CHAPTER 7 PRELIMINARY ENGINEERING STUDY

TABLE OF CONTENTS

TABLES AND FIGURES Page

CHAPTER 7

PRELIMINARY ENGINEERING STUDY

7.1 GENERAL

To assess the technical feasibility of the formulated alternative plans and the estimation of construction work quantities, preliminary engineering study has been accomplished. Based on these, the construction cost was calculated within a ± 20% accuracy of the final quantities.

For the preliminary engineering study, particular care was taken to achieve the following:

1) The establishment of appropriate design of the Project Roads to conform with the existing road network and to maintain continuity with related roads.

2) For the vertical alignment of the Project Roads to follow the existing ground as much as possible to provide direct access to roadside developments.

3) The planning should ensure that all work accomplished in Stage 1 could be utilized in Stage 2.

4) The type of structure, pavement and interchange to be adopted should be based on a comparative analysis of the various types.

7.2 BASIC DATA

7.2.1 Aerial-photo Mosaics

The unavailability of topographic maps at an appropriate scale necessitated the preparation of aerial-photo mosaics. Aerial-photo found available covering Metro Manila are as follows:

- photo scale of 1/15,000 taken in 1976
- photo scale of 1/5,000 taken in 1978
- photo scale of 1/60,000 taken in 1980
- photo scale of 1/32,000 taken in 1982

As development, specifically housing development, in the DIZ has been quite rapid in the recent years, the latest aerial photos (the 1982 photos) were selected for preparation of aerial-photo mosaics. The following mosaics were prepared;

- Mosaic scale of 1/25,000, covering most part of the DIZ for the land use study and the candidate route study
- Mosaic scale of 1/5,000, covering most parts of the DIZ for the detailed candidate route study
- Mosaic scale of 1/2,500 along the optimum routes for the preliminary engineering study

7.2.2 Route Survey

Traversing, profile leveling and cross section survey along the center line of optimum routes were conducted. Profile leveling was conducted at 100-meter intervals and at some other points where there is an abrupt change in the terrain and the surveyed data were plotted in the scale of 1/2,500 horizontal and 1/250 vertical. Cross sections were taken at 100-meter intervals and were plotted in the scale of 1/200. River cross sections were also taken at bridge sites.

7.2.3 Soils and Materials Investigation

1) Soils and Materials Survey Conducted

In addition to the available data gathered and verified, field and laboratory soil investigations including tests were conducted to supplement the available data.

Existing materials were gathered from the NCR office, Quezon City District Engineer's Office of MPWH, the Metropolitan Waterworks and Sewerage System (MWSS), and other offices with the assistance of MPWH counterpart.

The following field and laboratory tests were conducted:

- Mechanical boring at 14 locations of major structures for a depth of 10 to 20 meters per hole, for a total depth of 201 meters.
- Penetration tests of boreholes at 75 locations
- Along the planned roads: auger boring at 25 locations and 14 test pits (density test was done at 9 of the pits).
- Laboratory soil test of samples obtained from the mechanical and auger boring and from test pits.

Mechanical boring and standard penetration tests (at the standard intervals of 1.5 meters) were conducted at the locations of major structures in order to determine the form of foundations and to obtain various constants needed for the design of foundation structures. Auger boring and test pits were accomplished in order to obtain constants needed for the planning and design of roads. The location of these tests are shown in Fig. 7.2–1.

As for the laboratory soil test, classification of samples obtained through mechanical and auger boring and from the test pits was conducted as a means of identifying the characteristics of the soils. In addition, uniaxial compression test was done to measure the strength of cores obtained through boring, and the samples obtained from test pits were subjected to compaction and C.B.R. tests in order to determine their suitability as filling materials for embankment.

As far as NCR is concerned, the projects implemented in the past involved a fairly adequate survey of material sources, and therefore, such survey findings were collected. Information was also obtained from the central office laboratory and regional office material collections of the MPWH.

2) Geology of the Project Area

The Project Area is located in the center of the Guadalupe Plateau, which, together with the alluvial areas of the Manila Coastal Margin, the Marikina Valley, and the Laguna Lowland, constitutes Manila and its vicinity The elevation of the Project Area ranges from about 80 to 20 meters precipitates to about 10 meters above sea level into the Marikina Valley, and its average elevation is from 40 to 50 meters above sea level. With additional undulation due to the presence of gorges and ravines created by eroding streams running into Manila Bay, the Project Area presents serriform contour lines.

In comparison with the alluvial lands, the Project Area has a firm foundation – basically of sedimentary rocks containing much tuffaceous materials, which are presumed to have formed in the Tertiary or the early Quarternary period. The sedimentary rocks can be classified into those which are predominantly of sand, those which are

FIGURE 7.2-1 LOCATION PLAN OF SUBSOIL INVESTIGATION

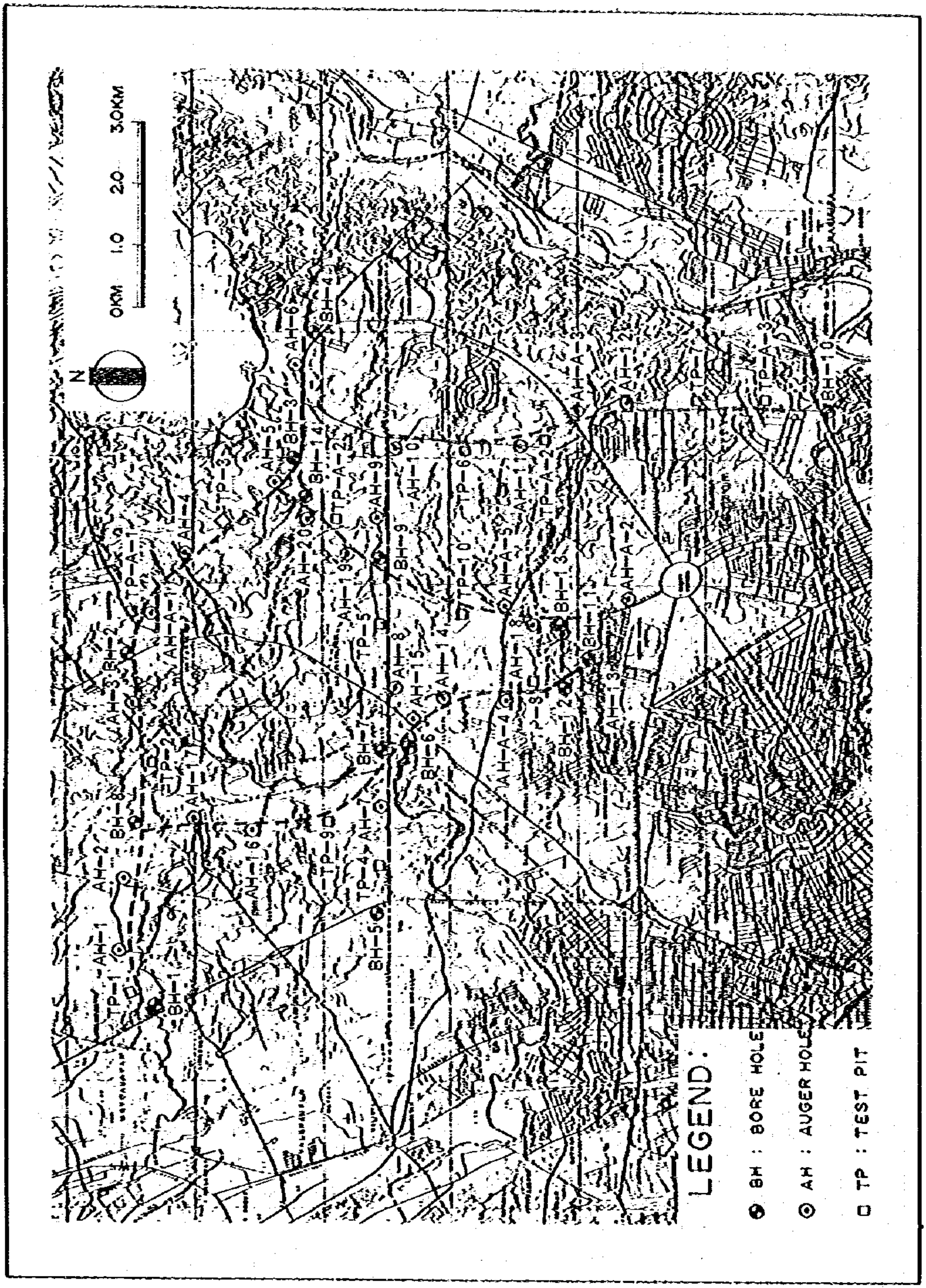
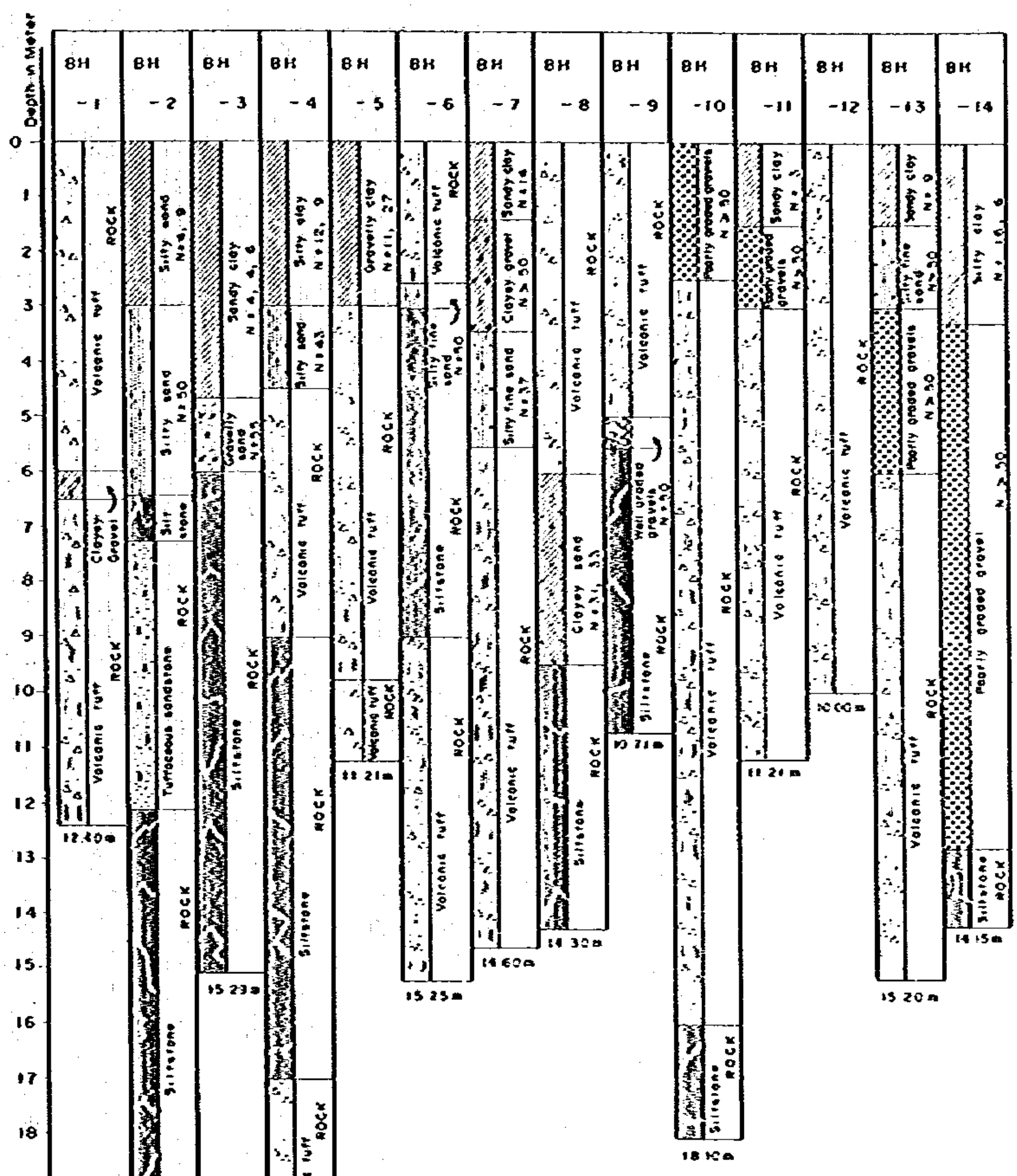


FIGURE 7.2–2 SUMMARY OF BORING LOGS



predominantly of clay and/or mud, and tuffaceous rocks. The first of these three is generally of a low concretion, while the latter two are highly consolidated. These soft rocks are called "adobe" by the local people, and hard adobe has since long been and still is being quarried and used as building blocks. In the Project Area, hard adobe is particularly abundant in the area between MNE and Quirino Highway, where many quarries are located. Adobe is found in relatively shallow layers throughout the Project Area, covered either by clayish soil containing volcanic ash sand presumably from the Diluvium, by eroded adobe which has turned into clayish soil, or by humus soil containing biodegraded grass roots. On both sides of streams, adobe is thinly covered by pebbles containing sediments caused by the river. Outcrops of adobe are frequent and can be seen on the beds of most streams running in the Project Area.

The parts of the Project Area where housing or industrial development has not taken place are being used as pastureland or, the easily irrigable land such as areas along streams with a suitably thick topsoil, as rice land.

3) Survey Results and Analysis

The mechanical boring test resulted in the finding of an adobe layer in all of the boreholes. At boreholes No. 1, 6, 8, and 9, the topsoil is extremely thin, and the adobe layer is nearly on the surface. At other boring sites, the layer deposited above the adobe layer is also relatively thin, averaging about 3.0 meters. The relatively thick -- about 9.0 meters -- gravel layer found over the adobe layer at borehole No. 14 could very well be sediments caused by the nearby river, but, judging from the fact that adobe outcrops are found on river beds, it is more reasonable to think that it is either an adobe layer which caught much gravel in the process of final solidification or an eroded adobe layer. In any event, this gravel layer showed an N value of over 50 by the standard penetration test, which is adequate to support the foundation of structures.

The uniaxial compression test results shown in Table 7.2–1 indicate silt rocks and igneous tuffs, which are adobe, also showed an N value of 50 or more in most cases. The fair levels of strength shown by those hard adobe rocks as a result of the strength test were of the hard core columns obtained at the time of boring and, therefore, not believed representative of the entire adobe layers, which were believed to have somewhat lower levels of strength.

In fact, an unsolidified adobe layer showing the penetration test values of 31 and 32 was found in borehole No. 8 about 6.0 to 9.5 meters from the surface.

Nevertheless, the adobe layer is expected to be adequate to support bridges, and believed safe to regard the adobe layer as soft rocks and to use 40 t/sq. m. as the regular bearing power in the ordinary bridge design.

Auger boring and test pits were accomplished along the planned roads at interval of about 1.5 meters to determine the suitability of cutting part of the subsoil for pavement and the suitability of the soil from road excavation as an embankment material. Samples obtained through auger boring were brought to the laboratory for natural water content and classification tests. In addition to these tests, samples from test pits

TABLE 7.2–1 SUMMARY OF UNIAXIAL COMPRESSION TEST

Samples No.		1	2	3	4	5	6	7	8	9	10	11
BH. No.		1	1	2	2	3	3	4	4	5	6	7
Depth (m)		3.2 –4.7	4.8 –6.30	11.96 –13.46	13.46 –14.96	7.26 –8.76	8.86 –10.36	6.15 –7.65	12.28 –13.78	3.45 –4.95	0.70 –1.05	5.27 –6.99
Size of	Dia meter (cm)	4.73	7.54	4.09	4.09	6.12	6.12	5.86	4.71	6.12	7.21	5.36
Samples	Length (cm)	12.46	13.16	13.08	11.04	11.34	16.00	7.63	12.15	15.29	19.40	13.96
Maximum strength (kg/cm²)		1075.70	86.23	289.19	131.66	224.34	239.63	174.27	318.60	423.18	189.08	77.13

Sample No.		12	13	14	15	16	17	18	19	20	21	22
BH. No.		7	7	7	8	9	10	10	11	12	13	14
Depth (m)		6.98 –8.48	11.60 –13.10	13.10 –14.60	1.50 –3.00	1.50 –3.00	6.10 –7.60	10.60 –12.10	7.71 –8.21	1.15 –2.55	10.70 –12.20	12.15 –14.25
Size of	Diameter (cm)	5.35	5.23	5.14	7.59	7.21	6.12	4.09	4.11	7.13	4.02	5.65
Samples	Length (cm)	16.62	13.83	14.26	22.98	13.16	13.65	11.41	10.96	10.61	10.99	7.07
Maximum strength (kg/cm²)		162.37	129.19	171.08	141.47	85.23	263.43	254.95	316.50	114.45	136.33	141.60

were also subjected to compaction and C.B.R. tests. Both auger boring and test pit, which are manual work, were discontinued when a hard adobe layer was encountered before reaching the designated depth of 1.5 meters. The locations are listed below. Thus, the samples obtained consisted of topsoils, alluvial sediments, and the portions of fairly eroded adobe layer which had turned clayish.

Along Route C–6: AH–1, TP–2, AH–5, and AH–6
Along Route C–5: TP–7, AH–12, and TP–4
Along Mindanao Avenue: AH–13, AH–15, AH–16, TP–8, and TP–9
Along Visayas Avenue: AH–19, AH–20 and AH–A–2

The clayish topsoil is unsuitable for use as roadbed material, but the hard adobe is suitable for such purpose in view of the C.B.R. value of 25 to 30 as estimated based on past project data (see Table 7.2–2) because the C.B.R. test of non-disturbed samples, which is usually conducted as roadbed test of cut ground, was not accomplished in this Study. It should be noted, however, that adobe layers, once disturbed and have become moist, can show a fairly low C.B.R. value and that particularly, tuffaceous, silty, or clayish adobe, when disturbed and has become moist, turns to soft sandy clay or silty clay. Therefore, when utilizing adobe obtained from excavation for embankment purposes, the granularity and composition of the adobe, previously discussed, should be carefully considered. Likewise, care should be taken when working on adobe surface which has shown out as a result of cutting, because such surface can become soft and its strength impaired by rainwater and heavy equipment. In road designing, effort should be made to avoid as much as possible the excavation of adobe layers which are hard but not easily usable as embankment material and to minimize soil borrowing, which will be inevitable due to the difficulty of utilizing the material to be generated in situ for such purposes.

TABLE 7.2–2 CBR RESULTS OF UNDISTURBED SAMPLES
(Adobe Formation)

SOIL DESCRIPTION	LOCATION	NATURAL MOISTURE CONTENT %	ATTERBERG LIMITS		# 200 PASSING	SOIL CLASSIFICATION (AASHO)	CBR
			LL	PI			
SILTY TUFF, gray moderately cemented.	ARANETA AVE.	26.5	–	–	68	A – 4 (8)	27.8
		27.5	–	–	72	A – 4 (8)	25.6
SILTY TUFF; yellowish brown: poor to moderately cemented.	ARANETA AVE.	29.0	39	9	82	A – 4 (8)	26.3
		27.3	41	8	86	A – 5 (8)	24.7

Source: Feasibility Study of C–3 and C–4 and Related
Road Projects "SUPPLEMENTS" March, 1978

The study of material sources was achieved through the collection and analysis of available data. It was confirmed that the distribution channels of cement, aggregates, timbers, and reinforcing steel bars were well established in Manila, the capital of the Republic and where numerous road and building construction projects are presently being implemented, and such construction materials were available in adequate quality and quantity. The quantity of asphalt production, however, is much affected by the demand-supply situation and its price fluctuates substantially. Aggregates, roadbeds materials, and gravel, which are used in huge volumes for road construction, are produced at commercial plants and their availability both in terms of quality and quantity will be adequate, constituting no hindrance to the implementation of this road project. Inasmuch as the material created in situ may not be usable for filling and embankment purposes, as pointed out earlier, the filling and embankment soil may have to be taken from abundantly available sources in Bulacan Province, north of the Project Area, on selective basis in consideration of the soil quality and the convenience of transportation.

FIGURE 7.2-3 DIFFERENT LANDFORMS IN THE PROJECT AREA

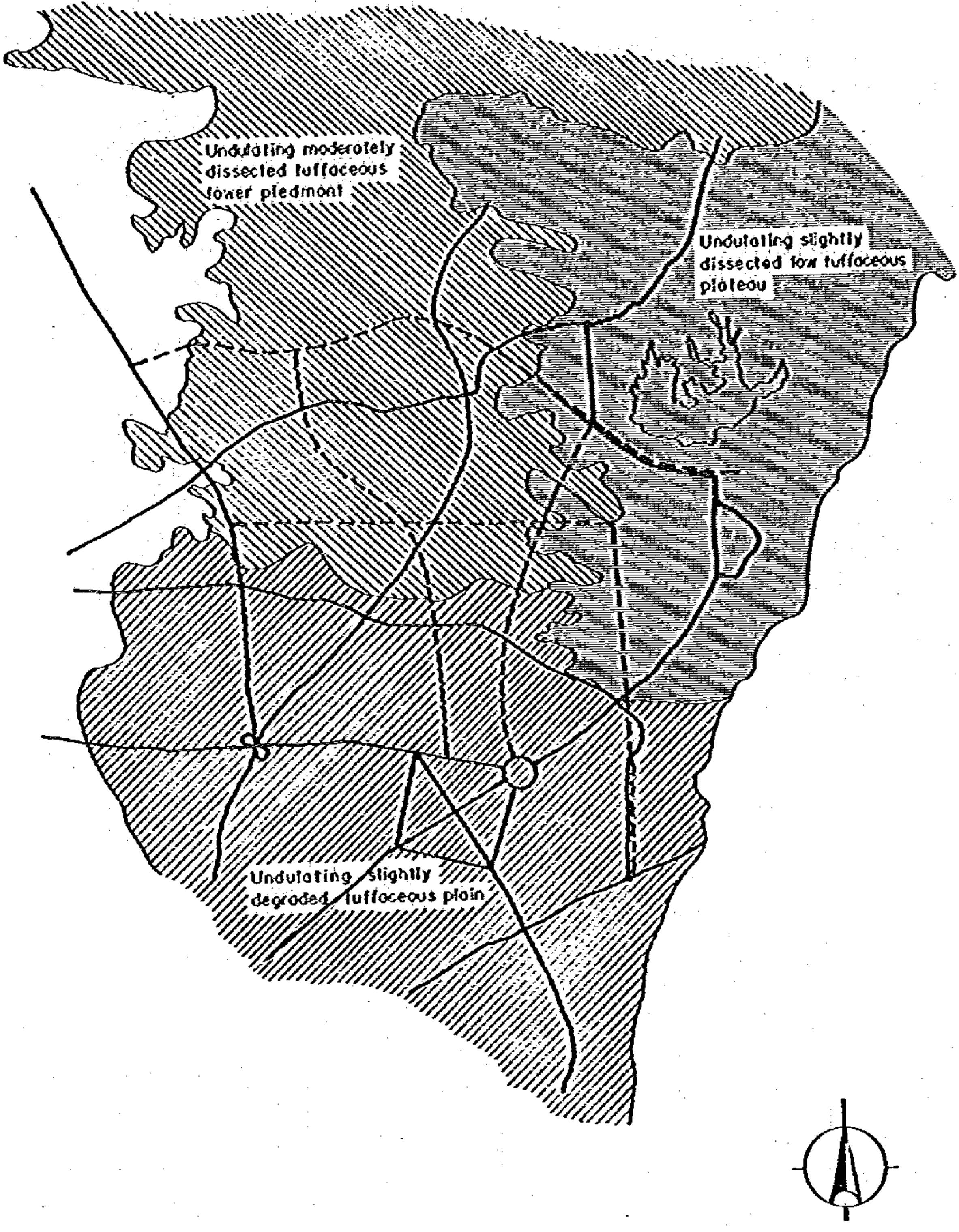


TABLE 7.2–3 SOIL PROPERTIES AND QUALITATIVE POTENTIAL SUITABILITY

Source: Bureau of Soils
Ministry of Agriculture

Main Landform	SOIL PROPERTIES									
	Slope (percent)	Depth to bedrock (cm)	Drainage	Flooding	Ground (cm) water table	Perme-ability	Soil Texture	Plasticity Index	Organic Matter (%)	Compre-sibility
undulating slightly degraded tuffaceous plain	2–10	10–100	Moderate-ly well to well	None	None	Moderate	Silty clay, clay loam	12.4–36.9	0.91–1.50	None to slight
undulating slightly dissected low tuf-faceous plateau	2–8	50–150	well drained	None	None	slow	clay	32.4–42.6	1.15–1.47	None to slight
Undulating moderate-ly dissected tuf-faceous lower piedmont	2–10	30–100	Moderate-ly well	None	None	slow	clay	34.12	1.04–1.5	None to slight

Main Landform	Limitation		Qualitative Potential Suitability			
		Houses and low building	Light Industries	Road, Streets and airports	Playground parks and golf links	Source of roadfill (subgrade)
Undulating slightly degraded tuffaceous plain	Shallow, slightly degraded soil	Moderately suitable	Moderately suitable	Moderately suitable	Marginally suitable	Marginally suitable
Undulating slightly dissected low tuf-faceous plateau	Slightly rolling; moderately shallow soils; slow permeability; and slightly acidic	Moderately suitable	Moderately suitable	Moderately to marginal-ly suitable	Moderately marginally suitable	Marginally suitable
Undulating moderate-ly dissected tuffa-ceous lower piedmont	Slightly rolling; moderately shallow soils: slow permeability	Moderately suitable	Moderately suitable	Moderately suitable	Moderately suitable	Marginally suitable

7.3 PRELIMINARY ROAD DESIGN

7.3.1 Outline of Project Roads

1) C–5

a) Route

C–5 is approximately 14.4 kilometers and passes through the proposed Republic Avenue which starts from the MNE and runs due east towards Batasan Pambansa (the Congress) for about 7.5 kilometers till it reaches the proposed Luzon Avenue and extends south, following the proposed Luzon Avenue and the existing Katipunan Avenue.

b) Present Land Use

Areas along the section from MNE to the Tullahan River are prediminantly agricultural (field and paddies) with sporadic quarries. From the Tullahan River to Visayas Avenue, across the existing Quirino Highway, residential areas are predominant with some commercial activities near the vicinity of Quirino Highway. Vacant lots are conspicuous along the section from Visayas Avenue to the existing Don Mariano Marcos Avenue via Luzon Avenue, which are presently being developed into subdivisions. From Don Mariano Marcos Avenue to Aurora Boulevard along Katipunan Avenue exists a school zone (University of the Philippines, Ateneo de Manila, and others) with some residential areas in the vicinity.

c) Future Land Use

Future developments along Republic Avenue will be an industrial area in the vicinity of MNE intersection, commercial areas in the vicinity of intersections with Mindanao Avenue, Quirino Highway, and Luzon Avenue, and residential areas along other sections. Along Luzon Avenue will be a school zone centering the Far Eastern University and subdivisions around it, and a commercial area from said university to Don Mariano Marcos Avenue.

2) C–6

a) Route

The route of C–6 project starts from the MNE and extends bypassing the urban area of Novaliches, and crossing the Quirino Highway and General Luis Road, until it joins with Fairview Avenue, inside the Fairview Park Subdivision. The total length of the route is about 12.2 kilometers.

b) Present Land Use

Fields and paddies are predominant, with scattered factories, about 4.0 kilometers east from MNE. In the vicinity of Fairview Subdivision, residential areas are developed with a few commercial establishments. There are still a few number of houses and vacant lots in the northern section of Fairview Avenue.

c) Future Land Use

In the section from MNE to Mindanao Avenue the land will be developed for industrial use, around Novaliches will be for commercial use and the remaining sections will be for residential use. In the Fairview Subdivision, a commercial area will be developed in the vicinity of Visayas Avenue.

3) Mindanao Avenue

a) Route

Mindanao Avenue will be a radial road emanating from North Avenue to C–6. It follows the existing section from North Avenue up to Culiat Creek, thence, the route will swing northwest, intersecting with Quirino Highway and C–5 until it intersects with C–6, for a total length of 9.0 kilometers.

b) Present Land Use

Other than the hospital and government offices seen in the vicinity of the intersection with North Avenue, the section up to Culiat Creek is trimmed with houses. Along the section from Tandang Sora Avenue across Quirino Highway and up to the Tullahan River are typically residential areas developed around the commercial area along Quirino Highway. Except for scattered quarries and factories, agricultural activities predominate the area along the section from that river, across C–5, and up to C–6.

c) Future Land Use

Commercial areas will be developed around its intersections with Quirino Highway and C–5. Industrial areas will be opened along other sections.

4) Visayas Avenue

a) Route

Visayas Avenue will be a radial road, extending north from the Elliptical Road till it intersects C–6. The existing road from the Elliptical Road to Tandang Sora

Avenue will be utilized and the remaining sections will be constructed. From Tandang Sora Avenue, the route will bend northeast, intersect with C–5, and connect with C–6. The total length is about 6.7 kilometers.

b) Present Land Use

Houses exist from Elliptical Road to Tandang Sora Avenue and public facilities are predominant in the vicinity of the intersection with Elliptical Road. Except for the residential areas along Tandang Sora Avenue, vacant lots are common on the new section from Tandang Sora Avenue up to C–6 (Fairview Avenue).

c) Future Land Use

Areas along this route will be practically all residential.

7.3.2 Geometric Design Standards

In the Philippines, geometric design standard for urban roads are not yet established and are determined on project to project basis through the analysis of each project requirement. To Project Roads, which will form part of the major road network are extensions of existing and planned major roads in the NCR. Homogeneity and continuity in terms of design speed, cross-sectional elements, etc. should be maintained as much as possible.

The design speeds used in previous highway studies are:

C–3 (detailed design)	60 km/hour
EDSA (C–4) Upgrading Project (detailed design)	70 km/hour
R–10 (detailed design)	60 km/hour
C–5: MNDR – Manila Bataan Coastal Road (F/S)	80 km/hour
Aurora Blvd – Rodriguez Avenue (detailed design)	64 km/hour
C–6: MNDR – Manila Bataan Coastal Road (F/S)	100 km/hour

Taking into consideration the design speed used for the other projects, the following were adopted for the project roads:

C–5: Design speed: 80 kilometers/hour

C–5 should be designed with a higher speed than C–4 (70 kilometers per hour) to attract greater volumes of traffic from C–4 and other congested roads in Project Area. The low design speed (64 kilometers per hour) used in the detailed engineering of C–5 section from Aurora Boulevard to Rodriguez Avenue is mainly due to substandard horizontal and vertical alignments.

C–6: Design speed: 80 kilometers/hour

The C–6 section of the Manila-Bataan Coastal Road Study adopted a design speed of 100 kilometers per hour due to relatively flat terrain. This speed when utilized for the C–6 project would not be adoptable in view of the rugged terrain that would require high cut and fill impairing the accessibility of adjacent area. The design speed of 80 kilometers per hour for C–6 will be adopted.

Mindanao Avenue and Visayas Avenue:
Design Speed: 60 kilometers/hour

Design speed for these two secondary major roads may be lower than those for C–5 and C–6. Design speed shall be 60 kilometers per hour for these two radial roads in conformity with the same design speed of R–10.

The geometric design of each project road was established based on the above indicated design speed and is presented in Table 7.3–1. Also, the geometric designs of interchange ramps are shown in Table 7.3–2.

TABLE 7.3–1 GEOMETRIC DESIGN STANDARDS

	UNIT	C–5		C–6	MINDANAO & VISAYAS AVENUES
		REPUBLIC AVENUE	OTHER SECTIONS		
Design Speed	kph	80	80	80	60 60
Right-of-Way Width	M	50	40–60	45	38
Lane Width	M	3.50	3.50/3.25	3.50	3.50/3.25
Bus/Jeepney Land Width	M	3.50	3.25	3.50	3.00
Median Width	M	4.00	4.00/2.50	6.00	3.00
Inner Shoulder Width	M	0.25	0.25	0.25	0.25
Outer Shoulder Width	M	2.00	2.00	2.00	2.00
Outer Shoulder Width (When B/J lane provided)	M	0.50	0.25	0.50	0.50
Crossfall of Roadway	%	1.5/2.0	1.5/2.0	1.5/2.0	1.5/2.0
Minimum Radius	M	260	260	260	260
Maximum Superelevation	%	6	6	6	6
Maximum Gradient	%	7	7	7	8
Critical Length of Gradient	M	400	400	400	300

TABLE 7.3–2 GEOMETRIC DESIGN STANDARDS FOR INTERCHANGE

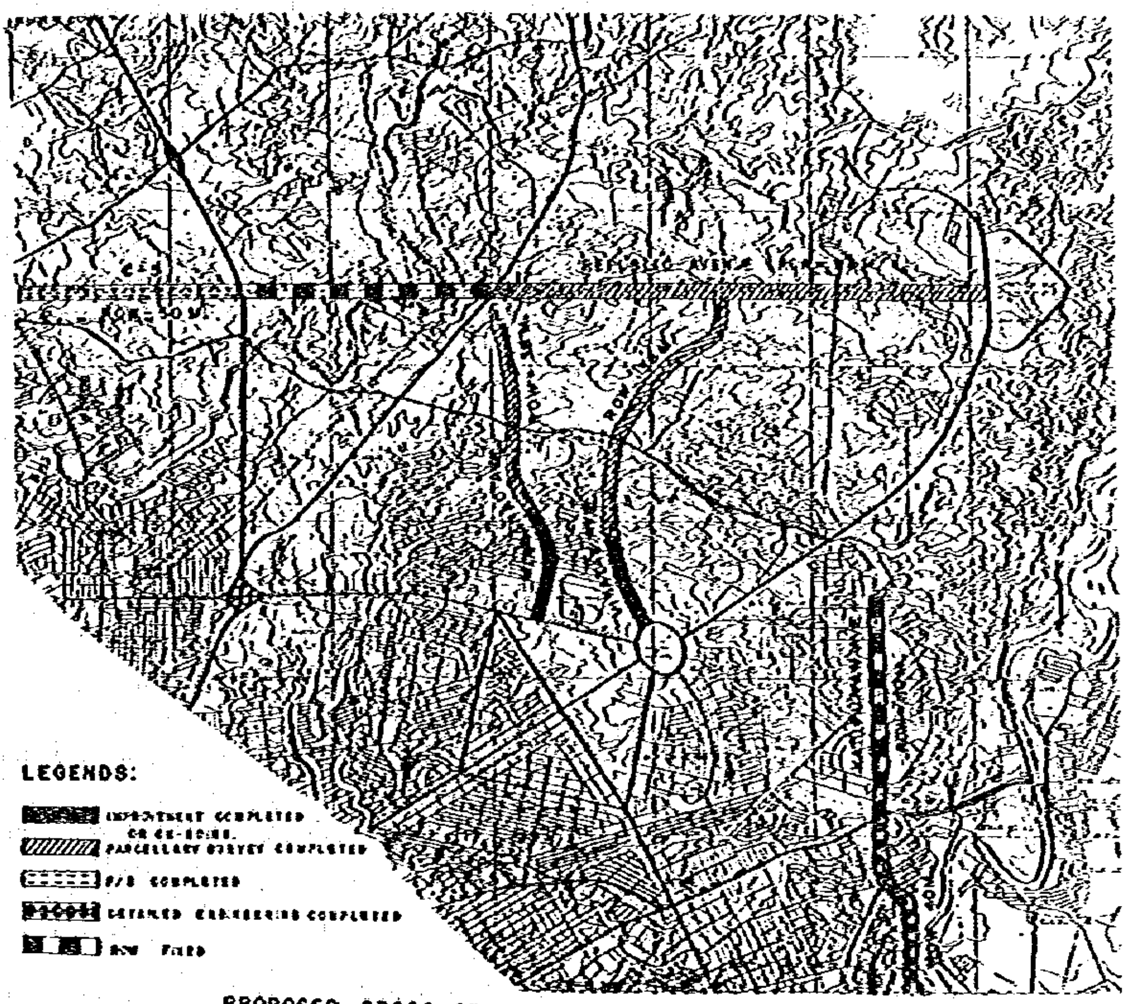
ITEM	UNIT	INTERCHANGES MNDR/C–58 MNDR/C–6	
DESIGN SPEED	Km/h	40.00	
ONE WAY LANE WIDTH	Meter	3.50	
SHOULDER WIDTH	Meter		
RIGHT		1.50	
LEFT		1.00	
MEDIAN WIDTH FOR TWO-WAY ONE LANE	Meter	2.00	
CROSSFALL OF CARRIAGE WAY (P C C)	%	1.50	
MINIMUM RADIUS	Meter	50.00	
MAXIMUM GRADIENT	%	6.00	
MAXIMUM SUPERELEVATION	%	10.00	
ACCELERATION LANE (INCLUDING TAPERS)	Meter	HIGHWAY DESIGN SPEED Km/h	
		100	80
		240	210
DECELERATION LANE (INCLUDING TAPERS)	Meter	HIGHWAY DESIGN SPEED Km/h	
		100	80
		150	130

7.3.3 Right-of-Way and Road Cross Section

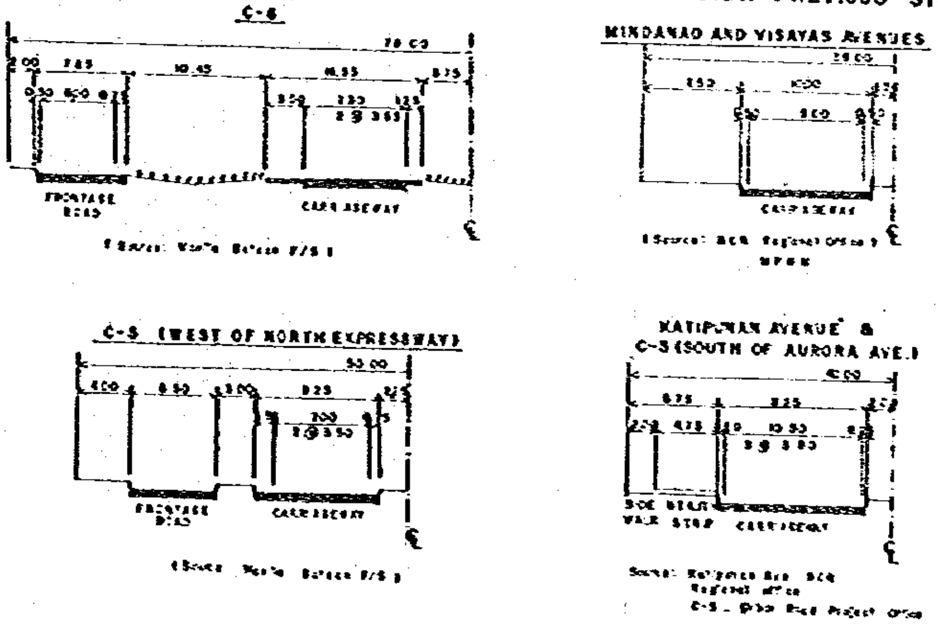
1) Right-of-Way Width

The right-of-way width of the Project Roads and their related roads are partially existing, reserved and proposed from other studies were gathered and shown in Figure 7.3–1. With these data as reference, the following right-of-way width were adopted for the project roads:

FIGURE 7.3-1 PROPOSED R.O.W. AND CROSS-SECTION BY PREVIOUS STUDIES



PROPOSED CROSS-SECTION BY MPWH and/or PREVIOUS STUDIES



i. Republic Avenue (a section of C–5)

The right-of-way width of Republic Avenue, which is a section of C–5, shall be 50 meters. A 50-meter right-of-way was recommended for the section of C–5 west of Manila North Expressway by the Manila-Bataan Coastal Road Project. A 98-meter right-of-way for Republic Avenue has already been acquired since 1958 under the National Planning Commission (organized in 1946) covering about 90% of the section of about 6.1 kilometers from Quirino Highway to Don Mariano Marcos Highway. Based on the traffic forecast, Republic Avenue, would require eight to ten lanes and should be built to a standard corresponding to that of EDSA (C–4), whose right-of-way is 50 meters.

ii. Luzon Avenue (a section of C–5)

Luzon Avenue will be constructed on the 60-meter right-of-way of the MWSS aqueduct.

iii. Katipunan Avenue (a section of C–5)

Katipunan Avenue presently have a 40-meter right-of-way, from Aurora Boulevard to the University of the Philippine, the same width used in the section of C–5 from Aurora Boulevard to Rodriguez Avenue. The section about 300 meters from Aurora Boulevard should be widened to 45.00 meters in order to provide an area for grade separation at its intersection with Aurora Blvd. in Stage 2.

iv. C–6

A right-of-way width of 45 meters is recommended for C–6, based on an overall consideration of the following. A 70-meter right-of-way was recommended for the section of C–6 west of Manila North Expressway by the feasibility study of the Manila-Bataan Coastal Road Project. Fairview Avenue, which will be part of C–6, has been constructed by a private developer on a right-of-way of 38-meters. Areas along C–6 will be utilized for residential purposes, and a wide right-of-way will be desirable from the stand point of preventing traffic from causing nuisance to the public. However, the acquisition of land for a very wide right-of-way and the accompanying relocation of buildings can be prohibitively large in Fairview Park Subdivision, where development has already started.

C–6 will be the outermost circumferential road around NCR and will be required to accommodate large traffic moving at high speed, therefore, it must be designed to a high standard with six to eight lanes and in the future intersections be improved by grade separation.

v. Mindanao Avenue

A 38-meter right-of-way is stipulated for Mindanao Avenue to conform with the existing section of the Avenue as well as its proposed extension up to Quirino Highway.

vi. Visayas Avenue

Also a 38-meter right-of-way is recommended in accordance with its existing section from Elliptical Road to Tandang Sora Avenue.

2) Standard Cross Section

The elements of the cross sections for the Project Roads are as follows:

- Lane width shall be 3.5 meters. When the width of right-of-way is limited in the final stage, it may be 3.25 meters.
- Jeepney/bus lanes shall be installed in Stage 2 chiefly for loading and unloading purposes. This lane shall have the width of 3.5 meters as a principle, with an exceptional 3.0 meters when compelled.
- The inner shoulder shall have the width of 0.25 meter.
- The outer shoulder shall have the width of 2.0 meters or, where jeepney/bus lane is installed, 0.50 meter. No outer shoulder may be installed when compelled.
- Center median width and sidewalk width shall be 2.5 meters and 3.0 meters, respectively, at the minimum, but shall be determined in such a manner as to maintain a balance between the two in view of the width of right-of-way.
- For phasing of construction work from Stage 1 through the final stage, outer lanes (those adjoining the sidewalk) shall be constructed first. To start construction work from inner lanes (those adjoining the center median) will result in the following consequences:

i. The limits of right-of-way may be obscured, and squatters may find it easier to occupy parts of right-of-way.

ii. Sidewalk, if installed in Stage–1, will be demolished for later road widening and be re-installed on an outer strip.

iii. Access from roadside houses, stores, offices and other activities will be disrupted during widening.

iv. Like sidewalk, roadside ditches will result in double investments.

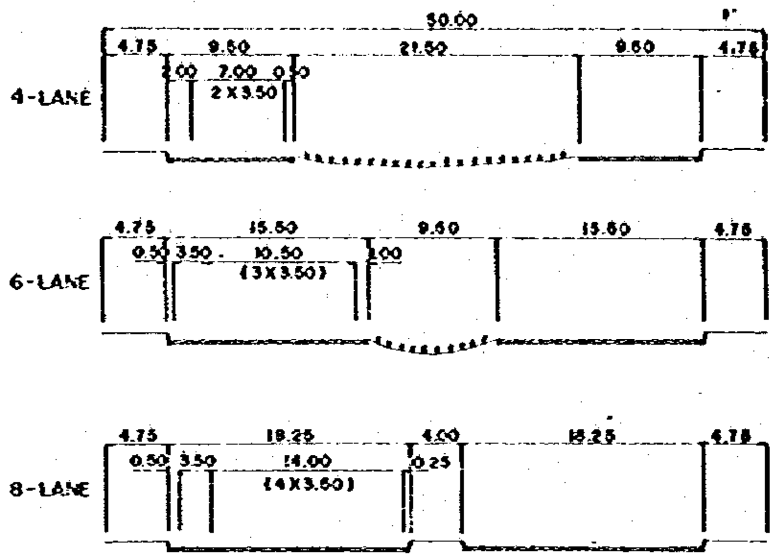
Following the above concept, the cross sections of the Project Roads have been determined and the cross section of each road at different stages is illustrated in Figure 7.3–2.

FIGURE 7.3-2 STANDARD CROSS-SECTIONS

C-5
(REPUBLIC AVE.)

NO. OF LANES

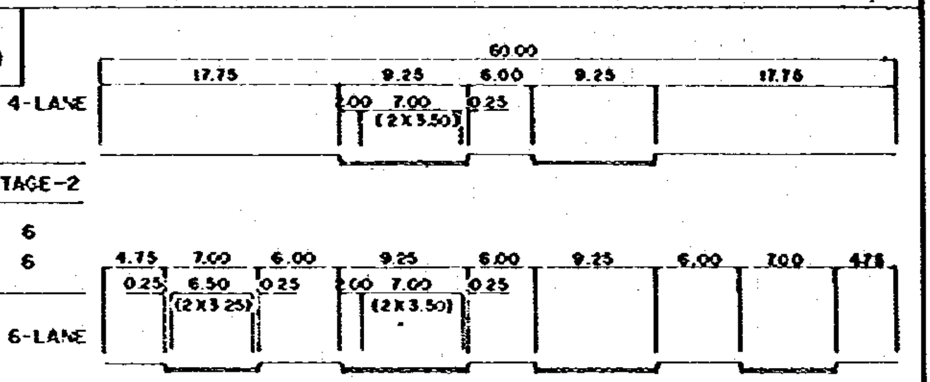
	STAGE-1	STAGE-2
ALT.-1	4	6
-2	4	6



C-5
(LUZON AVE.)

NO. OF LANES

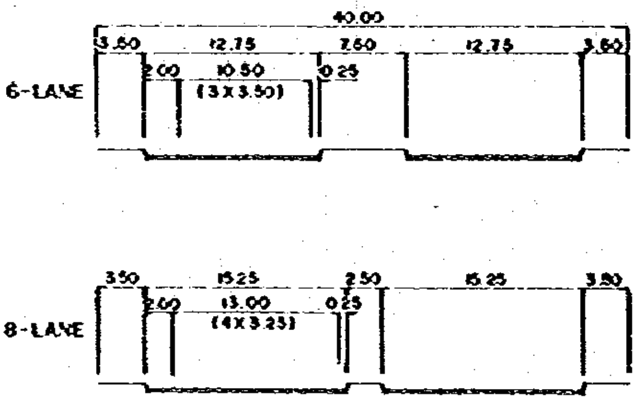
	STAGE-1	STAGE-2
ALT.-1	4	6
-2	4	6



C-5
KATIPUNAN AVE

NO. OF LANES

	STAGE -1	STAGE-2
ALT.-1	6	8
-2	6	8

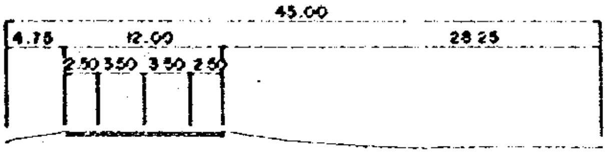


C-6

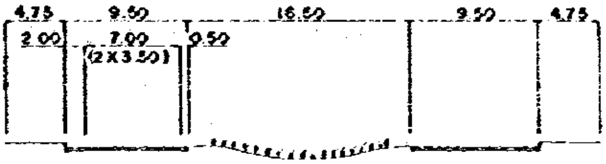
NO. OF LANES

	STAGE-1	STAGE-2
ALT-1	2	4
	4	6
-2	4	6

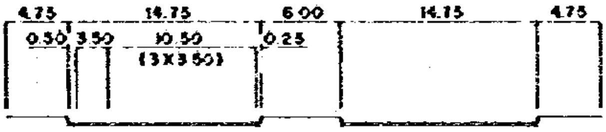
2-LANE



4-LANE



6-LANE

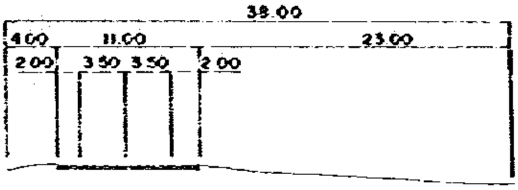


MINDANAO AVE.

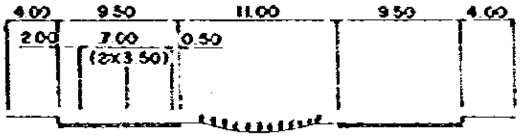
NO. OF LANES

	STAGE-1	STAGE-2
ALT.-1	2	4
	4	6
-2	4	6

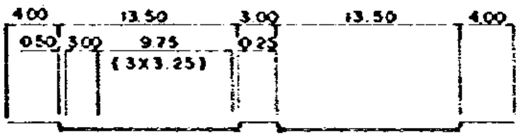
2-LANE



4-LANE



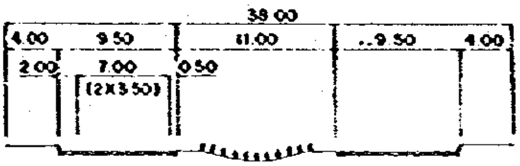
6-LANE

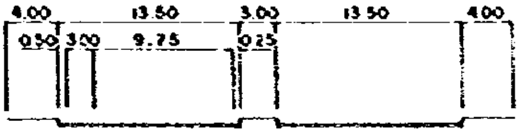


VISAYAS AVE.

NO OF LANES

	STAGE-1	STAGE-2
ALT.-1	4	4
-2	4	6





7.3.4 Road Capacity

As discussed in Section 6.7.2, the traffic capacity of each Project Road at different stages of construction was computed based on the Highway Planning Manual prepared by the PPDO, MPWH, and the Highway Manual of Japan. Traffic capacity of each Project Road is shown below.

TRAFFIC CAPACITY OF PROJECT ROADS

Unit: PCU per day

	2–Lane	4–Lane	6–Lane	8–Lane
C–5				
Republic Avenue	–	64,000	96,000	–
Luzon Avenue	–	64,000	96,000	–
Katipunan Avenue	– –	–	96,000	128,000
C–6				
MNDR–Quirino Highway	18,000	64,000	96,000	–
Quirino Highway – Don Mariano Marcos Ave.	–	64,000	96,000	–
Mindanao Avenue				
North Ave. – C–5	–	56,000	84,000	–
C–5 – C–6	18,000	56,000	84,000	–
Visayas Avenue	–	56,000	84,000	–

7.3.5 Road Alignments

Based on aerophotographs at a scale of 1:2500, the horizontal alignment for the optimum routes was designed and had been identified on aerophotograph mosaic at a scale of 1:5000. With the finalization of the horizontal alignment, the vertical alignment was designed against the designated control points and in consideration of the results of detailed field surveys along the optimum routes.

1) Horizontal Alignment

a) C–5

The control points which governed the design of the alignment of C–5 are:

- The C–5/MNE intersection as established by the Manila-Bataan Coastal Road Project Study will be the starting point of C–5.

- C–5 will be within the 98-meter right-of-way of the Republic Avenue. About 90% of the area between Quirino Highway to Batasan Pambansa has been acquired.
- C–5 will utilize the 60-meter (some section 100 meter) right-of-way of Luzon Avenue acquired by the MWSS.
- The 40.00 meter right-of-way of Katipunan Avenue between Aurora Blvd. and the University of the Philippines will be utilized as part of C–5.

Based on the above control points and in consideration of the present and future land use in the area, the alignment of C–5 was established as described below.

- Republic Avenue

  A double-trumpet type of interchange will be adopted at its intersection with MNE. The center line of C–5 was shifted from the alignment recommended by the Manila-Bataan Coasta Road Study, approximately 150 meters farther north of the MNE in order to avoid the large remains of a quarry, some 250 meters square and 15 to 20 meters deep southeast of the intersection, and the dense housing area west of MNE.

  From its intersection with MNE, C–5 center line will connect with the centerline of the proposed Republic Avenue before Quirino Highway then follows the centerline of the proposed Republic Avenue up to its intersection with Luzon Avenue. The minimum radius of curvature used is 3000 meters.

- Luzon Avenue

  C–5 follows the centerline of the MWSS-acquired right-of-way up to about midway to Don Mariano Marcos Avenue, then shifts to the left to connect with the wide portion of the Katipunan Avenue crossing Don Mariano Marcos Avenue at a convenient location. The minimum radius of curvature is 1000 meters.

- Katipunan Avenue

  C–5 follows the centerline of the Katipunan Avenue from the University of the Philippines to Aurora Boulevard. The minimum radius of curvature is 1000 meters.

b) C–6

The control points for the determination of the alignment of C–6 are:

- The route will start from its intersection with the MNE as established by the Manila-Bataan Coastal Road Study.

  The factories scattered along the section between the MNE and Novaliches.

- The existing Faiview Avenue

  Against these control points and in view of the present and the contemplated future land use, the alignment of C–6 was determined as described below.

- MNE to Fairview Subdivision

  From the MNE, C–6 alignment runs smoothly down to Novaliches avoiding factories scattered in between agricultural lands and traversing the relatively sparse residential area of Novaliches, until it connects with Fairview Avenue. The minimum radius of curvature is 500 meters.

- Fairview Avenue

  The widening of the right-of-way of Fairview Avenue as part of C–6 will be in the southern side due to lesser number of building/structures. The minimum radius of curvature is 280 meters.

c) Mindanao Avenue

The control points are:

- The existing 38-meter right-of-way from North Avenue to Culiat Creek
- The reserved right-of-way for the extension of Mindanao Avenue before Quirino Highway
- Mindanao Avenue/Quirino Highway intersection, Mindanao Avenue/C–5 intersection and C–5/Quirino Highway intersection shall be located with an adequate space (at least 300 meters) distance.
- Factories in the vicinity of the intersection with General Luis Road

  From these control points and in consideration of the present and future land use, the horizontal alignment of Mindanao Avenue has been established as described below.

- Existing Section

  The center line of the right-of-way of the existing section will be adopted. The minimum radius of curvature is 650 meters.

- From Tandang Sora Avenue to C–6

  Along the section from the end of the existing section up to Quirino Highway down to the Tullahan River are dense concentrations of houses, and this section is aligned through the reserved right-of-way through relatively sparse parts of the area. Minimum radius of curvature used is 300 meters. After crossing C–5, the route proceeds in a moderate horizontal alignment with a minimum radius of curvature of 600 meters while avoiding the factories scattered along General Luis Road.

d) Visayas Avenue

The control points are:

- The 38-meter right-of-way of the existing section from Elliptical Road to Tandang Sora Avenue.
- Therton Street, in the Fairview Park subdivision as the connection to C–6.

The alignment of Visayas Avenue extension is described below:

- The center line of the right-of-way of the existing road will be followed with a minimum radius of curvature of 1000 meters.
- Tandang Sora Avenue to C–5

  This section is aligned through a lightly developed area to connect with C–6 (Fairview Avenue) utilizing Therton Street of the subdivision with a minimum radius of 700 meters.

2) Vertical Alignment

Using the profile (horizontal scale, 1:2500; vertical scale, 1:250) locations where the routes of the Project Roads cross rivers, channels, and existing roads were identified and used as control points. The vertical alignment is then established using these control points, taking into consideration the future roadside development and the drainage systems. The finished grade of project roads should, as much as practicable, have the same elevation as the existing ground level to allow easy access from roadside activities. A minimum vertical clearance of 4.88 meters was adopted at grade separations.

a) C–5

The following control points were used for C–5, whose route runs over generally gentle hills with the exception of a section from Mindanao Avenue to Quirino Highway and in some sections of Luzon Avenue, where the terrain is rugged:

- Intersection (interchange) with MNE
- Intersection (grade separation) with Mindanao Avenue
- Proposed bridge over the Tullahan River
- Intersection (grade separation) with Quirino Highway
- Republic Avenue/Luzon Avenue intersection (grade separation)
- The elevation of the existing section of Katipunan Avenue
- Intersection (grade separation) with Aurora Boulevard
- All other intersections shall be at grade.

At intersections where grade separation will be necessary, C–5 will be on a flyover except on Mindanao Avenue and Quirino Highway where C–5 will be depressed.

b) C–6

C–6 route runs over a generally rolling terrain. The control points are:

- Intersection (Interchange) with MNE
- Fairview Avenue
- Intersection (grade separation) with Don Mariano Marcos Avenue

C–6 will be depressed at its intersection with Don Mariano Marcos Avenue

c) Mindanao Avenue

Except for the steep hills in the section of Quirino Highway to C–5, the route of Mindanao Avenue goes through generally gentle hills. The following control points are:

- The elevation of the existing road
- The heights of proposed bridges over Culiat Creek, the Pasong Tamo River, the Darino River and the Tullahan River.

d) Visayas Avenue

Visayas Avenue will traverse a generally gentle hill with some undulation in section passed Tandang Sora Avenue up to C–6. The control points are:

- The elevation of the existing road
- The elevation of existing bridges over Culiat Creek and the Pasong Tamo River
- The elevation of the proposed bridge over the Tullahan River

7.3.6 Intersection

1) Type

Intersections will be either of the following:

a) Grade Separation

Intersections between major roads and intersections between a major road and a secondary major road will be built at-grade in Stage–1 and will be upgraded to grade separation in Stage–2.

b) Major At-Grade Intersection

This type of intersections will allow traffic to proceed in all directions (straight, left, and right) from any of the approach roads. Spacing between these intersections are usually between 500 to 700 meters, with the allowable minimum of 300 meters as a principle.

c) Minor At-Grade Intersection

Most of the intersections of the Project Roads with local roads will be of this type, through which the center median of the Project Roads will not be opened to discourage crossings and that the traffic on the local roads could make right-turn only.

2) Capacity

Intersection traffic capacities have been analyzed using the estimated traffic flow in each direction as determined in the traffic assignment and assuming the following lane capacities:

- Capacity per straight lane: 2,000 PCU/green hour
- Capacity per left or right-turn lane: 1,800 PCU/green hour
- Peak Hour Rate: 8.0%

The result of intersection traffic capacity analysis is presented in Appendix 7.3–1.

3) Grade Separation

a) C–5

i. Republic Avenue/Luzon Avenue

Major flows at this intersection are the right turning traffic from Republic Avenue to Luzon Avenue and vice versa. The grade separation at this intersection will be a fly-over for the traffic from Luzon Avenue to Republic Avenue.

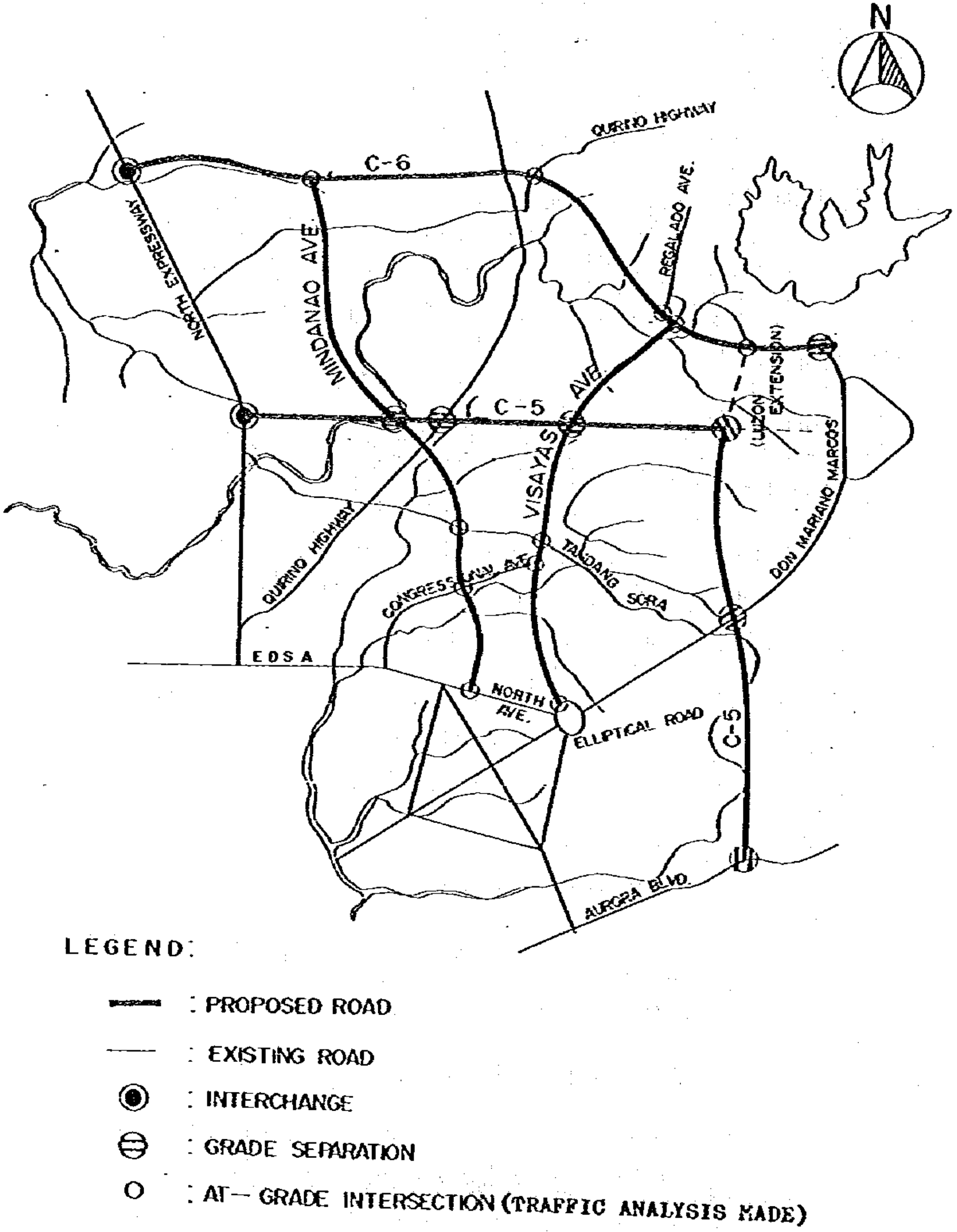
ii. C–5/Don Mariano Marcos Avenue

Due to the higher traffic volume along the Don Mariano Marcos Avenue, the grade separation at this intersection will be a fly-over along the 95.00-meter right-of-way of the Don Mariano Marcos Avenue.

iii. Other Intersections

Other intersections with grade separation in the future will be at the locations where C–5 intersects Mindanao Avenue, Quirino Highway and Visayas

FIGURE 7.3-3 LOCATION OF MAJOR INTERSECTION/INTERCHANGE



Avenue. Since the major flow will be along C–5 and due to the topographic conditions, the type of grade separation will be a C–5 depressed in the first two intersections and a C–5 fly-over in the last.

b) C–6

Grade separation shall be only at C–6/Don Mariano Marcos Avenue where C–6, traffic on which is the major flow, shall overpass Don Mariano Marcos Avenue.

7.3.7 Interchange

Interchanges will be constructed at the intersections of C–5 and C–6 with the MNE, an access-controlled speedway. Although the Manila-Bataan Coastal Road Project Study indicated a cloverleaf type of interchanges at these two intersections, a double trumpet has been selected after a detailed analysis of the two types (see Table 7.3–3). The latter was preferred in view of lower construction cost (by a factor of 0.88) and that it conforms with the major traffic flow, though the former is more effective in terms of total PCU-Kms of traffic utilizing the interchanges.

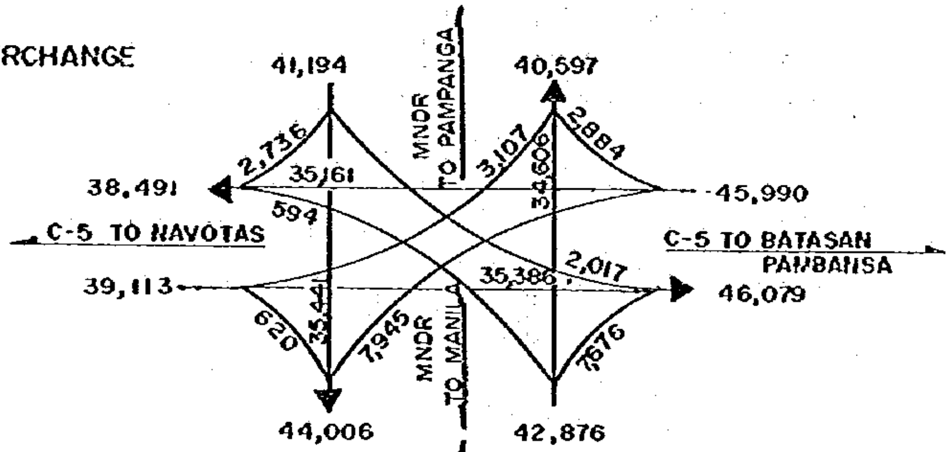
In addition of these two new interchanges to the existing two (Malinta and Meycauayan Interchanges) will result in the presence of closely located four interchanges in the DIZ as illustrated in Figure 7.3–4. The proximity of these interchanges will increase chances of traffic accident and impair the traffic capacity of MNE and therefore, it will be necessary that traffic behavior of MNE be assessed after the opening of the two interchanges to determine whether or not the two old ones should be closed.

TABLE 7.3- 3 COMPARISON OF CHARACTERISTICS OF TYPE OF INTERCHANGE

ITEM	Cloverleaf Type	Double Trumpet Type
(R.O.W)	₱29.9 Million	₱28.5 Million
(Ramp way)	₱30.3 Million	₱24.6 Million
Total Construction Cost	₱60.2 Million (1.00)	₱53.1 Million (0.88)
Traffic Capacity	High	High
Traffic Movement	Good	Fair
Vehicle–Kms. Within Interchange		
– C–5(Veh–Kms./day)	36,000	45,980
– C–6(Veh–Kms./day)	37,250	45,150
Difficulty of Stag Construction	Difficult	

FIGURE 7.3–4 DIRECTIONAL TRAFFIC FLOW VOLUME (PCU/DAY)

C-5/MNDR INTERCHANGE



C-6/MNDR INTERCHANGE

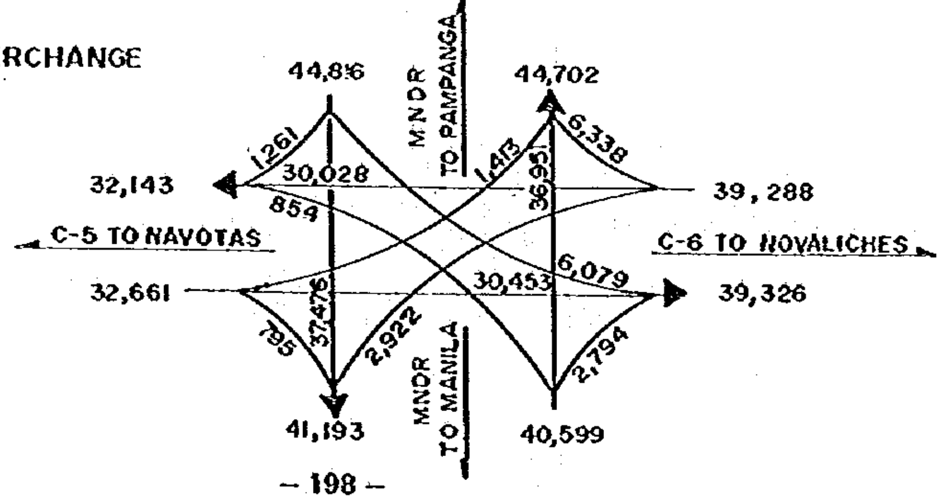
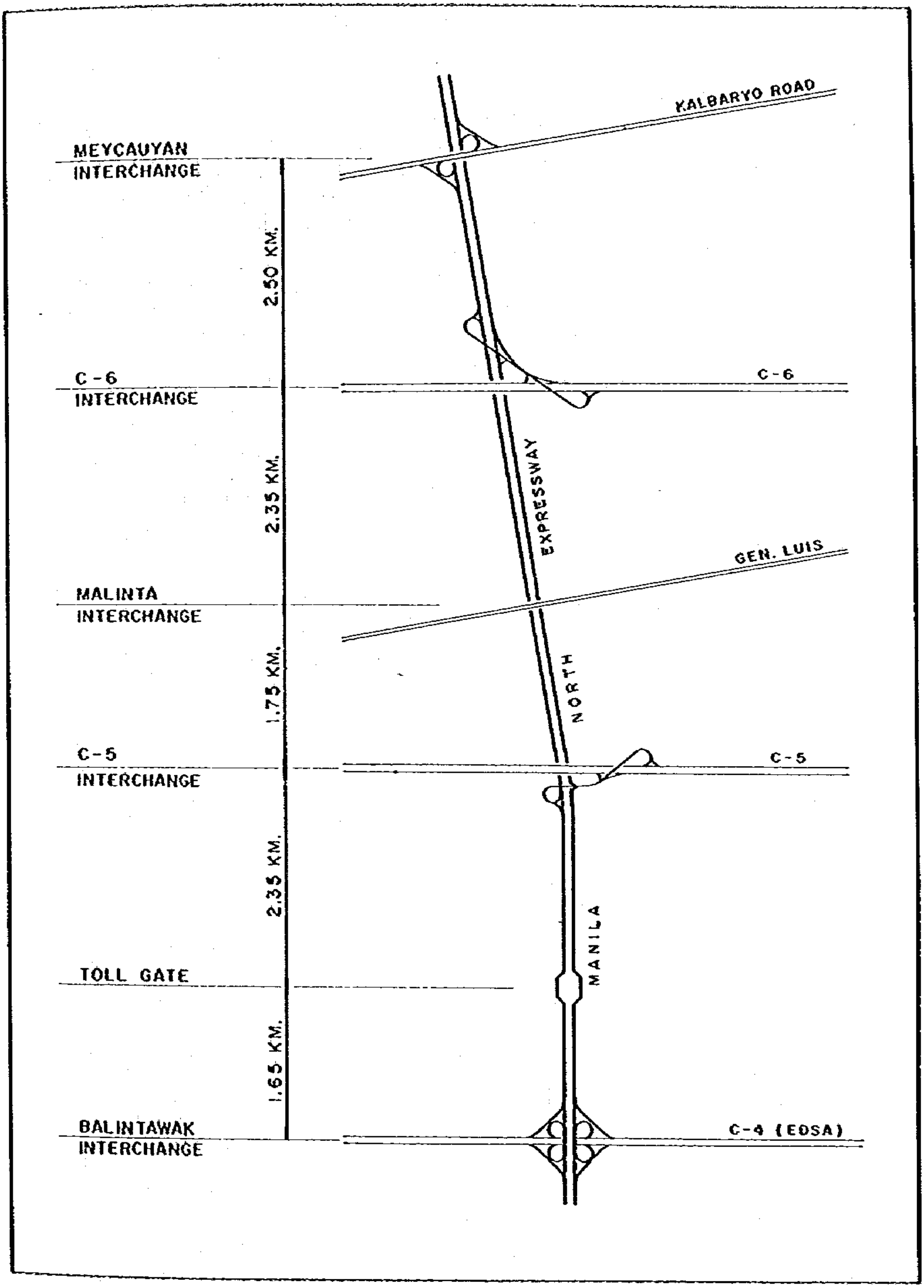


FIGURE 7.3–5 LOCATION OF INTERCHANGE ALONG MANILA NORTH EXPRESSWAY



7.4 PAVEMENT

7.4.1 Type

After comparing (see Table 7.4–1) portland cement concrete pavement and asphalt concrete pavement – the commonly used pavement types in NCR, the former was selected in preference to its lower maintenance requirement over the lower initial investment cost of the latter (the comparison was based in terms of total cost, that is, initial investment and maintenance costs). In the NCR, where the roads are not properly maintained due to inadequate budget, asphalt concrete roads present more deteriorated surface conditions than do Portland Cement Concrete roads.

7.4.2 Design

The design of Portland Cement Concrete Pavement was based on the "AASHTO Interim Guide for Design of Pavement Structure, 1972". The following conditions were used:

1) Annual Average Daily Traffic (AADT)

Using 20-year design life from 1989 to 2000, AADT in 2000 has been estimated for each of the Project Roads, as shown in Appendix 7.4.1.

2) Traffic-Load Conversion

The volume of traffic has been converted to equivalent 18-kip single-axle load application for the 20-year period using the conversion coefficient for each type of vehicle as obtained through the loadometer survey conducted in the NCR (see Appendix 7.4–1 for the result of conversion).

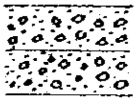
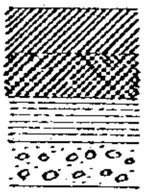
3) Bearing Capacity of Subgrade

CBR of subgrade : 2.5 (based on geological survey findings)
Subgrade K value : 100 psi
Subbase thickness : 12 inches
Subbase K value : 190 psi (see Appendix 7.4–2)

4) Stress Tolerance of Concrete

Allowable bending stress of concrete : 640 psi
Allowable working stress of concrete : 480 psi

TABLE 7.4–1 COMPARISON OF RIGID AND FLEXIBLE PAVEMENTS

		RIGID PAVEMENT	FLEXIBLE PAVEMENT
1. THICKNESS DESIGN	CUT	 P.C.C. SLAB 25 cm. LEVELING 10 cm.	 SURFACE 5cm BINDER 5cm. BITUMEN TREATED BASE 10 cm. LEVELLING 10 cm.
	FILL	 P.C.C. SLAB 25 cm. AGGREGATE SUB-BASE 30 cm.	 SURFACE 5 cm. BINDER 5 cm. BITUMEN TREATED BASE 10 cm. SUB-BASE 30 cm.
2. CONSTRUCTION COST [1]	CUT	a) ₱247.00	a) ₱210.00 b) ₱240.00
	FILL	a) ₱274.00	a) ₱247.00 b) ₱266.00
3. CONSTRUCTION		In case of widening of the existing road, the maximum utilization of existing pavement is not always possible.	In case of widening of the existing road, both the design and construction is easy with the minimum use of the existing.
4. MAINTENANCE		Much Lower	Higher
5. EXPERIENCE IN THE PHILIPPINES AND PERFORMANCE		The most prevailing type on trunk roads. Their performance is mostly acceptable. Mostly labor intensive in the past.	The construction on asphalt concrete is becoming popular. Their poor performance in the past is due mainly to drainage. Machine intensive.
6. SUPPLY OF MAIN MATERIALS		All the materials are to be supplied.	The supply of asphalt is unstable. The supply of crushed stone is more difficult compared to the aggregate of P. C. C.
7. RIDING QUALITY		Fair	Good
8. VISIBILITY IN THE DARK.		Good as a whole, but the function of pavement marking is poor.	Fair
9. TRAFFIC ACCIDENT		Fair	Slippery when wet
10. DURABILITY	Good Drainage	Good	Good or Fair
	Poor Drainage	Fair	Poor or Very Poor
11. MAINTENANCE		Sealing of joints and cracks.	Sealing of cracks, patching, leveling of ruts.
12. REPAIR WORK		Overlay is easy but repaving is difficult and expensive	Mostly easier and cheaper.
13. UNDERGROUND UTILITIES		Much more difficult and expensive	Easier and cheaper.

NOTE:

[1] Construction Cost: Pesos per square meter.

a) Initial cost

b) Cost includes periodic maintenance cost discounted at the rate of 15 % per annum.

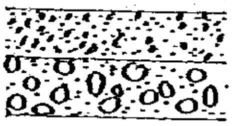
5) Serviceability Index

pt – 2.5

Under these conditions, the concrete slab thickness have been calculated as presented in Table 7.4–2.

TABLE 7.4–2 PAVEMENT THINKNESS

ROUTE	PCC
C–5	
M.N.D.R. – MINDANAO AVENUE	25 cm.
MINDANAO AVE – DON MARIANO MARCOS HIGHWAY	23 cm.
DON MARIANO MARCOS HIGHWAY – AURORA BLVD.	25 cm.
C–6	
M.N.D.R. – MINDANAO AVE.	25 cm.
MINDANAO AVE. – QUIRINO HIGHWAY	23 cm.
QUIRINO HIGHWAY – DON MARIANO MARCOS HIGHWAY	23 cm.
MINDANAO AVENUE	23 cm.
VISAYAS AVENUE	23 cm.



PCC PAVEMENT

SUB-BASE COURSE : 30 cm. for FILL SECTION

: 10 cm. for CUT SECTION OF ADOBE

7.5 HYDROLOGIC ANALYSIS

7.5.1 General

A hydrologic analysis was conducted for the purpose of determining hydrologically and hydrodynamically;

a. a waterway cross-section of rivers as a basis for the preliminary design of bridges and box culverts; and

b. the minimum bank height as a control point for road profile design.

In the Project Area are three river systems:

1) the San Francisco River, which originates from the southern part of the project area and joins the Pasig River;

2) the Tullahan River, which originates from the northern part of the project area and the Novaliches Reservoir, traverses the Project Area and joins the Navotas River; and

3) the Meycauayan River, which runs north from the northwestern part of the project area.

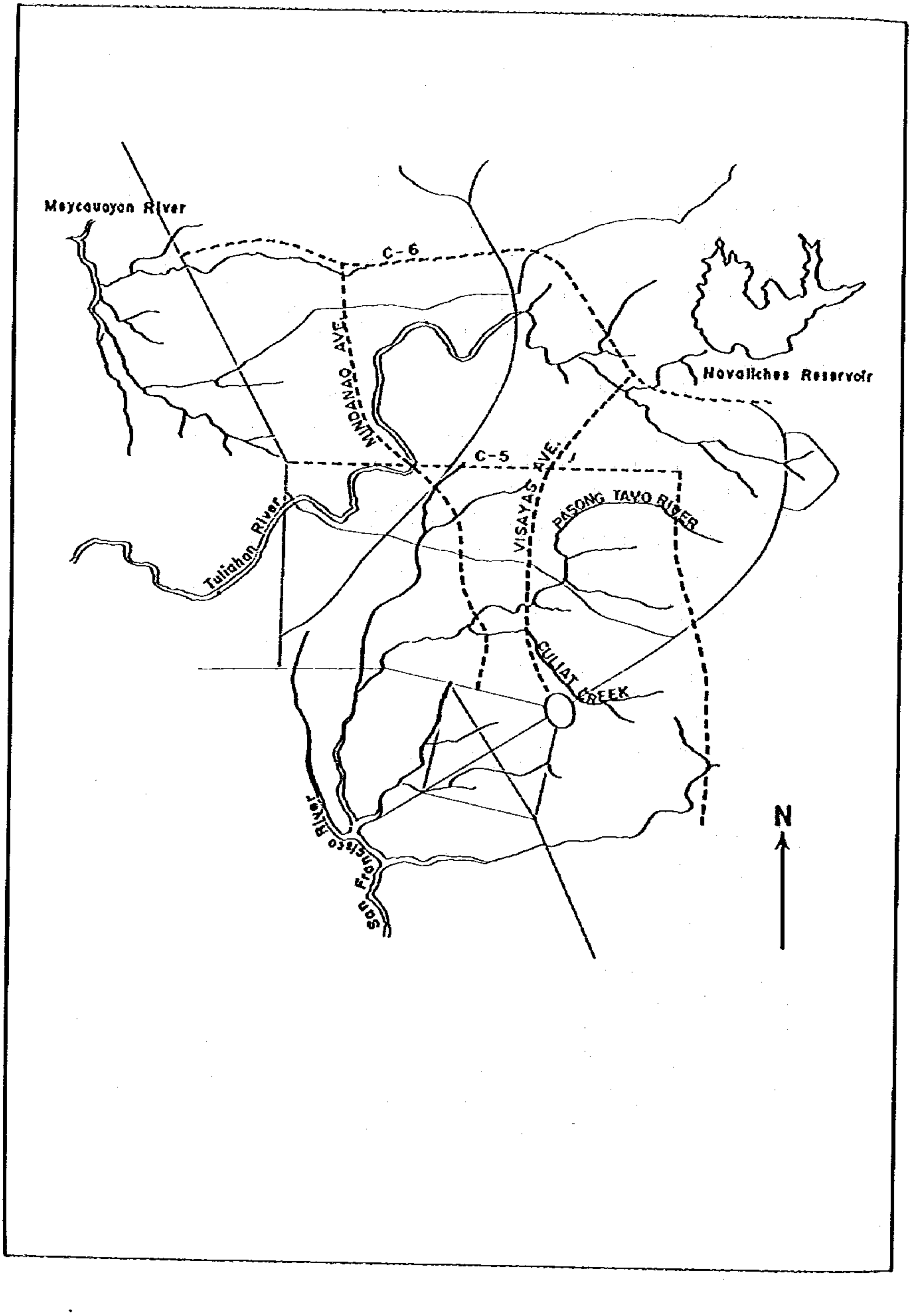
(See Figure 7.5–1). These are all small rivers, each with the flux of less than 500 cubic meters per second, and they stretch over the project area in a tree-shape, forming gullies and gorges.

7.5.2 Rainfall and Discharge

1) Rainfall

P.A.G.A.S.A. calculated in February 1981, the probable rainfall intensity for major cities in the Philippines using the E.G. Gambel method. But in the absence of observatory data for the project area, data for the Manila Port Area (the closest area with available data) were used for the hydrologic estimation. Probable rainfall intensity in the Port Area is given for 2– to 200-year frequency and 5-minute to 23-hour duration, based on observatory records for 26 years. Rainfall intensity-duration curve in the Manila Port Area is presented in Appendix 7.5–1.

FIGURE 7.5-1 RIVERS IN DIZ



2) Water Discharge Estimation

a) Calculation Formula

The sizes of river basins running in the project area are not large enough to require the consideration of the quantity of stagnant water, and therefore, the following rational formula, which is widely used in the Philippines, is used for estimating the quantity of flood discharge:

$$Q = \frac{1}{36} f.r.A$$

Where: Q = Peak discharge volume of flood (cubic meter per second)

f = Coefficient of run-off

r = Rainfall intensity for a duration (mm/hour)

A = Drainage area (square kilometers)

b) Coefficient of Run-off

In determining the coefficient of run-off, the area must be taken into consideration. The project area lies in a steep (1/100 to 1/150) hilly land with scattered tuff of the Pliocene of the Tertiary period to the Pleistocene of the Quarternary period, and it is believed that residential, commercial and industrial areas will be developed in the Project Area. Therefore, the coefficient of run-off in the range of 0.7 to 0.8 is used for the calculation of maximum run-off.

The standard coefficients of run-off given by the American Association of Civil Engineers are shown in Table 7.5–1.

TABLE 7.5–1 STANDARD COEFFICIENTS OF RUN–OFF

USE OF AREA	COEFFICIENT
Commercial Area	0.50–0.95
Residential Area	0.25–0.75
Suburban Area	0.25–0.40
Industrial Area	0.50–0.90
Green Area and Others	0.10–0.40

c) Concentration Time

Concentration time, as used in the rational formula, is defined as the time needed for the rain water to flow from the farthest point in the watershed to the basin's exit. This time is calculated as the total of the:

1) inlet time needed for the water to flow into the channel; and the

2) time needed for the water to flow down to the estuary.

Inlet time has been estimated based on the values given by AACE or by Kravel's formula, band reaching time has been obtained by Kravel's formula.

TABLE 7.5-2 VALUES OF THE INLET TIMES PER A.A.C.E.

Crowded area with complete pavement and sewerage	5 minutes
Development area having a comparatively gentle slope	10–15 minutes
Residential area in flat	10–20 minutes

TABLE 7.5-3 RELATIONSHIP BETWEEN VELOCITY AND SLOPE

H/L	Over 1/100	1/100 to 1/200	Below 1/200
V (m/s)	3.5	3.0	2.1

Where: H = height of waterway in meters

L = length of waterway in meters

V = velocity of stream in meter per second

d) Drainage Area

The area of each river basin has been sized up using maps on the scale of 1:50,000 or, as necessary, 1:25,000.

e) Discharge from La Mesa Dam

Discharge from La Mesa Dam is completely controlled since 1982, and the maximum discharge is 3,000,000 gallons per day (or 131.4 cubic meters per second), regardless of rainfall intensity and frequency.

7.5.3 Hydrodynamic Estimate

1) Draining Capacity

Flux at a given point is obtained from the maximum flood discharge. Mean velocity and discharge capacity of each waterway have been estimated by Manning's formula, which assumes uniform flow.

$$Q = V . A \frac{1}{n} . R^{2/3} . I^{1/3} . A$$

Where: Q = Quantity of flux (cubic meters per second)

n = Manning's roughness coefficient (see Table 7.5–4 for standard values)

R = Hydraulic mean depth (meter)

I = Incline of waterway

A = Area of waterway cross-section

TABLE 7.5-4 VALUES OF MANNINGS'S ROUGHNESS COEFFICIENT

Type of Lining	Values of n
Natural river with slope protection	0.03
Artificial channels	
Earth ditches with vegetation	0.035
Concrete pipe culvert	0.013
Side ditches, cast-in-place concrete	0.014

7.5.4 Hydrologic and Hydrodynamic Estimates for Structures

1) Hydrologic Standards of Rivers

Probable rainfall intensity curve is used for the estimate of discharge, and rainfall intensity of 50-year frequency for bridges, 25-year frequency for box culverts and 5-year frequency for road surface and slope drainage.

Choice between bridge and box culvert has been based on the following elements:

i. Design flooding volume (if 65 cubic meters per second or less, box culvert)

ii. Size of debris

iii. Drainage area (if 2.0 square kilometers or less, box culvert)

In the Philippines, under-the-grinder clearance of 1.0 to 1.5 meters is used, based on experienced maximum flood level. The clearance has been decided for the purpose of this Study based on the design flood discharge as follows:

Design Flood Discharge of 550 M^3 or
less: clearance of 1.0 M

Design Flood Discharge of over 500 M^3: clearance of 1.5 M

2) Estimation of Discharge

Locations at which the optimum route of the Project Roads will cross a river have been spotted and design flood discharge at such locations has been estimated by the calculation method discussed heretofore. Such locations and the estimates of design flood discharges are presented in Appendices 7.5–2 and 7.5–3. The largest discharge of 551 cubic meters per second including water released from the dam will occur at locations where C–5 and Mindanao Avenue will cross the Tullahan River. In addition, a discharge of 300 cubic meters per second will occur at two locations and of 200 cubic meters per second, at one location. Thus, rivers running in the DIZ are all relatively small in terms of discharge.

3) River Cross-section for Bridge Plan

Based on the findings of cross-sectional leveling of rivers, plan cross-section of waterways has been established carefully (see Table 7.5–5) so that the new cross-section dimensions would neither be smaller, nor larger than the existing ones, and that its dimensions would be as close to the existing ones as possible. Rivers in the project area cut deep into the ground, steep slope and fairly high flow speed, but an attempt to reduce the water flow velocity by improving (widening) the cross-sectional dimensions of the rivers will result in the need of longer bridges with higher costs. Therefore, rather than trying to control the velocity, retaining walls shall be erected at the location (10 meters each upstream and downstream) of a proposed bridge (all bridges proposed in the project area are of single span) to prevent erosion and damage to bridge substructures.

4) Cross-section of Box Culverts

The discharge capacity of standard box culverts specified by the MPWH has been calculated and the plan cross-section of the culverts has been decided (see Table 7.5–6) with care to hold water flow velocity to less than 4.5 meters per second in order to prevent inner walls of the culverts from being eroded.

TABLE 7.6–5 ADOPTED CROSS–SECTIONS OF WATERWAYS FOR BRIDGES

Route	Bridge Number	Dimensions (m)			CROSS SECTION AREA	MEAN DEPTH	SLOPE OF WATERWAY	DISCHARGE
		B_1	B_2	H_1				
C–5	BR–4	19.5	11.3	4.1	63.1	2.3	1/240	560
	BR–7	11.1	8.5	1.3	12.7	1.1	1/110	90
C–6	Existing	9.8	9.8	1.7	16.7	1.3	1/80	150
	Existing	20.5	20.5	1.7	34.9	1.5	1/130	270
Visayas Avenue	BR–1	10.8	6.4	2.2	18.8	1.5	1/160	140
	BR–2	16.5	16.5	2.4	39.6	1.9	1/130	310
	BR–3	19.2	14.8	2.2	37.4	1.8	1/110	360
Mindanao Avenue	BR–1	12.8	9.0	1.9	20.7	1.4	1/160	140
	BR–2	18.8	14.0	2.4	40.9	1.9	1/180	320
	BR–3	12.8	10.0	1.4	16.0	1.1	1/130	110
	BR–4	20.0	11.8	4.1	66.0	2.8	1/240	560

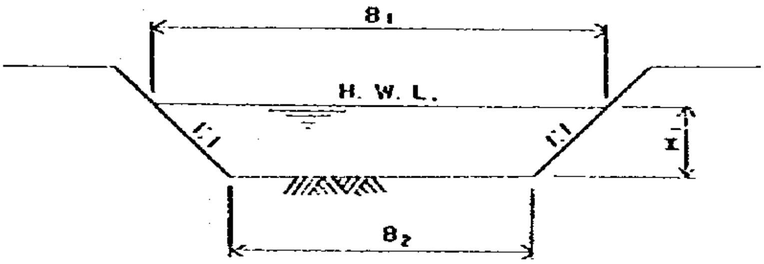


TABLE 7.5–6 ADOPTED SECTIONS OF BOX CULVERTS

ROUTE	CULVERT NUMBER	WIDTH HEIGHT BARREL (Meter)	CAPACITY (m^3/sec)
C–5	C – 3	3.0 x 2.75 x 2	53
	C – 4	3.0 x 2.75 x 1	29
	C – 5	3.0 x 2.75 x 2	58
	C – 6	2.4 x 2.40 x 2	39
	C – 7	3.0 x 3.00 x 2	65
C–6	C – 1	2.4 x 2.40 x 1	19
	C – 2	2.4 x 2.40 x 2	39
	C – 3	2.4 x 2.40 x 1	19
Visayas Avenue	C – 1	3.0 x 2.75 x 1	29
	C – 2	2.4 x 2.40 x 2	39
Mindanao Avenue	C – 1	3.0 x 3.00 x 2	65
	C – 2	2.4 x 2.75 x 2	46
	C – 3	3.0 x 2.75 x 1	29

7.6 PRELIMINARY DESIGN OF STRUCTURES

7.6.1 Bridge Design Standards

All structures shall be designed based on the "Standard Specifications for Highways and Bridges (12th Edition, 1977)" and the latest edition of "Interim Specifications for Bridges" released by the American Association of State Highway and Transportation Officials (AASHTO). However, matters not covered by the AASHTO standards will be based on the standards of the Ministry of Public Works and Highways or those used in Japan. Major design conditions are as follows:

1) Design Method

Tolerable stress method shall be used for the design of structures.

2) Load

a) Dead load shall include, in addition to the total weight of the superstructure, 107 kilograms per square meter of roadway area as allowance for future wearing course overlay.

b) Live load shall be MS 18, equivalent to HS 20-44 loading per AASHTO.

c) Seismic horizontal force: For the superstructure, 10% (DL + 1/2 LL) shall be applied horizontally at the bridge site. For the substructure, 10% DL shall be applied horizontally at the center of gravity of the weight of the substructure.

d) Sidewalk live load shall be 45 kilogram per square meter.

e) Unit Weight of Bridge Materials

Steel	7,849 Kg/M^2
Reinforced and non-reinforced concrete	2,403 Kg/M^2
Compacted earth, sand, grits, and gravel	1,922 Kg/M^2
Earth, sand and grits	1,602 Kg/M^2

3) Materials

Concrete:	Class A 210 Kg/M^2	Bridge superstructures, understructures, box culverts, reinforced concrete structures for revetment
	Class B 170 Kg/M^2	Non-reinforced concrete structures
	Class D 350 Kg/M^2	Pre-stressed concrete structures

7.6.2 Selection of Bridge Type

1) Superstructure

Bridge superstructure type must be selected based on a comprehensive evaluation of economics, workability, materials availability, maintenance and aesthetics. Drawing from precedents, superstructure types are specified for various applied span lengths in Table 7.6–1.

The construction costs of various types of superstructures have been roughly estimated under the assumption that each type is used for an appropriate span length and that the longest span of the bridge proposed in the Project Area will be 40 meters. The construction cost per unit of area, thus estimated, is contained in Appendix 7.6–1. From this, most economic superstructure types have been identified for the classes of span length, as follows: reinforced concrete slabs for the span length of 18 meters or less; prestressed concrete composite I beam for the span lengths from 18 to 37 meters; and prestressed concrete box girders for the span length in excess of 37 meters. The types of the superstructures shall be decided for this Project accordingly.

2) Substructure

Bridge piers and abutments must be of a type which will conform with rationality, be economic, and ensure safety. Based on records, a "rule of thumb" for the selection of abutment type by the structure height is proposed in Table 7.6–2. The structural choice of piers can sometimes be limited by the road, the river, and other external factors, but the types of piers shown in Table 7.6–3 are usually selected for topographic reasons. The substructures of the proposed bridges shall be of reinforced concrete in view of economics, workability, and materials availability.

3) Foundation

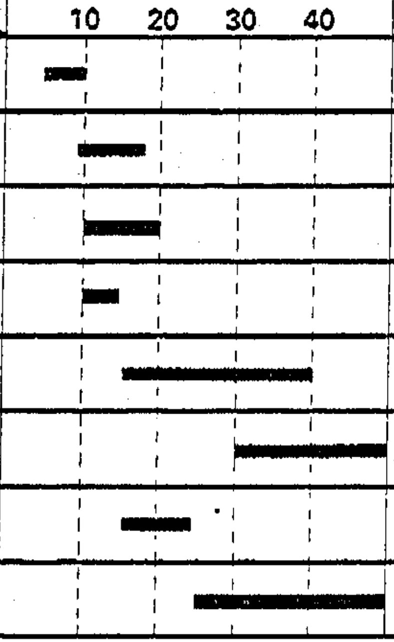
A most safe and economic structural type of bridge foundation must be selected based on the result of thorough investigations into the conditions of the superstructure, ground, and construction work conditions. Inasmuch as the field survey of the Project Area resulted in the finding of the so-called "adobe" or Tertiary shale within three meters from the surface, spread footing will be used at practically all locations.

7.6.3 Preliminary Bridge Design

1) Field Survey

A field survey of the identified optimum routes of the Project Roads has been accomplished for the purpose of obtaining data necessary for the preliminary design of engineering structures.

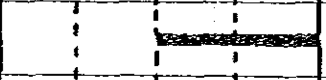
TABLE 7.6–1 TYPE AND APPLIED SPAN LENGTH



	SPAN LENGTH (M)	EASE OF CONSTRUCTION	AVAILABILITY OF MATERIALS	MAINTENANCE	APPLICATION FOR CURB BRIDGE
R.C. SOLID SLAB		○	◎	◎	◎
R.C.D.G.		○	◎	◎	○
R.C. VOIDED SLAB		○	○	◎	◎
PRETENSION BEAM		◎	○	◎	○
P.C. I–BEAM		◎	○	◎	○
P.C. BOX GIRDER		△	○	◎	◎
H.B.B.C.		◎	△	△	◎
STEEL PLATE GIRDER		◎	△	△	◎

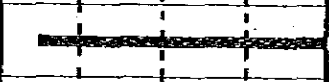
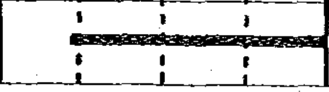
◎ : Excellent ○ : Normal △ : Inferior

TABLE 7.6-2 TYPE OF ABUTMENT

TYPE	STRUCTURE HEIGHT (M) 5 10 15	FOUNDATION TYPE	
		SPREAD	PILE
Gravity		○	
Semi-Gravity		○	
Reversed-T		○	○
Buttress		○	○
Pile Bent			○
Box		○	○

○ : Suitable

TABLE 7.6-3 TYPE OF PIER

TYPE	STRUCTURE HEIGHT (M) 5 10 15	FOR RIVER	FOR INTER-SECTION
1-Column with coping		○	○
Wall		○	
2 or 3 column Rigid Frame			○

○ : Suitable

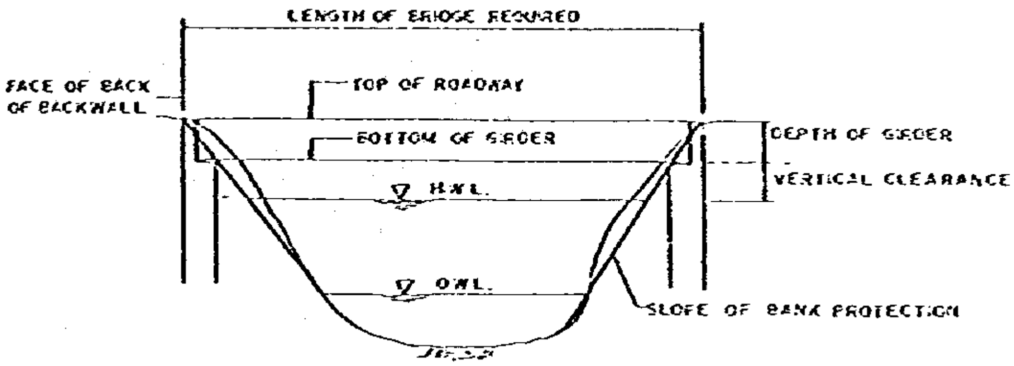
The existing sections of these routes which can be upgraded (widened) are: (1) of C-5, the section of Katipunan Avenue from Aurora Boulevard to the University of the Philippines; (2) of C-6, the entire extension of Fairview Avenue; (3) the sections of Mindanao Avenue from North Avenue to Culiat Creek and from Tandang Sora Avenue up to about 500 meters north; and (4) the section of Visayas Avenue from Elliptical Road to Tandang Sora Avenue. The dimensions of bridges and box culverts existing within these sections have been measured. As for the bridges, their drawings have been collected. (See the particulars of the existing srtructures in Appendices 7.6-2 and -3). The areas around these bridges and culverts were carefully inspected for the trace of flood, and the cross sections of these structures were compared with those indicated as necessary as a result of hydrodynamic analysis in an attempt to determine whether these existing structures could be utilized or should require improvements.

At locations where the Project Roads are to be newly constructed and will cross a river, the shape and flux of the river and the topography of the area were investigated.

2) Bridge Length

a) Bridges over River

The length of bridges over the river has been determined by aligning the back face of abutment parapet with the cross point of the bank protection slope line and the plan vertical line.



b) Elevated Bridges

The length of elevated bridges is defined by the location of abutment in the approach. For the proposed elevated bridges, the location of the abutment should be designed properly in order to facilitate the utilitization of the space under the bridge and to achieve an adequate level of aesthetic value. In the case of bridges over an expressway, the abutment location has been determined with an additional care for securing a horizontal margin of at least 3.0 meters from the end of the shoulder.

The minimum vertical limit of road construction under those bridges has been set at 4.88 meters to allow th future application of an overlay, and the minimum horizontal limit, at 1.22 meters from the shoulder to the abutment or the front face of the pier as stipulated by the AASHTO specifications.

3) Superstructure

Prestressed concrete I-beams, which are easy to work on, can be used in the construction of all over-the-river bridges, because such bridges will have an effective span within the range of 15 to 30 meters. AASHTO standard beams (prestressed I-beams), which have been much used in the Philippines, shall be used. (In the case of phase construction of a bridge, only the number of beams needed to support the interim road width will be placed first, and the remainder will be installed at the time of completion of the final width.)

Elevated bridges for grade separation at intersections will have an effective span length ranging from 40 to 55 meters. Of the types of superstructure usable for such span lengths, the combination of box girders and composite girders (suspended), both of prestressed concrete, shall be used, rather than steel box girders or only pre-cast concrete box girders, in view of economics, workability, the extent of hindrance of work to existing traffic, and maintenance. For the approach, 20-meter prestressed concrete composite I girders shall be used. Such girders shall be used also for bridges crossing over an expressway which can be supported by pier that can be built on the center median and whose effective span will not exceed 35 meters. In case of bridges with spans of varying lengths, the same girder type used for the long effective spans shall also be used for the short ones for the sake of aesthetics. As for the existing bridges, that on C–6 will be continuously used as is, while that on Visayas Avenue will be replaced with a new one since it may not be used continuously because of the difficulty in upgrading work and for reasons of hydrodynamics. It should be necessary that the safety of the existing bridges on C–4 be confirmed and that the feasibility of partial use of the bridge on Visayas Avenue be evaluated at the time of detailed engineering. The locations of proposed over-the-river bridges, elevated bridges, and box culverts are shown in the map of Figure 7.6–1.

4) Substructure

The planned structure heights of abutments fall within the range of 5 to 10 meters, and semi-gravity abutments shall be used for structure height up to 6 meters, and reversed T abutments shall be used for height over 6 meters. The planned structure heights of piers, which are needed only for elevated bridges, range from 7 to 11 meters, and the width of road is less than 10 meters except for bridges with which C–5 and C–6 will cross over MNE, where road width is 13.75 meters. For the c-5 and C–6 bridges, rigid frame piers with two round columns will be used in view of the road width and aesthetics. For all other elevated bridges, single-square-column piers will be used.

5) Foundation

In view of the geological finding that load bearing stratum is no deeper than three meters from the surface, spread footings are to be used for all bridges.

7.6.4 Miscellaneous Structures

1) Box Culverts

Box culverts, which are less expensive than bridges, shall be used where the Project Roads will cross a river whose flux is 65 cubic meters per second or less and whose catchment area is two square kilometers or smaller.

The standard box culverts specified by the MPWH have been stress-tested and found

FIGURE 7.6-1 LOCATION OF STRUCTURES

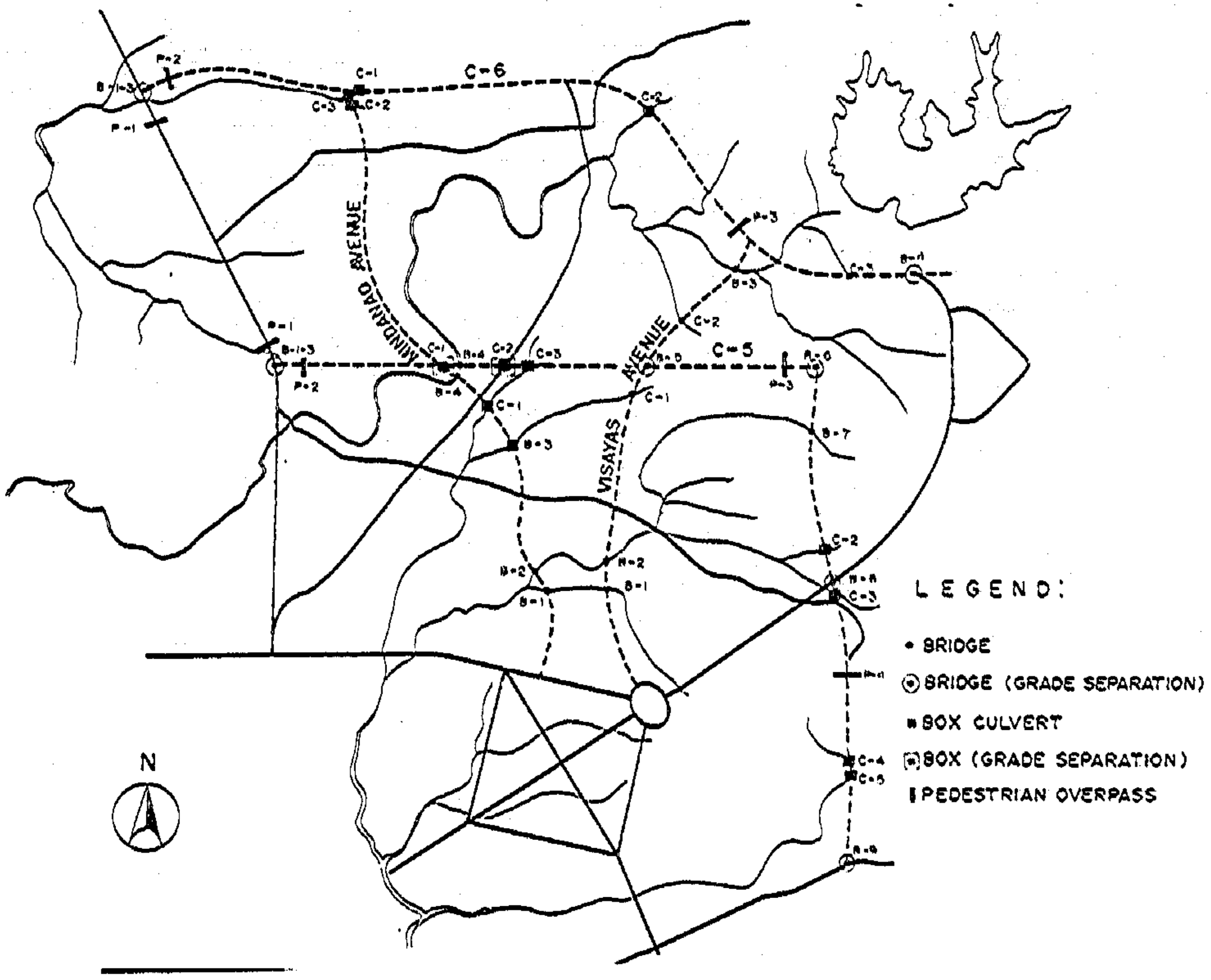


TABLE 7.6–4 LIST OF PROPOSED BRIDGE

ROAD	BRIDGE NO.	STATIONS	BRIDGE LENGTH (GIRDEN LENGTH)	SUPER STRUCTURE TYPE	FOUNDATION TYPE	CROSSING OBJECT	REMARKS
C – 5	BR–1	0 + 023.51	47.020 (21.0 + 24.6)	P.C. Composite	Spread	M.N.D.R.	Interchange Br.
	BR–2	2 + 44.805	50.390 (20.2 + 29.5)	P.C. Composite	Spread	M.N.D.R.	Interchange Br.
	BR–3	3 + 09.109	51.782 (21.5 + 29.5)	P.C. Composite	Spread	C – 5	Interchange Br.
	BR–4	2 + 620.651	26.698 (26.0)	P.C. Composite	Spread		River Br.
	BR–5	5 + 192.995	274.010 (7 x 20.0 + 49.5 + 33.0 + 49.5)	P.C. Composite + P. C. Box	Spread	Visayas	Grade Separation
	BR–6	7 + 247.00	386.000 (12 x 20.0 + 25.0)	P.C. Composite + P. C. Box	Spread	Luzon	Grade Superation
	BR–7	8 + 669.17	15.600 (15.0)	P.C. Composite	Spread		River Br
	BR–8	0 + 690.00	298.070 (9 x 20.0 + 44.0 + 29.0 + 44.0)	P.C. Composite + P. C. Box	Spread	Don Mariano	Grade Separation
	BR–9	14 + 287.105	155.790 (3 x 20.0 + 35.5 + 24.0 + 35.5)	P.C. Composite + P. C. Box	Spread	Aurora	Grade Separation
C – 6	BR–1	0 + 021.454	42.908 (2 x 21.1)	P.C. Composite	Spread	M.N.D.R.	Interchange Br.
	BR–2	0 + 41.509	56.982 (32.2 + 23.9)	P.C. Composite	Spread	M.N.D.R.	Interchange Br.
	BR–3	0 + 32.659	54.682 (21.6 + 32.3)	P.C. Composite	Spread	C – 6	Interchange Br.
	BR–4	11 + 851.04	197.920 (2 x 20.2 + 37.0)	P.C. Composite	Spread	Don Mariano	Grade Separation
MINDANAO AVENUE	BR–1	1 + 091.17	17.660 (17.0)	P.C. Composite	Spread		River Br.
	BR–2	1 + 397.67	24.660 (24.0)	P.C. Composite	Spread		River Br.
	BR–3	3 + 101.17	17.660 (17.0)	P.C. Composite	Spread		River Br.
	BR–4	4 + 626.655	26.670 (26.0)	P.C. Composite	Spread		River Br.
VISAYAS AVENUE	BR–1	1 + 318.614	15.722 (15.0)	P.C. Composite	Spread		River Br.
	BR–2	1 + 748.199	22.852 (22.1)	P.C. Composite	Spread		River Br.
	BR–3	6 + 197.695	24.610 (24.0)	P.C. Composite	Spread		River Br.
C – 5	Box–1	2 + 295.000	56.0 (9.25 x 6.3 x 2)	R.C. Box	Spread		Under Pass
	Box–2	3 + 221.75	42.5 (9.25 x 6.3 x 2)	R.C. Box	Spread		Under Pass

STATIONS LISTED ABOVE ARE ALL FIRST APPROACH STATIONS.

adequate in terms of strength, and such culverts shall be used. The following types of box culverts have been specified for the indicated lengths of effective span:

Type	*Effective Span Length*
Precast concrete pipe culvert	1.5 meters or less
Precast concrete single box culvert	1.5 to 3.0 meters
Precast concrete dual box culvert	3.0 to 6.0 meters

2) Retaining Wall

Retaining walls shall be erected to cover approaches to elevated bridges and the cutting surfaces in the underpass portions of road. The gravity type is specified for walls with structure height of 3.0 meters or less and the cantilever type for those with such height from 3.0 to 10.0 meters as the types suitable to the indicated structure heights. After confirming the stability, MPWH standard specifications of protection walls shall be used.

3) Pedestrian Overpass

For pedestrian safety and smooth traffic flow, pedestrian overpasses will be installed where the number of pedestrian is large or in the vicinity of grade separation intersections.

The standard structure of the overpasses shall consist of AASHTO specified prestressed concrete I girders, as the major structural materials, and prestressed concrete floor panels. The footpath shall have a width of three meters.

CHAPTER 8 ENVIRONMENTAL IMPACTS OF THE PROJECT ROADS

TABLE OF CONTENTS

TABLES AND FIGURES

CHAPTER 8

ENVIRONMENTAL IMPACTS OF THE PROJECT ROADS

In compliance with the provisions of PD 1157 and PD 1586 and the National Environmental Protection Council (NEPC), in order to obtain the approval and issuance of an Environmental Clearance Certificate for the implementation of this Project, an environmental study for the Project Roads was made, described in two separate volumes, "Environmental Impact Statement" and "Environmental Impact Study".

The purpose of the Environmental Impact Statement system is to determine the adverse impacts and provide mitigating measures to be adopted which are usually incorporated in the design of the project roads.

8.1 EXISTING ENVIRONMENT

8.1.1 Hydrology

There are three (3) rivers in the project area, namely, the Meycauayan River, the Tullahan River and the San Francisco River. The water quality of surface water of the rivers in the project area is almost under Class D of the standard, which means that those water can be utilized for agricultural, irrigational, livestock, industrial, cooling and processing uses.

8.1.2 Atmosphere

The level of air quality in Metro Manila gradually decreases due to the increasing number of automobiles and consumption of oil in general. Referring to historical variation of air pollution in the Study Area, concentration of dust has increased from 68.9 ug/m^3 in 1976 to 79.3 ug/m^3 in 1981 both within the standard. On the other hand, sulfur dioxide (SO_2) and carbon monoxide (CO) have been level during the same period which are also within the standards.

8.1.3 Vegetation

The area covered by agricultural and open space within the OIZ has a relatively natural environmental condition. Precious floral species and location of agglomeration of the precious trees are not defined in the Project Area.

8.1.4 Wildlife

There are several wildlife living in the project area. They are relatively few in number because their territory is limited due to urbanization. There is no specific specie threatened for extinction within the DIZ.

8.2 PREDICTION AND ASSESSMENT OF THE IMPACTS

Urbanization follows road network. The possible impacts due to urban major roads development is shown in Figure 8.2–1. These impacts are categorized into three phases:

a) Pre-construction phase – demolition of affected houses and facilities and dislocation of affected families.

b) Construction phase – increased job opportunities but traffic congestion, noise, dust and water pollution will occur.

c) Operation phase – the direct and indirect impacts will increase the socio-economic development accompanied by adverse impacts such as environmental pollution, hazards and reduction of community cohesiveness.

Result of the assessment of the impacts are summarized in Table 8.2–1.

8.2.1 Demolition of Affected Structures and Facilities within the ROW

This is a major and adverse impact in the pre-construction phase of the project. Number of houses and major facilities affected by the project roads are about 840 houses and 16 facilities, such as school and church.

The total number of families affected is estimated about 4,000 people and the estimated number of workers affected is about 160. But the actual number of people affected should be established after a more detailed survey. The location of affected houses along the project roads is shown in Figure 8.2–2.

8.2.2 Impacts during the Construction Phase

There are five major impacts during the construction phase. These are dust pollution, noise pollution, water pollution at bridge construction, traffic congestion caused by construction equipment and job opportunity. Four of these are pollutions caused by construction activities and the other is social impact. Tehse impacts are temporary and are considered not severe.

8.2.3 Direct Impacts during Operation

During the operation phase, there are direct and indirect impacts. Both impacts affect the natural and social environment. However, the beneficial impacts outweigh the adverse impacts of the Project. Major direct impacts in this phase are as follows:

FIGURE 8.2-1 GENERAL ENVIRONMENTAL IMPACT CAUSED BY MAJOR URBAN ROAD

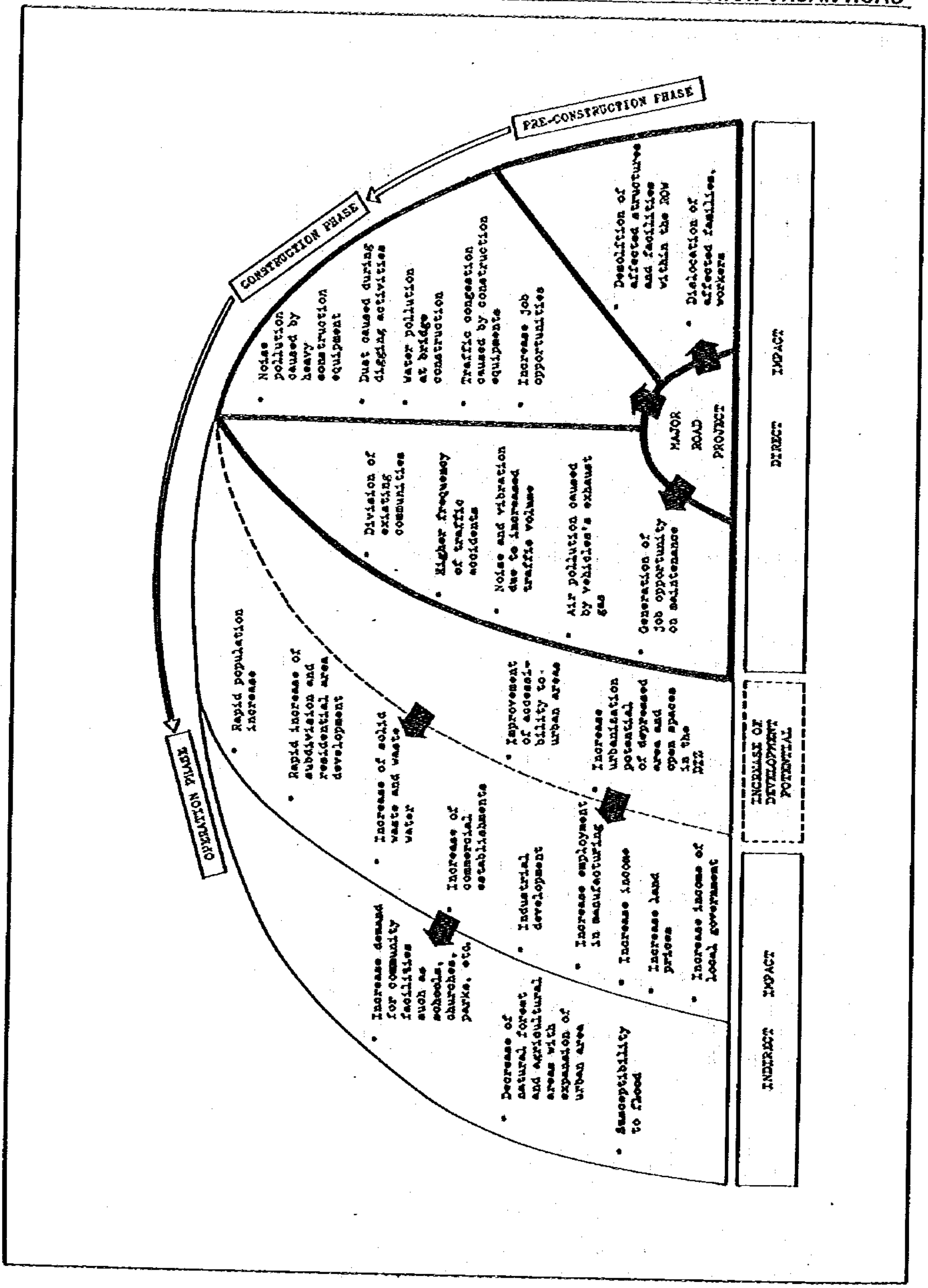


TABLE 8.2–1 PROBABLE ENVIRONMENTAL IMPACT MATRIX

KINDS OF IMPACT	AGGLOME-RATION OF OBJECTS AFFECTED	CHARACTE-RISTICS* OF IMPACT	DEGREE OF IMPACT **			
			Minor	Moderate	High	Unknown
Pre-construciton Phase						
Demolition of Structures and Facilities within ROW	Medium	–			0	
Dislocation of Families, Workers Affected	Medium	–			0	
Construction Phase						
Noise Caused by Heavy Equipment	Small	–	0			
Dust during Digging	Small	–	0			
Water Pollution by Bridge Construction	Small	–	0			
Traffic Congestion	Small	–	0			
Increase Job Opportunities	Small	+	0			
Operation Phase (1)						
Division of Existing Communities	Medium	–			0	
Noise and Vibration	Medium (Present) Large (Future)	–			0	
Air Pollution	Medium (Present) Large (Future)	–	0			
Generation of Job Opportunities	Small	+	0			
Operation Phase (2)						
Population Increase	–	0			▨	
Residential Area Development	–	0			▨	
Solid Waste and Waste Water		–			▨	
Increase of Commercial and Industrial Establishments	–	0			▨	
Increase of Employment in Industry	–	+			▨	
Increase of Income	–	+	▨			
Increase of Land Price	Large	0			▨	
Increase of Income of Local Government	Small	+	▨			
Increase Demand for Community Facilities	Large	0			▨	
Decrease of Natural Forest and Agricultural Area	Small	–			▨	
Susceptibility of Flood	Large	–			▨	

Source: Metro Manila Outer Major Roads Project, Northern Package

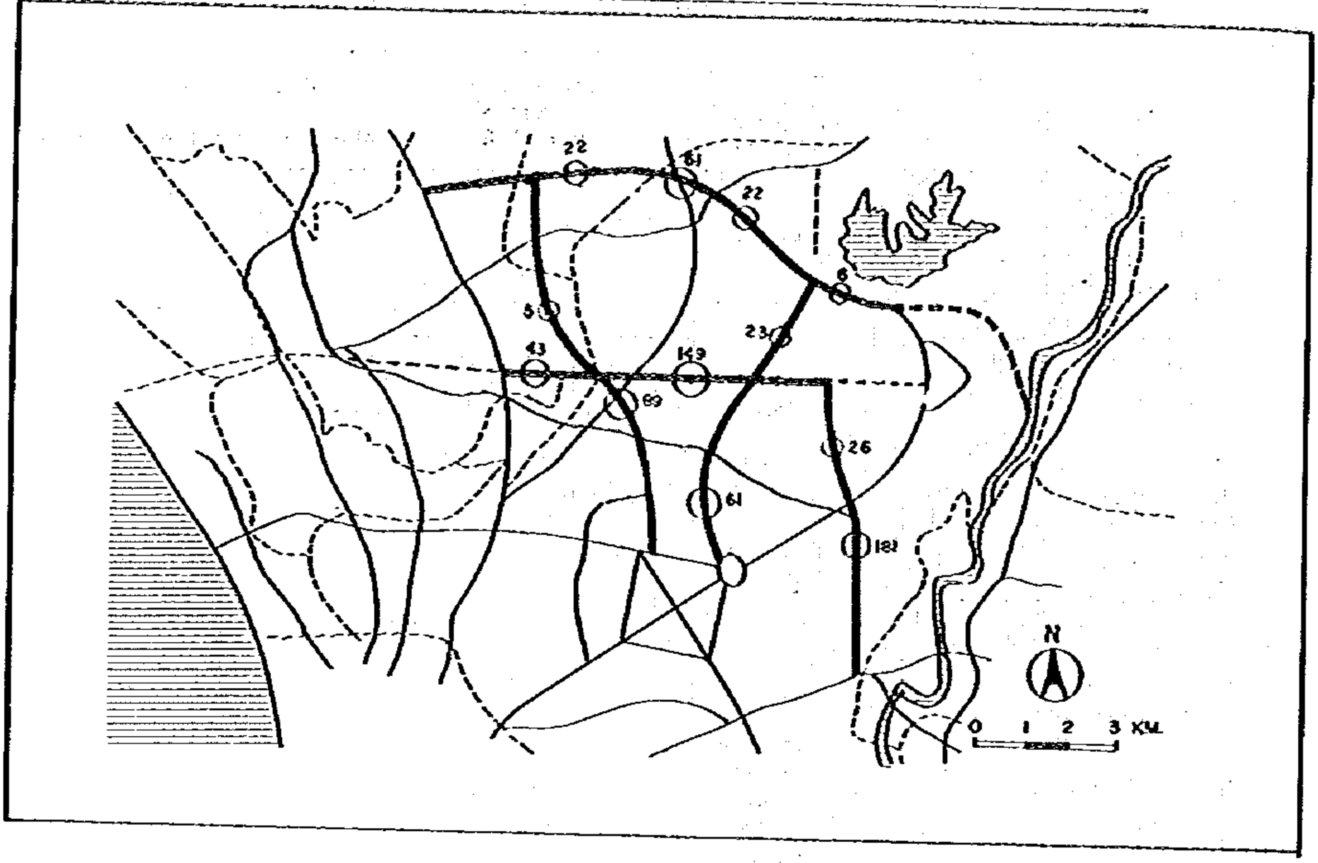
* Characteristics of Impact

+ : Impact favorable
– : Impact unfavorable
0 : Impact neither favorable nor adverse

* Degree of Impact

0 : Direct Impact
▨ : Indirect Impact

FIGURE 8.2–2 NUMBER OF HOUSES AFFECTED BY RIGHT-OF-WAY ACQUISITION



1) Division of existing communities
2) Pollution caused by traffic
3) Impacts resulting from traffic accidents
4) Generation of job opportunity on road maintenance

1) Division of existing of communities

Construction of major roads traversing existing communities reduces their cohesiveness. This adverse impact brought by the road project is unavoidable in view of the present urbanization in the area. Although considered to be a severe impact, an overall view of the road network indicates the impact as negligible. The degree of impact on existing communities in the areas affected by the project roads could be considered not so severe for the reason that some subdivisions are in different stages of development and the plans can still be modified to incorporate the project roads.

2) Pollution caused by traffic

Among pollutions caused by traffic, noise pollution in the area is relatively more eminent than the other pollutions, such as air pollution and vibration.

The standard noise level along a Class A residential area facing a major road with four (4) lanes or more is 60 db. Assuming that the land use along the Project Roads is a Class A residential area, the width of strip where the estimated noise level exceeds the standard in 2000 varies correspondingly to traffic volumes and road cross-sections. This affected width can be considered tolerable because the land use along major roads is mostly for commercial purpose.

3) Other impacts

With the completion of the project roads, traffic on congested existing major roads will be attracted to the project roads due to its higher level of service which would result to lesser number of accidents through the implementation of a more effective traffic management, such as installation of traffic signals, proper road markings, installation of traffic safety devices, etc.

The maintenance activities, such as road marking, road surface repair, drainage clearing and others, are usually done directly by the MPWH but additional unskilled workers might be recruited for the project.

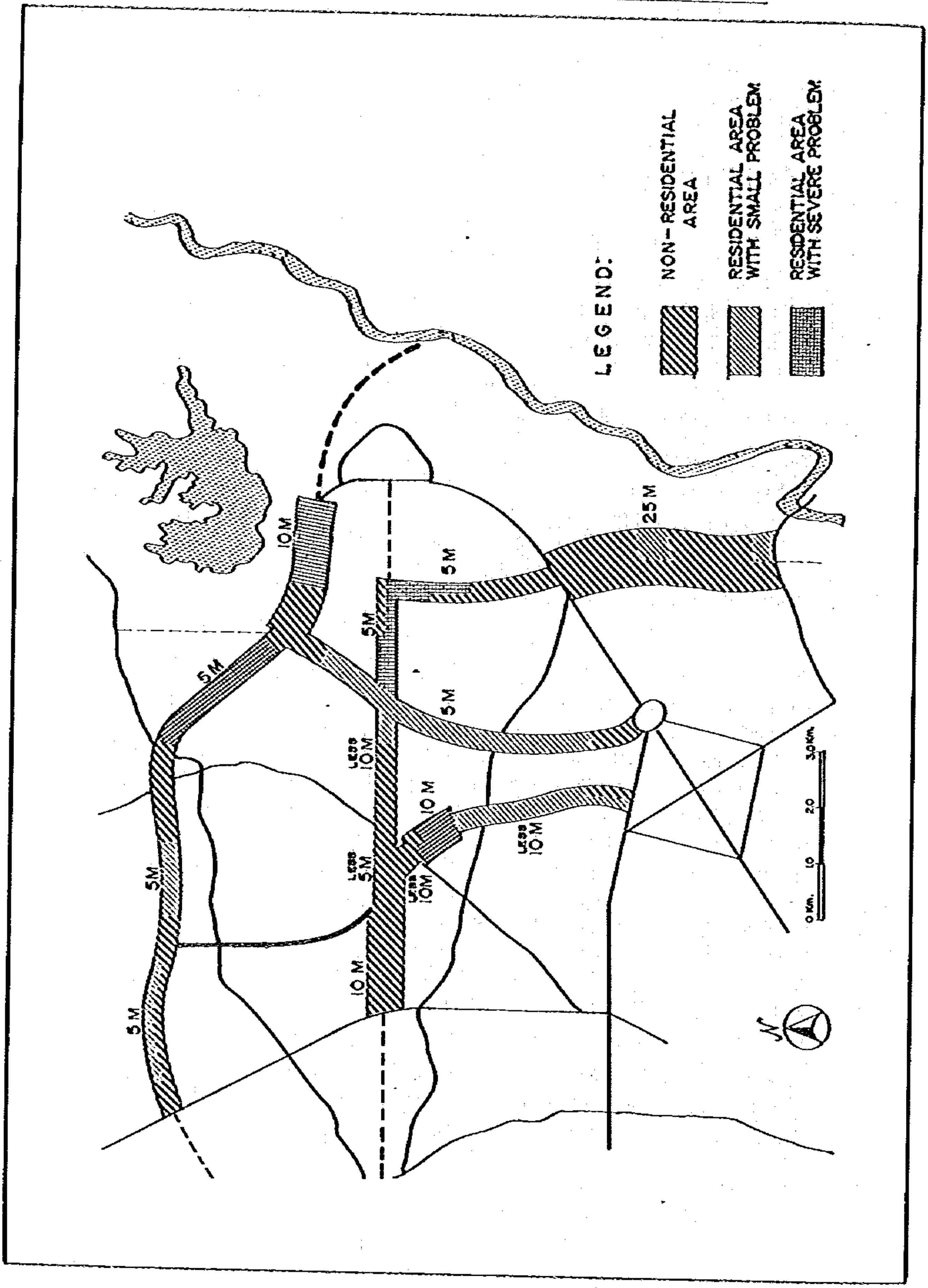
8.2.4 Indirect Impacts during Operation

One of the positive impacts in the completion of the project roads is the improved accessibility of its direct influence area to urban centers. At present, it takes one and one-half hours from Novaliches town proper to the center of Manila City by private car because of the traffic congestions along Quirino Highway and/or Gen. Luis Avenue. After completion of the Project, it will take only about one hour in view of new links in the north-south directions, such as Visayas and Mindanao Avenues, whose end effect is the reduction of traffic volume along Quirino Avenue and provides alternate routes with higher service level than the existing major roads in the area.

Notable impacts caused by the development of the project is rapid increase of population and increase industrial activities. This will promote subdivision and industrial developments in the DIZ. This tendency of development will force expansion of urban area and increase of public service, i.e. education, social security, public health etc.

To support urbanization of the area, supportive infrastructures are necessary, such as water supply, electricity, drainage, sewerage, telecommunication, secondary road network system and other related activities.

FIGURE 8.2–3 STRIP AFFECTED BY NOISE IN YEAR 2000



8.3 MITIGATING MEASURES

8.3.1 Affected Families

To mitigate the effect of the Project on affected properties within the proposed road right-of-way, compensation procedure will be through existing Presidential Decrees. For dislocated families, the Government, through the MHS gives priority to those affected families in subdivisions near the area. Affected squatter families will be relocated at the Resettlement Project of the NHA.

8.3.2 Demolition of Affected Structure and Facilities

The existing structures and facilities within the proposed alignment will have to be removed in accordance with the right-of-way acquisition plan of the project roads. In the demolition of these structures and facilities, the government should extend assistance in the form of manpower personnel and equipments.

8.3.3 Construction Nuisance

The surrounding communities will be inconvenienced during construction, by noise, gas, fumes, dust and dirt caused by unstable and abnormal conditions incidental to construction activities. Moreover, the migratory workers to stay during construction will strain existing services and facilities and aggravate public health in the area. This nuisance and inconvenience during construction should be significantly reduced by introduction of proper construction management and supervision and adoption of proper construction equipment and methods. Against the latter problems, the Government and the contractors should collaborate in providing necessary services and facilities.

8.3.4 Pollution

Noise pollution from major roads which is more eminent than other pollutions is difficult to avoid completely, but the effect could be reduced by several mitigating measures shown in Table 8.3–1.

Pollution could also be mitigated by providing space for a planting strip. The land use control through the zoning system is thought to be effective and should be introduced along the roads. Major features of the proposed zoning system are as follows:

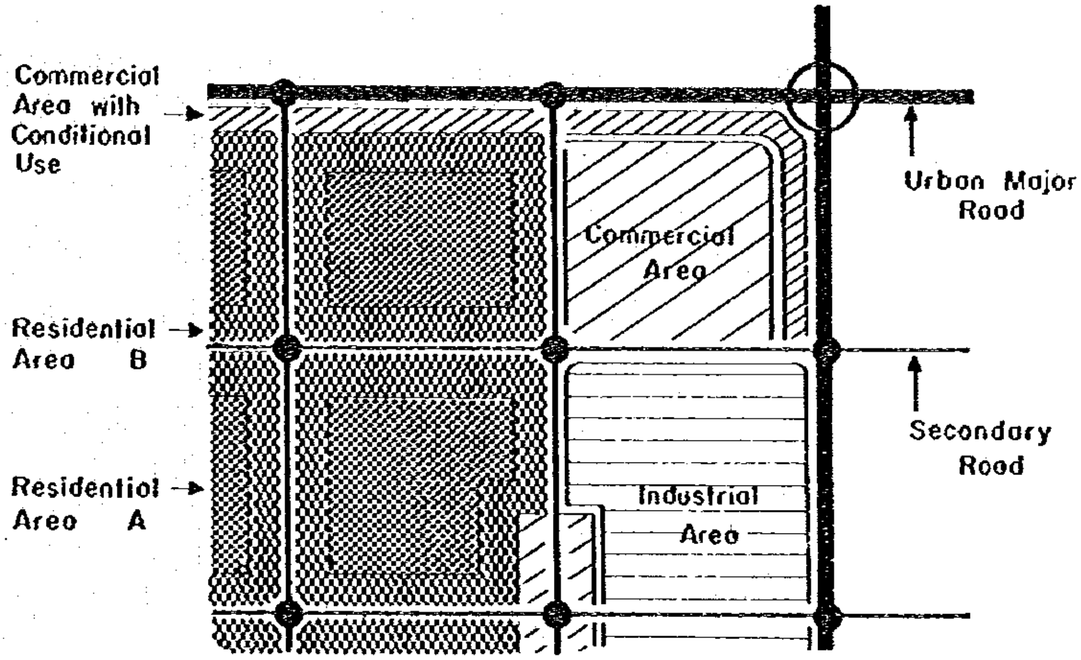
TABLE 8.3–1 GENERAL NOISE MITIGATING MEASURE AND THEIR LIMITATION

OBJECTS OF COUNTERMEASURES		METHOD OF MITIGATION	LIMITATION
Improvement of source of noise	Improvement of automobile structure	1) Tightening of permissible limit of noise of car – as of friction noise of tires and engine	Full implementation of car inspection system
	Improvement of traffic control	1) Limitation of maximum speed	Full implementation of traffic control system
		2) Restriction of large-sized vehicles and designation of lanes for those kinds of vehicles	—do—
		3) Prohibit overloaded trucks	—do—
		4) Minimum usage of horn except in cases of emergency	Improvement of driving manner through driver's education
		5) Reduction of traffic demand	Opposition of the role of the project roads
		6) Reduction of traffic volume in specific road – Exclusion of through traffic	Implementation of regional traffic control and opposition of the role of the project roads
		– Reduction of lanes	Opposition to the traffic demand
Improvement of road structure		1) Construction of noise interception wall	Opposition to land use along the roads
		2) Securing of buffer zones	Increase of land acquisition cost
Countermeasures for roadside		1) Noise interception work for facilities	Change of the construction expense
		2) Construction of buildings for noise interception	Implementation body of the construction of buildings
		3) A minimum distance from the roadside should be adopted	

a) Commercial, industrial, and/or other uses which are not susceptable to environmental pollution caused by traffic should be located along urban major roads to reduce pollution effect on residential areas.

b) Residential areas which are classified into two (2) categories, Residential A, with better living environmental condition and Residential B, with a lower living environmental condition should be arranged such that Residential A should be enclosed by Residential B to reduce the effect of traffic pollution on Residential A.

FIGURE 8.3–1 PROPOSED ZONING SYSTEM TO MITIGATE EFFECTS OF POLLUTION



8.3.5 Community Cohesiveness

To maintain the cohesiveness of existing communities, traffic safety devices at strategic points such as pedestrian crossings with road markings, traffic signs and signals and pedestrian overpasses are necessary. Pedestrian crossing bridges should be considered across wide roads with high concentration of people, such as commercial centers, industrial zones, schools and hospitals.

8.3.6 Provision of Utilities and Facilities Associated with the Urbanization Caused by the Project Roads.

Roads are very important component in forming townscape. Establishment of the project roads will not only handle the expected traffic in the area but will also change the townscape to comfortable and acceptable human environments. The realization of this development, however, would require utilities and facilities such as water supply, electricity, drainage, sewerage, telecommunication, schools, churches, etc. The government as well as the private sector should join hands in planning and construction of these said utilities and facilities.

CHAPTER 9 PROJECT COST

TABLE OF CONTENTS

TABLES

CHAPTER 9

PROJECT COST

The total project cost consists of detailed engineering cost, land acquisition cost, compensation for affected buildings and structures, construction cost, supervision cost and maintenance cost. The project costs were estimated in May 1982 prices broken down into the local currency component, foreign currency component and taxes. The local component includes costs of locally procured equipment, materials and supplies, local wages, local supervision, local transport and freight and local overheads and profits. Foreign component includes costs of imported equipment and spare parts, the foreign currency portion of locally purchased goods and services, wages of expatriate personnel, and foreign overheads and profits. The following conversion rates are applied to foreign components:

₱1.00 = ¥29.13 = U.S. $0.117

The economic cost of a project consists of local and foreign components, excluding taxes. Financial cost consists of economic cost and tax.

9.1 CONSTRUCTION COST

The unit cost of each construction item has been analyzed and estimated based on market price survey findings, information from contractors, and latest unit costs from other projects. Unit costs of major construction items are presented in Table 9.1–1. The unit costs of construction equipment, materials, supplies and labor which were used in this unit cost analysis are enumerated in Table 9.1–2. The analysis of unit costs of major items is explained in Appendix 9.1–1.

9.2 DETAILED ENGINEERING AND SUPERVISION COSTS

Detailed engineering cost usually amounts to 3% to 5% of construction cost and supervision cost, 5% to 9%. For this Study, detailed engineering and supervision costs have been estimated at 3% and 7%, respectively, of construction cost.

9.3 LAND ACQUISITION AND COMPENSATION COSTS

Land acquisition cost has been estimated using the assessment values of land as established by the Assessor's Office of the City or the Municipality concerned. The assessment values of land in the area along the routes of the Project Roads are as follows:

TABLE 9.1–1 UNIT CONSTRUCTION COST

Price Level : May 1982

ITEM NO.	WORK ITEM	Unit	Unit Cost (Pesos)	Component (%)		
				Foreign Currency	Local Currency	Tax
100	Clearing and Grubbing	sq.m.	0.80	61	27	12
105(1)	Roadway/Drainage Excavation (common)	cu.m	22.00	63	25	12
105(2)	Roadway/Drainage Excavation	cu.m	46.00	60	28	12
107	Borrow (common)	cu.m	43.00	61	20	19
108	Aggregate Sub–base	cu.m.	110.00	64	20	16
200	Aggregate Base Course	cu.m.	145.00	63	21	16
316	Portland Cement Concrete Pavement (0.25 m. thick)	cu.m.	186.00	56	29	15
405(1)	Class A Concrete (Substructure)	cu.m.	921.00	52	24	14
405(2)	Class A Concrete (Superstructure)	cu.m.	1,174.00	53	33	14
405(3)	Class B Concrete	cu.m.	780.00	51	35	14
405(4)	Class C Concrete	cu.m.	575.00	54	31	15
405(A)	P. C. Structure Member (L = 17 m)	Each	26,300.00	56	29	15
405(B)	P. C. Structure Member (L = 24 m)	Each	68,800.00	56	29	15
406	Reinforcing Steel Bar	kg.	8.80	61	24	15
413(1)	RCPC 0.46 m. dia.	L.M.	255.00	45	43	12
413(2)	RCPC 0.76 m. dia.	L.M.	476.00	51	27	12
413(3)	RCPC 0.91 m. dia.	L.M.	599.00	54	33	13
502(1)	Concrete Curb/Gutter (0.25)	L.M.	60.50	50	37	13
502(2)	Concrete Curb/Gutter (0.50)	L.M.	76.00	48	38	14
503	Concrete Sidewalk	sq.m.	70.00	52	34	14
505	Catch Basin	Each	2,184.00	53	34	13
511	Beam Type Guardrail	L.M.	401.00	60	27	13
512	Top Soil	cu.m.	45.00	53	35	12
514	Sodding	sq.m.	20.50	7	91	2
SPL–1	Pavement Marking	sq.m.	54.00	43	44	13
SPL–2	Traffic Sign (Regulatory)	Each	788.00	42	48	10
SPL–3	Traffic Sign (over head type)	Each	87,224.00	48	39	13
SPL–4	Traffic Signal	Set	236,925.00	53	24	13

TABLE 9.1-2 (1) HOURLY COSTS OF CONSTRUCTION EQUIPMENT

Unit : Pesos At May 1982

	CONSTRUCTION EQUIPMENT		Hourly Cost	Component (%)		
				Foreign Currency	Local Currency	Tax
1.	Crawler Tractor (Bulldozer)	250 HP	480.00	67	21	12
2.	-do-	200 HP	410.00	67	22	11
3.	-do-	125 HP	260.00	67	22	11
4.	--do–	75 HP	150.00	65	24	11
5.	Wheel Tractor	60 HP	80.00	60	28	12
6.	Motor Scraper 8 cu. yd.	120 HP	190.00	65	23	12
7.	Crawler Type Loader 1½ cu yd	60 HP	180.00	64	24	12
8.	-do- 2 cu yd	135 HP	260.00	66	22	12
9.	Wheel type Loader 2 cu yd	105 HP	220.00	66	22	12
10.	–do– 1½ cu yd	80 HP	140.00	65	23	12
11.	Motor Grader	125 HP	200.00	64	24	12
12.	--do–	145 HP	270.00	66	22	12
13.	-do–	183 HP	320.00	66	22	12
14.	Road Roller Tandem 8–10 t	60 HP	130.00	65	24	11
15.	Road Roller Macadam 8-10 t	117 HP	150.00	65	24	11
16.	Rubber Tire Roller 20 t	100 HP	190.00	65	24	11
17.	Sheepsfoot Roller 17 t	170 HP	310.00	67	22	11
18.	Vibratory Plate Compactor 2.5T	7 HP	15.00	32	62	6
19.	Asphalt Finisher 100 t/H	120 HP	380.00	61	22	17
20.	Asphalt Distributor 600 liters	200 HP	250.00	60	23	17
21.	Concrete Finisher 50 t/H	100 HP	340.00	67	22	11
22.	Crushing Plant 80-135 t/H	200 HP	720.00	58	26	16
23.	Asphalt Plant 50 t/H	150 HP	1,340.00	61	23	11
24.	Concrete Batching Plant 94 cu. in./H	107 HP	620.00	59	23	18
25.	Dumpt Truck 12t		230.00	67	19	14
26.	Water Tank Truck 6,000 liters	160 HP	170.00	67	21	12
27.	Jeep 4-wheel Drive	145 HP	80.00	59	26	15
28.	Pick–up Truck 1.0 t	160 HP	90.00	60	26	14
29.	Belt-conveyor 270 t/H		50.00	67	20	13
30.	Truck Mounted Crane 80 t		930.00	68	19	13
31.	--do-- 60 t		760.00	68	20	12
32.	--do– 40 t		580.00	68	20	11
33.	Crawler Crane 6o t		610.00	68	19	13
34.	–do– 30 t		370.00	67	20	13
35.	Excavator Hydraulic Type ½ cu yd		240.00	66	23	11
36.	-do– 3/4 cu yd		260.00	66	22	12
37.	–do– 1-3/4 cu yd		330.00	69	18	13
38.	Concrete Mixer 7 cu ft	7.5 HP	17.00	35	55	10
39.	--do– 16 cu ft	18 HP	35.00	51	35	14
40.	Concrete Vibrator	3.5 HP	10.00	33	60	7
41.	Concrete Saw	30 HP	25.00	50	38	12
42.	Air Compressor 3.5 m^3/min.		85.00	56	25	19
43.	Motor Generator 15 KW	50 HP	65.00	59	28	13
44.	Jack Hammer		13.00	23	71	6
45.	Water Pump 1,700 gpH	7.5 HP	18.00	41	47	12

TABLE 9.1-2 (2) LOCAL LABOR COST

Unit : Pesos at May 1982 Price

Labor Category	Daily Rate	Hourly Rate
Foreman	73.36	9.17
Assistant Foreman	67.52	8.44
Heavy Equipment Operator	61.68	7.71
Light Equipment Operator	50.00	6.25
Driver	50.00	6.25
Carpenter	46.88	5.86
Skilled Labor	50.00	6.25
Unskilled Labor	38.32	4.79

TABLE 9.1–2 (3) COST OF MAIN MATERIALS

Unit : Pesos at May 1982 price

MAIN MATERIALS	UNIT	UNIT PRICE	Component (%)		
			Foreign	Local	Tax
Market Prices of Purchased Materials					
Portland Cement	M.T.	825.00	50	35	15
Reinforcing Steel bar	Kg.	6.40	70	12	18
High tensile strand	kg.	31.50	70	12	18
Asphalt Cement (Penetration 85/100)	M.T.	3,400.00	50	35	15
Cutback Asphalt (MC–70)	M.T.	3,500.00	50	35	15
Diesel Fuel	1	3.11	62	19	19
Lumber, Yacal/Guijo	bd. ft.	11.00	30	55	15
Beam Type Guardrail	L.M.	246.00	65	20	15
Processed Materials					
Fine Aggregate for Cement Concrete	m³	84.00	62	22	16
Coarse Aggregate for Cement Concrete	m³	95.00	62	22	16
Aggregate for Sub–base course	m³	71.00	64	19	17
Aggregate for base course	m³	110.00	63	21	16
Concrete Class A	m³	557.00	55	30	15
Concrete Class B	m³	533.00	56	29	15
Concrete Class C	m³	575.00	55	30	15
RCPC 0.46 m. dia.	L.M.	158.00	49	37	14
RCPC 0.76 m. dia.	L.M.	358.00	55	31	14
RCPC 0.91 m. dia.	L.M.	463.00	55	31	14

	Road Section	*Land Value (₱/sq.m.)*
C–5:	Republic Ave.	40 – 100
	Luzon Ave.	220
	Katipunan Ave.	280 – 440
C–6:	MNE – Quirino Highway	40 – 200
	Quirino Highway – Don Mariano Marcos Ave.	200 – 220
Mindanao Avenue:		
	North Ave. – C–5	120
	C–5 – C – 6	40 – 120
Visayas Avenue:		
	Elliptical Road – C – 5	200
	C–5 – C–6	80

Likewise, compensation cost has been estimated using the City or Municipal assessment values of buildings. The assessment values are listed below by type for new buildings, which have been reduced by 15% to 20% for depreciation for the purpose of estimation:

	₱/sq.m.
Residential houses:	
First group wooden structure framings	900
Third group wooden structural framings	600
Offices, stores:	
All reinforced concrete structure except hollow block walls	1,800
Factories, warehouses:	
Concrete columns and beams with hollow block walls	700

9.4 MAINTENANCE COST

Road maintenance cost has been estimated by the so-called EMK method, by which national road maintenance budget is decided in the Philippines. Under EMK method, the actual length of the road is converted into "equivalent maintenance kilometer" (EMK), and EMK is multiplied by the basic cost, which is a unit maintenance cost per EMK per year. Lighting cost has been added to this estimate, because the cost of road illumination is not considered by the EMK method.

The basic cost is supposed to be adjusted yearly for changes in labor and material costs. However, this adjustment has not been effected since 1976 due to the financial difficulties of the Government and EMK method does not necessarily reveal the amount truly needed for road maintenance. Maintenance cost is not however, a decisive element for the selection of alternative plan, inasmuch as portland cement concrete pavement will be used.

For the conversion of actual road length to EMK, a factor of 1.3 is allowed for pavement of 10 meters or more in width, and 1.1 for daily traffic of 3,000 vehicles or more. Annual maintenance cost per kilometer of concrete-paved roads is as follows:

2-lane : ₱11,342 x 1.3 x 1.1 = ₱16,219

4 to 6-lane : ₱11,342 x 1.3 x 1.1 x 2 = ₱32,438

Lighting cost has been estimated as follows based on early MPWH survey results:

2-lane : ₱ 7,500 per kilometer per year

4 to 6-lane : ₱15,000 per kilometer per year

9.5 PROJECT COST

The project costs for individual road sections are listed in Table 9.5–1. The summary of the project costs and the annual investment requirements of alternative plans are shown in Tables 9.5–2 and –3, respectively.

TABLE 9.5–1 (1) PROJECT COST : ALTERNATIVE – 1

					STAGE 1				STAGE 2				TOTAL				
ROAD NAME	CODE	SECTION	km	R.O.W.	DETAILED ENG'G	CON STRUCT ION	SUPER VISION	TOTAL	DETAILED ENG'G	CON STRUCT TION	SUPER VISION	TOTAL	R.O.W.	DETAILED ENG'G	CON STRUCT ION	SUPER VISION	TOTAL
C – 5	11	REPUBLIC AVE.	7.48	30.260	2.90	96.50	5.79	135.45	3.82	127.42	7.65	138.89	30.260	6.72	223.92	13.44	274.34
	12	LUZON AVE.	2.99	17.340	0.78	25.89	1.55	45.56	1.41	47.00	2.82	51.23	17.340	2.19	72.89	4.37	96.79
	13	KATIPUNAN AVE.	3.89	46.390	1.41	46.85	2.81	97.46	0.77	25.50	1.53	27.80	46.390	2.18	72.35	4.34	125.26
C–6	21	MNDR QUIRINO AVE	6.63	36.560	1.43	47.60	2.86	88.45	1.70	56.66	3.40	61.76	36.560	3.13	104.26	6.26	150.21
	22	QUIRINO AVE VISAYAS AVE	3.08	30.710	0.91	30.48	1.83	63.93	0.40	13.34	0.80	14.54	30.710	1.31	43.82	2.63	78.47
	23	VISAYAS AVE. DON MARIANO	2.53	24.030	0.63	20.98	1.26	46.90	0.89	20.77	1.79	32.45	24.030	1.52	50.75	3.05	79.35
MINDANAO AVENUE	31	NORTH AVE. REPUBLIC AVE.	4.90	21.740	1.90	63.32	3.80	90.76	0.56	18.67	1.12	20.35	21.740	2.46	81.99	4.92	111.11
	32	REPUBLIC AVE. GEN. LUIS AVE.	3.30	6.420	0.29	9.75	0.59	17.05	0.70	23.31	1.40	25.41	6.420	0.99	33.06	1.99	42.46
	33	GEN. LUIS AVE. C – 6	0.84	1.280	0.07	2.43	0.15	3.93	0.15	5.10	0.31	5.56	1.280	0.22	7.53	0.46	9.49
VISAYAS AVENUE	41	ELLIPTICAL RD REPUBLIC AVE.	4.55	25.060	1.51	50.25	3.02	79.84	0.14	4.65	0.28	5.07	25.060	1.65	54.90	3.30	84.91
	42	REPUBLIC AVE. C – 6	2.18	7.150	0.74	24.74	1.48	34.11	0.03	1.16	0.07	1.26	7.150	0.77	25.90	1.55	35.37
		TOTAL	42.37	246.940	12.57	418.79	25.14	703.44	10.57	352.58	21.17	384.32	246.940	23.14	771.37	46.31	1 087.76

NOTE.

a) CONSTRUCTION COST INCLUDES 10% PHYSICAL CONTINGENCY.
b) 1982 CONSTANT PRICE.

TABLE 9.5–1 (2) PROJECT COST : ALTERNATIVE – 2

					STAGE 1				STAGE 2					TOTAL			
ROAD NAME	CODE	SECTION	km	R.O.W.	DETAILED ENG'G	CON STRUCT ION	SUPER VISION	TOTAL	DETAILED ENG'G	CON STRUCT TION	SUPER VISION	TOTAL	R.O.W.	DETAILED ENG'G	CON STRUCT ION	SUPER VISION	TOTAL
	11	REPUBLIC AVE.	7.48	30,260	2.90	96.50	5.79	135.45	3.82	127.42	7.65	138.89	30,260	6.72	223.92	13.44	274.34
C – 5	12	LUZON AVE.	2.99	17.34	0.78	25.89	1.55	45.56	1.41	47.00	2.82	51.23	17,340	2.19	72.89	4.37	96.79
	13	KATIPUNAN AVE.	3.89	46,390	1.41	46.85	2.81	97.46	0.77	25.50	1.53	27.80	36,390	2.18	72.35	4.34	1 25.26
	21	M N D R QUIRINO AVE	6.63	36,560	2.89	96.22	5.77	141.44	1.11	36.86	2.21	40.18	36,560	4.0	133.08	7.98	181.62
C – 6	22	QUIRINO AVE. VISAYAS AVE	3.08	30,710	0.91	30.48	1.83	63.03	0.40	13.34	0.80	14.54	30,170	1.31	43.82	2.63	78.47
	23	VISAYAS AVE DON MARIANO	2.53	24,030	0.63	20.98	1.26	46.90	0.89	29.77	1.79	32.45	24,030	1.52	50.75	3.05	79.35
	31	NORTH AVE. REPUBLIC AVE.	4.90	21,740	1.90	63.32	3.80	90.76	0.56	18.67	1.12	20.35	21,740	2.46	81.99	4.92	1 11.11
MINDANAO AVENUE	32	REPUBLIC AVE. GEN. LUIS AVE.	3.30	6,420	0.81	26.06	1.26	35.81	0.20	9.78	0.59	10.66	6,420	1.10	36.74	2.21	46.47
	33	GEN LUIS AVE' C – 6	0.84	1,280	0.20	6.78	0.41	8.67	0.07	2.20	0.13	2.40	1,280	0.27	8.98	0.54	11.07
VISAYAS	41	ELLIPTICAL RD. REPUBLIC AVE.	4.55	25,060	1.55	51.64	3.10	81.35	0.51	17.05	1.02	18.58	25,060	2.06	68.69	4.12	99.93
AVENUE	42	REPUBLIC AVE C – 6	2.18	7,150	0.78	25.30	1.52	34.73	0.21	7.15	0.43	7.79	7,150	0.97	32.45	1.95	42.52
		TOTAL	42.37	246,940	14.74	490.92	29.46	782.06	10.04	334.74	20.09	364.87	246,040	24.78	825.66	49.55	1,146.93

NOTE:

a) CONSTRUCTION COST INCLUDES 10% PHYSICAL CONTINGENCY.
b) 1982 CONSTANT PRICE.

TABLE 9.6–2 SUMMARY OF PROJECT COST

Unit : Million Pesos (May 1982 constant price)

	ALTERNATIVE			
	1 (A)	1 (B)	2 (A)	2 (B)
STAGE 1				
Phase 1				
Foreign	209.34	154.62	211.81	167.36
Local	286.22	240.82	287.41	247.31
Tax	53.97	39.79	54.55	43.04
Total	549.53	435.23	553.77	457.71
Phase 2				
Foreign	48.23	102.94	90.12	134.55
Local	93.18	138.58	114.81	154.90
Tax	12.50	26.69	23.36	34.90
Total	153.91	268.21	228.29	324.35
Sub–Total				
Foreign	257.56	254.56	301.93	301.93
Local	379.40	379.40	402.22	402.22
Tax	66.48	66.48	77.91	77.91
Total	703.44	703.44	782.06	782.06
STAGE 2				
Foreign	211.20	211.20	200.50	200.50
Local	199.28	199.28	113.24	113.24
Tax	53.84	53.84	51.13	51.13
Total	384.32	384.32	364.87	364.87
GRAND TOTAL				
Foreign	468.76	468.76	502.43	502.43
Local	498.68	498.68	515.46	515.46
Tax	120.32	120.32	129.04	129.04
Total	1,087.76	1,087.76	1,146.93	1,146.93

TABLE 9.5–3 CASH FLOW OF EACH ALTERNATIVE PLAN

Unit : Million Pesos (May 1982 Constant Price)

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	TOTAL
Alternative 1(A)														
Foreign	5.66	1.88	60.54	80.72	60.54	24.12	24.11	-	-	4.76	1.58	102.43	102.43	468.76
Local	2.54	90.17	84.85	77.41	79.05	32.94	12.44	-	-	2.14	0.71	58.22	58.21	498.68
Tax	1.23	0.41	15.70	20.93	15.70	6.26	6.24	-	-	1.04	0.34	26.24	26.22	120.32
Total	9.43	92.46	161.09	179.06	155.29	63.32	42.79	-	-	7.94	2.63	186.89	186.86	1,087.76
Alternative 1(B)														
Foreign	5.66	1.88	44.12	58.84	44.12	51.48	51.46	-	-	4.76	1.58	102.43	102.43	486.76
Local	2.54	81.60	71.23	62.67	82.59	52.21	26.56	-	-	2.14	0.71	58.22	58.21	498.68
Tax	1.23	0.41	11.45	15.25	11.45	13.35	13.34	-	-	1.04	0.34	26.24	26.22	120.32
Total	9.43	83.89	126.80	136.76	138.16	117.04	91.36	-	-	7.94	2.63	186.89	186.86	1,087.76
Alternative 2(A)														
Foreign	6.63	2.21	60.89	81.19	60.89	45.06	45.06	-	-	4.52	1.50	97.25	97.23	502.43
Local	2.99	90.31	85.03	77.65	79.23	43.76	23.25	-	-	2.03	0.68	55.27	55.26	515.46
Tax	1.44	0.48	15.79	21.05	15.79	11.79	11.67	-	-	0.98	0.33	24.91	24.91	129.04
Total	11.06	93.00	161.71	179.89	155.91	100.51	79.98	-	-	7.53	2.51	177.43	177.40	1,146.93
Alternative 2(B)														
Foreign	6.63	2.21	47.54	63.44	47.54	67.28	67.27	-	-	4.52	1.50	97.25	97.23	502.43
Local	2.99	81.74	73.00	65.03	84.36	60.37	34.72	-	-	2.03	0.68	55.27	55.26	515.46
Tax	1.44	0.48	12.33	16.46	12.33	17.45	17.45	-	-	0.98	0.33	24.91	24.91	129.04
Total	11.06	84.43	132.87	144.93	144.23	145.10	119.44	-	-	7.53	2.51	177.43	177.40	1,146.93