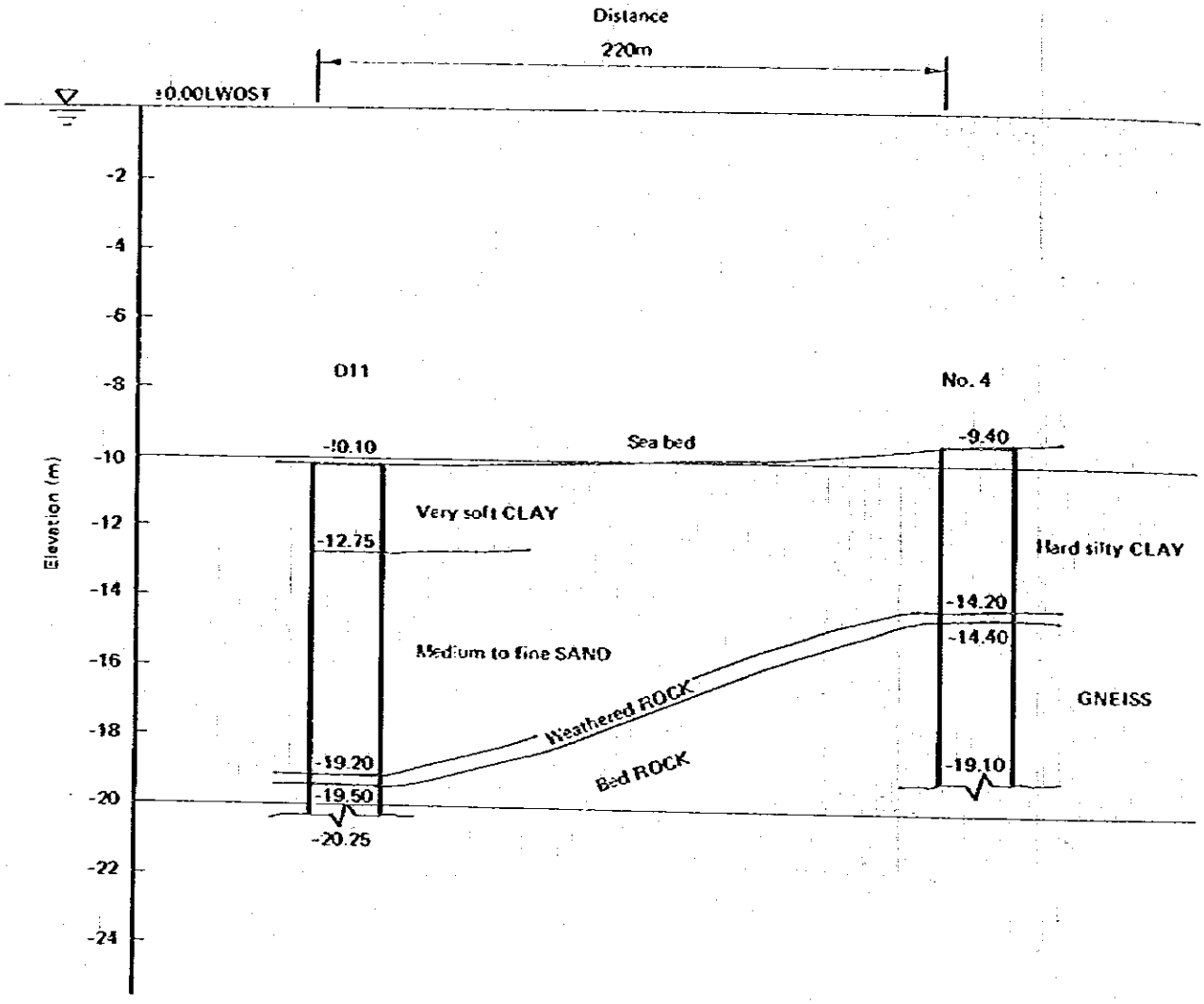


Fig. – I.2.37 Plasticity Chart

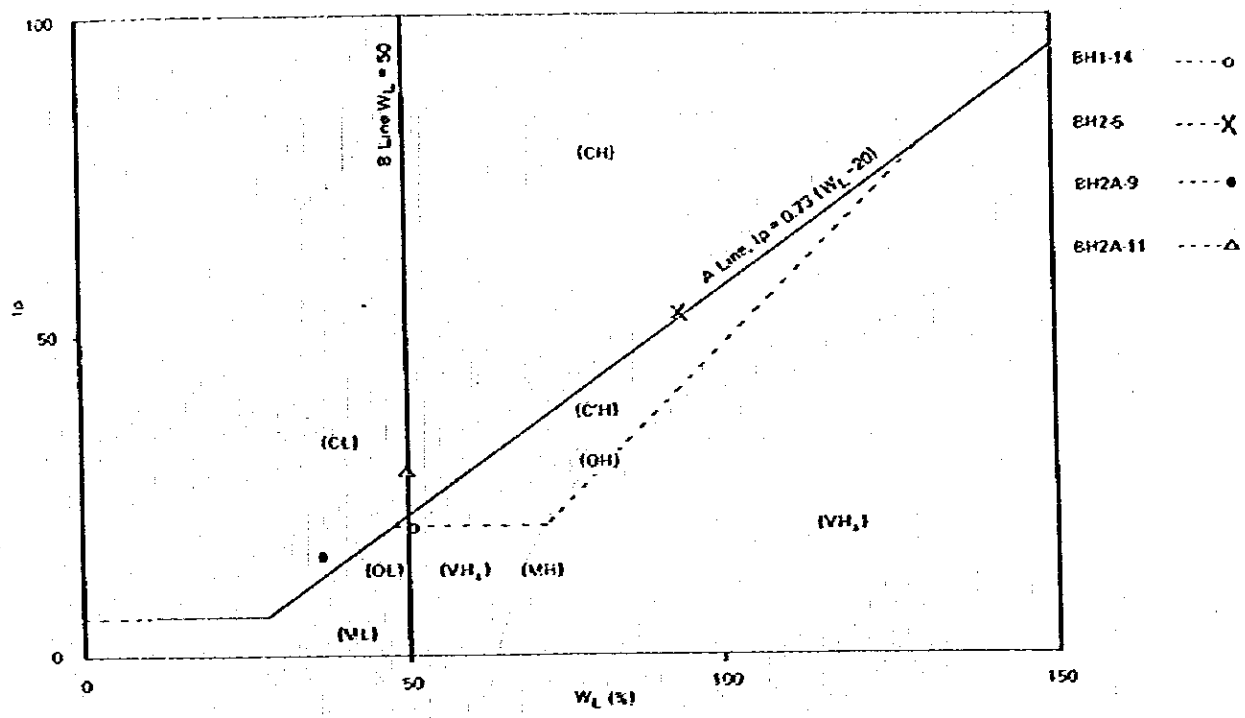


Fig. – I.2.38 Soil Classification

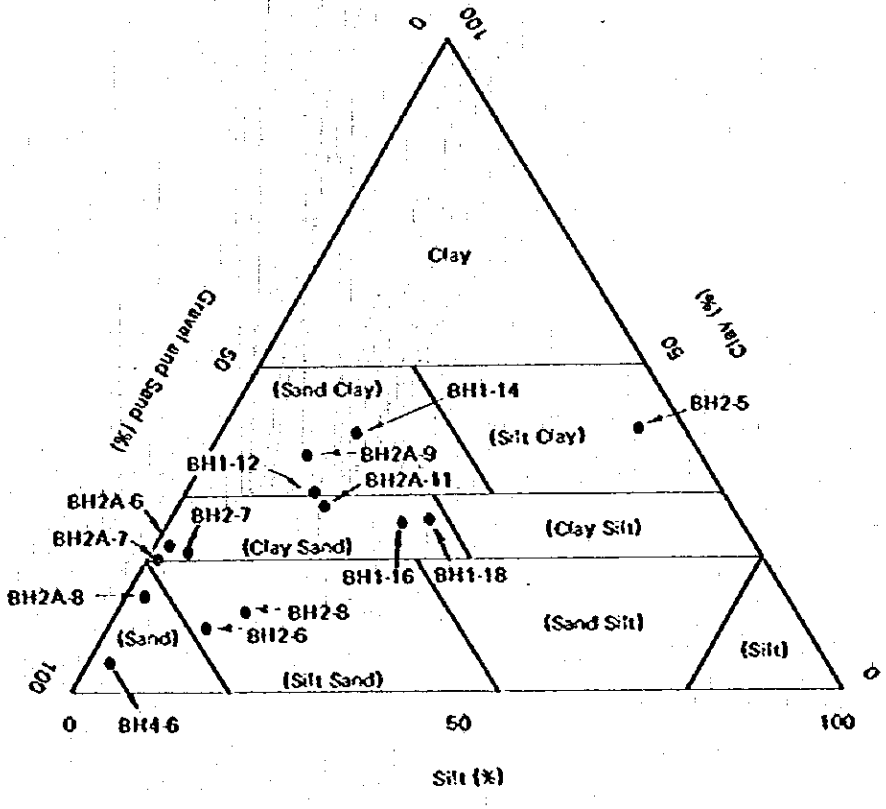
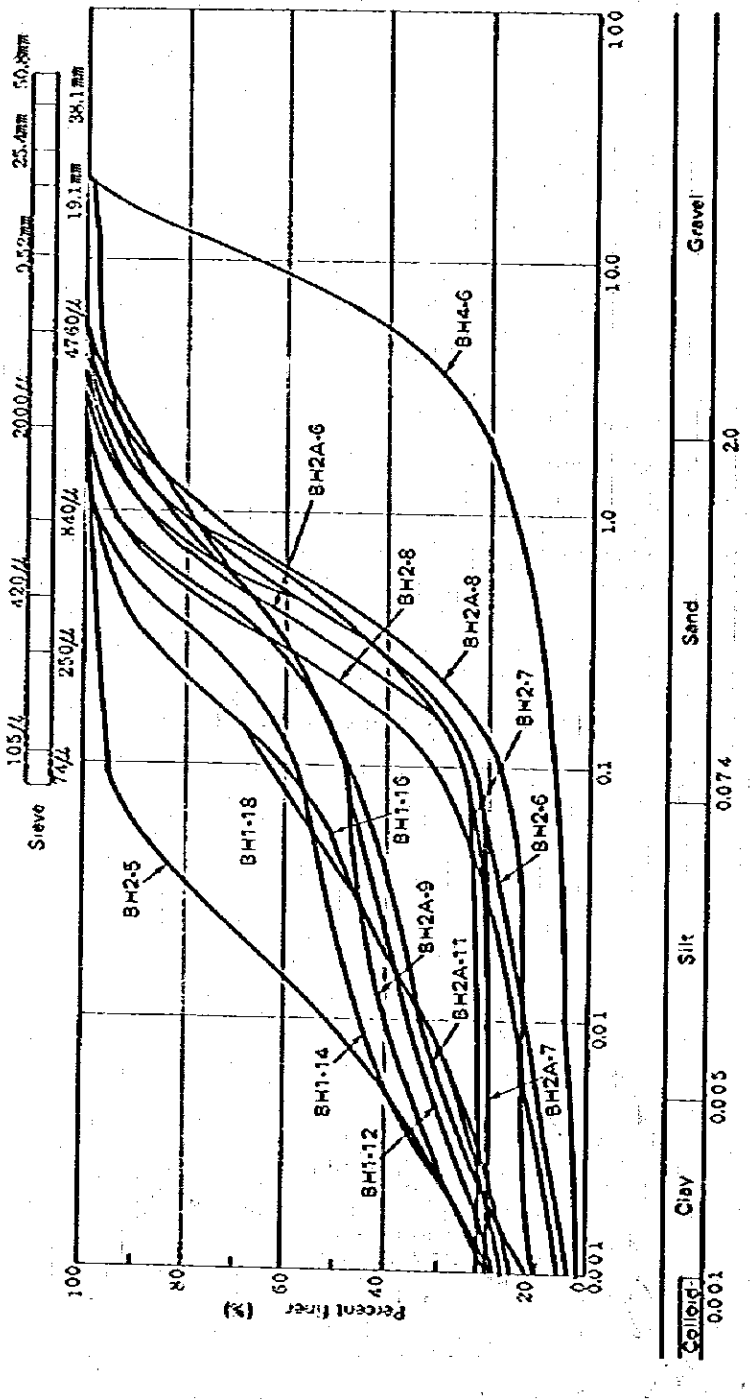


Fig. – I.2.39 Grain Size Accumulation Curve



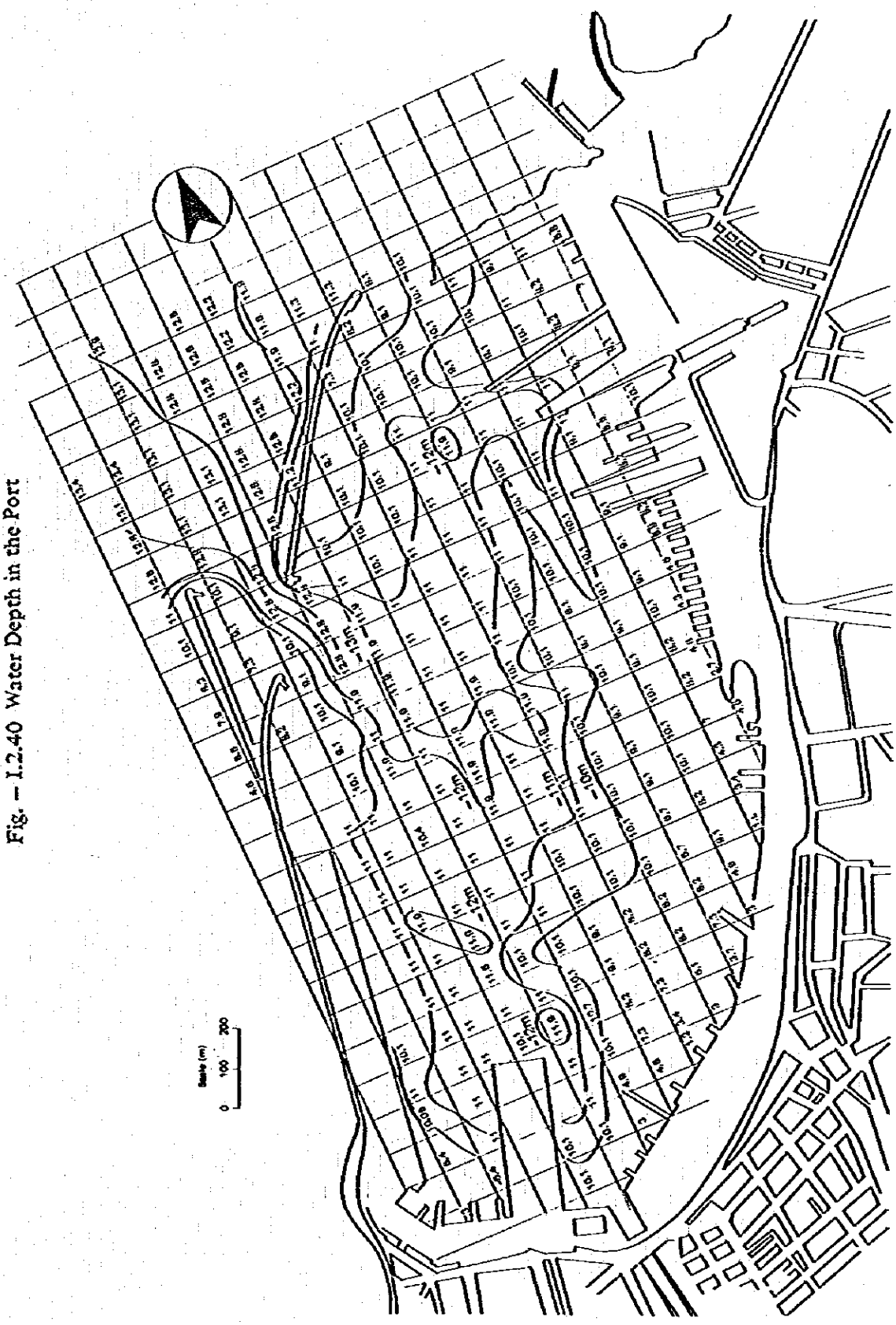


Fig. – I.2.40 Water Depth in the Port

PART II

PRESENT SITUATION OF THE PORT OF COLOMBO

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CHAPTER 1 PORT MANAGEMENT

1-1 Background of the Establishment of the Sri Lanke Ports Authority

The Sri Lanka Ports Authority was finally organized on August 1st last year (1979) by unifying, the Colombo Port Commission, the Port (Cargo) Corporation and the Port Tally and Protective Services Corporation.

Management and pilotage of the three ports of Colombo, Galle and Trincomalee were previously controlled by the Colombo Port Commission as one of the government organizations. Construction of the port facilities was also controlled by the same organization.

On the other hand, cargo handling work in these three Ports was previously performed by a public corporation called "the Port (Cargo) Corporation", while the Port Tally and Protective Services Corporation was in charge of tally and protective services in the Ports of Colombo and Trincomalee.

1-2 Port Management Organizations prior to Establishment of the Sri Lanka Ports Authority

1-2-1 The Colombo Port Commission

This was a government organ established under the Port of Colombo Administration Act implemented in 1950 and belonging to the Ministry of Trade and Shipping, which was responsible for construction, maintenance, operation and pilotage in the Ports of Colombo, Galle and Trincomalee.

Being a government organization, business accounting system was not employed for its accounting.

The Organization and main tasks are shown in Fig.-II.1.1.

1-2-2 The Port (Cargo) Corporation

The Port (Cargo) Corporation was organized in 1958 as a public body belonging to the Ministry of Trade and Shipping and is in charge of cargo handling work for all cargo in the three ports except petroleum products.

While the Colombo Port Commission was a government body and did not adopt a business accounting system, the Port (Cargo) Corporation adopted an independent accounting method. Its revenue and expenditure balance over the last several years was fairly good.

1-2-3 The Port Tally and Protective Services Corporation

This was organized in 1967 as a public body to conduct tallying and guarding work for cargo in the Ports of Colombo and Trincomalee. Though its scale was smaller than that of the Port (Cargo) Corporation it adopted a business accounting system.

1-3 Sri Lanka Ports Authority

1-3-1 Character, supervising minister and duties of the Sri Lanka Ports Authority

The Sri Lanka Ports Authority is a body corporate established by unifying the Colombo Port Commission, the Port (Cargo) Corporation and the Port Tally and Protective Services Corporation.

The competent minister is the Minister of Trade and Shipping.

The Sri Lanka Ports Authority's duties described in the Ports Authority Act are as follows:

① to provide in any specified port, efficient and regular services for stevedoring, lighterage, shipping and transhipping, landing and warehousing of dry and wet cargo and cargo in bulk; for wharfage, the supply of water, fuel and electricity to vessels, for handling petroleum, petroleum products and lubricating oils to and from vessels and between bunkers and depots; for pilotage and the mooring of vessels; for diving and under-water ship repairs and for other services incidental thereto;

② to provide in any specified port, efficient and regular tally and protective services;

③ to regulate and control navigation within the limits of, and the approaches to, the specified ports;

④ to maintain port installations and to promote the use, improvement and development of the specified ports;

⑤ to co-ordinate and regulate all activities within any specified port excluding the functions of the Customs;

⑥ to establish and maintain on and off the coast of Sri Lanka such lights and other means for the guidance and protection of vessels as are necessary for navigation in and out of the specified ports;

⑦ to perform such other duties as are imposed on the Ports Authority by this Act;

⑧ to conduct the business of the Ports Authority in such manner and to make in accordance with this Act such charges for services rendered by the Authority as will secure that the revenue of the Authority is not less than sufficient for meeting the charges which are proper to be made to the revenue of the Authority, to replace assets, make new investments and to establish and maintain an adequate general reserve; and

⑨ to endeavour to manage the specified ports and each of them as a self supporting enterprise in accordance with the provisions of this Act.

1-3-2 Organization and Employees of the Sri Lanka Ports Authority

The Board of the Sri Lanka Ports Authority consists of a chairman and 8 other members. Among them, a chairman and 5 members are appointed by the Minister. The remaining three are a representative of the General Treasury nominated by the Minister in charge of the subject of Finance, the Principal Collector of Customs and a representative of the Ministry in charge of the Minister to whom the subject of Fisheries has been assigned, nominated by such Minister.

The prescribed staff of the Sri Lanka Ports Authority are only the general manager and finance manager. At the time of preparation of this report, it was not yet decided what kind of divisions other than the finance division should be placed.

The Sri Lanka Ports Authority's Labour force by port and by section at the time of establishment on August 1st, 1979, is shown in Table-II.1.1.

Table – II.1.1 Labour Force of the Sri Lanka Ports Authority – on 1st Aug. 1979

	P (C) C			CPC			PTPSC			Total
	Executive	Other Non. Labour	Labour	Executive	Other Non. Labour	Labour	Executive	Other Non. Labour	Labour	
Colombo	123	2,920	10,856	61	5,753		13	817	81	20,624
Galle	2	74	439	1	163		–	–	–	679
Trincomalee	6	304	1,071	1	191		1	71	3	1,648

Fig. – II.1.1 Organization of CPC