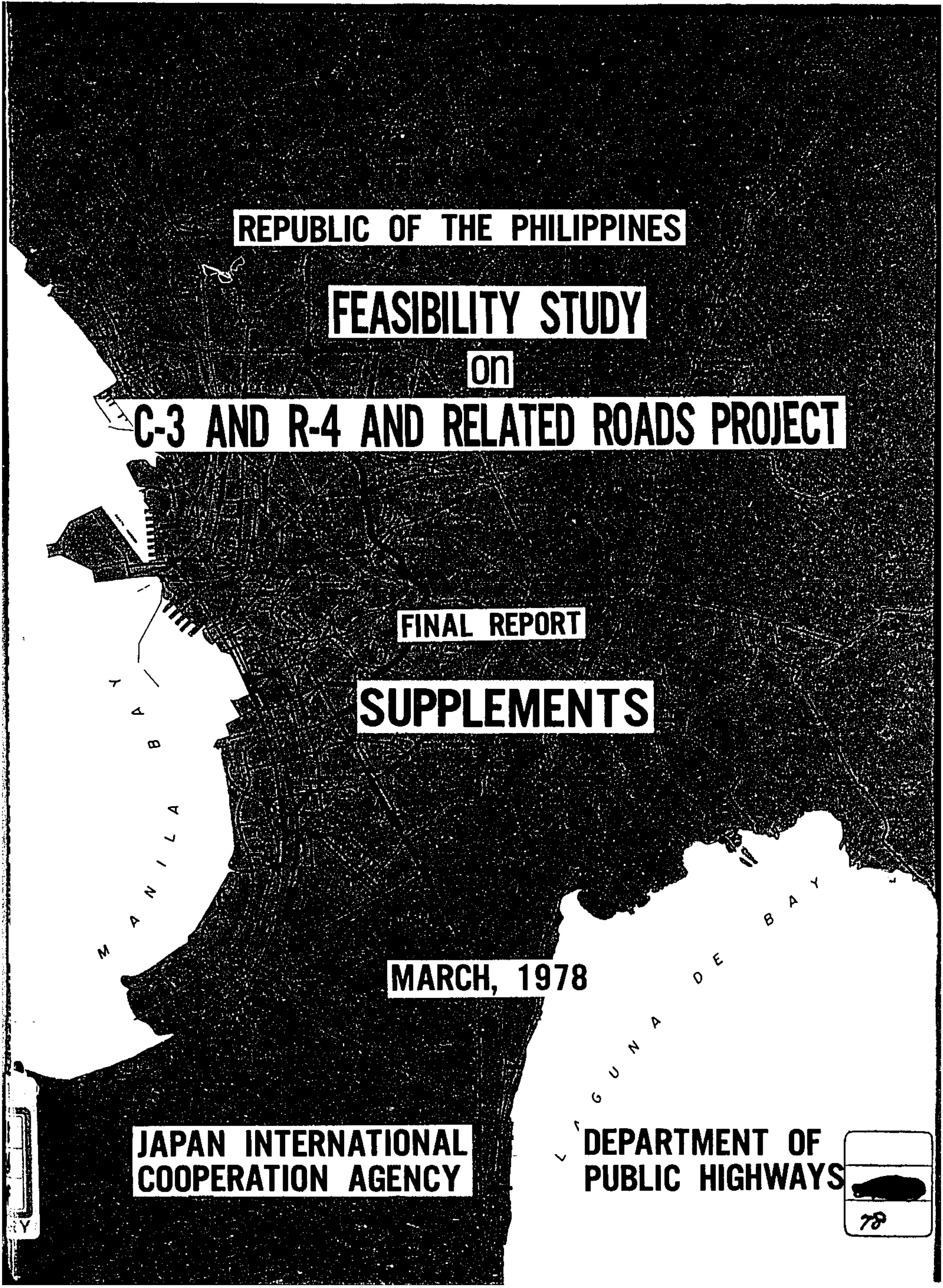

REPUBLIC OF THE PHILIPPINES

FEASIBILITY STUDY
on
C-3 AND R-4 AND RELATED ROADS PROJECT

FINAL REPORT

SUPPLEMENTS

MARCH, 1978

JAPAN INTERNATIONAL
COOPERATION AGENCY

DEPARTMENT OF
PUBLIC HIGHWAYS

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S1 LAND USE AND POPULATION PLAN

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1. INTRODUCTION

The aim of this section is to discuss and prepare the parameters describing land use and socio-economic characteristics in 1980, 1990 and 2000 which will be used as inputs to the land use/transport model.

The forecast in 1980 and 1990 prepared in MMETROPLAN were used in the C-3 and R-4 study, being modified by the new zoning plan decided by the team.

The estimation to be made for the year 2000 were based on recent growth, future growth (estimation which was carried out in MMETROPLAN for the 1980 and 1990 land use/transport model), and developments would be brought about by government policy in the future. Therefore, it is significant to show that the forecast given and discussed in this section for the year 2000 land use/transport model would have to be modified as the needs arise corresponding to the change of conditions.

2. GROWTH AND CHANGE OF POPULATION AND LAND USE

Metro Manila is growing and changing in response to increasing population, rising aspirations and improving standard of living. This growth and changes must be considered in determining land use and population plans in the future.

The most important and significant consideration in planning for the future is population increase. Many people living in Metro Manila have migrated to the area from other parts of the Philippines. As mentioned in MMETROPLAN which was conducted by the Philippine Government, many migrants have come from other urban areas of the Philippines rather than directly from the rural areas. They are both pushed by circumstances in their province, such as job shortages, and attracted by the big city which they believe promises job opportunities, higher income, access to education and, in general terms, "the good life".

Population growth of Metro Manila and its natural increase and migration is summarized on Tables 2-1 and 2-2. A comparison is also given with the figures of the City of Manila and the Philippines as a whole.

These tables show that:

- growth in Metro Manila has been taking place at significantly faster rates than in both the nation as a whole and the City of Manila. This higher rate of growth has been due to the rapid growth of the surrounding areas of the City of Manila.
- the growth rate in the City of Manila has been considerably less than that of either Metro Manila or the nation as a whole. This lower rate of growth is mainly due to out-migration.
- during the period between 1960 and 1970, the annual rate of migration accounts for about half of the growth of Metro Manila.

Table 2-1 Population Growth 1948 ∿ 1975

YEAR	City of Manila	Metro Manila*	Philippines
1948	983,906	1,567,000	19,200,000
Annual increase 1948 ∿ 60	1.2 %	3.8 %	2.9 %
1960	1,138,611	2,464,000	27,000,000
Annual increase 1960 ∿ 70	1.6 %	4.9 %	3.1 %
1970	1,330,788	3,969,000	36,700,000
Annual increase 1970 ∿ 75	1.8 %	4.2 %	2.7 %
1975	1,454,352	4,863,000	41,831,045

Source: National Census and Statistics Office * 17 jurisdictions

Table 2-2 Natural Increase and Migration 1960 ∿ 1970

	City of Manila	Metro Manila*	Philippines
Annual rate of natural increase, 1960 ∿ 1970	2.3 %	2.5 %	3.1 %
Annual rate of migration	-0.7 %	2.4 %	-
Total annual rate of increase	1.6 %	4.9 %	3.1 %

Source: National Census and Statistics Office * 17 jurisdictions

The annual rate of increase of Metro Manila during the period 1970 ∿ 1975 has been less than that in the period 1960 ∿ 1970. It is likely that such decline in the rate of increase would be continued further. Anyhow, this level of growth is by no means unusual.

As the zoning plan for this study was discussed in another section, the study area to be adopted by the feasibility study team includes 17 jurisdictions as opposed to 27 jurisdictions in MMETROPLAN. The consideration and forecast were, therefore, made on these 17 jurisdictions.

The population of the City of Manila has increased in recent years from approximately 0.98 million in 1948 to 1.14 million in 1960, 1.33 million in 1970 and 1.45 million in 1975. Compared with other jurisdictions of the study area, these figures of time series information of the city indicate the main concentration of population, there being about one third of the people of the study area as a whole in 1970.

On the other hand, it is very interesting to note that the population of Quezon City has grown rapidly and is expected to be on the same level with that of the City of Manila. This rapid growth was mainly due to the policies of decentralization initiated by government which encourages the growth of other urban centers.

The population growth of other jurisdictions within the study area is characterized by a comparative concentration of population in the surrounding areas of the City of Manila, especially Caloocan and Makati.

The recent growth of population of these jurisdictions during the period 1948 to 1975 are given in Table 2-3.

The gross density in person per hectare of the Ciry of Manila has increased from 260 in 1948 to 300 in 1960, 350 in 1970 and 380 in 1975. However these time series show the highest density of population compared with other jurisdictions, the change of the density in Navotas indicates more rapid congestion. It suggests that the density of Navotas will get ahead of that of Manila. The trend information of Pasig, moreover, has inclined rapidly, especially during the period between 1960 and 1975.

However, the trend information of Pasay City has declined from 1970. On the basis of the analysis of past trends and information of other jurisdictions, it is expected to incline again in anything less than 5 ∿ 10 years.

As of 1975, the gross densities of six jurisdictions; Manila, Navotas, Pasig, Pasay, Makati and San Juan del Monte had already been over 100 persons per hectare. All of these jurisdictions except Pasig, surround the City of Manila. Based on these considerations and the relationship of these jurisdictions, the assumption would be made that the development pressures for population growth would expand the main concentrated area to four directions. One of them is in the direction of north passing Navotas, Malabon and Caloocan City; the second one is in the direction of south passing Pasay City and Makati, the third is in the direction of southeast passing San Juan del Monte, Mandaluyong and Pasing and the last one is in the direction of Quezon City as shown in Fig. 2-1.

The time series information of gross density of population of each jurisdiction up to 1975 are given in Table 2-4.

Table 2-3 Population of the Jurisdiction of MMA, 1948 ∿ 1975

Jurisdiction	Population 1948	Population 1960	Population 1970	Population 1975
Manila	984,000	1,139,000	1,331,000	1,454,000
Caloocan City	55,000	146,000	274,000	293,000
Makati	41,000	115,000	265,000	332,000
Mandaluyong	26,000	72,000	149,000	181,000
Navotas	29,000	49,000	83,000	97,000
Pasay City	89,000	133,000	206,000	187,000
Quezon City	111,000	398,000	754,000	960,000
San Juan del Monte	31,000	57,000	105,000	121,000
Las Piñas	9,000	16,000	46,000	84,000
Malabon	46,000	76,000	142,000	174,000
Marikina	24,000	40,000	113,000	165,000
Muntinglupa	18,000	22,000	65,000	92,000
Parañaque	29,000	62,000	97,000	155,000
Pasig	35,000	62,000	156,000	211,000
Pateros	8,000	13,000	25,000	33,000
Taguig	15,000	22,000	55,000	74,000
Valenzuela	17,000	42,000	98,000	150,000
Total	1,567,000	2,464,000	3,964,000	4,863,000

Source: National Census and Statistics Office

The distribution of land uses within the urban area has been changing in response to the social, economic and political activities of its population, and the opportunities for development. Figs. 2-2 and 2-3 compare the distribution of activities in the study area in 1960 and 1975. They show the clear distribution between the locational patterns of new industry and commercial development.

Table 2-4 Increases in Gross Density of Jurisdiction within the MMA 1948 ∿ 1975

Jurisdiction	Area in has.	Gross density in persons per hectare 1948	Gross density in persons per hectare 1960	Gross density in persons per hectare 1970	Gross density in persons per hectare 1975
Manila	3,830	260	300	350	380
Caloocan City	5,580	10	30	50	70
Makati	2,990	10	40	90	110
Mandaluyong	2,600	10	30	60	70
Navotas	260	110	190	320	370
Pasay City	1,390	60	100	150	130
Quezon City	16,620	10	20	40	60
San Juan del Monte	1,040	30	60	100	120
Las Piñas	4,150	5	5	10	20
Malabon	2,340	20	30	60	70
Marikina	3,890	10	10	30	40
Muntinglupa	4,670	5	5	10	20
Paranaque	3,830	10	20	20	40
Pasig	1,300	30	50	120	160
Pateros	1,040	10	10	20	30
Taguig	3,370	5	10	20	20
Valenzuela	4,700	5	10	20	30
TOTAL	63,600	25	39	62	76

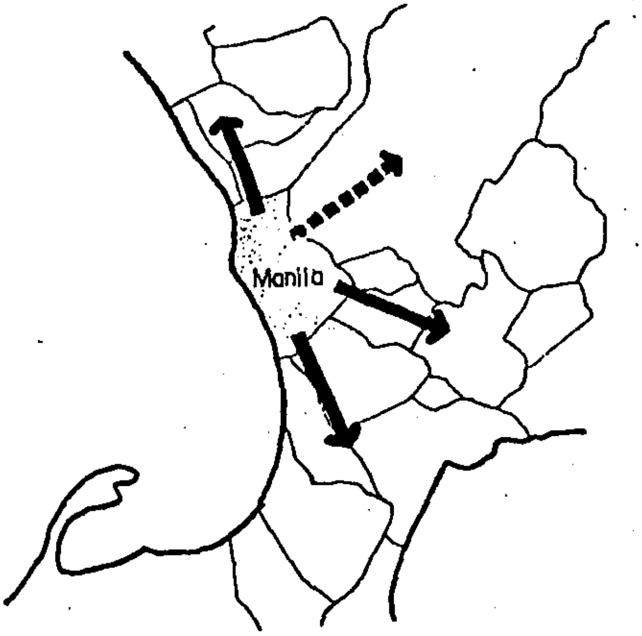


Fig. 2-1

Directions of Growth of Main Concentrated Area

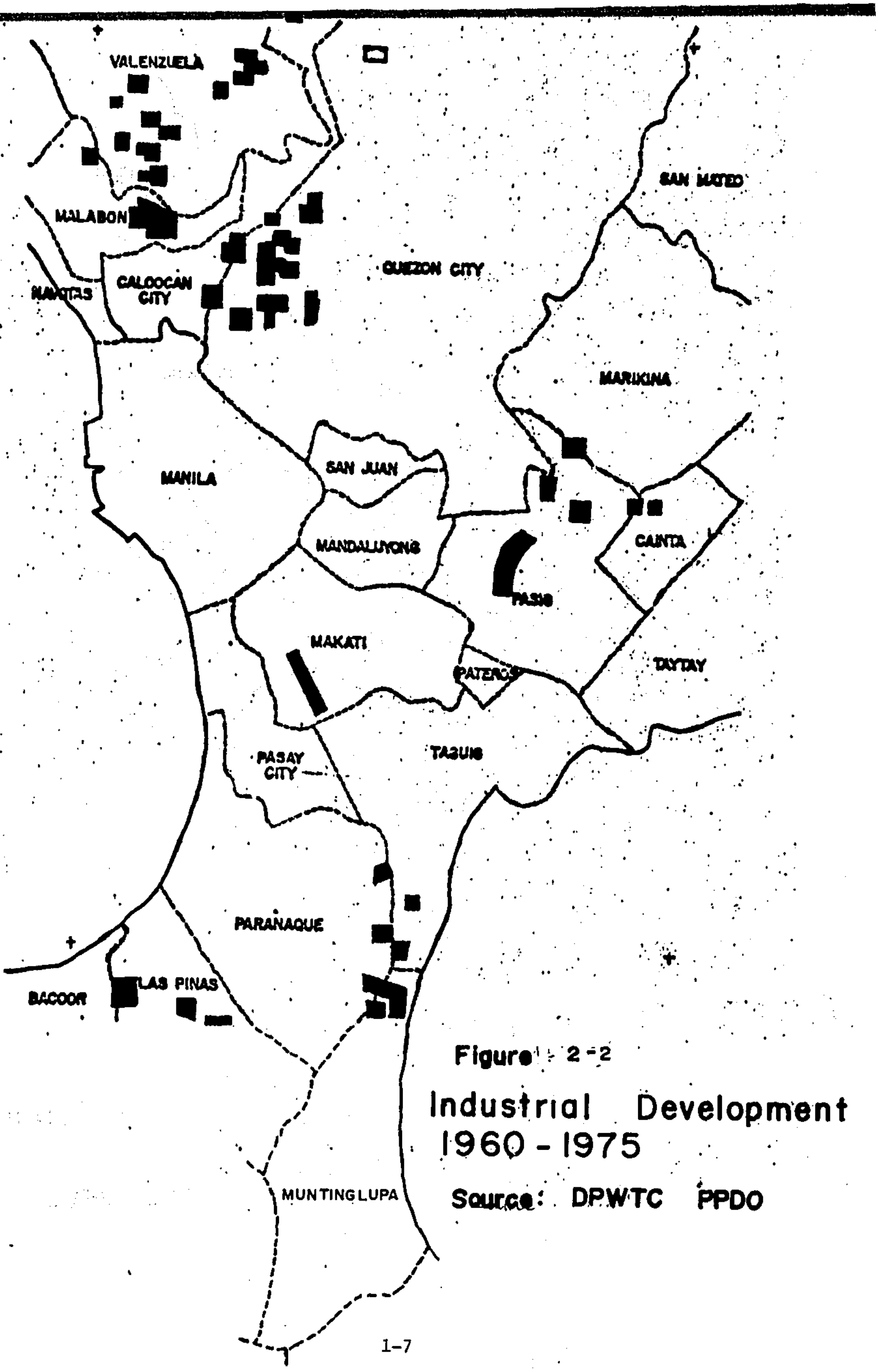


Figure 2-2

Industrial Development 1960 - 1975

Source: DPWTC PPDO

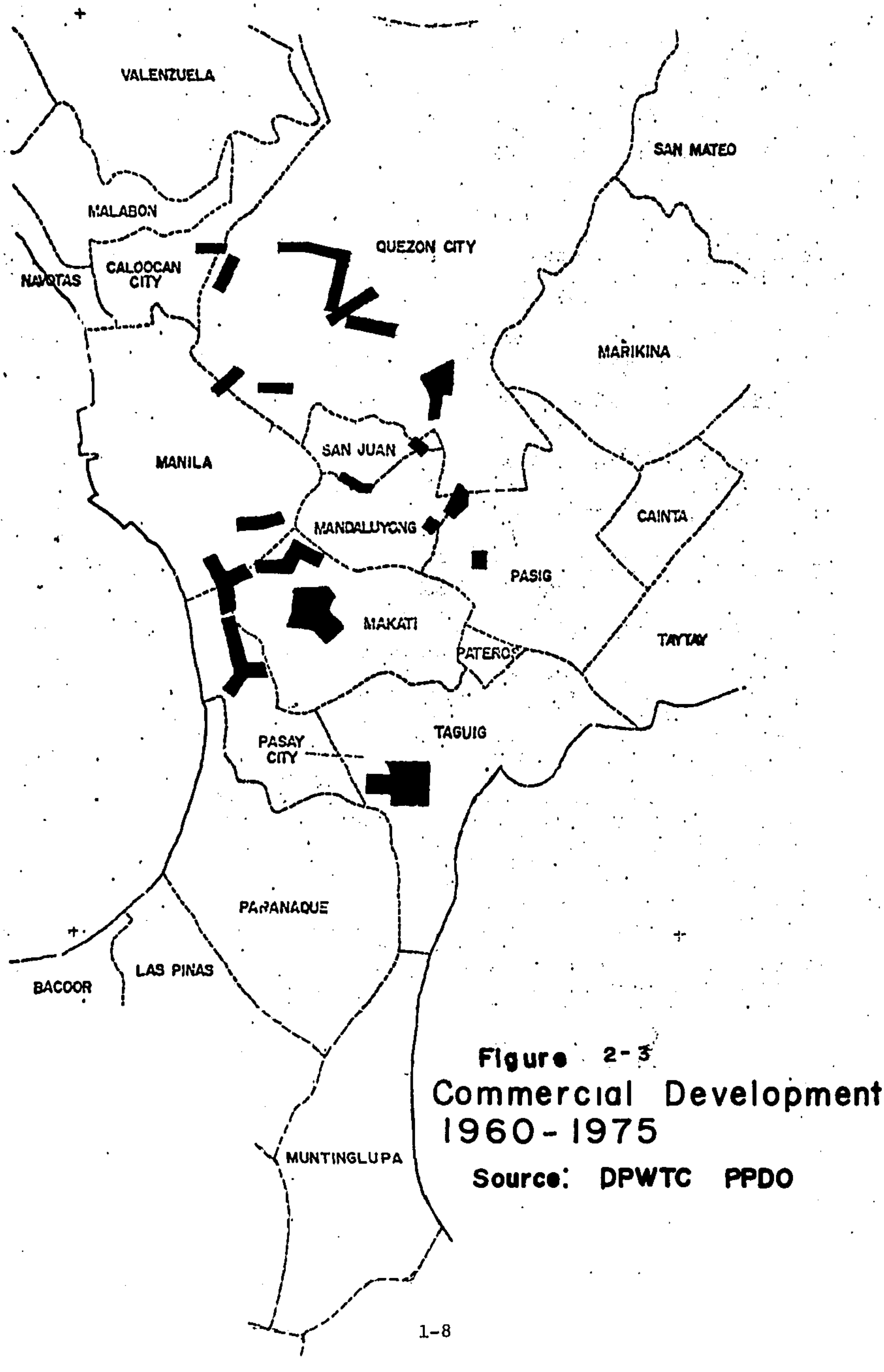


Figure 2-3
Commercial Development 1960-1975
Source: DPWTC PPDO

Industrial development has been characterized by dispersion to the suburbs, mostly outside Epifanio de los Santos Avenue (EDSA) and concentrated in three areas, along the McArthur Highway and Manila North Diversion Road in the north, in the Marikina Valley and in the east, along the South Superhighway and the Pamplona road. The pattern reflects the need of industry to find cheaper sites on the periphery with good transport links to markets and supplies of new materials.

New commercial activities have in contrast been largely confined to the area within or adjacent to EDSA. New centers have been created in Makati, Cubao and Greenhills, and commercial development has been strengthened along the main radial roads and along EDSA. This reflects a fundamental shift away from the formerly dominant, old commercial centers.

3. PROBLEMS AND FORMS OF URBAN DEVELOPMENT

3.1 PROBLEMS OF URBAN DEVELOPMENT

In this section, these problems are discussed, together with the form of urban development in the future.

The urban problems that generally have high influence on urbanization are the following:

1) provision of infrastructure;
2) specific projects; and
3) development controls.

The most important infrastructure that influences urbanization is the transport network, especially roads, though other transport projects such as railroad, port and airport facilities also have high influences.

The second problem to have high influence on urbanization is the implementation of specific projects such as the Government Center, the Southern reclamation and the Greenhills commercial complex. These projects will stimulate urbanization and growth of surrounding and related areas.

The third influence is development control. The available controls in Metro Manila are the following:

a) control on changes of use in areas subject to zoning ordinances;
b) control on new industry within 50-kilometer radius of the center of Manila;
c) control on the use of land within a band of 500 meters on either side of a public highway; and
d) control on the conversion of land into other users.

Local governments are vested with the power to adopt zoning ordinances to control and regulate land use under Republic Act (RA) 2264. This Act, better known as the Local Autonomy Act, was passed in 1959. Four of the 17 jurisdictions presided over by the Metro Manila Commission have zoning ordinances covering the whole jurisdiction, and seven have zoning ordinances which apply on locations only (spot zoning). The four with areawide zoning are the cities of Manila and Quezon and the municipalities of Makati and Pasig. The seven with spot zoning are Las Piñas, Mandaluyong, Marikina, Muntinglupa, Parañaque, San Juan and Taguig.

The second control is that relating to new industrial development within the 50-kilometer radius of the center of Manila. Imposed through a Memorandum Circular of the President in December 1973, it is a reaction to the concentration of pollutive industry in Manila. According to the Human Settlements Commission, its value is in guiding industrialists to sites that are considered suitable for industrial development.

The third control is that relating to the use of land within a band of 500 meters on either side of public highways. The legal basis for the control is Presidential Decree 399. The aim of the legislation is to restrict development along highways outside established towns, cities and settlements until comprehensive and integrated land use and development plans are prepared. The control has been in operation since 1974.

The fourth area of control relates to the conversion of tenanted rice and corn lands into some other purposes. The legal basis for this control was laid down in PD 815 and was introduced in 1975. The aim of this control is to protect tenant farmers from being ejected from the land they farm.

3.2 FORMS OF URBAN DEVELOPMENT

It is said that there is no shortage of land for development in Metro Manila. In fact, much of the land on the verge of urbanization such as those in Quezon City, Las Piñas and Parañaque is more suitable for urban development than the low-lying, flooded land on which large part of the city of Manila is situated. Locally, there may be shortage of land for development or redevelopment, but these are caused by much of demands rather than by physical shortage of land. If future development is possible in numerous areas, the question as to which form of urban development is most desirable will arise.

In MMETROPLAN, the conceptual forms of growth of Metro Manila have been discussed. These forms were based on five "urban expansion goals". These are:

a. to follow current government policies and the development trends;

b. to minimize the diseconomies of urban sprawl and to increase the efficiency of the existing urban area;

c. to preserve and enhance the degree of social and economic interdependence that exists in large cities;

d. to establish new urban settlements within Metro Manila; and

e. to optimize obvious opportunities for the rapid urban expansion.

These forms of urban development expected in MMETROPLAN have been examined in detail by the feasibility study team. On the examination of these "urban expansion goals", the consolidation of forms of the urban growth and the refinement of differences of the expansion goals to each other were considered. The results of these consideration were obtained as the three forms of expansion of Metro Manila instead of five "urban expansion goals" discussed in MMETROPLAN. These three forms are:

Form 1 expansion of the main urban area corresponding with the availability of land and the pressure for development, establishing the new urban communities;

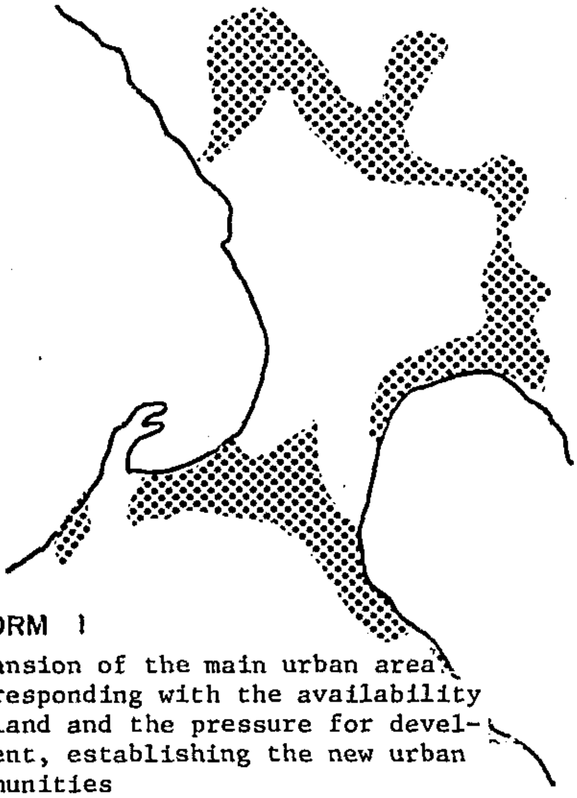
Form 2 establishment of new urban centers along the major cirridors, improving the function of the existing urban areas; and

Form 3 establishment of new urban settlements outside the existing urban area, minimizing the disadvantages of urban sprawl of the "mother city".

These forms are illustrated in Figure 3-1.

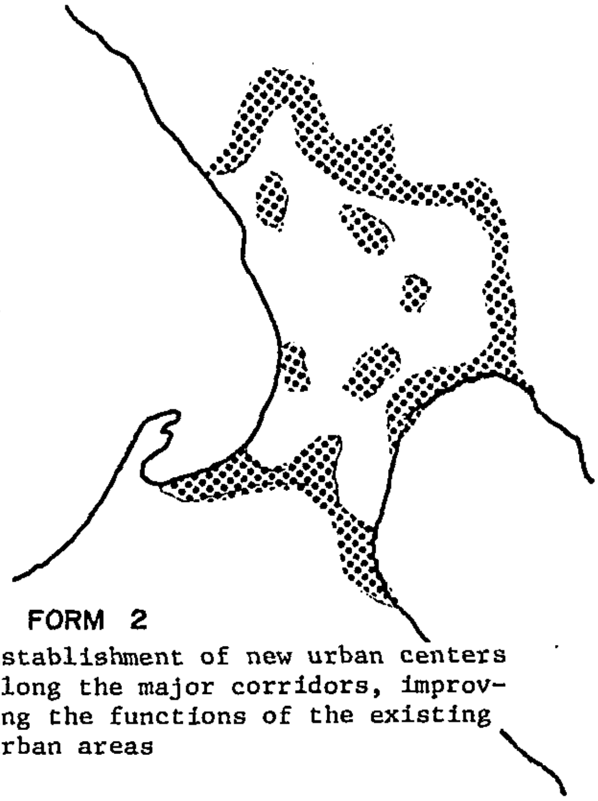
For Metro Manila, it is not only most likely that Form 3 will arise in the coming 15 ∿ 20 years but also most desirable. This is because the concentrated investments for the establishment of the new urban settlements will be less than those for the provision of the necessary services and facilities of proportion to the expansion of the existing urban area. Moreover, this is because of the existence of the new urban settlement projects initiated by the Government, such as "Sapang Palay" and "Dasmariñas", especially the existence of the immediate implementation of "Lungsod Silangan", in the Antipolo highlands.

Form 3 was therefore considered in estimating population distribution in the Metro Manila Area and in preparing the Land Use and Population Plan.



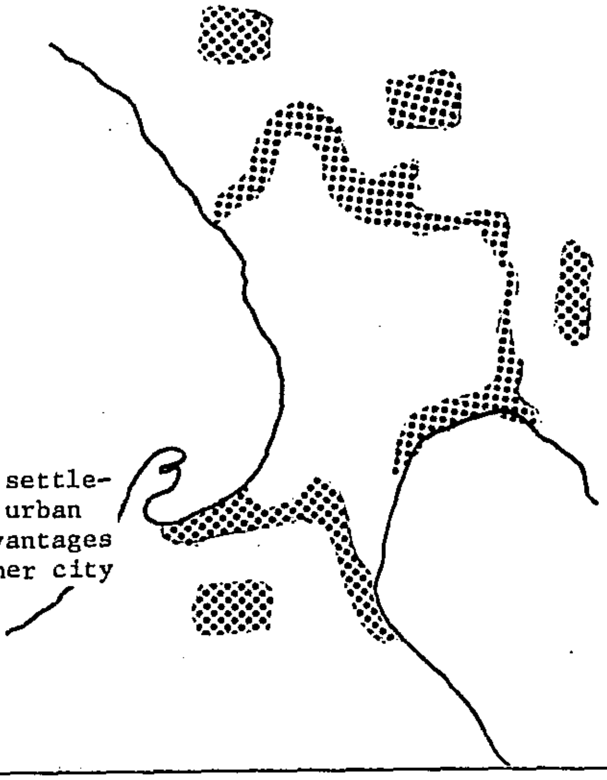
FORM 1

Expansion of the main urban area corresponding with the availability of land and the pressure for development, establishing the new urban communities



FORM 2

Establishment of new urban centers along the major corridors, improving the functions of the existing urban areas



FORM 3

Establishment of new urban settlements outside the existing urban area, minimizing the disadvantages of urban sprawl in the mother city

Figure 3-1

FORMS OF URBAN DEVELOPMENT

4. LAND USE AND POPULATION PLANS FOR THE YEARS 1980 AND 1990

4.1 GENERAL

The recent time series information of population of the Metropolitan Manila Area have already been discussed and examined in another section. Therefore, on the basis of the analysis of these past trends, the future amount and distribution of activities and the socio-economic characteristics of the population have been prepared for estimating future traffic demand and evaluation of transport investments.

The preparation of the land use and socio-economic inputs by traffic zones in 1980 and 1990 have already been carried out in MMETROPLAN. Therefore, the forecasts in 1980 and 1990 prepared in MMETROPLAN were basically adopted and applied to this feasibility study, being made over as the new zoning plan defined by feasibility study team.

4.2 POPULATION

According to MMETROPLAN, the global total population forecast was based on the United Nations Fund for Population Activites - National Census and Statistics Office (UNFPA-NCSO) forecasts that were prepared for provinces, cities and municipalities in the Philippines 1975. Though the three forecasts (low, medium and high forecast) were prepared by UNFPA-NCSO, which advise the University of the Philippines Population Institute, the forecast between medium and low was selected in MMETROPLAN.

The recent time series information and forecasts of population growth in 1980 and 1990 in Metro Manila are summarized in Table 4-1.

In addition to the global forecast of population growth in the MMA as a whole, trends at jurisdiction level were examined to provide a basis for jurisdiction.

For each jurisdiction, the absolute increases in population, the rate of recent growth, and the resultant changes in gross density were examined. The analysis of recent trend information went back to 1948.

On the basis of past trends, the availability of land and the pressures for development, a judgement was made on the distribution of future growth at jurisdiction level. For each jurisdiction, a projection of the trend was prepared. The resultant figures were totalled and checked against the global total for the MMA as a whole. An adjustment was then made to the jurisdiction totals to bring them into line with the global total.

The recent growth and forecasts at jurisdictions level in MMA are summarized in Table 4-2.

Table 4-1 Recent Growth and Forecasts of Population in MMA

Year	Population (persons)	Actual increase (persons)	Annual rate of increase (percent)
1948	1,567,000	-	-
1960	2,464,000	897,000	3.8 %
1970	3,964,000	1,500,000	4.9 %
1975	4,863,000	899,000	4.2 %
1980	6,092,000	1,229,000	4.6 %
1990	8,281,000	2,189,000	3.1 %

Source: 1948 ∿ 1975 ..... Census
1980 & 1990 ..... Forecasts in MMETROPLAN

Fig. 4-2 Projected Increase in Population for the Jurisdiction of MMA 1970 ∿ 1990

Jurisdiction	1970 (Census)	1980 (Estimated)	1990 (Estimated)
Manila	1,331,000	1,587,500	1,820,000
Caloocan City	274,000	477,500	710,000
Makati	265,000	367,000	560,000
Mandaluyong	149,000	199,000	315,000
Navotas	83,000	116,000	130,000
Pasay City	206,000	207,000	280,000
Quezon City	754,000	1,203,000	1,690,000
San Juan del Monte	105,000	129,500	160,000
Las Piñas	46,000	190,000	315,000
Malabon	142,000	211,000	270,000
Marikina	113,000	271,000	390,000
Muntinglupa	65,000	156,000	260,000
Parañaque	97,000	325,000	435,000
Pasig	156,000	280,000	340,000
Pateros	25,000	40,500	66,000
Taguig	55,000	95,000	170,000
Valenzuela	98,000	237,000	370,000
Total	3,964,000	6,092,000	8,281,000

The estimated jurisdiction totals in 1980 and 1990 were allocated to the individual traffic zones on the basis of the distribution of population in 1971 and the development that had taken place since then; the availability of land for new development, known infrastructure commitments, and pressures for development within the urban area. In this distribution the influence and effect of transport conditions in the future must be considered. In this study, the transport condition especially on the project roads were taken into account in the distribution of population.

As already discussed, for the purpose of modelling travel demand, the study area has been devided to cover 80 traffic zones which are grouped into 16 sectors.

4.3 EMPLOYED PERSONS BY WORKPLACE

The number of employed persons by workplace was estimated by industries - primary, secondary and tertiary.

According to MMETROPLAN, the sources of information used for arriv ing at the global total for each of the three categories of employment were the 1971 Urban Transport Study and the Economic Census in 1967 and 1972. From analysis of the data available the following assumptions were made: Though primary employment would remain static up to 1980; it would decrease by degrees up to 1990 thereafter. The secondary and tertiary would together grow at 5 per cent annual rate of increase up to 1980, thereafter they would increase further. These assumptions reflected recent trends and expectations of future population and economic growth.

The global total of the study area as a whole for 1980 and 1990 were allocated to be individual traffic zones on the basis of the distribution of employment in 1971. However, the following information in recent and future distribution of employment was also taken into account:

a. growth of new primary employment in the suburbs corresponding with new agricultural development to supply fresh goods to the built-up area.

b. growth of new secondary employment largely on the fringes of and beyond the main urban area.

c. growth of new tertiary employment largely within the main urban area, in existing centers and along the major thoroughfares.

d. new employment opportunities being provided in on-going development projects such as the Southern Reclamation, the Greenhills commercial complex and the Government Center.

e. the trend, apparent from statistics, of a reduction in secondary employment in the City of Manila.

The significant and desirable modification and adjustment in distribution of total number for each of the three categories of employed person by workplace were carried out to take account of changes which had taken place between the time of data collection and the present.

4.4 EDUCATIONAL ATTENDANCE

According to MMETROPLAN, the estimates of school and college places in 1980 were produced by applying the ratio of educational places to population to the expected increase in population in the period 1971 to 1980, and adding this to the number of places existing in 1971. The same methodology was adopted and applied in estimating educational attendance in 1990. In 1970, according to the Census, there were 270 persons who attended school or college for every 1,000 people living in the jurisdictions defined in MMETROPLAN.

The same ratio (270 school and college attendance to 1,000 people) was adopted for 1980 and 1990 in MMETROPLAN. This was because there was no firm reason to change it. On the other hand, the Department of Education considered that attendance rates were more likely to increase than to decrease or remain static as educational standards are improved. On the other hand, a government policy exists to decentralize education from Metro Manila. Therefore, the assumption made on the ratio of school and college attendance in the future was based on increases in attendance rates brought about by government policy to improve standards of education, being balanced by losses brought about by decentralization out of Metro Manila.

According to the records of the Department of Education and Culture in the period 1970 ∿ 76, approximately one half of total educational attendance is for elementary schooling. In MMETROPLAN, it was assumed that this element of the additional demand for educational attendance for 1971 ∿ 80 and a small part of the secondary and college element would be met locally. Accordingly, it was assumed that 60 per cent (70 per cent in 1990), of the total additional school and college places 1971 ∿ 80 would be distributed in proportion to the expected built-up of population, and the remaining 40 per cent (30 per cent in 1990) of the demand would be distributed in proportion to the distribution of school and college places that existed in 1971.

4.5 SOCIO-ECONOMIC CHARACTERISTICS OF POPULATION

In addition to the increases and distribution of population, employed persons by workplace and educational attendance, future traffic demands are influenced by the demographic and economic characteristics of the population. These are the following:

a. employed persons by residence,

b. household size,

c. private vehicle ownership, and

d. family incomes

The total number of employed persons by residence gives significant information for estimating the global total of employed persons by workplace. In MMETROPLAN, the estimates of the proportion of the population in employment were based on a participation rate (the proportion of economically active people to 10 and over aged people) of 48 percent applied to the population rate of open employment.

The participation rate and the rate of unemployment were based on a study of past trends as recorded by the Labor Force Survey in the period 1968 ∿ 75. According to MMETROPLAN, it was estimated that the proportion of the population aged 10 and over would be 73.5 per cent in 1980 and 77.5 per cent in 1990, compared to 72.2 per cent in 1971.

The only forecast time series information available on unemployment is the Labor Force Survey. This shows that the level of unemployment in Manila and subrurbs has been generally about twice that for the nation as a whole and that during the period 1968 ∿ 75 this was around 10 per cent. The 10 per cent figure was therefore adopted and applied uniformly to the whole study area in MMETROPLAN.

A constant factor of 0.31750 (0.48 × 0.735 × 0.9) in 1980 and 0.3348 (0.48 × 0.775 × 0.9) in 1990 was therefore applied to the population in each zone to arrive at the number of employed persons by residence in each zone.

Household size in the MMA as defined in MMETROPLAN declined from 6.4 in 1960 and 6.2 in 1970. According to MMETROPLAN, it was assumed that this decline would continue further for estimation of traffic demand in 1980 and 1990. A figure of 5.8 in 1980 and 5.0 in 1990 was assumed. These figures were adopted and applied to the feasibility study for C-3 and R-4. Therefore, households of each traffic zones were estimated by dividing individual population of the traffic zones by estimated household size.

Between 1970 and 1975, the population of the MMA defined in MMETROPLAN grew at an average rate of 4.2 per cent annually. This results in an increase in private vehicle and motorcycle ownership per capita of approximately 2.4 per cent per annum from 41 per thousand population in 1969 to 47 per thousand in 1975.

On the basis of these past trends, a family income-based projection of car ownership has been carried out in MMETROPLAN. According to MMETROPLAN, the results of this analysis were obtained as the central assumption of 56 cars and motorcycles per 1,000 population in 1980 and 83 in 1990. These central forecasts imply that the proportion of household owning private vehicles will increase from 19 per cent in 1971 to 26 per cent in 1980 and 39 per cent in 1990. These figures were adopted and applied to the assumption of this feasibility study.

The distribution of increase in car ownership within the study area was assumed to be uniform and based on the distribution that existed in 1971 with an allowance of the individuality of each traffic zones.

In addition to these socio-economic factors, the income level of family also influences the travel behavior in the future. Average family incomes in Manila and the suburbs in 1971 reported by the Bureau of Census (Family Income and Expenditure Survey) were about ₱7,800 per annum; there were wide disparities in the income distribution, almost 40 per cent of families having income less than ₱4,000 per annum.

According to MMETROPLAN, for travel forecasting and evaluation purposes, it has been assumed that by 1980, family incomes in MMA will have recovered the ground lost since 1971 and that thereafter real average incomes will increase by 20 per cent between 1980 and 1990.

5. LAND USE AND POPULATION PLANS FOR THE YEAR 2000

5.1 GENERAL

The preparation of the land use and socio-economic inputs for traffic projection in the year 2000 has been made, being based on the analysis of the trends and understanding of the change of socio-economic conditions.

The similar methodology which have been applied in MMETROPLAN was largely adopted to this study. The general flow diagram for preparation of the land use and socio-economic inputs in 2000 is given in Figure 5-1.

As already mentioned, Form 3 - establishment of the new urban settlements outside the existing urban area minimizing the disadvantages of urban sprawl of the "mother city" - were adopted as the most desirable form of urban development expected in the Metropolitan Manila Area. Accordingly, the estimations of population, employed persons, educational attendance and other socio-economic characteristics in the year 2000 were carried out on the basis of this urban development form.

5.2 POPULATION

As already discussed in the section 4.2, the policies of decentralization to encourage the growth of other urban centers and rural development will help reduce the need for people to migrate to the Metropolitan Manila Area. They could be expected to have a significant effect on reducing the rate of migration population 10 ∿ 15 years later. The existence of organized family planning in the Philippines could be expected to reduce the rate of natural increase in MMA.

Based on these considerations, the assumption has been made that the rate of population growth in MMA will decline progressively, however, it is still expected that the absolute increase of population will continue further.

According to the reports published by the National Census and Statistics Office, the annual growth rate of natural increase and migration in MMA during the period 1960 ∿ 70 were shown as follows:

annual rate of natural increase	2.5 %
annual rate of migration	2.4 %
total annual rate of increase	4.9 %

On the basis of these figures, the annual rate of increase during the period 1990 ∿ 2000 were estimated as follows:

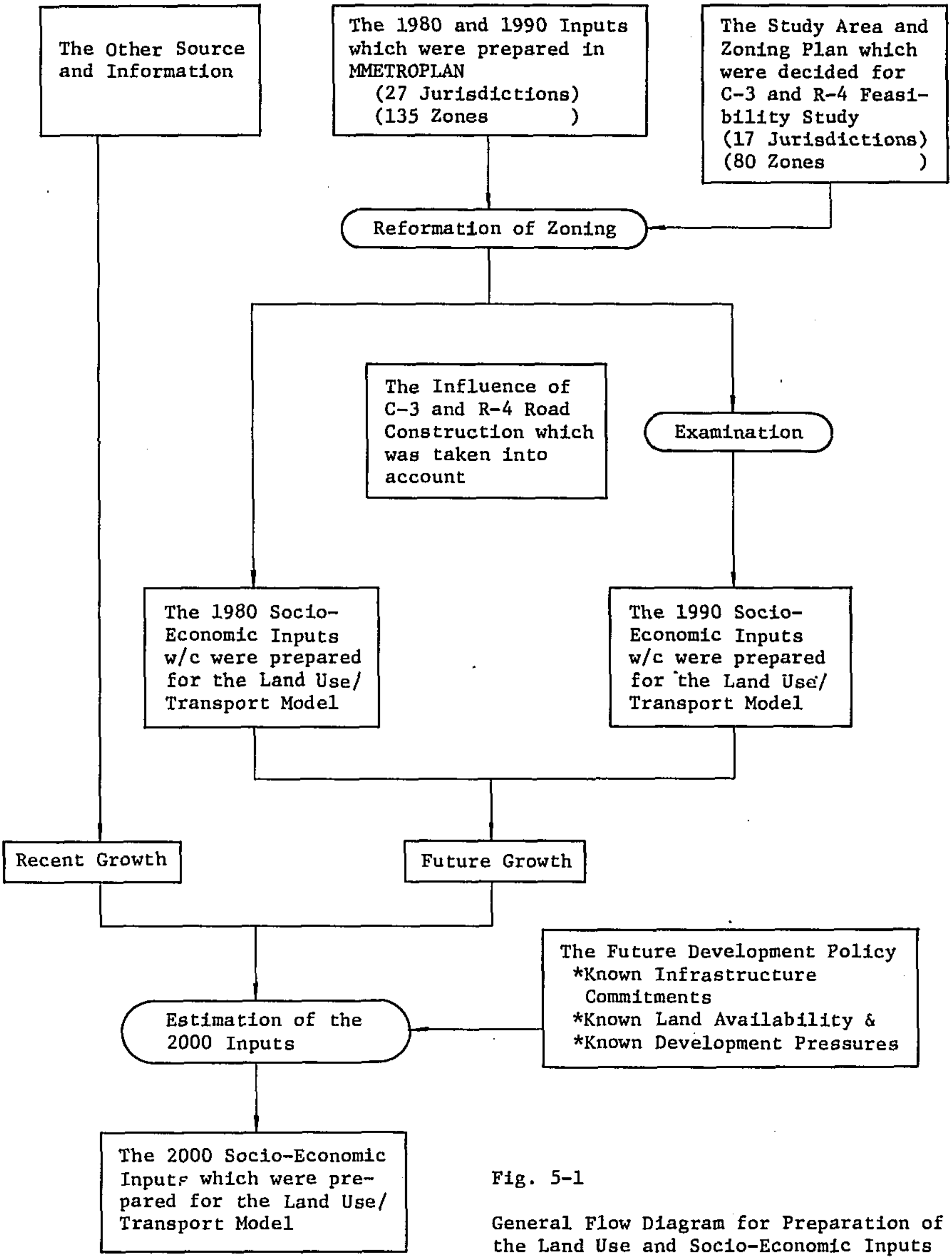


Fig. 5-1

General Flow Diagram for Preparation of the Land Use and Socio-Economic Inputs in 2000

annual rate of natural increase ..... 1.5 %
annual rate of migration .... 1.2 %
total annual rate of increase .... 2.7 %

The resultant figures were checked against the forecasts estimated in MMETROPLAN. According to MMETROPLAN, the annual rate of increase were estimated to be 4.6 per cent during the period 1975 ∿ 1980 and 3.1 per cent during the period 1980 ∿ 1990.

The forecast prepared in this feasibility study were adequate in comparison with these figures estimated in MMETROPLAN.

The actual number of population estimated for the year 2000 is given in Table 5-1, compared with other alternatives.

This Table shows that approximately 10.8 million of population in medium forecast would live in Metropolitan Manila Area in the year 2000 (4.9 million in 1975, 6.1 million in 1980 and 8.3 million in 1990).

In addition to the estimation on the basis of annual rate increase of population, the forecast on the basis of change of the gross density by jurisdictions was carried out to check the actual number of population.

The gross densities by jurisdictions in 2000 were estimated to take account of the time series information of gross density, the availability of land and the urban development form expected in MMA. The gross densities in the City of Manila and Navotas were estimated to remain static as the same level in 1990.

On the basis of the estimation of gross density by jurisdictions, the total number of population in MMA as a whole was obtained to be 10.7 million in 2000. This figure indicates that the medium forecast on the basis of the annual rate of increase is the most desirable to be expected in MMA. Table 5-2 shows the forecasts on the basis of the gross density by jurisdictions in the year 2000.

The estimated total number of population in MMA as a whole in 2000 was allocated to the individual traffic zones on the basis of the distribution of population in 1990 making allowance of the change of accessibility* of the individual traffic zones between 1990 and 2000. However, a significant adjustment and modification was then made to the sector totals which exceed the gross density by sectors in 2000 estimated on the basis of the gross density by jurisdictions in 2000 and the time series information of gross density by sectors up to 1990.

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* accessibility is given in the following formula:

$$Ai = \sum_{j=1}^{n} \frac{Si}{Dij}$$

where, Ai : accessibility of zone i
Si : socio-economic attraction
Dij: resistance factors (time, cost etc.) between zone i and j
n : number of zones

Table 5-1 Forecasts of Population in MMA in 2000

Year		Population (persons)	Actual increase (persons)	Annual rate of increase (percent)		
1948		1,567,000	-	-		
1960		2,464,000	897,000	3.8 %		
1970		3,964,000	1,500,000	4.9 %		
1975		4,863,000	899,000	4.2 %		
1980		6,092,000	1,229,000	4.6 %		
1990		8,281,000	2,189,000	3.1 %		
2000	high forecasts	11,457,000	3,176,000	natural increase 1.5%	migration 1.8%	3.3%
	medium forecasts	10,809,000	2,528,000	1.5%	1.2%	2.7%
	low forecasts	9,983,000	1,702,000	1.5%	0.6%	2.1%

Source: 1948 ∿ 1975 ..... Census
1980 & 1990 ..... Forecasts in MMETROPLAN
2000 .... Forecasts in this study (C-3 & R-4 project)

Table 5-2

Forecasts on the Basis of the Gross Density by Junisdiction in 2000

Jurisdictions	Area (ha.)	Gross density (persons/ha.)	Population (persons)
Manila	3,830	480	1,838,400
Caloocan City	5,580	170	948,600
Makati	2,990	270	807,300
Mandaluyong	2,600	180	468,000
Navotas	260	500	130,000
Pasay City	1,390	240	333,600
Quezon City	16,620	140	2,326,800
San Juan del Monte	1,040	190	197,600
Last Piñas	4,150	120	498,000
Malabon	2,340	150	351,000
Marikina	3,890	130	505,700
Muntinglupa	4,670	100	467,000
Paranaque	3,830	150	574,500
Pasig	1,300	320	416,000
Pateros	1,040	90	93,600
Taguig	3,370	90	303,300
Valenzuela	4,700	100	470,000
TOTAL	63,600	169	10,729,400

The forecasts of each sector in 2000 are summarized in Table 5-3, compared with the figures in 1971, 1980 and 1990.

5.3 EMPLOYED PERSONS BY WORKPLACE

The number of employed persons by workplace was estimated individually for the three categories of employment - primary, secondary and tertiary.

The sources of information used for arriving at the total number for each of the three categories of employment were the MMETROPLAN'S report and the change of the economic indicators in Philippines as a whole from 1967 up to 1976. From analysis of the data available, the following assumptions were made:

a. Primary employment in 1990 would remain static up to 2000.

b. Secondary employment would grow at 5 per cent annual rate of increase from 1990 up to 2000.

c. Tertiary employment would grow at 2.5 per cent from 1990 up to 2000.

These assumptions reflected recent trends and expectations of future population and economic growth.

According to these assumptions, 4.2 million of employment were obtained as the total number in MMA as a whole in 2000. This forecast of employed persons by workplace is equal to the total number of employed persons by residence (3.7 million) discussed in section 5.5 adding up the number of inflowing employment from outside MMA (0.5 million) estimated on the basis of the relationship between employed persons by workplace and employed persons by residence, as shown in Table 5-4.

The total number of employed persons by workplace by categories in 2000 was allocated to the individual traffic zones on the basis of the distribution of employment in 1990 making allowance the estimated gross density of employment in the year 2000. The following information in recent and future distribution of employment were also taken into account.

a. growth of new secondary employment largely on the fringes of, and beyond the main urban area.

b. growth of new tertiary employment largely within the main urban area, in existing centers and along the major thoroughfares.

c. new employment opportunities being provided in on-going development projects such as the Southern Reclamation, the Greenhills Commercial Complex and the Government Center.

d. the trend of reduction in secondary employment in the City of Manila.

The forecasts of each sector in 2000 are summarized in Table 5-5, compared with the figures in 1971, 1980 and 1990.

Table 5-3 Forecasts of Population, 1980 ∿ 2000

Year Sectors	1971	1980	1990	2000
CBD-1	114,309	125,300	127,500	127,500
CBD-2	19,202	19,200	27,500	27,500
A-1	488,335	573,400	670,700	670,700
A-2	278,074	340,200	423,200	458,400
A-3	290,792	348,150	403,100	403,100
A-4	315,396	382,750	421,500	421,500
B-1	265,846	417,300	534,000	630,500
B-2	262,689	423,900	570,000	703,000
B-3	283,027	411,950	554,000	667,300
B-4	292,960	367,400	512,500	643,700
B-5	415,265	512,800	731,500	946,800
C-1	179,986	306,450	411,900	555,300
C-2	81,540	193,950	411,900	792,600
C-3	442,335	808,500	1,057,100	1,574,500
C-4	366,699	860,750	1,365,400	2,007,300
D	0	0	60,000	179,300
Total	4,096,445	6,092,000	8,281,000	10,809,000

Table 5-4 Forecasts of Employed Persons by Workplace in 2000

Year	Employed persons by workplace in MMA				Employed persons by residence in MMA	Inflow from outside MMA	
	Primary	Secondary	Tertiary	Total		Trend	New development
1971	20,897	368,352	1,023,544	1,412,793	1,386,641	26,152	-
Annual rate of increase	-	4.4%	5.0%	4.8%	3.6%	28.5%	
1980	20,670	541,000	1,588,000	2,149,670	1,900,100	249,570	-
Annual rate of increase	-1.8%	5.6%	2.8%	3.6%	3.6%	2.9%	
1990	17,150	934,500	2,098,000	3,049,650	2,718,900	330,750	-
Annual rate of increase	-	5.0%	2.5%	3.3%	3.2%	2.9%	
2000	17,150	1,522,200	2,685,600	4,224,950	3,735,600*	438,300	30,000**
Comparison	Forecast by categories			4,224,950	forecast on the basis of the relationship between workplace and residence		4,203,900

* See the section 5.5

** Forecast on the basis of the information on new settlement projects

Table 5-5 Forecast of Employed Persons by Workplace, 1980 ∿ 2000

(1) Primary

Year / Sectors	1971	1980	1990	2000
CBD-1	2,526	2,520	0	0
CBD-2	661	660	0	0
A-1	1,127	1,110	0	0
A-2	594	590	0	0
A-3	0	0	0	0
A-4	543	530	0	0
B-1	1,509	1,500	1,800	1,800
B-2	1,680	1,660	1,700	1,700
B-3	995	970	1,100	1,100
B-4	455	440	0	0
B-5	2,015	1,990	0	0
C-1	3,022	3,000	5,300	5,300
C-2	605	590	500	500
C-3	2,893	2,870	2,750	2,750
C-4	2,272	2,240	4,000	4,000
D	0	0	0	0
Total	20,897	20,670	17,150	17,150

Table 5-5 Forecasts of Employed Persons by Workplace 1980 ∿ 2000 (cont'd)

(2) Secondary

Year / Sectors	1971	1980	1990	2000
CBD-1	25,092	25,000	24,000	22,200
CBD-2	14,768	19,000	21,600	22,100
A-1	22,289	23,500	23,800	24,000
A-2	11,911	16,000	19,200	21,300
A-3	13,649	19,000	23,400	26,100
A-4	18,268	22,500	23,500	24,700
B-1	26,765	41,000	66,200	98,100
B-2	26,859	45,000	86,500	154,700
B-3	14,018	26,000	48,500	80,100
B-4	36,070	54,000	71,000	101,100
B-5	42,677	54,000	131,000	177,500
C-1	10,220	25,000	36,800	64,600
C-2	3,878	11,000	61,000	134,600
C-3	71,208	90,000	144,000	248,600
C-4	30,680	68,000	149,000	308,200
D	0	2,000	5,000	14,300
Total	368,352	541,000	934,500	1,522,200

Table 5-5 Forecasts of Employed Persons by Workplace, 1980 ∿ 2000 (cont'd)

(3) Tertiary

Year / Sectors	1971	1980	1990	2000
CBD-1	107,988	133,000	143,100	149,500
CBD-2	119,634	150,000	170,700	177,000
A-1	80,526	106,000	112,000	120,000
A-2	66,426	95,000	109,700	127,900
A-3	36,941	49,000	59,000	89,400
A-4	52,610	77,000	100,500	132,300
B-1	37,092	63,000	68,500	98,100
B-2	49,338	88,000	103,000	140,600
B-3	83,076	142,000	179,000	240,200
B-4	63,832	86,000	145,000	252,700
B-5	133,455	198,000	309,200	402,400
C-1	35,933	60,000	66,900	76,000
C-2	8,125	35,000	56,500	103,500
C-3	92,433	170,000	192,000	222,400
C-4	56,135	120,000	147,900	174,300
D	0	16,000	135,000	179,300
Total	1,023,544	1,588,000	2,098,000	2,685,600

5.4 EDUCATIONAL ATTENDANCE

According to MMETROPLAN, the estimation of school and college places in future were carried out by applying the ratio of educational places to population to the expected increase of population, and adding this to the existing number of places. The same methodology was adopted and applied in estimating educational attendance in 2000.

The same ratio (270 educational attendance to 1,000 people) discussed in the section 4.4 was applied to the actual increase of population in MMA as a whole for 2000. Accordingly, the actual increase of educational attendance in the period 1990 ∿ 2000 were estimated to be 0.7 million in MMA as a whole, applying the ratio of 270 educational attendance to 1,000 people. According to these assumptions, 3.1 million were obtained as the total number of educational attendance in MMA as a whole in 2000 as shown in Table 5-6.

According to the records of the Department of Education and Culture in the period 1970 ∿ 76, approximately one half of total educational attendance is for elementary schooling. Accordingly, it was assumed that 70 per cent of the total additional educational places 1990 ∿ 2000 would be distributed in direct proportion to the expected distribution of population making allowance for the improvement of educational standards, and the remaining 30 per cent of the demand would be distributed in direct proportion to the distribution of school and college places that existed in 1971.

The forecasts of each sector in 2000 are summarized in Table 5-7, compared with the figures in 1971, 1980 and 1990.

5.5 SOCIO-ECONOMIC CHARACTERISTICS OF POPULATION

In addition to the estimation of population, employed persons by workplace and educational attendance, the socio-economic characteristics of population were estimated. As already mentioned, these are employed persons by residence, household size, private vehicle ownership and family income.

The total number of employed persons by residence gives significant information for estimating the total number of employed persons by workplace. According to MMETROPLAN, the estimates of the proportion of the population in employment were based on the participation rate, i.e. the proportion of economically active people to 10 and overaged people.

In MMETROPLAN, it was estimated that the proportion of the population aged 10 and over would grow from 72.0 per cent in 1971 to 73.5 per cent in 1980 and 77.5 per cent in 1990. Accordingly, the proportion of the population aged 10 and over in 2000 was estimated to be 80.0 per cent making allowance for the existence of organized family planning in the Philippines. The participation rate (48.0%) and the rate of unemployment (10.0%) estimated in MMETROPLAN were

Table 5-6 Forecasts of Educational Attendance in 2000

Year	Total number of educational attendance	Actual increase	Forecast of actual increase 1990 ∿ 2000
1971	1,300,804		Increase of population
Annual rate of increase	4.0%	548,496	1990 ∿ 2000 ... 2,528,000
1980	1,849,300		Ratio of educational attendance to 1,000 people 270
Annual rate of increase	2.8%	591,700	
1990	2,441,000		Increase of educational attendance
Annual rate of increase	2.5%	682,600	1990 ∿ 2000 682,600
2000	3,123,600		

Table 5-7 Forecasts of Total Educational Attendance, 1980 ∿ 2000

Year Sectors	1971	1980	1990	2000
CBD-1	408,488	479,600	523,200	593,200
CBD-2	105,977	124,000	136,900	154,800
A-1	106,630	138,500	170,000	216,400
A-2	97,091	123,700	150,700	186,300
A-3	50,048	67,700	84,600	110,300
A-4	82,194	107,000	124,300	155,800
B-1	35,675	66,000	95,500	129,000
B-2	33,190	65,100	99,300	135,600
B-3	65,597	97,700	133,800	173,600
B-4	63,900	86,800	121,900	160,500
B-5	64,422	91,500	140,600	192,600
C-1	25,613	51,300	75,800	104,300
C-2	3,135	21,700	65,300	100,800
C-3	100,228	179,800	246,700	332,100
C-4	58,616	148,900	261,200	359,200
D	0	0	11,200	19,100
Total	1,300,804	1,849,300	2,441,000	3,123,600

adopted and applied for the forecasts of employed persons by residence for the year 2000. A constant factor of 0.3456 (0.48 × 0.80 × 0.90) was therefore applied to the population in MMA as a whole to arrive at the total number of employed persons by residence in 2000. The resultant figure (3.7 million) was obtained as shown in Table 5-8 and distributed to each traffic zone multiplying the population of individual traffic zone by the same constant factor.

The forecasts of each sectors in 2000 are summarized in Table 5-9, compared with the figures in 1971, 1980 and 1990.

Household size in MMA declined from 6.4 in 1960 and 6.2 in 1970, and figures of 5.8 in 1980 and 5.0 in 1990 were assumed in MMETROPLAN. Therefore, it was assumed that this decline would continue further and the household size in MMA would be 4.5 in 2000 in this study.

Accordingly, the number of households by each traffic zone was estimated in dividing the individual population of each traffic zone by the estimated household size.

The forecasts of each sector in 2000 are summarized in Table 5-10, compared with the figures in 1971, 1980 and 1990.

The number of private vehicles and motorcycles per thousand population in MMA grew up from 39.7 in 1970 to 43.7 in 1975. On the basis of these past trends, a family income-based projection of vehicle ownership was carried out and the central assumption of 56 private vehicles and motorcycles per thousand population in 1980 and 83 in 1990 were estimated in MMETROPLAN.

Therefore, it is assumed that this incline would continue further and the number of private vehicles and motorcycles per thousand would be 107.2 in 2000, making allowance for the estimated family income in 2000.

This figure was adopted and applied to the assumption of vehicle-owning households in 2000 as shown in Table 5-11. The results of this analysis were obtained as vehicle-owning households of 1.1 million and vehicle ownership of 45.3 per cent in 2000 as shown in the said Table. However, the same figure of vehicles per owning household in 1990 was applied in this assumption.

The total number of vehicle-owning household were distributed to each traffic zones with an allowance of the individuality of these zones.

The forecasts of number of non-vehicle owning households by each sectors in 2000 are summarized in Table 5-12, compared with the figures in 1971, 1980 and 1990.

According to MMETROPLAN, it was assumed that average family incomes would increase from ₱7,785 at 1971 prices in 1980 to ₱9,342 in 1990. Corresponding with these forecasts, the total incomes in MMA as a whole would grow up from ₱515.99 million in 1971 to ₱820.54 million in 1980 (annual rate of increase of 5.29 per cent) and ₱1547.96 million in 1990 (annual rate of increase of 6.55 per cent).

Table 5-8 Forecasts on Employed Persons by Residence in 2000

Year	Proportion of 10 and over aged people to total population	Participation rate (proportion of economically active people to 10 and over aged people)	Proportion of open unemployment people to economically active people	Proportion of population in employment to total population
1971	72.0 %	50 %	10 %	32.4 % (0.72 × 0.50 × 0.90)
1980	73.5 %	48 %	10 %	31.75 % (0.735 × 0.48 × 0.90)
1990	77.5 %	48 %	10 %	33.48 % (0.775 × 0.48 × 0.90)
2000	80.0 %	48 %	10 %	34.56 % (0.80 × 0.48 × 0.90)

Total number of population in 2000 10,809,000
Proportion of population in employment to total population 0.3456
Total number of employed persons by residence in 2000 3,735,600

Table 5-9 Forecasts of Employed Persons by Residence, 1980 ∿ 2000

Year Sectors	1971	1980	1990	2000
CBD-1	33,679	40,000	42,800	44,100
CBD-2	7,735	7,700	9,300	9,500
A-1	157,367	182,300	224,900	231,800
A-2	102,148	108,300	141,900	158,400
A-3	98,213	110,800	135,100	139,300
A-4	105,280	121,800	141,300	145,700
B-1	94,193	132,800	179,100	217,900
B-2	90,554	135,500	191,100	243,000
B-3	111,009	131,200	185,800	230,600
B-4	82,089	116,900	171,800	222,500
B-5	153,923	163,200	245,300	327,200
C-1	66,006	97,500	138,200	191,900
C-2	30,613	61,700	137,800	273,900
C-3	139,660	256,900	354,200	544,100
C-4	114,172	273,700	457,500	693,700
D	0	0	20,300	62,000
Total	1,386,641	1,940,300	2,776,400	3,735,600

Table 5-10 Forecasts of Households, 1980 ∿ 2000

Year Sectors	1971	1980	1990	2000
CBD-1	18,496	21,700	25,500	28,300
CBD-2	3,107	3,400	5,500	6,100
A-1	79,018	99,100	134,300	149,000
A-2	44,776	58,900	84,700	101,900
A-3	46,897	60,200	80,700	89,600
A-4	51,030	66,200	84,300	93,700
B-1	44,052	72,100	106,800	140,100
B-2	43,705	73,700	114,000	156,200
B-3	44,571	71,300	110,800	148,300
B-4	46,085	63,500	102,500	143,000
B-5	68,118	88,700	146,300	210,400
C-1	29,628	53,100	82,500	123,400
C-2	14,699	33,600	82,300	176,100
C-3	70,575	139,700	211,500	349,900
C-4	58,040	148,800	273,300	446,100
D	0	0	12,000	39,800
Total	662,797	1,054,000	1,657,000	2,401,900

Table 5-11 Forecasts of Vehicle-owning Households in 2000

Year	Population	Number of vehicles per 1,000 people	Number of vehicles (A)	Total number of households (B)	Number of vehicle-owning households (C)	Vehicle ownership (C/B)	Number of vehicle per owning household (A/C)
1971	4,096,445	40.2	164,677	662,797	123,449	18.6 %	1.334
1980	6,092,000	56.0	341,200	1,054,000	277,100	26.3 %	1.231
1990	8,281,000	83,0	687,300	1,657,000	645,900	39,0 %	1.064
2000	10,809,000	107.2	1,158,700	2,401,900	1,088,800	45.3 %	1.064

Table 5-12 Forecast of Non-Vehicle Owning Households, 1980 ∿ 2000

Year Sectors	1971	1980	1990	2000
CBD-1	16,340	17,600	17,100	17,000
CBD-2	2,890	3,000	4,000	4,000
A-1	69,451	79,300	88,900	88,400
A-2	36,088	45,400	55,600	61,300
A-3	40,841	48,200	53,500	53,300
A-4	44,764	53,300	56,200	56,000
B-1	37,750	56,700	69,500	81,800
B-2	33,577	53,400	69,900	87,900
B-3	30,130	42,300	54,400	65,300
B-4	38,418	47,600	63,600	79,500
B-5	51,830	60,500	82,600	106,600
C-1	22,753	40,200	53,800	76,200
C-2	11,317	23,700	48,000	92,100
C-3	56,144	98,300	123,500	183,200
C-4	57,055	107,400	163,200	238,800
D	0	0	7,300	21,700
Total	539,348	776,900	1,011,100	1,313,100

On the basis of the forecasts of the annual rate of increase on the total incomes in MMA and the time series information of annual rate of increase of GNP during 1972 to 1976, it was assumed that the total income in MMA would grow at 7.00 per cent up to 2000. Accordingly, the resultant figure of this assumption was obtained average family income of ₱12,678 at 1971 prices for the year 2000 as shown in Table 5-13.

5.6 SUMMARY OF FORECASTS

Summary of forecasts for the year 2000 is given in Table 5-14.

Fig. 5-13 Forecasts of Family Incomes in 2000

Year	Average family incomes in pesos at 1971 prices	Number of households	Total incomes in MMA at 1971 prices
1971	₱7,785	662,797	₱515.99 million
Annual rate of increase	-	5.3 %	5.29 %
1980	₱7,785	1,054,000	₱820.54 million
Annual rate of increase	1.84 %	4.6 %	6.55 %
1990	₱9,342	1,657,000	₱1,547.96 million
Annual rate of increase	3.10 %	3.8 %	7.00 %
2000	₱12,678	2,401,900	₱3,045.07 million

Annual rate of increase of GNP at 1972 prices *	1972	1973	1974	1975	1976
	4.9 %	9.6 %	6.0 %	5.9 %	6.3 %

* NEDA Economic Indicators

Table 5-14 Summary Table of Forecasts

(MMA as a whole)

Year / Item	1971	1980	1990	2000
Population	4,096,445	6,092,000	8,281,000	10,809,000
Employed persons by workplace	1,412,793	2,149,670	3,049,650	4,224,950
(Primary)	20,897	20,670	17,150	17,150
(secondary)	368,352	541,000	934,000	1,522,200
(tertiary)	1,023,544	1,588,000	2,098,000	2,685,600
Educational attendance	1,300,804	1,849,300	2,441,000	3,123,600
Employed persons by residence	1,386,641	1,940,300	2,776,400	3,735,600
Households	662,797	1,054,000	1,657,000	2,401,900
Non-vehicle owning households	593,348	776,900	1,011,100	1,313,100
Family incomes at 1971 prices	7,785	7,785	9,342	12,678

1980 & 1990 ..... forecasts in MMETROPLAN
2000 .... forecasts in this study

S2 TRAFFIC SURVEY AND ITS RESULT

S2. TRAFFIC SURVEY AND ITS RESULT

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1. GENERAL

Data from previous traffic surveys conducted by the DPH in 1974, 1975 and 1976 will be used in projecting traffic on the project road. After a review of these data, the study team, however, deemed to conduct supplementary traffic count surveys. The supplementary traffic surveys conducted were:

a. Screen line survey

b. Mid-block traffic survey

c. Turning movement traffic survey

d. Loadometer survey

These surveys were carried out by the study team coordinated with the DPH last June 28 and 29 this year. The location of the survey stations and summary of the results are shown in Fig. 1 and Tables 1 to 4, respectively.

2. DAILY AND HOURLY VARIATIONS OF TRAFFIC VOLUME

The daily variations of traffic volumes along C-2 and C-4 are shown in Fig. 2. From these figures, it can be observed that there are no significant changes in daily traffic volume for the whole week except on Sundays, where there is a decrease of traffic volume of about 20 to 30 per cent.

The hourly variation of traffic volumes are shown in Fig. 3. It has been observed that during the 12-hour period from 7:00 a.m, to 7:00 p.m., the hourly traffic volume decreases slightly at noon without any significant changes as compared with the peak-hour volumes in the morning and in the afternoon.

3. TRAFFIC COMPOSITION BY VEHICLE TYPES

The composition of traffic by vehicle type on screen line stations are as follows:

a. Approximately 80 to 90 per cent of the total traffic volume consist of cars, jeeps and passenger utility jeepneys in four stations.

b. The composition of PUJ in one station (Bambang station) is remarkably high, accounting for more than 40 per cent of the total traffic volume.

c. The share of bus traffic of the total volume is comparatively small, i.e. that on Nagtahan Bridge is 2.1 per cent, that on New Panaderos Bridge is less than one per cent, that on Guadalupe Bridge is 8.3 per cent and that on Bambang is 7.3 per cent. Fig. 4 shows this result.

4. TURNING MOVEMENT COUNT

The results of the turning movement count at Buendia-Ayala Junction on June 28 '77 (Tuesday) are shown in Table 5 and in Figs. 5 though 7.

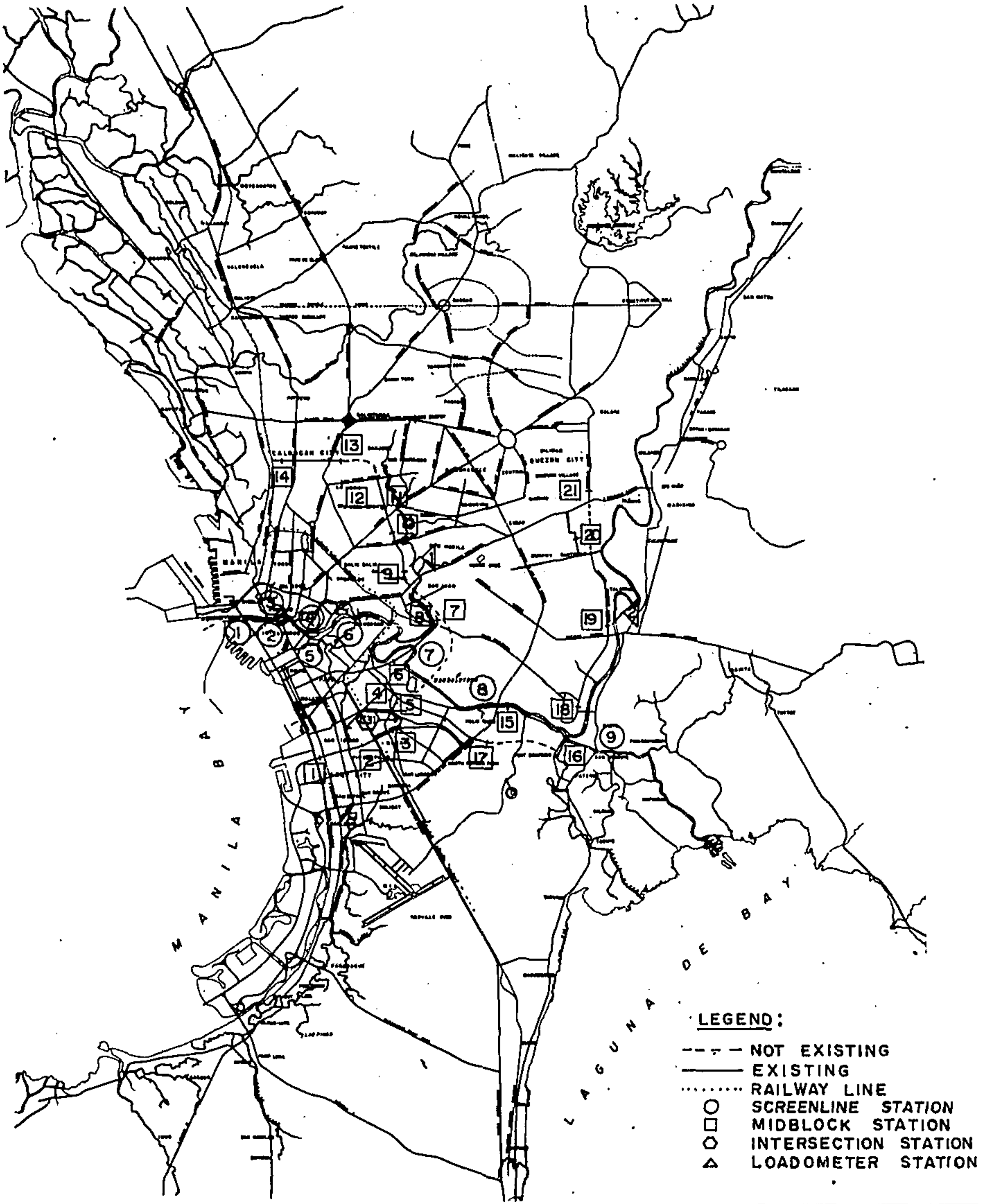


Figure 1

TRAFFIC SURVEY STATIONS

Table 1

The Results of Traffic Counts Survey at Screen Line Station

Date Survey: June 28, 1977

STA.	Name	Northern direction Eastern direction	Southern direction Western direction	Both Direction
1	ROXAS BRIDGE	20625	16257	36882
2	JONES BRIDGE	38553	19970	58523
3	MACARTHUR BRIDGE	27014	24832	51846
4	QUEZON BRIDGE	33781	37394	71175
5	AYALA BRIDGE	14192	24806	38998
6	NAGTAHAN BRIDGE	35309	32752	68061
7	NEW PANADEROS BRIDGE	15879	15462	31341
8	GUADALUPE BRIDGE	51892	54480	106372
9	BAMBANG BRIDGE	7388	7589	14977

Table 2

The Results of Traffic Counts Survey at Mid Block Station

Date Survey: June 28, 1977

STA.	Name	Northern direction Eastern direction	Southern direction Western direction	Both Direction
1	BUENDIA AVE BET. ROXAS BLVD & TAFT	14144	14530	28674
2	BUENDIA AVE BET. SUPER HIGHWAY & TAFT	22860	20926	43786
3	BUENDIA AVE BET. AYALA & PASONG TAMO	18597	19677	38274
4	PASONG TAMO BET. BUENDIA & KAMAGONG	9804	9016	18820
5	SOUTH AVE BET. VITO CRUZ & METROPOLITAN BLVD	1211	1232	2443
6	NEW PANADEROS ROAD BET. STA ANA & SHAW BLVD	10146	14627	24773
7	BLUMENTRITT BET. SHAW BLVD & F.MANALO	12523	12757	25280
8	N. DOMINGO BET. V. MAPA & CUBAO	9590	9561	19151
9	G. ARANETA BET. ESPANA EXT & AURORA BLVD	11374	15375	26749
10	G. ARANETA BET. ESPANA EXT & QUEZON BLVD	6660	1458	8118
11	G. ARANETA BET. QUEZON BLVD & DEL MONTE AVE	6024	4655	10679
12	DEL MONTE AVE BET. A. BONIFACIO & FRISCO	9450	10351	19801
13	5TH AVENUE EXT NORTH BOUND	7825	5283	13108
14	BET. RIZAL AVE EXT & MABINI	384	550	934
15	J.P. RIZAL EAST OF GUADALUPE BRG. BET. BAMBANG & GUADALUPE	9536	9670	19206
16	BO. BUTING ROAD PATEROS WEST-EAST	1911	2119	4030

(cont'd)

STA.	Name	Northern direction Eastern direction	Southern direction Western direction	Both direction
17	IMELDA AVENUE MAKATI EAST-WEST	842	925	1767
18	RODRIGUEZ BET. PASIG & SHAW BLVD	6052	6224	12276
19	E.RODRIGUEZ SR AVE NORTH BOUND	4884	5928	10812
20	KATIPUNAN PROJECT QUEZON CITY	8773	9793	18566
21	KATIPUNAN ROAD FRONT OF ATENEO GYM	10909	10611	21520

Table 3

Composition of Vehicle Type and Percentage of Vehicle Type at Screen Line Station

Date survey: June 28, 1977

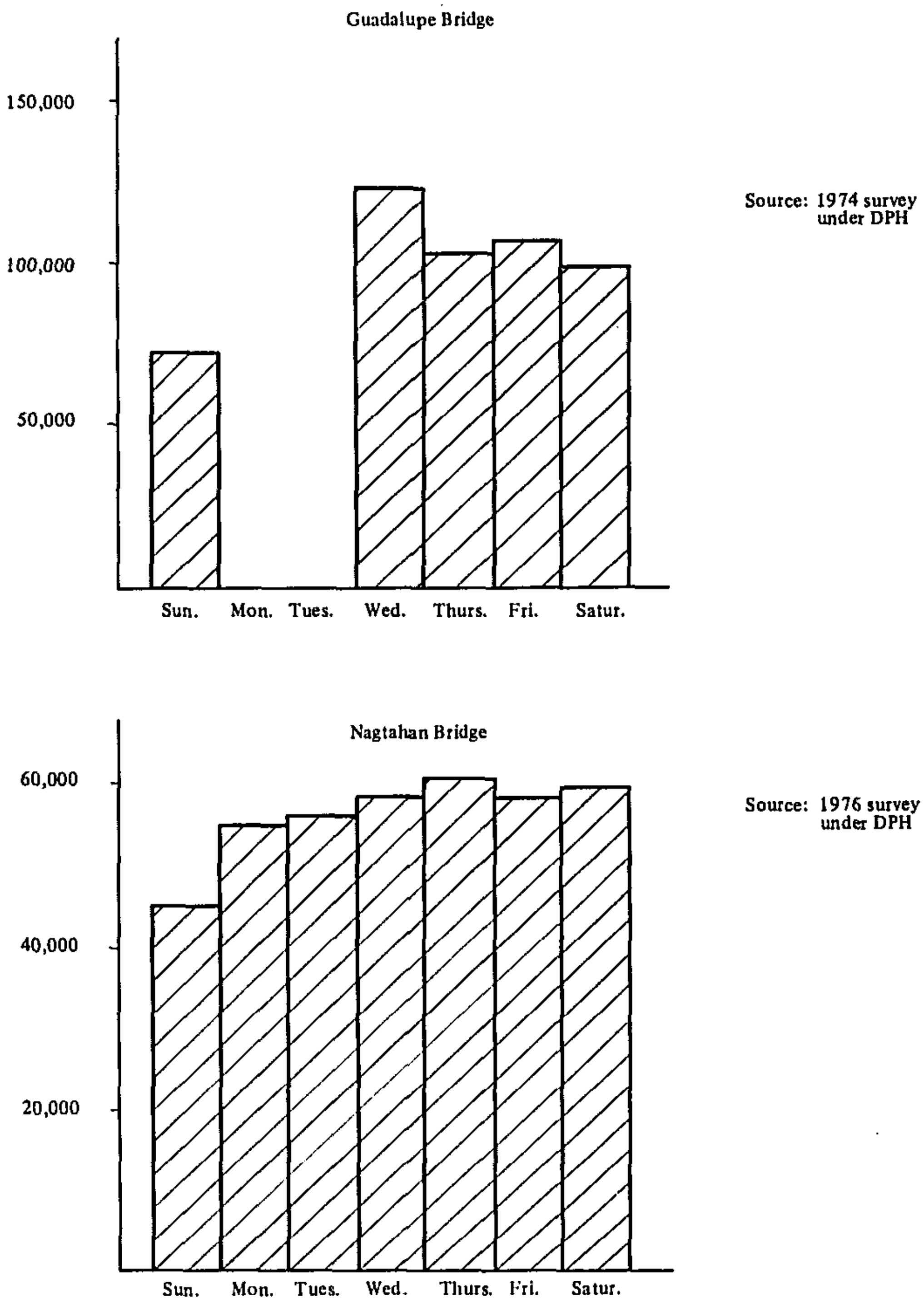
	TYPE OF VEHICLE							
STA.	CAR	PUJ	BIG BUS	MINI BUS	TRUCK	TRUCK-TR.	SEMI-TR.	TOTAL
1	28878	2692	111	37	4905	1	258	36882
	78.3%	7.3%	0.3%	0.1%	13.3%	0%	0.7%	100.0%
2	46642	9597	878	644	761	0	1	58523
	79.7	16.4	1.5	1.1	1.3	0	0	100.0
3	29137	19442	2437	415	363	0	52	51846
	56.2	37.5	4.7	0.8	0.7	0	0.1	100.0
4	45481	15445	8612	214	1281	71	71	71175
	63.9	21.7	12.1	0.3	1.8	0.1	0.1	100.0
5	30807	38	4952	350	2690	6	155	38998
	79.0	0.1	12.7	0.9	6.9	0	0.4	100.0
6	63220	3403	272	136	1020	5	5	68061
	92.9	5.0	0.4	0.2	1.5	0	0	100.0
7	26011	4603	62	125	532	3	5	31341
	83.0	14.7	0.2	0.4	1.7	0	0	100.0
8	91777	531	4977	2872	5744	46	425	106372
	86.3	0.5	4.7	2.7	5.4	0	0.4	100.0
9	6648	6318	1093	30	808	5	75	14977
	44.4	42.2	7.3	0.2	5.4	0	0.5	100.0

Table 4

Composition of Vehicle Type and Percentage of Vehicle Type at Mid Block Station

Date survey: June 28, 1977

	TYPE OF VEHICLE							
STA.	CAR	PUJ	BIG BUS	MINI BUS	TRUCK	TRUCK TRA.	SEMI TRA.	TOTAL
1	27539	168	359	72	507	8	21	28674
	96.1%	0.6%	1.2%	0.2%	1.8%	0%	0.1%	100.0%
2	37085	3144	2396	552	604	0	5	43786
	84.7	7.2	5.5	1.2	1.4	0	0	100.0
3	31241	1128	4028	1059	744	41	33	38274
	81.6	3.0	10.5	2.8	1.9	0.1	0.1	100.0
4	14747	3581	33	71	361	21	6	18820
	78.4	19.0	0.2	0.4	1.9	0.1	0	100.0
5	2286	7	0	28	97	8	17	2443
	93.6	0.3	0	1.1	4.0	0.3	0.7	100.0
6	19422	4260	505	52	498	26	10	24773
	78.4	17.2	2.1	0.2	2.0	0.1	0	100.0
7	16862	7755	47	5	585	19	7	25280
	66.7	30.7	0.2	0	2.3	0.1	0	100.0
8	11917	6215	346	125	537	1	10	19151
	62.2	32.4	1.8	0.7	2.8	0	0.1	100.0
9	24033	1239	71	109	1231	4	62	26749
	89.9	4.6	0.3	0.4	4.6	0	0.2	100.0
10	6584	1126	7	2	372	2	25	8118
	81.1	13.9	0.1	0	4.6	0	0.3	100.0
11	9954	81	21	38	574	2	9	10679
	93.2	0.8	0.2	0.3	5.4	0	0.1	100.0
12	12920	5483	95	60	1189	11	43	19801
	65.2	27.7	0.5	0.3	6.0	0.1	0.2	100.0
13	11825	135	21	40	1058	1	28	13108
	90.2	1.0	0.2	0.3	8.1	0	0.2	100.0
14	805	22	14	27	66	0	0	934
	86.2	2.3	1.5	2.9	7.1	0	0	100.0
15	11115	6967	374	107	630	13	0	19206
	57.9	36.3	1.9	0.5	3.3	0.1	0	100.0
16	3582	96	12	11	305	3	21	4030
	88.9	2.4	0.3	0.3	7.5	0.1	0.5	100.0
17	1635	39	3	21	66	1	2	1767
	92.5	2.2	0.2	1.2	3.7	0.1	0.1	100.0
18	8705	1852	393	99	1135	70	22	12276
	70.9	15.1	3.2	0.8	9.2	0.6	0.2	100.0
19	8903	141	33	19	1612	21	83	10812
	82.3	1.3	0.3	0.2	14.9	0.2	0.8	100.0
20	16928	87	121	58	1336	7	29	18566
	91.2	0.5	0.6	0.3	7.2	0	0.2	100.0
21	18527	1326	429	130	1068	1	39	21520
	86.1	6.1	2.0	0.6	5.0	0	0.2	100.0



Source: 1974 survey under DPH

Source: 1976 survey under DPH

Figure 2

DAILY VARIATION ON CONTROL STATION

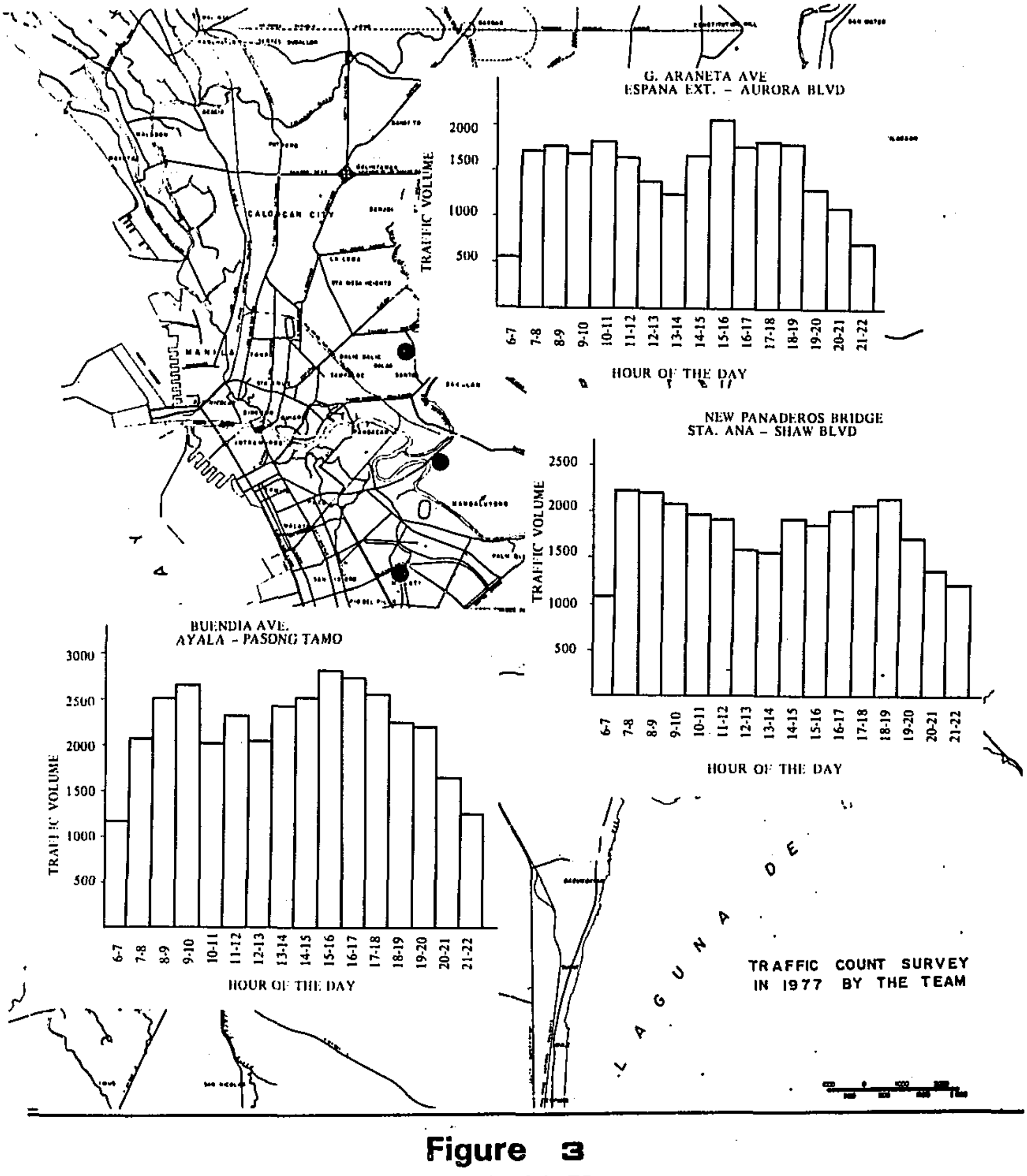


Figure 3

HOURLY VARIATION OF TRAFFIC VOLUME

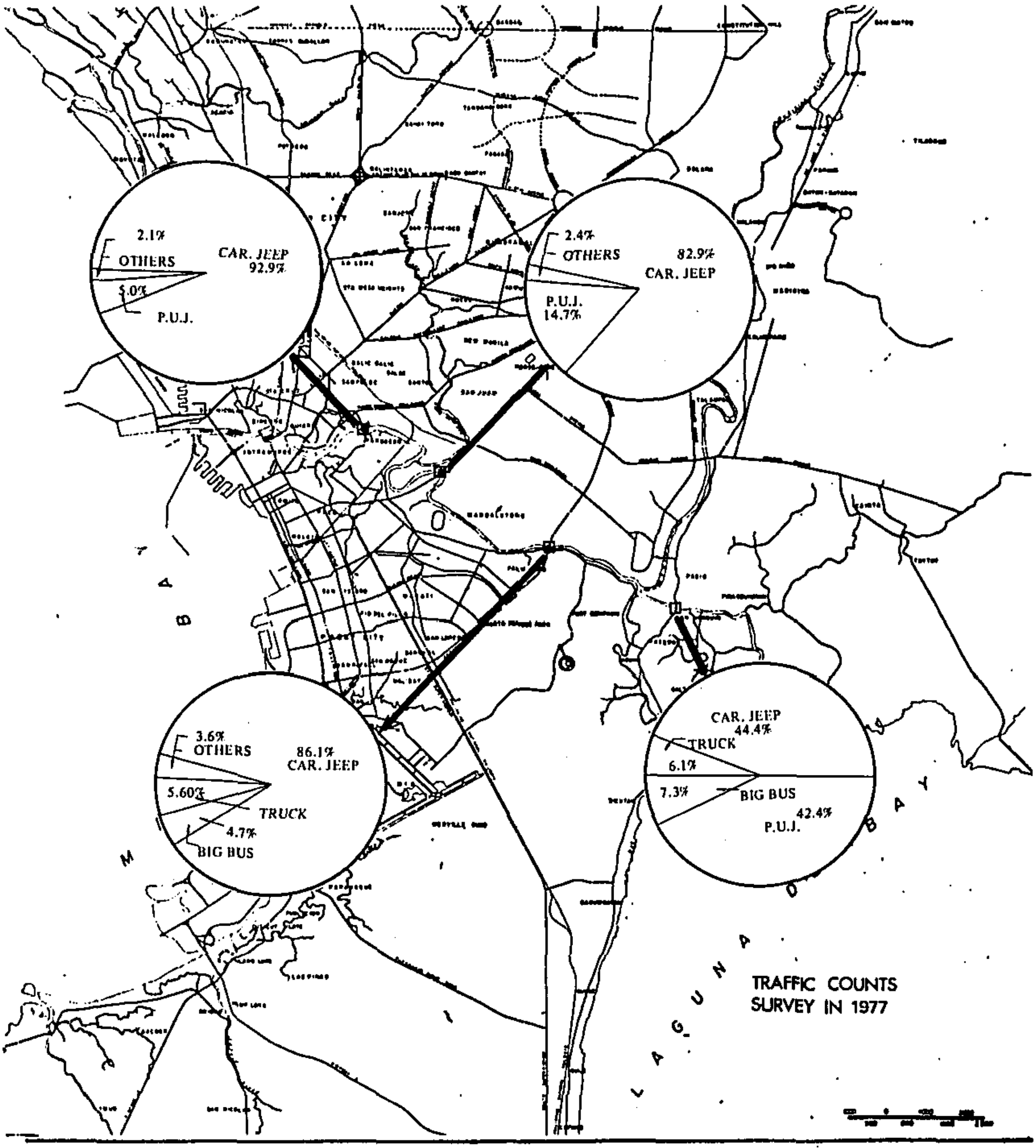
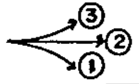
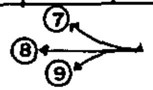
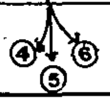
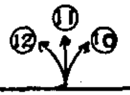


Figure 4

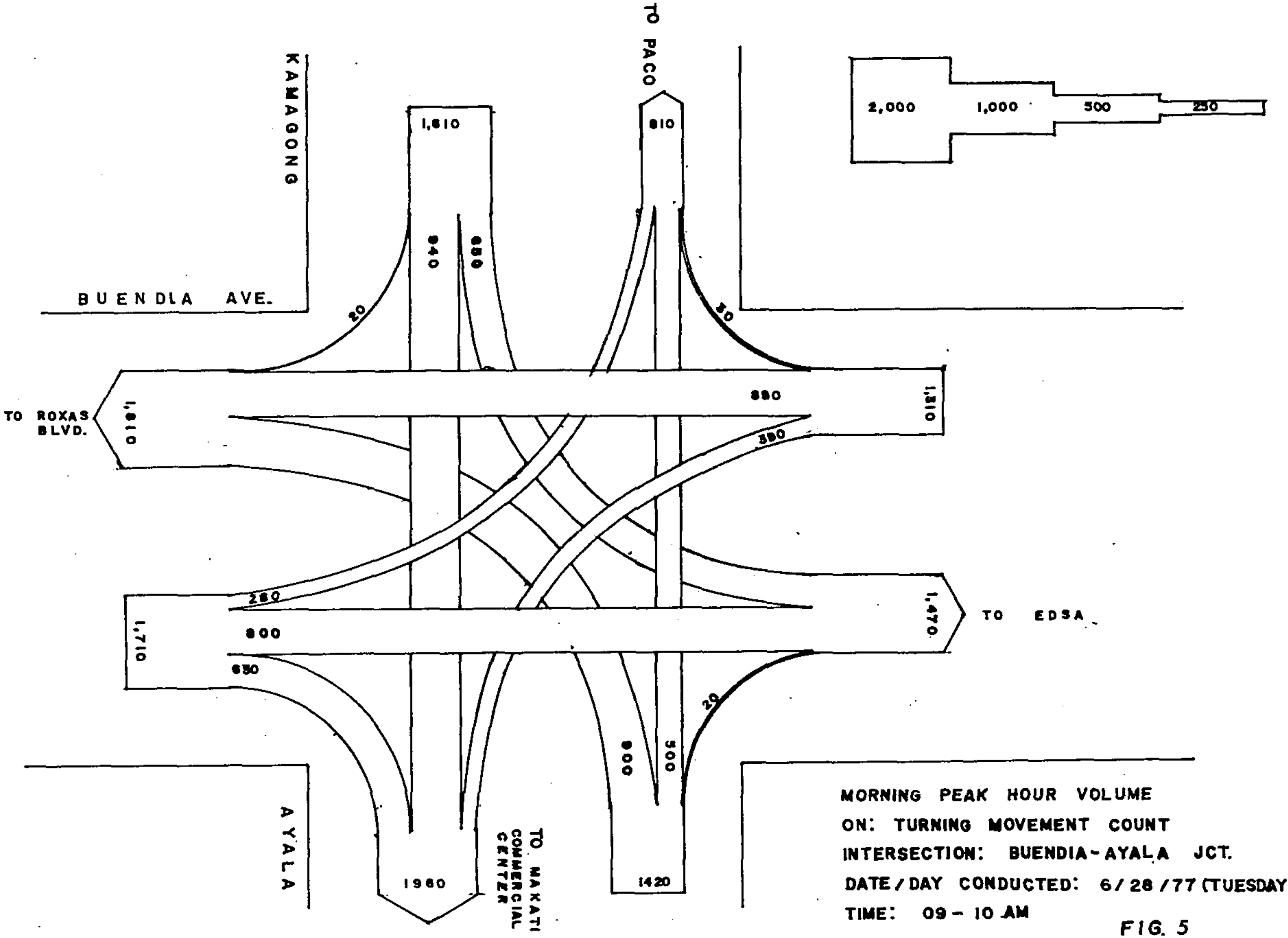
VEHICLE COMPOSITION ON SCREEN LINE STATION

DATE / DAY CONDUCTED: 6/28/77 (TUESDAY)

Table 5 TURNING MOVEMENT COUNT AT BUENDIA AYALA JCT. INTERSECTION

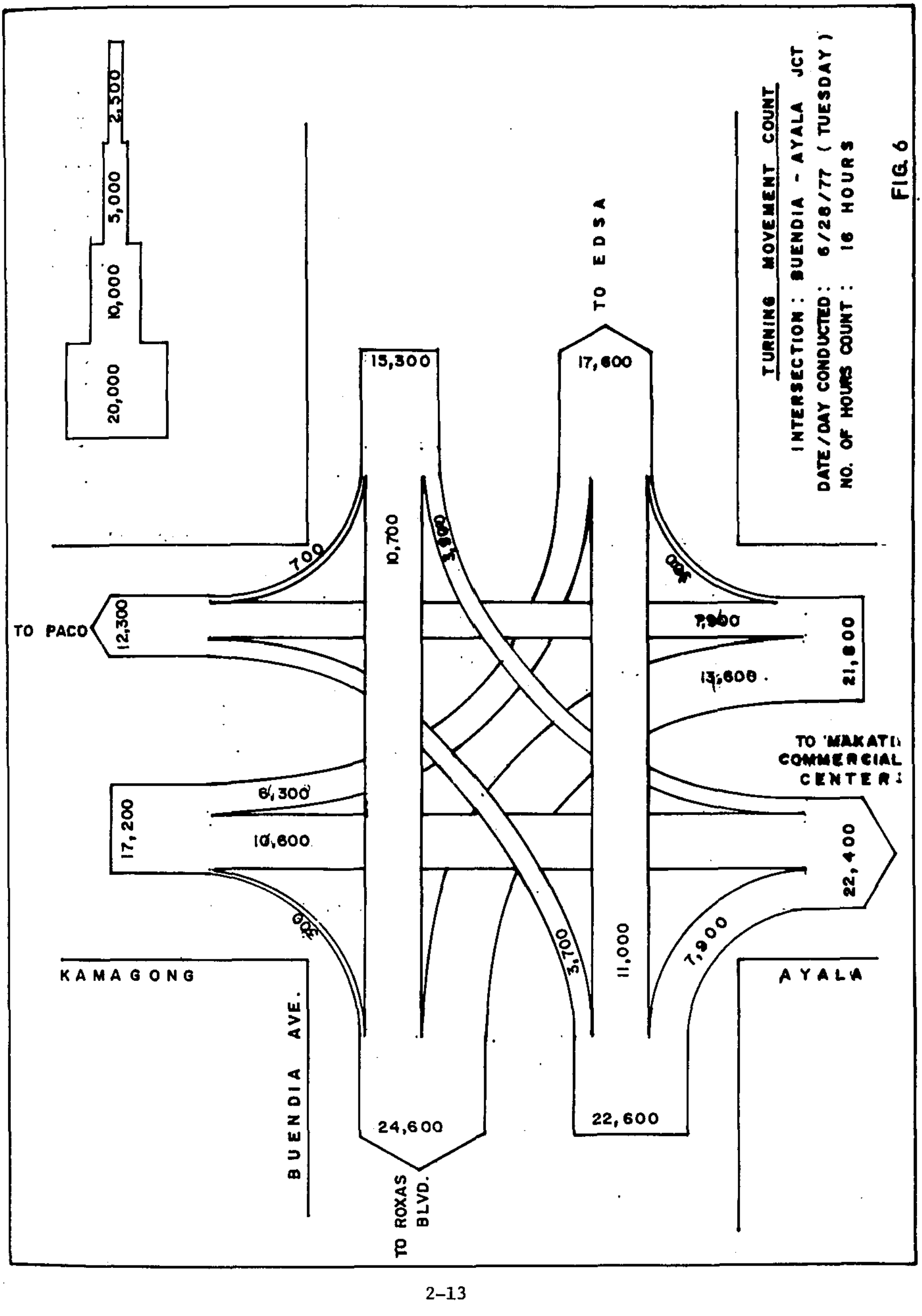
HOUR	BUENDIA APPROACHES								AYALA AND KAMAGONG APPROACHES							
	ROXAS BLVD. SIDE				EDSA SIDE				KAMAGONG APPROACH				AYALA APPROACH			
	1	2	3	TOTAL	7	8	9	TOTAL	4	5	6	TOTAL	10	11	12	TOTAL
06 - 07	116	172	118	406	19	460	121	600	13	400	171	584	14	267	342	623
07 - 08	325	636	121	1082	29	861	162	1052	11	519	289	819	19	348	559	926
08 - 09	558	909	295	1762	12	695	371	1078	6	1015	558	1579	16	616	816	1448
09 - 10	629	804	282	1715	29	887	390	1306	17	938	653	1608	19	503	904	1426
10 - 11	626	733	310	1669	66	813	315	1194	30	852	449	1331	30	477	884	1391
11 - 12	560	791	298	1649	59	782	342	1183	29	828	419	1276	19	519	1030	1568
12 - 13	480	689	244	1413	40	683	271	994	15	794	417	1226	45	575	974	1594
13 - 14	486	821	168	1475	31	607	317	955	26	710	519	1255	29	556	792	1377
14 - 15	632	745	244	1621	73	770	340	1183	28	760	476	1264	21	541	1007	1569
15 - 16	640	836	340	1816	71	792	344	1207	28	737	442	1207	28	569	1089	1684
16 - 17	637	734	368	1739	51	782	284	1087	27	724	471	1222	24	577	1080	1681
17 18	610	960	360	1950	29	705	273	1007	14	742	380	1138	12	690	1115	1817
18 19	536	705	328	1569	59	676	194	929	15	617	452	1084	14	679	1000	1693
19 20	499	599	192	1290	58	492	115	665	18	472	283	773	22	495	772	1289
20 21	324	465	48	837	36	429	70	535	18	323	202	543	9	316	645	970
21 22	238	385	13	636	33	316	25	374	6	158	168	332	5	211	536	752
TOTAL	7896	10984	3749	22628	695	10720	3934	15349	301	10589	6349	17239	324	7939	13545	21808
																

NOTE: ①②-----⑫ INDICATE TRAFFIC FLOW



MORNING PEAK HOUR VOLUME
ON: TURNING MOVEMENT COUNT
INTERSECTION: BUENDIA-AYALA JCT.
DATE / DAY CONDUCTED: 6/28/77 (TUESDAY)
TIME: 09 - 10 AM

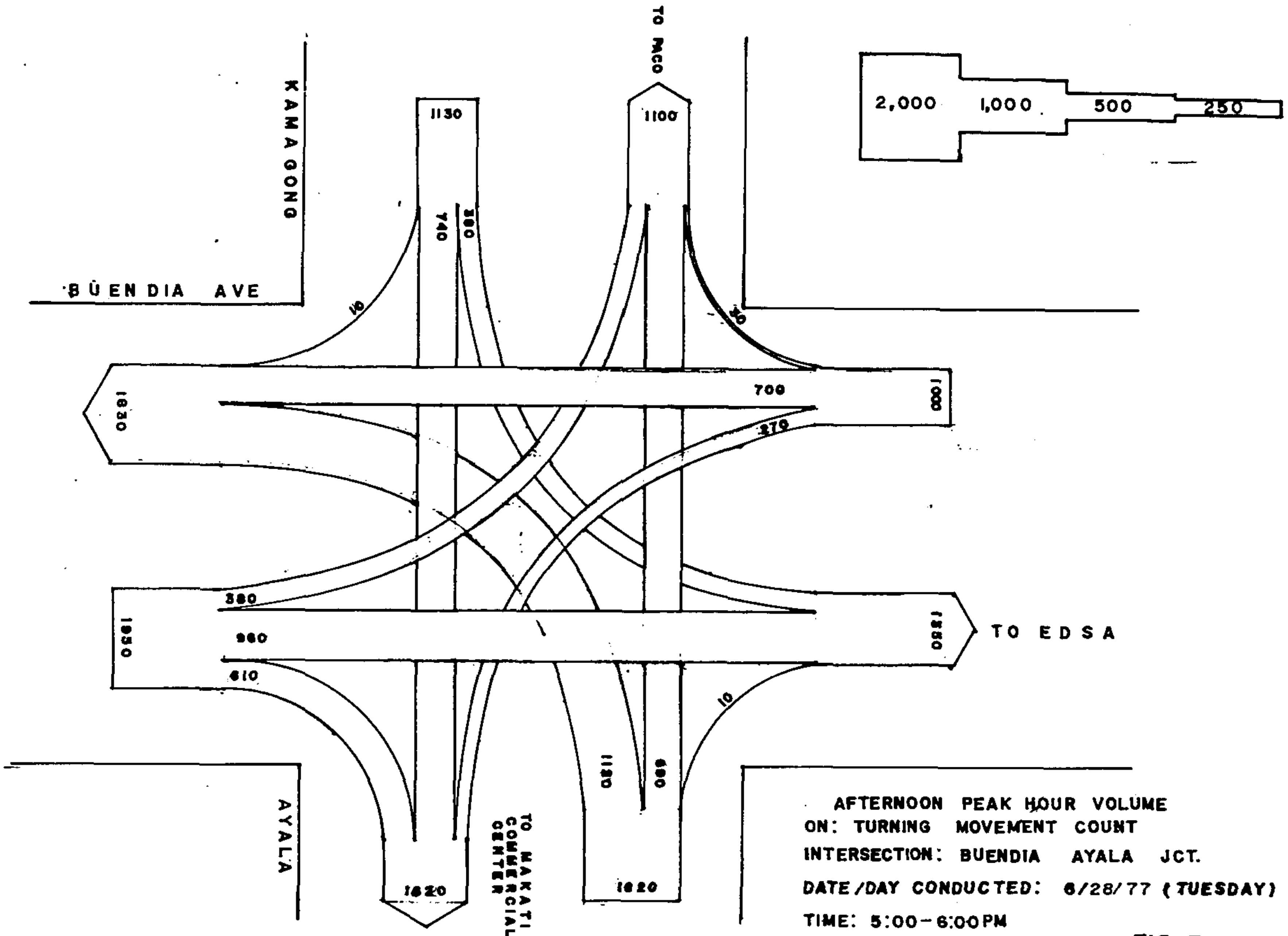
FIG. 5



TURNING MOVEMENT COUNT

INTERSECTION : BUENDIA - AYALA JCT
DATE / DAY CONDUCTED : 6/28/77 (TUESDAY)
NO. OF HOURS COUNT : 16 HOURS

FIG. 6



AFTERNOON PEAK HOUR VOLUME
ON: TURNING MOVEMENT COUNT
INTERSECTION: BUENDIA AYALA JCT.
DATE/DAY CONDUCTED: 6/28/77 (TUESDAY)
TIME: 5:00-6:00PM

FIG. 7

S3 TRAFFIC ANALYSIS

S3 TRAFFIC ANALYSIS

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1. METHOD AND RESULT OF TRAFFIC PROJECTION

1.1 SOCIO-ECONOMIC INDICES FOR TRAFFIC PROJECTION

Future population established in land use plan for the years 1980, 1990 and 2000 were broken down to the population by occupation and car-ownership referring to the UTSMMA, the rapid transit railway line No.1 report and the MMETROPLAN study.

The results are shown in Table 1.1-1 to 1.1-3.

Table 1.1-1 Future Population of The Study Area by Occupation and Car Ownership (1980)

(Unit in 1000 persons)

Car-ownership / Occupation	Owners	Non-owners	Total
Professional workers	108	123	231
Administrative workers	39	23	62
Clerical workers	68	159	227
Sales workers	67	141	208
Farmers	3	18	21
Workers in transport sector	66	195	261
Craftsmen	57	408	465
Service workers	234	231	465
(Sub-total)	642	1,298	1,940
School children	253	679	932
Students	333	584	917
(Sub-total)	586	1,263	1,849
House wives	198	899	1,097
Jobless	175	1,031	1,206
(Sub-total)	373	1,930	2,303
Grand total	1,601	4,491	6,092

Table 1.1-2 Future Population of The Study Area by Occupation and Car Ownership (1990)

(Unit in 1000 persons)

Car-ownership Occupation	Owners	Non-owners	Total
Professional workers	214	118	332
Administrative workers	77	12	89
Clerical workers	136	191	327
Sales workers	134	164	298
Farmers	3	14	17
Workers in transport sector	133	243	376
Craftsmen	117	552	669
Service workers	466	202	668
(Sub-total)	1,280	1,496	2,776
School children	467	763	1,230
Students	651	560	1,211
(Sub-total)	1,118	1,323	2,441
House wives	440	1,020	1,460
Jobless	388	1,216	1,604
(Sub-total)	828	2,236	3,064
Grand total	3,226	5,055	8,281

Table 1.1-3 Future Population of The Study Area by Occupation and Car Ownership (2000)

(Unit in 1000 persons)

Car-ownership / Occupation	Owners	Non-owners	Total
Professional workers	378	116	494
Administrative workers	136	12	148
Clerical workers	240	188	428
Sales workers	237	162	399
Farmers	5	12	17
Workers in transport sector	234	242	476
Craftsmen	281	600	881
Service workers	742	149	891
(Sub-total)	2,253	1,481	3,734
School children	665	904	1,569
Students	915	639	1,554
(Sub-total)	1,580	1,543	3,123
House wives	561	1,321	1,882
Jobless	506	1,563	2,069
(Sub-total)	1,067	2,884	3,951
Grand total	4,900	5,908	10,808

1.2 TRIP PRODUCTION

In MMETROPLAN, the forecast of trip generation and attraction was made in terms of the number of trips per household (household trips) based on the results of 1971 person trip survey. On the other hand, the study team forecasted them in terms of number of trips per capita (person trips).

The person trip survey in 1971 was carried out originally for the purpose of grasping the trip characteristics of "person trips", not "household trips", and, the methodology and procedure were for that particular purpose.

Therefore, there is a question about the accuracy of the results in MMETROPLAN because of unnatural, if not strained, projection of household trips from person trips.

Table 1.2-1 shows the number of trips per capita and per day as classified by car ownership and occupation, obtained from the results of person trip survey for the UTSMMA.

The total trip production by purpose in the study area has been calculated using the above 'Production Unit' (Number of trips per person per day) and the population by occupation and car ownership.

The classification and definition of trip purposes are as follows;

(1) Work

Commuting to work, and back home from work.

(2) Education

Going to school, and back home from school.

(3) Business

Business trip excluding (1) above.

(4) Other

All other than above.

Table 1.2-1 Production Unit per Person by Car-ownership and Occupation

Car-ownership	Trip purpose Occupation	Work	Education	Business	Other	Total
Owner	1. Professional, administrative, clerical workers	1.69	0.09	0.43	0.65	2.86
	2. Sales workers, farmers, craftsmen, service workers	0.45	0.02	0.47	0.25	1.19
	3. Workers in transport	0.64	0.01	2.60	0.23	3.48
	4. School children	0.00	1.78	0.00	0.09	1.87
	5. Students	0.00	2.52	0.00	0.24	2.76
	6. Housewives	0.00	0.02	0.00	0.93	0.95
	7. Joblesses	0.00	-	0.00	0.51	0.51
	Average (Owner)	0.46	0.70	0.31	0.38	1.85
Non-owner	1. Professional, administrative, clerical workers	1.73	0.12	0.24	0.18	2.27
	2. Sales workers, farmers, craftsmen, service workers	0.86	0.04	0.25	0.14	1.29
	3. Workers in transport	1.27	0.03	0.02	0.10	1.42
	4. School children	0.00	0.72	0.00	0.20	0.92
	5. Students	0.00	2.15	0.00	0.11	2.26
	6. Housewives	0.00	0.01	0.00	0.50	0.51
	7. Joblesses	0.00	-	0.00	0.32	0.32
	Average (Non-owner)	0.43	0.50	0.08	0.19	1.20
Average (Owner + Non-owner)		0.43	0.55	0.13	0.23	1.34

1.3 TRIP GENERATION AND ATTRACTION

Trip generation and attraction models by purpose have been developed through a multiple-regression analysis based on the 1971 UTSMMA data.

Collectable and available data as independent variables by zone are as follows:

> Residential Population, Number of workers by Industry (primary, secondary, tertiary), Number of Students in the Daytime, Number of Households and Number of Car-owning Households.

As a result, multi-regression models were obtained as shown in Table 1.3-1. According to this table, almost all of the models excluding those for trip purpose 'other' show the very high multi-correlation coefficients of over 0.950, and it is judged that these models are applicable for estimation of trip generation and attraction.

Trip generation and attraction by zone were calculated by substituting the future independent indices for model formula. Final estimates for the years 1980, 1990 and 2000 obtained through the procedure above were examined and checked whether they are reasonable or not in view of time series (namely, 1971, 1980, 1990 and 2000).

Table 1.3-2 shows trip generation and attraction by sector for the years 1980, 1990 and 2000.

Table 1.3-1 Multi-Regression Models of Trip Generation and Attraction

Trip Purpose	Generation (G) or Attraction (A)	Model Formula	Multi-Correlation Coefficients
Work	(G)	$Y_1 = 0.2257X_1 + 0.5193X_2 - 223$	0.987
	(A)	$Y_2 = 0.1962X_1 + 0.6057X_2 - 219$	0.986
Education	(G)	$Y_3 = 0.2524X_1 + 0.7985X_3 + 69$	0.999
	(A)	$Y_4 = 0.2465X_1 + 0.8179X_3 + 56$	0.999
Business	(G)	$Y_5 = 0.2723X_4 + 0.3464X_5 + 632$	0.969
	(A)	$Y_6 = 0.2734X_4 + 0.3457X_5 + 638$	0.969
Other	(G)	$Y_7 = 0.1278X_1 + 0.3207X_5 + 181$	0.878
	(A)	$Y_8 = 0.1068X_1 + 0.4243X_5 - 78$	0.828

* X_1 - Population, X_2 - Secondary and Tertiary Workers
X_3 - Total Educational Attendance, X_4 - Secondary Workers
X_5 - Tertiary Workers

Table 1.3-2 TRIP GENERATION & ATTRACTION BY PURPOSE & SECTOR

(Unit in 1000)

PURPOSE / YEAR / SECTOR	WORK			EDUCATION			BUSINESS			OTHERS			TOTAL		
	1980	1990	2000	1980	1990	2000	1980	1990	2000	1980	1990	2000	1980	1990	2000
CBD — 1	112	126	129	483	555	636	64	81	92	65	85	103	724	847	961
	121	136	138	492	566	649	64	87	92	75	97	119	752	886	998
CBD — 2	91	108	109	120	139	158	68	92	105	55	73	87	334	411	459
	104	122	123	122	142	162	68	92	105	69	91	109	363	447	499
A — 1	195	223	223	294	363	414	53	66	77	117	153	181	659	805	895
	189	214	215	293	363	414	53	66	77	112	146	174	647	789	880
A — 2	135	166	181	214	273	322	46	63	80	81	113	146	476	615	729
	134	164	179	214	273	323	45	63	80	82	113	147	475	613	729
A — 3	114	136	149	163	200	228	27	39	61	66	89	116	370	464	554
	109	131	146	153	199	220	27	39	60	62	84	114	361	453	540
A — 4	136	157	169	208	241	274	40	59	82	79	106	137	463	563	662
	133	155	168	208	241	275	40	59	82	77	105	140	458	560	665
B — 1	152	199	247	185	256	322	41	62	98	82	116	166	460	633	833
	148	194	243	184	254	320	41	62	98	77	109	158	450	619	819
B — 2	169	235	310	186	288	347	53	66	144	92	135	197	500	724	998
	168	233	311	185	287	346	53	67	144	89	131	193	495	718	994
B — 3	181	246	309	210	292	368	69	109	166	108	161	233	568	808	1,076
	183	248	313	210	292	368	69	108	166	111	166	243	573	814	1,090
B — 4	156	220	315	187	267	346	54	108	179	81	140	232	478	735	1,072
	151	230	322	186	266	345	54	100	178	86	141	243	477	737	1,088
B — 5	245	390	491	233	350	458	101	203	292	140	239	354	719	1,182	1,595
	251	403	506	231	348	456	101	203	292	147	253	376	730	1,207	1,630
C — 1	122	159	206	142	203	277	36	51	74	67	98	144	367	511	701
	120	155	201	141	202	276	36	51	74	66	94	136	363	502	687
C — 2	72	158	253	79	186	333	20	52	113	42	85	190	213	481	889
	70	151	278	78	184	331	20	52	113	40	84	179	208	471	901
C — 3	328	427	592	408	614	802	104	154	234	177	251	396	1,017	1,446	2,024
	327	423	582	406	614	800	104	155	233	173	242	375	1010	1,434	1,990
C — 4	316	498	716	397	661	960	76	138	234	168	269	461	957	1,566	2,371
	348	492	694	355	654	955	76	136	235	157	263	421	936	1,545	2,305
D	12	94	145	8	28	71	8	71	106	6	67	119	26	260	441
	14	104	154	8	28	70	8	71	106	8	80	136	38	283	466

1.4 TRIP DISTRIBUTION

The procedure of estimation of trip distribution is as follows:

Step 1. Distribution of trips going from origin to destination by purpose was estimated using the gravity model developed in UTSMMA study.

Step 2. Then, distribution of trips returning from destination to origin which were calculated using the ratio of "going" to "returning" trips obtained from the results of 1971 person trip survey, was added to the OD table of "going" trips.

Step 3. Flatter calculation using the controlled total (trip generation and attraction by zone) was carried out for the purpose of making up a final OD table.

OD tables for the years 1980 and 1990 were prepared through above steps. OD table for the year 2000, however, was estimated using the Flatter method and following the Origin Destination (OD) pattern for the year 1990.

The Gravity Model has been prepared using the following formula:

$$X_{ij} = \alpha U_i V_j t_{ij}^{-\gamma}$$

where: X_{ij}: traffic volume between zones, i and j

U_i : trip generation of zone i

V_j : trip attraction in zone j

t_{ij}: travel time between zones, i and j

α : constant of trip purpose

γ : exponent of travel time

Exponent of travel time for estimation by purpose is as follows:

Purpose	Exponent of travel time
Work	2.00
Education	2.64
Business	1.56
Other	1.66

For the purpose of examining the accuracy of the models for projection and the justifiability of the projected values, the OD traffic volume projected for the year 1980 and the results of traffic count on the screen line set on the Pasig River were compared with each other in Table 1.4-1 with the total traffic by type of vehicle passing the screen line taken as a measure.

Table 1.4-1 Comparison of Number of Trips on Screen Line in 1,000 persons

Mode	Car (incl. Taxi)	Mass transit	Truck	Total
A. Result of Survey (1977)	737	1,176	53	1,967
B. Estimates in this Study (1980)	987	1,426	66	2,479
B/A	1.34	1.21	1.25	1.26

The average occupancy by type of vehicle was derived from the data of MMETROPLAN and RTR LINE NO: 1 REPORT, etc. as follows:

Car and taxi : 2.0 persons/unit
Jeepney : 10.3 persons/unit
Big bus : 40.0 persons/unit

A traffic growth expected during the three years for the observed year to the projected year justifies the results in the above table.

Table 1.4-2 shows the actually observed traffic volume crossing the bridges on the screen line, and the number of lanes the bridges have.

Table 1.4-2 Observed Traffic Volume Crossing the Bridges on the Screen Line

Station	Observed traffic volume	Number of lanes
1. Roxas Brg.	36,882	2
2. Jones Brg.	58,523	4
3. MacArthur Brg.	51,846	4
4. Quezon Brg.	71,175	4
5. Ayala Brg.	38,998	4
6. Nagtahan Brg.	68,061	4 or 6
7. New Panaderos Brg.	31,341	2
8. Guadalupe Brg.	106,372	6
9. Bambang Brg.	14,977	2

Considering the lane capacity the bridges have, the traffic volume in 1977 seems likely to have almost hit the ceiling. This is evidenced by the fact that the traffic volume has remained unchanged since 1971. In the projection of the trip distribution, the bridges lying on C-3 and C-5 were taken into account.

1.5 MODAL SPLIT

The modal split curve by travel time ratio developed in Japan was adjusted to be compatible with the results of the person trip survey conducted in 1971. The final modal split curve is shown in Fig. 1.5-1.

The trip sharing between cars (privately owned cars) and mass transit was made by making use of the curve referred to above.

As regards the taxi and truck, a separate method was applied for projection as touched upon in the text volume. The modal split is discussed briefly below.

Taxi

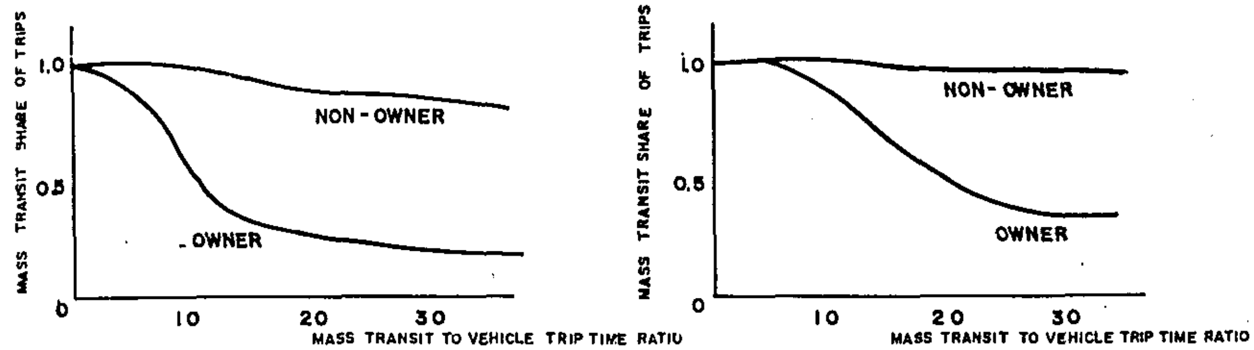
A method in which the future number of taxi trips is determined by multiplying the taxi holdings by the average number of trips was applied for projection. The number of registered taxis in the 1970 ∿ 71 period is reported to be 7,339. It is generally known that there is some correlation between the registered number of taxis and the population. By dint of this, the population growth was adopted as the major factor for estimating the future number of registered taxis.

The average number of taxi trips has been estimated at about 33 per taxi from the person trip survey in 1971. In the projection of the future taxi trips, the modal split ratio between privately owned cars and taxis, obtained from the traffic count, was also taken into account.

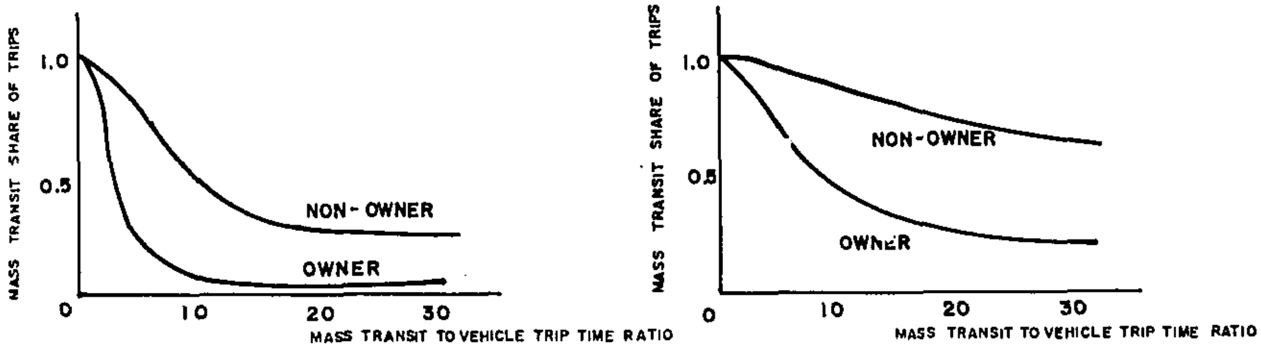
Truck

The same approach as with the taxi was applied to the projection of trucks, except that the GNP growth rate was taken up as a major factor in the projection of the number of truck trips.

Table 1.5-1 shows the estimated number of trips by mode and by year.



WORK EDUCATION



BUSINESS OTHERS

Fig.1.5-1 MASS TRANSIT SHARE OF TRIPS BY TRAVEL TIME RATIO

Table 1.5-1 Summary of The Number of Trips by Travel Mode

(Unit in 1000)

Travel Mode	Year Kind of Trip	1980	1990	1990/1980	2000	2000/1980	2000/1990
Mass Transit (unit in person)	Internal	6,004	8,525	1.42	11,416	1.90	1.34
	External	472	903	1.91	1,205	2.55	1.33
	Total	6,476	9,428	1.46	12,621	1.95	1.34
Car (unit in vehicle)	Internal	1,343	2,000	1.49	2,826	2.10	1.41
	External	109	205	1.88	288	2.64	1.40
	Total	1,452	2,205	1.52	3,114	2.14	1.41
Taxi (unit in vehicle)	Internal	401	587	1.46	811	2.02	1.38
	External	34	64	1.88	88	2.59	1.38
	Total	435	651	1.50	899	2.07	1.38
Truck (unit in vehicle)	Internal	85	168	1.98	252	2.96	1.50
	External	6	14	2.33	21	3.50	1.50
	Total	91	182	2.00	273	3.00	1.50

1.6 TRAFFIC ASSIGNMENT

1.6.1 Road Networks and their Zoning for Traffic Assignment

Fig. 1.6-1 shows a network made up of some existing roads for the purpose of traffic assignment. It also includes the roads projected for the years 1980, 1990 and 2000 as detailed in the text volume. In the study, the MMA defined by MMC was divided into 80 zones, and its outer region into 6 radial zones.

The area closely associated with the project roads was subdivided for traffic assignment calculation with a view to improving the accuracy of forecasting the traffic volume running on the project roads.

Finally, 118 internal zones and 6 external zones were prepared.

Fig. 1.6-2 gives a sketch of subzones.

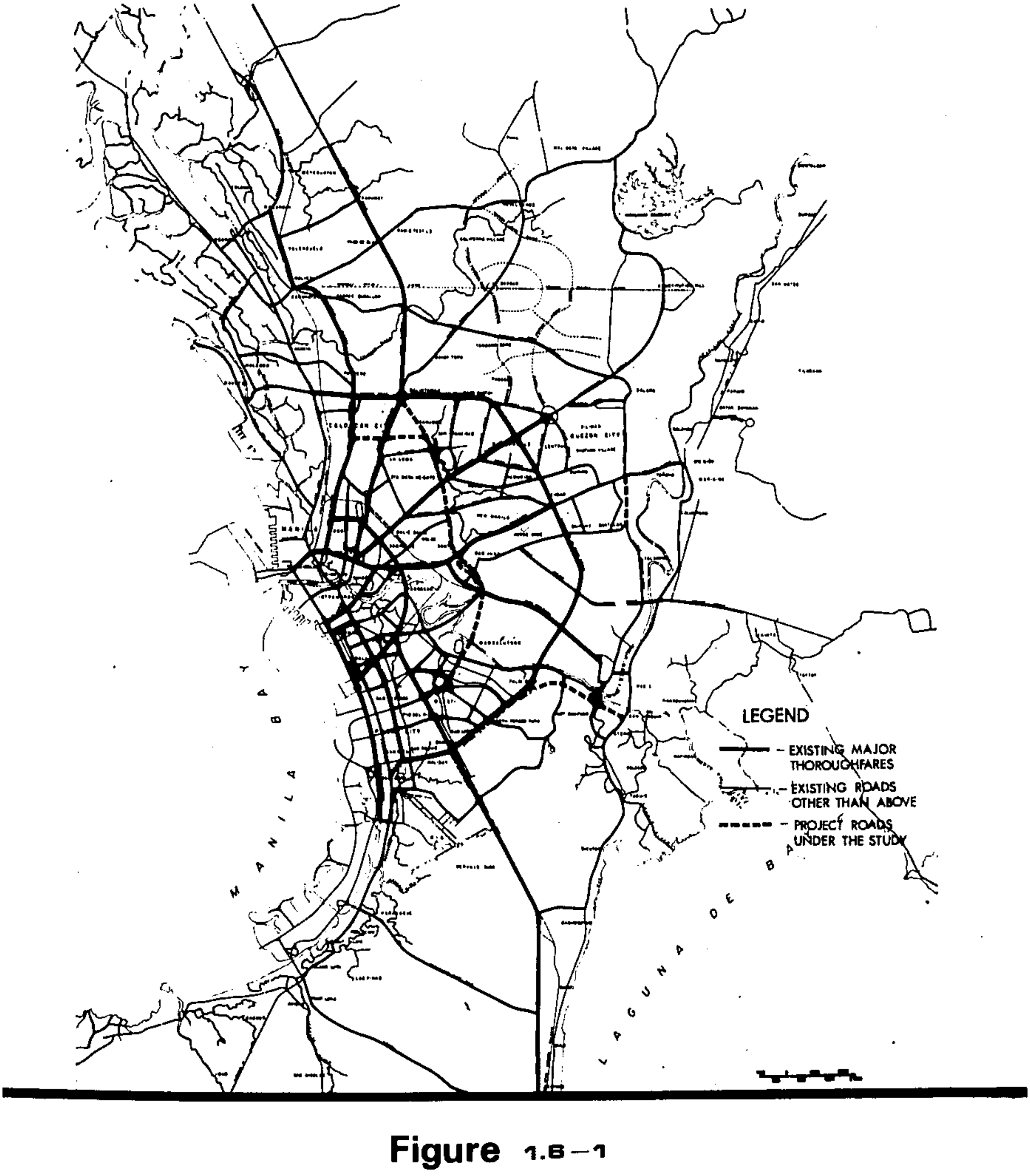


Figure 1.6-1

BASIC HIGHWAY NETWORK FOR TRAFFIC ASSIGNMENT

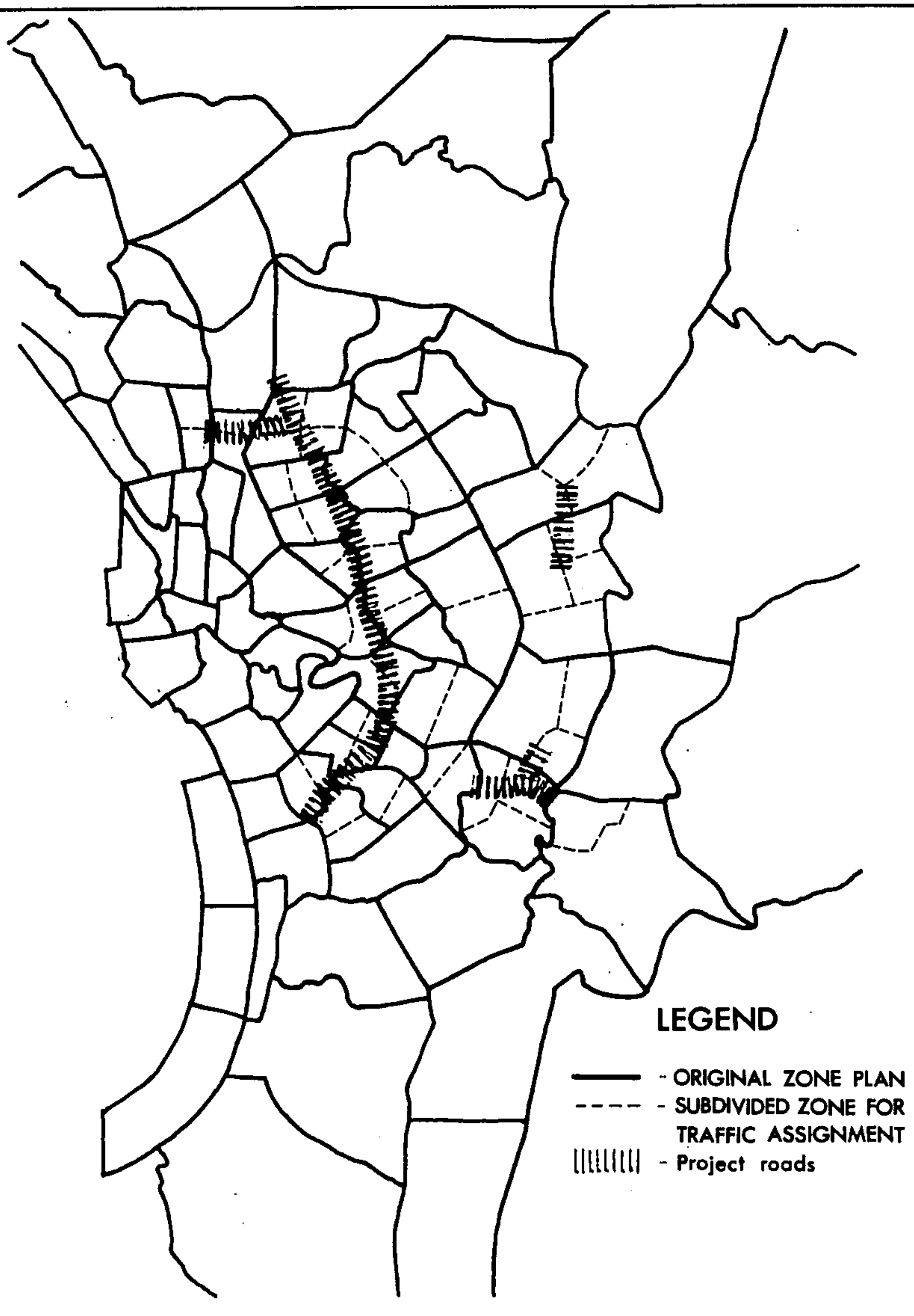


Fig 1.6-2 ZONE PLAN FOR TRAFFIC ASSIGNMENT

1.6.2 Velocity vs. Capacity Relationship

As already discussed in the text volume, roads among which traffic is to be assigned were classified into seven types -A, B, C, ... G, and then the roads of types B, C and D were subclassified into two as to whether they have bus lanes or not.

Finally, the velocity vs. capacity relationship was established for the following types of roads.

(1) Where bus and other vehicles run in a mixed state:

types: A, B-1, C-1, D-1, E, F, G

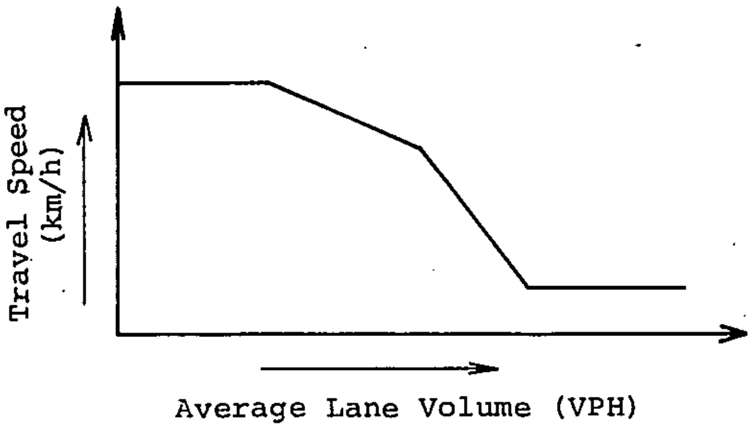
(2) Where bus traffic is excluded:

types: B-2, C-2, D-2

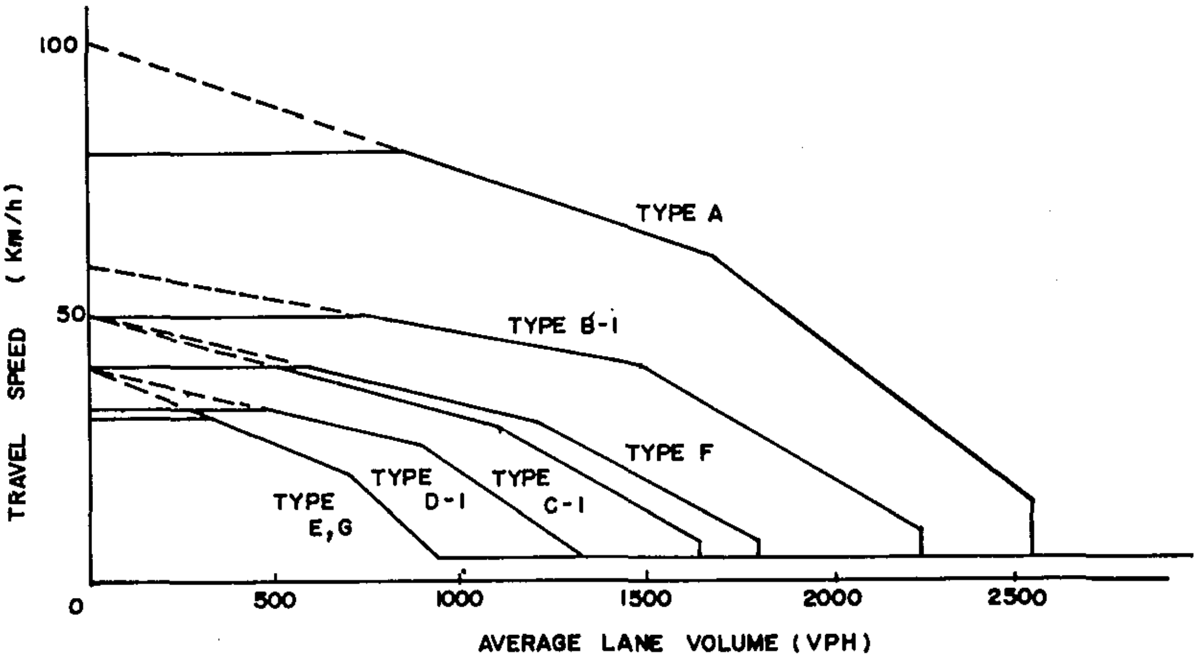
(3) Where bus lanes are installed:

* One-way one-line
* One-way two-line

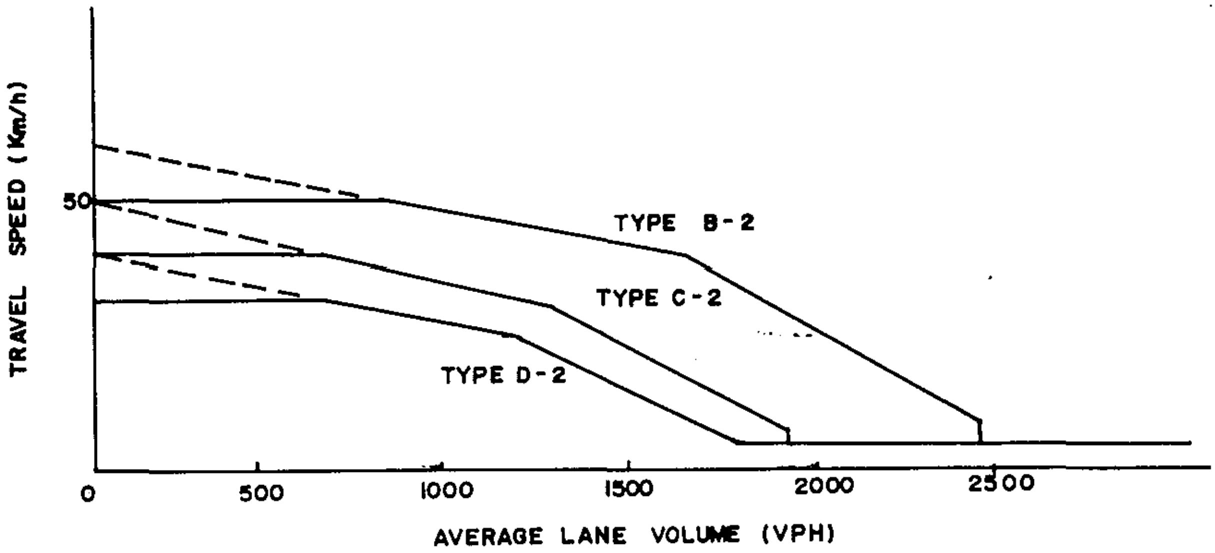
The basic pattern of the velocity vs. capacity curve was set as illustrated below.



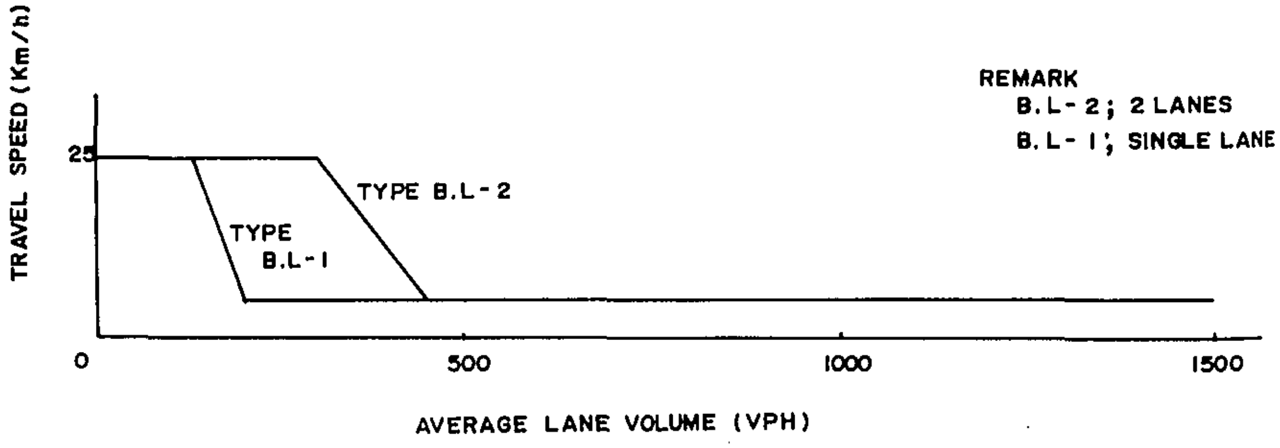
The velocity vs. capacity curves established for the road types classified as above are given in Fig. 1.6-3.



(a) INCLUDING BUS TRAFFIC



(b) EXCLUDING BUS TRAFFIC



(c) FOR BUS LANE

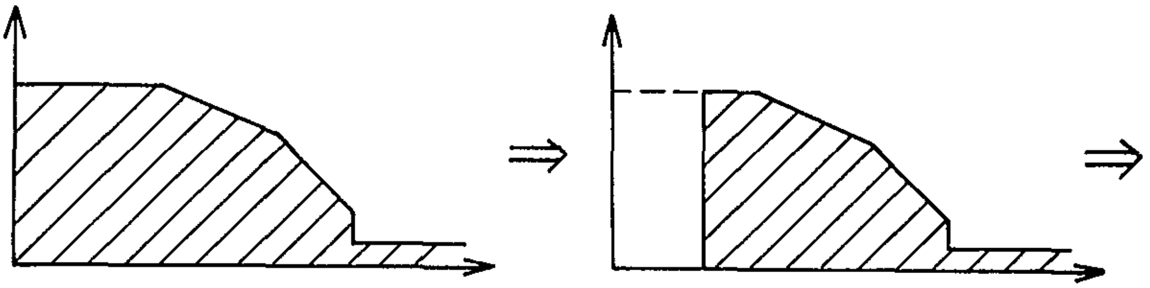
Fig. 1.6-3 TYPICAL RELATIONSHIP BETWEEN AVERAGE LANE VOLUME AND TRAVEL SPEED.

1.6.3 Traffic Assignment

The procedure of traffic assignment is outlined in Fig. 1.6-4.

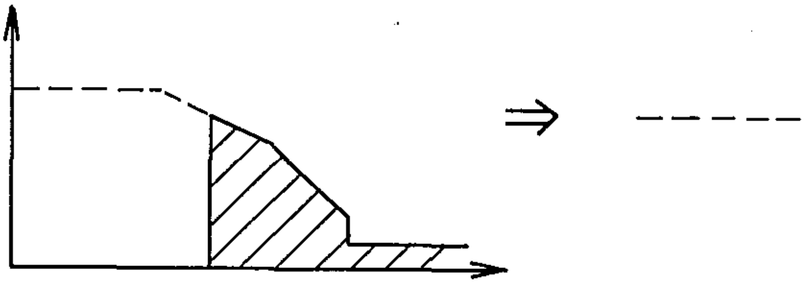
As illustrated in Fig. 1.6-4, the traffic assignment was made in four steps. Bus and truck were assigned first because these types of vehicles are least forced to change their route even if they meet with a considerably high degree of congestion.

In each step of traffic assignment, the velocity vs. capacity curve was modified in the procedure illustrated below.



(1) Mass Transit

(2) Truck



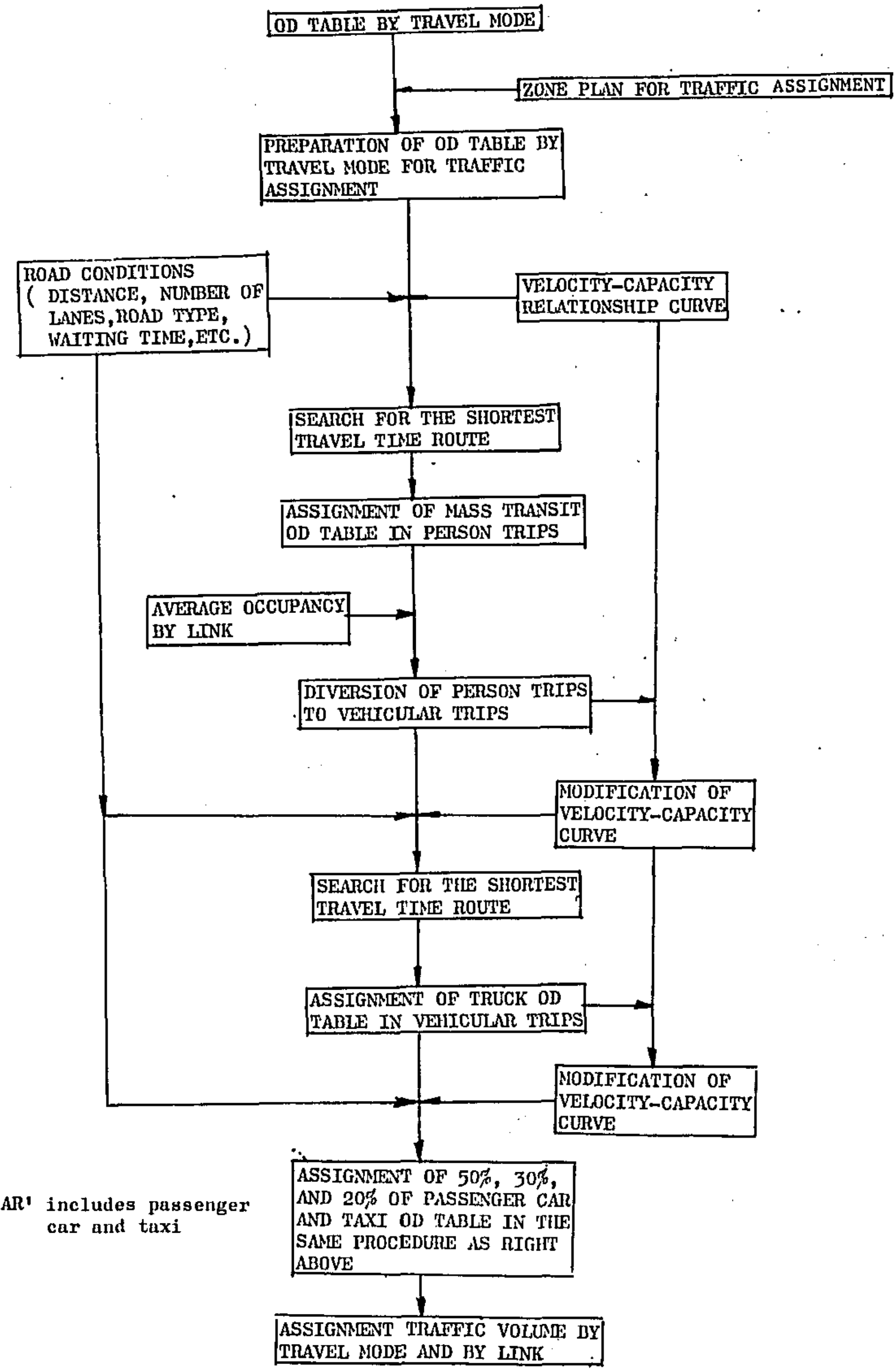
(3) 50% of passenger cars (incl. taxis)

The mass transit OD in person trip was assigned. Then, it was transformed into vehicular traffic using the average number of passengers aboard the mass transit which was set for each link.

The reason why this circuitous method was used was that, if the assignment is made on the basis of vehicular trips, the directivity of the mass transit system operating routes would hardly be reflected.

The person-kilometers and average trip lengths by type of vehicle after traffic assignment are shown in Table 1.6-1.

It is found in the table that the average trip length will rise steadily with the development of land use pattern.



*'CAR' includes passenger car and taxi

Fig. 1.6-4 Outline of Traffic Assignment Procedure

Table 1.6-1 Average Trip Length by Year (Plan 1-1)

		1980	1990	2000	$\frac{1990}{1980}$	$\frac{2000}{1990}$
Mass Transit	Person-Kilometer (unit in 1000)	42,026	63,278	87,311	1.51	1.38
	Number of Trips (unit in 1000 trip)	5,308	7,680	10,284	1.45	1.34
	Average Trip Length per Person (kms.)	7.92	8.24	8.49	1.04	1.03
Truck	Person-Kilometer (unit in 1000)	633	1,318	2,035	2.08	1.54
	Number of Trips (unit in 1000 trip)	77	154	231	2.00	1.50
	Average Trip Length per Person (kms.)	8.22	8.56	8.81	1.04	1.03
Car	Vehicle-Kilometer (unit in 1000)	12,959	20,610	29,048	1.59	1.41
	Number of Trips (unit in 1000 trip)	1,594	2,414	3,335	1.51	1.38
	Average Trip Length per Person (kms.)	8.13	8.54	8.71	1.05	1.02

Note: Excluding Intrazonal Trips

2. BENEFIT CALCULATION

A routine for benefit calculation is outlined in Fig. 2-1. The traffic cost was calculated in the steps explained below.

Step 1. Breakdown of daily traffic into hourly traffic

In order to reflect the time-dependent traffic changes, such as peak-hour traffic and off-peak-hour traffic, in the estimate of traffic cost, the daily traffic volume was dissected into hourly values according to the results of traffic counts made in 1974 and 1976 as to the road type and hourly traffic distribution by type of road. Fig. 2-2 shows the 16-hour traffic distribution by type of road.

Step 2. Calculation of travel time

The travel time between zones was calculated by making use of the assigned hourly traffic and the hourly velocity vs. capacity curves.

For the purpose of consistency with the calculation of traffic assignment, the OD paths determined by traffic assignment were also used for the calculation of travel time.

In traffic assignment, bus/jeepney, truck, car and taxi were assigned within the network in the said order. To this end, the running speed by type of vehicle and by time zone of the day was calculated to simulate a condition that a variety of vehicles are running on a road at the same time, because the calculation by the vehicle-wise running speed of the running cost would bring about a preposterous result that the running speed of a vehicle would become the lower, the later it would come in the assignment order.

In principle, therefore, the running speed of the passenger cars was calculated from the velocity vs. capacity curve used in the traffic assignment, and that of the buses was derived on assumption that it will be reduced in direct proportion to the speed reduction of passenger cars.

Step 3. Calculation of traffic cost

The fixed cost and operating cost by type of vehicle were calculated using the travel time between zones, trip length, running speeds on specific links, and specific cost by type of vehicle.

At the same time, the costs were enumerated as to normal, diverted, and non-diverted traffic, respectively.

Step 4. Benefit calculation

The steps 1 through 3 were applied to two cases; one where project roads are implemented and the other where they are not.

Then, the difference in traffic cost between the two cases was reckoned as benefit.

By making use of the benefit calculated in step 4, an economic analysis was made, the results of which have been expatiated in the text volume.

The yearly flow of benefits and its relation to the economic indicies (IRR, B/C) were also discussed to some degree as reported hereunder.

Concerning Plan 2, the traffic volume on C-3 expected to be in 1990 is as shown in Fig. 2.2-6 of the text volume (see Chap. 2, para. 2.2.8).

It warns that the entire C-3 will be saturated in early 1990's as more than half of C-3 will have already been run in excess of its design capacity in 1990.

This will be also the case with other major roads, and when the benefits will continue to accrue from C-3, their growth rate will be on a steady decline.

For the purpose of looking into the relationship between the benefits and economic indicies (IRR, B/C) as a function of time, the B/C was estimated as listed in Table 2-1 with the economic life set at an interval of five years.

Table 2-1 Trends of B/C and IRR by Economic Life

Economic Life		5	(8)	10	15	20	25
Year		1987	(1990)	1992	1997	2002	2007
B/C (15%)	Plan 2	2.2	3.3	3.8	4.9	5.5	5.8
	Plan 3	2.2	3.2	3.8	4.8	5.4	5.7
IRR	Plan 2	42.8	45.8	48.0	48.7	48.8	48.8
	Plan 3	42.9	45.8	48.0	48.7	48.8	48.8

Table 2-1 shows that the costs and benefits are balanced (B/C = 1) in not more than five years after commencement for use.

The IRR will reach 48.0% in ten years (1992) after commencement for use, and the benefits accruing thereafter till 2007 (end of 25-year economic life) will contribute to just a bit rise of 0.8% in IRR.

Namely, it will suffice to discuss the benefits and costs expected to arise in at least ten years after commencement for use, that is, by the time when the entire C-3 will be nearly saturated, and this simplified calculation will matte not a jot to the substance of the economic evaluation.

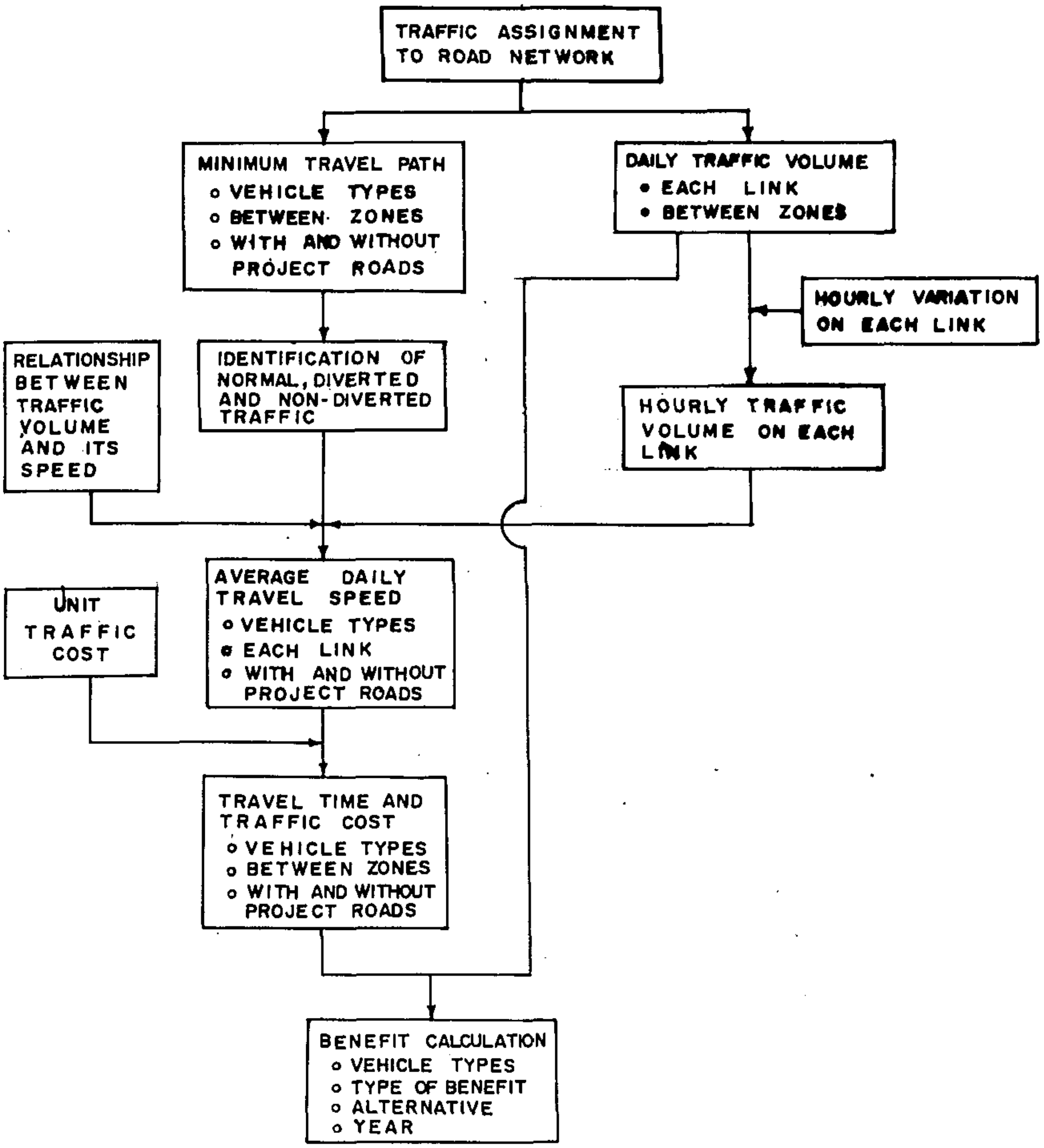


FIG. 2 – 1 PROCEDURE FOR BENEFIT CALCULATION

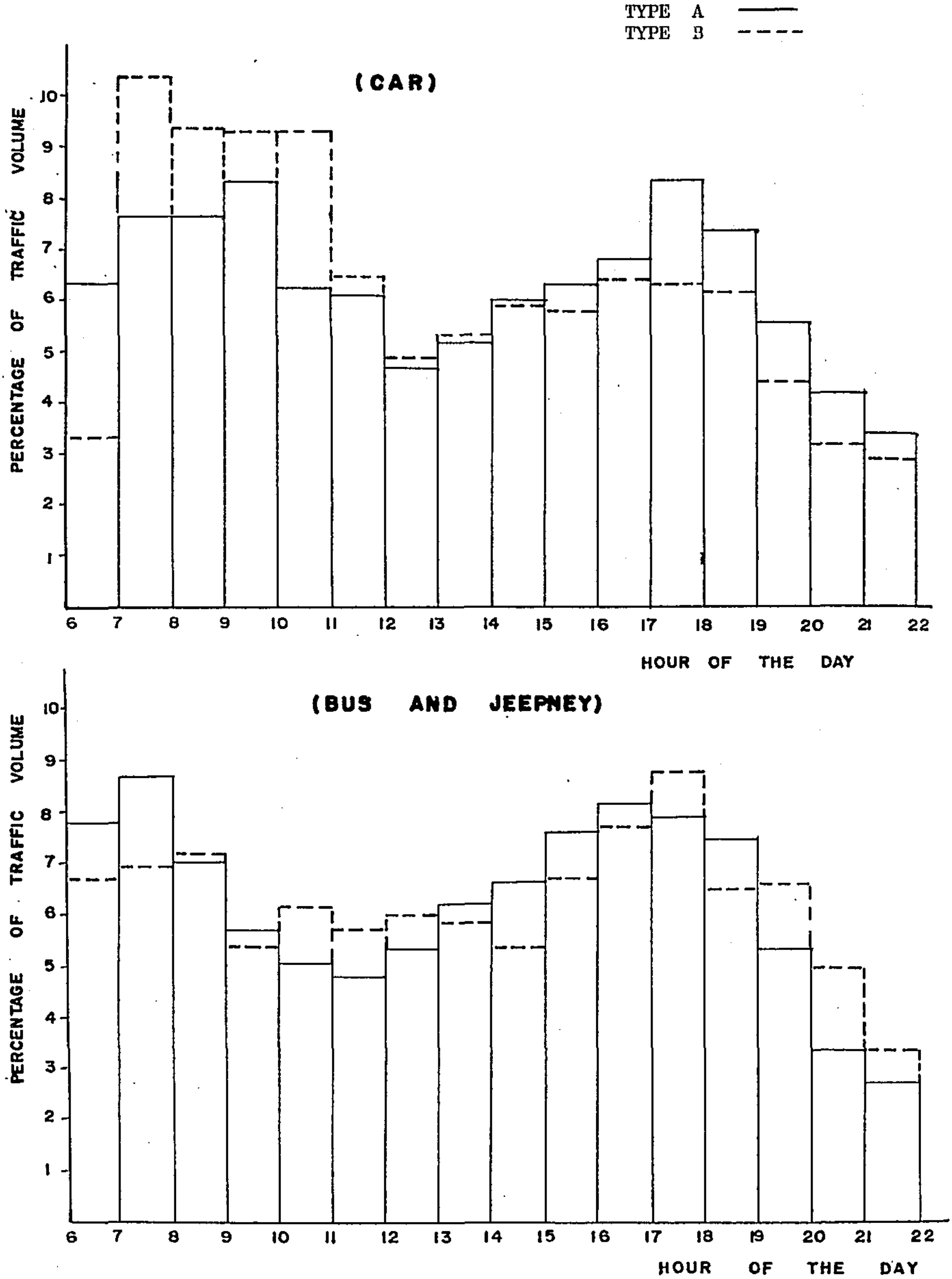


Fig. 2-2 Hourly Traffic Variation

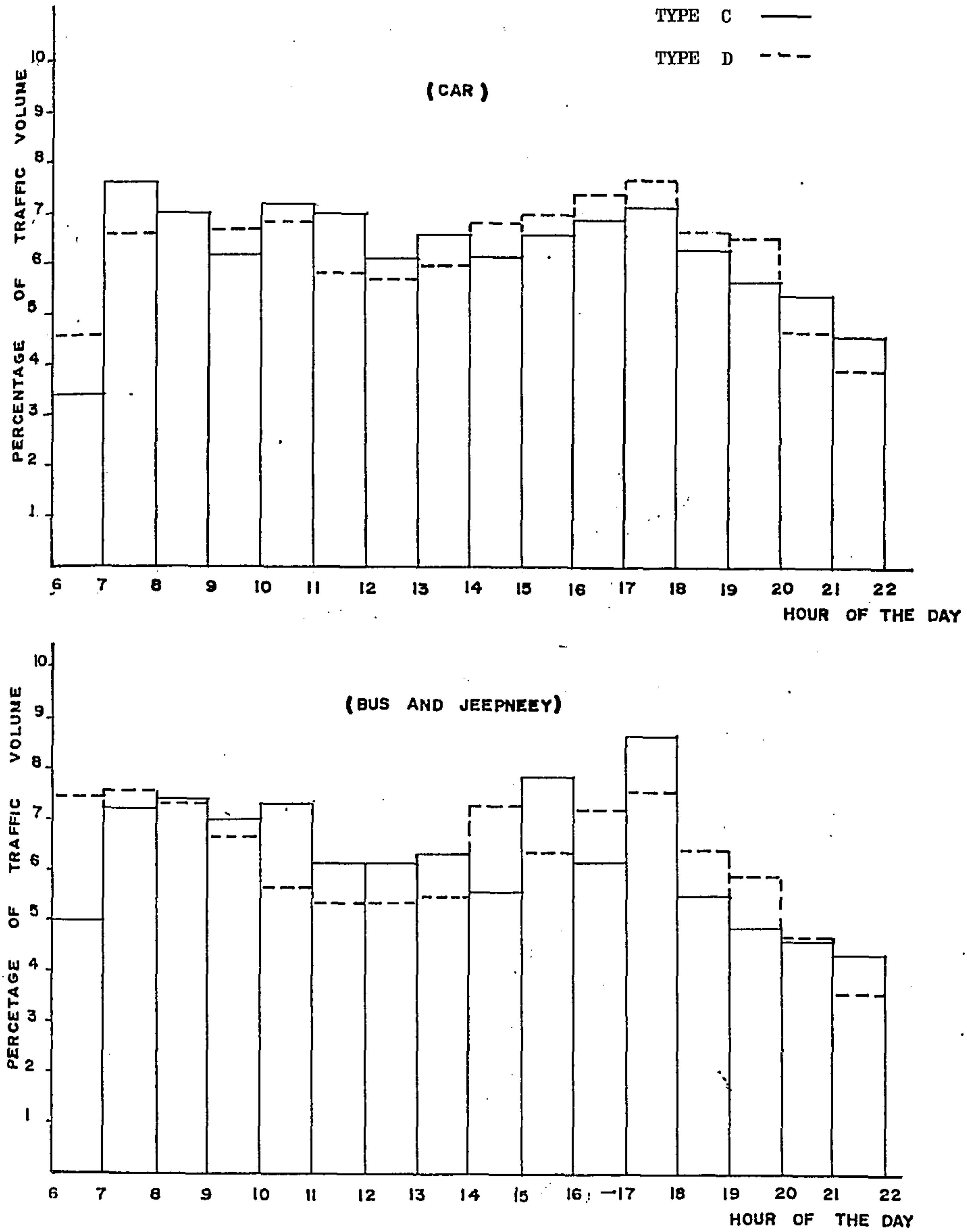


Fig. 2-2 Hourly Traffic Variation (cont'd)

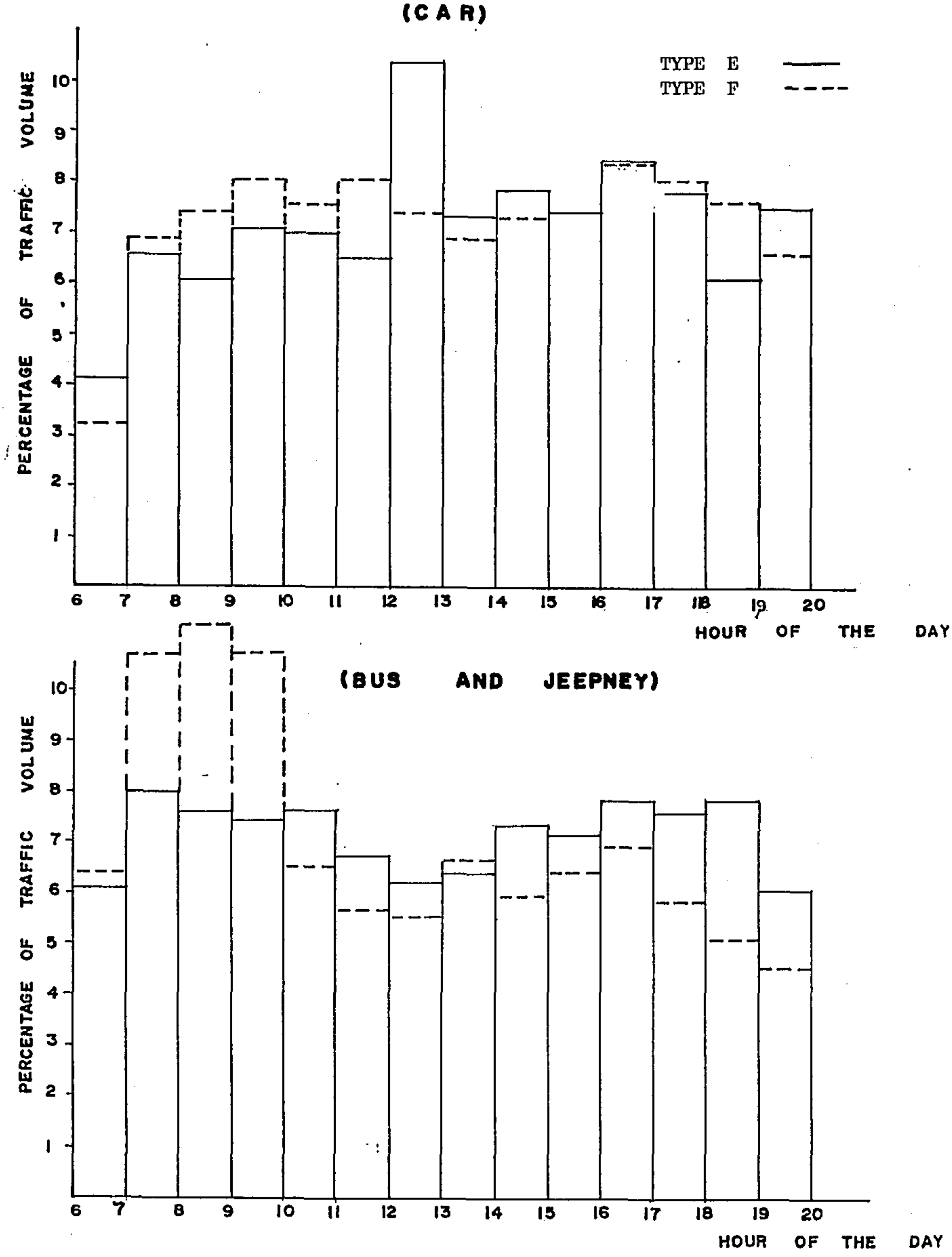


Fig. 2-2 Hourly Traffic Variation (cont'd)

3. CORDON PRICING AND BUS LANE

3.1 CORDON PRICING

As regards the effect on the traffic volume running on C-3 when cordon pricing is introduced along C-2, the results alone have been shown in the text volume.

In this section, the estimation method of the effect will be discussed.

An outline of procedure is shown in Fig. 3.1-1.

What was taken into consideration in cordon pricing was car and taxi. In projecting the change in C-3-using traffic, the diversion of the users from car and taxi to bus/jeepney was estimated on assumption that an extra charge of ₱2 or ₱3 on taxis and cars crossing C-2 road would direct some of the car or taxi passengers to bus/jeepney.

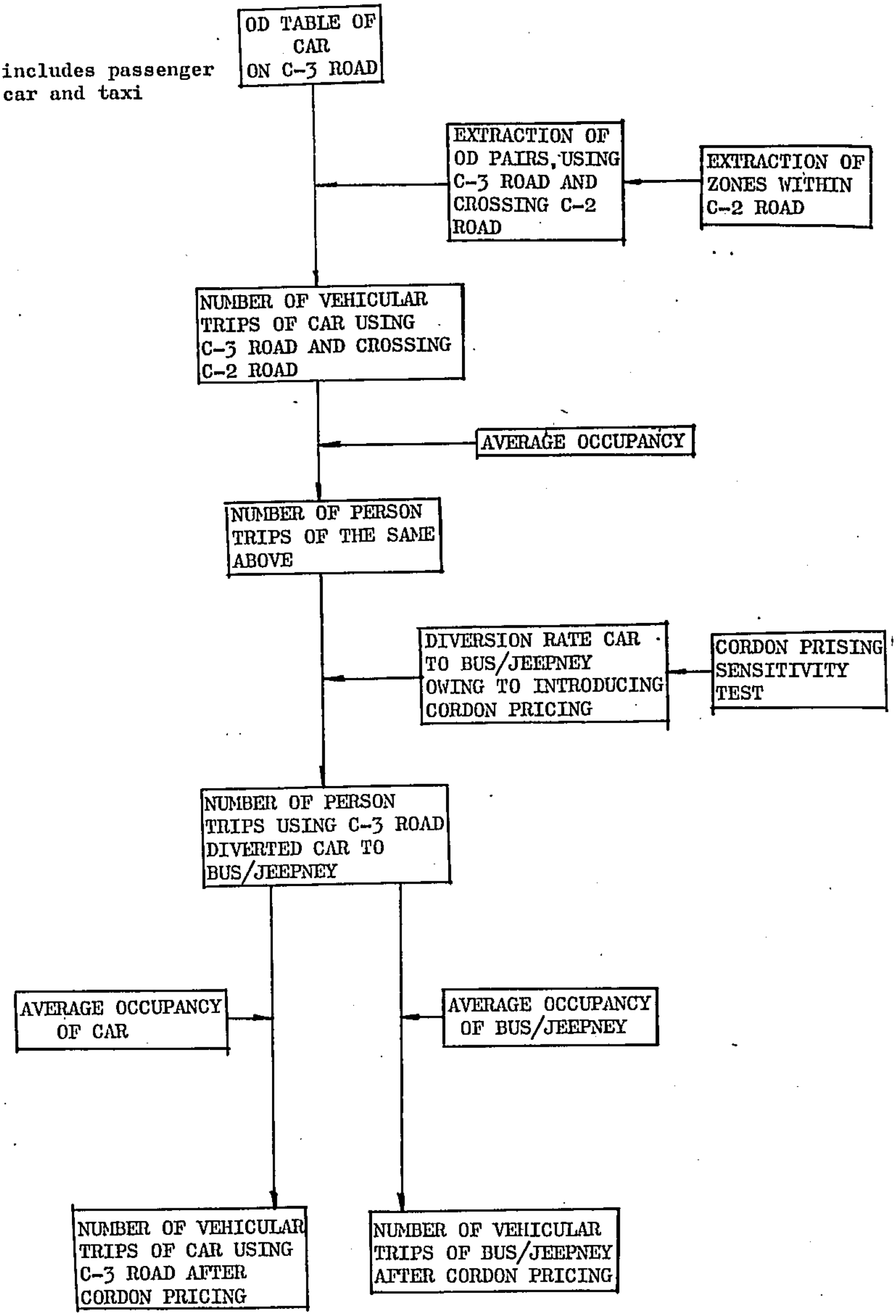
Here, the trucks have nothing to do with the case, and more disregarded, accordingly.

First, the zones which are present within C-2 were picked up, and the passenger trips by car or taxi which take C-3 and at the same time cross C-2 were enumerated.

In the year 1980, for instance, a total 46 thousand cars or a total 92 thousand persons are expected to follow the aforesaid pattern of flow.

According to the cordon pricing sensitivity test in MMETROPLAN, it is reported that each corridor will have a car/taxi-to-bus/jeepney diversion rate of 21% as against a ₱2 charge or 45% as against ₱3 charge, the rate being calculated in terms of the number of passengers.

The diverted traffic referred to in the text volume was calculated by making use of these diversion rates.



* 'CAR' includes passenger car and taxi

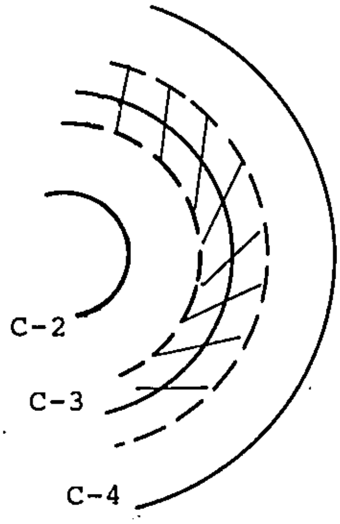
Fig.3.1-1 Diverted Traffic Volume owing to Introducing Cordon Pricing

3.2 BUS LANE

The diverted traffic volume in the case of introducing but lane on C-3 has been presented in the text volume.

An outline of estimation procedure is given in Fig. 3.2-1.

First, the influence area of C-3 was set up as schematically shown by the hatched section in the figure below.



Using as a basis those trips which use C-3 and which at the same time are related to the zones included in the influence area, the trips to be diverted were identified on presupposition that little or no diversion would be developed if the distance by which C-3 is used is shorter compared with the interzonal trip distance.

The influence area was further divided into the following two.

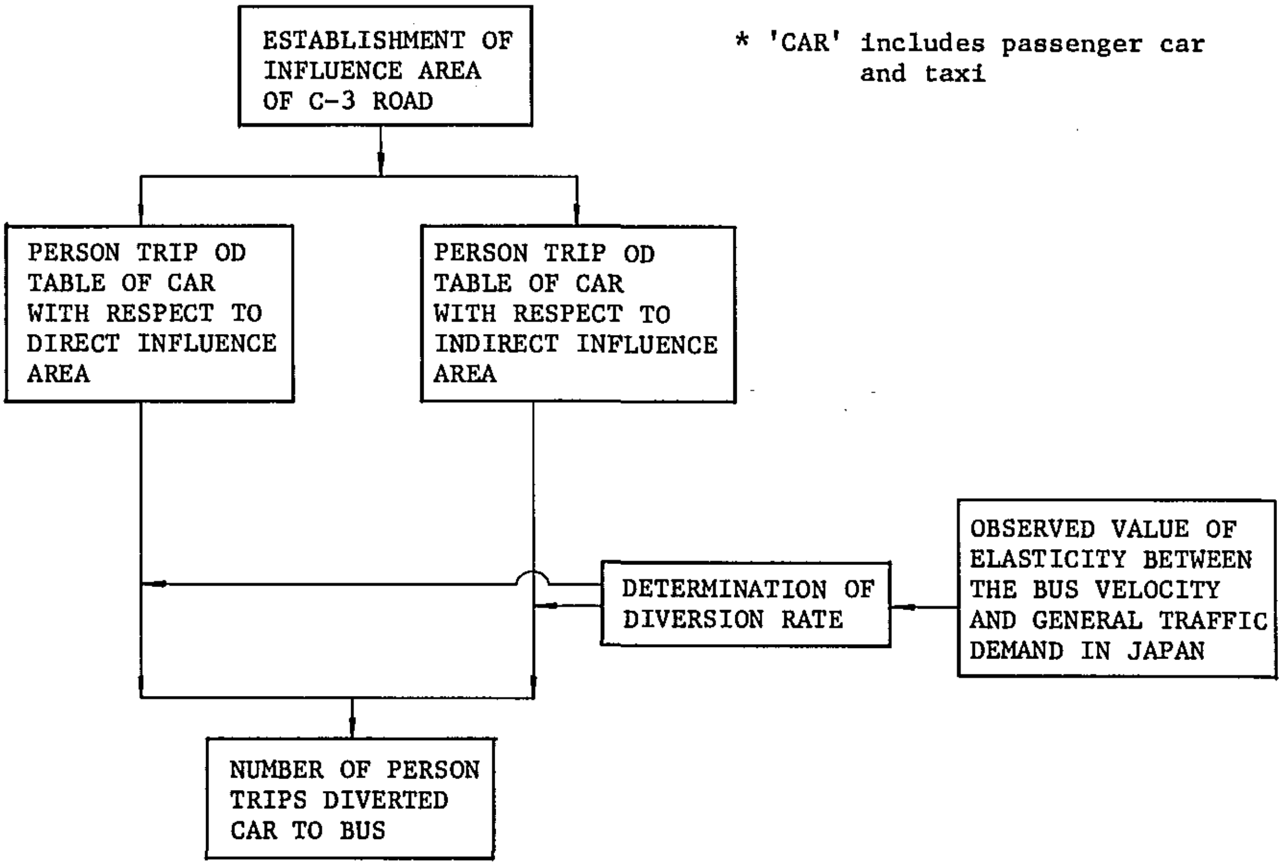
* Direct influence area

Where trips have their origins and destinations within the influence area.

* Indirect influence area

Where trips have their origins or destinations, but not both, in the influence area.

In the study, the diversion rate was set at 6% based on the survey results in Japan, and a sensitivity analysis was made with respect to 4% and 10%. For the indirect influence area, half the diversion rates were applied, however.



* 'CAR' includes passenger car and taxi

Fig. 3.2-1 Estimation of Diverted Traffic Volume in the Case of Introducing Bus Lane

4. INTERSECTION ANALYSIS

4.1 CAPACITY ANALYSIS

A capacity analysis was made at five major intersections on the project roads.

The conditions on which the capacity analysis was made have been described in detail in the text volume, and the calculation method applied may be summarized as in Table 4.1-1 in which the C-3-to-Ayala Intersection is taken up as an example.

Table 4.1-1 An example of capacity analysis

Approach	Direction	Peak-hour traffic volume	Phase	Number of lanes	(1) Capacity	(2) Ratio of volume to capacity	(3) Green time allocated, sec.
A	T	501	3	2	(1,800 + 1,620) × 0.885 = 3,026	(501 + 600/2) ÷ 3,026 = 0.265	(120 ÷ 0.786) × 0.265 = 40
	R	600	Any				
B	L	469	4	2	1,620 × 2 × 0.885 = 2,867	469 ÷ 2,867 = 0.165	(120 ÷ 0.786) × 0.165 = 25

Notes:

(1) In the case of the approach "A", one of the two lanes is used for both through and right-turn traffic. Thus, the capacity of the approach "A" was calculated by multiplying the adjustment factor in terms of the ratio of large vehicles to total by the sum of the capacity of the through traffic lane and that of the right-turn traffic lane.

(2) In principle, this is calculated by dividing the inflow traffic volume by the capacity. As regards the approach "A" where the right-turn vehicles run irrespective of the phase, only half the number of right-turn vehicles were counted for the calculation.

(3) This is the remainder obtained by subtracting the red and yellow times from a 130 sec. cycle, divided by the degree of saturation, and then multiplied by the ratio of volume to capacity obtained in (2).

For details of calculations, refer to Tables 4.1-2.

4.2 STUDY OF GRADE SEPARATION PLAN

The capacity analysis of the at-grade intersection was carried out with respect to the traffic volume for the year 1980. The future traffic growth expected foretells great difficulties in store for the traffic control at-grade intersections. For this reason, the modification of the intersections into grade-separated types was studied from the technical and economic viewpoints of traffic control.

TABLE 4.1-2

INTERSECTION TRAFFIC FLOW ANALYSIS

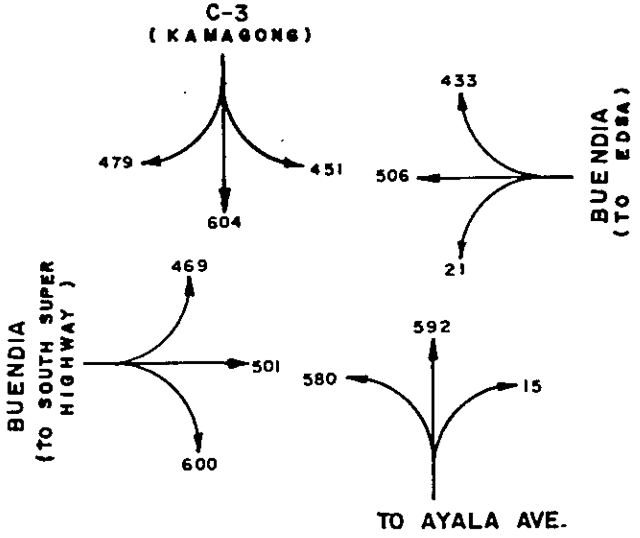
(a) C-3 (BUENDIA) - AYALA INTERSECTION

DIRECTION		PEAK HOUR TRAFFIC VOLUME	PHASE	NUMBER OF LANE	CAPACITY	RATIO OF VOLUME TO CAPACITY	GREEN TIME ALLOCATED
BUENDIA (SOUTH SUPER HIGHWAY)	T	501	1	2	3026	*0.265	40
	R	600	ANY				
	L	469	2	2	2867	*0.165	25
BUENDIA (EDSA)	T	506	1	2	3026	0.239	40
	R	433	ANY				
	L	21	2	1	1434	0.015	25
AYALA AVE.	T	592	3	2	3026	*0.198	30
	R	15	ANY				
	L	580	4	3	4301	0.135	25
C - 3 (KAMAGONG)	T	604	3	3	4619	0.183	30
	R	479	ANY				
	L	451	4	2	2867	*0.158	25

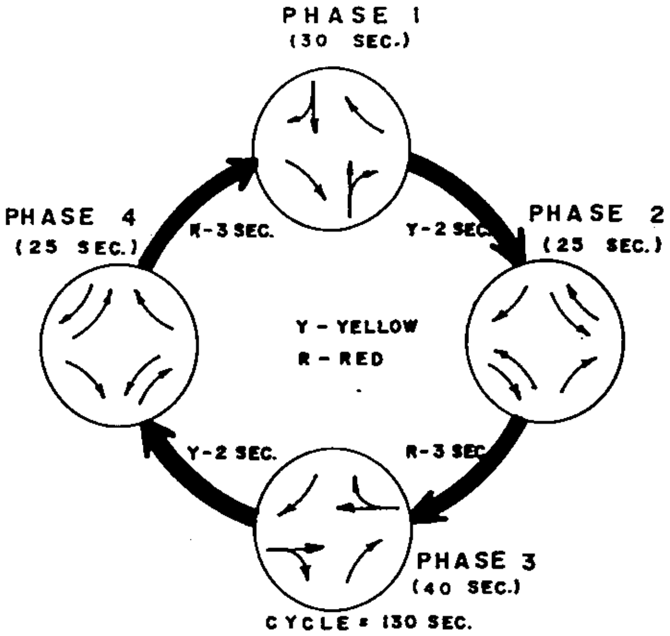
*** NOTE : T - THROUGH , R - RIGHT , L - LEFT**

SATURATION DEGREE 0.786

(SUM UP THE FIGURES WITH *)



PEAK HOUR TRAFFIC FLOW



SIGNAL LIGHT PHASE

TABLE 4.1 - 2

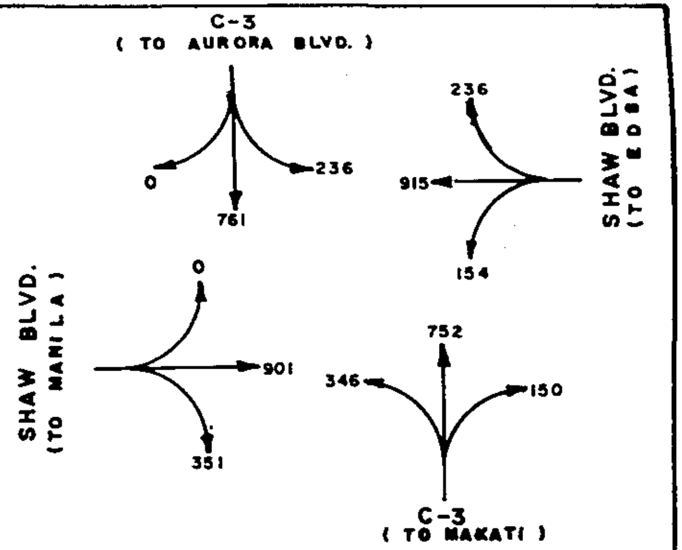
INTERSECTION TRAFFIC FLOW ANALYSIS (cont'd)

(b) C-3 - SHAW BLVD. INTERSECTION

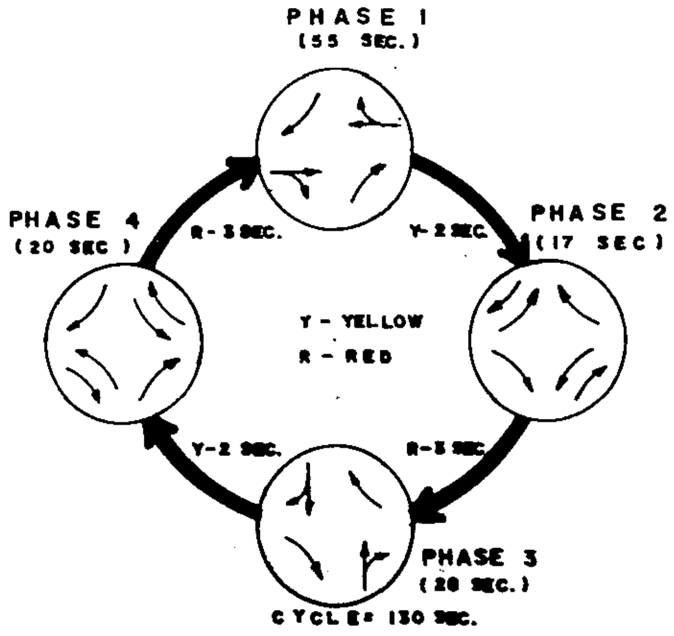
DIRECTION		PEAK HOUR TRAFFIC VOLUME	PHASE	NUMBER OF LANE	CAPACITY	RATIO OF VOLUME TO CAPACITY	GREEN TIME ALLOCATED (SEC.)
SHAW BLVD (MANILA)	T	901	1	3	3026	* 0.233	55
	R	351	ANY				
	L	0	2	—	1433	—	17
SHAW BLVD (EDSA)	T	915	1	2	3026	* 0.542	55
	R	236	ANY				
	L	154	2	1	1433	* 0.107	17
C - 3 (MAKATI)	T	752	3	3	4620	* 0.179	28
	R	150	ANY				
	L	346	4	2	2866	* 0.122	20
C - 3 (AURORA BLVD)	T	761	3	3	4620	0.165	28
	R	0	ANY				
	L	236	4	2	2866	0.082	20

* NOTE : T - THROUGH , R - RIGHT , L - LEFT

SATURATION DEGREE 0.750
(SUM UP THE FIGURES WITH *)



PEAK HOUR TRAFFIC FLOW



SIGNAL LIGHT PHASE

TABLE 4.1-2

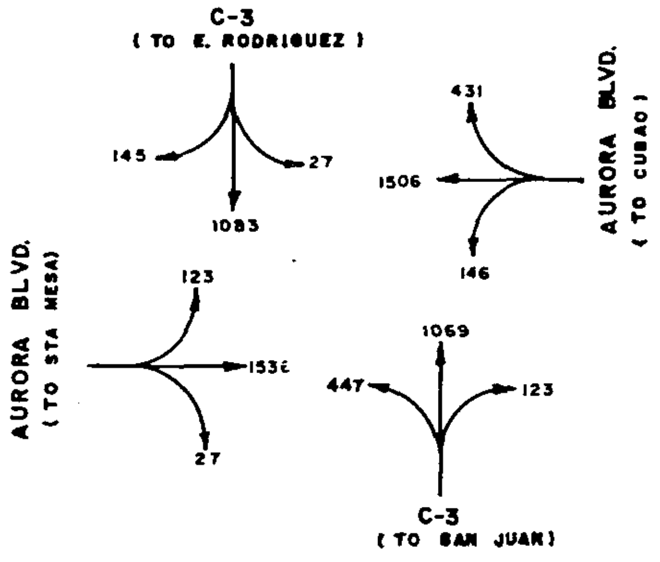
INTERSECTION TRAFFIC FLOW ANALYSIS (cont'd)

(c) C-3 - AURORA BLVD. INTERSECTION

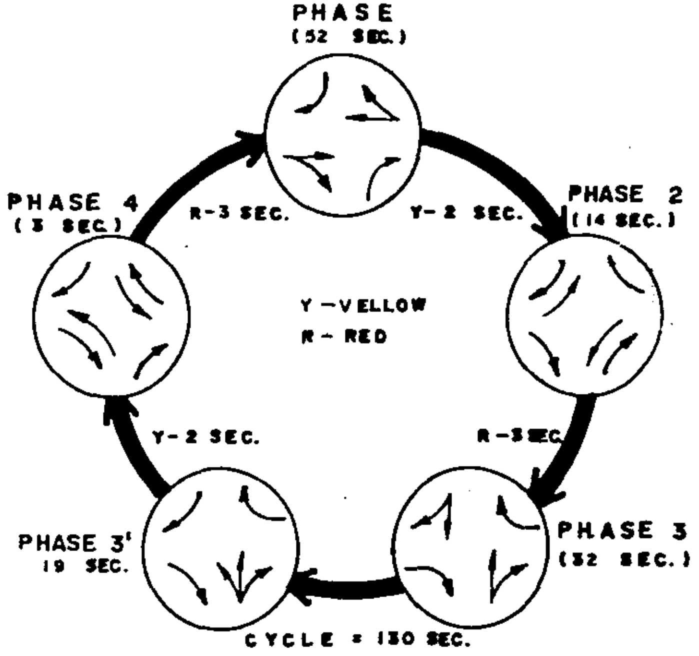
DIRECTION		PEAK HOUR TRAFFIC VOLUME	PHASE	NUMBER OF LANE	CAPACITY	RATIO OF VOLUME TO CAPACITY	GREEN TIME ALLOCATED (SEC.)
AURORA BLVD. (CUBAO)	T	1536	1	3	4620	0.335	52
	R	27	ANY				
	L	123	2	1	1433	0.086	14
AURORA BLVD. (STA. MESA)	T	1506	1	3	4620	*0.372	52
	R	431	ANY				
	L	146	2	1	1433	*0.102	14
C-3 (E. RODRIGUEZ)	T	1083	3	3	4620	0.250	32
	R	145	ANY				
	L	27	4	1	1433	0.019	22
C-3 (SAN JUAN)	T	1069	3+3'	3	4620	*0.230	32
	R	123	ANY				
	L	447	3'+4	2	2867	*0.155	22

* NOTE : T - THROUGH , R - RIGHT , L - LEFT

SATURATION DEGREE 0.859
(SUM UP THE FIGURES WITH *)



PEAK HOUR TRAFFIC FLOW



SIGNAL LIGHT PHASE

TABLE 4.1 - 2

INTERSECTION TRAFFIC FLOW ANALYSIS (cont'd)

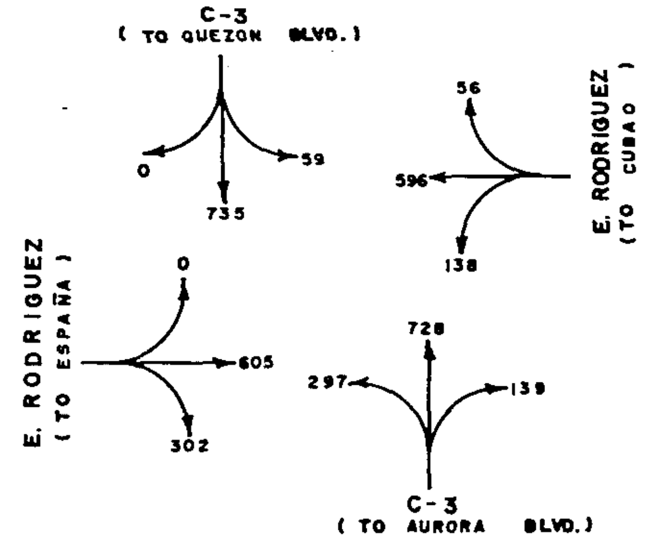
(d). C-3 - E. RODRIGUEZ INTERSECTION

DIRECTION		PEAK HOUR TRAFFIC VOLUME	PHASE	NUMBER OF LANE	CAPACITY	RATIO OF VOLUME TO CAPACITY	GREEN TIME ALLOCATED
C - 3 (QUEZON BLVD.)	T	735	1	3	4620	0.159	29
	R	0	ANY				
	L	59	2	1	1433	0.041	34
C - 3 (AURORA BLVD.)	T	728	1	3	4620	*0.173	29
	R	139	ANY				
	L	297	2	1	1433	*0.207	34
E. RODRIGUEZ (ESPAÑA)	T	605	3	2	3027	*0.250	41
	R	302	ANY				
	L	0	4	1		—	16
E. RODRIGUEZ (CUBAO)	T	596	3	2	3027	0.206	41
	R	56	ANY				
	L	138	4	1	1433	*0.096	16

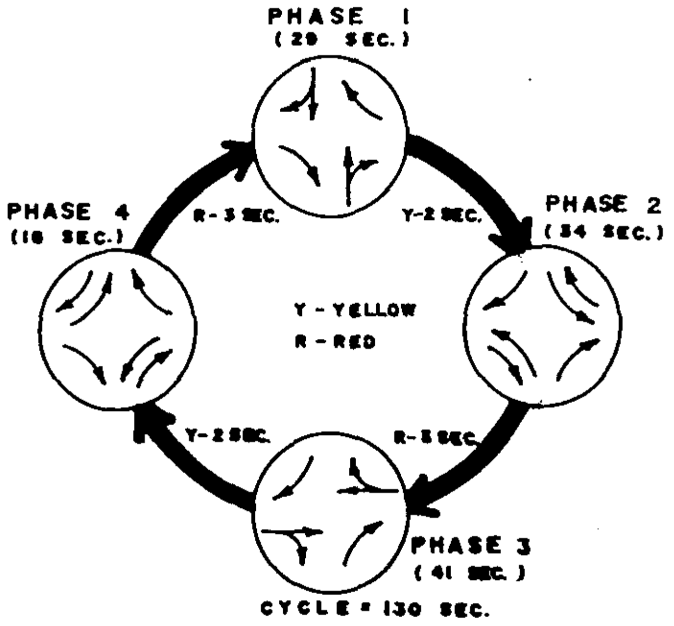
* NOTE : T - THROUGH , R - RIGHT , L - LEFT

SATURATION DEGREE 0.726

(SUM UP THE FIGURES WITH *)



PEAK HOUR TRAFFIC FLOW



SIGNAL LIGHT PHASE

TABLE 4.1-2

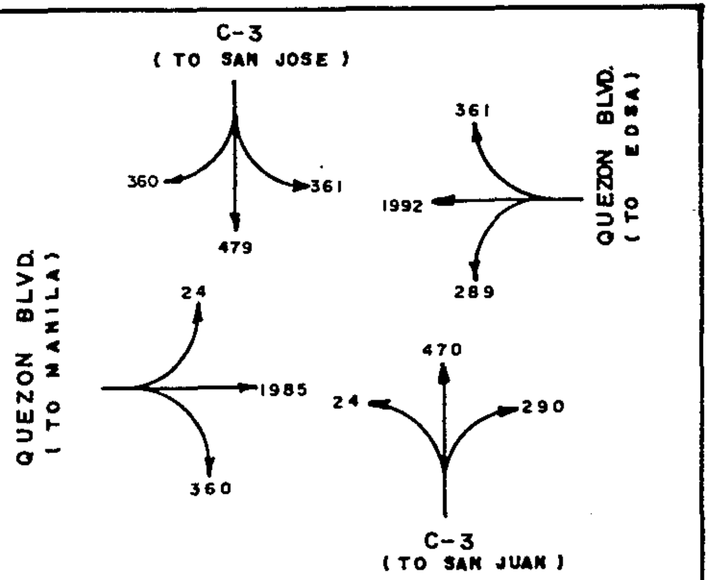
INTERSECTION TRAFFIC FLOW ANALYSIS (cont'd)

(e) C-3 – QUEZON BLVD. INTERSECTION

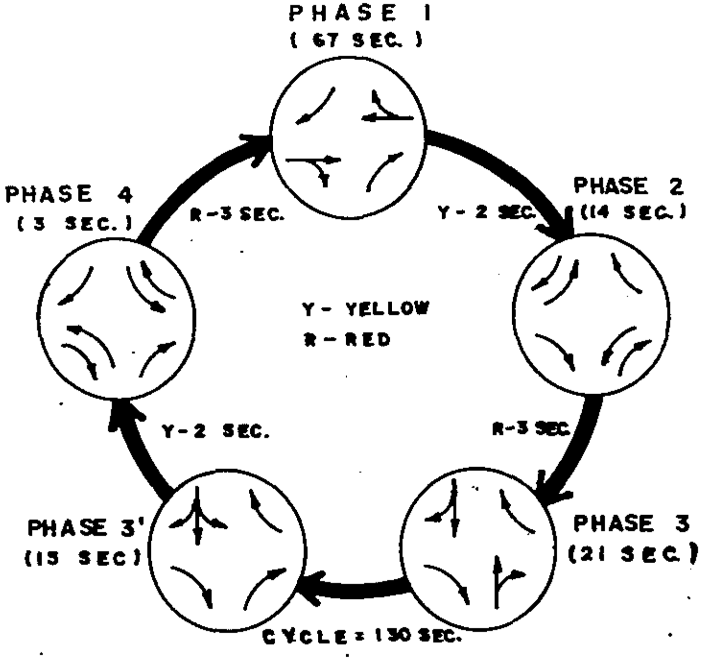
DIRECTION		PEAK HOUR TRAFFIC VOLUME	PHASE	NUMBER OF LANE	CAPACITY	RATIO OF VOLUME TO CAPACITY	GREEN TIME ALLOCATED (SEC.)
QUEZON BLVD. (EDSA)	T	1992	1	3	4620	*0.469	67
	R	361	ANY				
	L	289	2	2	2867	*0.101	14
QUEZON BLVD. (MANILA)	T	1985	1	3	4620	0.468	67
	R	360	ANY				
	L	24	2	1	1433	0.017	14
C-3 (SAN JOSE)	T	479	3+3'	3	4620	*0.142	21
	R	360	ANY				
	L	361	3'+4	2	2867	*0.125	18
C-3 (SAN JUAN)	T	470	3	3	4620	0.133	21
	R	290	ANY				
	L	24	4	1	1433	0.017	18

* NOTE : T - THROUGH , R - RIGHT , L - LEFT.

SATURATION DEGREE 0.837
(SUM UP THE FIGURES WITH *)



PEAK HOUR TRAFFIC FLOW



SIGNAL LIGHT PHASE

4.2.1 Capacity Analysis of Grade Separation Plan

For each intersection, two grade separation plans were discussed in which the through lanes were contemplated to be elevated for efficient channelling of traffic. The results of capacity analysis and the process on which the final plan was selected have been discussed in the text volume.

4.2.2 Benefit Calculation for Intersection Plan

Discussed here are the methods of figuring out the stop time and the number of vehicles forced to stop which are counted among the most fundamental parameters for the calculation of benefits incidental to grade separation.

(1) Waiting time (stop time) in a cycle

Notation

C : cycle, sec.

g_i: green time, sec.

q_i: traffic volume at approach i, by time zone, vehicles/sec.

y_i: degree of saturation at approach i, by time zone, q_i/s_i

s_i: saturated flow rate at approach i, by time zone, vehicles/sec.

T_W: waiting time by time zone, sec.

Derivation of waiting time at approach i

Assumption: Arrival flow is uniform.

(a) Number of vehicles per lane arriving during red indication

$$q_i\ (C - g_i) \quad \dots\dots\dots\dots\dots\dots \ (1)$$

(b) Time required to discharge (1)

$$q_i\ (C - g_i)/s_i = (C - g_i)\cdot(q_i/s_i) \ \dots\dots \ (2)$$

(c) Time required to discharge the queue accumulated

$$(C - g_i)\cdot(q_i/s_i)/(1 - (q_i/s_i)) \ \dots\dots\dots \ (3)$$

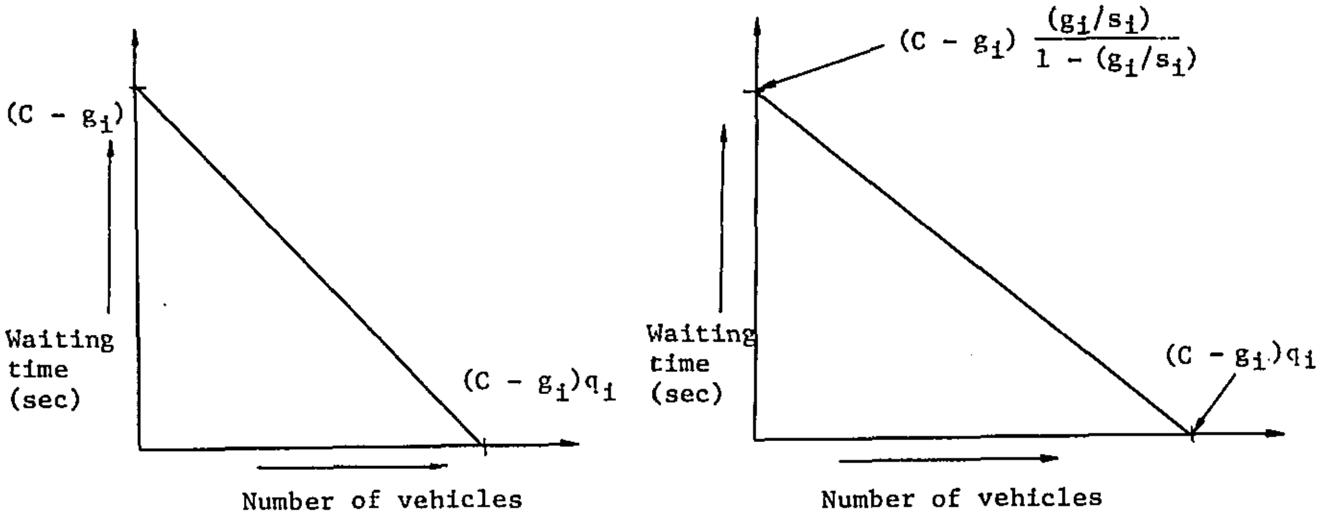
(d) Average waiting time per vehicle which is included in a queue

There are two kinds of waiting time:

i) Waiting time during red indication

ii) Waiting time while the queue is being discharged

It is possible to distribute the waiting time as shown in Fig. 4.2-1 because it has been assumed that the arrival flow is uniform.



Waiting time during red indication

Waiting time while queue is being discharged

Fig. 4.2-1 Distribution of Waiting Time

As a result, the total waiting time of the vehicles in a queue in a cycle is calculated as follows:

$$\frac{(C - g_i)^2}{2} q_i + \frac{(C - g_i)^2}{2} q_i \left(\frac{(q_i/s_i)}{1 - (q_i/s_i)} \right)$$

$$= \frac{(C - g_i)^2}{2(1 - y_i)} q_i \qquad \text{..........} \quad (4)$$

Finally, the average waiting time at approach i, in a cycle is expressed as follows:

$$\frac{(C - g_i)^2}{2C(1 - y_i)} \qquad \text{..........} \quad (5)$$

(2) The number of vehicles forced to stop in a cycle

The number of vehicles forced to stop at approach i, in a cycle was calculated using the following formula:

$$\frac{(C - g_i)}{C} q_i + \frac{(C - g_i)y_i}{C(1 - y_i)} q_i = \frac{C - g_i}{C} \left(\frac{1}{1 - y_i}\right) q_i$$

In the above equation, the first term on the lefthand member denotes the number of vehicles arriving during the red indication and the second term the number of vehicles arriving after the red indication and forming a queue.

S4 SOIL INVESTIGATION AND MATERIAL SURVEY

S4 SOIL INVESTIGATION AND MATERIAL SURVEY

TABLE OF CONTENTS

1. INTRODUCTION

In connection with the Feasibility Study on C-3 and R-4 and related roads project, the Soil and Material Survey was conducted during the period from May 15 to August 27, 1977. The site works were accomplished in association with a local firm, Development & Technology Consultants, Inc. (DTCI).

The proposed routes have an aggregate length of officially called 23 km. In some parts where several alternative alignments were being considered, the soil survey was conducted along the route which was considered to be most probable at that point of time. However, the alignment of R-4 supposed in this chapter has been shifted in the Fort Bonifacio area in the final proposal.

The soil survey work consists of:

- 25 boreholes ranging from 15 to 40 meters with a total depth of 500.5 meters at the sites of major structures
- 401 Standard Penetration Tests at the boreholes
- 18 CBR tests along the C-3 Route
- 11 shallow soundings with a portable cone penetrometer in swampy areas along the C-3 Route
- laboratory tests on undisturbed samples and on selected disturbed samples from the boreholes

The survey on the fill materials and aggregates was undertaken by reviewing the corresponding items of the R-10 Feasibility Study (1975), by collecting data from other projects in Metro Manila, and by supplemental sampling and laboratory testing.

Since the primary purpose of this survey for feasibility level studies is to obtain information on the subsurface conditions which could greatly affect the design and construction costs, the following activities were likewise conducted in order to make the data available for preliminary design:

- Compilation and presentation of obtained data
- Design CBR values of subgrade
- Seismicity
- Foundation studies for main structures and approach embankments

2. SOIL SURVEY

The field works were carried out basically in accordance with the Manual on Foundation Investigations (1967) published by American Association of State Highway Officials (AASHO). The specification for laboratory testing was based on the Interim Specifications and Methods of Sampling and Testing adopted by the American Association of State Highway and Transportation Officials (AASHTO) Subcommittee on Materials (1977).

2.1 BORING INVESTIGATION

The investigation along the 23 kilometers routes were carried out by drilling 25 boreholes at the sites shown in Figures 1. Depth of boreholes ranged from 15 to 40 meters with a total of 500.5 meters. The borings were advanced with two sets of drilling machines by using drilling mud on washable soft soils and by coring on soft rocks. Borehole designation, location, depth, sampling points, working periods and other data are shown in Appendix 1.

The boreholes were located on major intersections, river bridge sites and in swampy areas. As much as possible, the locations of boreholes were selected in public spaces. 23 boreholes were drilled on shore and two off shore boreholes were located in the Pasig River along the C-3 Route. The offshore holes were drilled with the drill rig set-up on a bamboo raft.

24 undisturbed samples were taken with Shelby tubes from soft clayey soils. 401 Standard Penetration Tests by split samplers were carried out with triggering hook device basically at one meter intervals. The undisturbed Shelby samples were sealed with paraffin wax at each end and transferred to the laboratory. The undisturbed samples were bagged and likewise transferred to the laboratory. From soft rocks, locally called "Adobe", continuous core samples were taken and placed in core boxes and transferred to the laboratory. The logs of each boring are presented in Appendices 2.1 to 2.25. Representative portions of disturbed, undisturbed, and core samples, placed in tightly sealed plastic bottles, are kept in DTCI office at the site for future reference.

2.2 LABORATORY INVESTIGATION

Laboratory Investigations were performed to determine in-place moisture and density, soil classifications and strength characteristics. Soil classification tests such as specific gravity, Atterberg limit, grain size distribution, were performed on selected split samples and all Shelby tube samples. Unconfined compression tests and consolidation tests were also performed on selected Shelby tube samples to determine the strength characteristics. On selected core samples from soft rocks, unconfined compression, moisture and specific gravity tests were carried out.

Summaries of test results are shown in Appendices 3.1 to 3.10. Details of each test result are kept at JOC office in Tokyo and will be forwarded if requested.

2.3 SHALLOW SOUNDING

A total number of 11 cone tests were carried out with a portable static cone penetrometer to depths of around one meter at selected points in swampy areas along the C-3 Route. The main purpose of these tests is to estimate CBR values of the soft surface soil with around one meter thickness based on measured cone point resistance.

The tests were carried out by pushing a cone with a top angle of 30° and 6.45 cm^2 in base area at the end of a $\frac{1}{2}$" diameter rod directly into the ground and reading an automatically recorded cone point resistance. The test results are presented in Appendix 4.

2.4 CBR TESTING

Undisturbed samplings using CBR molds and a coring machine were performed to collect specimens for determination of in-place CBR values along the C-3 Route. Sampling depth ranged from 20 to 60 cm below existing ground surface. The samples were first trimmed down in standard size and soaked in water for four days with a surcharge weight of two kg. After soaking, penetration tests were performed. Classification and density tests were also made. The test results are summarized in Appendix 5.

3. MATERIAL SURVEY

3.1 EMBANKMENT MATERIAL

Most of the material sources for common borrow presented in the R-10 Feasibility Study Report which was conducted in 1975 and presented below, are located within an economic hauling radius from our proposed routes.

Table 2.4.1 Results of Tests for Embankment Materials (derived from R-10 report)

Sample Location	Maximum Dry Density (g/cm^3)	Optimum Water Content (%)	CBR (Soaked) (%).
Barrio Capre	1.59	15.6	3.8
Novaliches	1.64	15.0	4.2
Balara	1.59	14.6	3.6
Navotas	1.71	12.5	4.7
C-4 Route	1.56	14.9	3.3
C-3 Route	1.64	12.0	4.2
Cardona	1.56	14.4	3.1

The R-10 project is still in a detailed design stage, and these sources are still available for other projects.

Quantities of common borrow for new embankments are not required so much for the project roads. Hence, Balara source designated MS-13 in the R-10 Study Report is recommended for our project mainly bacause its transport distance to the proposed routes is the shortest and the place is now opened for DPH's use as a common borrow site.

Five soil samples were collected from this source for testing: Sample 1 from the existing quarry area, Samples 2 and 3 from a point 200 meters S 70°W of the quarry area, and Samples 4 and 5 from a point 150 meters S 15°W. These samples are yellowish brown coloured fragments of silty tuff.

All samples obtained were subjected to soil classification tests. CBR tests on Samples 1 were performed in accordance with AASHTO at optimum moisture content. Maximum dry density at optimum moisture content of 25% on Sample 1 is 1.33 g/cc. On all the other samples, CBR tests were performed at natural moisture contents under varying number of blows for compaction. Results of test are summarized below.

No.	SMC (%)	Atterberg Limit		#200 passing	Soil Classification (AASHO)	CBR (%) Number of blows		
		LL(%)	PL(%)			20	40	65
1	30.0	50	14	52	A-7-5 (6)	10.0	15.9	25.3
2	34.9	76	58	50	A-7-5(11)	7.5	13.3	24.8
3	50.1	85	46	57	A-7-5(15)	1.5	8.1	14.4
4	33.6	51	19	83	A-7-5(14)	5.0	8.5	8.9
5	42.8	67	23	58	A-7-5(15)	8.5	15.0	26.4

Legend : NMC : Natural Moisture Content
LL : Liquid Limit, PL : Plastic Limit

Above data show that the materials from this source are not so suitable but can be useful for embankment material.

3.2 OTHER RAW MATERIALS

Within Metro Manila Area, raw construction materials such as aggregates, base coarse, and crushed stones, can be produced from commercial plants whose locations are shown in Figure 3.

Qualities of those materials were not tested for our project, but test data from producers were collected and shown in Tables 1.1 to 1.2. Crushed stones will come from the same sources as coarse gravels, so that their physical qualities will be the same.

Unit costs of those materials at plants are also shown in the same Tables, and delivery charge of 19.00 per ton within Metro Manila Area will be added to the said costs.

4. GEOLOGY

4.1 TOPOGRAPHY

4.1.1 Study Area

As shown in Figure 1, the proposed Radial and Circumferential Road Complex is located in Metro Manila which we call the Study Area.

The topography within the Study Area is divided into two general land forms; one is the lowland comprising the Manila deltaic plain and the Marikina flood plain; and the upland which comprises the remaining areas. The lowland and the upland are underlain by recent deposits and tuff (Adobe), respectively.

On the west of the Study Area, the deltaic plain of Metro Manila abuts against Manila Bay. The ground elevation within this plain is generally less than five meters above sea level. The ground slopes gently seawards. Drainage characteristics are inherently poor and the area is usually subjected to periodic floodings.

Further east, north, and southeast of Manila, the geomorphological development is characteristically subdued to rolling. Made up dominantly of broadly undulating hills and valleys, the ground elevation averages from 10 to 30 meters above sea level attaining a maximum of 50 to 70 meters in some areas in Quezon City.

East of Quezon City is a topographically subdued valley which trends roughly north-south, from north of Marikina to as far south as Pasig. This valley known as the Marikina Valley is a flood plain and is interpreted as a graben, and is markedly separated from the adjoining topographically prominent area towards the west by a 30 to 40 meter high escarpment. The divide is identified as the west Marikina fault which is traceable for 80 kms along an almost north-south following the general trend of the valley which exists to the south up to and beyond Laguna de Bay. Laguna de Bay is a lake traversed by the same graben that caused the development of the Marikina River. Laguna Lake covers a huge area and is believed by some local geologists to be an extinct collapsed volcanic crater (caldera).

4.1.2 Proposed Route

Topographical changes along the Study Routes are presented in Figures 1 & 2. Circumferential Road C-3 traverses the municipal districts of Makati, Mandaluyong, San Juan and Caloocan.
Along the Route, the topographic development between Makati and San Juan is essentially flat with minor ground undulations. Its ground elevation varies 2 to 5 meters above sea level, except near Mandaluyong with a hill of 17 meters in elevation.
In this area, Pasig River and its tributary San Juan River flow meandering. Along the Route from San Juan to Caloocan and Balintawak the topographic development is undulating and its ground elevations are more than 4 meters with peaks in near A. Bonifacio (20 meters) along the main C-3 Route and in San Jose (22 meters) along the Subdivision of C-3 Route.

Radial Road R-4 traverses Guadalupe and Fort Bonifacio and Buting. The Route passes through relatively high terrains characterized by the prevalence of natural and man-made escarpments. The escarpments are cliffy and steep to vertical. The ground elevation rises from 15 to more than 30 meters above sea level, except near the Study Route terminal at Buting with 4 meters in elevation. Despite of prominent elevation, the ridge tops are generally of a conformable skyline configuration.

The Route alignment proposed for Circumferential Road C-5 traverses the district of Pasig and proceeds northwards along E. Rodriguez Avenue towards Quezon City, thence along the Blue Ridge area until finally connecting with Katipunan Avenue. The Study Route is divided into the southern segment (Pasig) and the northern segment (Blue Ridge). The alignments of each section follow approximately the trace of the Marikina fault. The ground elevation of the southern segment is flat with 4 meters above sea level, except in the Pasig River bed which was dissected by the River. The alignment of the northern segment passes the escarpment which separates the Marikina Valley and the up-faulted tuff bedrocks. Hence, the topographic changes along the Route are greatly undulating although the ridge top is flat. The elevation along the Route varies from 10 to 50 meters above sea level.

4.2 STRATIGRAPHY

4.2.1 Study Area

The low land within the Study Area was developed by extensive alluviation of Pasig River and its tributaries. The alluvial plains which form mainly the low land are considered to have developed according to following processes. During the last ice age at a time of lowered sea level, Pasig River and its tributaries dissected their valleys downward to that level. Then, these valleys were drowned in consequence of the post glacial rise of sea level and gradually filled with the sediments supplied from the loaded rivers and coastal currents. At last these valleys which were completely aggradated with inland sea marine deposits and fluvial deposits changed into alluvial plains, such as the flood plain and delta.

The recent deposits are generally formed with fluvial deposits as the surface layers and under these layers marine sediments commonly exist. Furthermore, the layers in the valley bottom are fluvial in origin and were deposited during the regression stage before the succeeding transgression to the early stage of the postglacial transgression. The sequence of the deposits in the drowned valleys are in general as follows,

Fluvial ——→ Marine ——→ Fluvial

In case of the Manila deltaic plain, the recent deposits are generally thick within the coastal area of Manila Bay and thin out eastward in the vicinity of Makati, Sta Mesa, and Caloocan. At the coastal zone, it is estimated that the recent soils could be as much as 70 meters thick.

At the alluvial plains, the underlying bed rocks are generally well consolicated and cemented tuff which is locally known as "Guadalupe tuff" or "Adobe" whose outcrops are easily observed at the up land areas. These deposits have the hardness of low strength rock as a whole and presented to be of Late Tertiary to early Quaternary. During this period, violent volcanic outburst occurred intermittently and during the intervening periods of quiescence the previously laid volcanic materials were redeposited subaqueously.

"Intertongueing" between newly-laid tuff beds, on one hand, and transported sediments on the other, is a characteristic feature. Three varietal types are usually distinguished, namely; shaly-tuff, sandy-tuff and pebbly-tuff.

The typical section of the Guadalupe tuff formation is exposed at the Guadalupe Quarry close along the R-4 Route. The rock succession consists of thick beds of shaly tuff, although locally they may be thinly bedded and slabby with minor intercallations of sandy tuff. The formation is generally horizontal to low dipping, regional dips are generally oriented to the west at 8° to 15°.

Within the 20 meter precipice, three thin horizons of highly fossilized soils are included. Their thickness is variable, however ranging from less than one meter to two meters at most. They are generally bleached or light brown coloured, and comparatively very soft, porous and friable. They are potentially erodible. The actual thickness of the Guadalupe formation is unknown. It is reported that drilling for water wells at the several sites within the Study Area failed to bottom the tuff formation at depths of over 450 meters.

4.2.2 Proposed Route

The generalized soil profiles along the proposed Routes, C-3, R-4 and C-5, are shown in Figure 2. Detailed logs of individual boreholes are given in Appendices 2.1 to 2.25.

It is evident from those drawings that there is an abrupt change of depositions at the limited stretches along Pasig River and its tributaries where burried valleys exist, whereas the remaining portions of the Routes consist of over-consolidated and cemented tuff formations although with weathered tuff at the surface.

In the burried valleys, recent deposits are composed of interlayerings of soft and generally unconsolidated clayey soils and loose sandy soils with occasional gravels. Commonly admixed with appreciable amount of sea shells at some depths of the burried valleys except of San Juan River, these deposits are identified to be marine although the upper layers are fluvial.

At the burried valley of San Juan, the deposits consist mainly of uniform and organic soft clay without any sea shells. This indicates that the environmental conditions of depositions were very quiet and swampy unlike in other river sites.

At the swampy area in Mandaluyong, the adjoining area of Pasig River Channel which is periodically flooded, the burried valley similiar with the present Pasig River is also uncovered. This indicates that the old Pasig River might have once migrated laterally under the present wide flood plain.

5. DATA ANALYSIS AND RECOMMENDATIONS

5.1 FOUNDATION PROBLEMS

The soil survey indicates that the tuff formation obtaining along the proposed Routes, except at the sites crossing the rivers where the thick recent soils are encountered, will provide structurally adequate foundation for all structures considered in this project. Although in a detailed design stage it will be necessary to conduct additional and supplementary soil investigation regarding the existence of erodible fossilized soils and swelling characteristics of the tuff formation, especially of the shaly tuff. The characteristics of the fossilized soils are like a surface clayey soil and easily distinguished at the outcrops, being strongly bleached and to a certain extent tinted by rusty hues.

Unconfined compressive strength of the tuff formation is generally over 20 kg/cm^2. Excavation, therefore, might require the use of mechanical equipment with ripping. Shaly tuff might be apt to be weathered and loses its strength easily when exposed. So in case of placing the spread foundation directly on this stratum or exposed as a cutting portion, its weathering characteristics and/or slope protection should be investigated.

Regarding the Marikina fault which passes approximately along C-5 Route and the proposed bridge site of Pasig River, it is not reported that any detail study has been conducted to determine whether major earthquakes affecting Metro Manila have caused appreciable displacement of the fault or not. In other words, it is not definitely established that this fault is active or not. In the absence of these information and data the alignment of C-5 Route crossing the river is tentatively assumed as it is for preliminary design in the feasibility study stage. At the adjoining east side, the Napindan Hydraulic Control Structure Project is now on-going and the localization of the fault is under study at the site. After the data become available the alignment could be restudied.

Because of the recent deposits of soft clayey soils and/or loose sandy soils filled in the burried valleys along the Route, there exist the problems on whether the subsurface soils can safely support the load of the approach embankments to the river bridges without causing excessive differential settlements of the pavement surface; and on whether they can support the foundations of the river bridges during an earthquake.

In order to solve the said problems, the data analysis and recommendations concerning foundation support and aseismatic design are presented below. Also, from the soil survey, design CBR values of the subgrade section along the proposed Routes are recommended.

5.2 IMPROVEMENT OF SOFT GROUND

The procedure generally adopted for the design of earth structures which will be constructed on soft ground is presented in Figure 4. It indicates that the values of Factor of Safety against subground failure during construction and post construction residual settlement should be decided as a design standard. It is recommended that these values should be more than 1.25 as Factor of Safety and less than 5 cm as differential post construction settlement between approach embankments and adjacent abutments.

The properties of subsurface soils encountered at each borehole conducted in the alluvial plains are presented in Appendices 3.1 to 3.10. All results of consolidation tests are summarized in Appendix 6. Those laboratory data and foundation analysis presented below indicate that the subsurface soils on which approach embankments will rest are extremely soft at San Juan River in static condition compared with the other river sites.

Route	River Site	Embankment Load(t/m^2)	Estimated Settlement(cm)	Estimated Safety Factor
C-3	Pasig (Left Bank)	5	18	2.2
		10	32	1.1
		20	51	0.6
C-3	Pasig (Right Bank)	5	13	3.3
		10	24	1.7
		20	38	0.8
C-3	San Juan (Right Bank)	5	60	1.7
		10	116	0.8
		20	203	0.4
C-5	Pasig (Right Bank)	5	Negligible	Safe
		10		
		20		

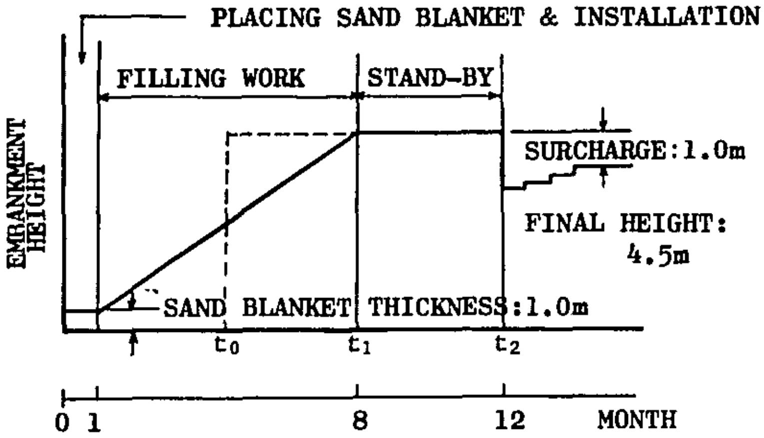
(Note: In case of Instantaneous Loading of Embankment)

The relationship between embankment loads and those estimated values is presented in Figure 5.

If the approach embankment height is planned to be 4.5 m and the unit weight of embankment material is conservatively assumed as 1.8 ton per cu. meter, the embankment load will be 8 ton per sq. meter. The settlement will be estimated by interpolation to be 20 to 25 cm at the Pasig River site along C-3 Route and 95 cm at the San Juan River site. The embankment at the Pasig River site is believed safe in an instantaneous loading condition, whereas the embankment at the San Juan River site is estimated to be critical because of Factor of Safety being 1.0.

In order to decrease the post construction settlement at the Pasig River site to be less than 5 cm, it is proposed to take one year of stand-by period after finishing filling work until comencement of paving work. It is also proposed to overestimate the quantity of embankment material as 5% of embankment volume for settlement amount and to estimate 50 cm thick of sand mat placed before filling common soil.

In case of the San Juan River site, it is proposed to adapt a combination of surcharging and vertical drain work as an acceleration means of settlement. Vertical drain work is also effective to increase shearing strength of the subsoils. After calculating several combinations of surcharging amounts and spacings of sand drains, the following scheme of improvement work is recommended. Time versus settlement curves with a selected combination of surcharging and sand drain is presented in Figure 6.



SAND DRAIN WORK:
DIAMETER: 0.40m
SPACING : 2.0m SQUARE
LENGTH : 12m BELOW G.L.

Along C-3 Route, the swampy areas exist in Mandaluyong and in Bonifacio Subdivision. The results of cone penetrometer testing at the swampy areas are summarized in Appendix 4. Mandaluyong, the area is considered to be the remnant portion of the trace of previous Pasig River. The ground elevation varies from 1 to 2 meter above sea level. Most part of the area below 2.0 meter above sea level is always submerged in water in rainy seasons. So, in case of the type of the road structure being determined to be an embankment, the proposed grade will be around 2.5 meter above mean sea level. Because of the variable thickness of an embankment height, it is apt to cause the lateral flow of the weak surface soil. It is recommended to replace the surface soil up to the level of one meter above mean sea level with coarse sand. At Bonifacio Subdivision the surface soil is less than 50 cm thick and is extremely very weak, so replacement with coarse sand is also recommended.

5.3 DESIGN CBR VALUES

The CBR value of the subgrade soil used for the thickness design of pavement is called the design CBR value and expressed as the average CBR value of 1 m thick layers below the subgrade surface.

Based from the data on the measured CBR values along C-3 Route which are presented in Figure 1 and Appendix 5, cone penetrometer testing results presented in Appendix 4 and other laboratory testing, the following CBR values in Feasibility Study Stage are recommended:

TERRAIN	SUBSOIL	GRADE BELOW GROUND SURFACE (m)	DESIGN CBR(%)	* DESIGN K30(kg/cm^3)
Low Land: Alluvial Plain	Recent Deposits	0 ∿ 0.5	1	-
		0.5 ∿	2.5	4
Up Land : Hilly Area	Tuff Formation	0 ∿ 1.0	5	8
		1.0 ∿	10	12

* In case of adopting Portland Concrete Pavement

Note: Design CBR and K_{30} for embankment material are 2.5% and 4 kg/cm^3, respectively.

5.4 SEISMICITY

Along C-3 and C-5 Routes three major river bridges are proposed. Two bridges are along C-3 Route, one spanning Pasig River and another over San Juan River. Along C-5 Route, one bridge is proposed crossing Pasig River at Bagong Ilog.

Detailed geological profiles at each bridge site are presented in Appendices 7.1 to 7.3. The soil testing results are shown in Appendices 3.1, 3.2, 3.5, 3.8 and 3.9.

As well known, like in Japan Islands, the Philippines lies along the Circum-Pacific Seismic Zone which is one of the two great earthquake belts in the world. Those Seismic Zones are presented in Appendix 8. Major seismic activities in the Philippines are presented in Figure 7 and are associated with crustal movements along major structural linearments, particularly the Philippine fault zone, the Philippine trench and the Luzon trench. Occurrences of earthquakes along these structures almost always affect the Metro Manila area. The earthquake on March 19, 1977 which had recently affected Manila had an intensity of 6.9 (Ritcher Scale) with epicenter in the sea off Cagayan province 400 km north-east or Metro Manila. Several buildings in Manila suffered cracked walls and broken windows. Other significant earthquakes with magnitude of greater than 7 recorded for the last 77 years are shown in the Figure 7. Five earthquakes among them occured within the range of 200 km from Metro Manila.

In order to evaluate the earthquake forces applying the river bridge structures and estimate bearing capacities of the foundation soils, the major procedure shown in Figure 8 was taken for this study. However in this soil survey, any dynamic strength parameters were not investigated, so the procedure adopted is a conservative one. And in the detailed design stage those strength parameters should be investigated.

For the purpose of estimating the forces of earthquakes at the River Sites, the following earthquakes were considered:

Design Earthquake	Date	Magnitude	Epicenter	Approximate Distance, χ
1	1901, Dec.	7.8	$14^N 122^E$	120 km
2	1937, Aug.	7.5	$14.5^N 21.5^E$	70
3	1942, Apr.	7.9	$13.5^N 121^E$	100

Maximum surface acceleration, α_{max}, at proposed sites are estimated from the following empirical formula proposed by Dr. KANAI and presented below. (Improved Empirical Formula for the Characteristics of Strong Earthquake Motions; Proceedings of Japan Earthquake Engineering Symposium, Tokyo, Japan, October 1966)

$$\alpha_{max} = \frac{5 \times 10^{0.61M-(1.66+\frac{3.6}{\chi}) \log_{10} x + (0.167-\frac{1.83}{\chi})}}{\sqrt{T_g}} \quad \text{(gals)}$$

where, M : Magnitude of earthquake
χ : Length from the seismic center (km)
Tg: Predominant Period of the Ground (sec)

Design Earthquake	Estimated α_{max} (gals)	
	Pasig River	San Juan River
1	137	103
2	198	149
3	207	156

Notes: Values of Tg were estimated from the following formula

$$Tg = \frac{4H}{Vs}$$

Here, Vs: Shear Wave Velocity, m/sec
140 m/sec: at Pasig River Site
32 m/sec: at San Juan River Site

H : Thickness of Recent Deposits, m
30 m: at Pasig River Site
12 m: at San Juan River Site

According to National Structural Code for Building (The Association of Structural Engineering of the Philippines, 1977), design horizontal seismic coefficient, Kh will range from 0.17 to 0.24 on an assumption of the fundamental period of vibration of the structure constructed on poor ground being 0.2 to 0.5 second.

Also, according to Aseismatic Design Manual for Substructure of Bridge in Japan (Japan Road Association, 1972), Kh values of the Pasig River and San Juan River Sites will be 0.24 and 0.20, respectively, on an assumption of the site subsurface conditions.

Hence, values of estimated maximum surface accelaration α_{max} at each bridge site are believed appropriate, compared to estimated horizontal seismic coefficient Kh. Design values of α_{max} in this stage are recommended to be 200 gal. at the Pasig River site and 150 gal. at the San Juan River site.

However, any movement of the Marikina fault which might be triggered off by a major earthquake may occasion failure of the foundations directly locating the fault. It is, therefore, important that detailed investigation and study be conducted to ascertain the nature and the present condition of the fault structure before deciding the definite alignment.

5.5 FOUNDATION FOR RIVER BRIDGES

5.5.1 Estimation of Liquefaction Potentiality Zone

When saturated sands are subjected to vibratory loads, liquefaction occurs and volume tends to decrease. If drainage will not occur, there can be no volume change, and, therefore, causes an increase in pore water pressure. When the increase is sufficient to equal the overburden pressure, effective stress is reduced to zero, and sand loses its strength and behaves as a liquid. The liquefaction potentialities of the subground at both Pasig River sites along C-3 and C-5 Routes where thick loose sandy soils are encountered were estimated by the conventional simplified procedure proposed by Seed and Idriss.
(cf. Simplified Procedure for Evaluating Soil Liquefaction Potential, Journal of S.M.F.D., Proc. of A.S.C.E., Sept. 1971)

Assuming a maximum surface accelerating α_{max} of 200 gal., the estimated liquefaction zones are presented below:

Bridge Site	Location	Boring	Estimated Liquefaction Zone Depth (m)	Estimated Liquefaction Zone Soil Type
Pasig River along C-3 Route	Left Bank	C3-BH3	GL.-10 ∿ -16	Silty Sand
	River Bed	C3-BH3-2	GL.- 0 ∿ - 7	Sandy Silt & Silty Sand
	River Bed	C3-BH3-1	GL.- 0 ∿ - 3	Silty Sand
	Right Bank	C3-BH4	GL.- 4 ∿ - 7	Silty Sand
Pasig River along C-5 Route	Right Bank	C5-BH2	GL.-19 ∿ -24	Fine to Medium Grained Sand

5.5.2 Recommendation for Foundations

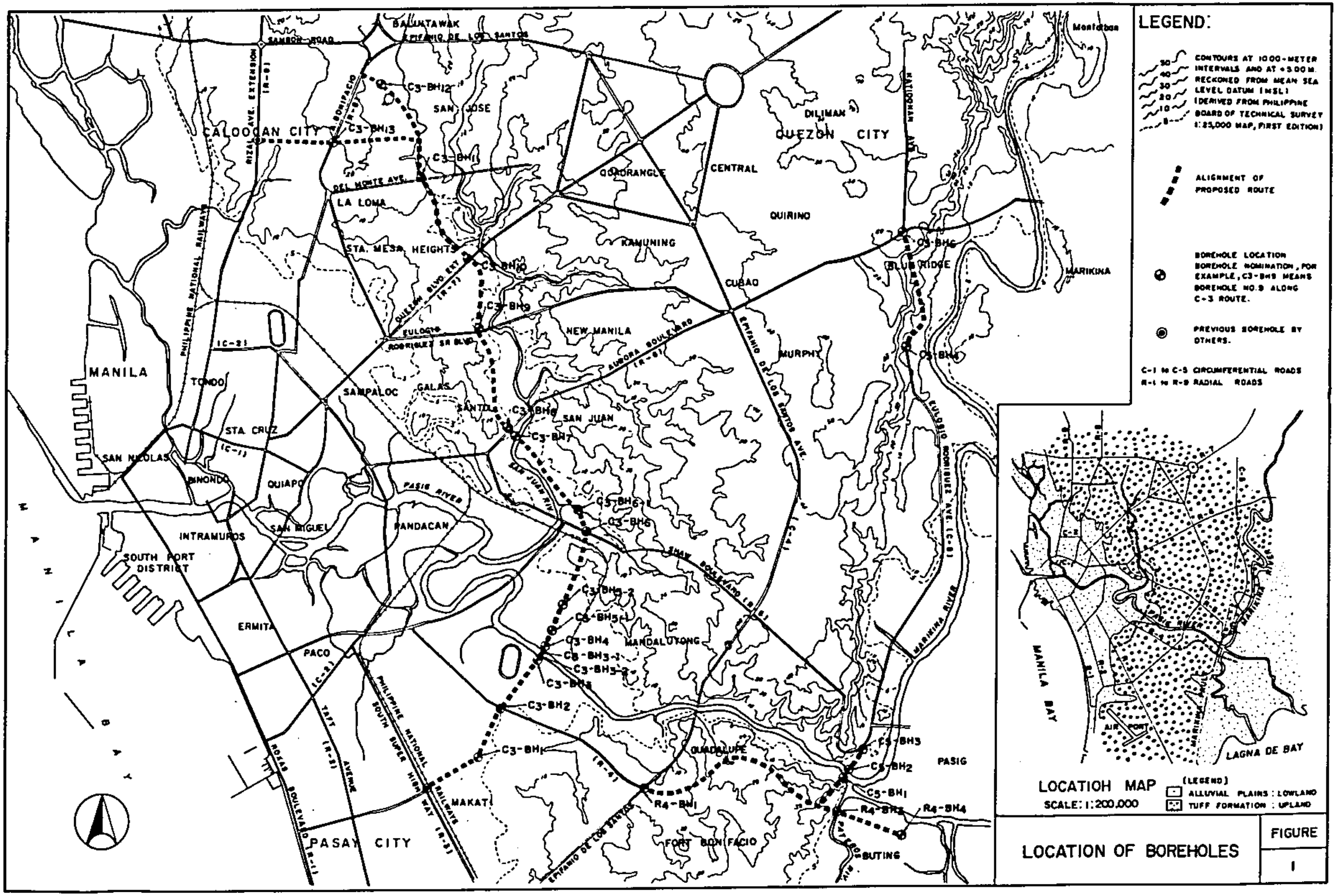
Based on the field and laboratory testing, the static design values of strength parameters are presented in Figure 9. In the design of horizontal resistance, the liquefaction potential zone should be neglected at the occurrences of earthquakes. To prevent possible liquefaction, the zones may be densified, however, these alternatives may be more expensive than the foundations designed on an assumption of neglecting the liquefaction potentiality zones.

In selecting a suitable foundation type at each river bridge site, the following conditions are to be taken into consideration: Construction materials and equipment could be manufactured and be available in Philippines. The recommendations of foundation for each river bridge are tabulated below.

BRIDGE SITE	LOCATION OF DESIGN SUBSTRUCTURE	RECOMMENDED FOUNDATION TYPE	MAIN BEARING LAYER
Pasig River along C-3 Route	Abutment (Left)	Steel Pipe Pile	Basal Gravel
	Piers	Open Caisson or Steel Pipe Pile Caisson	Tuff Formation
	Abutment (Right)	Steel Pipe Pile or Open Caisson	Tuff Formation
San Juan River	Abutment (Right)	Steel Pipe Pile or Reverse Circulation Pile	Tuff Formation
Pasig River along C-5 Route	Abutment (Left)	Spread Foundation	Tuff Formation
	Abutment (Right)	Steel Pipe Pile or Reverse Circulation Pile	Basal Gravel

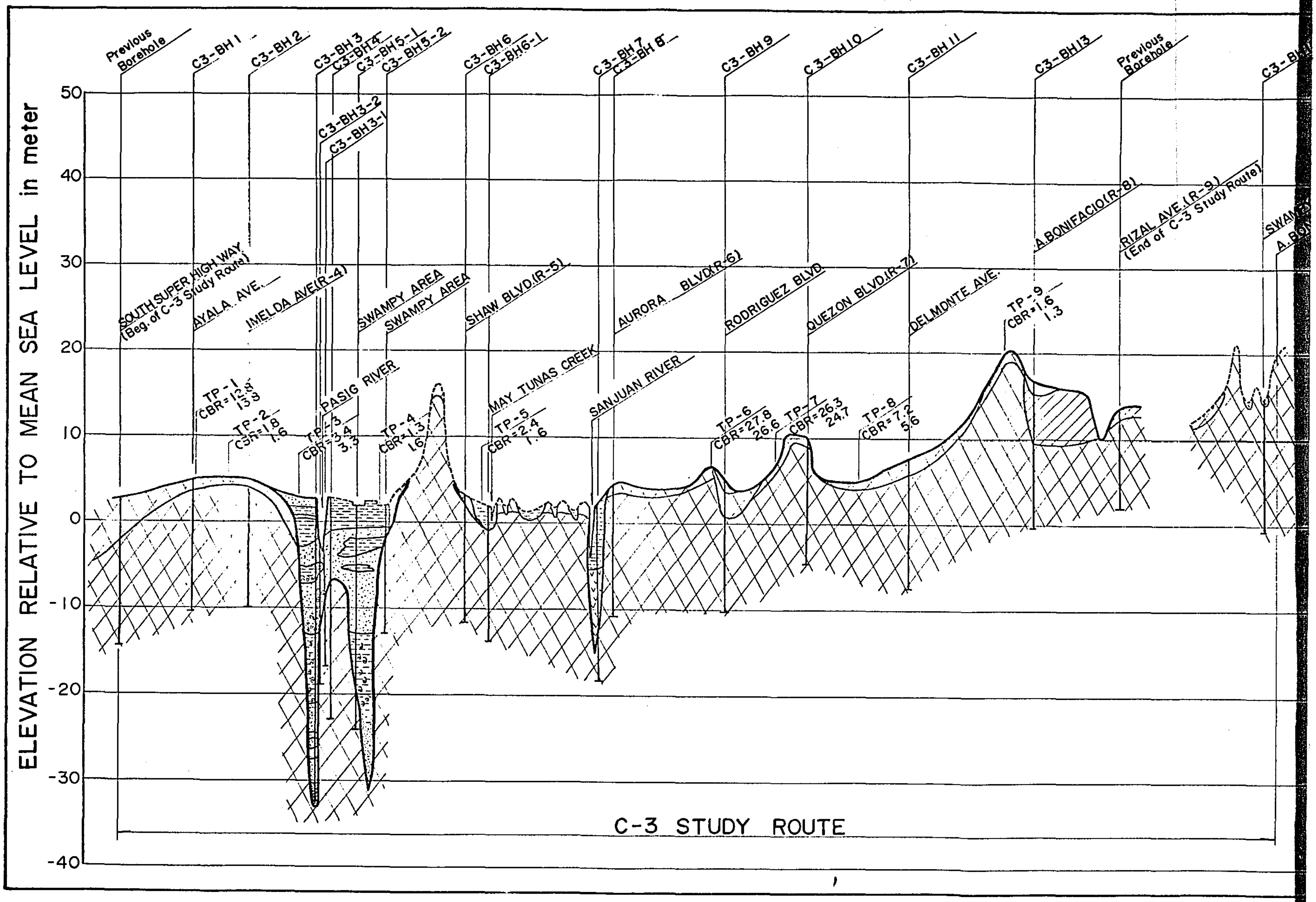
Note: End Bearing Capacities are recommended as follows.

FOUNDATION TYPE	ALLOWABLE BEARING CAPACITY OF MAIN BEARING LAYER
Steel Pipe Pile (ϕ800mm)	120 ton/pile
Reverse Circulation Pile (ϕ1,200mm)	200 ton/pile
Open or Steel Pipe Pile Caisson	80 ton/m^2
Spread Foundation	50 ton/m^2

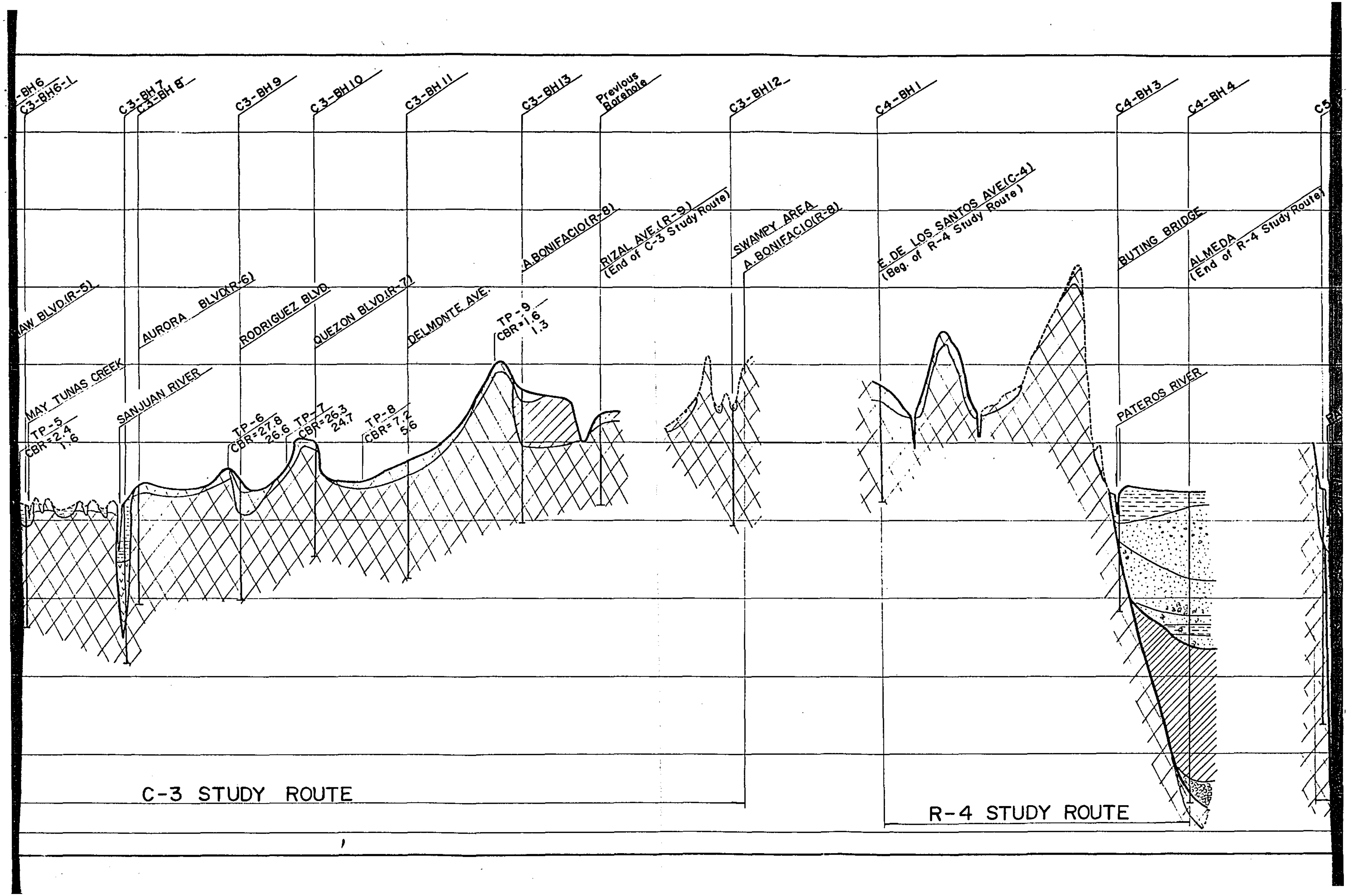


LOCATION OF BOREHOLES

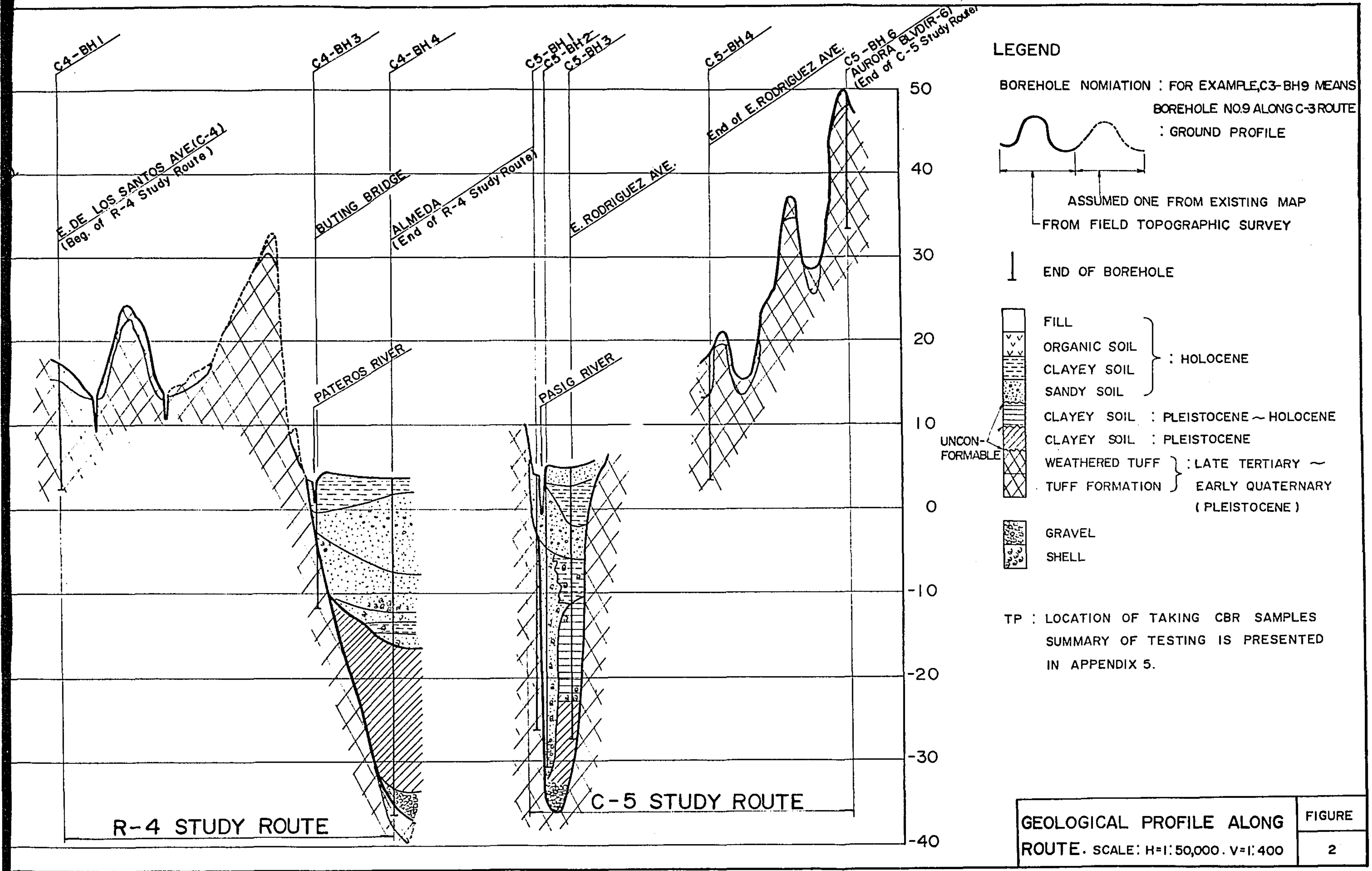
FIGURE 1



ELEVATION RELATIVE TO MEAN SEA LEVEL in meter
50
40
30
20
10
0
-10
-20
-30
-40
Previous Borehole
C3-BH1
C3-BH2
C3-BH3
C3-BH4
C3-BH5-1
C3-BH5-2
C3-BH3-2
C3-BH3-1
C3-BH6
C3-BH6-1
C3-BH7
C3-BH8
C3-BH9
C3-BH10
C3-BH11
C3-BH13
Previous Borehole
C3-BH
SOUTH SUPER HIGH WAY (Beg. of C-3 Study Route)
AYALA AVE.
IMELDA AVE(R-4)
SWAMPY AREA
SWAMPY AREA
SHAW BLVD.(R-5)
AURORA BLVD(R-6)
RODRIGUEZ BLVD.
QUEZON BLVD.(R-7)
DELMONTE AVE.
A.BONIFACIO(R-8)
RIZAL AVE.(R-9) (End of C-3 Study Route)
SWAM
A.BON
PASIG RIVER
MAY TUNAS CREEK
SANJUAN RIVER
TP-1 CBR=12.8 13.8
TP-2 CBR=1.8 1.6
TP-3 CBR=3.4 3.3
TP-4 CBR=1.3 1.6
TP-5 CBR=2.4 1.6
TP-6 CBR=27.8 26.6
TP-7 CBR=26.3 24.7
TP-8 CBR=7.2 5.6
TP-9 CBR=1.6 1.3
C-3 STUDY ROUTE

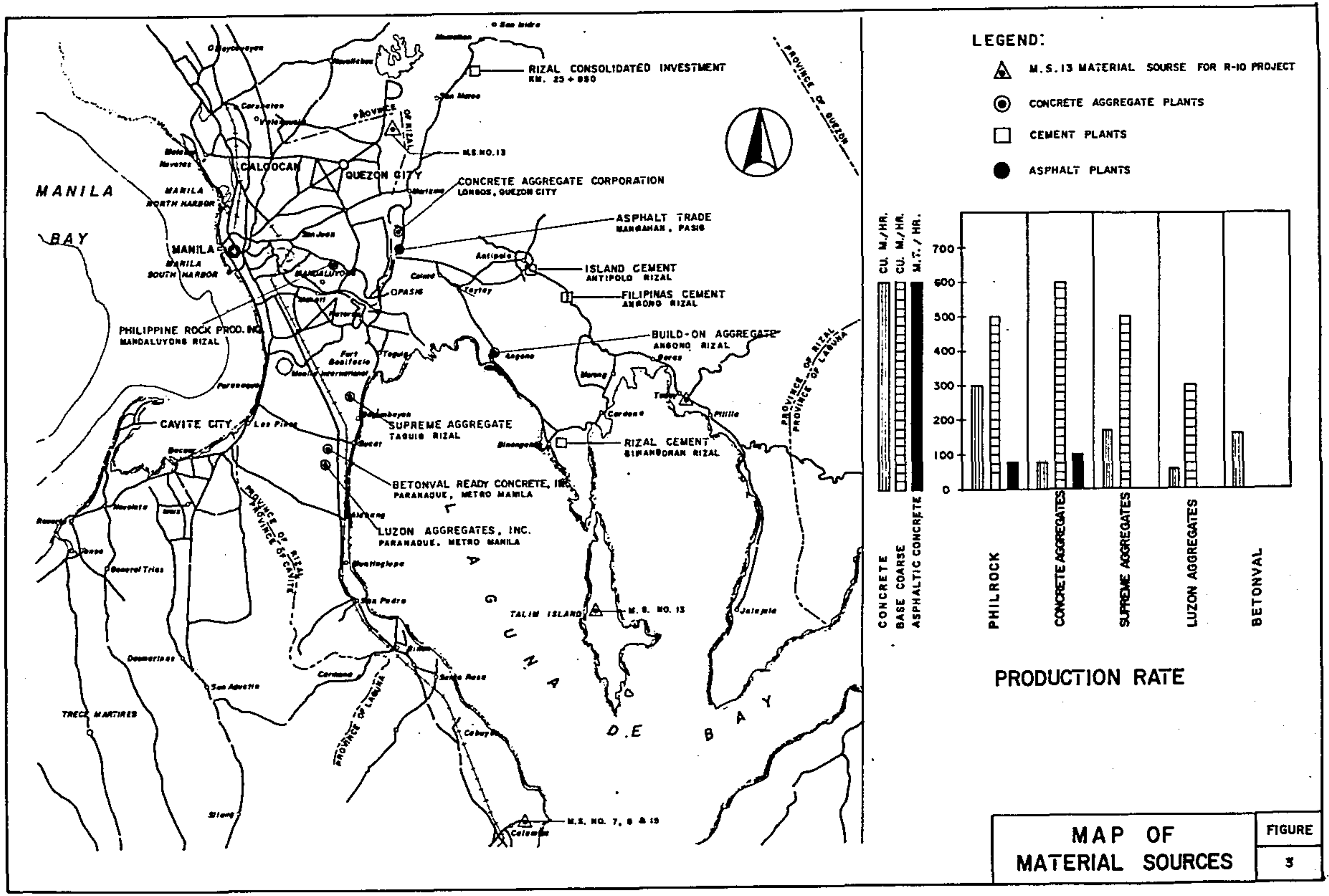


-BH6
C3-BH6-L
C3-BH7
C3-BH 8
C3-BH9
C3-BH10
C3-BH11
C3-BH13
Previous Borehole
C3-BH12
C4-BH1
C4-BH3
C4-BH4
C5
AW BLVD.(R-5)
AURORA BLVD(R-6)
RODRIGUEZ BLVD
QUEZON BLVD.(R-7)
DELMONTE AVE.
A.BONIFACIO(R-8)
RIZAL AVE.(R-9)
(End of C-3 Study Route)
SWAMPY AREA
A.BONIFACIO(R-8)
E. DE LOS SANTOS AVE.(C-4)
(Beg. of R-4 Study Route)
BUTING BRIDGE
ALMEDA
(End of R-4 Study Route)
MAY TUNAS CREEK
SANJUAN RIVER
PATEROS RIVER
TP-5
CBR=2.4
1.6
TP-6
CBR=27.8
26.6
TP-7
CBR=26.3
24.7
TP-8
CBR=7.2
5.6
TP-9
CBR=1.6
1.3
C-3 STUDY ROUTE
R-4 STUDY ROUTE



GEOLOGICAL PROFILE ALONG ROUTE. SCALE: H=1:50,000. V=1:400

FIGURE 2



MAP OF MATERIAL SOURCES

FIGURE 3

COARSE & FINE AGGREGATES(ITEM 316 -405)

NAME OF PRODUCER	MATERIAL SOURCE	LOCATION	TYPE OF AVAILABLE MATERIALS	QUANTITY AVAILABLE	PHYSICAL PROPERTIES OF MATERIALS																			UNIT Cost/M3 (EX-PLANT)	TMC Conc UNIT Cost/M3 (1 1/2")
					Soundness Loss, %	Abrasion Loss, %	Specific Gravity	Absorption %	Wash Loss, %	UNIT WT., g/cc.		CUMULATIVE PERCENT PASSING													
										Loose	Rodded	2"	1 1/2"	1"	3/4"	1/2"	3/8"	#4	#8	#16	#30	#50	#100	#200		
CONCRETE AGGREGATE CORPORATION 70 INDUSTRIA ST. BAGUMBAYAN, QUEZON CITY	ANGONO QUARRY	ANGONO RIZAL	Conc. Aggr. Coarse Aggr.(1 1/2"	UNLIMITED		17.00	2.89	1.03	0.05		1.83	100	100	86	67	42	17	2.5							₱35.00	₱244.50
	PAMPANGA	PORAC PAMPANGA	FINE AGGREGATE	UNLIMITED			2.72	2.894	2.05	1.39							100	97	75	54	30	21	10	2	18.00	
PHILIPPINE ROCK PRODUCTS, INC. 650 SHAW BLVD. MANDALUYONG METRO MANILA	MONTALBAN RIZAL	PURAY MONTALBAN RIZAL	Conc.Aggr.(1 1/2" Coarse Aggr.	UNLIMITED	2.00	12.00	2.80	1.46	0.80	1.49	1.67	100	96	48	11	7	3								35.00	244.50
	PAMPANGA	PORAC PAMPANGA	FINE AGGREGATES	UNLIMITED	5.00		2.60	2.80	1.00	1.54	1.62						100	96	87	69	49	22	5	1	18.00	
SUPREME AGGREGATE CORPORATION VFP COMPOUND TAGUIG , RIZAL	CALAMBA QUARRY	CALAMBA LAGUNA	Conc. Aggr. Coarse Aggr.(1 1/2"	UNLIMITED	6.00	26.00	2.56	0.91	0.35	1.35	1.51	100	92	41	10	7	3	1							37.00	244.50
	PAMPANGA	PORAC PAMPANGA	FINE AGGREGATES	UNLIMITED	6.90		2.62	2.04	1.14	1.52	1.67						100	96	87	68	49	16	4	1	26.00	
LUZON AGGREGATES INC . KM. 17 SOUTH SUPER HIGHWAY, PARANAQUE METRO MANILA	Norzagaray QUARRY	Norzagaray BULACAN	Conc.Aggr.(1 1/2" Coarse Aggr.	UNLIMITED	3.50		2.83	1.16				100	100	80	66	35	13	1							35.00	244.50
	PAMPANGA	PORAC PAMPANGA	FINE AGGREGATES	UNLIMITED	4.00		2.66	2.82	2.00								100	99	85	71	39	10	2	0	18.00	
BETONVAL READYCONCRETE INC. SEVERINA INDUSTRIAL SUBD., KM. 16 SOUTH SUPER HIGHWAY, PARA-NAQUE, M.M.	POROCK MONTALBAN QUARRY	MONTALBAN RIZAL	Conc.Aggr.(1 1/2" Coarse Aggr.	UNLIMITED		15.00	2.694	0.884			2.22	100	95	27	5	1	1	1							35.00	244.50
	PAMPANGA	PORAC PAMPANGA	FINE AGGREGATES	UNLIMITED			2.484	3.04			2.30						95	92	88	81	67	42	15	1	18.00	

NOTE :

1. ALL DATA, INFORMATION AND COST WERE FURNISHED BY THE PRODUCER.
2. TESTING DATA WERE OBTAINED BY THE PRODUCERS AT THEIR OWN LABORATORIES.
3. COST ARE AS OF AUGUST, 1977.
4. ITEM NOS. ARE DESIGNATION NOS. OF THE MATERIALS AS PER DEPARTMENT OF PUBLIC HIGWAYS DESIGNATION.

MATERIAL FROM COMMERCIAL PLANT	TABLE
*COARSE AND FINE AGGREGATES	1.1

ASPHALTIC CONCRETE (ITEM 310)

NAME OF PRODUCER	MATERIAL SOURCE	LOCATION	TYPE OF AVAILABLE MATERIALS	QUANTITY AVAILABLE	TEST DESCRIPTION AND PROPERTIES OF MATERIAL														Asphaltic Concrete Cost/MT (ITEM 310)
					BUCK DENSITY g./cc.	STABILITY kg.	FLOW	AIR VOIDS, %	ASPHALT CEMENT,%	VOIDS FILLED W/A.C.	Absorption %	SWELL %	CU. M. PERCENT PASSING						
													3/4"	1/2"	# 4	# 10	#40	#200	
CONCRETE AGGREGATES CORPORATION 70 INDUSTRIA ST. BAGUMBAYAN, Q. C.	ANGONO QUARRY	ANGONO, RIZAL	BITUMINOUS CONCRETE MIX	UNLIMITED	148.00	2880	14	3.50	5.12	76.2	1.50	0.30	98	85	59	48	22	5	₱138.50
PHILIPPINE ROCK PRODUCTS, INC. 650 SHAW BLVD. MANDALUYONG, M.M.	MONTALBAN RIZAL	PURAY, MONTALBAN RIZAL	BITUMINOUS CONCRETE MIX	UNLIMITED	148.00	1880	11	4.00	5.50	84			100	92	52	33	40	6	138.50

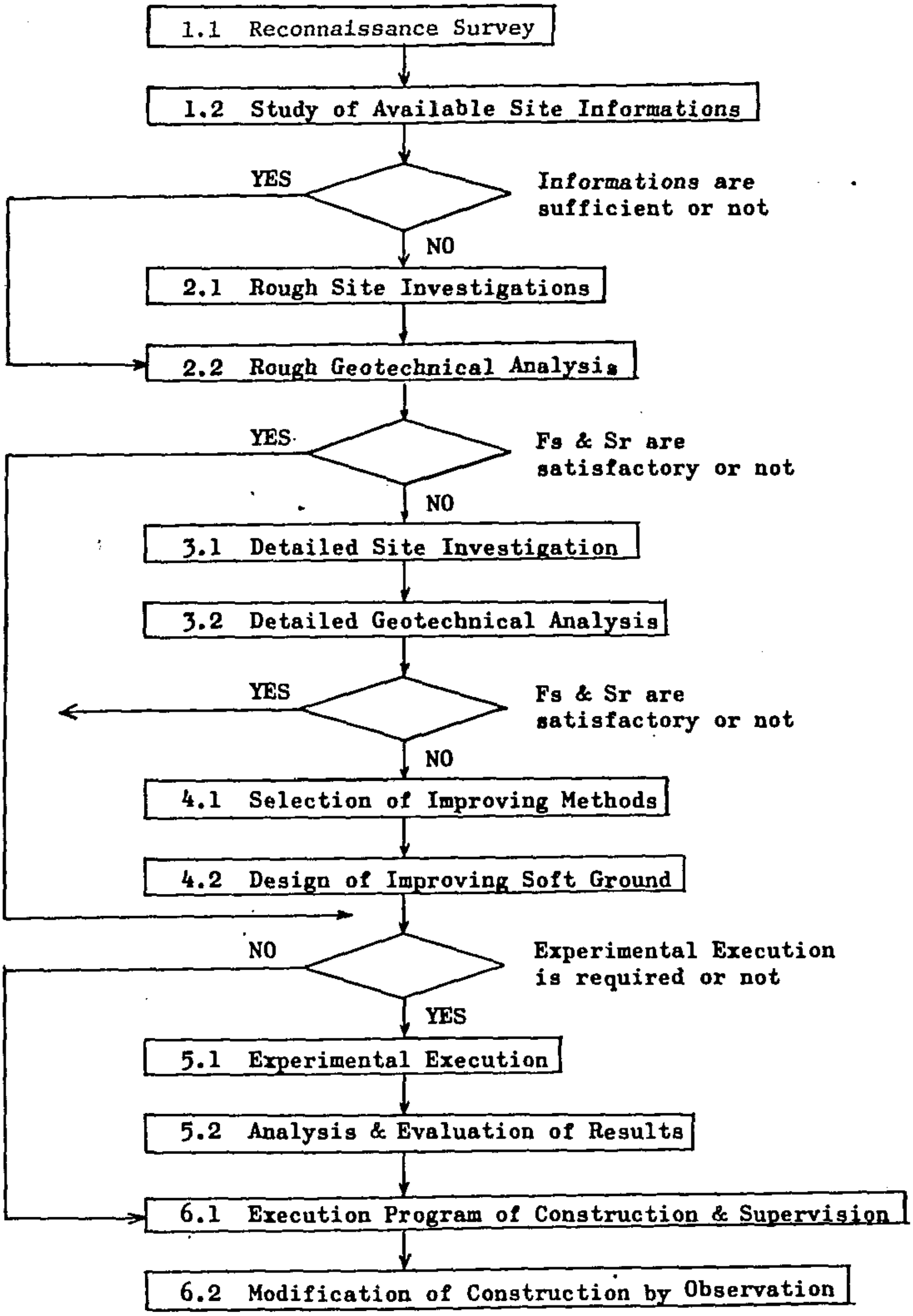
BASE COARSE (ITEM 200)

NAME OF PRODUCER	MATERIAL SOURCE	LOCATION	QUANTITY AVAILABLE	TEST DESCRIPTION AND PROPERTIES OF MATERIAL																	BASE COARSE PRICE/ cu. m. (ITEM 200)
				Abrasion Loss, %	Moisture - Density		LL	PL	PI	CBR, %	CUMULATIVE PERCENT PASSING										
					MDD, pcf	OMC, %					2"	1 1/2"	1"	3/4"	3/8"	# 4	# 10	# 40	#200	
CONCRETE AGGREGATES CORPORATION 70 INDUSTRIA ST. BAGUMBAYAN, Q. C.	ANGONO QUARRY	ANGONO RIZAL	UNLIMITED	27.00	131.50	10.50	20.00	16.00	4.00	98.00	100	83	72	69	40	29	19	9	5	₱ 19.00
PHILIPPINE ROCK PRODUCTS, INC. 650 SHAW BLVD. MANDALUYONG, M.M.	MONTALBAN RIZAL	PURAY MONTALBAN RIZAL	UNLIMITED	26.00	136.00	11.00		NP	NP	89.00	100		75		46	35	28	14	6	35.00
SUPREME AGGREGATES CORPORATION VFP COMPOUND TAGUIG, RIZAL	CALAMBA PLANT	CALAMBA LAGUNA	UNLIMITED	27.00	126.00	12.20	18.00	NP	NP		100	100	76	62	49	35	27	10	7	28.00
LUZON AGGREGATES, INC. KM.17 SOUTH SUPER HIGHWAY, PARANAQUE METRO MANILA	NORZAGARAY QUARRY	NORZAGARAY BULACAN	UNLIMITED																	25.00

NOTE:
1. ALL DATA, INFORMATION AND COST WERE FURNISHED BY THE PRODUCER.
2. TESTING DATA WERE OBTAINED BY THE PRODUCERS AT THEIR OWN LABORATORIES.
3. COST ARE AS OF AUGUST, 1977.
4. ITEM NOS. ARE DESIGNATION NOS. OF THE MATERIALS AS PER DEPARTMENT OF PUBLIC HIGHWAYS DESIGNATION.

MATERIAL FROM COMMERCIAL PLANT
* ASPHALTIC CONCRETE
* BASE COARSE

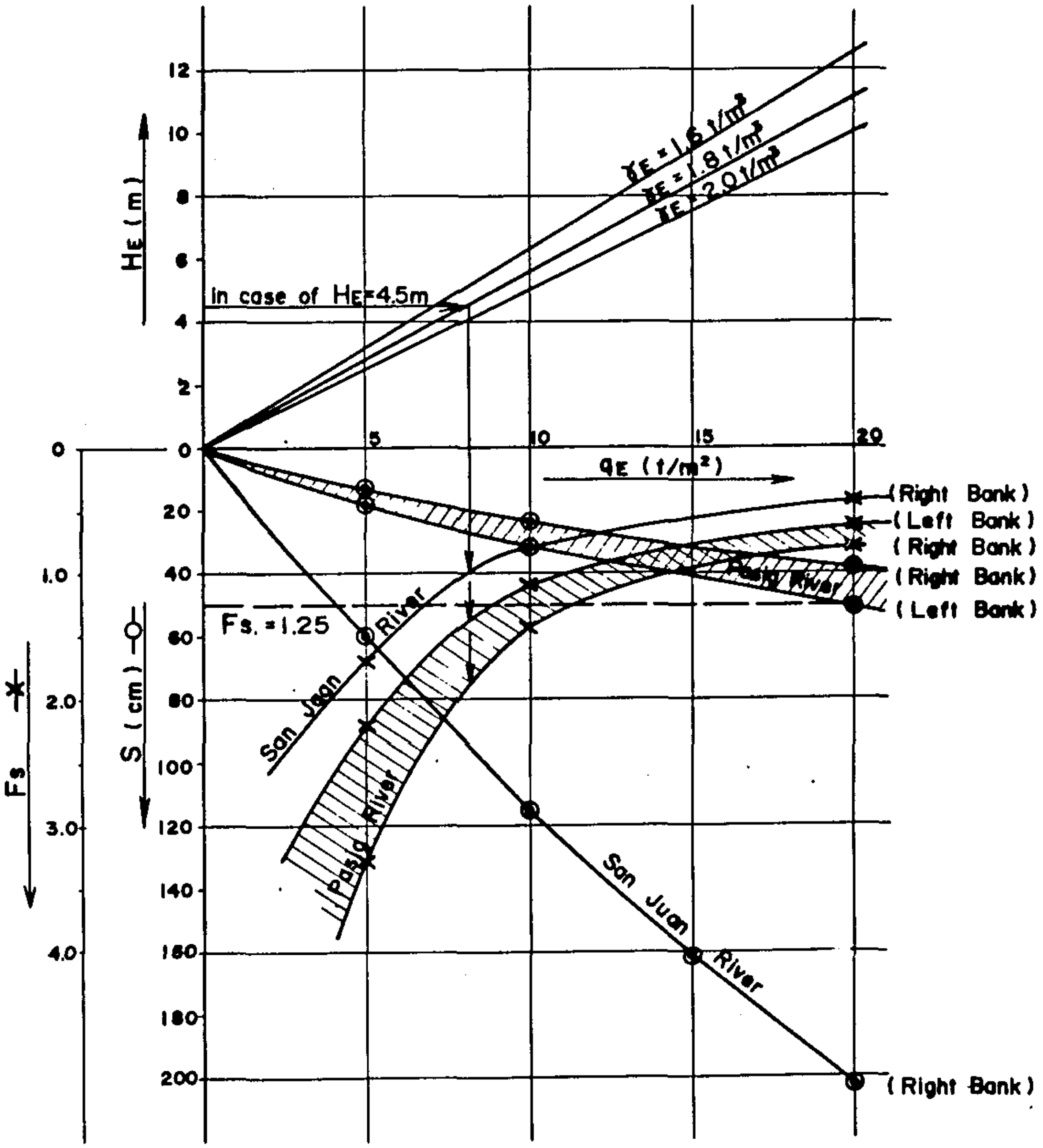
TABLE 1.2



LEGEND
Fs : *Factor of Safety against subground failure*
Sr : Postconstruction Residual Settlement

DESIGN PROCEDURE OF IMPROVING SOFT GROUND

FIGURE 4



LEGEND

γE : Unit Weight of Embankment Material

HE : Embankment Height

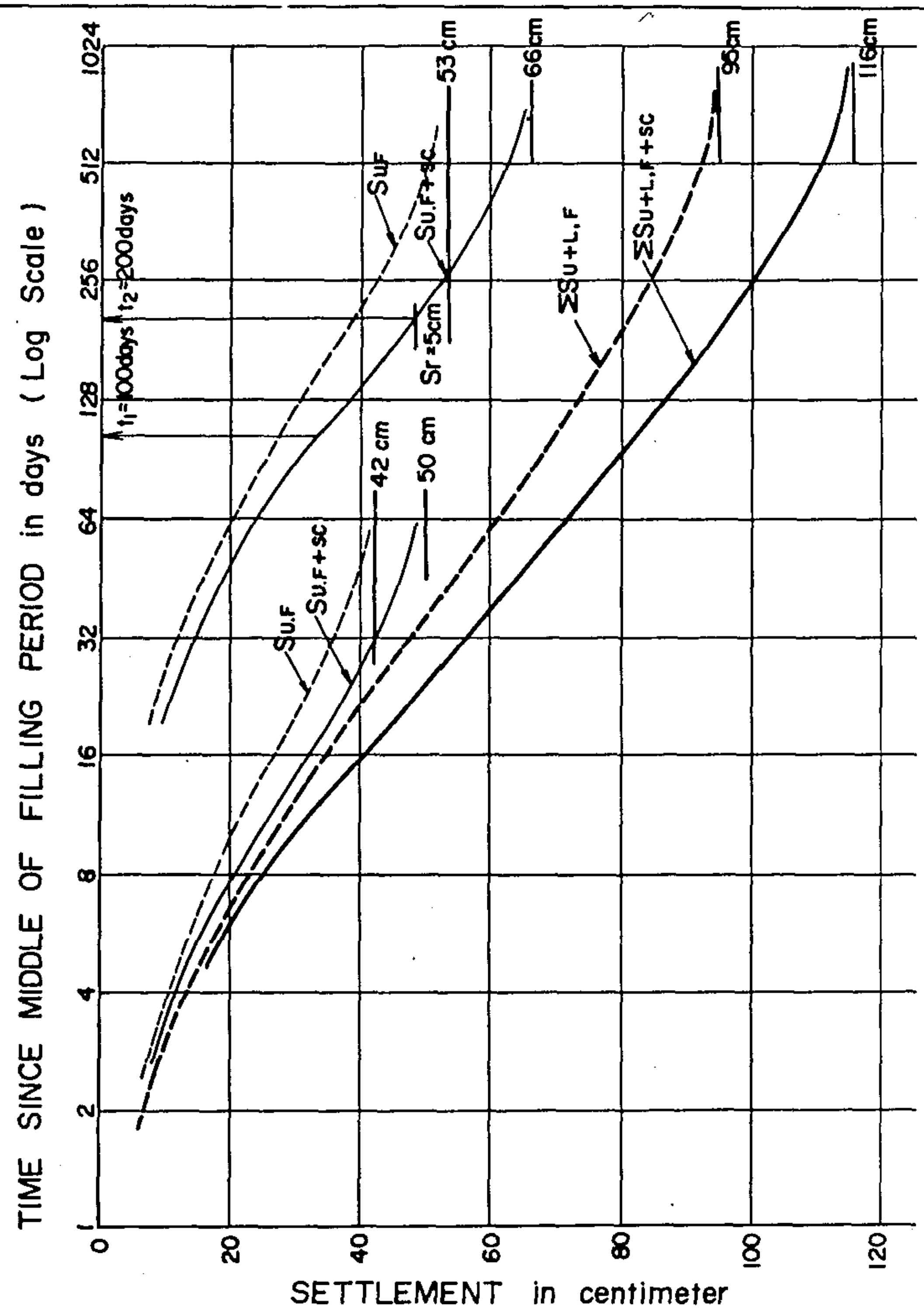
Fs : Estimated Factor of Safety in an instantaneous loading

S : Estimated Settlement

qE : Embankment Load

SETTLEMENT AND FACTOR OF SAFETY VS EMBANKMENT LOAD

FIGURE 5



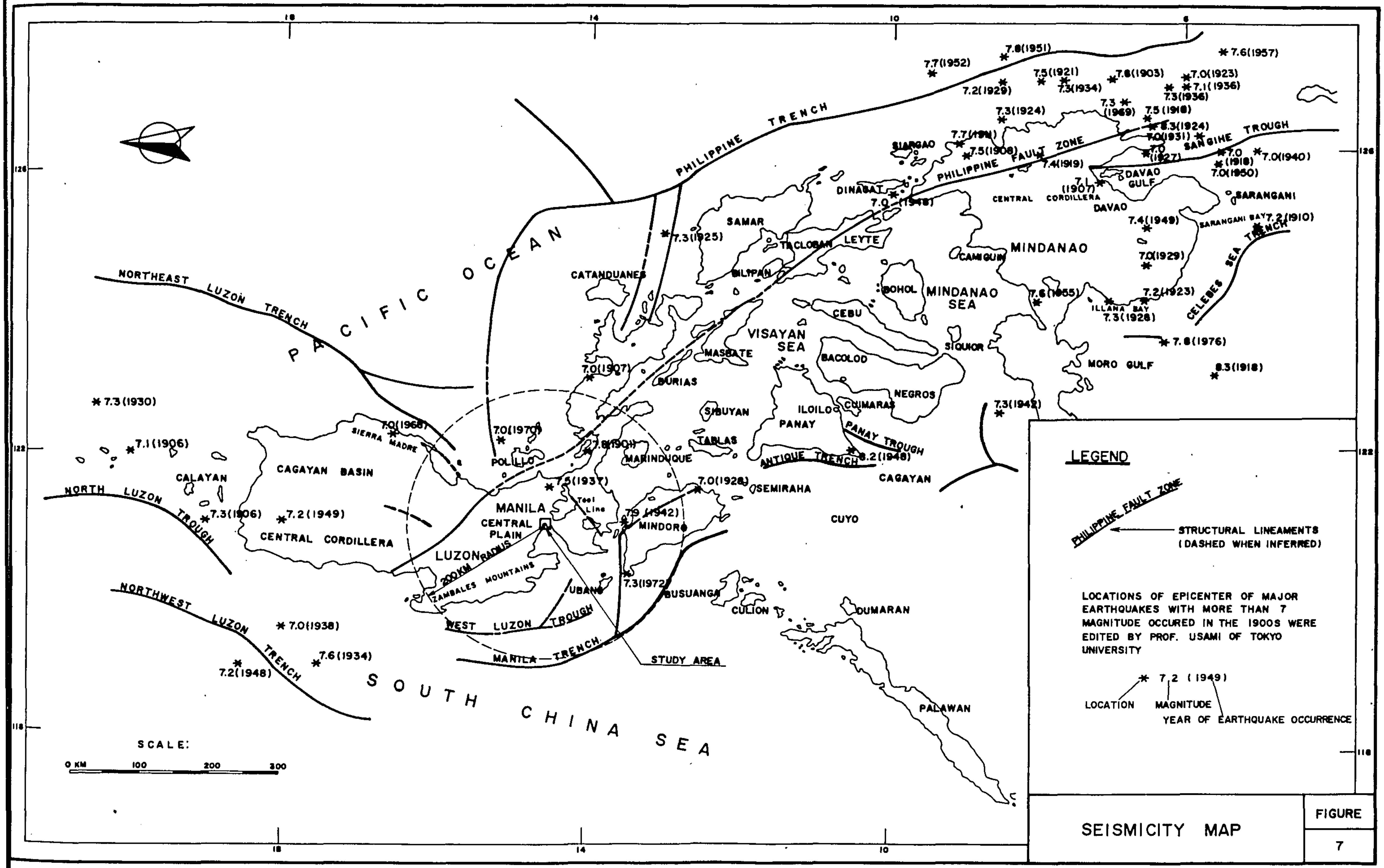
LEGEND

S_U : SETTLEMENT OF UPPER LAYER t_1: TIME FOR OBTAINING REQUIRED STRENGTH
S_L : SETTLEMENT OF LOWER LAYER t_2: TIME FOR REDUCING POSTCONSTRUCTION SETTLEMENT
SUFFIX : F; FINALLOAD, SC; SURCHARGE LOAD, U; UPPER LAYER, L; LOWER LAYER

NOTES

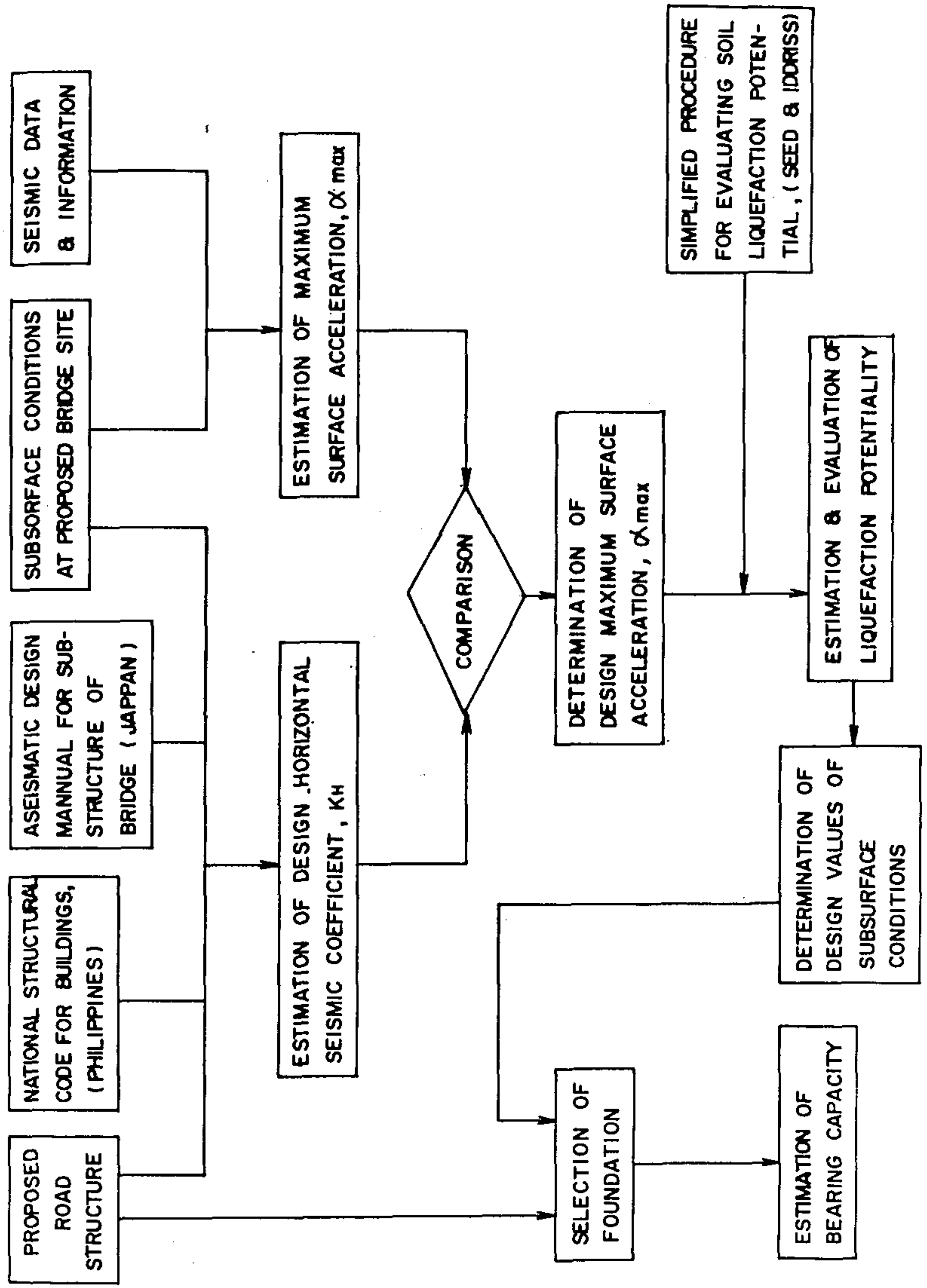
FINAL HEIGHT : 4.5 m
SURCHARGE THICKNESS : 1.0 m
SAND DRAIN : 0.40 m diameter
SPACING 2.0 m, SQUARE ARANGEMENT

TIME VS SETTLEMENT CURVE WITH IMPROVING WORK	FIGURE 6



SEISMICITY MAP

FIGURE 7



DESIGN PROCEDURE OF FOUNDATIONS

FIGURE 8

DESIGN VALUES

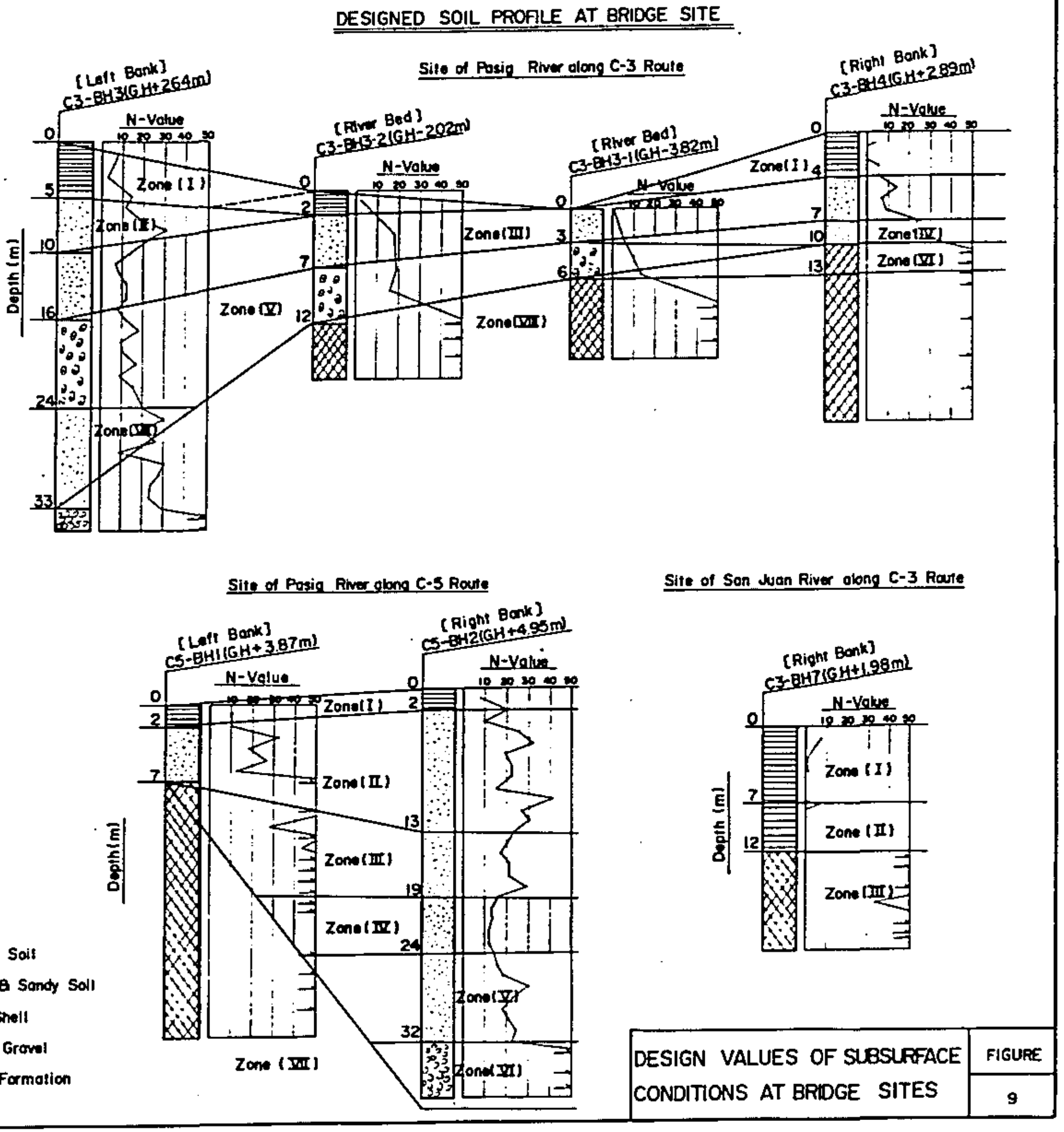
Bridge Site	Zone	Soil Type	N- Value	qu(kg/cm²)	E (kg/cm²)
Pasig River along C-3 Route	(I)	Clayey Soil	———	qu≒0.3 (0.2~0.6)	20
	(II)	Sandy Soil	N≒15 (10~30)	———	120
	(III)	Sandy Soil	N≒10 (5~20)	———	70
	(IV)	Sandy Soil	N≒20-25	———	150
	(V)	Sea Shell	N≒15 (10~20)	———	100
	(VI)	Tuff	N = 50 (>50)	———	500
	(VII)	Sandy Soil	N≒20 (10~30)	———	150
	(VIII)	Basal Gravel and Tuff	N = 50	———	1,000
Pasig River along C-5 Route	(I)	Clayey Soil	N≒10	———	70
	(II)	Sandy Soil	N≒25 (20~40)	———	170
	(III)	Sand	N≒20 (15~30)	———	150
	(IV)	Sand	N≒12~14	———	90
	(V)	Sand	N≒20 (15~30)	———	150
	(VI)	Basal Gravel	N = 50	———	500
	(VII)	Tuff	———	qu≒20 (10~40)	1,000
San Juan River along C-3 Route	(I)	Clayey Soil	N≒3	qu≒0.4 (0.2~0.6)	20
	(II)	Clayey Soil	N≒1	qu≒0.4 (0.2~0.6)	30
	(III)	Tuff	N = 50	qu≒15	1,000

LEGEND

☐	Estimated Liquefaction Zone
qu	Unconfined Compressive Strength
E	Modulus of Deformation ; estimated from results of S.P.T tests on Sandy Soils and of Unconfined Compression tests on Clayey Soils and Tuffs
( )	Range of Actual Values

- ▤ Clayey Soil
- ⛆ Sand & Sandy Soil
- ▨ Sea Shell
- ▩ Basal Gravel
- ▧ Tuff Formation

DESIGNED SOIL PROFILE AT BRIDGE SITE

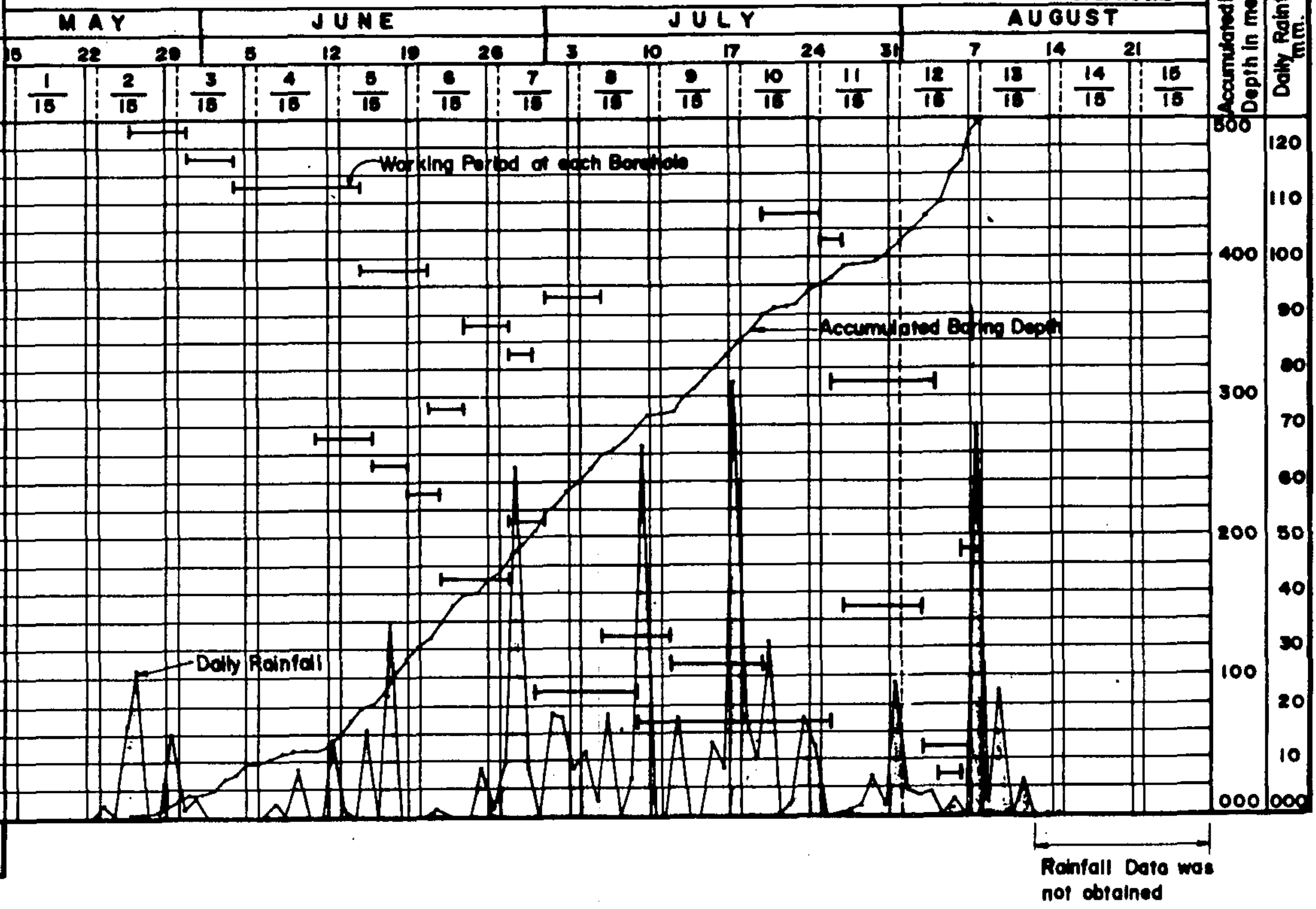


DESIGN VALUES OF SUBSURFACE CONDITIONS AT BRIDGE SITES

FIGURE 9

BOREHOLE NOMINATION	LOCATION	EXECUTED BORING DEPTH In meters	CLASSIFIED BORING LENGTH In meters		CLASSIFIED TAKING SAMPLES (no.)	
			WASH	CORE	STANDARD PENETRATION TEST	UNDISTURBED SAMPLE
C3-BH 1	Malugay St. cor. Kamagong St.	15.0	3.9	11.1	7	0
C3-BH 2	Cor. South Ave. and R-4 ROAD	15.0	5.3	9.7	10	0
C3-BH 3	Left of PASIG RIVER, MAKATI	35.0	35.0	0.0	35	3
C3-BH3-2	PASIG RIVER, C-3 ROUTE	17.0	12.2	4.8	8	0
C3-BH3-1	PASIG RIVER, C-3 ROUTE	13.5	9.3	4.2	5	0
C3-BH 4	Right of PASIG RIVER MANDALUYONG	26.0	14.5	11.5	17	2
C3-BH5-1	Near cor. Vergara & Blumentrit St.	26.0	26.0	0.0	26	1
C3-BH5-2	Back of Boni Cemetery, MANDALUYONG	15.0	7.2	7.8	12	2
C3-BH 6	Shaw Blvd. near R-5 INTERSECTION	15.0	11.3	3.1	14	0
C3-BH6-1	C-3 ROUTE at Maytunas Creek	15.0	15.0	0.0	15	0
C3-BH 7	Araneta Ave. at SAN JUAN RIVER	20.0	15.0	5.0	19	10
C3-BH 8	Cor. Araneta Ave. & Magsaysay Blvd.	15.0	2.9	12.1	7	0
C3-BH 9	Cor. Araneta Ave. & Rodriguez Ave.	15.0	8.6	6.4	11	0
C3-BH10	Cor. Araneta Ave. & Quezon Blvd.	15.0	4.8	11.2	10	0
C3-BH11	Cor. Araneta Ave. & Del Monte Ave.	15.0	4.3	11.7	10	0
C3-BH12	Balingasa Elem. School Cpd.	15.0	5.4	9.6	8	0
C3-BH13	Cor. Sgt. Rivera & Bonifacio Sts.	15.0	15.0	0.0	15	0
R4-BH 1	EDSA at R-4 INTERSECTION	15.0	5.3	9.7	11	0
R4-BH 3	BUTING BRIDGE, Buting, PASIG	15.0	10.6	4.4	13	1
R4-BH 4	End of R-4, San Joaquin, PASIG	40.0	40.0	0.0	40	2
C5-BH 1	Left of PASIG RIVER, Ft. Bonifacio	30.0	20.7	9.3	23	0
C5-BH 2	Right of PASIG RIVER, Ft. Bonifacio	37.0	34.2	2.8	35	0
C5-BH 3	Rodriguez Ave., Bagong Ilog, PASIG	31.0	31.0	0.0	31	4
C5-BH 4	Rodriguez Ave., Libis MURPHY	15.0	9.0	6.0	11	0
C5-BH 6	Aurora Blvd., R-6 INTERSECTION	15.0	3.0	12.0	8	0
TOTAL		500.5	349.5	152.4	401	25

PROGRESS OF BORING WORK VERSUS DATE & NO. OF WEEKS ELAPSED (Month/Day/ $\frac{\text{No. of Weeks}}{\text{Total Weeks}}$)



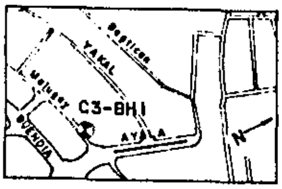
REMARKS :

1. Location of Boreholes is shown in Figures 1 & 3.
2. Borehole Nomination : For example, C3-BH9 means Borehole No. 9 conducted along C-3 Route. Some designated Boreholes were not drilled due to inaccessibility and space limitations. Others were abandoned because tuff (rock) surface are already exposed.
3. Boreholes C3-BH3-1 and C3-BH3-2 are located in the Pasig River Bed. (off shore boring)
4. Each Borehole are located at main intersections, River Bridge Sites and Swampy Areas. As much as possible location of boreholes were selected in public spaces.
5. Two sets of hydraulic speed type drilling machine (KOKEN OE-2L MODEL) were used.
6. Core Samples were obtained from tuff formations locally called "adobe".
7. Standard Penetration Tests were undertaken by using trigging hook.
8. Undisturbed Samples were obtained by using 60 cm. long.
9. Rainfall Data taken from Science Garden, Diliman, Quezon City and furnished by Philippine Atmospheric Geophysical and Astronomical Service Administration.

PROGRESS OF BORING WORK, (SHOWING DAILY RAINFALL)	APPENDIX 1

Appendix 2.1

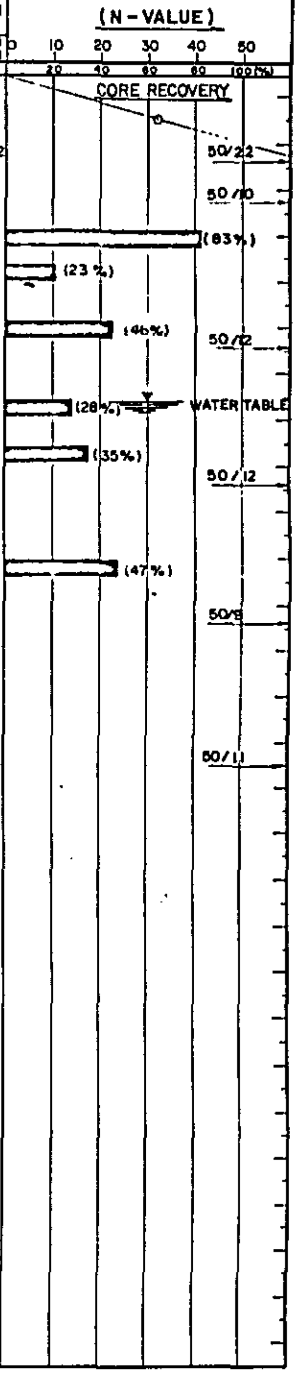
FIELD BORING LOG

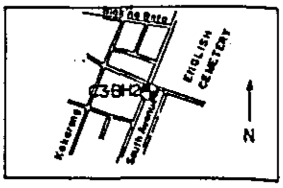


LOCATION PLAN

Name of Project C-3/R-4 FEASIBILITY STUDY
Hole no. C3 - BH I
Grd. Elev. + 4.45 M.
Location Corner MALUGAY and KAMAGONG Streets, MAKATI.
Water Table G.L. - 7.10 M.
Date MAY 25-30, 1977

SCALE IN (M.)	ELEVATION IN (M.)	DEPTH IN (M.)	THICKNESS	LEGEND	TYPE OF SOIL	COLOUR	RELATIVE DENSITY OR CONSISTENCY	GENERAL REMARKS	STANDARD PENETRATION TEST OR CORE RECOVERY: DEPTH IN (M.)	SAMPLING FOR LAB.	N-VALUE BLOWS 30 CM	BLOWS PER EACH 10 CM.: 10 CM	10 CM	10 CM
	3.45	1.00	1.00		SANDY SILT	brownish gray	dense	with medium size gravel 15 to 25 mm diameter	0.55 1.00	SS-1	32	10	12	13
	1.65	2.80	1.80		SILTY SAND (WEATHERED SANDY TUFF)	dark brownish gray dark gray	very dense	fine to medium sand relatively soft tuffaceous grains, slighly plastic fines tuffaceous grains; slightly plastic fines.	1.55 1.97 2.55 2.80	SS-2 SS-3	50/22 50/10	21	23	6/2
	.70	3.75	0.95		SANDY TUFF			medium to coarse grained; w/ thin interbeds of fine sandstone & siltstone moderate to well cemented		CS-1		CORE		
	-1.52	5.97	2.22		CLAYEY TUFF	grayish brown cream		fractured vesiculated moderately cemented. very fine-grained; poorly cemented	4.50 5.70 5.97	CS-1a CS-2 SS-4	50/12	CORE CORE	5/2	
	-3.05	7.50	1.53		SANDY TUFF	light brown		medium to coarse grained binded by shale; moderately cemented.	7.50	CS-3		CORE		
	-4.25	8.70	1.20		SILTY TUFF	brown		fine to medium grained moderate to well cemented	8.70	CS-4		CORE		
	-4.52	8.97	0.27		SANDY SILT	buff brown		slight to low plasticity	8.97	SS-5	50/12	40	10/2	
	-6.05	10.50	1.53		TUFFACEOUS FINE SAND			wash sample						
	-6.85	11.30	0.80		CLAYEY TUFF			moderately cemented, with volcanic cinders		CS-6		CORE		
	-7.05	11.50	0.20		SANDY TUFF			coarse grained moderately cemented		CS-6a		CORE		
	7.49	11.94	0.44		CLAYEY TUFF			poorly cemented slight to low plasticity	11.70 11.94	CS-6b SS-6	50/9	CORE		
	-9.05	13.50	1.56		SANDY TUFF			no recovery	13.50	CS-7		CORE		
	-10.25	14.70	1.20		TUFFACEOUS MEDIUM SAND			wash sample	14.70	CS-8		CORE		
	-10.55	15.00	0.30		TUFFACEOUS - COARSE SAND	dark gray		non-plastic fines	15.00	SS-7	50/11	43	71	
		END OF BORING												





LOCATION PLAN

Appendix 2.2 FIELD BORING LOG

Name of Project C-3/FEASIBILITY STUDY

Hole no. C3-BH2

Grd. Elev. +4.87 M.

Location Corner SOUTH AVENUE and R-4 Road

Water Table G.L-0.75 M.

Date MAY 31 TO JUNE 3, 1977

SCALE IN (M.)	ELEVATION IN (M.)	DEPTH IN (M.)	THICKNESS	LEGEND	TYPE OF SOIL	COLOUR	RELATIVE DENSITY OR CONSISTENCY	GENERAL REMARKS	STANDARD PENETRATION TEST OR CORE RECOVERY						
									DEPTH IN (M.)	SAMPLING FOR LAB.	N-VALUE BLOWS 30 CM	BLOWS PER EACH 10 CM. 10 CM	10 CM	10 CM	(N-VALUE) 10 20 30 40 50 20 40 60 80 100(%) CORE RECOVERY
	4.12	0.75	0.75		CLAY	grayish	stiff	high plasticity	0.55						
1									1.00	SS-1	14	2	4	8	WATER TABLE
					CLAYEY SILT	light brown	hard	moderate to low plasticity.	1.55						
2	2.91	1.96	1.21						1.96	SS 2	50/26	13	19	18/6	50/26
					SANDY TUFF	grayish brown	very dense	friable, non plastic fine.	2.55						
3									2.77	SS-3	50/7	50/7			50/7
	1.12	3.75	1.79					fine grained; poor to moderately cemented.							
4					SILTY TUFF	brown		moderately cemented with spot black cinders.	4.50	CS-1		core			(49 %)
5	-0.43	5.30	1.55												
	-0.91	5.78	0.48		CLAYEY TUFF			poorly cemented	5.28	CS-2		core			(82%)
6	-1.06	5.93	0.15		SANDY SILT			non plastic tuffaceous	5.93	SS-4	50/23	20	21	9/3	50/23
7	-2.30	7.17	1.24		CLAYEY TUFF	buff brown		poor to moderately cemented.	7.17	CS 3		core			(60%)
8	-3.13	8.00	0.83		SILTY. TUFF	brown to grayish brown		with interbeds of shale & coarse sandstone; poor to moderately cemented	8.00	CS-4		core			(78%
	-3.93	8.80	0.80		CLAYEY TUFF	buff brown		poor to moderately cemented with traces of black cinders & medium sand grains							
9								moderately cemented	9.00	CS-5		core			(80%)
	-4.46	9.33	0.53		SILTY TUFF	yellowish grayish		poorly cemented in place	9.33	SS-5	50/8	16	34/8		50/8
10					TUFFACEOUS SILTSTONE	brown		low plasticity; compacted	10.00						
								and poorly cemented	10.33	SS-6	50/29	11	16	23/9	50/29
11									11.00						
	-6.58	11.45	2.12				hard		11.45	SS-7	41	8	10	23	
12					SILTY TUFF	light to buff gray		moderate plasticity; very friable shale	12.00						
									12.42	SS-8	50/27	13	21	16/7	50/27
13									13.00						
	-8.56	13.43	1.98						13.43	SS-9	50/28	13	16	21/8	50/28
14	-9.08	13.95	0.52		CLAYEY TUFF	buff brown		poor to moderately cemented.	13.95	CS-6		core			(74%)
					TUFFACEOUS SANDSTONE	light brown	medium	medium to coarse sand;	14.55						
15	-10.13	15.00	1.05					low to slightly plastic fines	15.00	SS-10	12	4	4	4	
		END	OF BORING												
16															
17															
18															
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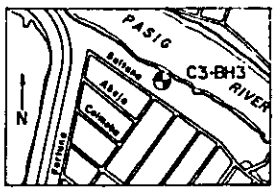
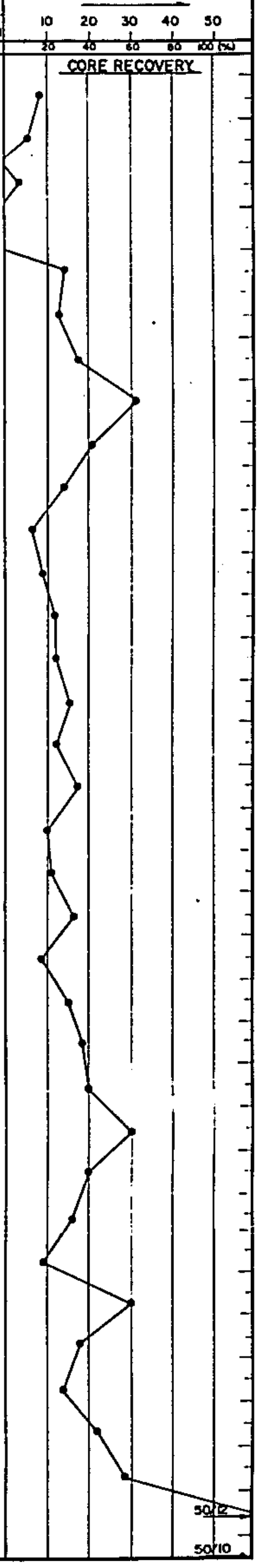
Appendix 2.3 **FIELD BORING LOG**

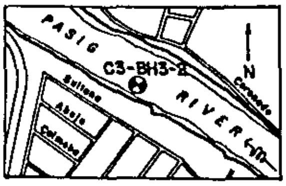


LOCATION PLAN

Name of Project C-3 / R-4 FEASIBILITY STUDY   Hole no. C3-BH3
Grd. Elev. + 2.64 M.   Location Left side of PASIG RIVER, End of Trabaho St., MAKATI
Water Table G.L. -1.80 to -3.00 M. (FLUCTUATING)   Date JUNE 4 - 14, 1977

SCALE IN (M.)	ELEVATION IN (M.)	DEPTH IN (M.)	THICKNESS	LEGEND	TYPE OF SOIL	COLOUR	RELATIVE DENSITY OR CONSISTENCY	GENERAL REMARKS	STANDARD PENETRATION TEST OR CORE RECOVERY: DEPTH IN (M.)	SAMPLING FOR LAB.	N-VALUE BLOWS 30 cm	BLOWS PER EACH 10 CM: 10 CM	10 CM	10 CM
	1.94	0.70	0.70	‖	SILTY SAND	dark gray	stiff	with fine gravel, non-plastic.	0.55					
1	1.64	1.00	0.30	‖	CLAYEY SILT	brown		low plasticity.	1.00	SS-1	9	3	3	3
	0.94	1.70	0.70	▨	SILTY CLAY	grayish brown	medium stiff	low to moderate plasticity.	1.55					
2	0.49	2.15	0.45	‖	SILTY SAND	brown		non to slight plasticity.	2.00	SS-2	6	2	2	2
				▨	SILTY CLAY	dark gray	soft	low to moderate plasticity; slightly organic.	2.55	ST-1	PRESSED			
3									3.00	SS-3	3	1	1	1
									3.55	ST-2	PRESSED			
4									4.00	SS-4	PRESSED			
									4.50	ST-3	PRESSED			
5	-2.26	4.90	2.75				stiff		5.00	SS-5	14	4	4	6
				‖	SILTY Fine SAND		medium dense	slightly plastic fines; with mottles of tiny white shells.	5.55					
6	-3.36	6.00	1.10						6.00	SS-6	12	3	4	5
				●	SILTY GRAVEL	gray		fine to coarse subrounded fragments; low plastic fines.	6.55					
7	4.36	7.00	1.00						7.00	SS-7	18	6	6	6
				‖	SILTY SAND	dark gray	dense	fine to medium sand; w/ tiny white shells; non-plastic fines.	7.55					
8	5.36	8.00	1.00						8.00	SS-8	31	10	10	11
				▨	SILTY CLAY	brownish gray	very stiff	w/ traces of shell fragments; moderate plasticity.	8.55					
9	-6.21	8.85	0.85						9.00	SS-9	21	6	7	8
				○	SEASHELLS	creamy white	medium dense	intermixed w/ silty clay. and silty fine to medium sand.	9.55					
10	-7.36	10.00	1.15						10.00	SS-10	14	4	4	6
				‖	SILTY SAND		loose	with seashell fragments; and traces of fine to medium gravels; non-plastic fines.	10.55					
11									11.00	SS-11	7	3	2	2
									11.55					
12									12.00	SS-12	9	1	4	4
							medium dense		12.55					
13									13.00	SS-13	12	4	4	4
									13.55					
14									14.00	SS-14	12	5	4	3
							loose		14.55					
15									15.00	SS-15	8	2	3	3
							medium dense		15.55					
16	-13.36	16.00	6.00						16.00	SS-16	12	4	3	5
				○	SEASHELLS			w/small amount of sandy silt and fine to medium gravel; non-plastic fines.	16.50					
17									17.00	SS-17	18	6	6	6
									17.55					
18									18.00	SS-18	10	3	4	3
									18.55					
19									19.00	SS-19	11	3	4	4
									19.55					
20									20.00	SS-20	17	5	6	6
							loose		20.55					
21	-18.36	21.00	5.00						21.00	SS-21	9	4	3	2
				▨	CLAY	light gray	stiff	w/ large amount of shell fragments; highly plastic	21.55					
22	-19.36	22.00	1.00						22.00	SS-22	15	6	5	4
				○	SEASHELLS	creamy white	medium dense	w/ traces of silty clay; non-plasticity.	22.55					
23									23.00	SS-23	18	7	6	5
									23.55					
24	-21.36	24.00	2.00						24.00	SS-24	20	5	7	8
				‖	SILTY SAND	dark gray		fine to coarse sand; w/shell fragments & fine gravel; slighly plastic fines.	24.55					
25	-22.36	25.00	1.00						25.00	SS-25	30	11	10	9
				∴	Very Fine SAND			w/ traces of shell fragments; slighly plastic fines	25.55					
26									26.00	SS26	20	5	5	10
									26.55					
27	-24.36	27.00	2.00						27.00	SS-27	26	4	7	15
				‖	CLAYEY SILT		stiff	w/fine sand and traces of shell fragment; low plasticity.	27.55					
28	-25.21 [illegible]	27.85 [illegible]	0.85 [illegible]	▨	[illegible]			MODERATE PLASTICITY	28.00	SS-28	9	5	2	2
				‖	SILTY SAND		medium dense	fine to medium sand; non to slightly plastic fines.	28.55					
29	-26.36	29.00	1.00						29.00	SS-29	30	11	10	9
				▨	SANDY CLAY			w/traces of fine gravel; moderate plasticity.	29.55					
30	-27.36	30.00	1.00						30.00	SS-30	28	5	11	12
				‖	Fine SANDY SILT			w/traces of shell fragments; slightly plastic fines	30.55					
31	-28.36	31.00	1.00						31.00	SS-31	24	9	8	7
				‖	SILTY SAND			very fine sand; slightly plastic fines.	31.55					
32	-29.36	32.00	1.00						32.00	SS-32	23	8	7	8
								w/traces of angular gravel; slightly plastic fines.	32.55					
33	-30.36	33.00	1.00						33.00	SS-33	29	10	10	9
							very dense	medium to coarse sand; w/angular gravel; non-plastic fines.	33.55					
34									34.00	SS-34	50/12	39	11/2	
									34.55					
35	-32.36	35.00	2.00						35.00	SS 35	50/10	50/10		





LOCATION PLAN

Appendix 2.4 **FIELD BORING LOG**

Name of Project C-3/R-4 FEASIBILITY STUDY Hole no. C3-BH3-2

Grd. Elev. - 2.02 M. Location C-3 PASIG RIVER CROSSING

Water Table OFF SHORE Date JULY 25-26, 1977

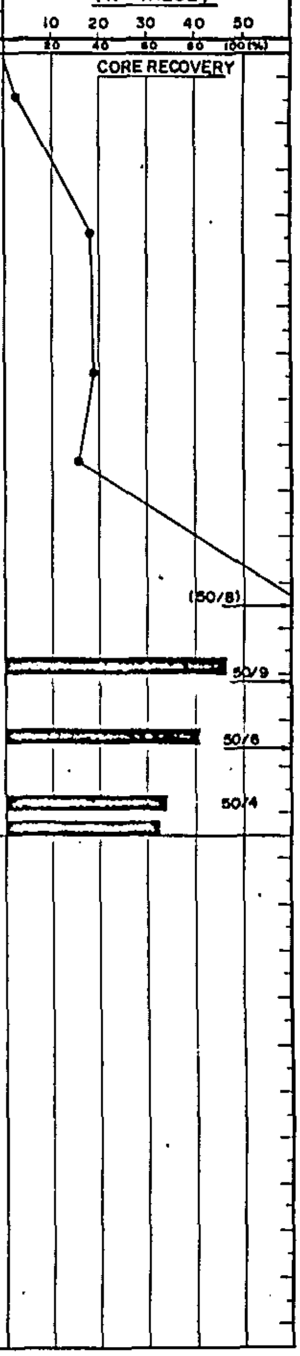
ELEVATION IN (M.)	DEPTH IN (M.)	THICKNESS	TYPE OF SOIL	COLOUR	RELATIVE DENSITY OR CONSISTENCY	GENERAL REMARKS
-4.12	2.10	2.10	SANDY SILT	dark gray	soft	with gravel and traces of seashells, slight to low plastic fines
-4.52	2.50	0.40	SILTY CLAY			look moderate plasticity
-6.02	4.00	1.50	SEASHELLS	cream	medium dense	with sand
-9.02	7.00	3.00	SILTY SAND	dark gray		fine to medium sand with seashells, non to slightly plastic fines
-13.72	11.70	4.70	SEASHELLS	light gray		with sandy silt, non to slightly plastic fines
-15.52	13.50	1.80	SANDY TUFF	dark gray	very dense	poor to moderately cemented
-17.02	15.00	1.50	SILTY TUFF	grayish brown		
-18.52	16.50	1.50	SANDY TUFF	dark gray		poor to moderately cemented
-19.02	17.00	0.50				with fine gravel
	END	OF	BORING			

STANDARD PENETRATION TEST OR CORE RECOVERY

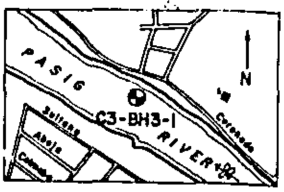
DEPTH IN (M.)	SAMPLING FOR LAB.	N-VALUE BLOWS 30 CM	BLOWS PEP EACH 10 CM. 10 CM	10 CM	10 CM
0.55 1.00	SS-1	3	1	1	1
3.55 4.00	SS-2	18	5	6	7
6.55 7.00	SS-3	19	6	7	6
8.55 9.00	SS-4	16	5	5	6
11.55 12.00	SS-5	50/8	50/8		
13.50	CS-1	core			
13.55	SS-6	50/9	50/9		
15.00	CS-2	core			
15.06	SS-7	50/6	50/6		
16.50	CS-3	core			
16.54	SS-8	50/4			
	CS-4	core			

no recovery

no recovery



Appendix 2.5 **FIELD BORING LOG**



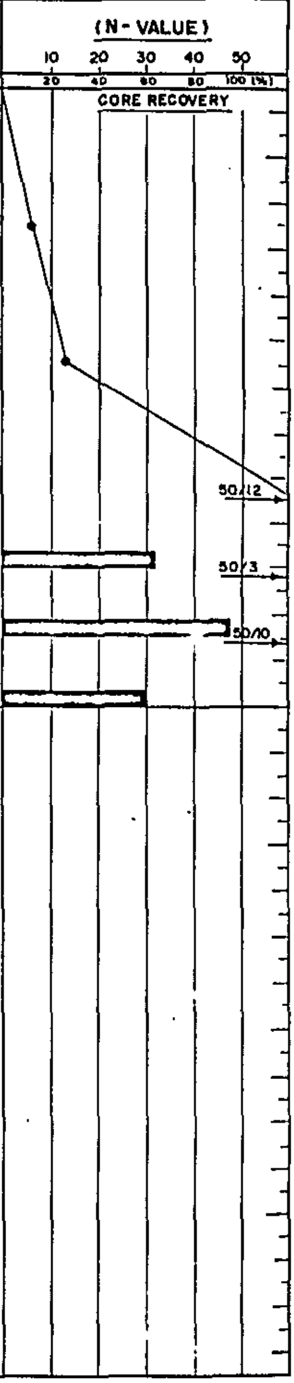
LOCATION PLAN

Name of Project C-3/R-4 FEASIBILITY STUDY Hole no. C3-BH3-1

Grd. Elev. - 3.82 M. Location C-3 PASIG RIVER CROSSING

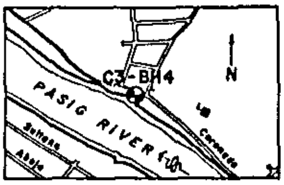
Water Table OFFSHORE Date JULY 22-24, 1977

SCALE IN (M.)	ELEVATION IN (M.)	DEPTH IN (M.)	THICKNESS	LEGEND	TYPE OF SOIL	COLOUR	RELATIVE DENSITY OR CONSISTENCY	GENERAL REMARKS	STANDARD PENETRATION TEST OR CORE RECOVERY: DEPTH IN (M)	SAMPLING FOR LAB.	N-VALUE BLOWS 30 CM	BLOWS PER EACH 10 CM. 10 CM	10 CM	10 CM
	-6.82	3.00	3.00		SILTY Fine SAND	dark gray	loose	non to slightly plastic fines.	2.55 3.00	SS-1	6	2	2	2
	-10.12	6.30	3.00		SEASHELLS	cream	medium dense	w/sand; non-plastic fines.	5.55 6.00	SS2	13	4	4	5
	-14.32	10.50	4.20		SANDY TUFF	brownish gray	very dense	fine to medium grained; poor to moderately cemented.	8.55 9.00	SS3	50/12	50/12		
									10.50	CS-1	core			
	-15.32	12.00	1.50		SILTY TUFF	grayish brown		poor to moderately cemented.	10.68	SS4	50/3	50/3		
									12.00	CS2	core			
	-16.32	13.00	1.00		SANDY TUFF	dark gray			12.10	SS5	50/10	50/10		
	-16.82	13.50	0.50		CLAYEY TUFF	grayish				CS-3	core			
		END	OF	BORING										



Appendix 2.6 **FIELD BORING LOG**

Name of Project C-3 / R-4 FEASIBILITY STUDY
Hole no. C3-BH4
Grd. Elev. + 2.88 M.
Location Right of PASIG RIVER, MANDALUYONG Side
Water Table G.L. - 2.70 M.
Date 20 JUNE 1977

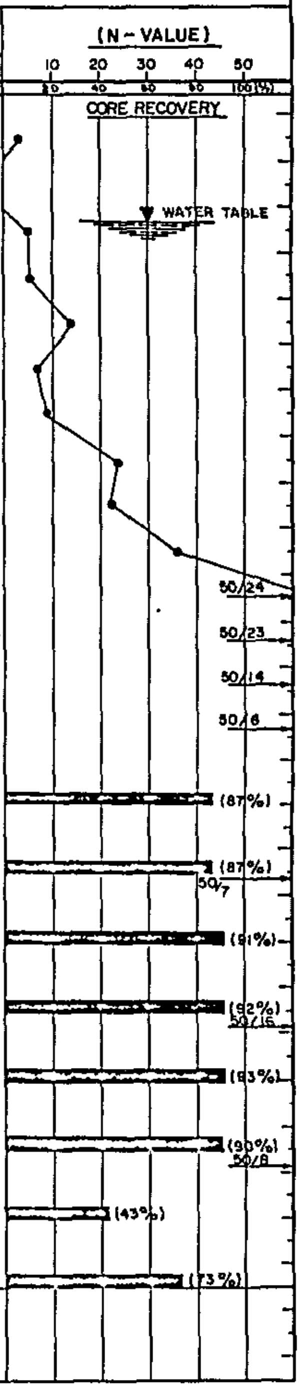


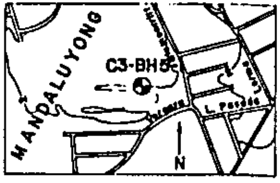
LOCATION PLAN

SCALE IN (M)	ELEVATION IN (M)	DEPTH IN (M)	THICKNESS	LEGEND	TYPE OF SOIL	COLOUR	RELATIVE DENSITY OR CONSISTENCY	GENERAL REMARKS
1	1.88	1.00	1.00		CLAYEY SILT	rust brown	soft	low plasticity
2	0.88	2.00	1.00		SILTY CLAY	brown		low to moderate plasticity
3	-0.12	3.00	1.00		ORGANIC SILTY CLAY	gray	medium stiff	w/ traces of shell fragments; moderate plasticity.
4	-1.12	4.00	1.00		SILTY CLAY			w/ organic materials; moderate plasticity.
5	-2.12	5.00	1.00		SILTY SAND		stiff	fine to coarse sand; w/ some gravels and shell fragments; slightly plasticity fine.
6	-3.12	6.00	1.00		SILTY FINE GRAVEL	dark gray	medium stiff	w/ some shell fragments non - plastic fines
8	-5.02	7.90	1.90		SILTY FINE TUFFACEOUS SAND		stiff very stiff	w/ traces of shell fragments, gravels, non - plastic fines.
10	-7.12	10.00	2.10		TUFFACEOUS SILTY SAND			fine to coarse sand; w/ fine gravel; traces of shell fragments; non - plastic fines.
13	-9.96	12.84	2.84		CLAYEYSILT (WEATHERED SILTY TUFF)	buff gray buff brown	hard	tuffaceous; slight plasticity.
17	-14.52	17.40	4.56		SANDY TUFF	dark gray		fine to coarse grained moderately well cemented.
	-14.92	17.80	0.40		SILTY TUFF			
20	-17.02	19.90	2.10		SANDY TUFF	dark gray	very dense	moderately cemented
22	-18.97	21.85	1.95		FINE GRAINED CLAYEY TUFF	grayish brown		slightly cemented
	-19.22	22.10	0.25		SILTY TUFF	brownish		
	-19.72	22.60	0.50		TUFFACEOUS GRAVEL	gray		
23	-19.92	22.80	0.20		CLAYEY TUFF	yell. brn.		
	-20.42	23.30	0.50		SILTY TUFF	dark gray		
24	20.92	23.80	0.50		FINE GRAINED CLAYEY TUFF	yellowish brown		moderately cemented
26	-23.12	26.00	2.20		SILTY TUFF	dark gray		
27		END	OF BORING					
28								

STANDARD PENETRATION TEST OR CORE RECOVERY

DEPTH IN (M)	SAMPLING FOR LAB.	N-VALUE BLOWS 30 CM	BLOWS PER EACH 10 CM. 10 CM	10 CM	10 CM
0.55 1.00	SS-1	3	1	1	1
1.55	ST-1	p r	e s	s e	d
2.00	SS-2	p r	e s	s e	d
2.55	ST-2	p r	e s	s e	d
3.00	SS-3	5	1	2	2
3.55 4.00	SS-4	5	3	1	1
4.55 5.00	SS-5	14	3	6	5
5.55 6.00	SS-6	7	2	2	3
6.55 7.00	SS-7	9	3	3	3
7.55 8.00	SS-8	24	7	9	8
8.55 9.00	SS-9	22	9	6	7
9.55 10.00	SS-10	36	9	10	17
10.55 10.94	SS-11	50/24	18	21	11/4
11.55 11.93	SS-12	50/23	12	20	18/3
12.55 12.84	SS-13	50/14	25	25/4	
13.55 13.76	SS-14	50/6	50/6		
	CS-1	c o	r e		
17.00	CS-2	c o	r e		
	SS15	50/7			
	CS-3	c o	r e		
20.00	CS-4	c o	r e		
20.31	SS-16	50/16	17		
	CS-5	c o	r e		
23.00	CS-6	c o	r e		
23.33	SS-17	50/8			
	CS-7	c o	r e		
	CS-8	c o	r e		





LOCATION PLAN

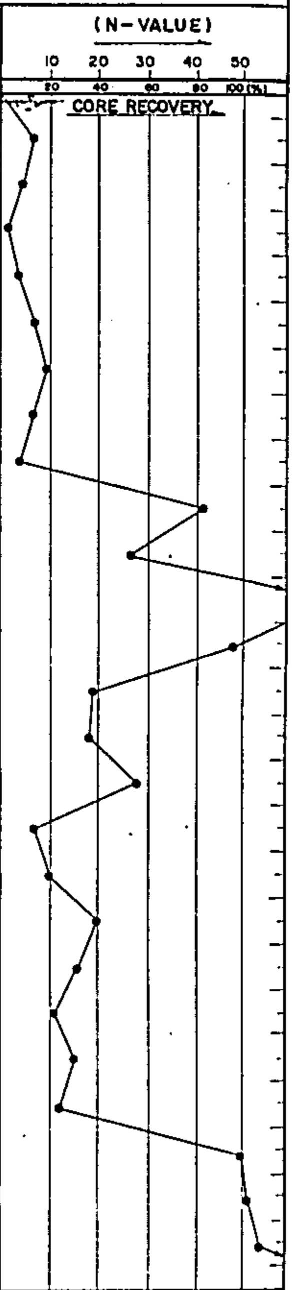
Appendix 2.7 FIELD BORING LOG

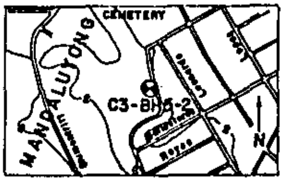
Name of Project C-3/R-4 FEASIBILITY STUDY
Hole no. C3-BH5-1
Grd. Elev. + 1.90 M.
Location Vergara St. near cor. Blumentritt, MANDALUYONG
Water Table G.L. − 0.20 M.
Date JULY 1 − 5, 1977

SCALE IN (M.)	ELEVATION IN (M.)	DEPTH IN (M.)	THICKNESS	LEGEND	TYPE OF SOIL	COLOUR	RELATIVE DENSITY OR CONSISTENCY	GENERAL REMARKS
1	0.90	1.00	1.00		SANDY SILT	light gray	loose	w/sandy tuff fragments; low plasticity.
2	-0.10	2.00	1.00		CLAY		soft	highly plastic.
3	-1.10	3.00	1.00		SILTY CLAY	brownish gray	very soft	moderate to high plasticity; organic.
4	-2.10	4.00	1.00		CLAYEY Fine SAND	light gray	very loose	moderately plastic fines; slightly organic.
	-2.90	4.80	0.80		CLAYEY SILT	dark gray	medium stiff	w/very fine sand; low plasticity.
5	-3.10	5.00	0.20		SILTY SAND		loose	fine sand
6	-4.10	6.00	1.00		CLAYEY SILT		stiff	w/traces of very fine sand; slight to low plasticity.
7	-5.10	7.00	1.00		SILTY SAND			fine sand; slightly plastic fines.
	-5.80	7.70	0.70		SILTY CLAY	light gray	soft	low plasticity
8					SILTY SAND	dark gray	very loose	fine to medium
	-6.80	8.70	1.00				dense	fine to coarse w/occasional gravels; contains shell particles.
9	-7.10	9.00	0.30		SANDY SILT SILTY SAND			
10							medium dense	
11					SAND		very dense	medium to coarse; w/ fine to coarse gravel; partly tuffaceous.
12	-10.10	12.00	3.00					
13, 14, 15	-13.10	15.00	3.00		SEASHELLS	dirty white	medium dense	w/ appreciable silty fine sand and fine gravels; low plastic fines.
16							medium stiff	
17							stiff	low to moderate plasticity; with high percentage of shell fragments.
18, 19					SILTY CLAY	light gray	very stiff	
20, 21	-19.10	21.00	6.00				stiff	
22	-20.10	22.00	1.00		SANDY SILT		medium dense	appreciable shells; low plastic fines.
23	-21.10	23.00	1.00		SILTY SAND	light brown	very dense	fine sand, w/traces of silty tuff fragments.
	-21.95	23.85	0.85		SILTY TUFF	buff brown	very hard	poorly cemented; very friable.
24	-22.10	24.00	0.15		SANDY TUFF	dark gray	very dense	
25	-23.10	25.00	1.00		FINE GRAINED CLAYEY TUFF	buff brown	very hard	
26	-24.10	26.00	1.00		SILTY TUFF	dark gray	hard	
27, 28		END	OF	BORING				

STANDARD PENETRATION TEST OR CORE RECOVERY

DEPTH IN (M.)	SAMPLING FOR LAB.	N-VALUE BLOWS 30 CM	BLOWS PER EACH 10 CM: 10 CM	10 CM	10 CM
0.55 1.00	SS-1	7	3	2	2
1.55 2.00	SS-2	4	1	1	2
2.55	ST-1				
3.00	SS-3	1	0	1	0
3.55 4.00	SS-4	3	1	1	1
4.55 5.00	SS-5	7	3	2	2
5.55 6.00	SS-6	9	3	3	3
6.55 7.00	SS-7	6	1	2	3
7.55 8.00	SS-8	3	1	1	1
8.55 9.00	SS-9	42	13	14	15
9.55 10.00	SS10	27	8	8	11
10.55 10.87	SS-11	50/22	28	22/7	
11.55 12.00	SS12	48	15	16	17
12.55 13.00	SS13	19	6	7	6
13.55 14.00	SS14	18	6	6	6
14.55 15.00	SS15	28	8	9	11
15.55 16.00	SS16	7	2	2	3
16.55 17.00	SS17	10	3	3	4
17.55 18.00	SS18	20	7	7	6
18.55 19.00	SS19	16	5	5	6
19.55 20.00	SS20	11	5	3	3
20.55 21.00	SS21	15	4	5	6
21.55 22.00	SS22	12	4	4	4
22.55 23.00	SS23	50	13	19	18
23.55 23.99	SS24	50/29	12	14	24/9
24.55 24.98	SS25	50/28	15	18	17/8
25.55 [illegible]	SS26	50/3	50/3		





LOCATION PLAN

Appendix 2.8 **FIELD BORING LOG**

Name of Project C-3/R-4 FEASIBILITY STUDY Hole no. C3-BH5-2

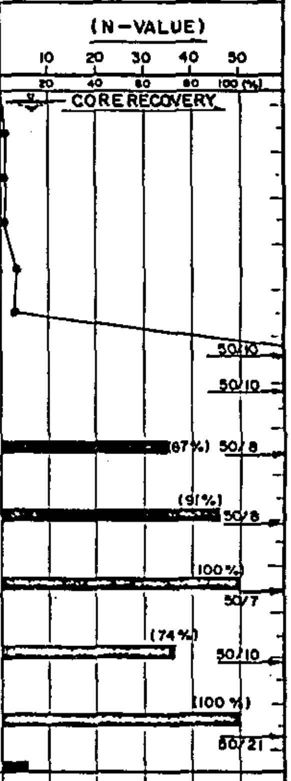
Grd. Elev. + 1.97 M. Location Back of BONI Cemetary, MANDALUYONG

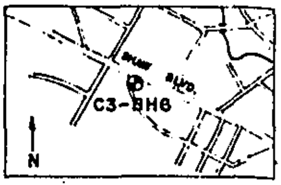
Water Table G.L.-0.35 M. Date JUNE 25-27, 1977

SCALE IN (M.)	ELEVATION IN (M.)	DEPTH IN (M.)	THICKNESS	LEGEND	TYPE OF SOIL	COLOUR	RELATIVE DENSITY OR CONSISTENCY	GENERAL REMARKS
1	0.97	1.00	1.00		CLAY	light to medium gray	very soft	w/organic matter moderate plasticity
3	-1.03	3.00	2.00		ORGANIC SILTY CLAY			low plasticity w/ traces of peat materials
4	-2.03	4.00	1.00		SILTY SAND	dark gray	very loose	medium to coarse w/ large amount of shells, organic.
5	-3.03	5.00	1.00		CLAYEY SILT		soft	sandy w/ large amount of shells, no plasticity.
7	-5.23	7.20	2.20		SILTY TUFF	light gray light brown	hard	low plastic fines. w/ appreciable amount of fine sand, poorly compacted
	-5.43	7.40	0.20		SANDY TUFF	dark gray	very dense	moderately well compacted.
8	-6.03	8.00	0.60		TUFFACEOUS CONGLOMERATE			
10	-8.08	10.05	2.05		SILTY TUFF	grayish brown	hard	moderately compacted to fragmental:
	-8.38	10.35	0.30		SANDY TUFF	drk.gray	verydense	coarse grained.
11	-9.33	11.30	0.95		SILTY TUFF	brownish gray	very hard	fine grained, with vesicles throughout, porous
	-9.58	11.55	0.25		CLAYEY TUFF	brown		
12	-9.93	11.90	0.35		SILTY TUFF	brn.gry.		
	-10.53	12.50	0.60		CLAYEY TUFF			
13	-11.18	13.15	0.65		SILTY TUFF	dark gray		poorly cemented, partly fragmental
	-11.48	13.45	0.30		CLAYEY TUFF			
14	-12.03	14.00	0.55		SILTY TUFF			
	-12.24	14.21	0.21		CLAYEY TUFF			
15	-13.03	15.00	0.79		SILTY TUFF	brownish gray		
		END OF BORING						

STANDARD PENETRATION TEST OR CORE RECOVERY

DEPTH IN (M.)	SAMPLING FOR LAB.	N-VALUE BLOWS 30 CM	BLOWS PER EACH 10 CM. 10 CM	10 CM	10 CM
0.55					
1.00	SS-1	1	0	1	0
1.55	ST-1	pressed			
2.00	SS-2	1	0	1	0
2.55	ST-2	pressed			
3.00	SS-3	0	0	0	0
3.55					
4.00	SS-4	3	1	1	1
4.55					
5.00	SS-5	3	1	1	1
5.55					
5.88	SS-6	50/12	40	10/2	
6.55					
6.65	SS-7	50/10			
8.00	CS-1				
8.08	SS-8	50/8			
9.50	CS-2				
9.58	SS-9	50/8			
11.00	CS-3				
11.07	SS-10	50/7			
12.50	CS-4				
12.60	SS-11	50/10			
14.00	CS-5				
14.21	SS-12	50/21			
15.00	CS-6				





LOCATION PLAN

Appendix 2.9 **FIELD BORING LOG**

Name of Project C-3/R-4 FEASIBILITY STUDY

Hole no. C3-BH6

Grd. Elev. + 3.53 M.

Location Shaw Blvd. near R-5 Intersection, MANDALUYONG

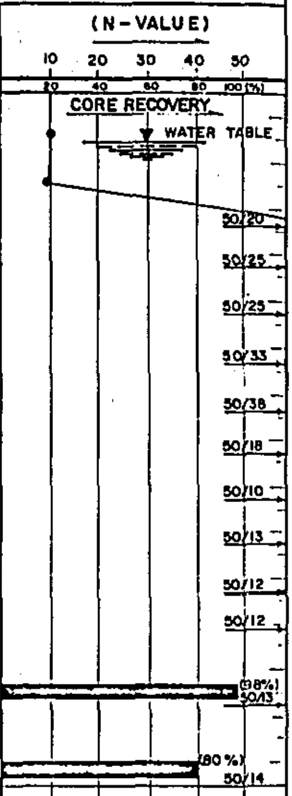
Water Table G.L. -1.84 M.

Date JUNE 28 - 29, 1977

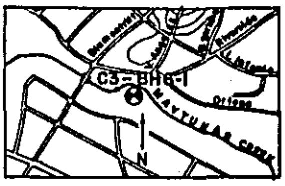
SCALE IN (M.)	ELEVATION IN (M.)	DEPTH IN (M.)	THICKNESS	LEGEND	TYPE OF SOIL	COLOUR	RELATIVE DENSITY OR CONSISTENCY	GENERAL REMARKS
1	2.53	1.00	1.00	▨	CLAY (Weathered Fine grained tuff)	gray	stiff	with traces of fine sand; high plasticity.
2	1.53	2.00	1.00	▨	SILTY CLAY (Weathered Tuff)			low to moderate plasticity.
3	0.63	2.90	0.90		SANDY TUFF	brownish gray	very dense	slightly weathered; slight to low plastic fines
4 5 6 7	-3.37	6.90	4.00		SILTY TUFF Fine Grained Porous	light brown buff brown		w/mottles of silty tuff fragments; slight to low plastic fines. easily erodible. non-plastic fines. w/sandy tuff fragments; slight to low plastic fines. easily erodible.
8 9	-5.37	8.90	2.00		TUFFACEOUS SANDSTONE			fine to medium sand; non-plastic fines.
10 11	-7.29	10.82	1.92		SILTY TUFF	dark gray	very hard	w/fine sand & sandy tuff fragments; slight to low plastic fines. non to slight plastic fines.
12 13	-9.77	13.30	2.48		TUFFACEOUS SANDSTONE		very dense	fine grained; poor to moderately cemented.
14 15	-11.51	15.04	1.74		SILTY TUFF Fine Grained			
16			END	OF	BORING			
17								
18								
19								
20								
21								
22								
23								
24								
25								
26								
27								
28								

STANDARD PENETRATION TEST OR CORE RECOVERY

DEPTH IN (M.)	SAMPLING FOR LAB.	N-VALUE BLOWS/30 CM	BLOWS PER EACH 10 CM: 10 CM	10 CM	10 CM
0.55 1.00	SS-1	10	3	2	5
1.55 2.00	SS-2	9	2	3	4
2.55 2.90	SS-3	50/20	13	37/10	
3.55 3.80	SS-4	50/25	50/25		
4.55 4.80	SS-5	50/25	50/25		
5.55 5.88	SS-6	50/33	50/33		
6.55 6.93	SS-7	50/38	50/38		
7.55 7.88	SS-8	50/18	21	39/8	
6.55 8.80	SS-9	50/10	30/10		
9.55 9.83	SS-10	50/13	30	20/3	
10.55 10.82	SS-11	50/12	38	12/2	
11.55 11.67	SS-12	50/12	50/12		
13.15 [illegible]	CS-1 SS-13	c 50/13	o 50/13	r	e
14.90	CS-2 SS-14	c 50/14	o 50/14	r	e



Appendix 2.10 FIELD BORING LOG



LOCATION PLAN

Name of Project C-3 / R-4 FEASIBILITY STUDY

Hole no. C3-BH6-I

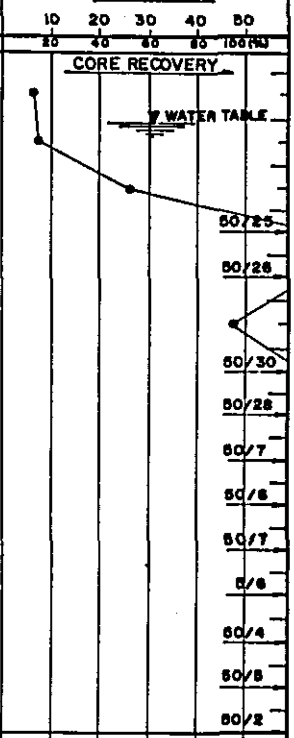
Grd. Elev. + 2.15 M.

Location C-3 ROUTE at MAYTUNAS CREEK

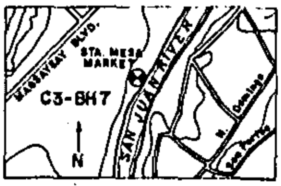
Water Table G.L. 1.60 M.

Date AUGUST 1-3 ,1977

SCALE IN (M.)	ELEVATION IN (M.)	DEPTH IN (M.)	THICKNESS	LEGEND	TYPE OF SOIL	COLOUR	RELATIVE DENSITY OR CONSISTENCY	GENERAL REMARKS	STANDARD PENETRATION TEST OR CORE RECOVERY						
									DEPTH IN (M.)	SAMPLING FOR LAB.	N-VALUE	BLOWS PER EACH 10 CM			(N-VALUE)
											BLOWS 30 CM	10 CM	10 CM	10 CM	
					SANDY CLAY	grayish brown		medium grained	0.55 1.30	SS-1	7	2	2	3	
	0.15	2.00	2.00					fine grained	1.55 2.00	SS2	8	2	3	3	
					SILTY TUFF	dark gray			2.55 3.00	SS-3	27	6	8	13	
								fine to medium grained	3.55 4.00	SS-4	50/20	20	20	10/5	50/25
	-2.85	5.00	3.00					fine grained	4.55 5.00	SS5	50/26	10	14	26/6	50/26
					SANDY TUFF	yellowish brown	soft	medium to coarse grained erodible layer	5.55 6.00	SS6	48	24	13	11	
								medium to coarse grained	6.55 7.00	SS-7	50/30	20	16	14	50/30
						dark gray			7.55 8.00	SS-8	50/28	15	20	15/8	50/28
								fine to coarse grained	8.55 9.00	SS9	50/7	50/7			50/7
						yellowish gray			9.55 10.00	SS10	50/6	50/6			50/6
						dark gray			10.55 11.00	SS11	50/7	50/7			50/7
						yellowish brown		fine grained w/ fragments of slightly silty tuff	11.55 12.00	SS12	50/6	50/6			5/6
								medium to coarse grained	12.55 13.00	SS13	50/4	50/4			50/4
									13.55 14.00	SS14	50/5	50/5			50/5
	-13.85	15.00	10.00					fine to medium grained w/ fragments of slightly weathere sandy tuff	14.55 15.00	SS15	50/2	50/2			50/2
			END OF BORING												



Appendix 2.11 **FIELD BORING LOG**



LOCATION PLAN

Name of Project C3/R-4 FEASIBILITY STUDY Hole no. C3-BH7

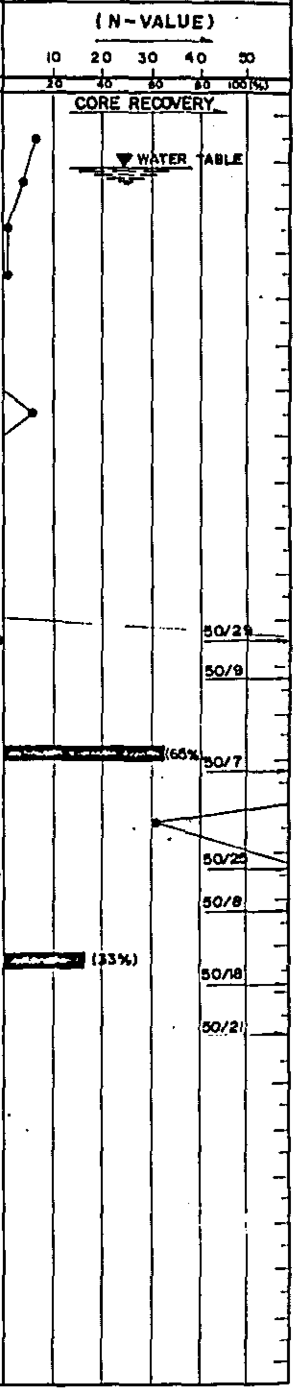
Grd. Elev. + 1.99M. Location End of ARANETA AVENUE at SAN JUAN RIVER

Water Table G.L.-1.60 M. Date JUNE 21-23 1977

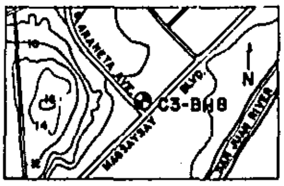
ELEVATION IN (M.)	DEPTH IN (M.)	THICKNESS	TYPE OF SOIL	COLOUR	RELATIVE DENSITY OR CONSISTENCY	GENERAL REMARKS
0.99	1.00	1.00	CLAYEY SILT	dark brown	medium stiff	fill material with tuffaceous lumps, low plasticity
-1.51	3.50	2.50	SILTY CLAY	light gray dark gray	soft very soft	with traces of organic materials, low to moderate plasticity.
-3.01	5.00	1.50	ORGANIC CLAY	black	very soft	high plasticity
-4.01	6.00	1.00	SILTY CLAY	dark gray		low to moderate plasticity
-5.01	7.00	1.00	CLAYEY SILT		medium stiff	slight to low plasticity
-9.56	11.55	4.56	ORGANIC SILTY CLAY	black	very soft	moderate plasticity
-10.80	12.79	1.24	SILTY TUFF	grayish brown	hard	slight to low plasticity, triable.
-13.56	15.55	2.76	SANDY TUFF	light gray dark gray	very dense	coarse grained; poor to moderately cemented. fine to medium grained with traces of organic matter & shells, poorly cemented.
-13.81	15.80	0.25	SILTY TUFF			slighly cemented
[illegible]	[illegible]	[illegible]	DECAYED WOOD			
-14.96	16.95	1.00	SILTY TUFF			slightly cemented
-18.37	20.36	1.38	SANDY TUFF	grayish brown [illegible] dark gray		fine to coarse grained; w/ traces of fine gravel decayed wood; compacted but poorly cemented fine grained compacted but poorly cemented.
	END	OF BORING				

STANDARD PENETRATION TEST OR CORE RECOVERY

DEPTH IN (M.)	SAMPLING FOR LAB.	N-VALUE BLOWS 30 CM	BLOWS PER EACH 10 CM: 10 CM	10 CM	10 CM
0.55					
1.00	SS-1	7	2	2	3
1.55					
2.00	SS-2	4	2	1	1
2.55	ST-1	pressed			
3.00	SS-3	1	0	1	0
3.55	ST-2	pressed			
4.00	SS-4	1	0	1	0
4.55	ST-3	pressed			
5.00	SS-5	0			
5.55	ST-4	pressed			
6.00	SS-6	0			
6.55	ST-5	pressed			
7.00	SS-7	6	2	2	2
7.55	ST-6	pressed			
8.00	SS-8	0			
8.55	ST-7	pressed			
9.00	SS-9	0			
9.55	ST-8	pressed			
10.00	SS10	0			
10.55	ST-9	pressed			
11.00	SS-11	0			
11.55	ST-10	pressed			
11.99	SS-12	50/29	19	9	22/9
12.55					
12.79	SS-13	50/9	50/9		
14.55	CS-1	core			
14.77	SS-14	50/7	50/7		
15.55	CS-2	core			
16.00	SS-15	32	5	7	2
16.55					
16.95	SS-16	50/25	18	20	14/5
17.55					
17.78	SS-17	50/8	50/8		
19.00	CS-3	50/18	core	27/8	
19.33	SS-18				
20.00					
20.36	SS-19	50/21	19	28	3/1



Appendix 2.12. FIELD BORING LOG



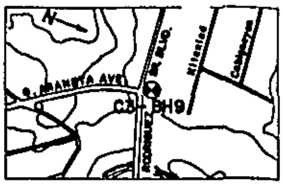
LOCATION PLAN

Name of Project C-3/R-4 FEASIBILITY STUDY
Hole no. C3-BH8
Grd. Elev. + 4.05 M.
Location Corner Araneta Ave. & Magsaysay Blvd.
Water Table
Date JUNE 10-15, 1977

SCALE IN (M.)	ELEVATION IN (M.)	DEPTH IN (M.)	THICKNESS	LEGEND	TYPE OF SOIL	COLOUR	RELATIVE DENSITY OR CONSISTENCY	GENERAL REMARKS
	3.23	0.82	0.82		CLAYEY SILT (WEATHERED SILTY-TUFF)	dark gray	hard	w/silty tuff fragments; slight to low plastic fines.
	0.15	3.90	3.08		SANDY TUFF	light gray	very dense	fine grained; moderate to well compacted.
	-1.50	5.55	1.65		SILTY TUFF	buff gray		poor to moderately compacted.
	-1.95	6.00	0.45		CLAYEY SANDSTONE	brown	med. dense	low to moderate plasticity.
	-2.30	6.35	0 35			light brwn		poor to moderately cemented
	-3.45	7.50	1.15		SANDY TUFF	buff brownish gray		fine grained.
	-4.95	9.00	1.50		CLAYEY TUFF (Fine Grained)	light brown	very hard	well compacted moderately cemented friable.
	-5.89	9.94	0.94		SILTY TUFF	olive gray		slight to low plastic fines compacted; friable.
	-7.45	11.50	1.56		CLAYEY TUFF (Fine Grained)	dark olive gray		well compacted; slightly friable..
	-7.92	11.97	0.47					fine grained, friable
	-8.95	13.00	1.03		SANDY TUFF	grayish brown		medium to coarse grained, moderately cemented.
	-10.95	15.00	2.00		CLAYEY TUFF (Fine Grained)	dark olive gray		poor to moderately cemented; slightly plastic fines.
		END	OF	BORING				

STANDARD PENETRATION TEST OR CORE RECOVERY

DEPTH IN (M.)	SAMPLING FOR LAB.	N-VALUE BLOWS 30 CM	BLOWS PER EACH 10 CM: 10 CM	10 CM	10 CM	(N-VALUE) 10 20 30 40 50 / CORE RECOVERY 20 40 60 80 100 (%)
0.55 0.85	SS-1	50/12	29	21/8		50/12
	CS-1	c o	r e			(60%)
4.00	CS-2	c o	r e			(95%)
4.33	SS-2	50	27	25		50
5.55	CS-3	c o	r e			(70%)
6.00	SS-3	16	6	7	3	
	CS-4	c o	r e			(67%)
	CS-5	c o	r e			(73%)
9.55 9.94	SS-4	50/29	13	29	21/9	50/29
	CS-6	c o	r e			(77%)
11.55 11.97	SS-5	50/27	18	16	17/7	50/27
13.55	CS-7	c o	r e			(100%)
13.94	SS-6	50/24	21	22	7/4	50/24
14.79	CS-8	c o	r e			(100%)
15.00	SS-7	50/6	50/6			50/6



LOCATION PLAN

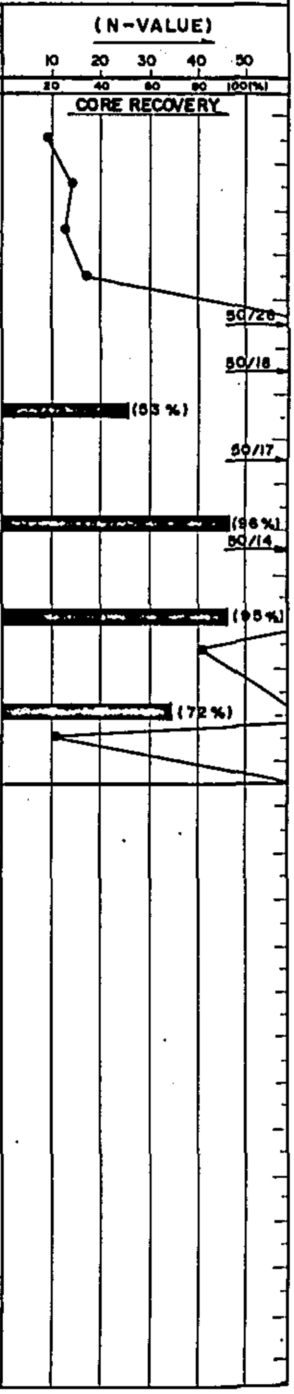
Appendix 2.13 FIELD BORING LOG

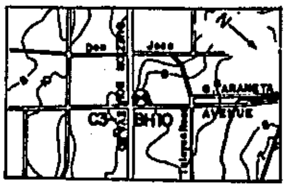
Name of Project C-3/R-4 FEASIBILITY STUDY
Hole no. C-3-BH 9
Grd. Elev. + 4.82 M.
Location ARANETA Ave. Corner RODRIGUEZ Ave.
Water Table
Date 16-18 JUNE 1977

ELEVATION IN (M.)	DEPTH IN (M.)	THICKNESS	LEGEND	TYPE OF SOIL	COLOUR	RELATIVE DENSITY OR CONSISTENCY	GENERAL REMARKS
2.82	2.00	2.00		SILTY SAND	brown gray	loose medium dense	slight to non-plastic fines
1.82	3.00	1.00		SILTY CLAY		stiff	contains tuffaceous lumps and fragments moderate plasticity
0.82	4.00	1.00		CLAY	light grayish brown	very stiff	w/weathered clayey tuff, highly plastic.
-1.18	6.00	2.00		CLAYEY SILT (WEATHERED SILTY TUFF)	brown	very hard.	w/silty tuff fragments; compacted but friable low plasticity.
-6.18	11.00	5.00		SILTY TUFF	buff brown		friable
					brown		compacted but friable; slight plasticity.
					buff brown		compacted but friable
					drk.gry.		slight to low plasticity.
					bluish gray		friable
-8.18	13.00	2.00		SANDY TUFF	drk.gry.	very dense	fine grained; friable.
					black		fine to medium sand; non-plastic fines
-8.73	13.55	0.55		CLAYEY TUFF	dark gray	very hard	friable
-10.18	15.00	1.45		SANDY TUFF	dark brownish gray	very dense	fine to medium sand; non plastic fines.
	END	OF BORING					

STANDARD PENETRATION TEST OR CORE RECOVERY

DEPTH IN (M.)	SAMPLING FOR LAB.	N-VALUE BLOWS 30 CM	BLOWS PER EACH 10 CM: 10 CM	10 CM	10 CM
0.55					
1.00	SS-1	9	3	3	3
1.55					
2.00	SS-2	15	6	6	3
2.55					
3.00	SS-3	13	4	4	5
3.55					
4.00	SS-4	17	5	6	6
4.55					
5.00	SS-5	50/28	12	14	24/8
5.55					
6.00	SS-6	50/18	17	33/8	
	CS-1	c	o	r	e
7.55					
7.97	SS-7	50/17	23	27/7	
9.55	CS-2	c	o	r	e
9.84	SS-8	50/14	28	22/4	
11.55	CS-3	c	o	r	e
12.00	SS-9	41	11	13	17
13.55	CS-4	c	o	r	e
14.00	SS-10	11	3	4	4
14.55					
15.00	SS-11	50/21	15	31	4/1





LOCATION PLAN

Appendix 2.14 FIELD BORING LOG

Name of Project C3/R-4 FEASIBILITY STUDY Hole no. C-3 BH10

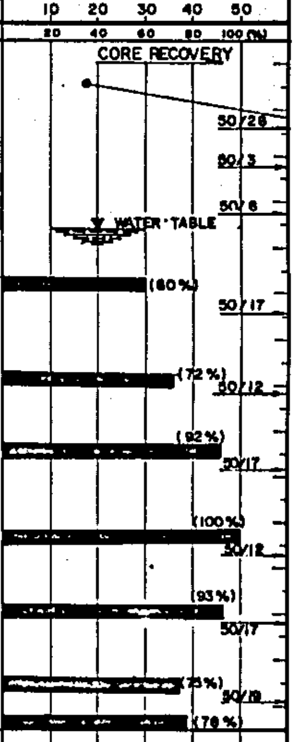
Grd. Elev. +10.26 Location Corner G. ARANETA AVE. and QUEZON BLVD.

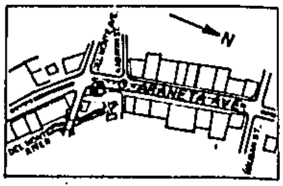
Water Table G.L. - 4.10 M. Date JUNE 19 - 21, 1977

SCALE IN (M.)	ELEVATION IN (M.)	DEPTH IN (M.)	THICKNESS	LEGEND	TYPE OF SOIL	COLOUR	RELATIVE DENSITY OR CONSISTENCY	GENERAL REMARKS
	9.26	1.00	1.00		CLAYEY SILT (WEATHERED SILTY TUFF)	light brown	very stiff	with some silty tuff fragments; slightly plastic fines.
	8.36	1.90	0.90		SILTY CLAY (WEATHERED SILTY TUFF)	dark brown	hard	intermixed with fragments of tuff; moderate plasticity.
	-1.34	11.60	9.70		SILTY TUFF	light grey	very hard	poorly cemented; slightly plastic fines. poor to moderately cemented; slightly plastic fine.
	[illegible]	[illegible]	[illegible]		SANDY TUFF			
	-2.94	13.20	2.08		SILTY TUFF	grey		poor to moderately cemented, slight to low plasticity fines
	-3.34	13.60	0.40		SANDY TUFF	light grey	very dense	coarse grained
	-4.74	15.00	1.40		SILTY TUFF	dark grey	very hard	friable
				END	OF BORING			

STANDARD PENETRATION TEST OR CORE RECOVERY

DEPTH IN (M.)	SAMPLING FOR LAB.	N-VALUE (BLOWS 30 CM)	BLOWS PER EACH 10 CM: 10 CM	10 CM	10 CM	(N - VALUE)
0.55 1.00	SS-1	17	9	4	4	
1.55 1.96	SS-2	50/26	1	5	44/6	50/26
2.55 [illegible]	SS-3	50/3	50/3			50/3
3.55 [illegible]	SS-4	50/6	50/6			50/6
5.55	CS-1		core			(60%)
5.87	SS-5	50/17	17	33/7		50/17
7.55	CS-2		core			(72%)
	SS-6	50/12				50/12
9.15	CS-3		core			(92%)
9.32	SS-7	50/17	50/17			50/17
11.00	CS-4		core			(100%)
11.12	SS-8	50/12	50/12	-		50/12
12.60	CS-5		core			(93%)
[illegible]	SS-9	50/17	50/17			50/17
14.20	CS-6		core			(75%)
14.24	SS-10	50/19	50/19			50/19
	CS-7					(76%)





LOCATION PLAN

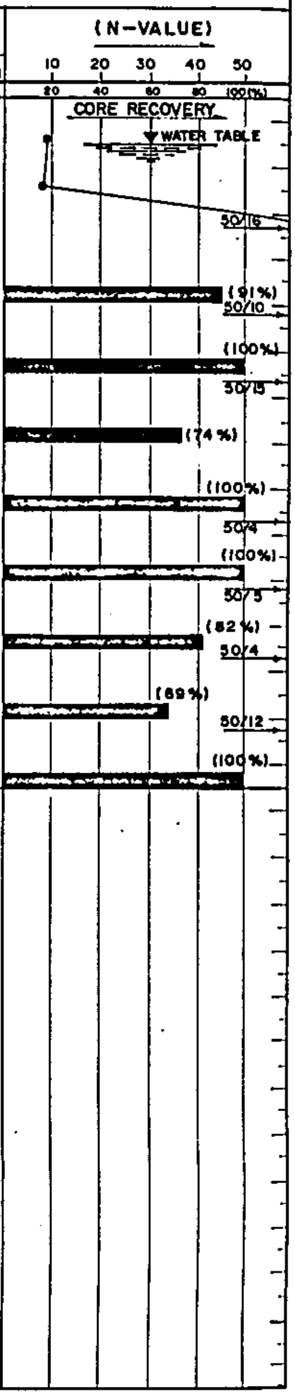
Appendix 2.15 FIELD BORING LOG

Name of Project C-3/R-4 FEASIBILITY STUDY
Hole no. C3-BH11
Grd. Elev. + 7.44 M.
Location Corner Del Monte Ave., Grace Park Ave.,
Water Table G.L. - 1.10 M.
Date JUNE 29-30, 1977

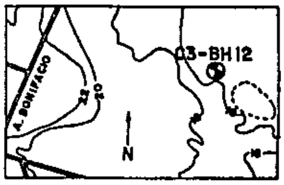
SCALE IN (M.)	ELEVATION IN (M.)	DEPTH IN (M.)	THICKNESS	LEGEND	TYPE OF SOIL	COLOUR	RELATIVE DENSITY OR CONSISTENCY	GENERAL REMARKS
1	6.44	1.00	1.00		CLAYEY SILT	dark brown	stiff	low plasticity (weathered sandy tuff)
2	5.44	2.00	1.00		CLAY	grayish brown	medium stiff	w/traces of coarse sand & fine gravels;high plasticity
3	4.58	2.86	0.86		CLAYEY TUFF	light gray	very hard	poor to moderately cemented; non to slightly plastic fines.
	2.94	4.50	1.64		SILTY TUFF			moderately cemented, porous.
6	1.44	6.00	1.50		SANDY TUFF			moderately cemented; slight to low plastic fines.
14	-6.56	14.00	8.00		SILTY TUFF			moderately cemented; slight to low plastic fines
15	-7.56	15.00	1.00		SANDY TUFF		very dense	compacted.
		END	OF	BORING				

STANDARD PENETRATION TEST OR CORE RECOVERY

DEPTH IN (M.)	SAMPLING FOR LAB.	N-VALUE BLOWS 30 CM	BLOWS PER EACH 10 CM 10 CM	10 CM	10 CM
0.55					
1.00	SS·1	9	3	3	3
1.55					
2.00	SS 2	8	2	3	3
2.55					
2.86	SS·3	50/16	30	20/6	
4.50	CS·1	c o	r e		
4.75	SS·4	50/10	50/10		
6.00	CS·2	c o	r e		
6.15	SS·5	60/15	50/15		
7.50	CS 3	c o	r e		
7.70	SS·6	50/5	50/15		
9.00	CS·4	c o	r e		
9.19	SS·7	50/4	50/4		
10.50	CS·5	c o	r e		
10.70	SS·8	50/5	50/5		
12.00	CS·6	c o	r e		
12.19	SS·9	50/4	50/4		
13.50	CS·7	c o	r e		
13.77	SS·10	50/12	35	15/2	
15.00	CS·8	c o	r e		



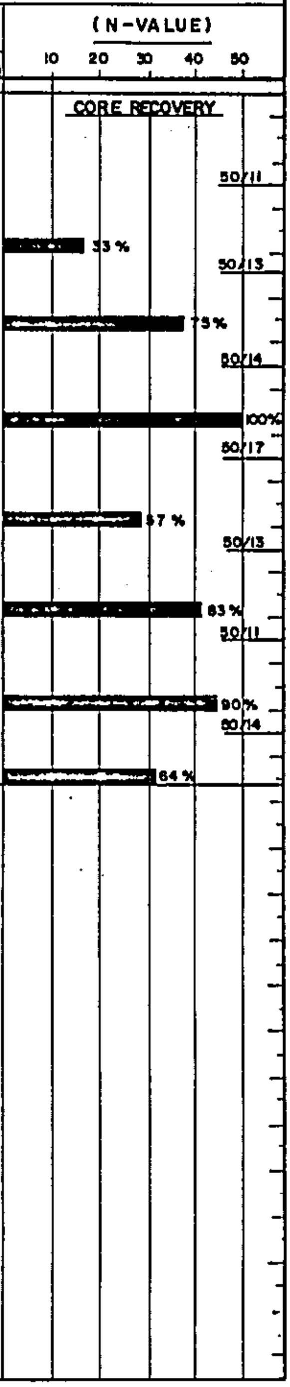
Appendix 2.16 FIELD BORING LOG



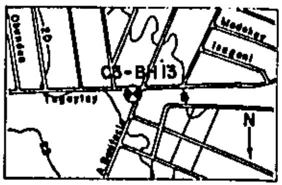
LOCATION PLAN

Name of Project C-3/R-4 FEASIBILITY STUDY
Hole no. C3-BH12
Grd. Elev. + 14.72 M.
Location Balingasa Elem. Sch. Compound, BALINTAWAK
Water Table G.L. -0.35 M.
Date AUG. 6-7, 1977

ELEVATION IN (M.)	DEPTH IN (M.)	THICKNESS	TYPE OF SOIL	COLOUR	RELATIVE DENSITY OR CONSISTENCY	GENERAL REMARKS
13.72	1.00	1.00	SANDY SILT	greyish	stiff	medium grained
			SANDY TUFF	dark gray	hard	fine grained
				greyish brown		fine grained, jointed.
10.72	4.00	2.00				fine grained.
	5.30	1.30	SILTY TUFF		very dense	medium grained;
			SANDY TUFF			medium grained.
7.42	7.30	3.00				lapilli; medium to coarse grained.
			SILTY TUFF	yellowish brown	hard	fine grained; jointed.
				grayish brown dark grey		fine grained.
-0.38	15.10	7.80				jointed.
	END	OF	BORING			



DEPTH IN (M.)	SAMPLING FOR LAB.	N-VALUE	BLOWS PER EACH 10 CM: 10 CM	10 CM	10 CM	(N-VALUE) / CORE RECOVERY
0.55						
1.00	SS-1	10	3	3	4	
1.55						
2.00	SS-2	50/11	45	5/1		50/11
3.50	CS-1	core				33 %
4.00	SS-3	50/13	50/13			50/13
5.30	CS-2	core				75%
6.00	SS-4	50/14	36	14/4		50/14
7.30	CS-3	core				100%
7.55						
8.00	SS-5	50/17	21	29/7		50/17
9.50	CS-4	core				57 %
10.00	SS-6	50/13	36	14/3		50/13
11.50	CS-5	core				83 %
12.00	SS-7	50/11	46	6/1		50/11
13.50	CS-6	core				90%
14.00	SS-8	50/14	50/14			50/14
15.10	CS-7	core				64 %



LOCATION PLAN

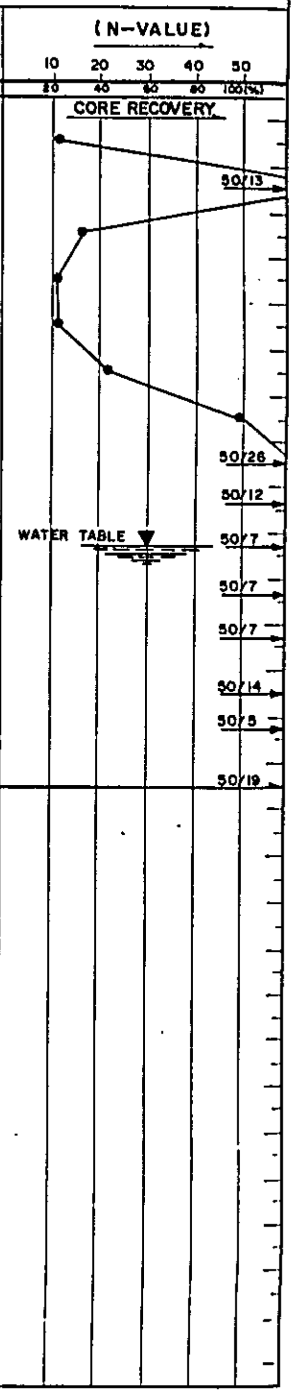
Appendix 2.17 FIELD BORING LOG

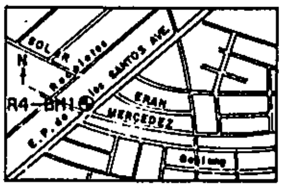
Name of Project C-3/R-4 FEASIBILITY STUDY
Hole no. C3-BH'13
Grd. Elev. + 16.89 M.
Location Corner A. Bonifacio St. and Sgt. Rivera St., Q.C.
Water Table G.L. -9.70 M.
Date JUNE 24-27, 1977

SCALE IN (M.)	ELEVATION IN (M.)	DEPTH IN (M.)	THICKNESS	LEGEND	TYPE OF SOIL	COLOUR	RELATIVE DENSITY OR CONSISTENCY	GENERAL REMARKS
1	15.89	1.00	1.00	▨	SANDY CLAY		medium dense	medium to coarse sand; slight to low plastic fines.
2	14.89	2.00	1.00	⁘	GRAVELS		very dense	no recovery
5	11.89	5.00	3.00	▨	SILTY CLAY	buff brown buff gray	very stiff stiff	moderate plastic fines.
7	9.89	7.00	2.00	▥	CLAYEY SILT	light gray light brown	very stiff hard	w/traces of fine to medium gravel; slight to low plastic fines.
	6.34	10.55	3.55	░	SANDY TUFF	brown dark gray light gray	very dense very hard	medium to coarse sand; w/traces of peasize gravel; low plastic fines. w/traces of gravel & silty tuff fragments; non to slight plastic fines. w/traces of silty tuff; slight to low plastic fines.
	6.09	10.80	0.25	░	SILTY TUFF			
	5.12	11.77	0.97	░	SANDY TUFF	dark gray	very dense	fine grained; w/some gravel; non plastic fines.
13	3.89	13.00	1.23	⁘	COARSE TUFFACEOUS SAND	grayish brown		medium to coarse; w/ some gravels; non plastic fines.
15	1.89	15.00	2.00	▓	SILTY TUFF	buff gray grayish brown	very hard very dense	friable,w/traces of fine gravel; slight to low plastic fines fine to medium sand; w/traces of fine gravel; non plastic fines.
		END	OF	BORING				

STANDARD PENETRATION TEST OR CORE RECOVERY

DEPTH IN (M.)	SAMPLING FOR LAB.	N-VALUE BLOWS 30 CM	BLOWS PER EACH 10 CM: 10 CM	10 CM	10 CM
0.55					
1.00	SS-1	13	4	4	5
1.55					
2.00	SS-2	50/13	50/13		
2.55					
3.00	SS-3	17	5	5	7
3.55					
4.00	SS4	13	3	4	6
4.55					
5.00	SS-5	13	4	4	5
5.55					
6.00	SS6	22	8	5	9
6.55					
7.00	SS 7	49	6	10	33
7.55					
8.00	SS 8	50/26	10	19	21/6
8.55					
8.80	SS9	50/12	34	16/2	
9.55					
9.79	SS10	50/7	50/7		
10.55					
10.80	SS-11	50/7	50/7		
11.55					
11.77	SS12	50/7	50/7		
12.55					
13.00	SS13	50/14	33	17/4	
13.55					
13.75	SS 14	50/5	50/5		
14.55					
15.00	SS-15	50/19	14	36/9	





LOCATION PLAN

Appendix 2.18 FIELD BORING LOG

Name of Project C-3/R-4 FEASIBILITY STUDY

Hole no. R4-BH1

Grd. Elev. + 17.49 M.

Location EDSA at R-4 INTERSECTION.

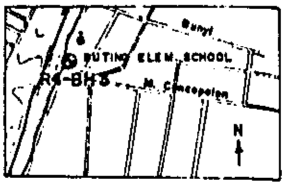
Water Table G.L. - 1.10 M.

Date 29 JULY-2 AUG.1977

ELEVATION IN (M.)	DEPTH IN (M.)	THICKNESS	LEGEND	TYPE OF SOIL	COLOUR	RELATIVE DENSITY OR CONSISTENCY	GENERAL REMARKS
16.49	1.00	1.00	▥	CLAYEY SILT	brown	medium	low to moderate plasticity.
15.49	2.00	1.00	▨	CLAY	dark gray		w/ fine gravel; high plasticity.
14.49	3.00	1.00	▥	SANDY SILT	dark brown	very dense	w/ fine gravel; slight to low plasticity.
13.84	3.65	0.65					no recovery
8.80	8.69	5.04	░	SANDY TUFF	dark gray		medium grained. moderate to coarse grained. fine to medium grained. fine grained.
4.49	13.00	4.31		SILTY TUFF	yellowish brown light gray dark gray		moderately hard. fine grained.
2.46	15.03	2.03	░	SANDY TUFF	grayish brown		
	END OF BORING						

STANDARD PENETRATION TEST OR CORE RECOVERY

DEPTH IN (M.)	SAMPLING FOR LAB.	N-VALUE BLOWS 30 CM	BLOWS PER EACH 10 CM 10 CM	10 CM	10 CM	(N-VALUE) 10 20 30 40 50 CORE RECOVERY 20 40 60 80 100(%)
0.55 1.00	SS-1	8	3	2	3	
1.55 2.00	SS-2	8	2	2	4	▼W.T.
2.55 3.00	SS-3	50/26	11	18	21/6	50/26
3.55 3.65	SS-4	50/10	50/10			50/10
5.80	CS-1	c	o	r	e	35%
5.83	SS-5	50/3	50/3			50/3
7.00	CS-2	c	o	r	e	60%
7.20	SS-6	50/6	50/6			50/5
8.50	CS-3	c	o	r	e	96%
8.54	SS-7	50/4	50/4			50/4
10.00	CS-4	c	o	r	e	80 %
10.45	SS-8	42	12	13	17	
11.50	CS-5	c	o	r	e	38%
11.64	SS-9	50/4	50/4			50/4
13.00	CS-6	c	o	r	e	92%
13.35	SS-10	50/10	50/10			50/4
14.80	CS-7	c	o	r	e	90%
15.03	SS-11	50/6	50/6			50/6



LOCATION PLAN

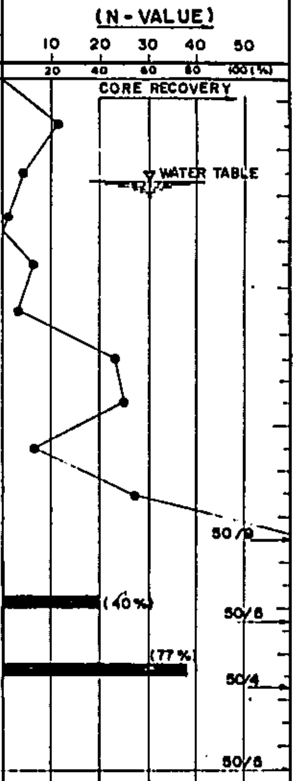
Appendix 2.19 **FIELD BORING LOG**

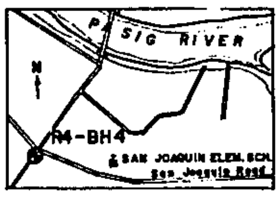
Name of Project C3 / R4 FEASIBILITY STUDY
Hole no. R4-BH3
Grd. Elev. + 3.52 M.
Location Right of BUTING BRIDGE ,BUTING,PASIG,METRO MANILA
Water Table G.L. - 2.20 M.
Date JULY 6 - 9 ,1977

ELEVATION IN (M.)	DEPTH IN (M.)	THICKNESS	LEGEND	TYPE OF SOIL	COLOUR	RELATIVE DENSITY OR CONSISTENCY	GENERAL REMARKS
2.52	1.00	1.00		SILTY CLAY	dark brown	stiff	w/sand; low to moderate plasticity.
0.52	3.00	2.00		SANDY SILT		very loose	slight to low plastic fines.
-0.48	4.00	1.00		SANDY CLAY		loose	low to moderate plastic fines.
-2.48	6.00	2.00		SILTY SAND		very loose medium dense	w/ fine gravel; non to slight plastic fines slightly plastic fines
-3.48	7.00	1.00					
-4.48	8.00	1.00		SEA SHELL FRAGMENTS	light gray	loose	w/stiff & sand; non-plastic fines.
-5.48	9.00	1.00		SILTY TUFF	dark gray	medium dense	weathered; poorly cemented.
-11.48	15.00	6.00		SANDY TUFF	brownish gray dark gray brownish gray	very dense	fine to medium grained; poor to moderately cemented. wash no recovery
	ENG	OF	BORING				

STANDARD PENETRATION TEST OR CORE RECOVERY

DEPTH IN (M.)	SAMPLING FOR LAB.	N-VALUE BLOWS 30 CM	BLOWS PER EACH 10 CM 10 CM	 10 CM	 10 CM
0.55					
1.00	SS-1	11	5	3	3
1.55					
2.00	SS-2	4	1	2	1
2.55					
3.00	SS-3	1	0	1	0
3.55	ST-1	pressed			
4.00	SS-4	7	3	2	2
4.55					
5.00	SS-5	3	1	1	1
5.55					
6.00	SS-6	23	6	8	9
6.55					
7.00	SS-7	25	9	8	8
7.55					
8.00	SS-8	7	3	2	2
8.55					
9.00	SS-9	28	6	9	13
9.55					
1000	SS10	50/9	50/9		
11.50	CS-1				
11.70	SS11	50/5	50/5		
13.00	CS-2				
13.19	SS12	50/4	50/4		
	CS-3				
14.80					
15.00	SS-13	50/5	50/5		



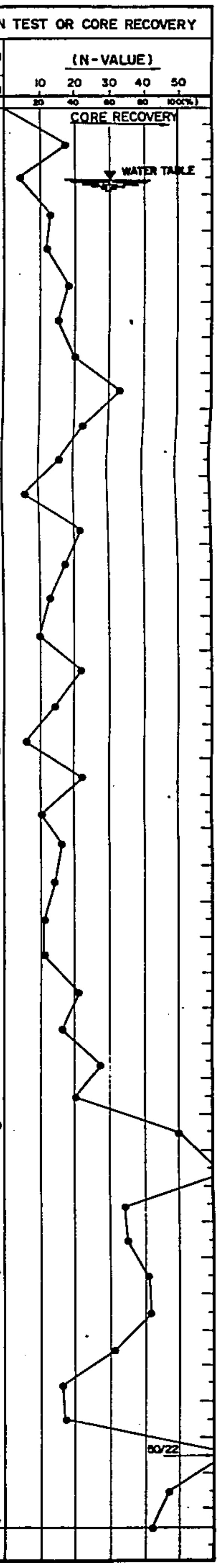


LOCATION PLAN

Appendix 2.20 **FIELD BORING LOG**

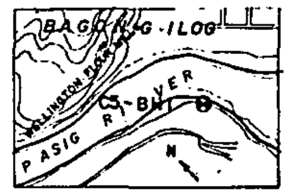
Name of Project C-3/R-4 FEASIBILITY STUDY
Hole no. R4-BH4
Grd. Elev. + 3.70 M.
Location End of R4, San JOAQUIN, PASIG, METRO MANILA
Water Table G.L. - 2.10 M.
Date JULY 10-19, 1977

SCALE IN (M.)	ELEVATION IN (M.)	DEPTH IN (M.)	THICKNESS	LEGEND	TYPE OF SOIL	COLOUR	RELATIVE DENSITY OR CONSISTENCY	GENERAL REMARKS	STANDARD PENETRATION TEST OR CORE RECOVERY					
									DEPTH IN (M)	SAMPLING FOR LAB.	N-VALUE BLOWS 30cm	BLOWS PER EACH 10 CM		
												10 CM	10 CM	10 CM
				▨	SILTY CLAY	grayish brown	very stiff	low to moderate plastic fines	0.55					
1	2.70	1.00	1.00						1.00	SS-1	17	4	7	6
				▨	SANDY CLAY	gray	very loose		1.55	ST-1	p r	e	s s	e d
2	1.70	2.00	1.00						2.00	SS-2	4	1	1	2
				▥	SILTY SAND	dark gray	medium dense	with fine grave, non-plastic fines	2.55					
3									3.00	SS-3	13	2	5	6
						dark brown			3.55					
4									4.00	SS-4	12	4	3	5
									4.55					
5									5.00	SS-5	18	5	6	7
									5.55					
6									6.00	SS-6	15	4	5	6
						dark grey		with gravel ; non plastic fines	6.55					
7									7.00	SS-7	20	4	6	10
							dense		7.55					
8									8.00	SS-8	33	10	12	11
							medium dense	with fine gravel, non plastic fines	8.55					
9									9.00	SS-9	22	10	6	6
									9.55					
10	-6.30	10.00	8.00						10.00	SS-10	16	5	5	6
				▨	CLAYEY SAND		loose	with fine gravel and sea-shell fragments, slight to low plastic fines	10.55					
11	-7.30	11.00	1.00						11.00	SS-11	6	3	2	1
				░	SAND		medium dense	with seashells	11.55					
12									12.00	SS-12	22	7	7	8
									12.55					
13									13.00	SS-13	18	6	5	7
									13.55					
14	-10.30	14.00	3.00						14.00	SS-14	13	5	4	4
				◎	SEASHELLS	light gray		with sand	14.55					
15									15.00	SS-15	10	3	4	3
									15.55					
16	-12.30	16.00	2.00						16.00	SS-16	22	7	8	7
				░	SAND	dark gray		with seashells	16.55					
17	-13.30	17.00	1.00						17.00	SS-17	14	8	4	2
				▨	SILTY CLAY	light gray	medium stiff	with seashells, low to moderate plastic fines.	17.55					
18									18.00	SS-18	6	2	2	2
	-14.80	18.50	1.50						18.55	ST-2	p r	e	s s	e d
19	-15.30	19.00	0.50	▥	SILTY SAND			with seashells; non to slight plastic fines	19.00	SS-19	22	7	7	8
				▨	CLAYEY FINE SAND	dark gray	loose	with seashells, and light to low plastic fines	19.55					
20	-16.30	20.00	1.00						20.00	SS-20	10	4	3	3
				▨	CLAY		very stiff	high plasticity	20.55					
21									21.00	SS-21	16	6	5	5
									21.55					
22									22.00	SS-22	14	4	6	6
							stiff		22.55					
23									23.00	SS-23	11	4	4	3
						brown			23.55					
24									24.00	SS-24	11	3	4	4
							very stiff		24.55					
25									25.00	SS-25	21	7	7	7
									25.55					
26									26.00	SS-26	16	4	5	7
						light brown			26.55					
27									27.00	SS-27	27	9	9	9
									27.55					
28	-24.30	28.00	8.00						28.00	SS-28	20	6	7	7
				▨	CLAY	dark brown	hard	high plasticity	28.55					
29									29.00	SS-29	50	11	19	20
						grayish brown			29.55					
30	-26.30	30.00	2.00						30.00	SS-30	50/16	29	21/6	
				▨	CLAY	light brown		high plasticity	30.55					
31									31.00	SS-31	34	9	12	13
									31.55					
32									32.00	SS-32	35	10	12	13
						brown			32.55					
33									33.00	SS-33	41	12	15	14
						grayish brown			33.55					
34									34.00	SS-34	42	13	15	14
						dark gray			34.55					
35									35.00	SS-35	31	9	11	11
							very stiff		35.55					
36	-32.30	36.00	8.00						36.00	SS-36	16	5	5	6
				▥	CLAYEY SILT			low to moderate plasticity	36.55					
37	-33.30	37.00	1.00						37.00	SS-37	17	4	6	7
				▨	CLAYEY SAND	brownish grey	very dense	slightly to low plasticity with angular gravel	37.55					
38									38.00	SS-38	50/22	18	28	4/2
							dense		38.55					
39	-35.30	39.00	2.00						39.00	SS-39	47	30	13	4
				▨	CLAY	dark gray	hard	high plasticity, moderately weathered sandy tuff	39.55					
40	-36.30	40.00	1.00						40.00	SS-40	42	13	13	16
			END	OF BORING										



Appendix 2.21 **FIELD BORING LOG**

Name of Project C3/R4/C5 FEASIBILITY STUDY
Hole no. C5 BH-1
Grd. Elev + 3.87 M.
Location Left Side of PASIG RIVER of FORT BONIFACIO
Water Table GL - 2.50 M.
Date JULY 1-8, 1977

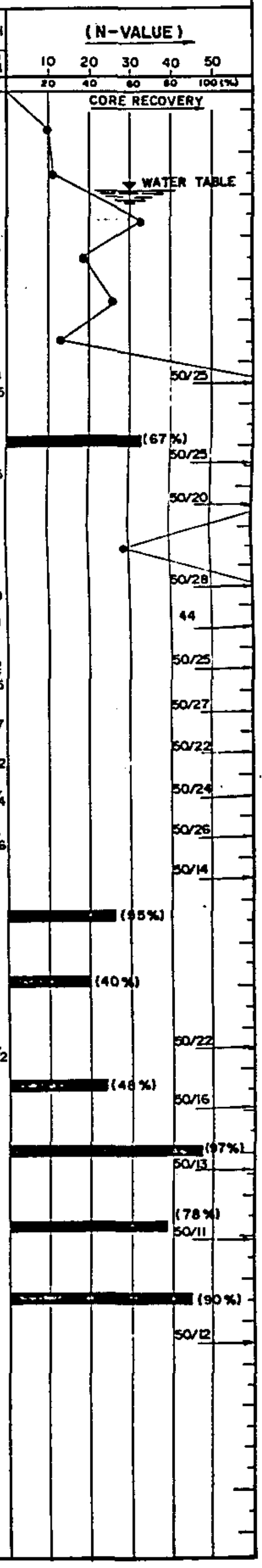


LOCATION PLAN

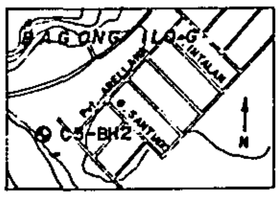
ELEVATION IN (M.)	DEPTH IN (M.)	THICKNESS	TYPE OF SOIL	COLOUR	RELATIVE DENSITY OR CONSISTENCY	GENERAL REMARKS
2.87	1.00	1.00	CLAYEY FINE SAND	dark brown	medium dense	with appreciable amount of fine gravels, slight plastic fines.
1.87	2.00	1.00	SILTY SAND	grayish brown		fine sand with traces of coarse grained sandy tuff (lapillic) grading to agglomerate formation, slight to low plasticity
-0.13	4.00	2.00				medium to coarse sand, with considerable amount of gravels.
-1.13	5.00	1.00				
-2.13	6.00	1.00		dark gray		with peasize gravels, with mottles of shell particles.
-3.13	7.00	1.00			very dense	with traces of silty tuff fragments & shell particles
-4.13	8.00	1.00	SILTY TUFF	massive gray		highly weathered
-4.63	8.50	0.50	SANDY TUFF	grayish brown		coarse grained
-5.03	8.90	0.40				with trace of medium gravel and fine sandy tuff fragments
-6.03	9.90	1.00				slightly compacted and tuffaceous
-7.13	11.00	1.10	CLAYEY TUFF	buff brown	medium dense	with mottles of silty tuff fragments, slightly moderate plastic fines.
-8.13	12.00	1.00	SANDY TUFF	brownish gray	very dense	with traces of lapilli tuff fragments, slightly low plastic fines.
-9.13	13.00	1.00	SILTY TUFF	buff brown		with mottles of silty tuff fragments and fine gravel, low plasticity.
-9.93	13.80	0.80	SANDY TUFF	grayish brown		slightly compacted and tuffaceous
-10.13	14.00	0.20	SILTY TUFF	buff brown		same as ss-12
-11.13	15.00	1.00	SILTY TUFF	brownish gray		with appreciable amount of fine to medium gravel and lapilli tuff fragments
-12.05	15.92	0.92	FINE SANDY TUFF	dark gray		fine to coarse sand, with peasize gravel; slightly tuffaceous
-13.13	17.00	1.08				fine sand (wash sample)
-14.09	17.96	0.96				medium to coarse sand with fine to medium subrounded gravels, tuffaceous
-14.97	18.84	0.88	SANDY TUFF			fragmented with silty coarse sand.
-17.63	21.50	2.66	COARSE SANDY TUFF	black		porous; micaceous origin; badly weathered
-19.05	22.92	1.42		dark gray		with traces with lapilli tuff fragments
-20.13	24.00	1.08		black		porous, micaceous origin, badly weathered, friable
-20.44	24.31	0.31	FINE SANDY TUFF			medium to coarse sand with lapilli tuff fragments.
-21.68	25.55	1.24	COARSE SANDY TUFF	brownish gray		coarse grained, porous and badly weathered, grading to conglomerate strata.
-21.96	25.83	0.32	FINE SANDY TUFF			same as ss-20
-23.43	27.30	1.47	SANDY TUFF	light gray		fine to medium grained, porous and badly weathered
-23.69	27.56	0.26		light brown		fragmented with silty coarse sand, low plasticity
-25.13	29.00	1.44		light gray		fine to medium grained porous and badly weathered.
-26.13	30.00	1.00		dark gray		fragments, with silty coarse sand, low plasticity
	END	OF	BORING			

STANDARD PENETRATION TEST OR CORE RECOVERY

DEPTH IN (M.)	SAMPLING FOR LAB.	N-VALUE BLOWS 30 cm	BLOWS PER EACH 10 CM. 10 CM	10 CM	10 CM
0.5					
1.00	SS-1	10	2	3	5
1.55					
2.00	SS-2	11	3	4	4
2.55					
3.00	SS-3	32	17	9	6
3.55					
4.00	SS-4	19	5	4	10
4.55					
5.00	SS-5	26	9	9	8
5.55					
6.00	SS-6	13	5	4	4
6.55					
7.00	SS-7	50/25	8	14	28/5
8.50	CS-1		c o	r	e
8.90	SS-8	50/25	15	23	12/5
9.55					
9.90	SS-9	50/20	29	21/10	
10.55					
11.00	SS-10	29	8	9	12
11.55					
12.00	SS-11	50/28	14	20	16/8
12.55					
13.00	SS-12	44	10	16	18
13.55					
14.00	SS-13	50/25	12	16	22/5
14.55					
15.00	SS-14	50/27	9	24	17/7
15.55					
16.00	SS-15	50/22	10	33	7/2
16.55					
17.00	SS-16	50/24	11	20	19/4
17.55					
18.00	SS-17	50/26	18	24	8/6
18.55					
19.00	SS-18	50/14	28	22/4	
	CS-2		c o	r	e
21.50	CS-3		c o	r	e
22.55					
22.92	SS-19	50/22	16	30	4/2
24.00	CS-4		c o	r	e
24.31	SS-20	50/16	32	18/6	
25.55	CS-5		c o	r	e
25.83	SS-21	50/13	33	17/3	
27.30	CS-6				
27.56	SS-22	50/11	34	16/11	
29.00	CS-7		c o	r	e
29.55					
30.00	SS-23	50/12			



Appendix 2.22 FIELD BORING LOG



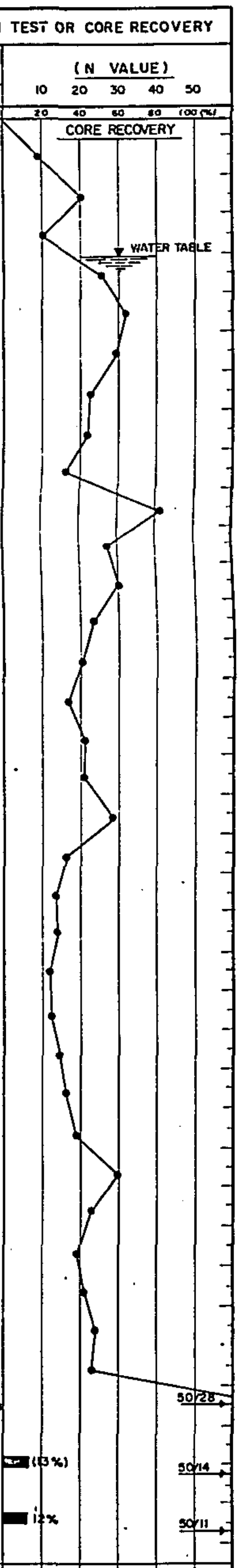
LOCATION PLAN

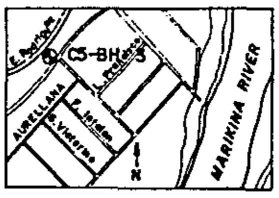
Name of Project .C-3/R-4/C-5 FEASIBILITY STUDY
Hole no. C5 - BH2
Grd. Elev. + 4.95 M.
Location Right side of PASIG RIVER at PASIG, Metro-Manila
Water Table GL - 3.60 M.
Date JULY 9-24, 1977

ELEVATION IN (M.)	DEPTH IN (M.)	THICKNESS	TYPE OF SOIL	COLOUR	RELATIVE DENSITY OR CONSISTENCY	GENERAL REMARKS
2.95	2.00	2.00	SANDY SILT	dark brown	loose medium dense	low plastic fines. w/gravel; low plastic fines.
-1.05	6.00	4.00	SILTY SAND		medium dense	w/gravel; non to slightly plastic fines. non-plastic fines.
-2.05	7.00	1.00	SANDY SILT			w/ pea-size gravel; non-plastic fines.
-5.05	10.00	3.00	SILTY MEDIUM TO COARSE SAND		very dense	
-7.05	12.00	8.00	SILTY FINE SAND			w/seashell fragments, non-plastic fines.
-8.05	13.00	1.00	CLAYEY SAND			w/seashell fragments; low to slightly plastic fines.
-22.05	27.00	14.00	SAND	dark gray	medium dense	fine to medium w/ seashell fragments; non plastic fines.
-27.05	32.00	5.00	FINE SAND	dark gray	medium dense	moderately fine to medium sand; w/sea shell fragments; non plastic fines.
-28.05	33.00	1.00	GRAVELLY SAND			w/shell fragments; non plastic fines.
-31.05	36.00	3.00	GRAVEL		very dense	coarse gravel no recovery
-32.05	37.00	1.00	GRAVELLY SAND		dense	w/ sea shells
	END	OF	BORING			

STANDARD PENETRATION TEST OR CORE RECOVERY

DEPTH IN (M.)	SAMPLING FOR LAB.	N VALUE BLOWS 30 CM	BLOWS PER EACH 10 CM. 10 CM	10 CM	10 CM
0.55 1.00	SS-1	9	4	3	2
1.55 2.00	SS-2	20	7	7	6
2.55 3.00	SS-3	10	3	3	4
3.55 4.00	SS-4	25	6	8	11
4.55 5.00	SS-5	32	8	11	13
5.55 6.00	SS-6	29	10	10	9
6.55 7.00	SS-7	22	6	6	10
7.55 8.00	SS-8	22	7	5	10
8.55 9.00	SS-9	16	6	4	6
9.55 10.00	SS-10	41	14	13	14
10.55 11.00	SS-11	27	11	6	10
11.55 12.00	SS12	30	7	11	12
12.55 13.00	SS13	23	5	9	9
13.55 14.00	SS14	20	6	7	7
14.55 15.00	SS15	17	7	5	5
15.55 16.00	SS16	21	6	7	8
16.55 17.00	SS-17	21	9	7	5
17.55 18.00	SS18	29	12	9	8
18.55 19.00	SS19	16	4	5	7
19.55 20.00	SS20	13	4	5	4
20.55 21.00	SS21	13	4	4	5
21.55 22.00	SS22	12	3	4	5
22.55 23.00	SS23	12	4	3	5
23.55 24.00	SS24	14	6	4	4
24.55 25.00	SS25	16	4	5	7
25.55 26.00	SS26	19	5	5	9
26.55 27.00	SS27	30	8	13	9
27.55 28.00	SS28	23	7	7	9
28.55 29.00	SS29	19	8	6	5
29.55 30.00	SS30	21	7	7	7
30.55 31.00	SS31	24	6	8	10
31.55 32.00	SS32	23	7	9	7
32.55 33.00	SS33	50/28	12	27	11/8
34.50	CS-1	core			
34.70	SS34	50/14	50/14		
36.00	CS-2	core			
36.20 37.00	SS35	50/11	50/11		



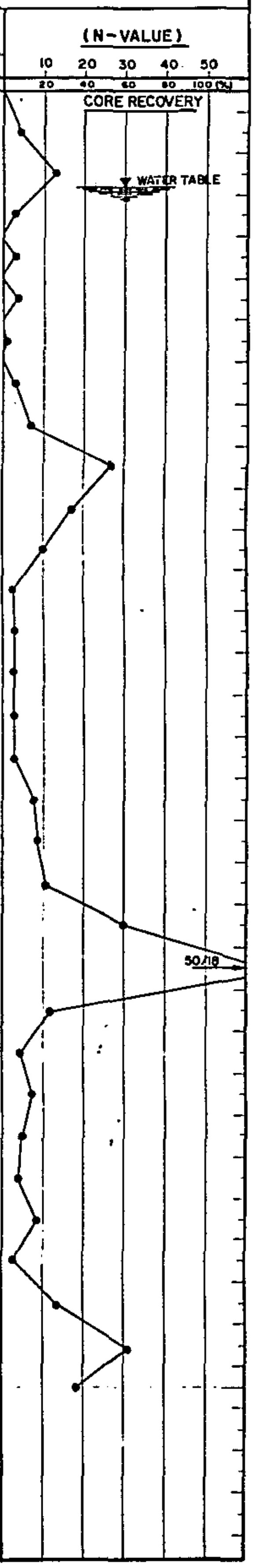


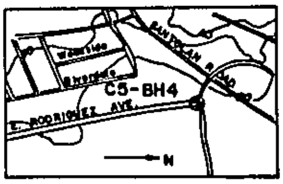
LOCATION PLAN

Appendix 2.23 FIELD BORING LOG

Name of Project C3/R4/C5 FEASIBILITY STUDY　Hole no. C5-BH3
Grd. Elev. + 4.81 M.　Location Corner PASIG BLVD. AND Dr. MAXIMO FLORES ST.
Water Table G.L. – 10.70 M.　Date AUGUST 3-6, 1977

SCALE IN (M.)	ELEVATION IN (M.)	DEPTH IN (M.)	THICKNESS	LEGEND	TYPE OF SOIL	COLOUR	RELATIVE DENSITY OR CONSISTENCY	GENERAL REMARKS	STANDARD PENETRATION TEST OR CORE RECOVERY					
									DEPTH IN (M.)	SAMPLING FOR LAB.	N-VALUE BLOWS 30CM	BLOWS PER EACH 10 CM. 10 CM	10 CM	10 CM
					SILTY SAND	brownish gray	medium dense	with angular fragments of fine siltstone, low to non plasticity.	0.55					
1									1.00	SS-1	4	2	1	1
								with gravel fragments with fine sand,low plasticity	1.55					
2	2.81	2.00	1.00						2.00	SS-2	13	3	5	5
					CLAYEY SILT	light brownish gray	soft	low to moderate plasticity	2.55					
3									3.00	SS-3	3	1	1	1
									3.55	ST-1	pressed			
4	0.81	4.00	2.00						4.00	SS-4	3	1	1	1
					ORGANIC CLAYEY SILT	dark brownish gray			4.55	ST-2	pressed			
5									5.00	SS-5	4	1	1	2
							very soft		5.55	ST-3	pressed			
6									6.00	SS-6	1	0	1	0
							soft		6.55	ST-4	pressed			
7	-2.19	7.00	5.00						7.00	SS-7	3	1	1	1
					SILTY FINE TO COARSE SAND	dark gray	loose	with few angular rock fragment, low to slight plasticity	7.55					
8	-3.19	8.00	1.00						8.00	SS-8	7	1	2	4
					MEDIUM TO COARSE SAND		medium dense	coarse grained, all mixed with pebble size gravel	8.55					
9	-4.19	9.00	1.00						9.00	SS-9	27	10	9	8
					COARSE SAND & FINE GRAVEL			pebble size with small amount of sand	9.55					
10	-5.19	10.00	1.00						10.00	SS-10	17	7	6	4
	-5.99	1080	0.80		SILTY VERY FINE SAND		loose	non-plastic fines	10.55					
11									11.00	-11.	10	5	2	3
					ORGANIC SILTY CLAY		soft	low to moderate plasticity	11.55					
12									1200	-12	3	1	1	1
								with minor shell particles	12.55					
13	-8.19	13.00	1.00						13.00	-13	3	1	1	1
					CLAYEY SILT			with appreciable shell particles	1355					
14	-9.19	1400	100						14.00	-14	3	1	1	1
					SILTY CLAY	light gray		moderate to high plasticity, plenty of tiny shells.	1455					
15									15.00	-15	3	1	1	1
								moderate plasticity with plenty of seashell fragment	1555					
16									1600	-16	3	1	1	1
						dark gray		few traces of shells	1655					
17									1700	-17	8	2	2	4
						bluish gray	medium stiff	with angular fine gravel fragments.	1755					
18									1800	-18	9	3	3	3
						dark yellowish brown		tuffaceous	18.55					
19	-14.19	19.00	5.00						19.00	-19	11	3	4	4
					CLAYEY SILT	yellowish brown	dense	highly weathered, non to slightly plastic fine	1955					
20									2000	-20	30	9	15	16
							very dense		2055					
21	-17.19	21.00	2.00						21.00	-21	50/18	15	18	17/8
					SILTY CLAY		stiff	moderate plasticity	2155					
22									2200	-22	12	3	4	5
							medium stiff		2255					
23									2300	-23	5	1	2	2
								with traces of seashell fragment, moderate plasticity	2355					
24	-19.19	2400	3.00						2400	-24	8	2	3	3
					CLAYEY SILT			low to moderate plasticity	2455					
25	20.19	2500	1.00						2500	-25	5	1	2	2
					ORGANIC CLAYEY SILT	dark gray		with traces of seashells fragments moderate plasticity.	2555					
26									2600	-26	4	1	1	2
							stiff		2655					
27	22.19	2700	2.00						2700	-27	9	3	3	3
					CLAYEY SILT		soft	low to moderately plasticity.	2755					
28	23.19	2800	7.00						2800	-28	3	1	1	1
					CLAYEY SAND	grayish brown	medium dense	fine to medium tuffaceous grained, slightly non plastic fines.	2855					
29	24.19	2900							2900	-29	14	7	3	4
					SILTY CLAY	dark bluish gray	very stiff	with tuffaceous fragment	2055					
30									3000	-30	31	10	11	10
								slightly organic	3055					
31	27.19	31.00	2.00						3100	-31	18	4	6	8
					END OF	BORING								
32														
33														
34														
35														





LOCATION PLAN

Appendix 2.24 FIELD BORING LOG

Name of Project C3/R-4/C5 FEASIBILITY STUDY

Hole no. C5-BH4

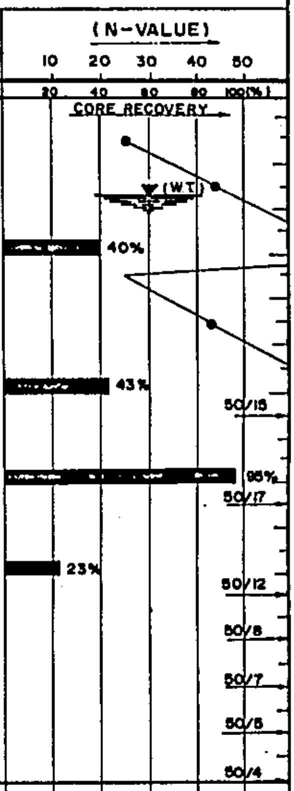
Grd. Elev. + 18.59 M.

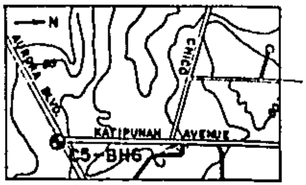
Location Corner RODRIGUEZ AVE. and SANTOLAN Rd. libis, MURPHY

Water Table G.L. - 2.20 M.

Date AUGUST 4-5, 1977

SCALE IN (M)	ELEVATION IN (M)	DEPTH IN (M)	THICKNESS	LEGEND	TYPE OF SOIL	COLOUR	RELATIVE DENSITY OR CONSISTENCY	GENERAL REMARKS	STANDARD PENETRATION TEST OR CORE RECOVERY						
									DEPTH IN (M.)	SAMPLING	FOR LAB	N-VALUE BLOWS 30cm	BLOWS PER EACH 10 CM. 10 CM	10 CM	10 CM
				▨	SILTY CLAY	grayish brown	very stiff	moderate plasticity	0.55						
									1.00		SS-1	25	7	8	10
							hard		1.55						
	16.59	2.00	2.00						2.00		SS-2	44	19	12	13
	15.09	3.50	1.50	▩	SILTY TUFF	light brown	hard	slightly weathered	3.50		CS-1		core		
				▨	SILTY CLAY	yellowish	very stiff	moderate plasticity	4.00		SS-3	25	6	8	11
	13.59	5.00	1.50				hard		5.00		SS-4	43	13	14	16
	12.09	6.50	1.50	▥	SILTY TUFFACEOUS SAND	brown	very dense	slightly weathered	6.50		CS-2		core		
				▩	SILTY TUFF	light gray	hard		7.00		SS-5	50/15	28	22/5	
	10.09	8.50	2.00						8.50		CS-3		core		
				●	TUFFACEOUS GRAVEL	brown	very dense	pebbly to cobbly size	9.00		SS-6	50/17	26	24/7	
									10.50		CS-4		core		
									11.00		SS-7	50/12	37	13/2	
						brownish gray			11.55						
									12.00		SS-8	50/8	50/7		
									12.55						
									13.00		SS-9	50/7	50/7		
						dark gray			13.55						
									14.00		SS10	50/5	50/5		
						yellowish brown			14.55						
	3.59	15.00	6.50						15.00		SS11	50/4	50/4		
			END	OF	BORING										





LOCATION PLAN

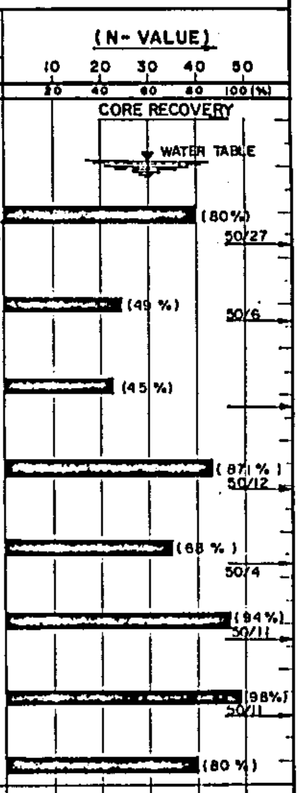
Appendix 2.25 FIELD BORING LOG

Name of Project C-3/R-4/C-5 FEASIBILITY STUDY Hole no. C5 – BH6

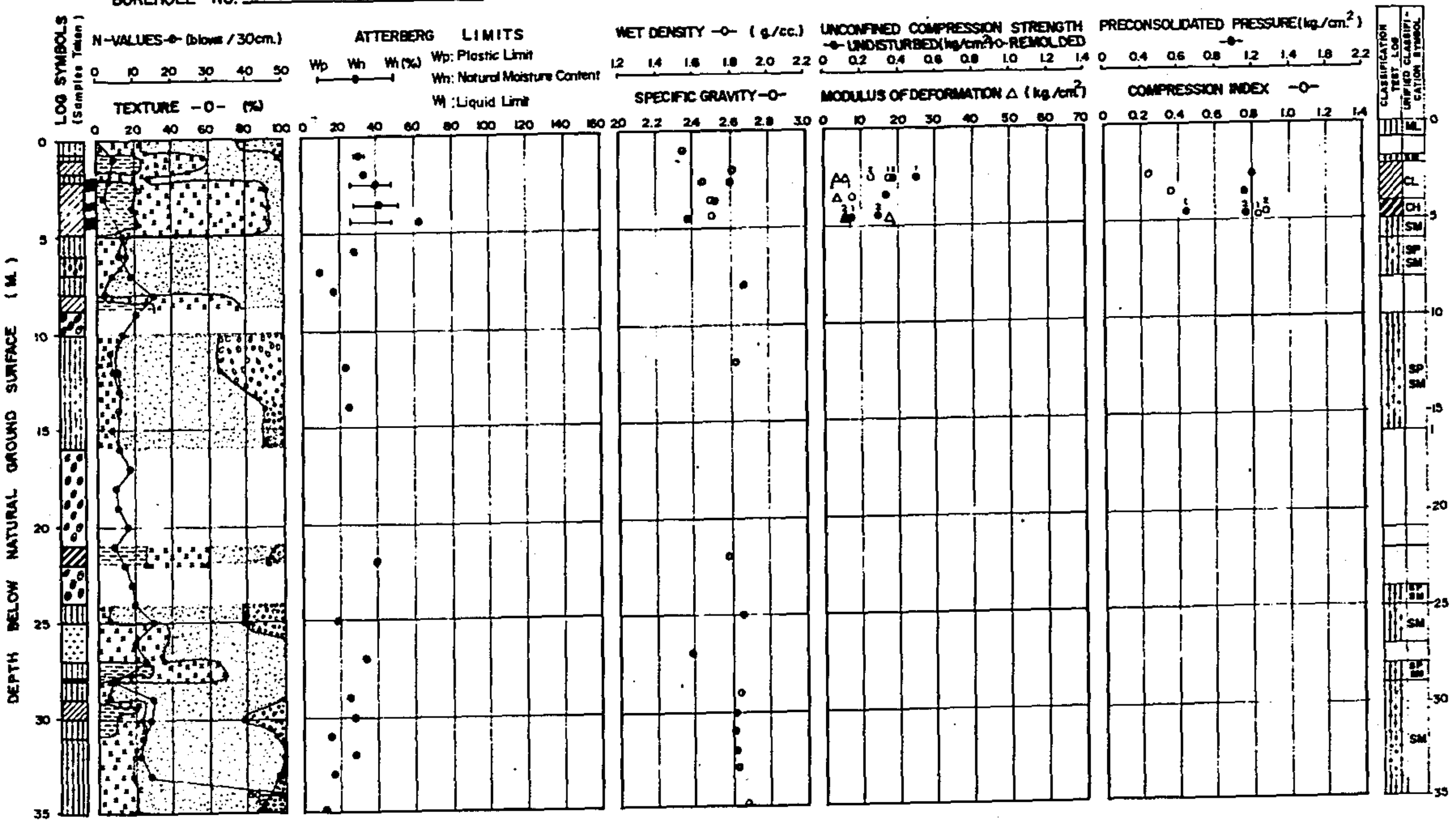
Grd. Elev. + 48.22 M. Location Corner Katipunan Ave. & Aurora Blvd., Q.C.

Water Table GL. –1.80 M. Date JULY 29–31, 1977

SCALE IN (M.)	ELEVATION IN (M.)	DEPTH IN (M.)	THICKNESS	LEGEND	TYPE OF SOIL	COLOUR	RELATIVE DENSITY OR CONSISTENCY	GENERAL REMARKS	STANDARD PENETRATION TEST OR CORE RECOVERY DEPTH IN (M.)	SAMPLING FOR LAB.	N-VALUE BLOWS 30 CM	BLOWS PER EACH 10 CM. 10 CM	10 CM	10 CM
1	47.22	1.00	1.00		SAND		dense	coarse grained.	0.55 1.00	SS-1	43	15	14	14
2 3					AGGLO-MERATE	dark brown	very dense	slightly jointed	2.80 3.25	CS-1 SS 2	c o r e 50/27	16	18	16/7
4 5								massive, cemented. W/ FINE SAND	4.75 4.98	CS-2 SS-3	c o r e 50/6	50/6		
6 7						darkgray		tuffaceous; jointed. w/angular fragments	6.50 6.79	CS-3 SS-4	c o r e 50/14	34	16/4	
8						grayish brown dark gray		massive, cemented. w/angular fragments	8.30 8.57	CS-4 SS 5	c o r e 50/12	38	12/2	
9 10						grayish brown		slightly jointed, fine to medium; w/angular frags	10.00 10.17	CS-5 SS-6	c o r e 50/4	50/4		
11 12						dark gray		slightly jointed, medium grained. fine to med. w/angular fragments	11.60 11.82	CS-6 SS-7	c o r e 50/11	43	7/1	
13						grayish brown dark gray		tuffaceous; slightly jointed.	13.25 13.51	CS-7 SS-8	c o r e 50/11	43	7/1	
14	33.41	14.81	13.81			grayish brown		coarse grained.	14.81 15.01	CS-8	c o r e 50/20			
15	33.21	15.01	0.20		SILTY TUFF		hard							
		END	OF	BORING										
16 17 18 19 20 21 22 23 24 25 26 27 28														



BOREHOLE NO. C3-BH3 GROUND ELEVATION : + 2.64 M. LOCATION : Left Side of PASIG RIVER End of Trabajo St, MAKATI



LEGEND: A. TEXTURE SYMBOLS

- ▨ GRAVEL Coarser than 2 mm.
- ▨ SAND
- ▨ SILT
- ▨ CLAY

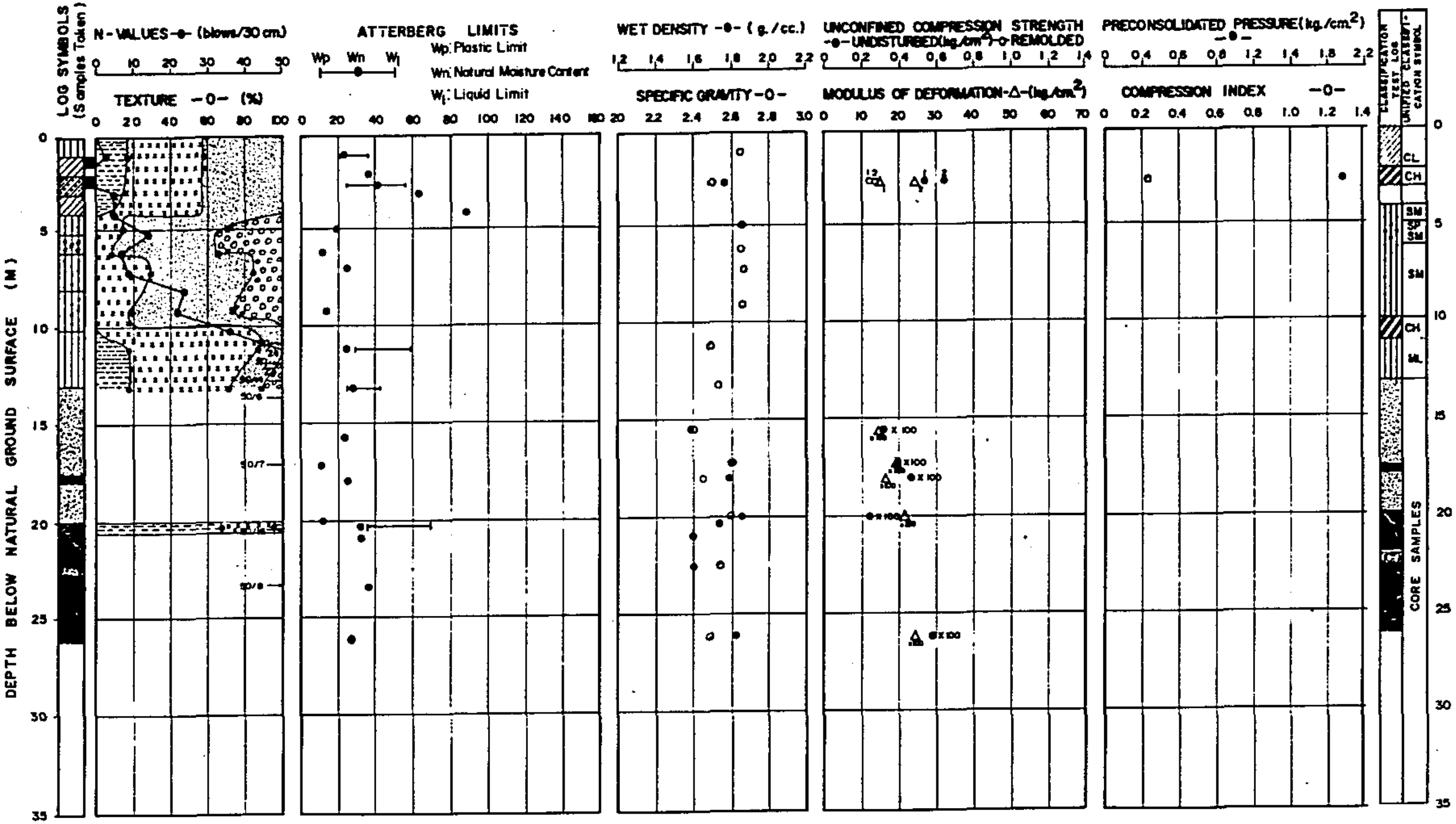
B. LOG SYMBOLS

- ▨ CLAY
- ▨ SILTY CLAY, SANDY CLAY GRAVELLY CLAY
- ▥ CLAYEY & SANDY SILT
- ▥ SILTY SAND
- ▨ CLAYEY SAND
- ▨ SILTY GRAVEL
- ▨ CLAYEY GRAVEL
- ▨ SAND
- ▨ GRAVEL
- ■ CLAYEY TUFF
- ■ SILTY TUFF
- ▨ SANDY TUFF
- ■ UNDISTURBED SAMPLE
- ▮ SPLIT SPOON SAMPLE
- ▥ CORE SAMPLE

SUMMARY OF SOIL PROPERTY
(C3-BH3)

APPENDIX
3.1

BOREHOLE NO. C3-BH4 GROUND ELEVATION : + 2.88M. LOCATION: Right of PASIG RIVER, MANDALUYONG Side



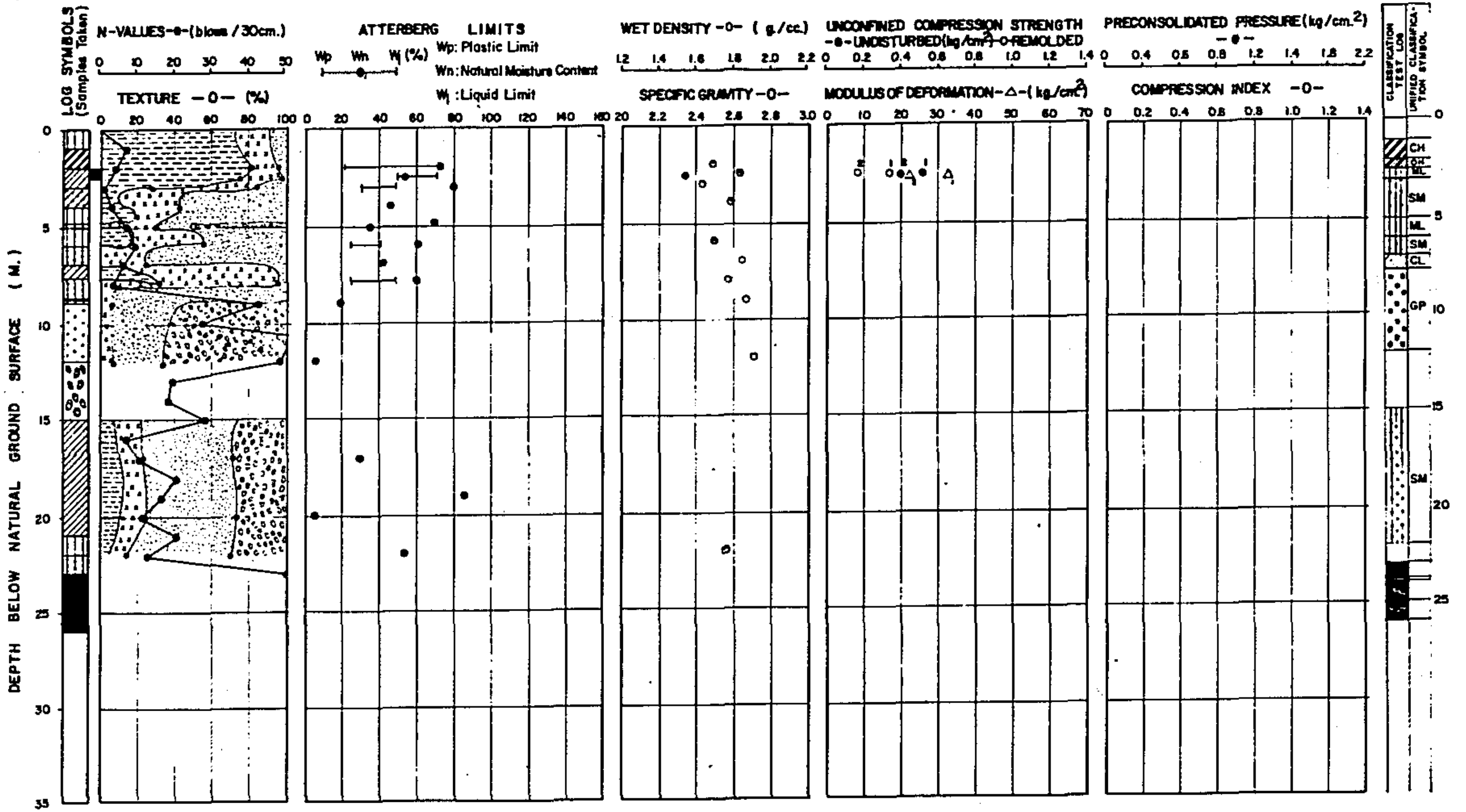
LEGEND: A. TEXTURE SYMBOLS
- ▨ GRAVEL Coarser than 2 mm.
- ▨ SAND
- ▨ SILT
- ▨ CLAY

B. LOG SYMBOLS
- ▨ CLAY
- ▨ SILTY CLAY, SANDY CLAY GRAVELLY CLAY
- ▥ CLAYEY & SANDY SILT
- ▥ SILTY SAND
- ▨ CLAYEY SAND
- ▥ SILTY GRAVEL
- ▨ CLAYEY GRAVEL
- ▨ SAND
- ▨ GRAVEL
- ■ CLAYEY TUFF
- ■ SILTY TUFF
- ▨ SANDY TUFF
- ■ UNDISTURBED SAMPLE
- ▯ SPLIT SPOON SAMPLE
- ▥ CORE SAMPLE

SUMMARY OF SOIL PROPERTY (C3-BH4)

APPENDIX 3.2

BOREHOLE NO. C3 - BH5 - I GROUND ELEVATION : + 1.90 M. LOCATION : Vergara St. near cor. Blumentritt, MANDALUYONG



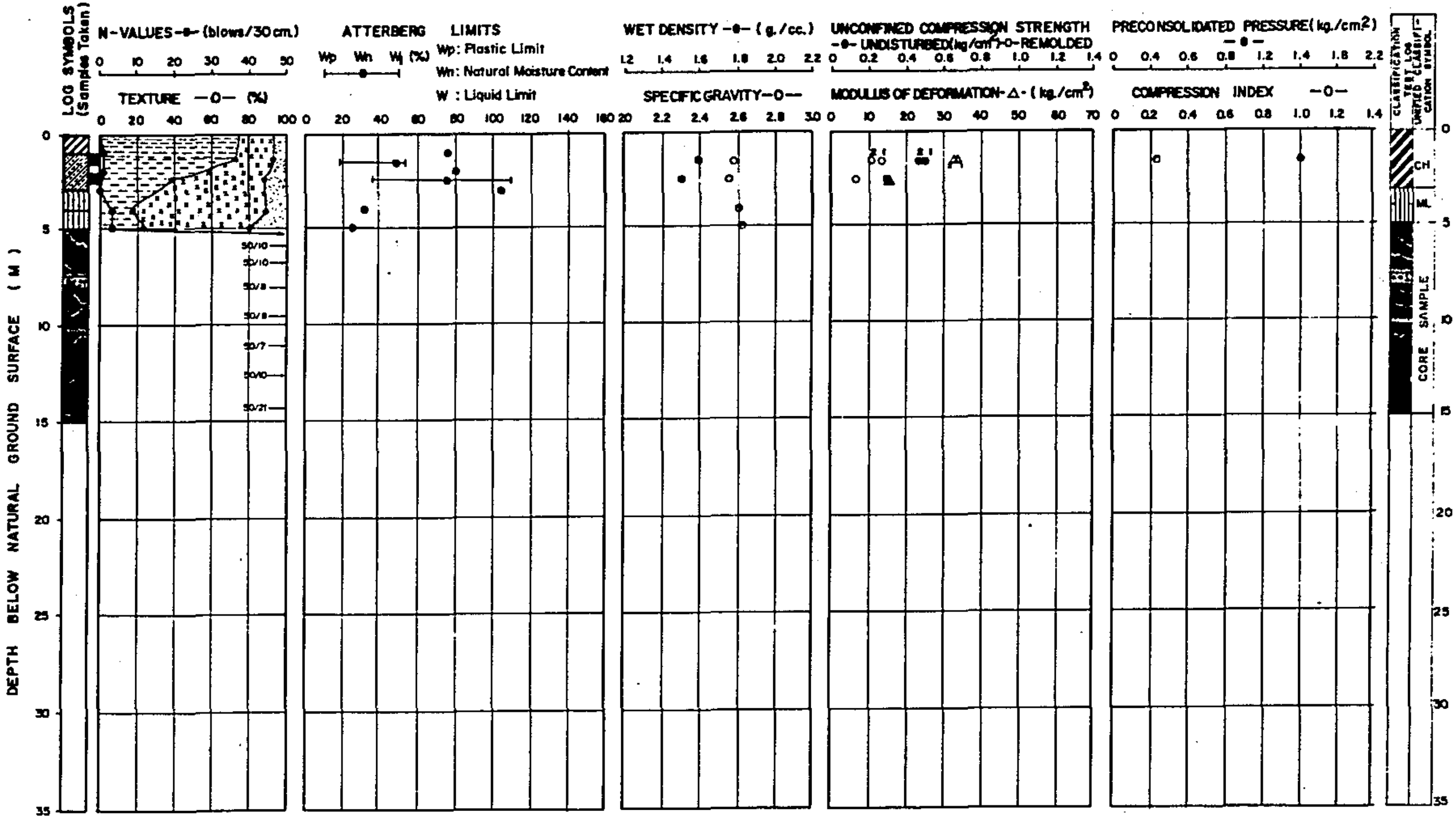
LEGEND: A. TEXTURE SYMBOLS
- ⊡ GRAVEL Coarser than 2 mm.
- ⊡ SAND
- ⊡ SILT
- ⊟ CLAY

B. LOG SYMBOLS
- ▨ CLAY
- ▨ SILTY CLAY, SANDY CLAY GRAVELLY CLAY
- ▥ CLAYEY & SANDY SILT
- ▥ SILTY SAND
- ▨ CLAYEY SAND
- ⊡ SILTY GRAVEL
- ▨ CLAYEY GRAVEL
- ⊡ SAND
- ⊡ GRAVEL
- ■ CLAYEY TUFF
- ■ SILTY TUFF
- ▩ SANDY TUFF
- ■ UNDISTURBED SAMPLE
- ▯ SPLIT SPOON SAMPLE
- ▥ CORE SAMPLE

SUMMARY OF SOIL PROPERTY
(C3 - BH5-1)

APPENDIX
3.3

BOREHOLE NO. C3-BH5-2 **GROUND ELEVATION :** +1.97 M. **LOCATION:** Back of BONI CEMETERY, MANDALUYONG



LEGEND:

A. TEXTURE SYMBOLS
- ▨ GRAVEL Coarser than 2 mm.
- ▨ SAND
- ▨ SILT
- ▨ CLAY

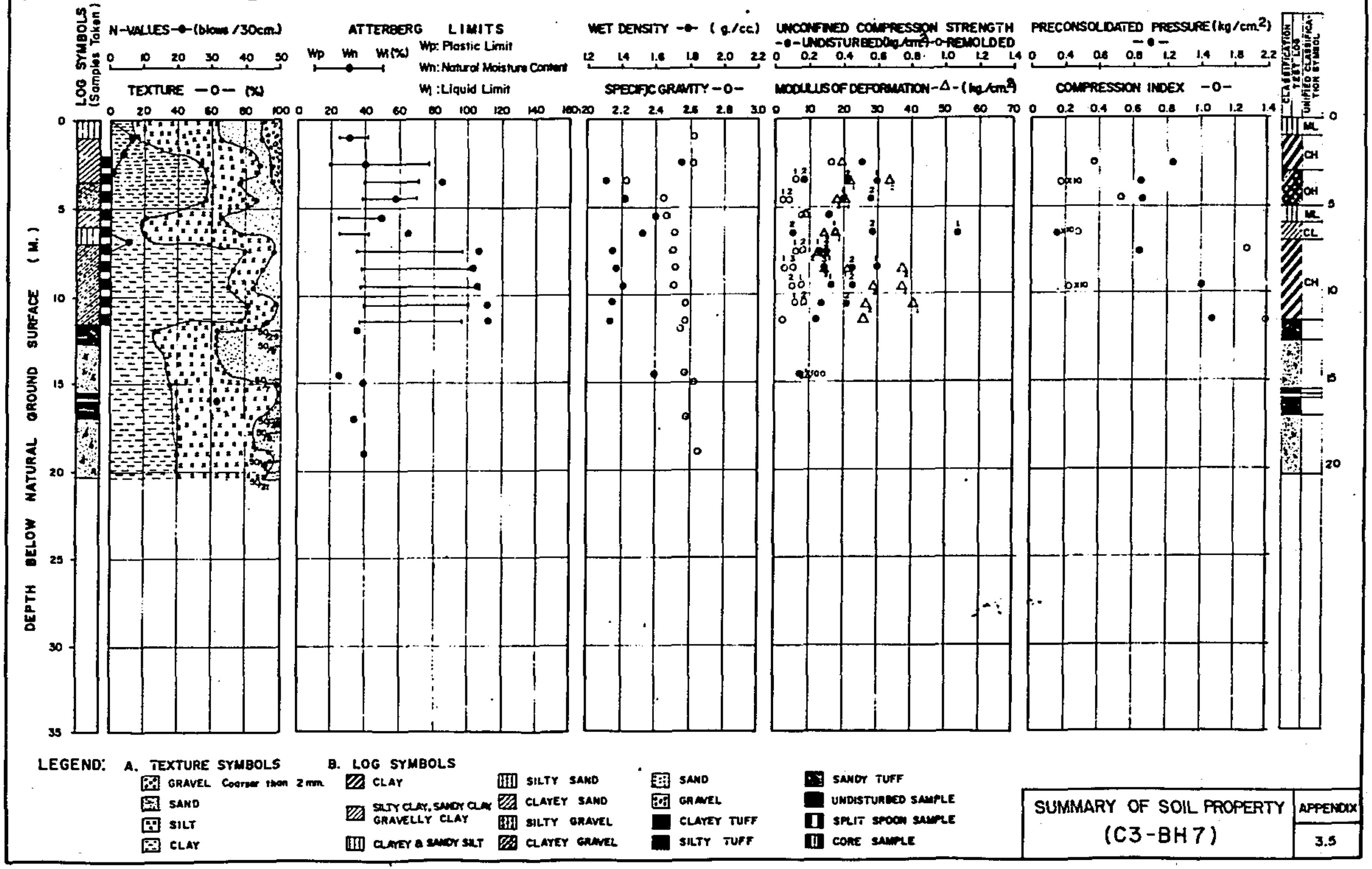
B. LOG SYMBOLS

▨ CLAY	▥ SILTY SAND
▨ SILTY CLAY, SANDY CLAY GRAVELLY CLAY	▨ CLAYEY SAND
▥ CLAYEY & SANDY SILT	▨ SILTY GRAVEL
	▨ CLAYEY GRAVEL
▨ SAND	▨ SANDY TUFF
▨ GRAVEL	■ UNDISTURBED SAMPLE
■ CLAYEY TUFF	▮ SPLIT SPOON SAMPLE
■ SILTY TUFF	▥ CORE SAMPLE

SUMMARY OF SOIL PROPERTY
(C3-BH5-2)

APPENDIX
3.4

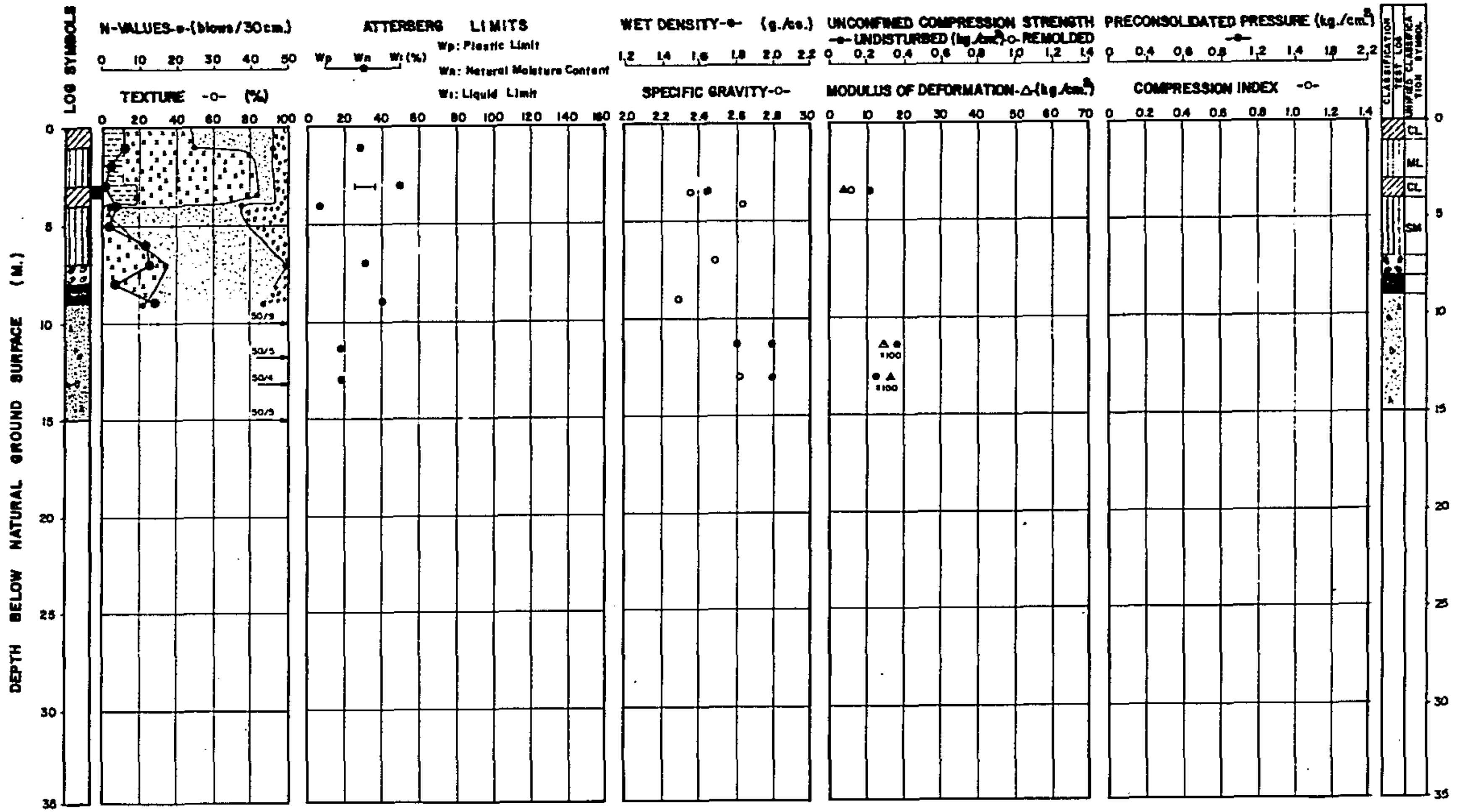
BOREHOLE NO. C3- BH7 GROUND ELEVATION : + 1.99 M. LOCATION : End of ARANETA AVENUE at SAN JUAN RIVER



SUMMARY OF SOIL PROPERTY
(C3-BH7)

APPENDIX
3.5

BOREHOLE NO. R4-BH3 GROUND ELEVATION: + 3.52 M. LOCATION: Right of Buting Bridge, Pasig, Metro-Manila

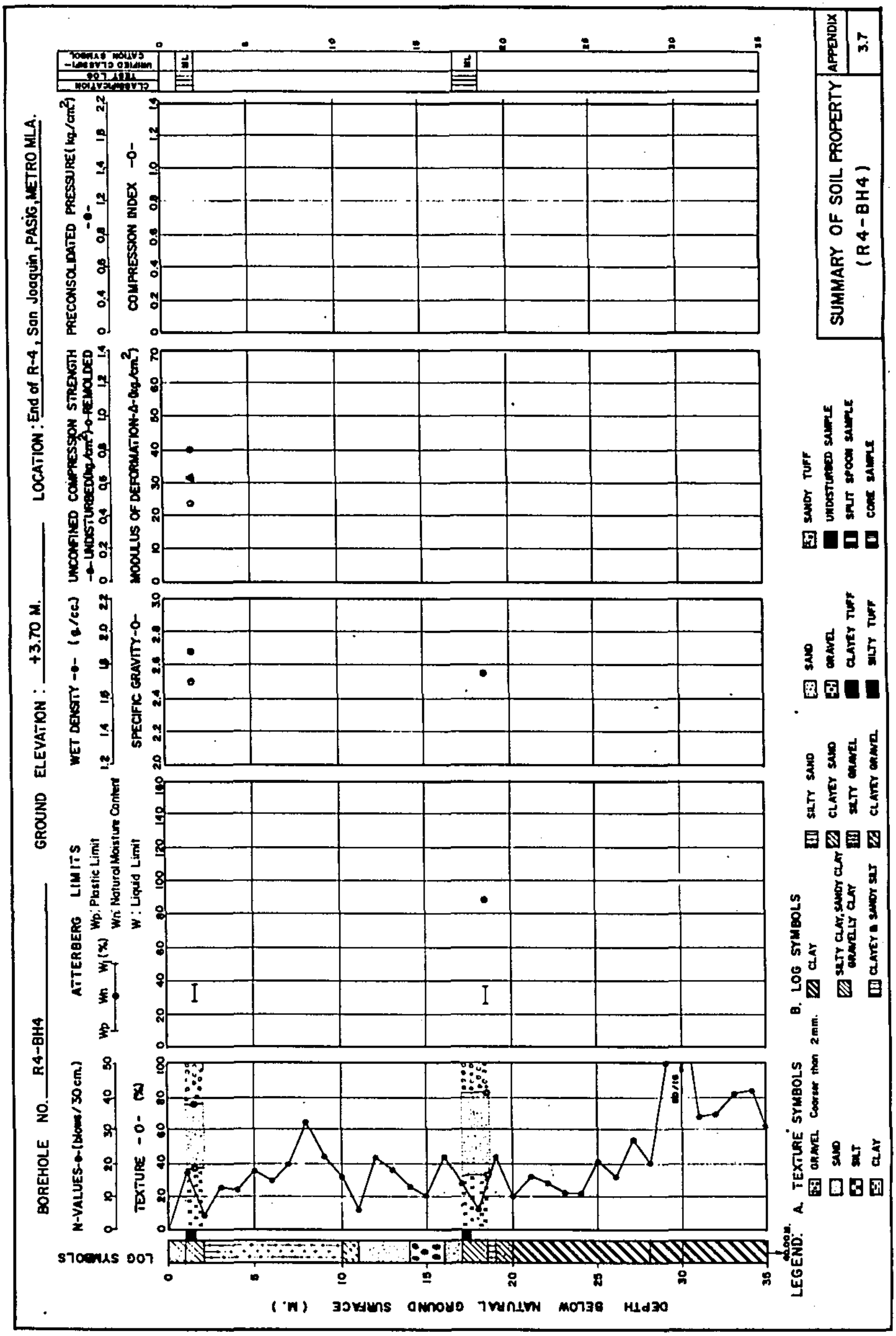


LEGEND:

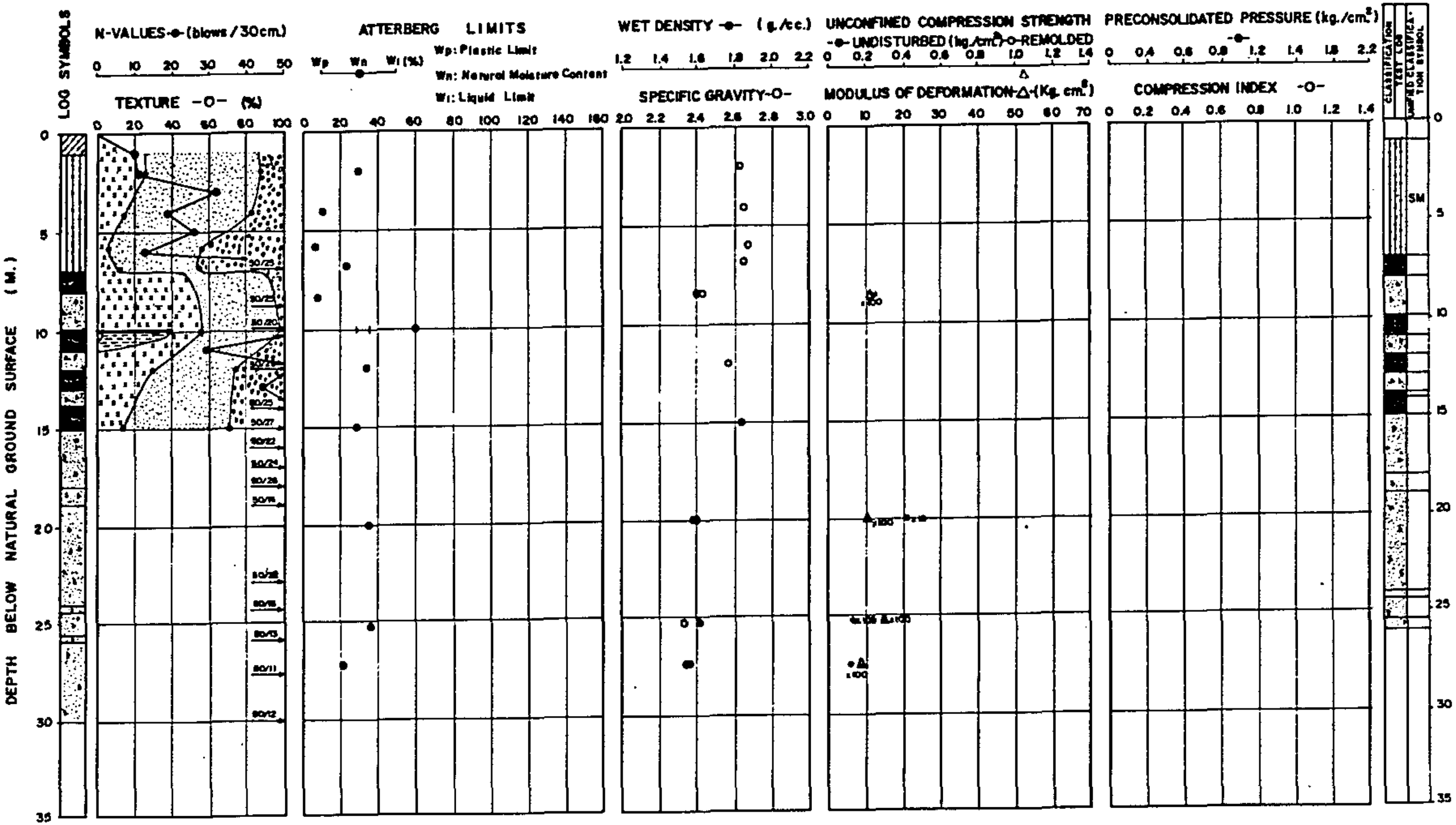
A. TEXTURE SYMBOLS
- GRAVEL (Coarser than 2 m.m.)
- SAND
- SILT
- CLAY

B. LOG SYMBOLS
- ▨ CLAY
- ▨ SILTY CLAY, SANDY CLAY GRAVELLY CLAY
- ▥ CLAYEY & SAND SILT
- ▥ SILTY SAND
- ▨ CLAYEY SAND
- ▥ SILTY GRAVEL
- ▨ CLAYEY GRAVEL
- ⬚ SAND
- ▩ GRAVEL
- ■ CLAYEY TUFF
- ■ SILTY TUFF
- ▩ SANDY TUFF
- ■ UNDISTURBED SAMPLE
- ▮ SPLIT SPOON SAMPLE
- ▥ CORE SAMPLE

SUMMARY OF SOIL PROPERTY (R4-BH3)	APPENDIX 3.6


BOREHOLE NO. R4-BH4
GROUND ELEVATION : +3.70 M.
LOCATION : End of R-4, San Joaquin, PASIG, METRO MLA.
N-VALUES-●-(blows/30 cm.)
0 10 20 30 40 50
TEXTURE -O- (%)
0 20 40 60 80 100
ATTERBERG LIMITS
Wp Wn Wl(%)
Wp: Plastic Limit
Wn: Natural Moisture Content
Wl: Liquid Limit
0 20 40 60 80 100 120 140 160
WET DENSITY -●- (g./cc.)
1.2 1.4 1.6 1.8 2.0 2.2
SPECIFIC GRAVITY -O-
2.0 2.2 2.4 2.6 2.8 3.0
UNCONFINED COMPRESSION STRENGTH
-●- UNDISTURBED (kg./cm.²) -o- REMOLDED
0 0.2 0.4 0.6 0.8 1.0 1.2 1.4
MODULUS OF DEFORMATION -Δ- (kg./cm.²)
0 10 20 30 40 50 60 70
PRECONSOLIDATED PRESSURE (kg./cm.²)
-●-
0 0.4 0.6 0.8 1.2 1.4 1.8 2.2
COMPRESSION INDEX -O-
0 0.2 0.4 0.6 0.8 1.0 1.2 1.4
CLASSIFICATION
TEST LOG
UNIFIED CLASSIFICATION SYMBOL
ML
ML
LOG SYMBOLS
DEPTH BELOW NATURAL GROUND SURFACE (M.)
0 5 10 15 20 25 30 35
50/18
LEGEND.
A. TEXTURE SYMBOLS
GRAVEL Coarser than 2 mm.
SAND
SILT
CLAY
B. LOG SYMBOLS
CLAY
SILTY CLAY, SANDY CLAY GRAVELLY CLAY
CLAYEY & SANDY SILT
SILTY SAND
CLAYEY SAND
SILTY GRAVEL
CLAYEY GRAVEL
SAND
GRAVEL
CLAYEY TUFF
SILTY TUFF
SANDY TUFF
UNDISTURBED SAMPLE
SPLIT SPOON SAMPLE
CORE SAMPLE
SUMMARY OF SOIL PROPERTY
(R4-BH4)
APPENDIX
3.7

BOREHOLE NO. C5-BH1 GROUND ELEVATION: + 3.87 M. LOCATION: Left side of PASIG RIVER at FORT BONIFACIO, RIZAL



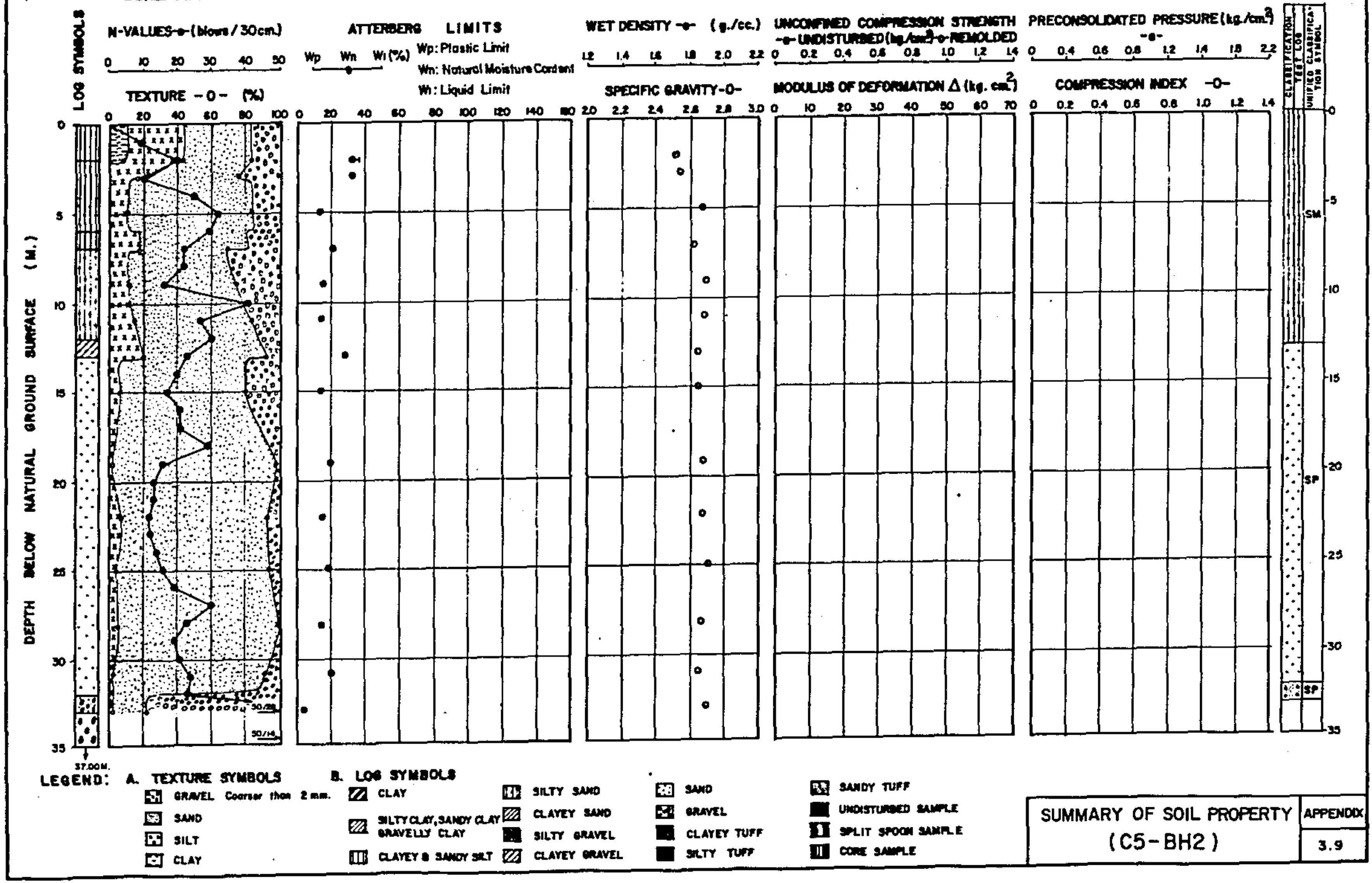
LEGEND: A. TEXTURE SYMBOLS
- ▨ GRAVEL Coarser than 2 mm.
- ☐ SAND
- ▨ SILT
- ▤ CLAY

B. LOG SYMBOLS
- ▨ CLAY
- ▨ SILTY CLAY, SANDY CLAY GRAVELLY CLAY
- ▥ CLAYEY & SANDY SILT
- ▥ SILTY SAND
- ▨ CLAYEY SAND
- ▨ SILTY GRAVEL
- ▨ CLAYEY GRAVEL
- ▨ SAND
- ▨ GRAVEL
- ■ CLAYEY TUFF
- ■ SILTY TUFF
- ▨ SANDY TUFF
- ■ UNDISTURBED SAMPLE
- ▮ SPLIT SPOON SAMPLE
- ▨ CORE SAMPLE

SUMMARY OF SOIL PROPERTY
(C5-BH1)

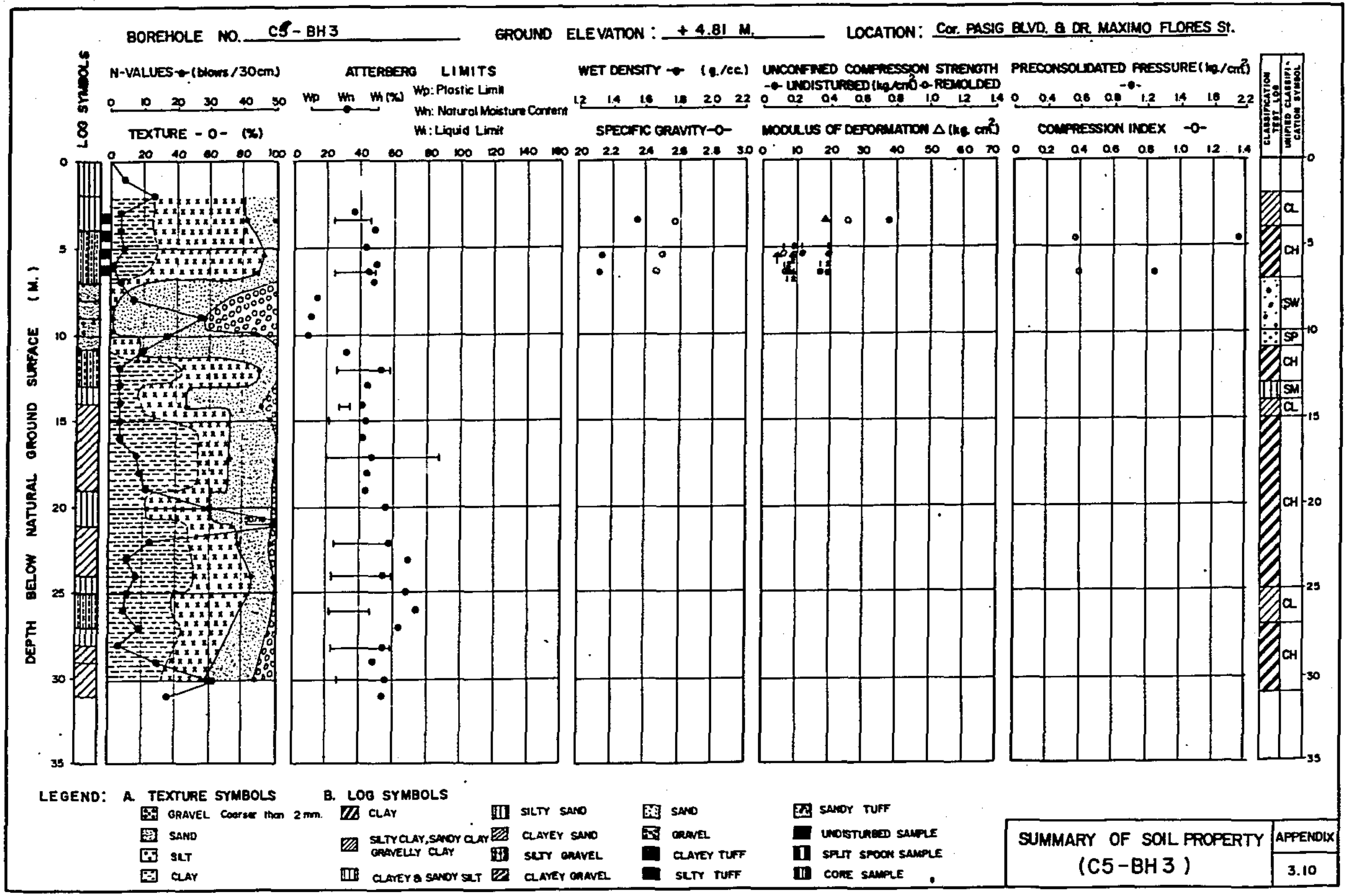
APPENDIX
3.8

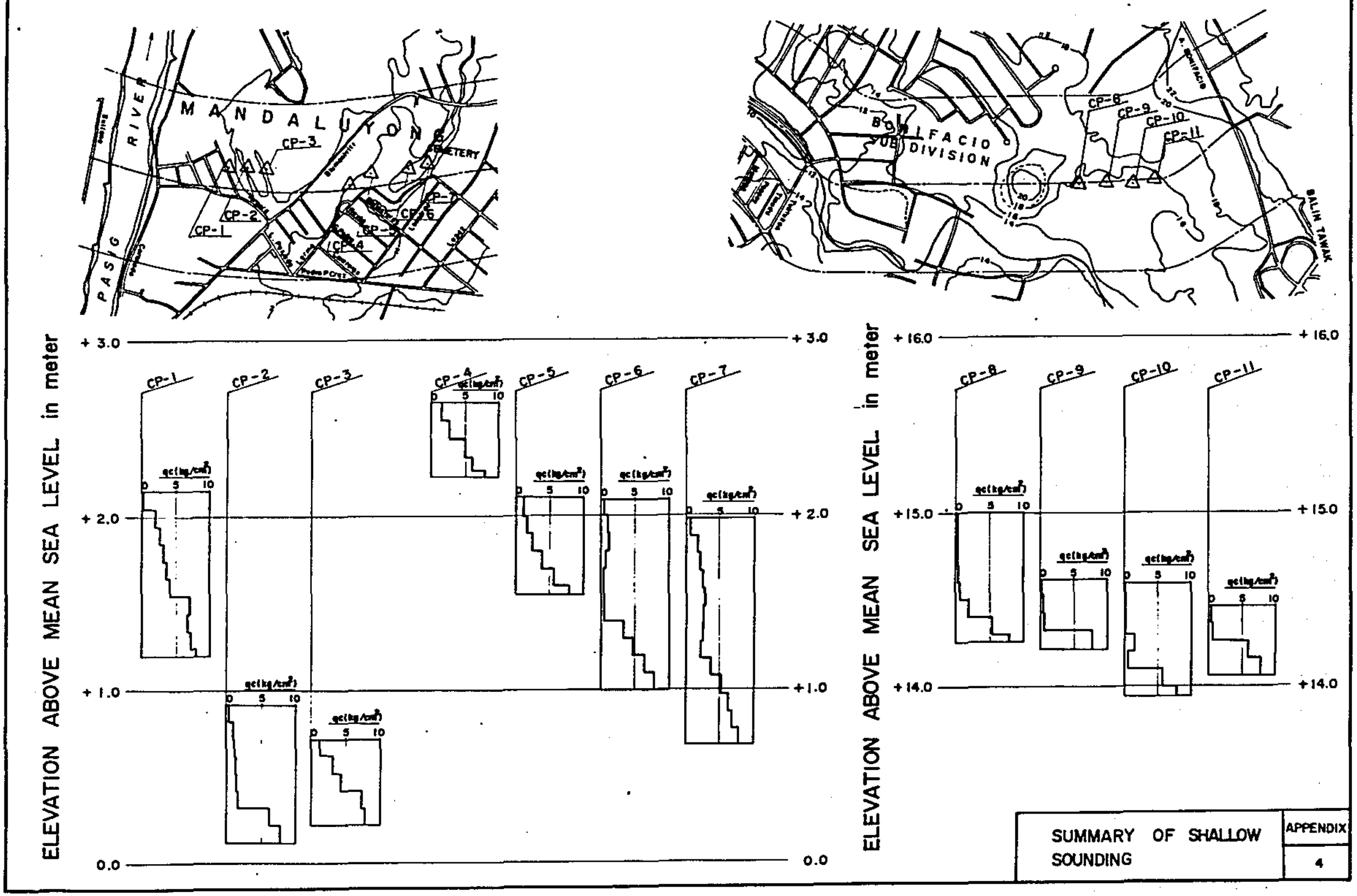
BOREHOLE NO. C5-BH2 GROUND ELEVATION : + 4.95 M. LOCATION: Right of PASIG RIVER, FORT BONIFACIO, RIZAL



SUMMARY OF SOIL PROPERTY
(C5-BH2)

APPENDIX
3.9


BOREHOLE NO. C5 - BH3
GROUND ELEVATION : + 4.81 M.
LOCATION : Cor. PASIG BLVD. & DR. MAXIMO FLORES St.
LOG SYMBOLS
N-VALUES -●- (blows / 30cm.)
0 10 20 30 40 50
TEXTURE - O - (%)
0 20 40 60 80 100
ATTERBERG LIMITS
Wp Wn Wl (%)
Wp: Plastic Limit
Wn: Natural Moisture Content
Wl: Liquid Limit
0 20 40 60 80 100 120 140 160
WET DENSITY -●- (g./cc.)
1.2 1.4 1.6 1.8 2.0 2.2
SPECIFIC GRAVITY -O-
2.0 2.2 2.4 2.6 2.8 3.0
UNCONFINED COMPRESSION STRENGTH
-●- UNDISTURBED (kg./cm²) -o- REMOLDED
0 0.2 0.4 0.6 0.8 1.0 1.2 1.4
MODULUS OF DEFORMATION Δ (kg. cm²)
0 10 20 30 40 50 60 70
PRECONSOLIDATED PRESSURE (kg./cm²)
-●-
0 0.4 0.6 0.8 1.2 1.4 1.6 2.2
COMPRESSION INDEX -O-
0 0.2 0.4 0.6 0.8 1.0 1.2 1.4
CLASSIFICATION TEST LOG
UNIFIED CLASSIFICATION SYMBOL
CL
CH
SW
SP
CH
SM
CL
CH
CL
CH
DEPTH BELOW NATURAL GROUND SURFACE (M.)
0
5
10
15
20
25
30
35
LEGEND: A. TEXTURE SYMBOLS
GRAVEL Coarser than 2 mm.
SAND
SILT
CLAY
B. LOG SYMBOLS
CLAY
SILTY CLAY, SANDY CLAY GRAVELLY CLAY
CLAYEY & SANDY SILT
SILTY SAND
CLAYEY SAND
SILTY GRAVEL
CLAYEY GRAVEL
SAND
GRAVEL
CLAYEY TUFF
SILTY TUFF
SANDY TUFF
UNDISTURBED SAMPLE
SPLIT SPOON SAMPLE
CORE SAMPLE
SUMMARY OF SOIL PROPERTY
(C5-BH3)
APPENDIX
3.10



SUMMARY OF SHALLOW SOUNDING

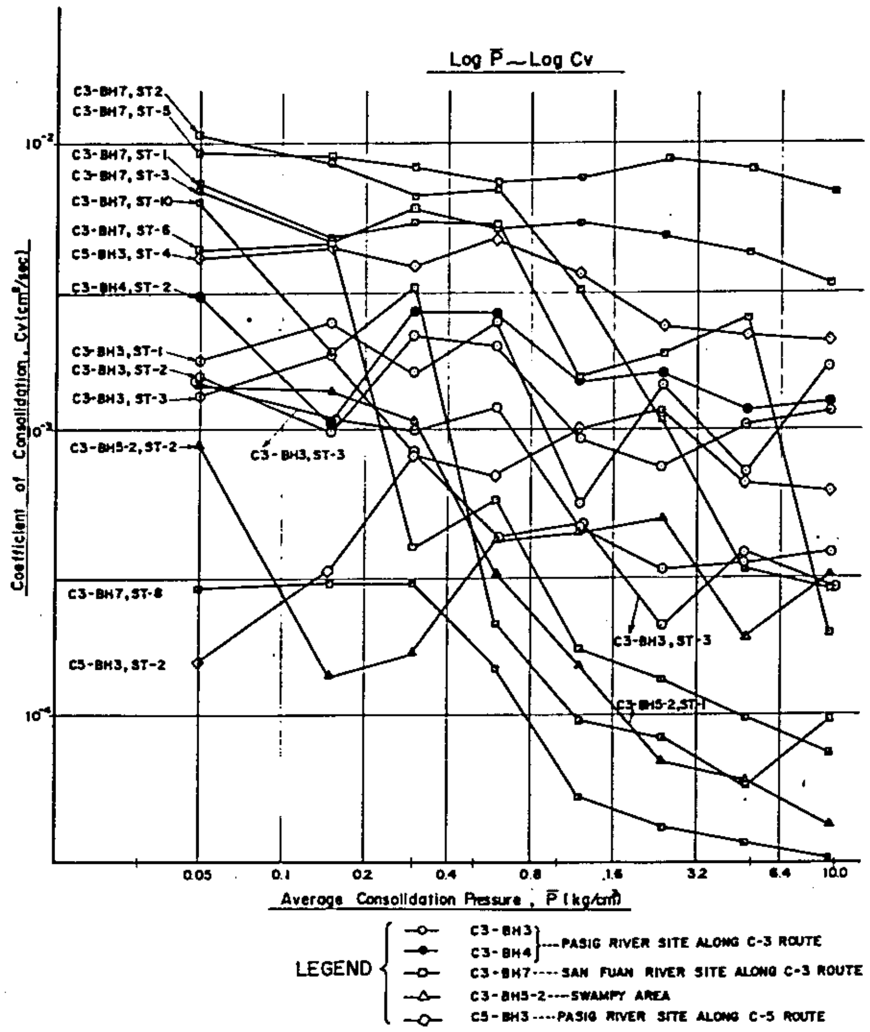
APPENDIX 4

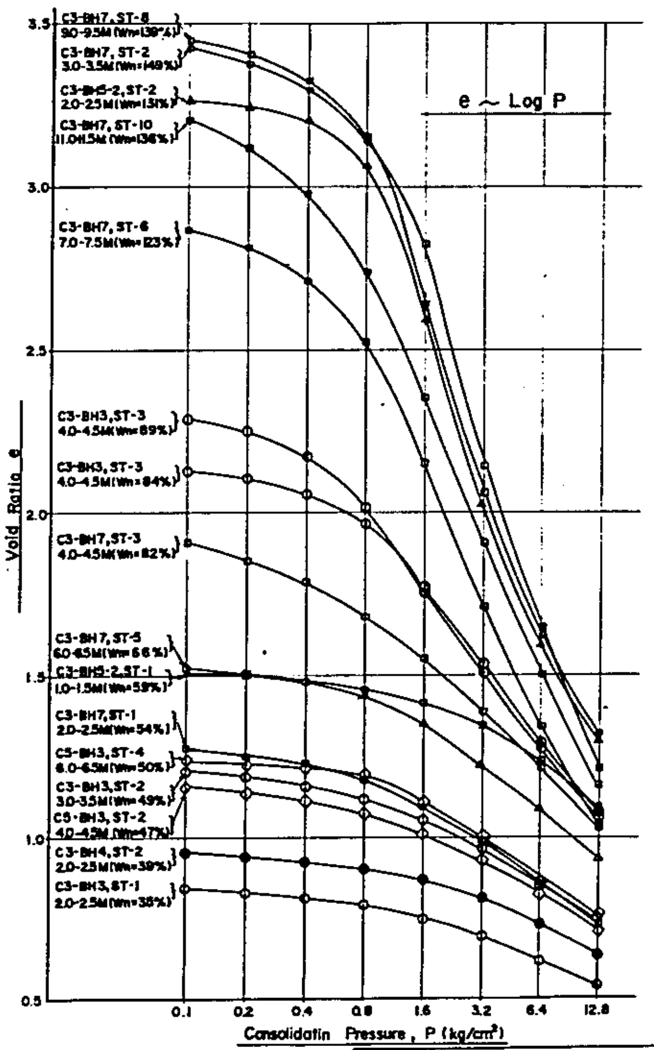
SOURCE NUMBER	LOCATION	SOIL DESCRIPTION	NATURAL MOISTURE CONTENT (%)	ATTERBERG LIMITS		# 200 PASSING	SOIL Classification AASHTO	CBR
				LL	PI			
TP-1,S#1	AYALA AVENUE	CLAY SILT,yellowish brown,w/siltstone fragments.	32.9	46	10	71	A-5-8	12.2
TP-1,S#2	Cor.Malugay St.		31.0	48	13	66	A-7-5(9)	13.8
TP-2,S#1	METROPOLITAN AVE,	CLAY,brownish gray, high plasticity.	40.4	59	35	82	A-7-6(20)	1.82
TP-2,S#2	Cor.South Avenue		40.5	58	34	83	A-7-6(20)	1.64
TP-3,S#1	TRABAHO ST.	SANDY CLAY,dark brown; moderate plasticity	33.4	43	17	40	A-7-6(4)	3.43
TP-3.S#2			33.4	41	18	49	A-7-6(6)	5.74
TP-4,S#1	M.LERMA ST.	CLAY,gray; high plasticity.	56.0	86	65	97	A-7-6(20)	1.33
TP-4,S#2			61.9	88	66	96	A-7-6(20)	1.64
TP-5,S#1	MAGALONA ST.	CLAY,grayish brown; high plasticity	34.9	57	30	58	A-7-6(15)	2.40
TP-5,S#2	Cor.Haig St.		28.7	75	52	86	A-7-6(20)	1.63
TP-6,S#1	ARANETA AVE.	SILTY TUFF,gray,moderately cemented.	26.5	-	-	68	A-4(8)	27.8
TP-6,S#2			27.5	-	-	72	A-4(8)	25.6
TP-7,S#1	ARANETA AVE.	SILTY TUFF,yellowish brown;poor tomoderately cemented.	29.0	39	9	82	A-4(8)	26.3
TP-7,S#2			27.3	41	8	86	A-5(8)	24.7
TP-8,S#1	ARANETA AVE.	CLAY,yellowish brown; high plasticity.	36.0	52	24	79	A-7-6(16)	7.18
TP-8,S#2	Cor.Galamba St.		33.5	54	25	75	A-7-6(18)	5.62
TP-9,S#1	TAGAYTAY ST.	CLAY,brownish gray; high plasticity.	31.7	57	35	74	A-7-6(19)	1.57
TP-9.S#2	Cor.Ragang St.		29.8	56	33	79	A-7-6(19)	1.34

Note: LOCATIONS OF TAKING
CBR SAMPLES ARE
SHOWN IN FIGURE 1

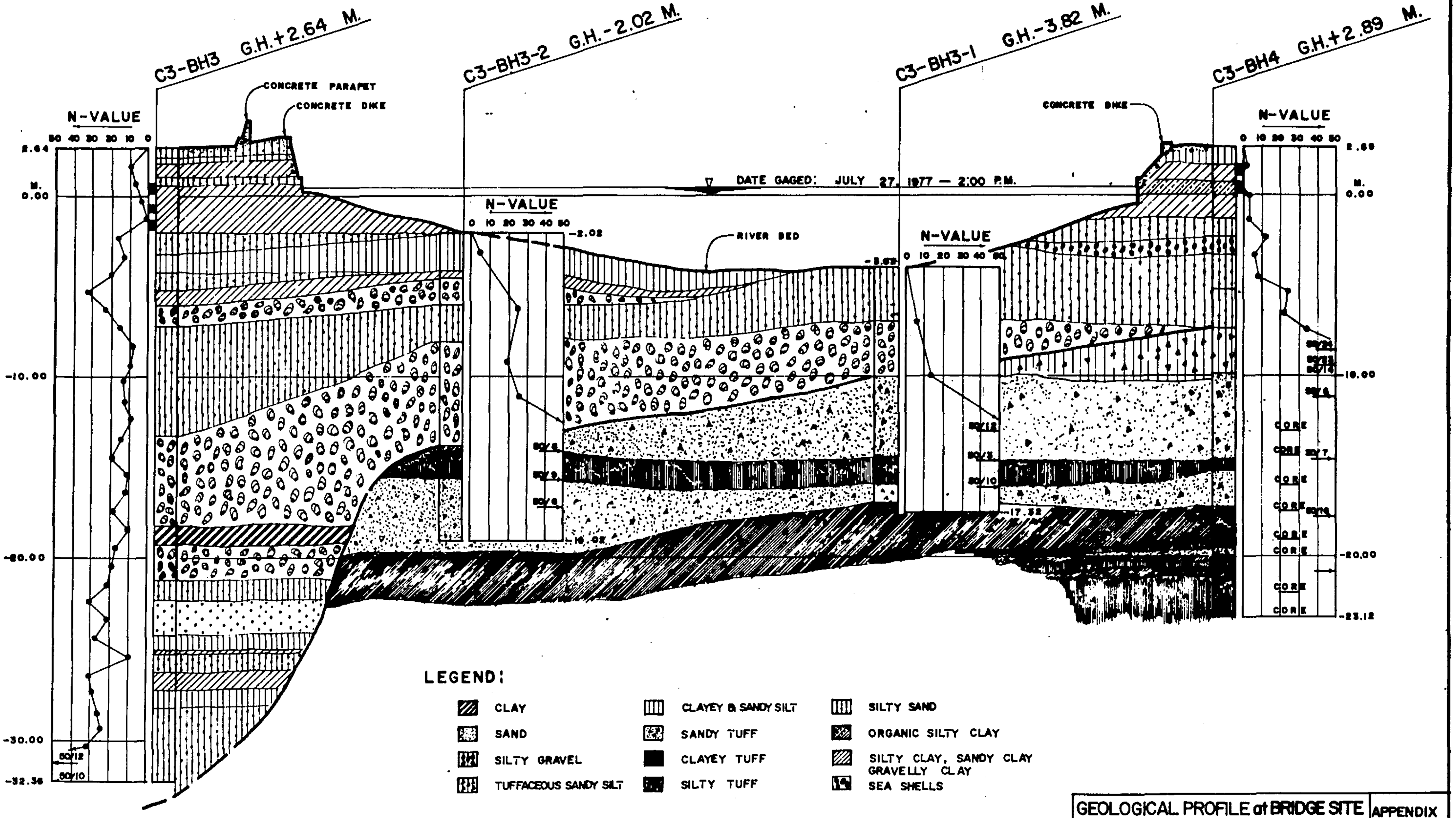
SUMMARY OF CBR TESTING

APPENDIX
5





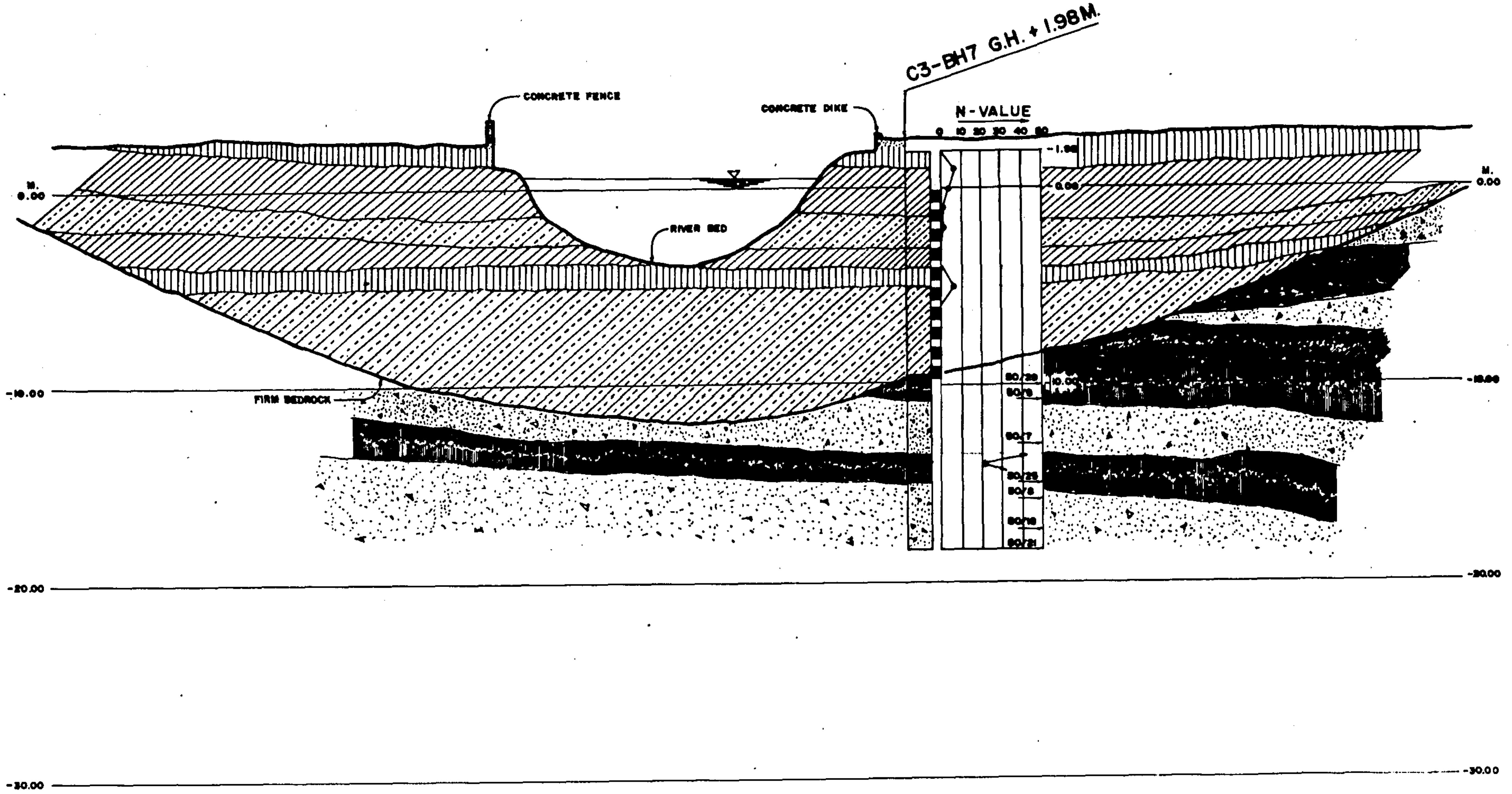
SUMMARY OF CONSOLIDATION TEST	APPENDIX
	6



GEOLOGICAL PROFILE at BRIDGE SITE
(PASIG RIVER)

SCALE: H-1/500 V-1/200

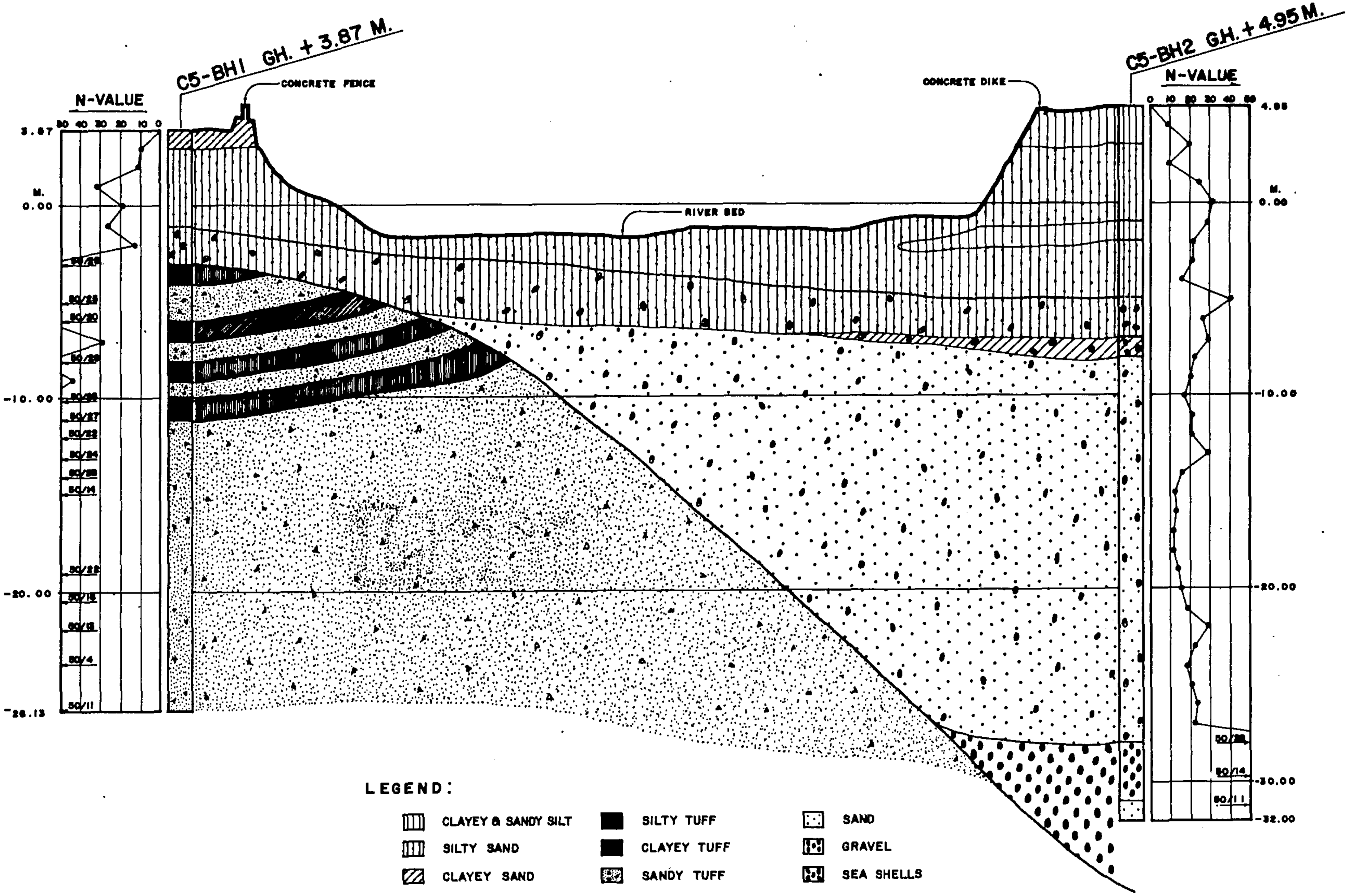
APPENDIX 7.1



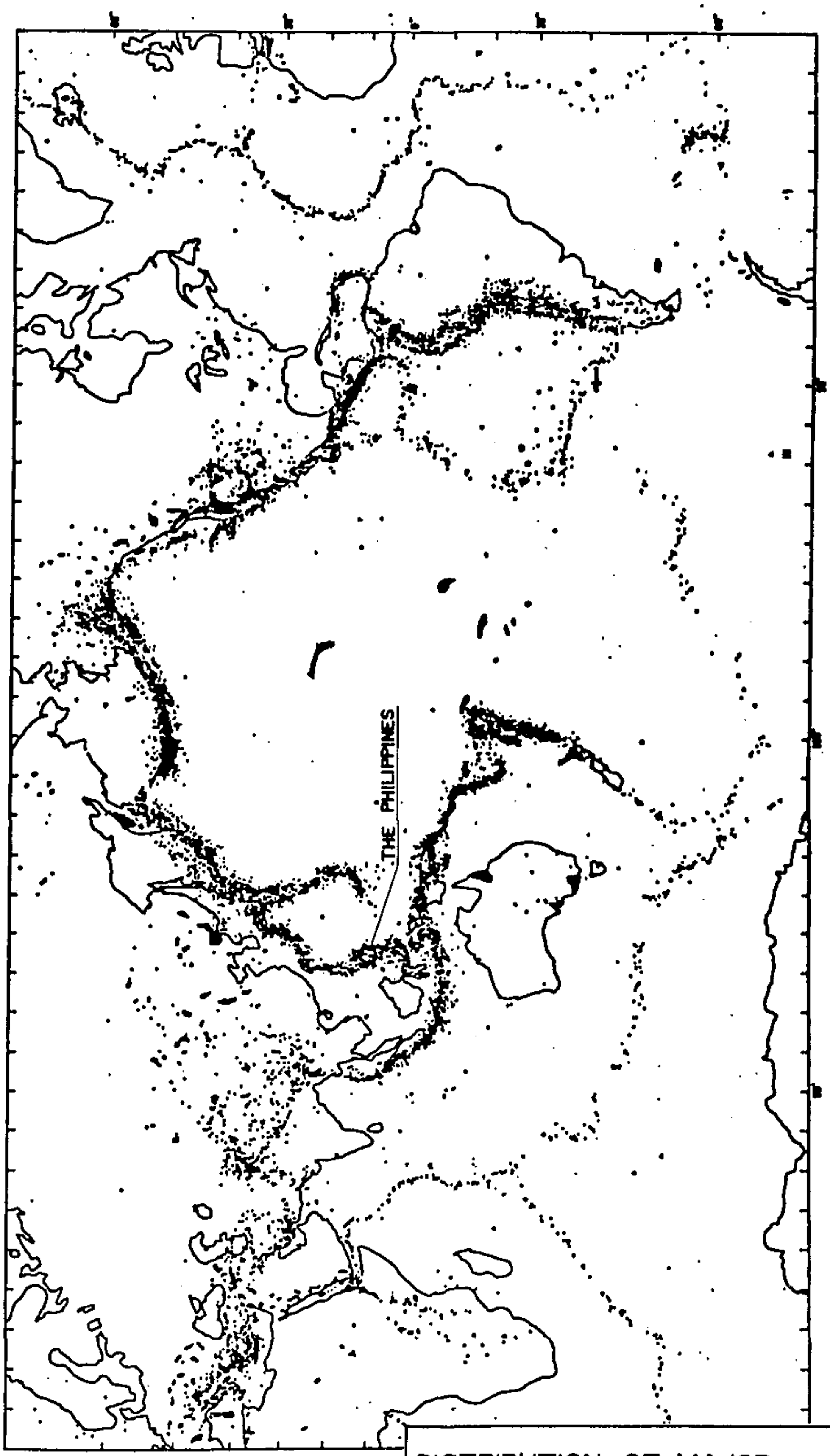
LEGEND

▨	SILTY CLAY
▨	ORGANIC SILTY CLAY
▥	CLAYEY SILT
░	SANDY TUFF
■	SILTY TUFF
■	CLAYEY TUFF

GEOLOGICAL PROFILE at BRIDGE SITE (SAN JUAN RIVER)	APPENDIX
SCALE: H - 1/500 V - 1/200	7.2



GEOLOGICAL PROFILE at BRIDGE SITE C-5 (PASIG RIVER)	APPENDIX
SCALE: H - 1/500 V - 1/200	7.3



NOTE { • EARTHQUAKES WITH MAGNITUDE MORE THAN 4
EPICENTER (1961-1967) PRESENTED BY BARAZANGI & DORMAN

DISTRIBUTION OF MAJOR EARTHQUAKES IN THE WORLD	APPENDIX 8

S5 ASSESSMENT SURVEY OF LAND AND PROPERTY

ASSESSMENT SURVEY OF LAND AND PROPERTY

The assessment survey of the C-3 and R-4 and related roads project in Metro Manila was carried out by the survey team of the Department of Public Highways in cooperation with Government Assessors Offices, with the primary purpose of obtaining information to determine the true values of the properties (land and buildings) lying within the one-hundred meter strip of the proposed road. After the field interview, research in government assessor's offices followed, to cross-check the field information and at the same time to acquire the missing data.

During the evaluation, it was discovered that the assessed values of the properties as determined by government assessors, were almost five years old (Government Assessors Offices up-date their records every five years and the next schedule of adjustment will be in 1978) and are not reflective of the present prevailing values. In order to up-date the values, some government assessors in each cities and municipalities were interviewed to determine the escalation rate to be applied to the 1973 cost index. A ten per cent annual escalation rate for the buildings and the government projected 1978 land values were adopted.

Figures 1 and 2 and Table 1 are shown as an example of the results of assessment survey.

The cost of right-of-way acquisition were estimated on the basis of the resultant figures as shown in the Text Volume.

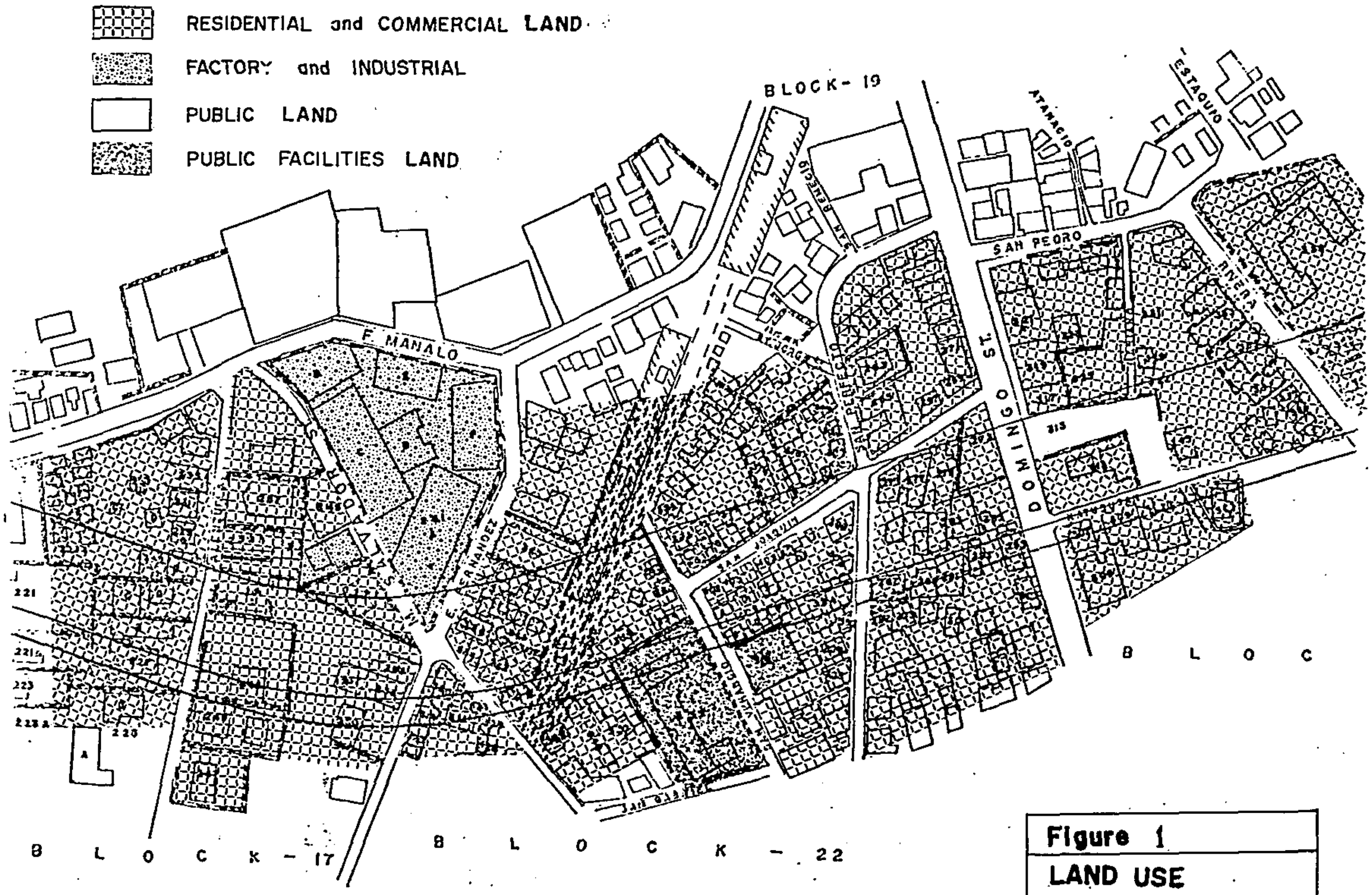


Figure 1

LAND USE

RESULT OF

ASSESSMENT SURVEY

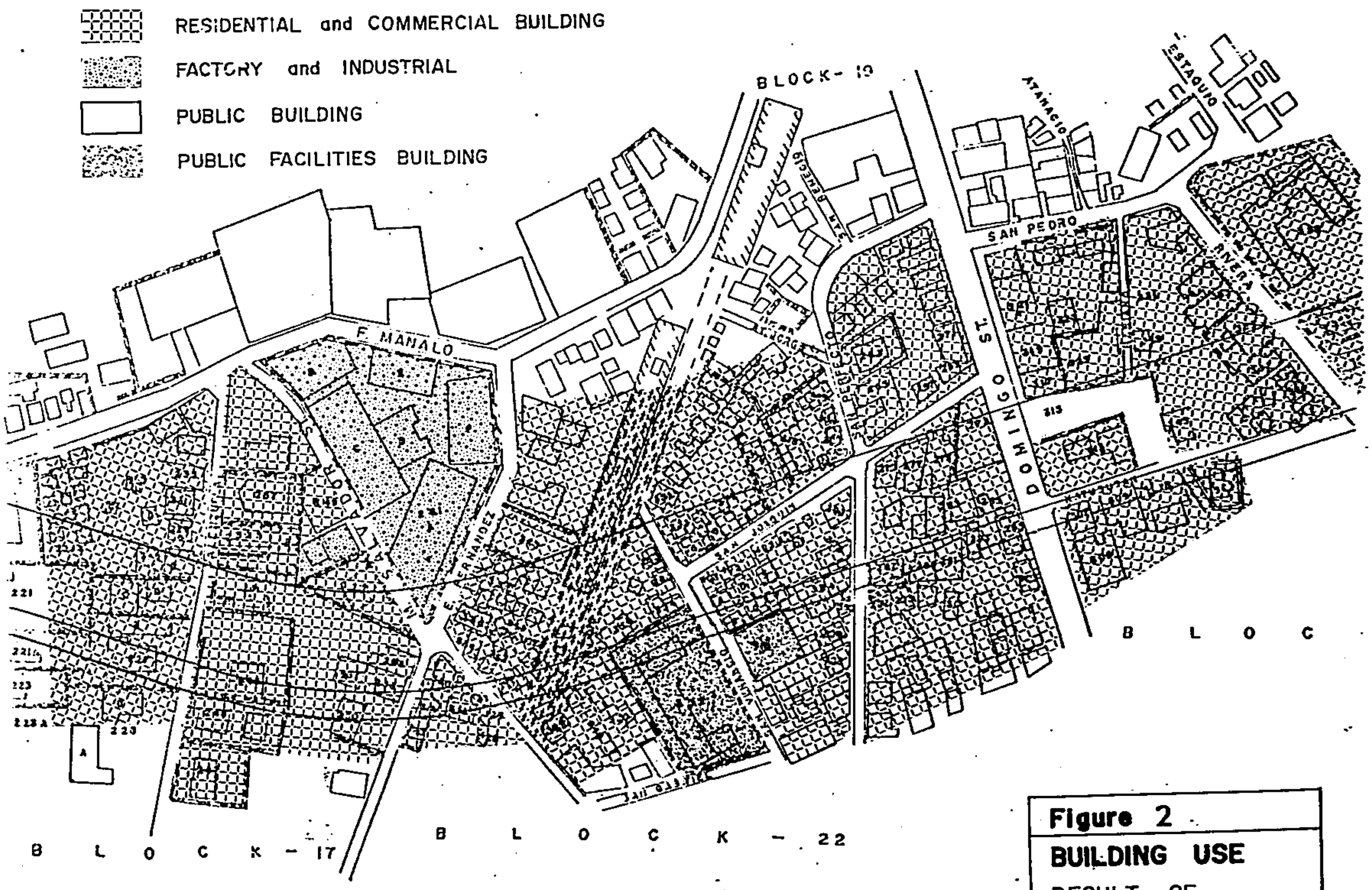


Figure 2

BUILDING USE

RESULT OF

ASSESSMENT SURVEY

Table 1 EXAMPLE OF ASSESSMENT SURVEY REPORT

ROUTE: C-3

STARTING POINT: J. WRIGHT TO VALENZUELA-E. FERNANDEZ

BLOCK NO. & LOT NO.	INDEX NO.	LAND USE	LAND AREA (SM)	LAND COST	BLDG. USE	NO. OF STORIES	CONS-TRUCT-ION TYPE	AREA	OTHER IM-PRVT.COST	BLDG.COST	TOTAL COST	REMARKS
BLK #17	231	R	194	38,820	R	2	M	170		25,000	63,820	
"	233	R	504	126,000	R	2	M	88		24,000	150,000	3 houses
"	233-A	R	990	198,000	R	2	M & W	293		158,300	356,300	13 houses
"	235	R	226	45,280	R & C	2	M	58		30,000	75,280	
"	237	R	994	198,800	R & C	2	M	81	3,500	32,450	234,750	
"	239	R	528	185,608	R & C	2	M	397	117,683	220,000	523,283	
"	241	C	237	47,400	R	2	M	72		45,000	92,400	
"	243	R	1,096	219,200	R & C	1	M	200		284,600	503,800	
"	245	R	740	207,200	R	2	M	256		125,491	332,691	
"	247	R	630	176,400	R	2	M	160		78,432	254,832	
"	249	R & C	908	181,600	R & C	2	M	350	9,500	140,500	331,100	2 houses
"	251	R	1,104	276,000	R	1 & 2	M	96		150,000	426,000	2 houses
"	253	R	180	50,400	R	2	C	169		82,843	133,243	

REFERENCE INDEX MAP NO. C-3 Sheet No. 2-A

S6 SOCIO-ECONOMIC SURVEY

1. GENERAL

The National Housing Authority (NHA) conducted a socio-economic survey (sampling only) of the squatter families affected by the project roads to determine the number of families qualified for relocation to existing and planned resettlement projects of the government.

The information obtained included the following:

1. Number of families affected
2. Length of residence of each family
3. Total monthly family income
4. Age
5. Sex
6. Occupation
7. Employment status
8. Place of employment
9. Educational attainment
10. Home province of family
11. Number of surucutures
12. Type of structures

Attached herewith are the results of socio-economic survey conducted.

2. CRITERIA FOR EVALUATION OF SQUATTER FAMILIES

The criteria adopted for determining the qualified squatter families are as follows:

a. Income - The combined monthly family income must not exceed ₱350.00 for a family of three plus ₱50.00 per additional minor child.

b. Housing Structure - The type of structure indicates mendicancy such as a house made of salvaged materials.

Hereunder are the criteria for determining whether a family is disqualified for government assistance:

a. Income - Combined family income exceeds ceiling set for qualified families.

b. Housing Structure - Made of strong materials.

c. Other Indications

   1. Owns expensive household appliances such as refrigerator or TV.

   2. House or rooms being rented out.

3. Previously relocated but came back to squat again

Breakdown of the cost of relocation and resettlement of squatters per family:

a.	Cost of census-survey per family, including processing and evaluation	₱ 48.36
b.	Labor cost to dismantle one squatter's dwelling and to load the housing materials on the trucks	120.00
c.	Truck hire per trip per family	300.00
d.	Cost of supervising and coordinating relocation operations	48.36
c.	Land development (per Lot)	
	Survey	19.35
	Road construction	3,174.63
f.	Land acquisition	145.78
g.	Water system	828.54
h.	Buildings	2,825.20
	TOTAL	₱ 7,510.22