3.3 Land Use

3.3.1 Basic Policy

A land use plan must conform to the planning objectives with regard to the population, industry, and the feature of the subject city and be formulated so as to enable healthy and cultural urban life and to promote the city's functional activities, taking into full account the natural, social, and economical potentials and constraints of the city. As such, the plan should have a planning intent of its own with regard to the process of the city's development and a vision about the final state of the city upon the completion of development.

In this view, the future socio-economic framework of Davao City be such that the Project Area is depended upon for the cultivation of urban industries which will support the future population increase in the City. The urban industries will chiefly be manufacturing, commercial, and business. Industrial development must be accomplished with due consideration to its harmony with other urban activities and to the preservation of healthy environment. Thus, the land use plan must support the development of a viable economy, the stable supply of employment opportunities and the expansion and upgrading of various public services -- particularly transport and public utility supply.

In non-Project Area, on the other hand, the productivity of its key industry--agriculture--should be improved for the formation of a sound rural area. Also important will be the strengthening of communication and linkage of Calinan and Mintal of non-Project Area, where urban development is planned, with the Project Area.

Thus, in this Sub-Chapter, urban development patterns will be studied in the light of the future socio-economic framework for Davao, land demand in commensuration with the framework will be estimated, and optimum land use plan will be formulated in terms of a master plan and area development plans. Furthermore, development strategies and schedule for the realization of the land use plan will also be identified in this Sub-Chapter.

3.3.2 Urban Development Pattern

(1) Alternative Patterns

In view of the past urban development process, natural conditions, and the future socio-economic framework, the following three urban development patterns are conceivable for the Project Area (see Figure 3.2 for their conceptual model diagrams):

Alternative A: *Mono-Center Development*

This is to plan for the external expansion of Poblacion, thereby containing urbanization to as compact an area as possible.

Alternative B: *Belt Shape Development*

This is to plan for a homogeneous geographical spread of urbanization into a belt shape along the major trunk road which will traverse the Project Area in north-south direction and along other major roads running in parallel thereto.

Alternative C: *Multi-Center Development*

This is to plan for the priority emphasis on the accumulation of social capitals at a number of strategic points selected for development into urban cores, thereby preventing both an excessive urban density and an excessive dispersion of investment.

Of these alternative development patterns, the monocenter pattern of Alternative A aims at a high accumulation of investments through the efficient use of land space and will be the easiest to be achieved, because it will be a continuation in the same path of development as before. However, the resultant over-crowding will at the same time bring about the deterioration of living environment and traffic congestion. Also, this pattern will neither help an even distribution of development effects throughout the Project Area, nor will it achieve the desirable segregation between commercial, industrial, and residential land uses.

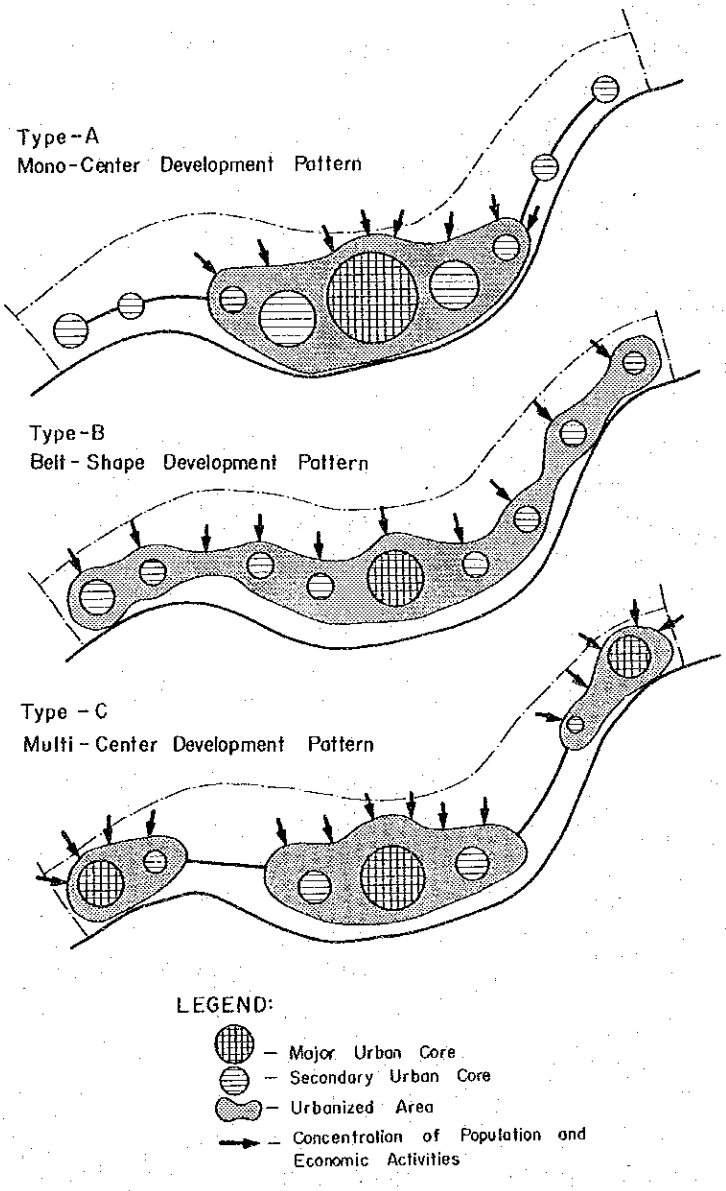


Figure 3.2 Alternatives of Urban Development Pattern for the Project Area

The pattern of Alternative B will be advantageous in that it will afford the freedom of site selection for various facilities and the formation of a pleasant living environment, although huge amounts of investment will be necessary in the development of public facilities and the promotion of rational land use in order to disperse various functions throughout the Project Area. In view of the presently low level of social capital accumulation in the Project Area, however, attempts to accomplish evenly spread development can result in an excessive dispersion of investments with a consequential low investment efficiency.

Therefore, the multi-center development under Alternative C remains as the desirable pattern, after the elimination of the first two patterns. This multi-center development pattern can be understood as an eclectic pattern or a transitional pattern in the process of development from mono-center to an ultimate belt shape development of the Project Area.

(2) Development Bases

For the purpose of developing several urban cores in conformity with this multi-center development pattern, a several development strategic bases or lodgment points which will become the urban core must be selected, together with the establishment of their sphere of influence. This selection is accomplished through the review of:

a) Present population distribution

b) Travel pattern

c) Present land use

d) Existing development projects

Presently, the most densely populated is Poblacion with approximately 120 persons per hectare. Outside Poblacion, densely populated barangays are Bunawan, Tibungco, Matina Crossing, Bucana, Talomo, and Ma-a in Talomo Block, and Crossing Bayabas, and Toril in Toril Block.

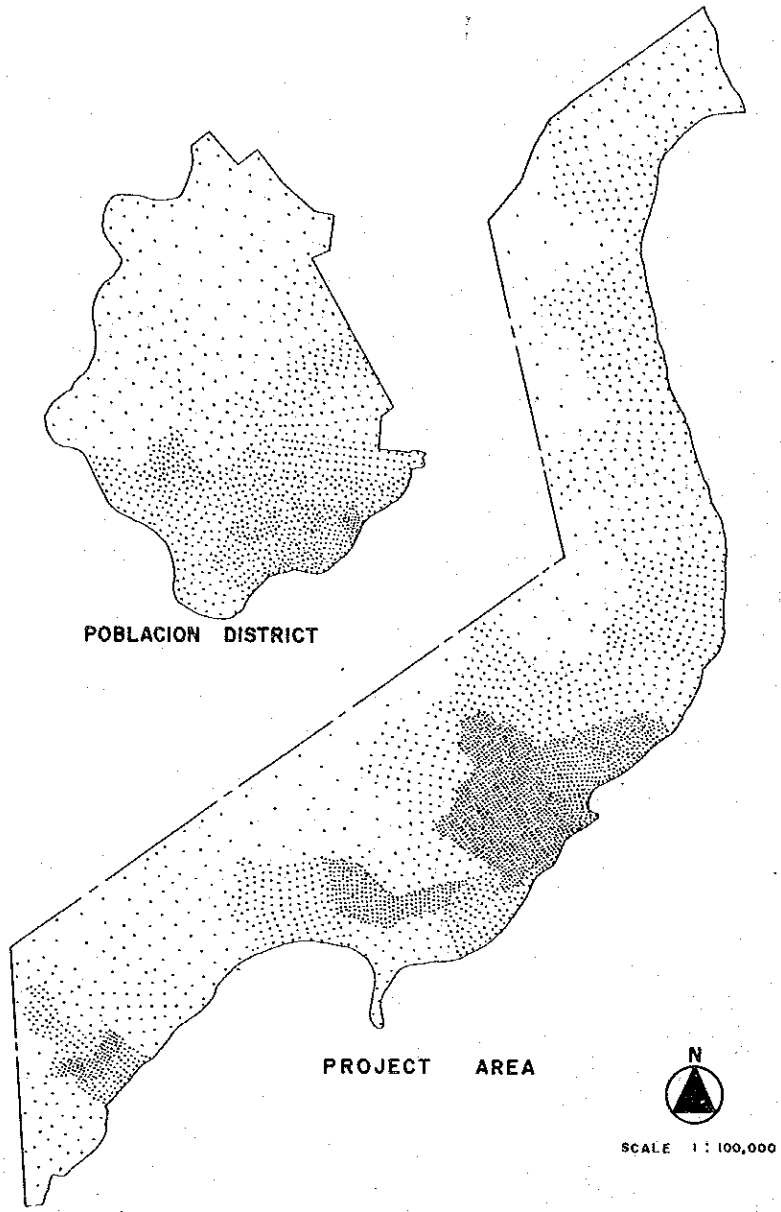


Figure 3.3 Population Distribution in 1979

The Person-Trip Survey revealed that the great majority of commuting (office, school), business, and shopping trips are attracted to Poblacion. Of trips ending outside Poblacion, relatively large in quantity are "to office" trips attracted to Tibungco, Panacan, and Sasa, "to school" trips to Sasa and Toril, business trips to Panacan, Sasa, and Toril, and shopping trips to Sasa and Toril. Thus, candidates for development base, seen from travel pattern, are Tibungco, Panacan, Sasa and Toril, in addition to Poblacion.

In the aspect of the present land use situation, the largest urban accumulation is seen in, of course, Poblacion. An urban core, through small, has been formed in Toril. Also in Bucana, which is adjacent to Poblacion, the development of Ecoland has been making progress. A large number of factories are located in Tibungco, Panacan, and Sasa, all along the Davao Gulf, which are becoming

industrial areas. In Talomo, a small core is now being formed near the junction of McArthur Highway and the road leading to Calinan. Thus, development which may lead to the formation of a full urban core in addition to Poblacion, is observed at several locations.

As for the existing development projects, areas subject to such projects (Sasa Wharf Expansion, Industrial Estate Construction, Housing Estate Construction, Ecoland Development, and Government Agencies Building Construction) are very likely candidates for development bases. Particularly, the areas where industrial estates will be constructed will become important bases, that is, Sasa, Panacan, Bunawan, and Toril, as planned by Davao authorities.

As a result of the foregoing review and the consideration of the future socio-economic framework, it is proposed that the Project Area be divided into the following six blocks: Bunawan, Panacan, Buhangin, Poblacion, Talomo, and Toril with their base cores and the areas of influence as shown in Table 3.18 and illustrated in Figure 3.4.

Table 3.18 Block and Barangay

Block	Barangay	Area (ha)
I (BUNAWAN)	Lasang, San Isidro, Bunawan Mahayag, Tibungco, Acasia	3,100
II (PANACAN)	Ilang, Panacan, Sasa, Mudiang, Communal	3,600
III (BUHANGIN)	Pampanga, Buhangin, Cabantian	2,200
IV (POBLACION)	Agdao, Bucana, Poblacion	2,100
V (TALOMO)	Ma-a, Matina Pangi, Matina Crossing, Matina Aplaya, Talomo, Catalunan Grande, Catalunan Pequeño	4,100
VI (TORIL)	Bago Gallera, Baliok, Dumoy, Lubogan, Crossing Bayabas, Toril, Daliao, Fagel Lizada	3,000
TOTAL		18,100

The future land use plan is to aim at the development of separate fairly self-sufficient urban functions in each of these blocks with organic linkage with Poblacion through the development of road network between these urban cores and the mother core in Poblacion.

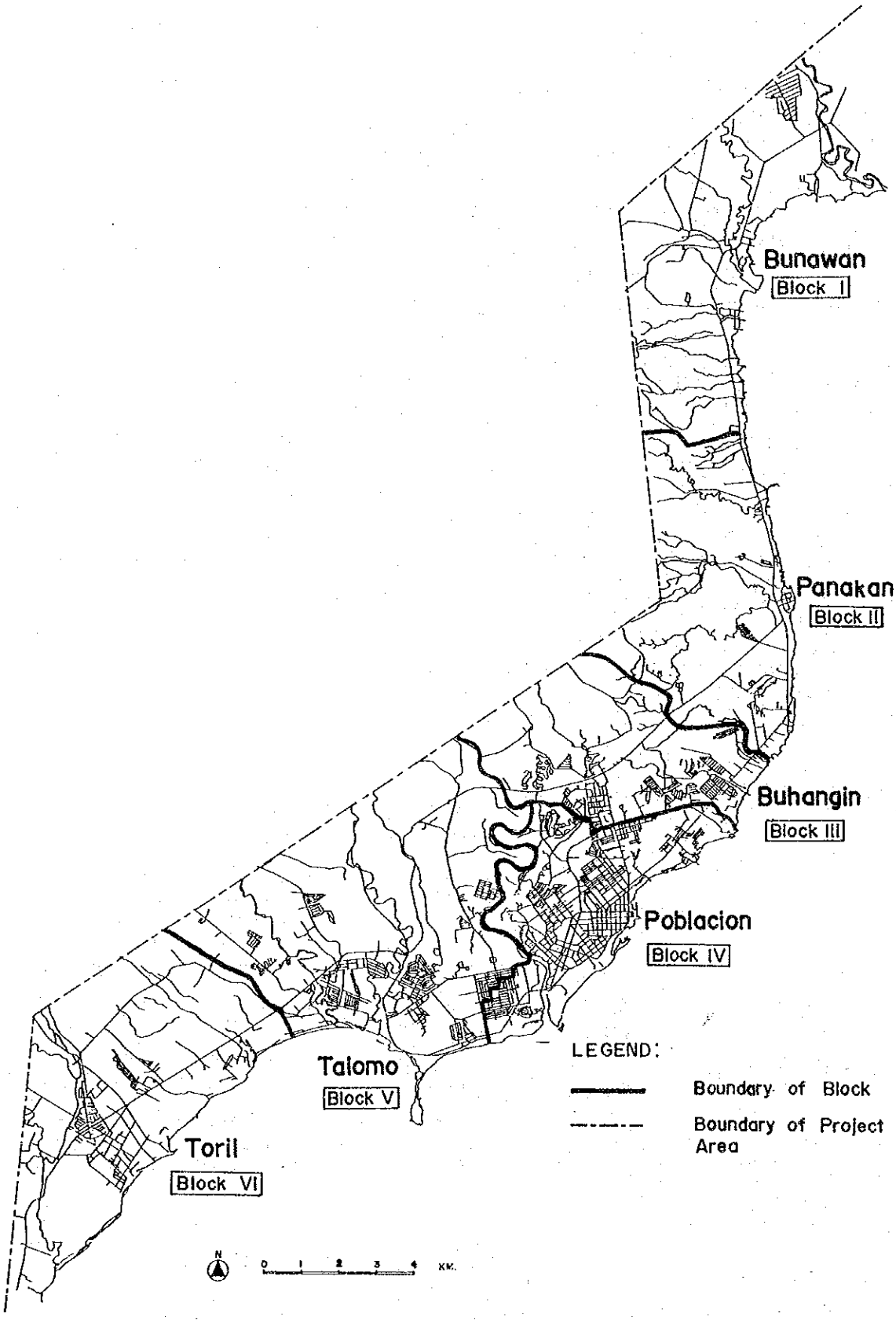


Figure 3.4 Block Division

(3) Block Population

The distribution of population to each block can be accomplished by a number of methods, including past trend method and the method of estimation separately by natural increase and social increase of population. However, such methods, in themselves, fall short of reflecting the planning intent. Therefore, the results of estimation by the following four methods will be adjusted in view of the characteristics of each block, the trend of development, and the space of developable land and also in the light of the socio-economic framework, in accomplishing the required population distribution. In the process of estimation by said four methods using appropriate equations, however, the populations of blocks III, IV, and V, which, together, function as a unified area, are to be processed together as one population and, then, the estimated population is to be broken down to each of the Blocks III, IV, and V.

METHOD I: Estimation by using the average annual increase rate registered during the period of 1970 to 1979.

METHOD II: Estimation by using the average annual increase rate registered during the period of 1975 to 1979.

METHOD III: Method whereby social increase of population is separated from natural increase and allocated to each block by the population distribution ratio of the block

METHOD IV: Method whereby social increase of population is separated from natural increase and allocated to each block by the proportionate ratio of its land areal size.

Table 3.19 The Result by Each Case

Block No.	Case I	Case II	Case III	Case IV
I	66,000 (7.3)	66,000 (7.4)	67,000 (7.4)	101,000 (11.2)
II	99,000 (11.0)	83,000 (9.2)	77,000 (8,6)	95,000 (10.6)
III + IV + V	640,000 (71.1)	659,000 (73.2)	652,000 (72.4)	581,000 (64.6)
VI	95,000 (10.6)	92,000 (10.2)	104,000 (11.6)	123,000 (13.6)
TOTAL	900,000 (100.0)	900,000 (100.0)	900,000 (100.0)	900,000 (100.0)

Source : DCUTCLUS

Inasmuch as the above methods I, II, and III are based on the past trend of a kind, population distribution by these methods would result in concentration of about 70% of the Project Area population and about 50% of social increase in three blocks, Blocks III, IV and V. Such would be the case of mono-center development. However, Multi-Center development anticipates a greater dispersion of population throughout the Project Area. Therefore, the result of the four-method estimation is adjusted as follows:

a. The closed population (present population + natural increase) is obtained for each block, to which social increase is allocated under policy decision.

b. Allocated to Blocks III, IV, and V, together, is 30% of total social increase.

c. Between Blocks I and II, which are both planned as urban areas with an emphasis on industrialization, a slightly greater social increase is allocated to the latter, which already has some accumulation of industries and which present a better siting conditions than the former.

d. Block VI, which already shows a formation of an urban core and, therefore, can develop independently from Poblacion, is to absorb a greater social increase than will Blocks I and II.

The result of the above undertakings are summarized in Table 3.20, That is, population distribution to Blocks I, II, and VI are 110,000, 130,000, and 120,000 respectively, while 540,000 or about 60% of the total Project Area population is distributed to Blocks III, IV, and V, together. Then, the 540,000 is distributed to each of Blocks III, IV, and V in consideration of the developable land space and the future population density in each of them. Population for each barangay (C zone), which is necessary for the purpose of traffic demand forecast, is shown in Volume IV 4.1.

Table 3.20 Distribution of Population by Block

Year	BLOCK						
	I	II	III	IV	V	VI	TOTAL
1990	45,000 (7.6)	60,000 (10.2)	65,000 (11.0)	225,000 (38.1)	125,000 (21.2)	70,000 (11.9)	590,000 (100.0)
2000	110,000 (12.2)	130,000 (14.5)	110,000 (12.2)	250,000 (27.8)	180,000 (20.0)	120,000 (13.3)	900,000 (100.0)

Figures in Parenthesis show share.
Source: DCUTCLUS

3.3.3 Land Demand

Necessary prior to the formulation of a future land use plan for the Project Area is the rough estimation of future land demand, that is, to know how much of land must be developed in view of the future socio-economic framework. Most important in order to make sure that a future population of 900,00 will be accommodated and a future labor force of 324,000 will be employed is that ample sizes of commercial, industrial, and residential land be secured through development.

Thus, necessary sizes of commercial, industrial, and residential land have been estimated using the standard unit values established for each such land uses (see Table 3.21), with reference to the average land size per unit of population and average population per unit of land as calculated for each such land uses by the Ministry of Human Settlement. The result of this estimation is as follows:

i) The required size of commercial land is estimated at 900 hectares.

ii) Assuming an allocation of labor force to light, medium, and heavy industries at the proportions of 50: 30: 20, as the future industrial structure, the sizes of land required is estimated at 155 hectares for light industries, 275 hecares for medium industries, and 300 hectares for heavy industries, for a total land of 730 hectares.

iii) Excluding from the total population those who will live in dual-purpose buildings (storehouses in commercial areas and factory-houses in industrial areas) and those who will live in agricultural areas, the remaining future population is allocated to low density housing areas, medium density, and high density at the proportions of 15: 35: 50 with reference to the population distribution by income levels. Then, the required sizes of residential land are estimated at 1,720 hectares for low density housing, 2,410 hectares for medium density, and 1,590 hectares for high density, for a total of 5,720 hectares. For the above exclusion, the commercial area residents are estimated at the rate of 200 persons per hectare, and the industrial area residents, at the rate of 100 persons per hectare of light industry area, 40 persons per hectare of medium industry area, and no night population in heavy industry area.

Thus, the total size of required commercial, industrial, and residential areas is estimated at 7,350 hectares.

In addition, public use land and open spaces are necessary. However, land requirement for such purposes may not be determined based on an average value per unit of certain criterion but must be decided per policy planning. Therefore, it is proposed that an additional 510 hectares be developed for use as athletic fields, academic towns, government agencies buildings, and other public use land, and 1,840 hectares of coastal areas and flood areas of rivers be used for green belts, recreational areas, and open spaces for other purposes.

A grand total of 9,700 hectares, or about one-half of the entire Project Area, is to be developed. Of the remaining one-half, about 2,400 hectares is non-developable rivers and hills, and about 6,000 hectares is to remain agricultural land. It is recommended that this size of agricultural land be retained intact for the preservation of natural environment.

Table 3.21 Planning Unit for Land Requirement

Land Use	Unit
Residential	
Low Density	65 persons/hectares
Medium Density	100 persons/hectares
High Density	200 persons/hectares
Commercial	1 hectare/1,000 population
Industry	
Light Industry	200 workers/hectares
Medium Industry	70 workers/hectares
Heavy Industry	40 workers/hectares

Source: Ministry of Human Settlements

Table 3.22 Current and Future Land Use

	1979		2000	
	Area (ha.)	%	Area (ha.)	%
Residential	2,549	(14)	5,720	(32)
Commercial	283	(1)	900	(5)
Industrial	322	(2)	730	(4)
Institutional	202	(1)	510	(3)
Open Space	160	(1)	1,840	(10)
Others	14,584	(81)	8,400	(46)
Total	18,100	(100)	18,100	(100)

Source: DCUTCLUS Team

3.3.4 Land Use Plan

(1) Overall Land Use

Based on the above estimated size of total land requirement, land use plan is developed for the entire Project Area, by various land uses, in conformity with the characteristics of each block, the topographical conditions of the Area, and the trend of urban development, as well as in coherence with the socio-economic framework.

The following are the fundamental concepts which underlie the overall land use plan.

i) Industrial Land

Industrial land tends to occur along national or other trunk road for the convenience of motor vehicle access, near a port for transportation convenience, or near a river for the ease of draining-all relatively lowlands. Also, low price makes a piece of land suitable for industrial use. That which will meet these conditions in the Project Area will be the land along Davao-Agusan Road and Davao-Cotabato Road. In fact, area from Panacan to Sasa along Davao-Agusan Road already has a number of industries located. It is expected that Panacan area in Block III will become the top industrial area in the Project Area in view of the closeness to a port, the ease of securing land, and the ease of obtaining labor. In Block I, Bunawan on Davao Gulf would be suitable for an industrial area. Ilang in the northmost part of the Project Area is believed unsuitable for industrial use, because of a large number of fish cultivation ponds which exist there, and Tibungco is too close to the industrial area in Block II. CPDO of Davao City has a definite plan for the development of an industrial area in Bunawan. In Block VI, Daliao and nearby Daliao as well as Fagel, Lizada, are to be industrial areas. In Daliao, the industrial estate project (about 30 hectares) is currently being executed by the Export Processing Zone Authority. Land necessary for the future extension of this industrial estate is to be sought for in Fagel and Lizada. In addition, the expansion of the existing industrial areas is conceivable in Agdao, Ma-a, and Matina Aplaya. The development of a meet processing industry is planned near Ma-a bridge. Room for development still remains in these areas, except in Matina Aplaya.

The classification of these industrial areas into light, medium, and heavy industries, the number of workers estimated for each of them, and the necessary land space for each of them, as calculated based on the average value per unit, are presented in the table below.

Table 3.23 Industrial Area and Employment

		Light Industry		Medium Industry		Heavy Industry		Total	
Block	Barangay	Employment	Area (ha.)	Employment	Area (ha.)	Employment	Area (ha.)	Employment	Area (ha.)
I	Bunawan	6,000	30	2,000	30	4,000	100	12,000	160
II	Panakan	8,000	40	9,000	130	6,000	150	23,000	320
III	Sasa	–	–	–	–	2,000	50	2,000	50
IV	Agdao	8,000	40	2,000	30	–	–	10,000	70
V	Ma-a	3,000	15	1,000	15	–	–	4,000	30
V	Matina Aplaya	2,000	10	–	–	–	–	2,000	10
VI	Daliao	–	–	2,000	30	–	–	2,000	30
VI	Fagel Lizada	4,000	20	3,000	40	–	–	7,000	60
Total		31,000	155	19,000	275	12,000	300	62,000	730

Source: DCUTCLUS

ii) Commercial Land

Three kinds of commercial land are considered: central commercial land which will serve the entire Project Area, sub-central commercial land which will serve each block, and local commercial land which will serve neighborhood community. Poblacion, which is and will continue to be the commercial and business center of not only Davao City, but also of the entire Mindanao Island, is the central commercial land.

In Poblacion, it is apparent from the present state of land use that the existing CBD will further develop along San Pedro Street, C.M Recto Avenue, R. Magsaysay Avenue, and E. Quirino Avenue. However, in view of the future land demand, it is expected that a more vigorous development of a new CBD will occur in the south of E. Quirino Avenue, up to M. Quezon Boulevard. Besides, Poblacion, as the future commercial and business center of Mindanao, will require, in addition to said existing CBD, another modern and highly efficient CBD with a higher level of land use specialization. Thus, the area along M. Roxas Avenue from the M. Roxas/E. Quirino Intersection, as the central traffic core, up to M. Quezon Boulevard is recommended for the development of this new CBD, where all kinds of offices be located for a very high business efficiency, supported by business and tourist hotels, restaurants, and other service facilities.

Another CBD is to be developed in Block IV, namely in Ecoland of Bucana, which will become important for sharing a part of Poblacion's functions and, thus, will become an urban sub-center. In Ecoland, concentrated is people travelling to Poblacion, and traffic congestion and other urban problems have been gradually surfacing. Therefore, Davao City authorities are now making efforts for the development of Ecoland.

To be established in each block are a block's central commercial land and local commercial areas for the supply of daily necessities to the neighborhood residents. The block's central commercial land is to be located in the central part of each block, namely, Bunawan in Block I, Panacan in Block II, Talomo in Block V, and Toril in Block VI, which is very close to and is under the strong influence of Poblacion.

A local commercial area is to be established at the center of each barangay to serve the community around it. Also, a local commercial area is to be established near the consolidated government building in Baliok.

The total commercial land of 900 hectares is allocated to each of these three kinds of commercial land in proportion to day population of each Block, provided that allocation to Poblacion is adjusted in consideration of the intensity of its influence, as presented in Table 3.24.

Table 3.24 Commercial Area by Block

(Hectares)

Block	Area	Commercial Center
I	80	Bunawan
II	80	Panakan
III	20	—
IV	540	Poblacion, Bucana
V	70	Talomo
VI	110	Toril
Total	900	

Source: DCUTCLUS

iii) Residential Land

Hilly suburban areas with a favorable topography and environment is usually considered suitable for residential land. The external expansion of housing areas in the environs of the existing urban areas is to be tolerated to some extent, but sprawling must be controlled. Housing land equipped with roads, water supply and drainage facilities, parks and schools to meet the residential district development standard must be developed and supplied.

Residential land should be clearly segregated from other land uses in order that a desirable living environment be secured. For instance, houses and industries should not be allowed to coexist in the same neighborhood area. Rather, they should be separated from each other, and the housing land be shielded from the industrial land by a green belt or other appropriate open space. Even if to do so is impossible, it should be at least contrived so as to locate the kind of light industries which do not emit pollution as buffer between the two.

Scenic coastal and hillside areas should be utilized for the development of environment-minded housing areas.

In view of the above, the following practical distribution of housing land in each block is recommended.

In Block I, where the Bunawan seaside area is utilized as industrial area, housing land should be distributed in the area surrounding the commercial land on the northwest of Davao-Agusan Road. In addition, housing areas should be located around commercial areas of Ilang and Tibungco. These housing areas should be classified into low density, medium density, and high density areas. The areas closest to a commercial land should be high density housing area, and the area surrounding the high density housing area should be medium density, and that surrounding the medium density, low density housing area. This is because the utilization value is the highest of the land closest to commercial area.

In Block II, housing area is to be developed centering around the industrial and commercial areas of Panacan on the north of the Philippine-Japan Friendship Highway, which is relatively hilly and is believed suitable for this purpose. A housing area is to be developed also around the airport land, provided that care should be used so as that the houses will be insulated from noises by a buffer zone.

Almost all of the entire area of Block III, which is close to Poblacion, is to be used as residential area. The area on the north of the Philippine-Japan Friendship Highway in Buhangin is rich in moderate undulation and is believed a relatively fine housing land. In fact, the Panorama Subdivision is now under construction in this area. Further development will be possible in this area, in response to the future demand increase. An airport land exists also in Block III, and in the development of housing area around it, the installation of an effective buffer zone between the two should not be neglected.

In Block IV, which is practically all developed, the future task will be to elevate the land utilization efficiency rather than areal expansion. In other words, the area on the north of E. Quirino Avenue should be developed into a high density housing area, whereas, area up to the Friendship Highway be developed as a medium density housing area. Both Agdao and Bucana should be developed as medium density housing areas.

Block V serves, as does Block III, as residential area for Poblacion. A number of housing estate development projects are being implemented in Block V. This Block has a large land area and much room remains for future development, but the future task will be to avoid random or haphazard development and to achieve concentrated development under plan. Areas along Ma-a Road, which is close to Poblacion, and the area near the commercial land of Talomo should be developed into a high density housing areas. All other land is to be medium or low density housing areas. The area north of the Philippine-Japan Friendship Highway and Shrine Hill between this Highway and Ma-a Road are considered topographically unsuitable for housing purposes and, therfore, should be reserved as scenic natural area.

In Block VI, high density housing areas are to be distributed around the commercial area of Toril. This Block occurs on the moderate slope suited to agriculture on the lower extension of the outskirt of Mt. Apo. Therefore, only medium and low density housing areas of a high quality should be developed at a limited number of locations. The scenic coastal area in this Block, as seen in Block V, should be developed into a high value housing area with ample open spaces between houses.

The size of residential land in each block is calculated by deducting the night populations of commercial, industrial, and agricultural land from the total block population, by allocating the balance of population thus arrived as to low density, medium density, and high density housing areas, and, by dividing the allocated populations by the average land use unit value. The result of this calculation is presented in the table below.

Table 3.25 Residential Area by Block

(hectares)

Block	Low Density	Medium Density	High Density	Total
I	200	310	220	730
II	240	360	260	860
III	250	370	260	880
IV	—	390	490	880
V	690	660	260	1,610
VI	210	320	230	760
Total	1,590	2,410	1,720	5,720

Source: DCUTCLUS

iv) Public Land

Public land is that which is used for as the sites of government buildings and educational institutions. Public land should be distributed so as to assure that local inhabitants are well served. A large number of government agencies are concentrated in Poblacion, which is the administrative center of Davao City. However, Davao City authorities are planning to build a consolidated government building in Baliok, into which the regional offices of central government agencies will be gathered, in order that public service to inhabitants will be improved.

Educational facilities include schools and ancillary facilities. Primary and high school land is to be secured in each barangay. While colleges and universities are currently concentrated in and around Poblacion, the securing of land for new colleges and universities, as will become necessary in response to the increase of students, will be very difficult in or around Poblacion. To avoid this difficulty and also to secure a better educational environment, new colleges and universities are to be constructed away from Poblacion. The aggregate size of colleges and universities must be large enough to accommodate the future increase in the number of students, namely, the estimated 45,000 students in the year 2000 less the current number of 28,700, for an increment of 16,300. Based on the Ministry of Human Settlement's standard of 1,800 students per college and the land of 17 hectares per college, nine additional colleges with a land requirement of 150 hectares will be needed by the year 2000. In order to offer better distributed educational opportunities to the residents, academic towns will be developed in Tibungco and Talomo, with the land space of 80 hectares and 70 hectares, respectively.

For the better physical development of youths and for the attainment of unity and friendship among local inhabitants through sports, a consolidated sports ground/stadium is to be established together with park in the vicinity of the junction of Ma-a Road and the Philippine-Japan Friendship Highway.

The Davao Gulf Masterplan, formulated by the Philippine Port Authority, recommends the upgrading of Sasa Wharf and Sta. Ana Pier and the construction of new port at Panabo, together with the recommendation to relocate, toward the airport, Davao-Agusan Road in order to provide ample space for the expansion of Sasa Wharf facilities. In view of the limited cargo handling capability due to the fact that the access road runs through a downtown area and that the hinterland is small, Sta. Ana Pier, which currently serves domestic passengers and cargo, will, in the future, be dedicated for use as a passenger port. In addition, new ports can become necessary in Panacan and Toril, depending on the future progress of industrial estate development projects and on the kind of industries which will be located in those estates, but it is likely that those ports, if established, will be established as private ports.

v) Open Spaces

Any urban space not occupied by a building -- whether it be a park, plaza, golf links, river, seashore, or whatever — is referred to as open space. For the purpose of this Study, airport land is included in open space. The larger the total open spaces, which provide for the refreshment of the inhabitants, the better.

In the Project Area, the existing open spaces include R. Magsaysay Park and two other parks, San Pedro Memorial Cemetery and four other cemeteries, Apo Country Club and two other golf courses, and F. Bangoy Airport, for a total land space of about 160 hectares, which is still inadequate to fully satisfy the recreational needs of the inhabitants. Therefore, efforts should be made for the creation of more open spaces.

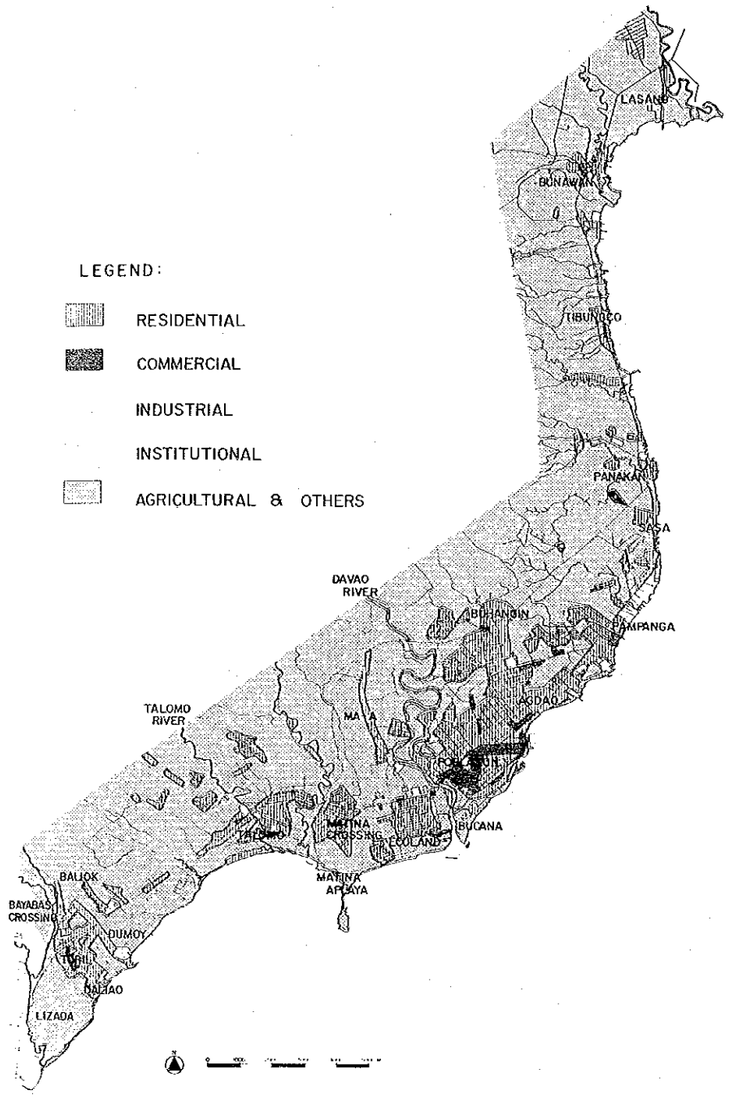
Likely, candidates for additional desirable open spaces are the following. First, the coastal area in Bucana, which is close to CBD in Poblacion, is believed an ideal candidate for open space to serve the recreational need of the citizens. Shrine Hill in Ma-a commanding a wonderful view of the Davao-Gulf, Samal Island, and Mt. Apo, which is already intended for use as a park, should be fully developed as a scenic park.

The coastal area from Talomo to Daliao, which is already crowded by families on weekends, is suited for development as a recreational land. Also recommended is the development of parks on the flood areas of the Davao River and Talomo River. Unusually river flood area is left unutilized, but it is desirable that adequate dam/embankment be constructed and such areas, together with adjacent areas, be used as parks.

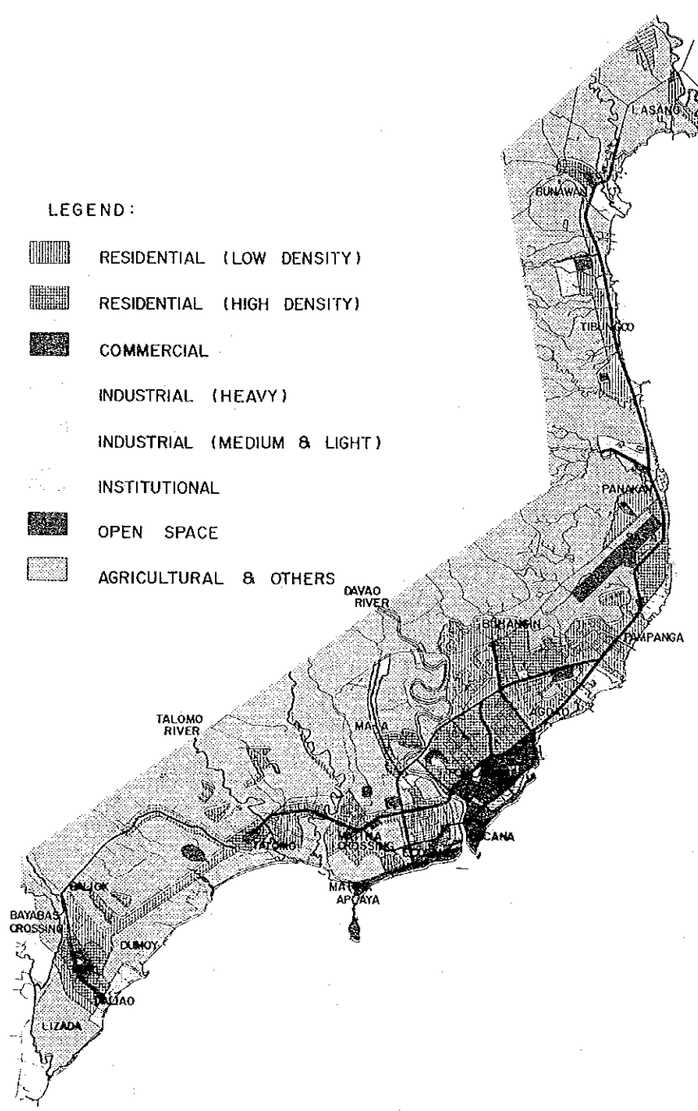
As for the aiport, there is no practical plans for the utilization of such land for recreational purposes. The expansion of F. Bangoy Airport is now under feasibility study by the Ministry of Transportation and Communication, with regard to airports, attention should be paid to the matter of noise and future increase in the number of passengers and the volume of air cargo. Although the inhabitants in the F. Bangoy Airport area have not much complained about noise, that which is caused by midnight flights can later

become an issue. The greater the buffer zone between airport and residential area the smaller the noise problem. In addition, future economic development and increased communication with foreign countries will result in increases in passenger and cargo, necessitating the expansion of the airport. Therefore, as large a land space as possible should be retained for better insulation and future expansion.

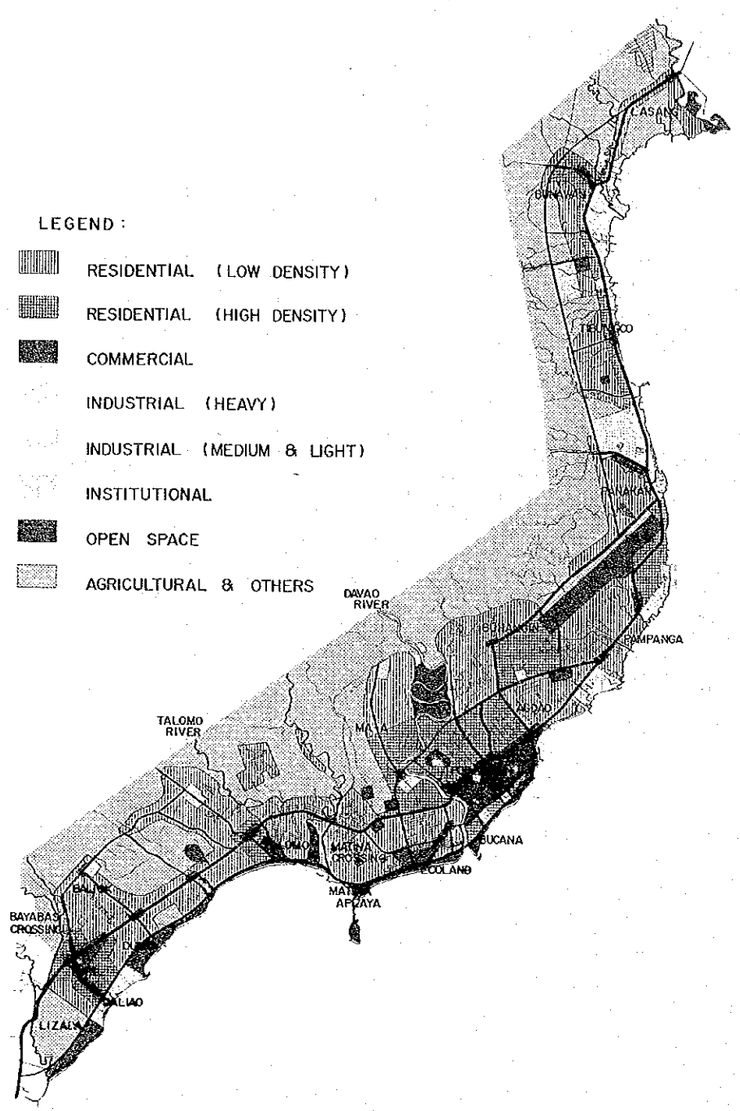
Land use in 1990 is to be established based on the review of program for the implementation of each development project, although it is fundamentally the mid-point between the existing land use and land use in the year 2000, inasmuch as it is desirable that development will be achieved with pure continuity until the land use planned for 2000 will be realized.



1979



1990



2000

Figure 3.5 Land Use Plan

(2) Conceptual Plan for Area Development

The DCUTCLUS development images of each of the following four areas will be explained in detail – the four areas which are believed most important for regional development within the framework of the overall land use plan for the entire Project Area:

- M. Roxas Avenue Area
- Bucana Island Area
- Panacan Industrial Estate Area
- Academic Towns

i) M. Roxas Avenue Area

M. Roxas Avenue, which runs through the middle of Poblacion, and the vicinity area, is to be positioned as the central business district of the Project Area. It should be desirable that this area be developed as the new CBD of not only the Project Area but also of the entire Mindanao Island, because the absence of a strong central business district in the area which is the case presently can discourage the future development of Davao City into a metropolis, thereby inactivating energy for the development of surrounding regions. Therefore, the development of this areas is expected to ignite to "explosive" development of Poblacion.

The facilities to be sited in this new CBD will include the offices of various kinds of business enterprises, banks, shopping centers, restaurants, hotels, and urban type (apartment) houses. In the future, when M. Roxas Avenue will be lined with modern buildings on both sides, it should be closed to motor vehicles and dedicated to pedestrians with the installation of green belts, kiosks, and various facilities for the people's resting and refreshment. Then, access to the roadside buildings is to be made from either E. Jacinto Street of A. Mabini Extension (which sandwich the M. Roxas Avenue area). A central traffic core with city bus and PUJ terminals, taxi loading/unloading zones, and taxi pool and parking lits, which will become the traffic symbol of Davao City, is to be established at the M. Roxas Avenue/E. Quirino Avenue Intersection. In these terminals, pedestrian flow path and vehicle flow path are to be separated as much as possible in order to achieve the safety of pedestrians.

The following points should be borne in mind in the development of this new CBD:

- Because residential houses now exist on both sides of M. Roxas Avenue, the construction of urban type (apartment) houses should be incorporated in and made a part of the program of CBD development.
- Because a large number of buildings already exist in the area where the traffic core is to be developed, the area should be "redeveloped" (through the urban redevelopment scheme explained in Chapter 10).
- Although M. Roxas Avenue is to be ultimately closed to motor

vehicles, it must be still opened to vehicles during the process of development.

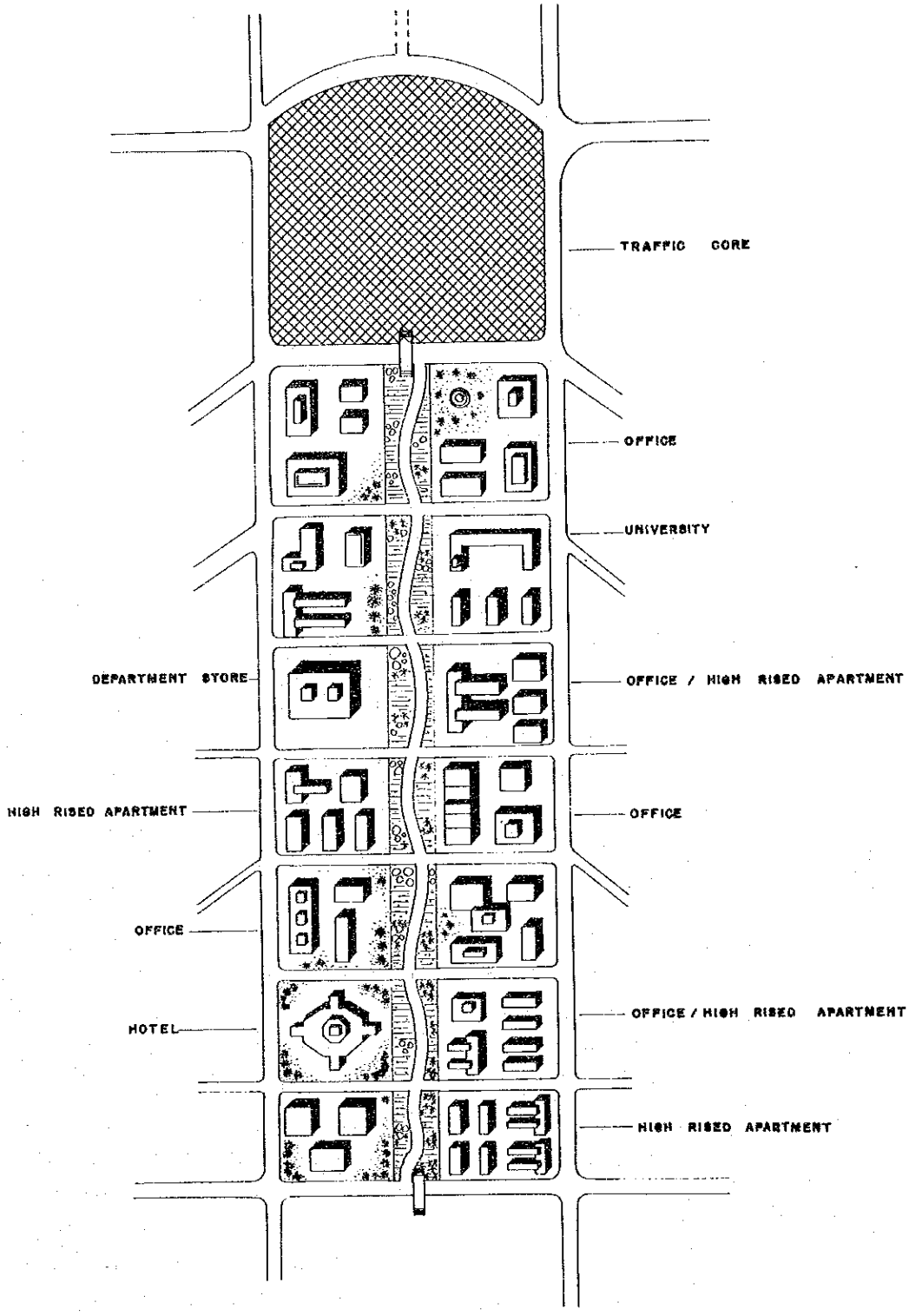


Figure 3.6 Future Image of Roxas Blvd. New CBD/Traffic Core

ii) Bucana Island Area

The swampy area (the old previous channel of the Davao River) extending from M. Quezon Boulevard to Davao Gulf is full of squatters, and the current state of land use must be said unhealthy. Therefore, it is recommended that this area be made subject to a comprehensive development including the reclamation of land to create a substantial size of land near Poblacion and the clearance of squatters.

This area, which will become the symbol of Davao City along with M. Roxas Avenue Area, is of a strategic importance to urban development in the Project Area. The contemplated land uses and facilities to be located are as follows:

Table 3.26 Zoning of Bucana Island

	Zone	Facilities	Area (ha)
1.	Administrative/ Culture/Educational	City Hall, Governmental Buildings Culture Center, Muslem Concert Hall, Library	9
2.	Business	Office Buildings	7
3.	Sports	Stadium, Tennis court, Basketball Court, Swimming Pool	8
4.	Park	Recreation Park, Plaza, Open Space	55
5.	Terminal	PUJ/Taxi Terminal	1
6.	Housing	Low Cost Houses	70
	TOTAL		150

The points to be borne in mind in the development of this area are as follows:

- The huge quantity of soil needed for the land reclamation is to be supplied through the dredging of the Davao River and with the soil cuttings to be produced in housing land development.
- For the purpose of acquiring land for public use, it will be desirable that, in addition to the presently utilized method of negotiated purchases, land re-adjustment scheme (see Chapter 10) be utilized.
- High density housing area should be developed on Bucana Island for the relocation of squatters, and the land opened after clearing squatters should be used as a public space.
- In view of the presently limited space available in Poblacion for recreational purposes of the citizens, recreational parks should be established along the coastal line.

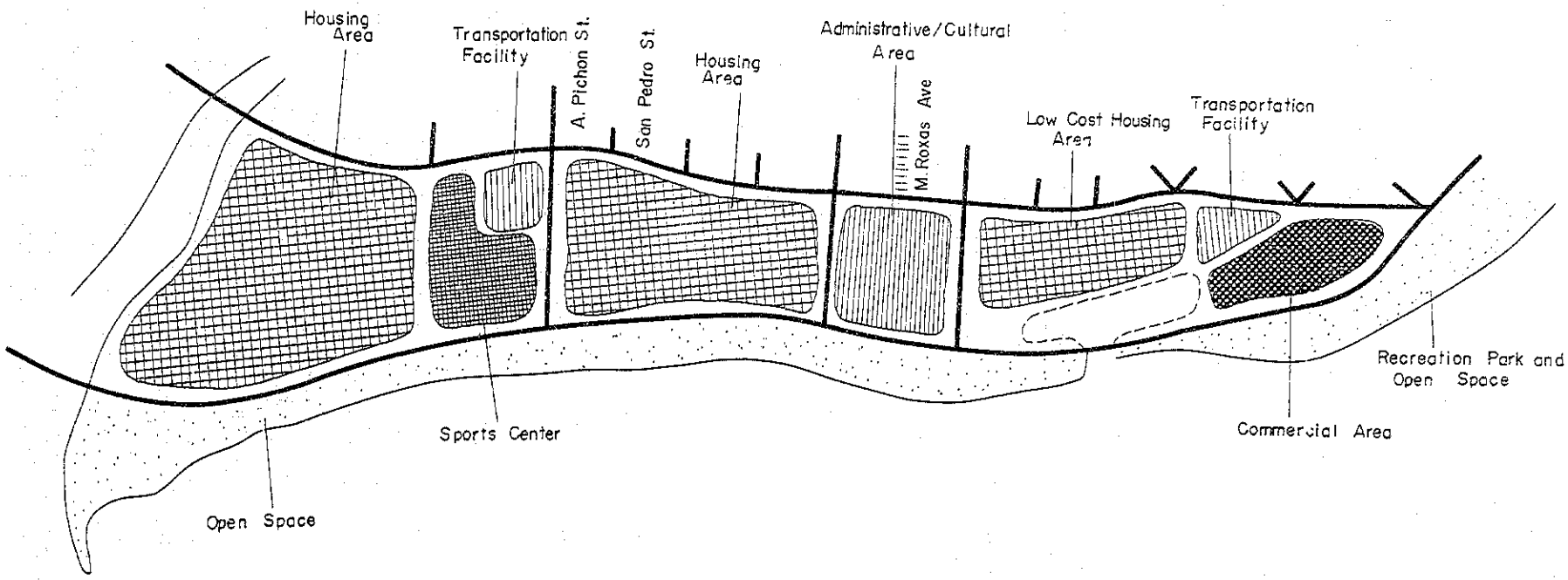


Figure 3.7 Zoning of Bucana Island Comprehensive Development Plan

iii) Panakan Area

Of a number of industrial estates planned in the Project Area, the estate to be developed in Panakan is believed to have a high potential from the following reasons:

- A relatively heavy accumulation of industries already exists.
- The estate will be close to Sasa Wharf
- The acquisition of land in the inland area is easy
- NEDA has a plan of developing an industrial estate in Panakan.

It is recommended that a commercial area be established adjacent to this industrial estate, which will not only serve as the commercial center of Block II but will also provide the service of distribution/marketing of the products of the estate.

The following will be the future task to be performed in connection with the development of Panakan Area:

- An industrial survey to select optimum types of industries for locating in the industrial estate.
- The establishment of as large a buffer zone between houses and industries as possible, when determining the factory locations; should this be impossible, the distribution of light industries for insulation between houses and heavier industries.
- The early acquisition of industrial land in the inland side of Davao-Agusan Road.

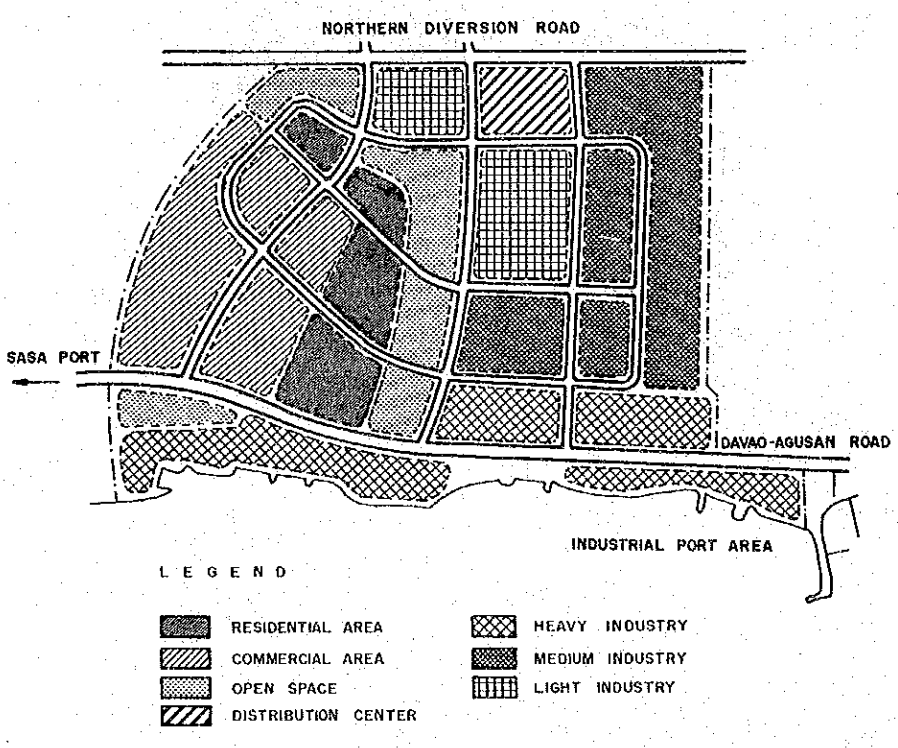


Figure 3.8 Panakan Industrial Estate Development

iv) Academic Towns

It is recommended that academic towns be developed in Tibungco and Talomo in order to accommodate the future increases in the number of students and for the purpose of developing human resources to support the future industries in Davao City. The reason why these town are to be established outside Poblacion is because the securing of needed land and the maintenance of a desirable educational environment will become difficult in Poblacion. Therefore, these towns are to be developed to accommodate the entire future increment of students.

The major components of the academic town will be colleges and various research laboratories. Ancillary facilities will include houses for the faculty members, research staff, and other employees, as well as a shopping center catering for life's daily necessities.

It is believed appropriate to characterize the academic town in Tibungco, which occurs at the midpoint between Panacan and Bunawan Industrial Estates, with specialized industrial research institutions, while that in Talomo, with political, economic, and commercial research institutions. Because the sites for these academic towns are presently totally undeveloped, therefore, it is recommended that the necessary land be acquired before development will start.

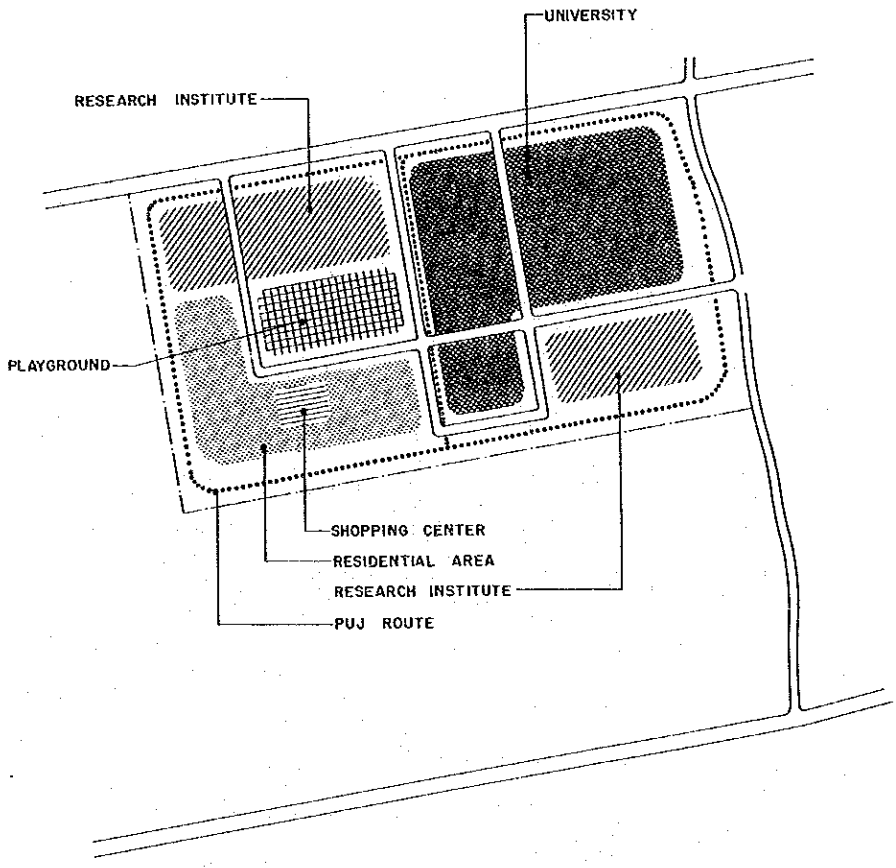


Figure 3.9 Academic Town Development

CHAPTER 4 FUTURE TRANSPORTATION DEMAND ESTIMATION

Tables and Figures

CHAPTER 4

FUTURE TRANSPORTATION DEMAND ESTIMATION

4.1 General

4.1.1 Purpose

Planning always involves the establishment of past trend and present situation, and, based on this, the forecasting of future situation. DCUTCLUS has the objectives of solving the existing transportation problems and of planning a transport system and a road/street network that will support and meet the demand created by the future socio-economic development in Davao City. This Study will make recommendations of:

(i) Road/Street Network Plan

(ii) Public Transport System Plan

(iii) Traffic Management System Plan

for the target years of 1990 (medium range plan) and 2000 (long range plan). The purpose of future forecasting is to offer, for use in the formulation of these plans, necessary and sufficient information on the travel of people and vehicles in each of the target years, as estimated based on the contemplated future land use, the predicted future socio-economic framework, and population allocation plan recommended in Chapter 3.

4.1.2 Forecasting Conditions

1) Basic Data

Data on transportation demand is basically obtained from the findings of the Person-Trip Survey conducted by the DCUTCLUS Team in 1979. This Survey, which covered only the trips of residents inside the Survey Area (residents), is supplemented by the data on the trips of residents outside the Survey Area (non-residents), as revealed through the Cordon Line Survey conducted at the same time. Person-trip survey is a typical tool of urban transportation planning, along with car O-D survey and commodity flow survey. Because it directly reveals the travel of people, the very source of trip generation, person-trip survey is capable of showing the mechanism of man's modal preference (what means of transportation would man use under what condition) and is therefore most suitable for use in the formulation of a comprehensive urban transportation plan encompassing not only road/street network plan but also public transport plan.

2) Area Subject to Estimation

The Project Area, for which the future land use plan has been established, is eight zones larger than the Person-Trip Survey Area. The same demographic indicators (population, number of persons at work, etc) predicted for the Survey Area are also predicted for the additional eight zones, and, based on these predictions, future traffic demand is estimated for the eight zones using the same techniques and same models used for the Survey Area.

3) Estimation of Cargo Vehicle Trips

The estimation of future cargo vehicle trips is accomplished separately from that of person-trips, because demographic indicators (night population), number of those at work, etc., which are useful variables to explain the behavior of person-trip) do not explain cargo vehicle trips that is to be stimulated by commodity flow, it is rather common and appropriate to use the value of GRDP, which shows the level of regional economic activities, and other economic indicators for the prediction of future level of cargo vehicle travel. Also, it is expected that cargo vehicle trips that will be generated in and attracted to the industrial estates to be developed in the future will show not only different generation/attraction pattern but also different O-D pattern from those existing. Therefore, the types of industries in each of such industrial estates have been predicted, and the future cargo vehicle transportation demand has been estimated based on commodity flow predicted in accordance with the types of industries and interrelationship between the estates.

4) Future Land Use and Transportation Demand

The future land use recommended by this Plan envisages the development of a multi-center urban complex, wherein socio-economic sphere is to be formed around the core of each block. Accordingly, it is expected that, with regard to people's travel, a transportation sphere will also be formed centering around each block core. Models which consider the formation of these sphere have been built for the estimation of transportation demand (particularly of trip distribution) in order that the estimation will be coherent with the future land use plan concept.

5) Alternative Public Transport Modes

In order to identify the major mode of public transport and its service systems most suitable to the Project Area, the following alternative plans addressing to different public transport modes have been devised, compared, and analyzed for the formulation of a Master Plan:

Alternative A: Introduction of rail-transit service

Alternative B: Introduction of bus service

Alternative C: Reliance on the existing PUJs

Different choices of the primary mode of public transport will result in different modal splits of demand. In this Study, demand sharing between car and public transport, (at large), is first obtained based on the level of public transport service, and, then, the split between various modes of public transport is estimated.

Table 4.1 Transportation Plan and Corresponding Estimation of Trip Demand

Transportation Plan \ Transportation Demand (O-D)			1979	1990		2000		
				Introduction of Bus Service	Reliance on the Existing PUJs	Introduction of Rail-Transit Service	Introduction of Bus Service	Reliance on the Existing PUJs
1979			Existing		Do Nothing Case 1990			Do Nothing Case 2000
1990 (Medium Term)				Transportation Plan in 1990				
2000 Long Term	Alternatives	Introduction of Rail-Transit Service				Alternative Case = A		
		Introduction of Bus Service					Alternative Case = B	
		Reliance on the Existing PUJs						Alternative Case = C
		Masterplan					Masterplan	

4.1.3 Process of Forecast

The so-called 4-step method (trip generation/attraction, trip distribution, modal split, and traffic assignment) – which offers a relatively simple process of estimation and affords the opportunity of checking the estimated values in visible manner at each step, and, for this reason, commonly used in urban transportation planning – is adopted for this Study. Largely, two types of modal split model are available under the 4-step method: trip-end model (modal split forecast precedes the trip distribution forecast) and trip-interchange model (modal split forecast follows trip distribution forecast). Whereas modal split characteristics and future trip distribution fluctuations by origin-destination pair are not considered under trip-end model, trip-interchange model is able to consider such elements by the use of O-D trips as an input data which was obtained in the step of distribution trip forecast. For this reason, it is advantageous the trip-interchange model is to be used as the estimation model for DCUTCLUS Study (see Figure 4.1).

4.1.4 Forecast Models

1) Application

As residents of the Survey Area will increase faster than non-residents, the ratio of non-residents trips (presently 63,000 trips/day) to total trips in the Survey Area will decline from the present 8% in the future. Therefore, in view of the small load of non-residents trips on the transportation plan as a whole, a simple growth rate method is conveniently used for the estimation of non-residents transportation demand. The forecast of residents transportation demand is to be accomplished by the use of carefully constructed forecast models explained hereunder.

Also, noting the fact that people's trip behavior is substantially affected by the purpose of the trip, models are built by the trip purposes and future demand forecast also by trip purposes.

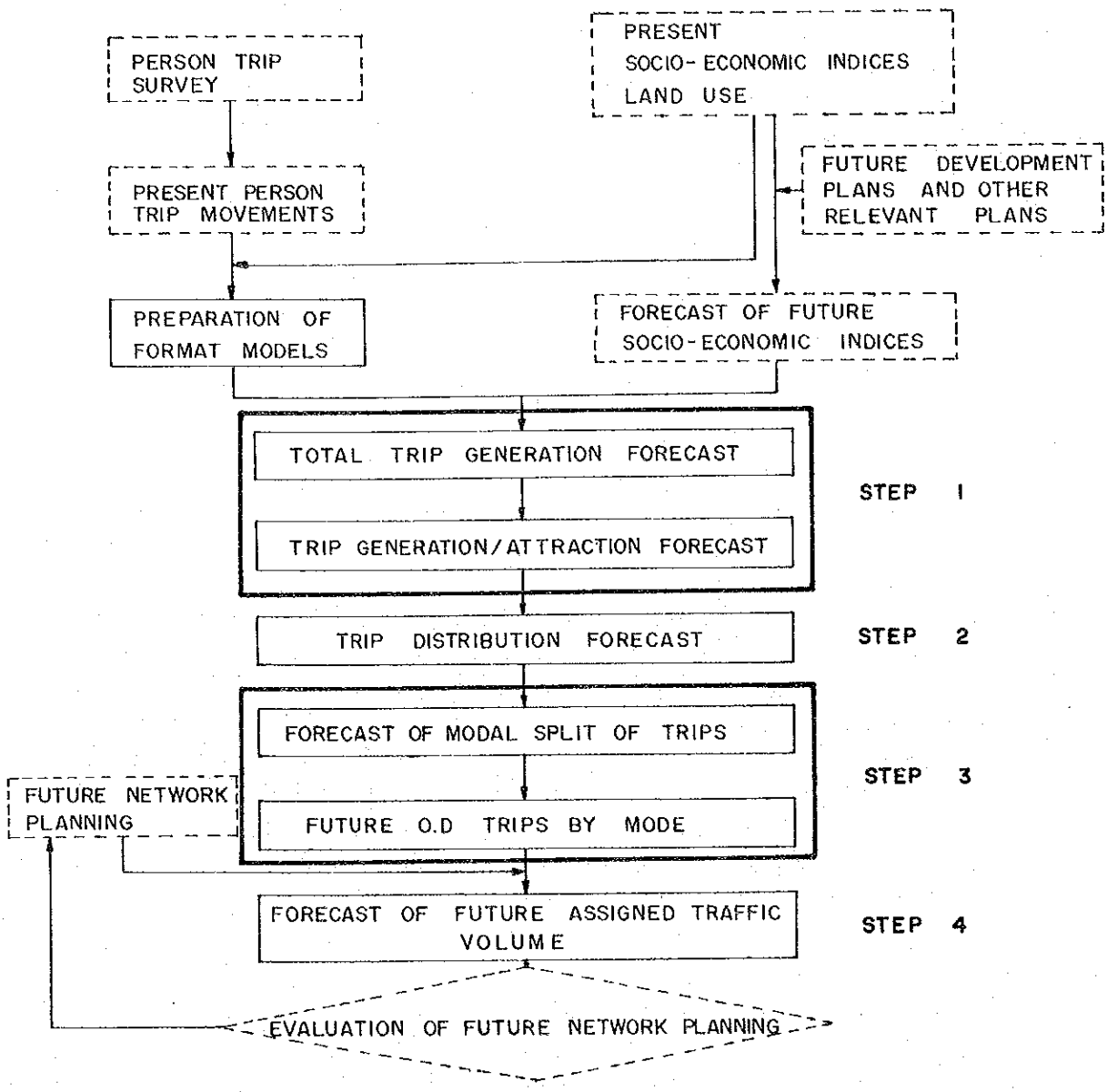
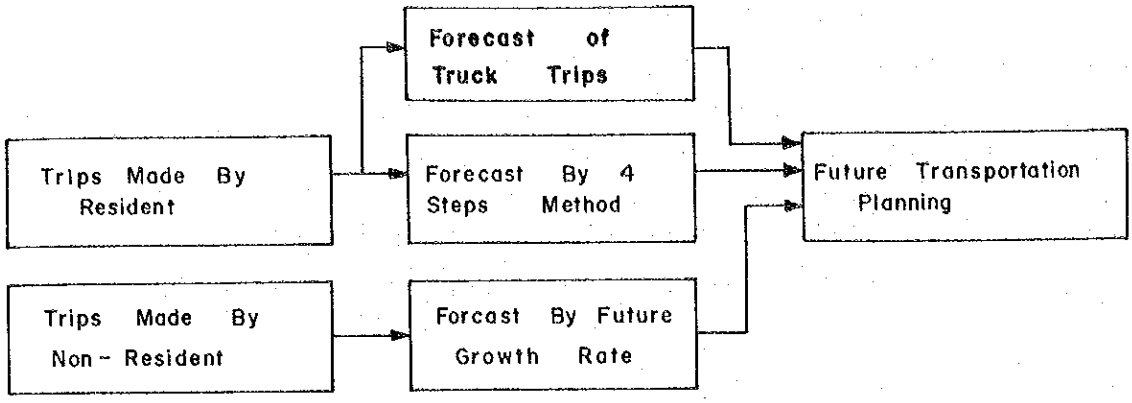


Figure 4.1 Future Traffic Volume Forecast Process



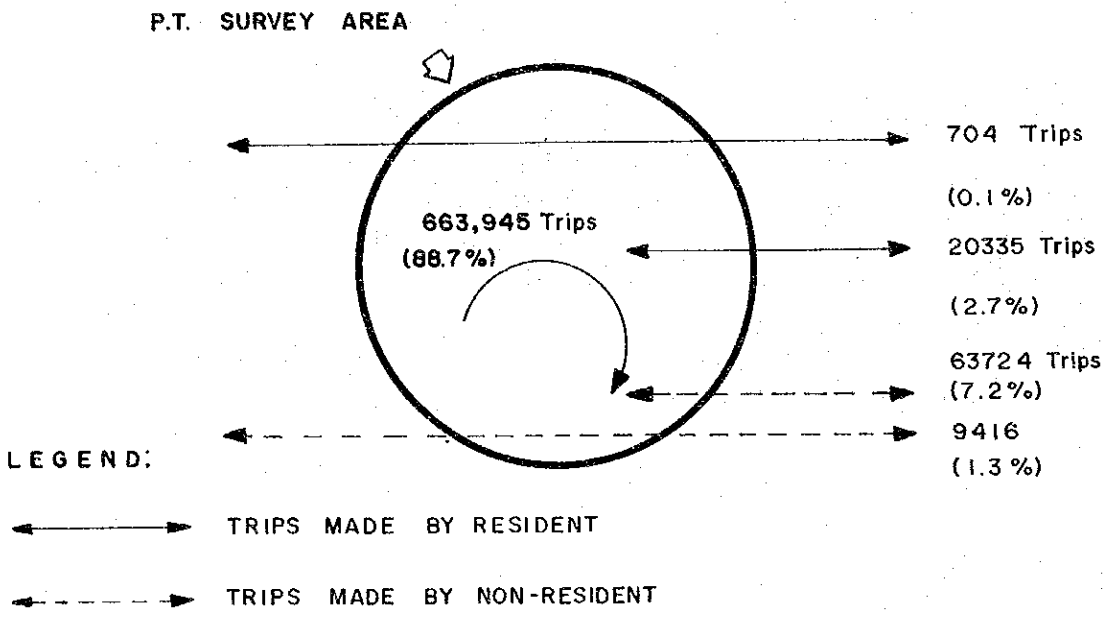


Figure 4.2 Application of Four-Steps Method

2) Trip Generation/Attraction Models (Step 1)

(1) Total Trip Generation Model (Sub-Step 1)

For the estimation of total generated trips in the Survey Area, the trip generation rate model (average number of trips per person by personal attributes), which is known to guarantee a high precision of estimates, is used. As for the personal attributes, efforts have been made to select, as much as possible:

- The attribute which shows little dispersions in the trip generation rates between zones and will show little dispersions between now and future, and
- Such attribute that population composition by attribute is expected to change substantially in the future, affecting the volume of transportation demand, and
- Such attribute that future population can be forecast by attributive differences.

(2) Trip Generation and Attraction Models (Sub-Step 2)

In this step, demand estimation is accomplished by multiple regression model, using demographic indicators as explanatory variables. Indicators with high correlations with the volumes of generated and attracted trips have been selected through analysis using correlation coefficient matrix. For instance, selected as explanatory variables of generated trips and attracted trips for commuting purpose are night population in the secondary and tertiary industrial sectors and day population in those sectors, respectively.

$$T_i = a_o + a_1X_{i1} + a_2X_{i2} + \ldots + a_mX_{im}$$

Wherein:

T_i : is trips generated in zone i (or attracted to zone i)

$x_{i1}, x_{i2}, \ldots x_{im}$: is the index value (1, 2, . . . m) of zone i

$a_o, a_1, \ldots a_m$: is invariable

3) Trip Distribution Models (Step 2)

A gravity model is used for the estimation of inter-zonal trips distribution, and aside from this model, intra-zonal model is built for the intra-zonal trips estimation. A simple forecast by growth rate is used for the estimation of external trip distribution. The gravity model is an analogy of Newton's law in natural science and assumes that inter-zonal trips are in reverse proportion to inter-zonal distance resistance. The gravity model is adjusted by access coefficient against the model's tendency to over-estimate long distance trips, so that the estimation results would be coherent with the future land use plan to form transportation spheres by blocks.

$$Xij = B_{MN} \cdot Gi \cdot \frac{Aj \cdot Tij^{-\gamma}}{\sum_{\substack{j=1 \\ (j \neq i)}}^{n} Aj \cdot Tij^{-\gamma}}$$

wherein:

Xij	:	number of trips between zones i and j
B_{MN}	:	coefficient of access which expresses the intensity of zonal linkage between blocks M and N
Gi	:	generated trips in zone i
Aj	:	attracted trips to zone j
Tij	:	distance between zones i and j
γ	:	parameter

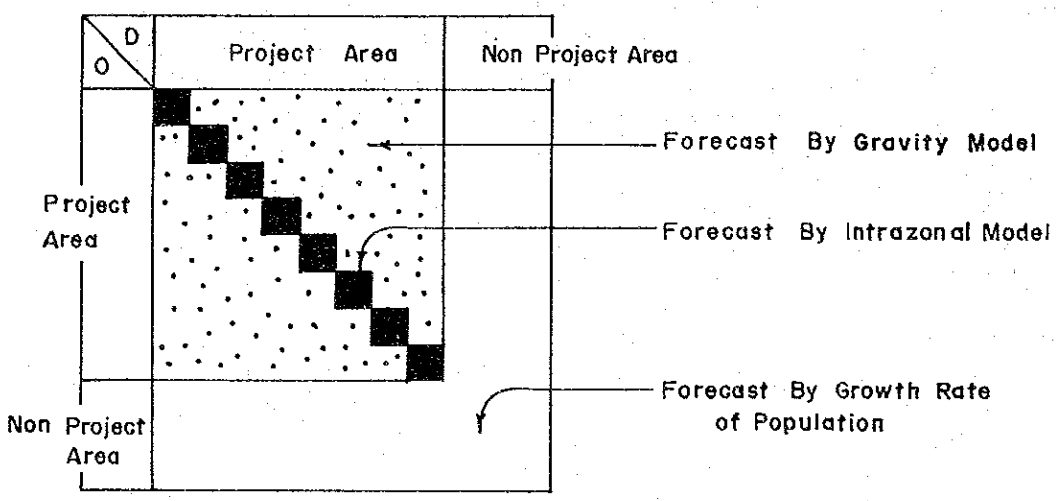
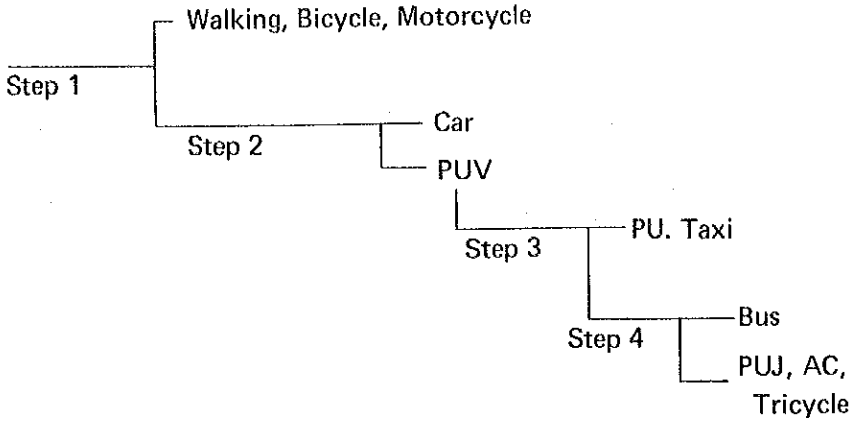


Figure 4.3 Model Sphere of Forecast

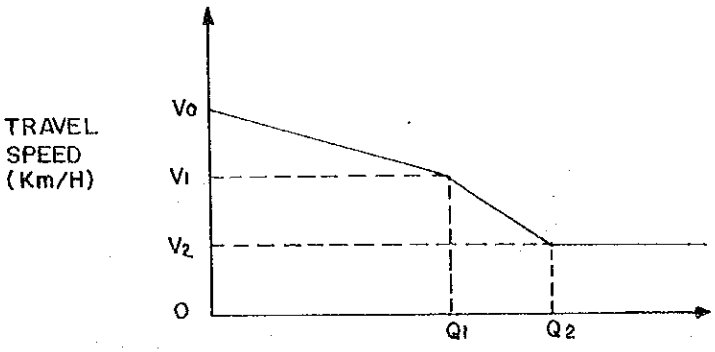
4) Modal Split Model (Step 3)

Inter-zonal trips are split into five groups of modes of travel through the sequence of binary choices, dividing the trips into two each time. First, distributed trips is divided into walking group and non-walking group by the "share-of-walking" model. Next, the non-walking group is divided into car group and public transport group. When the tree of choice illustrated below has been traced completely in this manner, the modal split of transportation demand is finally available by the five groups of travel modes.



b) Trip Assignment Model (Step 4)

The assignment of car trips to road network is accomplished by capacity restrained minimum path method, assuming the required travel time as the greatest factor for route selection. As for the capacity restraint, Q-V formula (equation to show correlation between traffic volume and vehicle speed) is prepared for each road classification, and the proper restraint is selected according to the specification of the component road of the subject network. This is the method of assignment of vehicles trips for which route is not stipulated. Bus and PUJ trips is assigned to the minimum travel time route within the planned Bus and PUJ network, without considering capacity restraint.



WHEREIN: V_o = INITIAL SPEED

V_1 = TRAVEL SPEED IN ROAD CAPACITY

V_2 = CRITICAL TRAVEL SPEED

Q_1 = ROAD CAPACITY

Q_2 = CRITICAL TRAFFIC VOLUME

Figure 4.4 Q-V Formula Pattern

4.2 Future Transportation Demand

4.2.1 Generation/Attraction Trips

(1) Total Trips in the Project Area

Total person-trips in the Project Area is estimated to increase by 2.81 times from the present 748,000 trips (685,000 by residents and 63,000 by non-residents) to 2,104,000 trips (1,957,000 by residents and 147,000 by non-residents) by the year 2000, wherein 93% of total trips will estimatedly be by residents. The transportation demand increase (2.81 times) than population increase (2.5 times) in the same period of time is believed a reasonable forecast in view of the expected industrial development and the expansion of economic activities in the project area in the future.

Also, trip generation rate is estimated to increase from the present 2.42 trips per day, which is somewhat lower than the rate shown as the result of studies in Japan, to 2.77 trips per day by 2000, which is comparable to the average level indicated by other studies.

"To home" trips and "private" trips are predicted to show, as they do now, high ratios to total trips (36% and 23%, respectively), while the number of "business" trips and "to office" trips are estimated to increase rapidly (particularly in the case of "to office" trips, by 3.5 times) from 1979 to the year 2000, due to increase in population in secondary and tertiary industrial sectors and rise in employment rate. The rise in employment rate suggests reduction in the number of housewives, which can explain the estimated decline in the rate of increase in trips for "shopping".

Traffic concentration and congestion in peak hours is one of the apparent problems in the Project Area, and peak hour transportation measures will continue to be important in the future in view that "to office", "to school", and "to home" trips will represent about high 63%, about the same as now, of total trips in the year 2000.

Table 4.2 Growth Rates in the Project Area

(unit: person trips/day)

	NUMBER OF TRIPS BY RESIDENTS			NUMBER OF TRIPS BY NON-RESIDENTS	TOTAL
	INTERNAL TRIPS	EXTERNAL TRIPS	SUB-TOTAL		
1979	664,000	21,000	685,000	63,000	748,000
1990	1,186,000 (1.79)	35,000 (1.67)	1,221,000 (1.78)	103,000 (1.63)	1,324,000 (1.77)
2000	1,902,000 (2.86)	55,000 (2.62)	1,957,000 (2.86)	147,000 (2.33)	2,104,000 (2.81)

NOTE: FIGURES IN ( ) SHOW GROWTH RATES IN EACH TARGET YEAR.

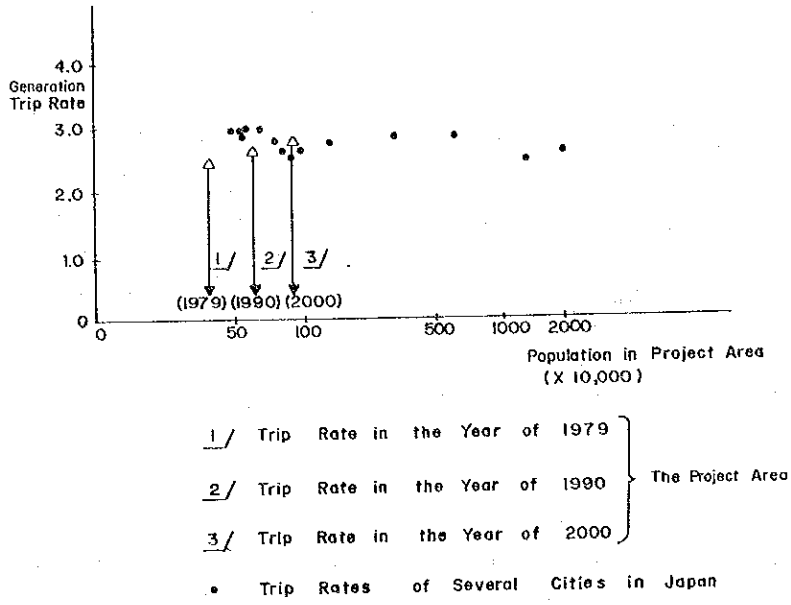


Figure 4.5 Comparison of Trip Generation Rates in other Studies

Table 4.3 Future Number of Person-Trips by Purpose

	1979		1990			2000		
	No. of Person Trips	Share of Purpose	No. of Person Trips	Growth Ratio	Share of Purpose	No. of Person Trips	Growth Ratio	Share of Purpose
OFFICE	69,536	10.2	141,000	2.03	11.5	242,000	3.48	12.4
SCHOOL	111,325	16.3	190,000	1.71	15.6	295,000	2.65	15.1
HOME	248,561	36.3	441,000	1.77	36.1	702,000	2.82	35.9
BUSINESS	61,910	9.0	117,000 1/ (3,000)	1.89	9.6 1/ (11,000)	197,000	3.18	10.1
SHOPPING	29,308	4.3	45,000	1.54	3.7	66,000	2.22	3.3
PRIVATE	163,844	23.9	287,000	1.75	23.5	456,000	2.78	23.3
TOTAL	684,984 2/ (2.42)	100.0	1,221,000 2/ (2.63)	1.78	100.0	1,957,000 2/ (2.77)	2.86	100.0

WHERE PRESENT AND FUTURE POPULATIONS ARE

<1979> 360,000
<1990> 590,000 (1.64)3/
<2000> 900,000 (2.50)3/

1/ TRUCK TRIPS GENERATED IN AND ATTRACTED TO PROPOSED INDUSTRIAL ESTATES
2/ TRIP RATE
3/ GROWTH RATE OF POPULATION

(2) Block Trip Increase

In the Project Area, population is estimated to increase by 2.5 times by the year 2000, and trips, by 2.86 times. By blocks, the highest rate of population increase of 4.75 times is in Block III (Buhangin), followed by 4.41 times in Block I (Bunawan) and 4.24 times in Block II (Panacan). As for trip increase, the greatest 6.31 times increase is predicted for Block II, which is expected to develop as an industrial area, followed by Block I and Block III, all in the Northern Project Area. Population and trip increases in Poblacion, only 1.39 times and 1.67 times, respectively, are much lower than increases in other blocks. As a result, the Poblacion's share in total trips in the Project Area will drop from the 61% in 1979 to 35% in the year 2000.

(Unit: Person Trips/Day)

	Generated Trips			Growth Rate	
	in 1979	in 1990	in 2000	1990/1979	2000/1979
Block I	39,000	85,000	228,000	2.2	5.8
Block II	46,000	129,000	288,000	2.8	6.3
Block III	34,000	105,000	178,000	3.1	5.3
Block IV	422,000	572,000	714,000	1.4	1.7
Block V	94,000	212,000	325,000	2.3	3.5
Block VI	65,000	141,000	258,000	2.2	3.9

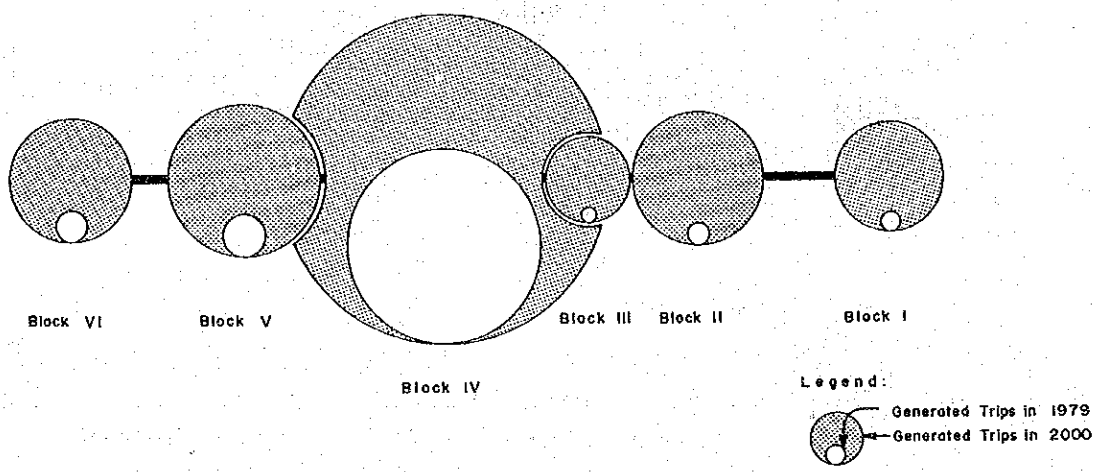


Figure 4.6 Generated Trips by Block

(3) Urban Trip Density

Poblacion shows an overwhelmingly high trip density (number of generated trips per hectare), indicating an extreme trip concentration in the area of only 2-kilometers radius from the City Hall, and traffic congestion and traffic accidents have become apparent problems. While Poblacion will continue to be the area of a high trip density, the high density area is expanding to the outskirts of Poblacion over 4-kilometer radius by the year 2000. This shows that not only the development of transportation facilities in Poblacion is an urgent task, but also Poblacion and the surrounding areas should be considered one body in the development of such facilities. Therefore, development of a ring road around such areas having a high effect of dispersing trips is required. Trip density will become heavy also in the central part of each block, and, therefore, the formation of street network will be indispensable.

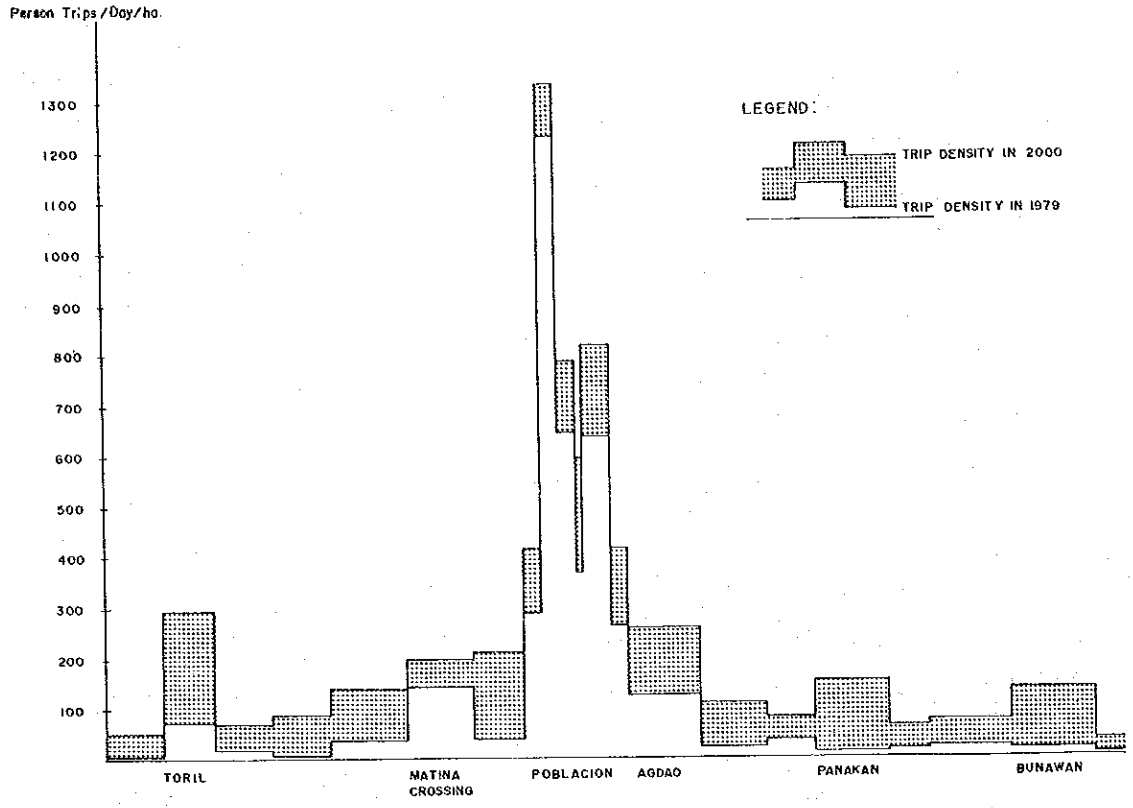


Figure 4.7 Trip Density along the Central Line in the Project Area

(4) Block Characteristics

With the average number of trips per night population (of 7 years or older) as an indicator of the level of activity, Block VI is presently highly active with the rate of 2.9 trips per person/day, while other Blocks similarly show about 1.9 trips per person/day. In the year 2000, Block IV still shows a high level of activity, even higher at 3.5 trips per person/day, while other Blocks are predicted to scatter within the range of 2.2 to 2.8 trips per person/day according to their characteristics; Block II, which will be an important industrial area in the Project Area is estimated to show the highest rate after Poblacion, while Blocks III and V are estimated to show a low level of activity, reflecting the fact that they are, to a much extent, residential areas.

Judging from trip purpose share, characteristics of each Block are as follows:

i) Block I (Bunawan)

Generated trips for the purpose of "to office" are estimated to be more than attracted trips for the same purpose. Although business area is allocated within the Block, this Block is characterized as a residential area as a whole.

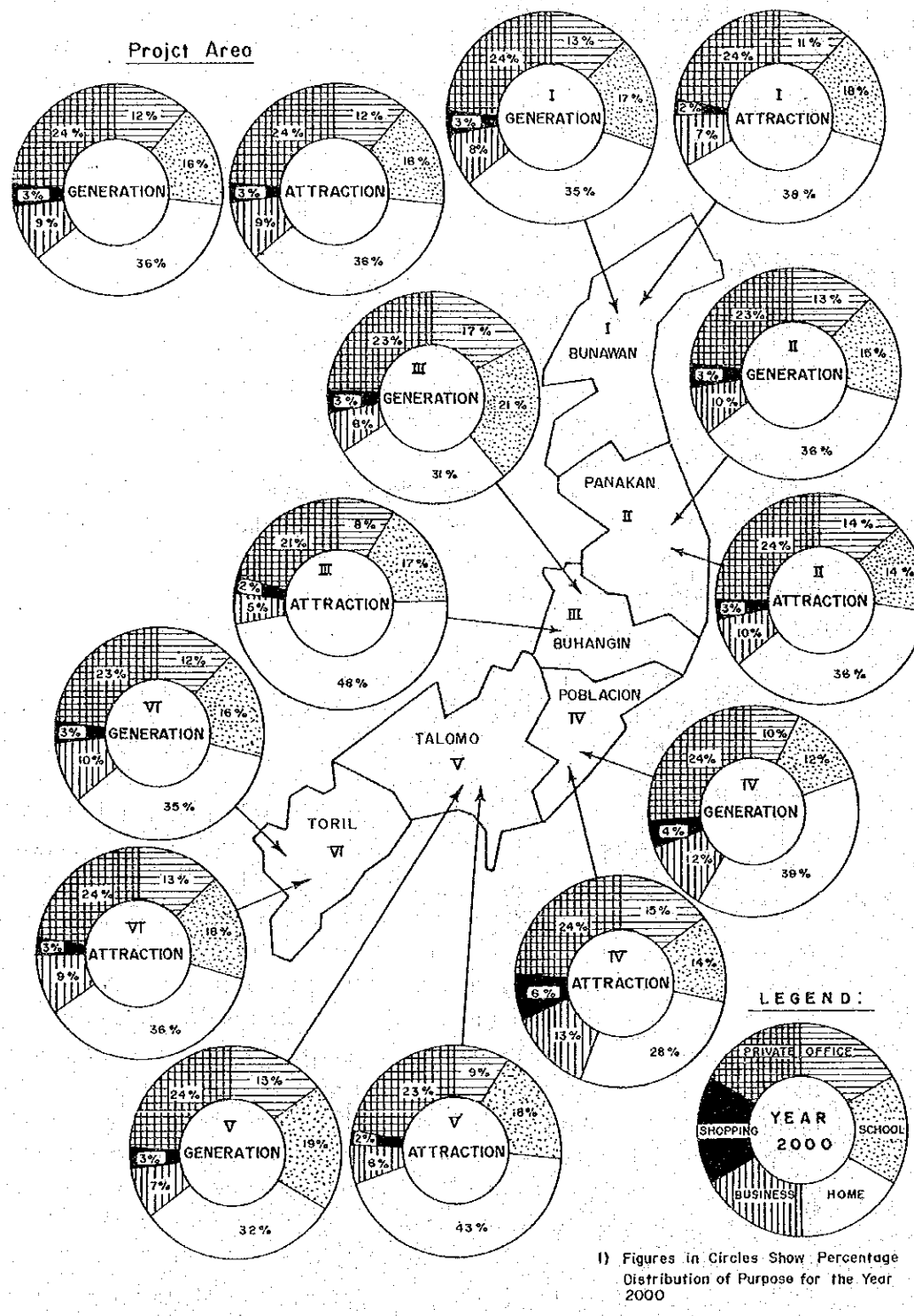
ii) Block II (Panacan)

As for trip purpose of "to office", attracted trips exceed generated trips. Share of trips for the purpose of "business" is also high. This Block

is characterized as a business area.

iii) Block III and V (Buhangin and Talomo)

Generated trips for the purposes of "to office" and "to school" have high share, while share of attracted trips for the same purpose is low. This Block is typically a residential area.



1) Figures in Circles Show Percentage Distribution of Purpose for the Year 2000

Figure 4.8 Trip Purpose Share by Block in 2000

iv) Block IV (Poblacion)

Share of attracted trips for the purposes of "to office" and "shopping" and generated/attracted trips for the purpose of "business" is high. This Block is characterized as the central business district of the Project Area.

v) Block VI (Toril)

Trip purpose share of this Block is almost the same as that of the Project Area. This Block is considered independent and is creating its own sphere of life.

4.2.2 Distributed Trips

(1) Formation of Transportation Spheres

The rate of the intra-block person-trips to the total generation in each Block is one of the important indicators of the independence of the block as a transportation sphere. In the year 2000, intra-block trips will represent about 80% of total generation in Blocks I, II, and VI, followed by about 70% in Block IV, and about 65% in Blocks III and V. The high intra-block rates shown for Blocks I, II, and VI indicate that these Blocks will function as separate transportation spheres around their centers as the core. Very much of trips will be absorbed into Block IV (Poblacion) from Blocks III and V, and these Blocks should be considered to form a transportation sphere together with Block IV, which is and will continue to be the center of the Project Area. About 73% of inter-block person-trips will be either generated or terminated in Poblacion, indicating that a large sphere will be formed centering around Poblacion.

(2) Inter-Block Communication

Of the total estimated 2,104,000 person-trips in the Project Area in the year 2,000, 66% will be intra-block trips, 24% inter-block, and 10%, external trips. The total inter-block trips will be 495,000 trips (3.2 times the present level). Of these, the largest 31% or 151,000 trips is travel between Blocks IV and V, followed by 17% or 82,000 trips between Blocks IV and III, and 13% or 62,000 trips between Blocks IV and II. Thus, Block IV is estimated to have much communication with Block III in the north and with Block V in the south. It was already pointed out that 73% of inter-block trips will be either generated in or attracted to Block IV. After Block IV, heavy inter-block trips are estimated between Blocks I and II and between Blocks V and VI, both being just under 40,000 trips. When inter-block trips are compared against total (inter- and intra-block) trips by trip purposes, it is noted that "to office" trips represents a greater portion (20%) of inter-block trips than (12%) of total trips. This is because, while future land use plan subscribes to the bringing of the place of residence close to the place of work, Block IV, as an active business area, will attract much "to office" trips from Blocks III and V, which are becoming predominantly residential areas. Conversely, "to school" trips are a smaller portion of inter-block trips than of total trips, and this is explained by the presence of schools within each block and by the short trip nature of this purpose. Routine trips, such as between office or school and home, represent 70% of inter-block trips.

(3) Transportation Demand Increases at Major Cross Sections

A review of transportation demand (number of person-trips) at block interfaces indicates that at Cross Section 5 (Davao River Cross Section) the largest number of trips, or 280,000 trips, will flow in the year 2000, although the rate of increase in such demand is rather low. The next largest but almost comparable number of trips is indicated at Cross Section 4. The highest rate of increase in transportation demand is indicated at Cross Section 3, followed by Cross Section 2 -- both showing about 3.5 times increase. It should be pointed out that transportation demand will increase particularly in the northern part of the Project Area.

The transportation demand becomes larger as it approaches to Poblacion. With the number of trips flowing at the northern boundary of the Project Area and that at the southern boundary (about comparable to each other) as the index of 1.0, transportation demand rises to 2.0 or greater at Panacan Section in the north and at Talomo section in the south, and reaches 3.5 at both entrances to Poblacion from north and south.

(4) People's Travel Pattern

The assignment of total person-trips in the Project Area to the spider network shows that the flow pattern is relatively simple due to the geographic conditions of the Project Area: an overwhelmingly majority of traffic flow in north-south direction, and little traffic flow in east-west direction. Also, it is predicted that the volume of traffic flowing from north and that from south will remain constant up to near Block IV, after which they will suddenly swell at the respective entrances to that Block. These flow pattern characteristics clearly indicate that in Blocks I, II, and VI capacity of north-south major roads will be insufficient and that, in consideration of the geographic location of the existing road and future land use, a new major road will have to be built on the mountain side in Blocks I and II and on the seaside in Block VI, while large-capacity major streets will have to be built at both entrances to Block IV in order to meet the rapidly increasing traffic at these points. Also, the relatively simple flow pattern extending in north-south direction indicates that a rapid public transit system with a high transport capacity, such as buses and railroad, will be more suited to this area than a public transport system with door-to-door convenience, such as PUJs.

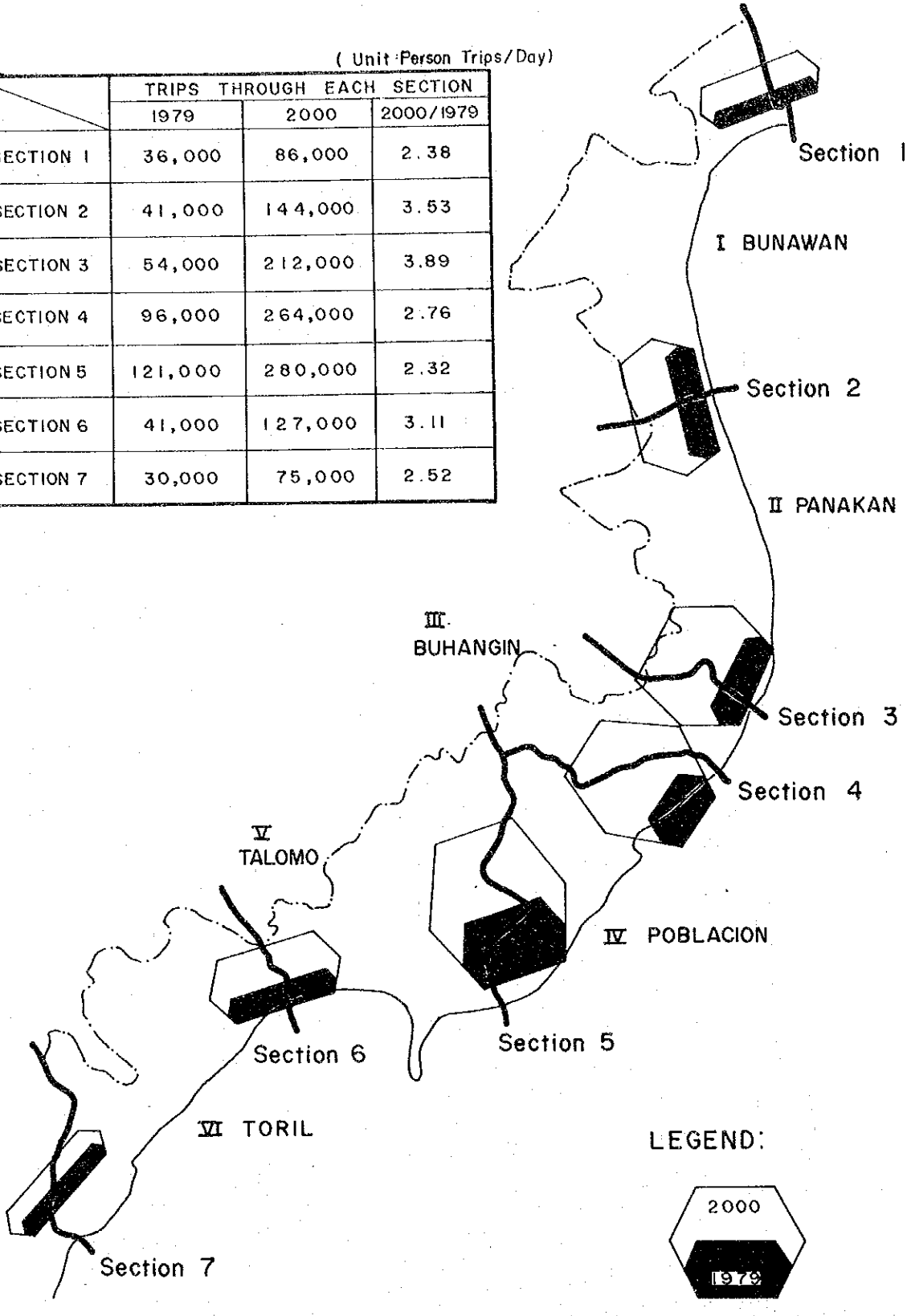
4.2.3 Modal Split

(1) Future Car Ownership Ratio

As income will continue to increase in real term, car ownership ratio (the total family members owning a car to population) in the Project Area will continue to rise from the present 8.7% and is predicted to reach 18.5%by the year 2000. This prediction assumes that income will increase by the same rate as will gross products and that the present car ownership ratio of each income class will remain unchanged in the future. The predicted value is believed right, because it about coincides with the result obtained from the extrapolation of past increase trends of the ratio up to the year 2000 and is in line with the relationship bet-

(Unit :Person Trips/Day)

	TRIPS THROUGH EACH SECTION		
	1979	2000	2000/1979
SECTION 1	36,000	86,000	2.38
SECTION 2	41,000	144,000	3.53
SECTION 3	54,000	212,000	3.89
SECTION 4	96,000	264,000	2.76
SECTION 5	121,000	280,000	2.32
SECTION 6	41,000	127,000	3.11
SECTION 7	30,000	75,000	2.52



Inner Box shows Trips for the year 1979
Outer Box shows Trips for the year 2000

Figure 4.9 Number of Person Trips through Each Section

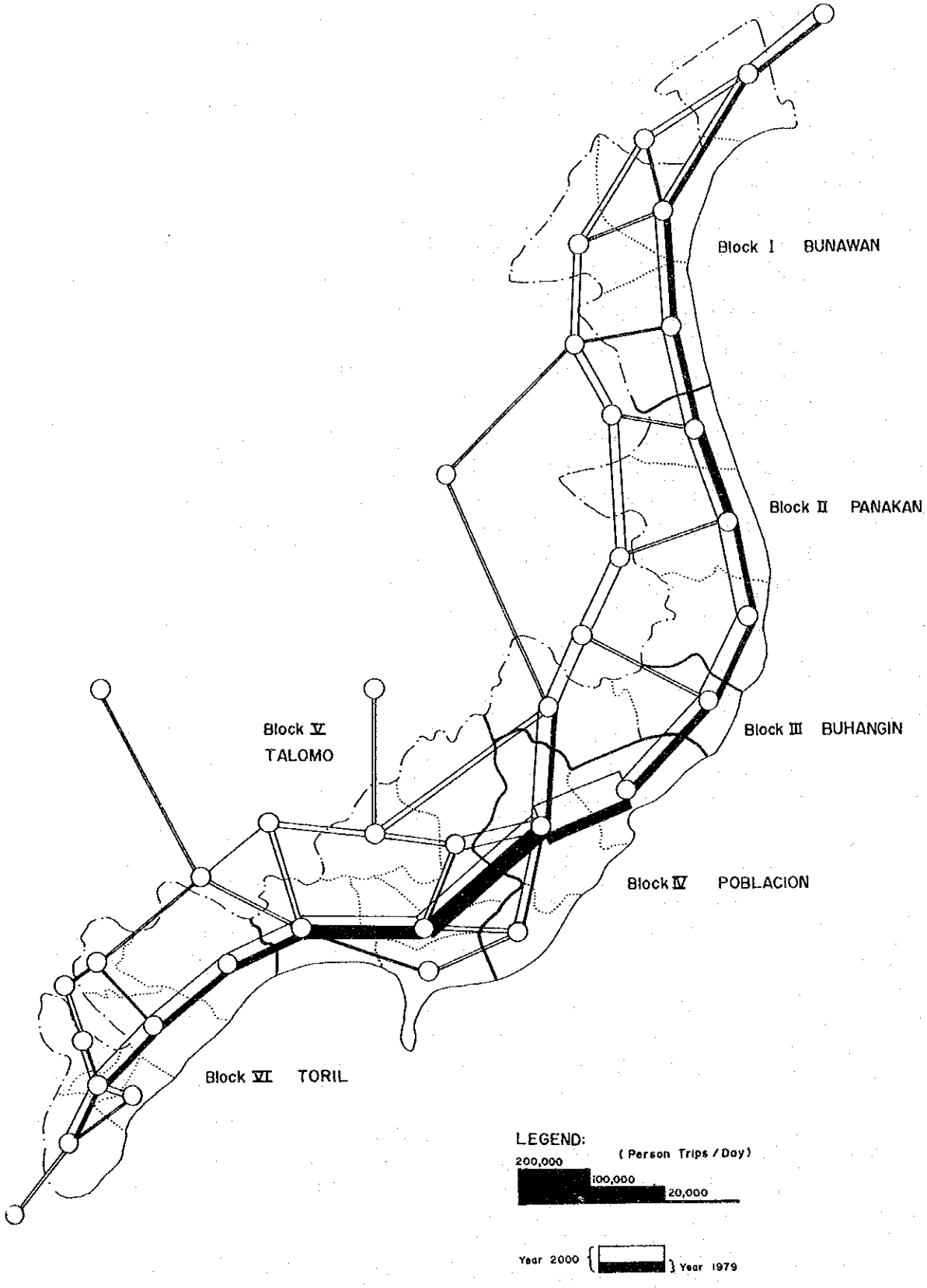


Figure 4.10 Person Trips Flow on Spider Network

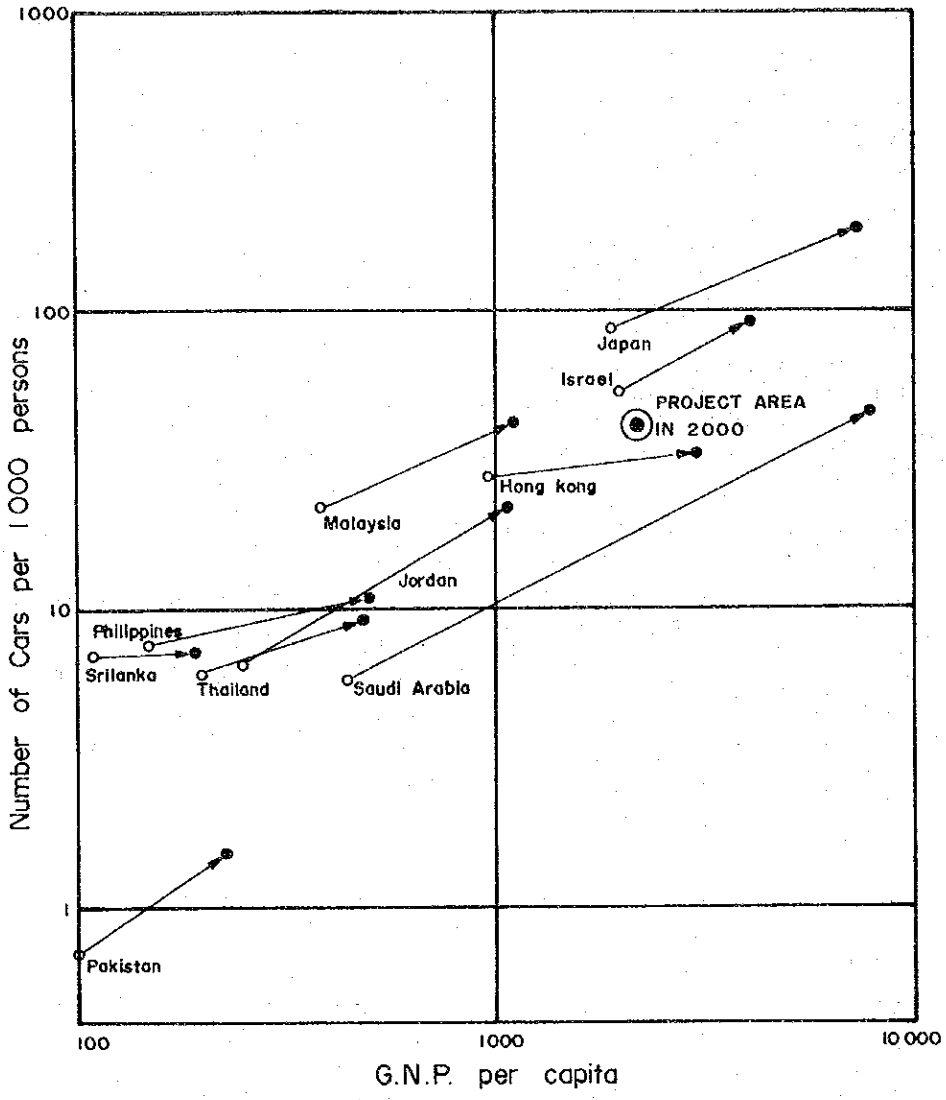
ween car ownership ratio and GNP observed in other Asian countries.

Car ownership ratio tends to be high in residential areas and in business areas, as revealed by Person-Trip Survey. This trend is believed to continue in the Future, and estimated car ownership ratio is high in Block III (22%) and Block V (21%), followed by Block IV (18%).

(2) Future Modal Split

The current modal split between walking group (walking, bicycle, and motorcycle), car group (car and cargo vehicle), and PUV group of 39%, 17%, and 44% is estimated to shift to 39%, 21%, and 40% by the year 2000, for a 4% point increase in the share of car group and a 4% point decrease in the share of PUV group. Accordingly, car trips is estimated to grow substantially by 3.4 times, as compared against 2.9 times increase in walking trips and 2.6 times increase in PUV trips.

Dividing the total trips into intra-block trips and inter-block trips, slightly over one-half (or 54%, to be exact) of intra-block trips is by walking, followed by PUV trips (31%) and car trips (15%). On the other hand, PUV is the main means of inter-block trips, representing a high 66% of total inter-block trips, followed by car trips (30%). While car ownership is expected to double, PUV will still be the main mode of transportation even in the year 2000.



SOURCE: World Road Statistics (1972, 1979)

NOTE: G.D.P. per capita in project area shows that in the year 2000 at 1978 price. (Unit: US$)

Figure 4.11 Car Ownership in Asian Countries

(3) Public Transport System vs. Car

As car ownership grows, the total number of car trips will inevitably increase. In the Project Area, where car ownership is still low, average number of trips per each car is presently a high 7.9 trips per day. If this average will be sustained, total number of car trips will "explode" to 4.8 times by the year 2000, when the shares of public transport and the car in person-trips will be 1:1, as compared against the present shares of 2.5: 1. Increase in car utilization of this magnitude will confuse urban transportation; it is possible that cars will flood every narrow street, and it is feared that parking space shortage, traffic accident increase, and the aggravation of living environment by cars will be brought about. It is desirable that car utilization will be held to a minimum in view of these and, also, in the interest of economy and fuel efficiency.

Recommended in the Masterplan is a series of measures to strengthen public transport system including the introduction of city buses and also establishment of exclusive bus lanes and the construction of bus terminals which support the bus system to be operated efficiently. These measures taken, average operation frequency of each car is expected to decline to about 2/3 of the present frequency, with resultant mitigation of traffic congestion by about 14% as compared with the situation when public transport system is not strengthened. This will also result in an equal or greater rate of reduction in the volume of gasoline and other fuel consumption.

Table 4.4 Modal Share of Car Dependent Case

(unit: person trips/day)

	Walk	Car /1	PUV	Total
Masterplan in 2000	777,000 (39.7)	401,000 (20.5)	779,000 (39.8)	1,957,000
Car-Dependent Case /2	777,000 (39.7)	578,000 (29.5)	602,000 (30.8)	1,957,000

Note: /1 Truck Trips are included in Car Trips

/2 In Car-Dependent Case, average number of daily Trips per Car in 2000 is assumed same as the present.

/3 Figures in ( ) show the share of modes.

4.2.4 Cargo Vehicle Trips Increase

Presently, the Person-Trip Survey indicates that cargo vehicles (trucks, pick-up trucks, and vans) are used not only for commodity conveyance, but also fairly much used for the transportation of people, such as to office, to home, and private trips. Cargo vehicle trips for the conveyance of goods average only about 7,800 vehicle-trips per day, or 29% of total cargo vehicle-trips. This is probably because pick-up trucks and vans are being used as semi-truck and semi-car.

Total cargo vehicle-trips for goods distribution will increase as production will increase and the quantity of goods to be distributed will increase in the Project Area and are predicted to reach 32,200 vehicle-trips per day, or 4.1 times the present level, in the year 2000. Of this total cargo vehicle-trips, those which will generate or terminate in the industrial estates recommended under Land Use Plan will amount to 20% of the total, or 6,300 vehicle-trips per day , most of which will generate or terminate in Bunawan or Panacan Industrial Estates which are located in the northern part of the Project Area.

Also, cargo vehicle-trips generating or terminating in these industrial estates will concentrate on Davao-Agusan Road, R. Castillo Street, and Coastal Road (between Sta. Ana Wharf and Toril), and, therefore, these roads should accordingly be given proper road structure and pavement, and its access road controlled by traffic management scheme such as "no entry of big cargo vehicles."

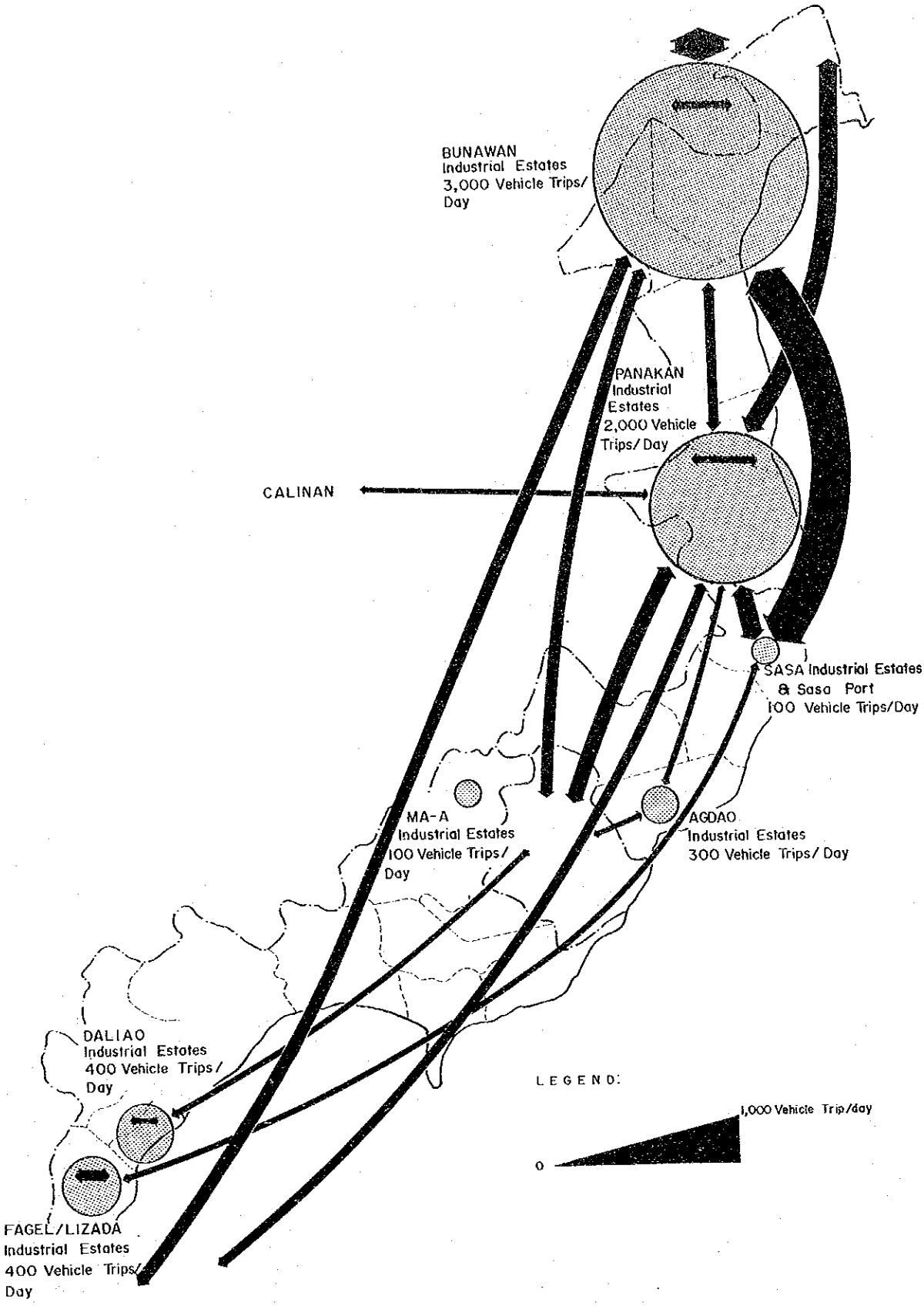


Figure 4.12 Commodity Truck Flows from Industrial Estates

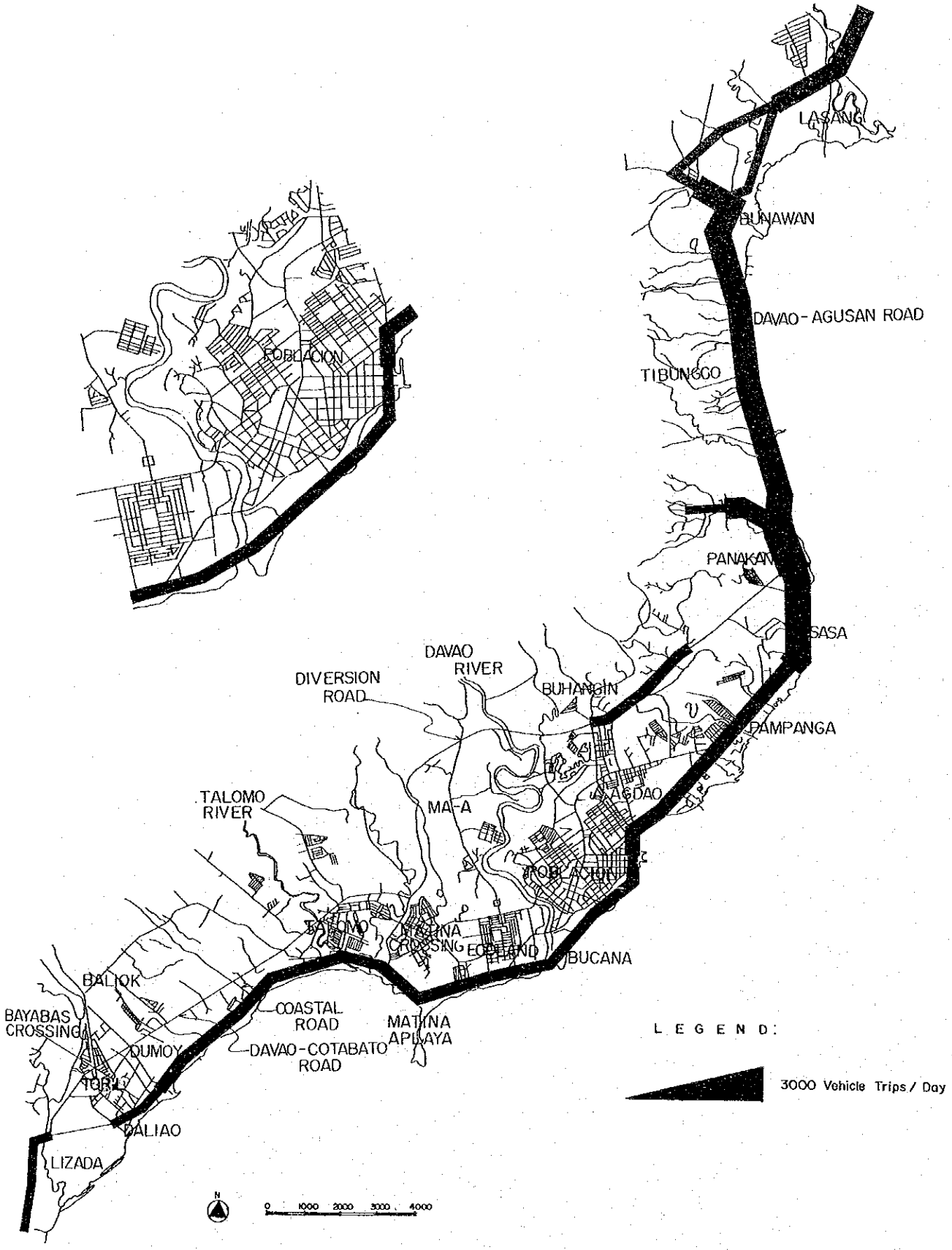


Figure 4.13 Assignment of Commodity Truck Trips Generated in and Attracted to Industrial Estates

CHAPTER 5 ALTERNATIVE PLANS: FORMULATION AND EVALUATION

Tables and Figures

CHAPTER 5

ALTERNATIVE PLANS: FORMULATION AND EVALUATION

5.1 Transportation Traffic Planning Idea

Man moves from place to place. This movement is what generates traffic. Traffic in itself is not a purpose, but is a tool for accomplishing a given purpose. As long as traffic is a tool, the guaranteeing of fast and economic movement is the necessary and sufficient condition of traffic facilities.

Nonetheless, inasmuch as traffic is — along with food, clothing, and shelter — the most fundamental and daily matter to man, the condition which urban traffic facilities are required to satisfy is not limited to the above said; they must simultaneously guarantee safe and pleasant movement to travel makers and safe and pleasant living environment to roadside inhabitants. The creation of a city attractive to both the citizens and visitors largely depend on the amenity offered by the urban traffic facilities. This must be borne in mind particularly when planning downtown streets, traffic management, and traffic terminals.

Traffic facilities are the infrastructure of commutation, business, shopping, and all other urban activities. Traffic must flow freely on road network, from the arterial to the capillary, if vigorous urban activities are to be sustained. Thus, the meeting of traffic demand generated in urban areas is the primary function of traffic system.

The secondary function is that of conducting urban growth to a greater geographical expansion — the development effect of traffic facility. Urban development is stimulated by the presence of adequate traffic facilities, or constrained by the absence. The greater the growth potential of a city, the greater the impact of traffic system on the form of its development.

That which emphasizes on the first function is demand-following investment, and that which aims to achieve the second, advance (development) investment. The implementation of the future traffic system projects of the DCUTCLUS Report, which primarily aims at the satisfaction of future traffic demand, as forecast, based on a land use plan, may, at a glance, appear as if a demand-following investment. However, because the land use plan itself presupposes the development of traffic facilities without which the forecast traffic demand will never be realized, these projects will pretty much constitute and advance investment. In project scheduling, full coordination must be maintained between traffic facility projects and urban development projects.

In advance to the formulation of a future traffic system plan, the plan purpose and the strategic plan approach will be explained.

5.1.1 Planning Target of the Masterplan

In developing the medium/long term transportation masterplan for the Project Area, the following have been set up as the basic objectives to be pursued:

(1) *Development of the Transportation Network in support of the future Socio-economic Activity*

In the next twenty years the Project Area is expected to undergo rapid

economic growth and urbanization to a great extent never experienced before. Transportation infrastructure development and realization of the land use plan must play an important role in supporting this growth. In this context, advance investment in transportation sector should be required, aiming to guide the urban development to a favorable course.

(2) *Pursuit of Convenience, Safety and Amenity*

The three elements – convenience, safety and amenity – should be the main subjects to be pursued whenever a transportation study is conducted. These targets could be accomplished basically through the development of facilities which can cope with the future traffic demand. Some measures of traffic management will be effective also to traffic safety maintenance and environmental conservation. In addition to traffic safety, the security of urban transportation function should be maintained. From this point of view, the formation of a stable and reliable transportation network should be planned, in which every origin-destination trip could have more than two routes to cope within an emergency case.

(3) *Formation of Plan capable of further Development*

The target year of this study is the end of this century, but urban growth, of course, will continue beyond the year 2000, and therefore, the traffic demand will also increase continuously. Taking this fact into account, masterplan should be designed to give ways for further development at the time new requirements come about.

(4) *Formation of realizable Plan*

The masterplan should be prepared as a guideline for future transportation investment and policy measures to be adopted. The masterplan, which could be an ideal goal in the future, should not be a mere impractical or imaginative theory. In order to make the plan realizable, sufficient study should be required not only on the efficiency and economic viability of the plan as a whole, but on the required investment and feasibility of main projects as well.

5.1.2 Development Strategies for Transportation System

The following strategies are to be highlighted to accomplish the aforementioned objectives. The validity and efficiency of the plan will be examined through the evaluation of alternative plans and discussion on the feasibility of main projects.

(1) *Harmonization with the Urban Development Pattern*

For the future urbanization of the Project Area, multi-center development pattern has been recommended, in which the Project Area is divided into six blocks, in each of which, socio-economic needs can be satisfied to some extent. Consequently, future traffic demand in the Project Area can be classified into two categories; one is inter-block trips with medium or long trip lengths and the other is intra-block trips with rather short trip lengths. This must be taken into consideration in planning future public transportation service and facilities.

(2) *Effective Utilization of Transportation Infrastructure*

Generally, a huge amount of investment will be required to develop transpor-

tation infrastructure such as roads, bridges and terminals, so newly developed facilities as well as existing ones should be used with the greatest efficiency. From this point, the introduction of larger-capacity PUVs could be suggested.

(3) *Formation of Project Packages*

When making a development schedule, special attention should be given to the inter-relationship between projects; some project may be inclusive of or supportive to another and one project may need to be implemented prior to another. Based on the study of these interrelationship, project packages will be consolidated. To develop the project packages, especially important is the combination of "hardware" projects such as construction or improvement of facilities with "software" projects such as the management and operation of these facilities.

(4) *Coping with further Motorization and Fosteration of Public Transportation Service*

The present car ownership ratio is still low in the Project Area, but in the future, fairly rapid motorization can be expected to advance, reflecting the past trend of vehicle increase and the rise of income-level. In such situation, not only traffic volume will increase, but also parking problems will become more serious in the central part of the City. Greatest effort should be continued to expand the current parking capacity both in the public and private sector. More essentially, however, shifting of passengers from car to PUV should be promoted by upgrading the PUV service level. In other words, one of the basic strategies to realize an efficient public transportation service in that urban activities could function without private cars. In order to accomplish this, it is essential to foster the privately operated PUV service.

(5) *Reinforcement of Administrative Institution in Transportation Sector*

The traffic issues will become more complicated and more serious, and will require multi-disciplinary approach to solve more than ever. To tackle these difficulties, it is inevitably necessary to promote a strong organization which could function effectively in making surveys, planning and implementation of all the required measures, from the user, operator and administrator's viewpoint. This institutional arrangement should be recommended strongly.

5.1.3 Planning Approach

The steps and procedures in formulating the masterplan are as follows, and as shown in Fig. 5.1.

Step 1 : Based on the information given in the previous chapter, several alternative transportation policies are set up. These policies are expected to exert a big influence upon the future network plan.

Step 2 : Next step is to make alternative network plans to cope with alternative policies. Each plan will correspond to one policy.

Step 3 : The amount of investment required to each alternative plan will be estimated.

Step 4 : Comparative evaluation of the alternative plans is to be done through

the examination of traffic volume, travelling speed and volume/capacity ratio of each link, using the result of traffic assignment.

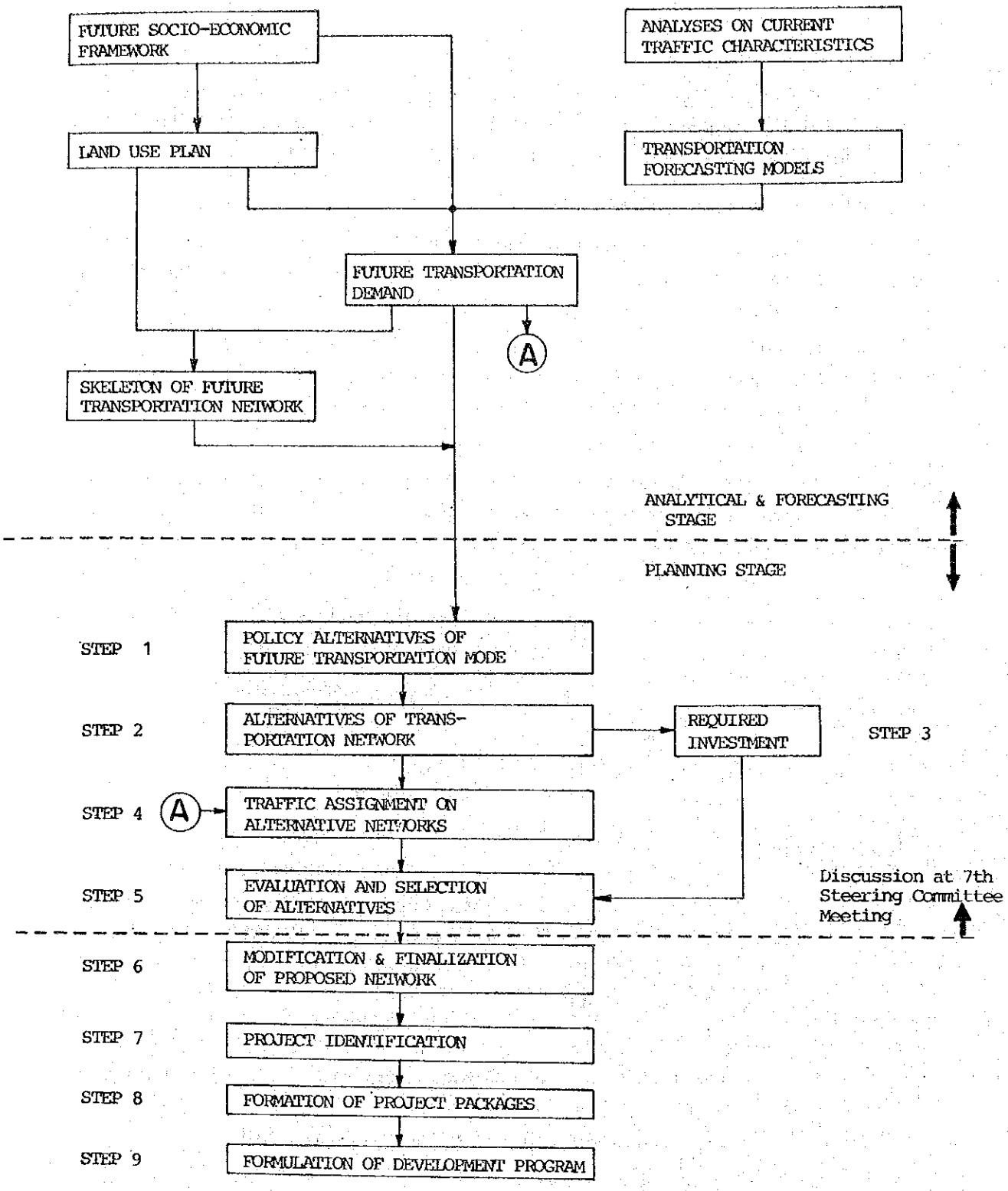
Step 5: Economic evaluation will be made by comparing the efficiency levels and required investments of alternative plans. Together with the result of Step 4, overall evaluation and identification of the most advantageous alternative will be achieved.

Step 6 : After a reexamination of assigned traffic volume of the selected alternative, it will be modified, if necessary, into the final masterplan.

Step 7 : Development projects of transportation facilities and traffic management will be identified and compiled based on the masterplan.

Step 8 : Project packages are composed through the study of inter-relationship among projects.

Step 9 : Implementation schedule of each project will be set, taking into consideration the possibility of realization of the regional development projects, the importance and urgency of the project based on the future traffic volume and possible amount of investment, and thus, finally investment program will be formulated.



SOURCE: DOUTCLUS TEAM

Figure 5.1 Formulation Procedure of Long-Term Transportation Masterplan for the Project Area

5.2 Planning Conditions

In the formulation of alternative transportation plans, planning conditions are identified from three aspects: 1) transportation projects recommended by various existing plans and programs for or relating to Davao City; 2) traffic problems anticipated in the future; and 3) amount of available public investment funds.

5.2.1 Existing Transportation Projects

Various plans and programs for or related to Davao City, whose contents are outlined in 3.1 above and will not be repeated here, recommends the following transportation projects:

(1) Comprehensive Development Plan of Davao City, 1979-2000

Recommendations are made for each of roads and bridges, land transportation, air transportation, and sea transportation sectors.

i) Roads and Bridges

The following road network development projects are recommended to focus mainly on securing of access to rural areas in order to improve living environment of rural inhabitants, and to stimulate agricultural development:

- The formation of road network based on the hierarchy of road functions
- Development of inter-District roads to stimulate regional development
  - Upgrading of Buhangin Road
  - Construction of road to connect Calinan-Callawa Road and Bongan-Bunawan Road
  - Calinan-Arakan link road upgrading
  - Extension of Diversion Road up to Toril
  - Construction of Mintal-Eden-Bayabas-Sirawan Road
  - Construction of Dominga-Callawa and Bongan-San Isidro Roads

City roads are to be constructed or upgraded by 63 porject components and barangay roads by 167 project elements for a total cost of 99 million pesos, with the City Engineer's Office as the implementing agency.

ii) Land Transportation

Following recommendations are made, but no project is proposed:

- The introduction of efficient inter-city and intra-city transportation system
- The adoption of an efficient traffic management plan
- Quality improvement of roads and bridges particularly with a heavy traffic
- Extension of land transportation service to rural areas.

iii) Air Transportation

Recommended is the improvement of F. Bangoy International Airport facilities and service to international level.

iv) Sea Transportation

For the development of port and harbor facilities which will be able to meet the future sea transportation demand recommendations are made for the development of Sasa Wharf and Sta. Ana Pier with a total cost of 23.2 million pesos and with the Philippine Port Authority as the implementing agency and the provision of incentives to private capitals for investment in port and harbor facilities.

(2) Davao City Integral Area Development Plan

This Plan makes the following recommendations in the area of Transportation:

- The construction of Calinan-Panacan Road to improve access from Calinan to Sasa Wharf or Sta. Ana Pier so as to promote agricultural product processing industries in Calinan
- Expansion of Sasa Wharf, Sta. Ana Pier, and F. Bangoy Airport
- Establishment of bus terminals in areas adjacent to Poblacion (Buhangin and Matina in mind)
- Implementation of traffic management study to eliminate traffic bottlenecks

(3) Regional Cities Development Project (RCDP)

RCDP addresses to both the transportation and urban problems, and makes recommendations of short term projects that can be implemented by 1985. RCDP study and DCUTCLUS were accomplished about the same time with close coordination to maintain their coherence. Some of short term transportation projects recommended by DCUTCLUS will be implemented under RCDP.

(4) Davao Gulf Masterplan Study

Davao Gulf ports are estimated to handle 650,000 passengers and 10.6 million tons of cargo in the year 2000. Recommendations pertaining to the facilities of Sasa Wharf and Sta. Ana Pier include the port facility development for a total cost of 68.5 million pesos by 1985, the relocation of Davao-Agusan Road, which is now located close to the port, away from the port toward F. Bangoy Airport in order to expand port site, and the construction of pier and the improvement/expansion of facilities of Sta. Ana Pier which will be used mainly as a passenger terminal, with a total cost of 8.6 million pesos by 1983. Recommendation pertaining to the new port is to construct a quay with seven berths and related facilities at a location about 21 kilometers north of Sasa Wharf (outside the DCUTCLUS Project Area) by the year 2000. In the First Phase (1989-1990), 3 or 4 berths are to be constructed for a cost of 314.6 million pesos and in the Second Phase (1997-2000), the remaining 3 or 4, for a cost of 346.5 million pesos, the total cost being 661.1 million pesos.

5.2.2 Predicted Future Transport Problems

The prediction of the kinds and characteristics of future transport problems when the transport demand discussed in Chapter 4 will be realized, will offer a very useful

information for the formulation of a future road network. The future transport problems that must be expected when nothing is done to expand or improve the existing road network (hereinafter referred to as the "do nothing case") are predicted through the assignment of the future demand onto the present road network. Here, it is assumed that the PUJ will still be playing the role of primary public transport mode under the existing PUV service trend pattern.

Future transport demand changes as well as the result of analysis based on the "do nothing case", will be explained hereunder:

(1) Transportation Demand Fluctuation

Transportation demand will increase by 2.9 times from the total 680,000 person trips per day of the present to 1,960,000 person trips per day in the year 2000. This comparison is translated into a spider network of Figure 4.10, which reveals the following features: presently almost all of urban facilities in the City are concentrated in Poblacion and land uses are distributed in the shape of a line along the shore, whereas, in the year 2000, six basically independent blocks will have been formed around urban cores and the urbanized space will have been expanded to the shape of a belt. Thus transportation demand pattern will also change from the present "thin blade" extending from Poblacion toward north and south to a "broad belt" running parallel to the shore line, in reflection of land use plan.

Of the six blocks to be formed in the Project Area, Block IV (See Figure 4.6), which will encompass Poblacion and Ecoland, will still be the central core of the Area. Transportation demand in and around Block IV is graphically presented by the diagram of Figure which shows that more trips – about 45% of the total trip generation and attraction – will flow into this Block from outside. Also, it is characterized that transportation demand between Poblacion and Talomo is biggest on inter-block trips (See Figure 5.2).

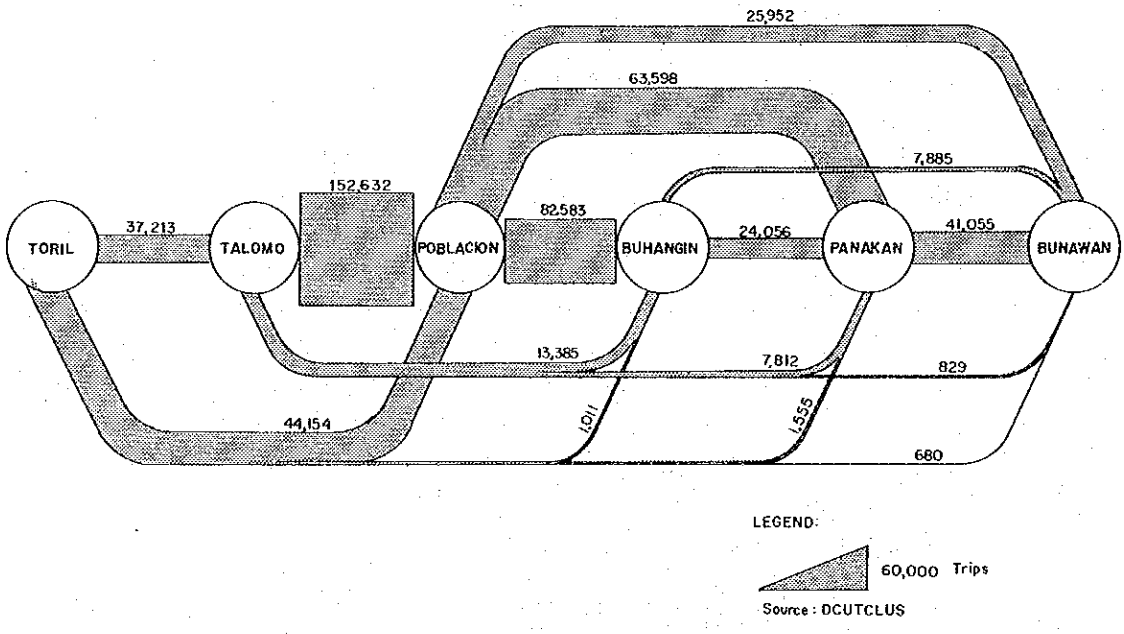


Figure 5.2 Trip Desire Line by Block

(2) Road Demand-Supply

Assigned traffic volume and congestion ratio (traffic volume/capacity) at major cross sections in the "do nothing case" are compared with present values in Figure 5.3, which shows that predicted traffic volume will increase by three to five times at each of these cross sections. As the only available north-south major road, traffic will concentrate and congestion ratio will become three to five on Davao-Agusan/Davao-Cotabato Road. On most of this route, traffic volume currently approaches the road capacity and, particularly in and around Poblacion, traffic jam is being experienced.

Compared in Figure 5.4 are road capacity and traffic demand at major cross sections; the hatched portion corresponds to traffic volume, in excess of the road capacity. Traffic demand is estimated to gradually increase toward Poblacion and reach 115,000 PCU/day at Cross Section 7 and 104,000 PCU/day at Cross Section 8, which will far greater than the present (or "do nothing" road capacity). The comparison between traffic demand and road capacity is translated into congestion ratios, presented in Figure 5.5 . Although traffic demand will be very high, congestion ratio will remain at about 3.0 in Poblacion and the vicinity, where the accumulation of road facilities is relatively high. In Panacan and Talomo areas, which are served by a single route, congestion ratio will reach 5.0 in some road sections.

If the forecast level of demand will be realized, traffic congestion will result on almost all of the roads. It is therefore, concluded that, if the construction and the upgrading road facilities is neglected, traffic environment will be seriously deteriorated and urban functions paralyzed.

(3) Necessary Road Facilities

The volume of additional road facilities which must be newly constructed in order to meet the all of excess future traffic demand is roughly estimated, disregarding measures to increase the efficiency of existing road use, such as the introduction of large-capacity public transport (buses, rail transit) and new traffic management systems (one-way traffic, exclusive bus lane, prohibition of roadside parking).

The needed road facilities, thus estimated, are expressed in terms of the number of carriageway lanes (assuming 10,000 PCU/day per lane) in Table 5.1.

i) Northern Area (Cross Sections 1 through 6)

Congestion ratio reaches 3.0 to 4.0 in Bunawan and Tibungco, north of Poblacion, and traffic volume (ADT) increases toward Poblacion and reaches about 70,000 PCU/day in the vicinity of Cross Section 6. In view that the existing 2- to 4-lane roads have the capacity of only 11,000 to 24,000 PCU/day, it is necessary that additional 4- to 6-lane be constructed.

ii) Poblacion and the Vicinity (Cross Sections 7 and 8)

Traffic volume reaches the maximum of 140,000 PCU/day in the central part of Poblacion. Even at the entrances to Poblacion, the volume exceeds 100,000 PCU/day. Therefore, the existing 6-lane capacity must be more than doubled by the construction of additional eight lanes.

iii) Southern Area (Cross Sections 9 through 12)

As in the Northern Area (Cross Sections 1 through 6), traffic volume gradually

increases toward Poblacion and reaches about 70,000 PCU/day, while congestion ratio will be 3.0 to 5.0 as estimated. In the south of Toril, additional 2-lane capacity will be sufficient. As for Cross Section 9 and 10, additional 6-lane capacity will be necessary in order to serve traffic from both Toril and Calinan.

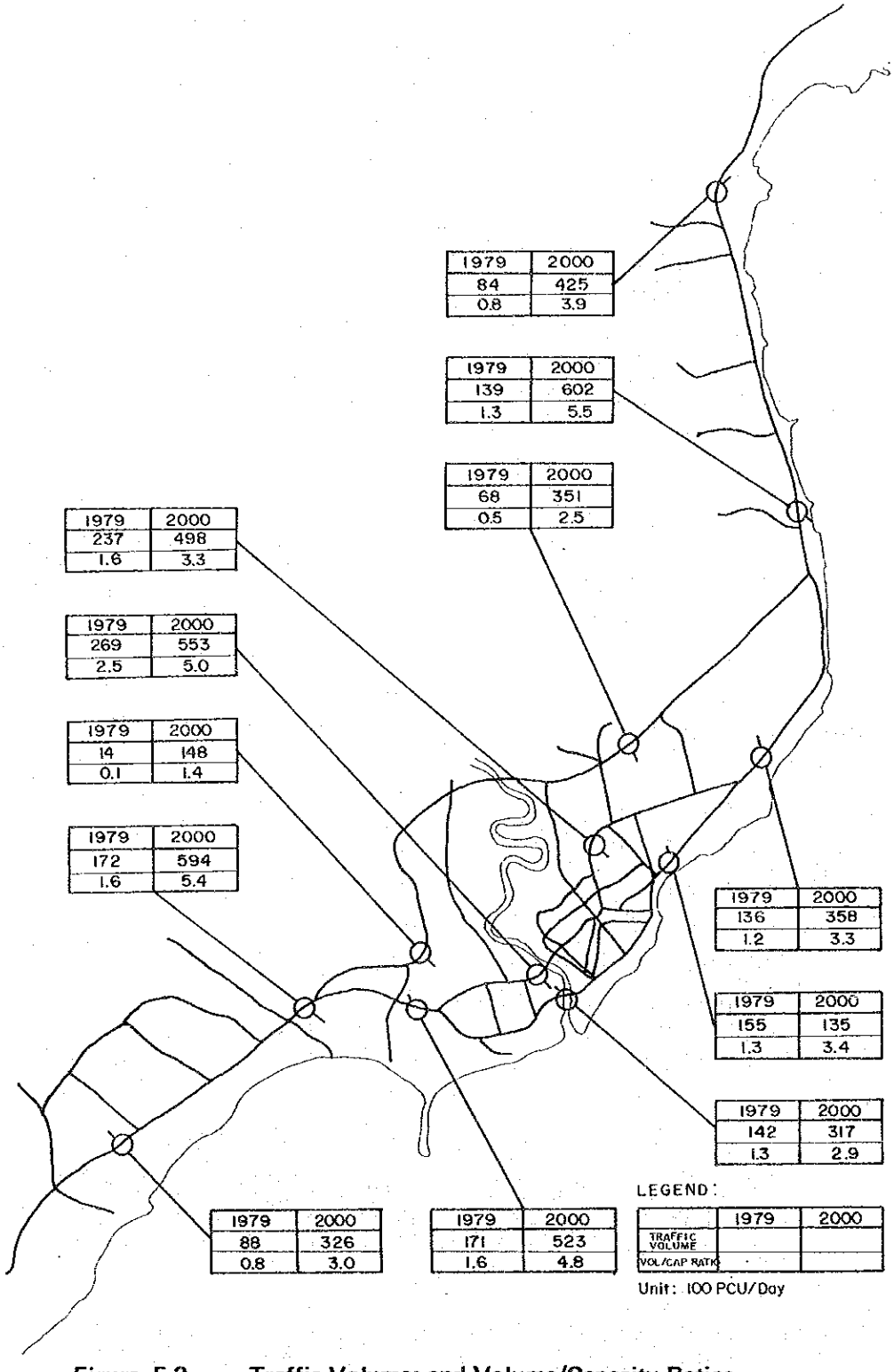


Figure 5.3 Traffic Volumes and Volume/Capacity Ratios

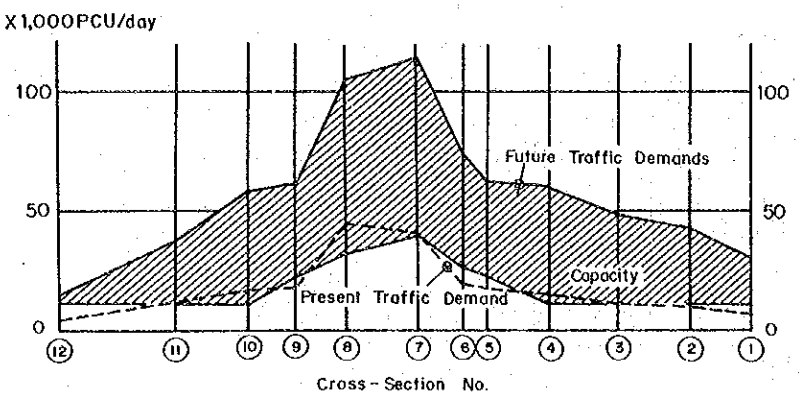


Figure 5.4 Traffic Demand and Road Capacity

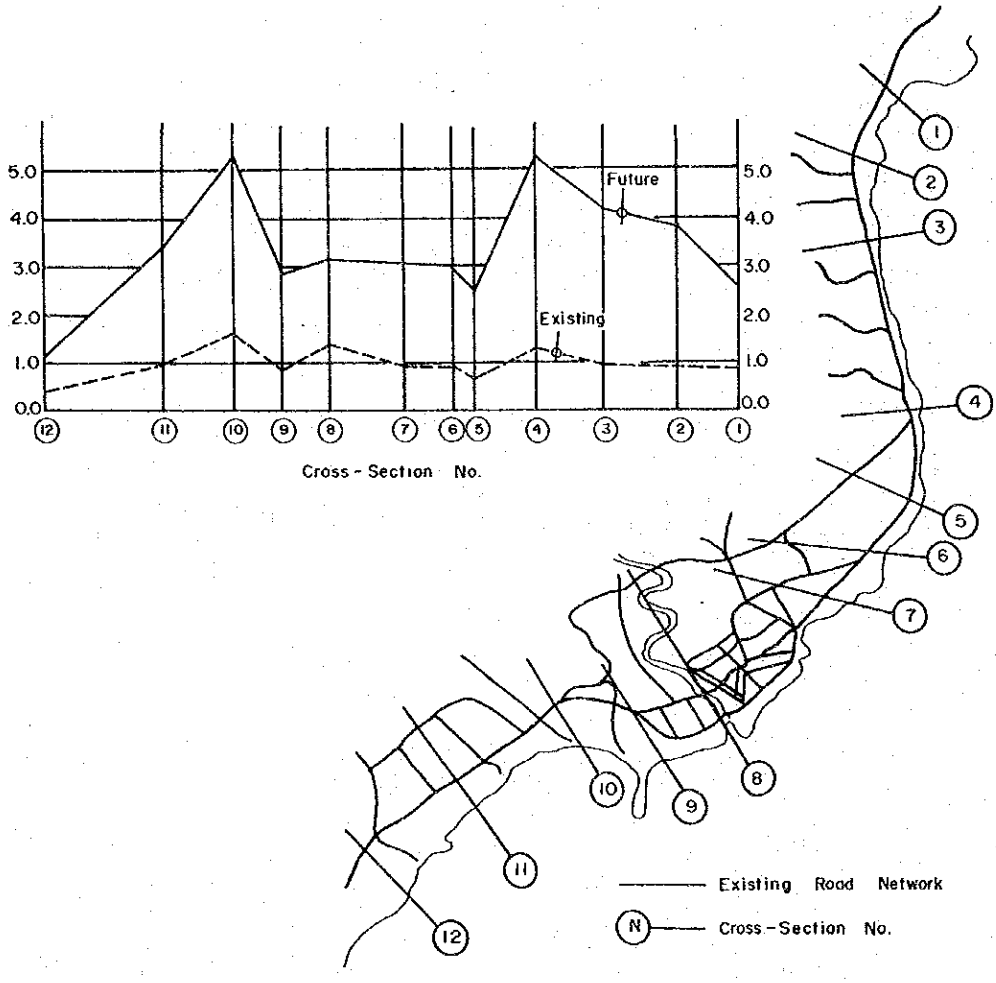


Figure 5.5 Traffic Congestion of Major Cross-Section

Table 5.1 Required Road Construction at Major Cross Sections

Cross-Section[1]	Present Road Capacity (100 PCU/day)	1979		2000		Excess volume of Traffic (100 PCU)	Additional Number of lanes Required	Existing Lanes
		Present ADT (100 PCU)	Volume/Capacity Ratio	Future ADT (100 PCU)	Volume/Capacity Ratio			
1	110	84	0.8	300	2.7	190[2]	4	2
2	110	103	0.9	425	3.9	315	4	2
3	110	110	1.0	471	4.3	361	4	2
4	110	139	1.3	602	5.5	492	6	2
5	240	178	0.7	609	2.5	369	4	4
6	240	204	0.9	689	2.9	449	6	4
7	390	400	1.0	1,152	3.0	762	8	6
8	330	431	1.3	1,042	3.2	713	8	6
9	220	185	0.8	671	3.1	451	6	4
10	110	171	1.6	594	5.4	484	6	2
11	110	101	0.9	374	3.4	265	4	2
12	110	41	0.4	137	1.2	27	2	2

1/ : Cross-Section No. Corresponds to Fig. 5.5.

2/ : Excess Volume of Traffic = Total Traffic Volume – Existing Road Capacity

5.2.3 Public Investment Fund

Whether a plan is realistic or not largely depends on the availability of investment fund. Therefore, in order to obtain a criterion for determining the amount of project investment fund and investment schedule, the amount of public investment funds which will become available is estimated (see Appendix for details of calculation), assuming:

- That the amount of public investment fund is 6% of GNP in the year 2000
- That Mindanao has a 25% share in public investment fund
- That Region XI has a 38% share in Mindanao's share of public investment fund (based on the 38% share of Region XI in the All-Mindanao GRDP increases in 1981-2000)
- That land transportation sector will enjoy 30% of public investment fund.
- That GNP in the year 2000 will be:
  - 474 billion pesos (1972 prices; per Long-Term Development Plan 2000), or
  - 374 billion pesos (1972 pricess: per NEDA Revised Estimate)
- That average public investment fund per each of Davao population will be:
  - Same as the average of Region XI, or
  - 20% higher than Region XI average
- That the share of the Project Area in Davao City will be:
  - by population ratio, or
  - by GRDP ratio

The amount of public investment funds which will be available as estimated under these conditions, is presented in Table 5.2. Here, the cost of repair and maintenance of the existing roads was taken into account (subtracted).

Table 5.2 Possible Public Investment on Land Transport Sector in Project Area at 1980 Constant Prices

GNP in 2000 (₱ Billion)	Per Capita Public-Investment in 2000	Project Area vs. Davao City	₱ Million 1/ 1980-1990	1991-2000	Total
474 (Long Term Plan 2000)	same as the Regional Average	Proportional to Population	111	1,206	1,317
		Proportional to GRDP	134	1,375	1,509
	20% higher than the Regional Average	Proportional to Population	124	1,412	1,536
		Proportional to GRDP	149	1,609	1,758
374 (Recent Estimate of NEDA)	same as the Regional Average	Proportional to Population	93	974	1,067
		Proportional to GRDP	114	1,116	1,230
	20% higher than the Regional Average	Proportional to Population	107	1,141	1,248
		Proportional to GRDP	131	1,300	1,431

1/ : excluding maintenance costs for existing road network, i.e. investment on new land transport facilities only

As a result, the amount of new public investment funds in land transportation facilities available during the next 20 years is estimated as 1,067 million to 1,758 million pesos. In any of the cases studied, the amount available during the first decade (1981-1990) is extremely small and is only about one-tenth of the amount available during the second decade (1991-2000), but advance investment will be possible by the issuance of public bonds and/or obtaining foreign loans. The better the loan condition and the greater the grant portion, the greater the fund available for investment.

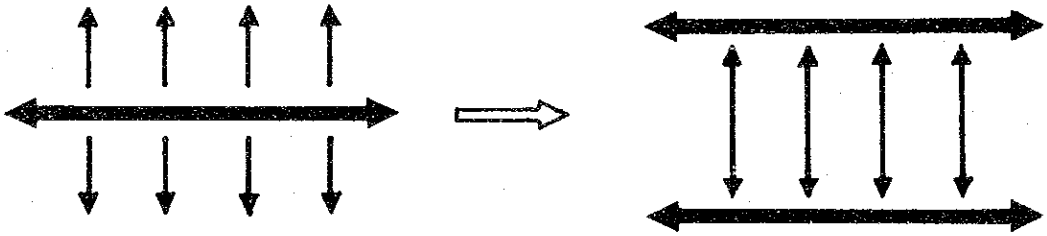
Although it roughly defines the reality of investment plan to be formulated later, this estimate is not to be regarded as the amount of planned investment or policy target for investment. The amount of total public investment in the Project Area accounts for 4.8% to 6.5% of GRDP in the year 2000, depending on which of the cases is to be used, and the indicated range of the rates is considered reasonable in view of the national target of 6%. However, with regard to public investment in the year 2000, the ratio of Region XI to Mindanao is an issue and may be changed politically or in relation to private investment.

5.3 Transport Network Pattern and Road Network

5.3.1 Transport Network Pattern

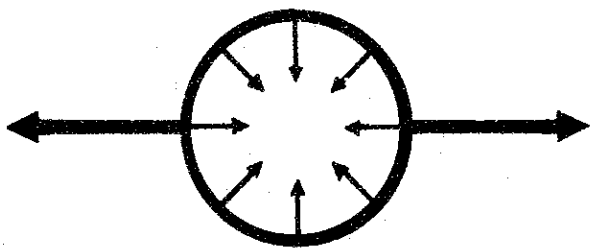
In order to determine an appropriate road network to be completed in the future in the Project Area, transport network patterns have been reviewed against the future transportation demand structure, land use plan, and the topography of the area, having in mind the transport plan target defined under Chapter 5.1. and the strategy for its accomplishment. As a result, it has been decided that the ladder shape skeleton is to be recommended as the basic pattern of the transport network. Detail considerations and concepts supporting this conclusion are discussed below.

(1) The transportation demand in the Project Area, which extends in north-south direction, is currently being met with a road network consisting of a one spinal road — the network of a fish-bone type skeleton (see below). In order to expand the transportation capacity of the network, a ladder type skeleton, is to be adopted. Such a network will provide alternatives of access to any given area covered, not only for traffic convenience but also for greater safety in emergency situations, as discussed under Chapter 5.1.



A) FIFH - BONE TYPE B) LADDER TYPE

(2) Added to the ladder shape skeleton is a ring road around Poblacion and Ecoland, which will continue to be the central core of Davao City and, as such, will generate and attract large volume of traffic. Currently, traffic entering Poblacion is compelled to pass through the downtown area in order to reach the destination. The Ring Road will prevent through traffic from uselessly entering into Poblacion, while it will distribute traffic destined to Poblacion to appropriate access roads so that traffic will flow on the access closest to each destination. Thus, the Ring Road is expected to mitigate traffic congestion and to improve traffic environment in the area encircled by it.



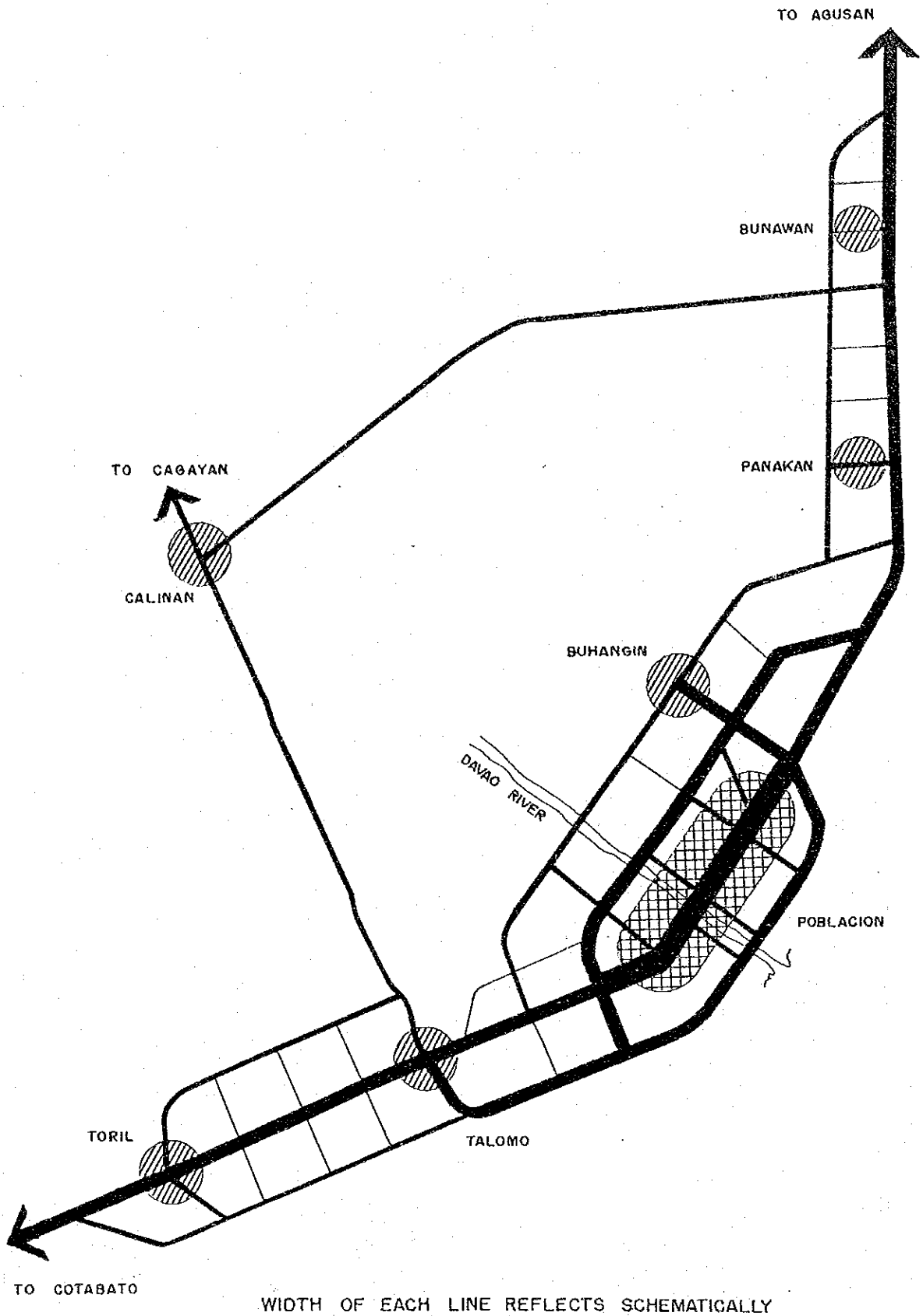
C) RING - ROAD AS DISTRIBUTOR

(3) Trunk roads are to be distributed in CBDs at the intervals of 500 meters in order that the downtown area utilization efficiency will be high, in residential areas at the intervals of about 1,000 in order that a desirable living environment will be preserved, and in other areas at the intervals of 1,000 to 1,500 meters, but never to exceed 2,000 meters, in order that the rational and traffic handling convenience of the ladder shape network pattern will be best realized. Thus, the northern part of the Project Area (Panacan-Bunawan) will have six lateral trunk roads and the southern part (Talomo-Toril), five lateral trunk roads.

(4) The Project Area has been so far developed basically in the shape of a line extending from Poblacion toward north and south. In the future, transportation demand will show a belt pattern on the north-south axis, reflecting the pattern of land use. In view of such land use pattern and the future area development plans, it is believed that the existing Davao-Agusan/Davao-Cotabato Road will continue to be the most important major road serving commuter (office, school) and business traffic.

(5) In coherence with the ladder shape road network in the Project Area, Diversion Road is to be extended for the complete connection between Bunawan and Toril, with the exception of about 5.5 kilometers between Ma-a and Talomo which will be left unlinked in view of the unfavorable economy of road construction due to the topography. Future changes in balance between traffic demand and traffic capacity of Davao-Cotabato Road and Coastal Road will more or less determine time for its full completion. In this Study, it is assumed that the time will come after 2000.

(6) Davao-Bukidnon Road is the only existing road which connects the coastal area of Davao City with its inland area. The predicted development of agro-based industries in Calinan will strengthen the coastal inland ties in the future. The formation of a high speed, convenient, and safe road network will beimportant if the development of these inland areas is to stimulated. It is, therefore, recommended that, in addition to the existing Davao-Bukidnon Road, a Bunawan-Calinan Road be constructed as the major road to form this network.



WIDTH OF EACH LINE REFLECTS SCHEMATICALLY
THE RELATIVE IMPORTANCE OF ITS ROLE AS TRUNK LINE

Figure 5.6 Transport Network Pattern (Ladder Type)

5.3.2 Road Network Pattern

The transport network pattern recommended under Chapter 5.3.1. must now be incarnated in an actual road network for the Project Area, defining the road distribution and the kind of road which will facilitate the performance of its function. Various kinds and functions of road are:

(1) Major Road

As the skeleton of an urban community, major roads have the function of handling inter-city traffic and through traffic which are on a relatively long trip. Therefore, they must have a road structure of a high level for a high traffic capacity.

(2) Secondary Road

Organically connecting major sources of traffic generation with a major road, secondary roads deliver traffic on a relatively long trip to the major road. Their structure must be of a fairly high standard.

(3) Collector Road

Fundamentally, collector roads connect local roads with secondary roads for the collection of traffic from, and the distribution of traffic to these roads. Within an area surrounded by secondary roads, the collector road functions as "major roads". Usually, collector roads constitute the contour of a residential area and serve as PUJ or bus service route. Collector roads are designed with relatively low standard structure.

(4) Local Roads

Providing to serve roadside housing premises, local roads are carefully distributed and traffic control effected thereon in order to prevent through traffic from entering into the area. Local roads are designed by a low standard structure.

When designing a road network for a given area, the function of each component road must be identified according to the above discussed classification and definition and road facilities which commensurate with the function identified in order that smooth and safe flow of traffic is to be achieved. Thus, the future road network of Davao City has been designed as presented in Figure 5.7, based on the transport network pattern selected under Chapter 5.3.1. The basic concept supporting this design is as follows:

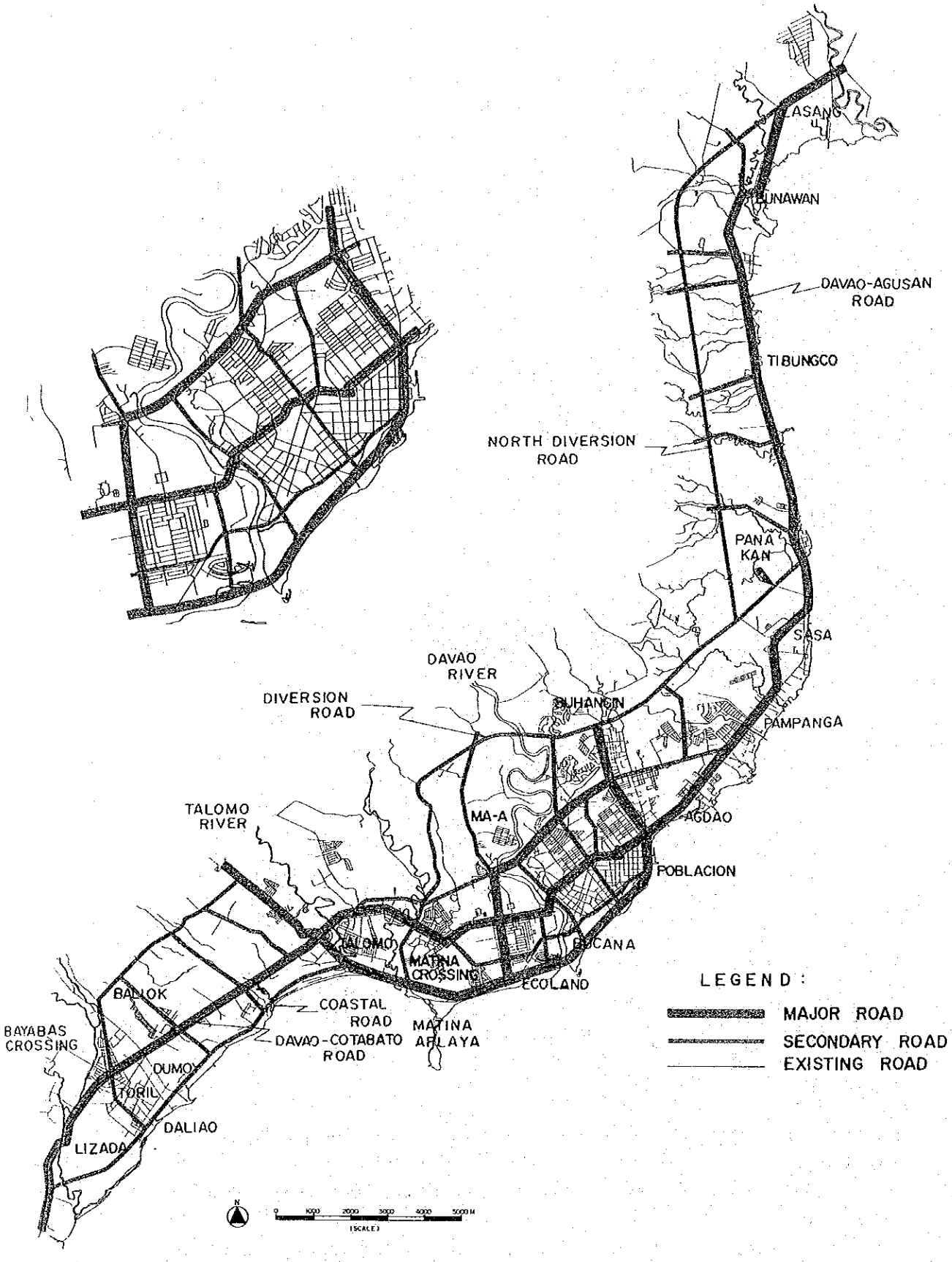


Figure 5.7 Proposed Road Network

(1) Coherence with the transport network pattern

The transport network pattern recommended in Chapter 5.3.1. is of a ladder type, which will stimulate the transfiguration of the urban area from the present mono-concentration structure to a multi-core structure. These selection of the mode or modes to serve on the network is a matter of transport policy decision. However, in the significance that the road is the base of land use, it has been decided that a road network is to be formed in the same shape as the transport network pattern in its entirety.

(2) Road Network Distribution Concept

Orderly road network distribution is to be achieved through the connection of roads principally according to the hierarchial order of road functions: major roads, secondary roads, collector roads, and local roads. In other words, the kind or functional role of each road and its distribution/positioning should be determined in such a manner that the function can be best performed, network efficiency be maximized, and local environment be preserved through access control, the effectuation of one-way traffic, and other traffic measures. The fundamental road network structuring concept is as presented in Figure 5.8.

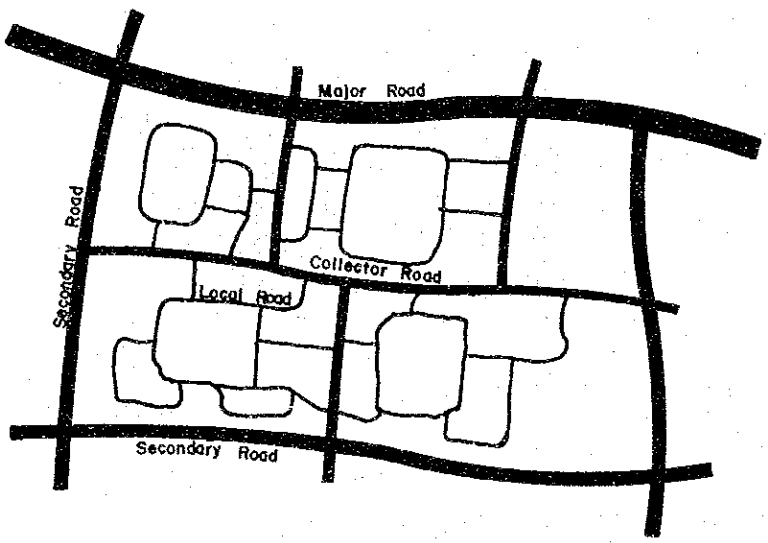


Figure 5.8 Conceptual Plan of Road Network

(3) Traffic Demand Structure and Road Structure Image

For road network distribution, it is important that the volume of distributed traffic be fully understood so that the network distribution and the selection of road function will be appropriate and suited to the orientation and the volume of traffic demand and trip length. In determining road functions, the road structure image of Figure 5.9 has been considered.

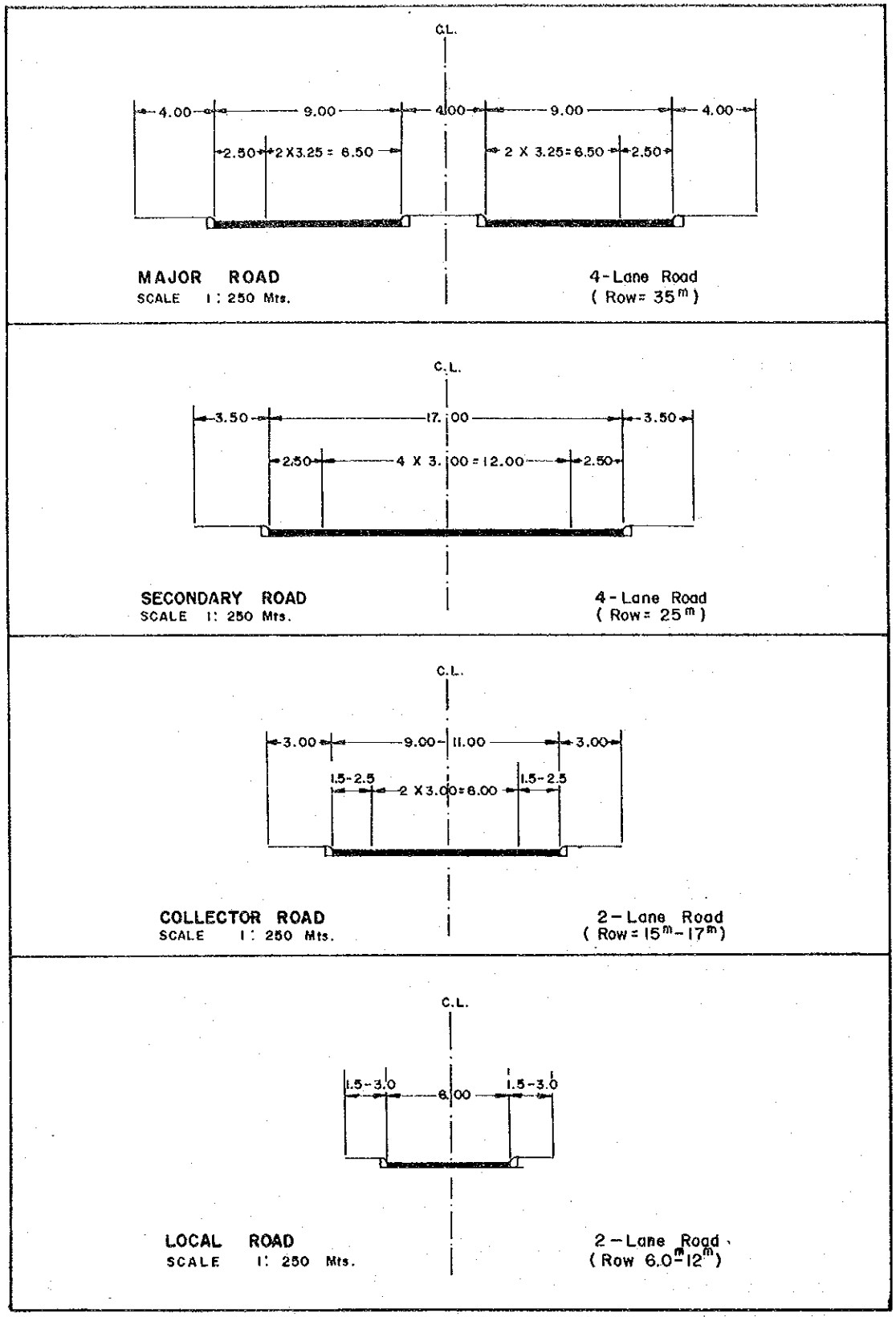


Figure 5.9 Standard Road Cross-Section

5.4 Plan Formulation

5.4.1 Alternative Plans and Transportation Policies

The transport network pattern and the road network recommended in Chapter 5.3. have been designed in consideration of the planning targets stated in Chapter 5.1. and the strategy for its realization. Their appropriateness is to be reviewed through the evaluation of below discussed alternative plans and project evaluation.

Only one set of road network which corresponds to the transport network pattern was recommended, and their modification, if any, will be very partial. Therefore, the alternative plans to be evaluated are formulated based on the difference of the capacity of each link. Link capacity difference between the alternative plans comes from difference in the modes to serve public transport demand under each of the alternatives, and the mode selection depends upon transportation policy to be pursued.

The introduction of public transport mode with a large capacity was recommended in Chapter 5.2. for the effective use of transportation infrastructure. The following three alternative plans two of which providing for the introduction of a large capacity mode are considered:

Alternative A: Introduction of rail transit service

Alternative B: Introduction of bus service

Alternative C: Reliance on the existing PUJs

The capacity of individual links constituting the road network varies depending on the mode of transportation adopted by the alternative plans.

Under Alternative C, no new mode of public transport is to be introduced but the PUJ is to be continuously relied upon as the chief mode of public transport, and the present trend of public transport service is considered to continue in the future. Also, "do nothing case" (wherein no additional investment will be made in road facilities and the PUJ will be continuously relied upon for public transport) is introduced for contrast.

The modes of public transport considered for use under each of the Alternative Plans are as follows:

Table 5.3 Public Transportation Modes and Alternative Plans

Alternative Plan	Rail-Transit	Bus	Jeepney
Plan—A	◎	○	△
Plan—B		◎	△
Plan—C			◎
Do Nothing Case			◎

◎ Major Public Transport Mode on Trunk Line
○ Feeder Service Transport Mode
△ Local Service Transport Mode for Short Trip

Note: In each case long distance Provincial Buses are operated.

The following are assumed common and same throughout the Alternatives:

i) The total length of roads constituting the road network (provided that Alternative A leaves the tunnel part of about 1.0 kilometer to connect J.P. Laurel Extension with Diversion Road unfinished).

ii) Long distance provincial bus service

iii) The local service function of PUJs and tricycles (provided that jeepneys are given the function of chief mode of public transport under Alternative C and "do nothing case").

iv) The partial relocation of Davao-Agusan Road in the vicinity of Sasa due to the port expansion plan.

v) Bucana Reclamation Plan and other development projects.

5.4.2 Alternative Plans

After the review of traffic demand based on each public transport system to be introduced under the Alternatives and of coherence with the road network concept recommended in Chapter 5.3, the road network for each Alternative has been developed as shown in Figures 5.11-5.13. Each road network comprises a total road length of 137.1 to 158.9 kilometers, constituting of 87.2 to 107.7 kilometers of existing roads to be upgraded and 49.9 to 51.2 kilometers of newly constructed roads depending upon the Alternative under consideration. The feature of each Alternative is as follows:

(1) Alternative A (Introduction of rail-transit)

This Alternative proposes to construct a total length of about 35.7 kilometers of rail-transit system along Davao-Agusan Road and Davao-Cotabato Road (with detouring to coastal area near Ecoland), where trip density is high. To serve passengers as well, railroad stations are to be positioned at the intervals of about 1,000 meters in suburban areas and of about 700 meters in urban area. In view of the impacts on traffic on the carriageway of road, an elevated railroad track is to be used in Poblacion and the vicinity (about 4.0 kilometers), while, in other areas, railroad track is to be built in the middle of the road right-of-way to avoid the problems on land acquisition.

It is expected that traffic demand will shift from motor vehicles to rail-transit, upon introduction, in view of the advantages of rail-transit service over motor vehicles: regularity, rapidity, absence of environmental pollution, and higher energy efficiency. Should this be the case, need for road construction will be smaller than without rail-transit. Thus, this Alternative will require the smallest volume of road development (that is, the construction of 6-lane road and the completion of the tunnel which will connect J.P. Laurel Extension and Diversion Road, which are taken up by other Alternatives, are not considered under Alternative A). For this reason, Alternative A provides for the smallest amount of road construction costs, but when the cost of railroad construction is added, requires the largest amount of construction costs (see Table 5.4).

The vehicle of the rail-transit system in this Alternative A is assumed the same vehicle type which is presently planned for introduction in Metro Manila, while

the cost of railraod construction is estimated with taking account of local condition in the Project Area.

The bus is to be introduced to serve on major roads in supplementation to rail-transit service. Basically, bus services are limited within each block to avoid the competition with railroad, and PUJs will be important as the mode serving local neighborhood needs. The functional structuring of the road network under this Alternative (and also under other Alternatives) are as follows:

i) Northern Area (Panacan-Bunawan)

Road network in this area is to be that of a ladder shape formed with (a) widened Davao-Agusan Road and newly constructed North Diversion Road in parallel to and on the west side of the former -- the two "shafts" for handling traffic demand flowing north-south direction, and (b) "ribs" of major roads distributed between the "shafts" to connect them at the intervals of 1.0 to 2.0 kilometers. The ladder shape skeleton has been selected in order to develop a stable road network which will offer a greater total road capacity to meet the expanding future traffic demand and greater safety in emergency situations.

ii) Poblacion Area

A Ring Road is to be formed encircling Poblacion/Ecoland urban area, consisting of Dacudao Avenue (to be upgraded), J.P. Laurel Extension (newly built), New Ma-a Road (newly built), Coastal Road (newly built), and R. Garcia Street (upgraded), for a total length of 14.9 kilometers. This development of Ring Road aims at the mitigation of traffic congestion and the improvement of traffic environment in the urban area through the distribution of traffic entering into the area and the by-passing of through traffic.

iii) Southern Area (Talomo-Toril)

As in the Southern Area, road network in the Area is to be also of a ladder shape, aiming at the same effects. Here, the network is to comprise three major roads -- Davao-Cotabato Road, the Old National Highway, and Coastal Road--running almost in parallel to each other with the distance of 500 to 1,000 meters between them, and with trunk roads connecting them at the intervals of about 1,000 meters.

(2) Alternative B (Introduction of City Buses)

This Alternative proposes to introduce buses to replace PUJs for serving medium and long distance trip demand. The use of buses with a greater passenger capacities is expected to result in a substantial saving in the volume of road construction work needed in meeting the same volume of demand. Alternative B provides for the same road network as does Alernative A, except that an about 1-kilometer tunnel is to be completed for the connection of J.P. Laurel Extension with Diversion Road under this Alternative. Therefore, the volume of required road construction would be greater under this Alternative than under Alternative A by the volume corresponding to the difference of transportation capability between rail-transit and buses. Thus, Alternative B would require greater road construction costs than Alternative A but smaller total construction cost than

Alternatives A and C.

In order to increase the service efficiency of the bus, it is recommended that a total length of about 22 kilometers from Panacan to Talomo (R. Castillo Street, Lapu-lapu Street, Sta. Ana Avenue, E. Quirino Avenue, and McArthur Highway), where traffic density is heavy, be upgraded to a 6-lane road and that, of the six lanes, two be designated as exclusive bus lanes.

Under this Alternative Plan, the PUJ will become the means of feeder service supplementing trunk bus service and will handle short distance trips within each block.

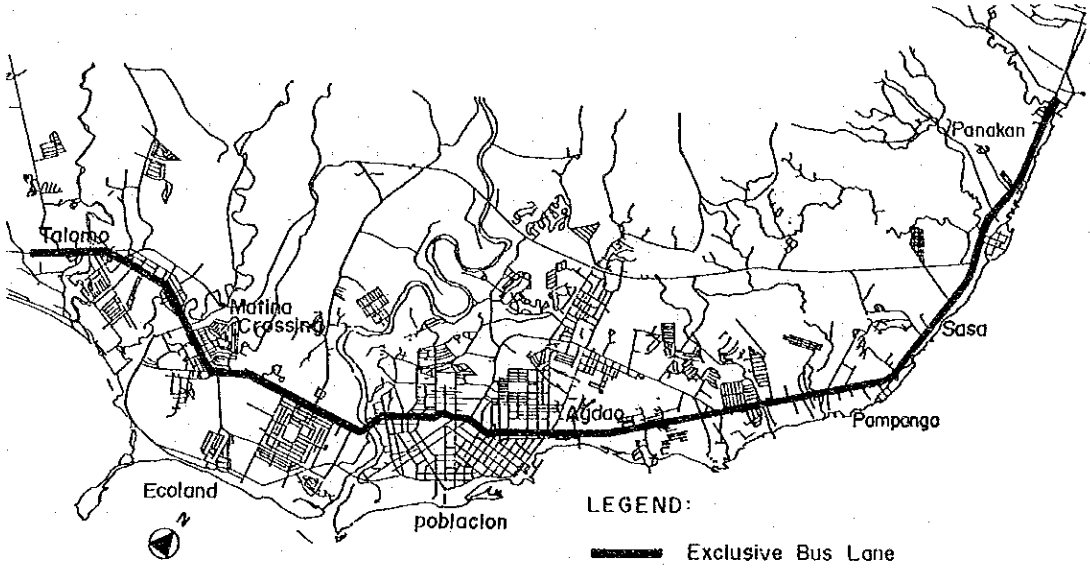


Figure 5.10 Assumed Location of Exclusive Bus Lane

(3) Alternative C (No new mode to be introduced)

This Alternative proposes to have the existing modes to continuously play the same functions in the future, without the introduction of any new mode. Thus, the PUJ will continue to be the chief mode of public transport serving long distance trip demand, while the tricycle will continue to serve local short distance trips.

Because the passenger-capacity of the mode relied upon for public transport is small, the required road construction costs will be the greatest under this Alternative than under others. The same road network as under Alternative B is contemplated for Alternative C, but, because of the greater road traffic demand, the capacity of each link is necessarily larger, as it is reflected by the volume of 4-lane roads required: a total length of 31 kilometers under Alternative C, against only 9 kilometers under Alternative B.

FACILITIES (IN KM.)	TRUNK ROAD NEW CONSTRUCTION	49.9
	TRUNK ROAD UP-GRADING	87.2
	RAIL ROAD	35.7
CONSTRUCTION COST (IN MILLION PESOS)	TRUNK ROAD	929.2
	RAIL ROAD	856.7
	TOTAL	1,785.9

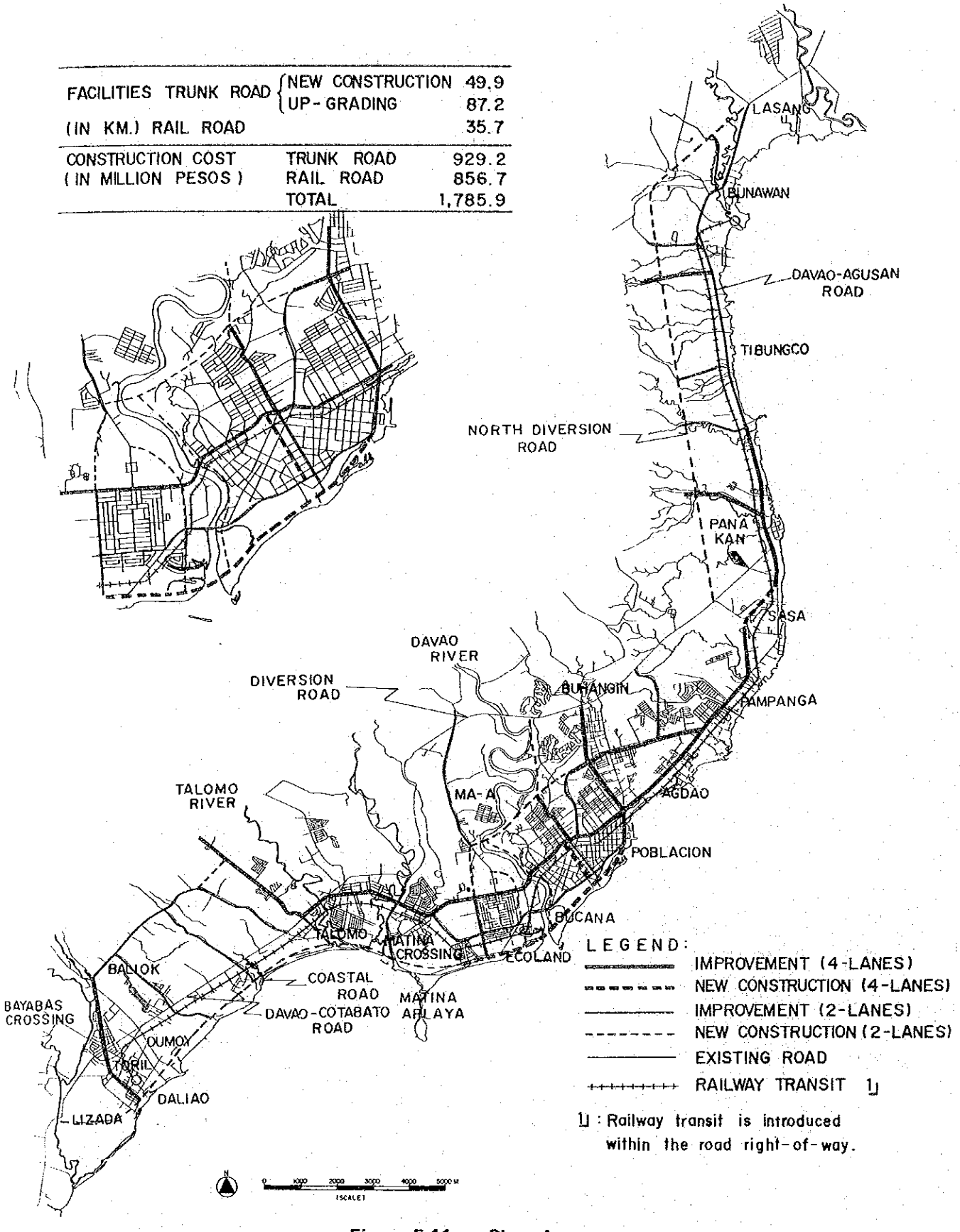


Figure 5.11 Plan--A

TRUNK ROAD FACILITIES (IN KM.)	NEW CONSTRUCTION	51.2
	UP-GRADING	148.9
CONSTRUCTION COST (IN MILLION PESOS)		1,265.8

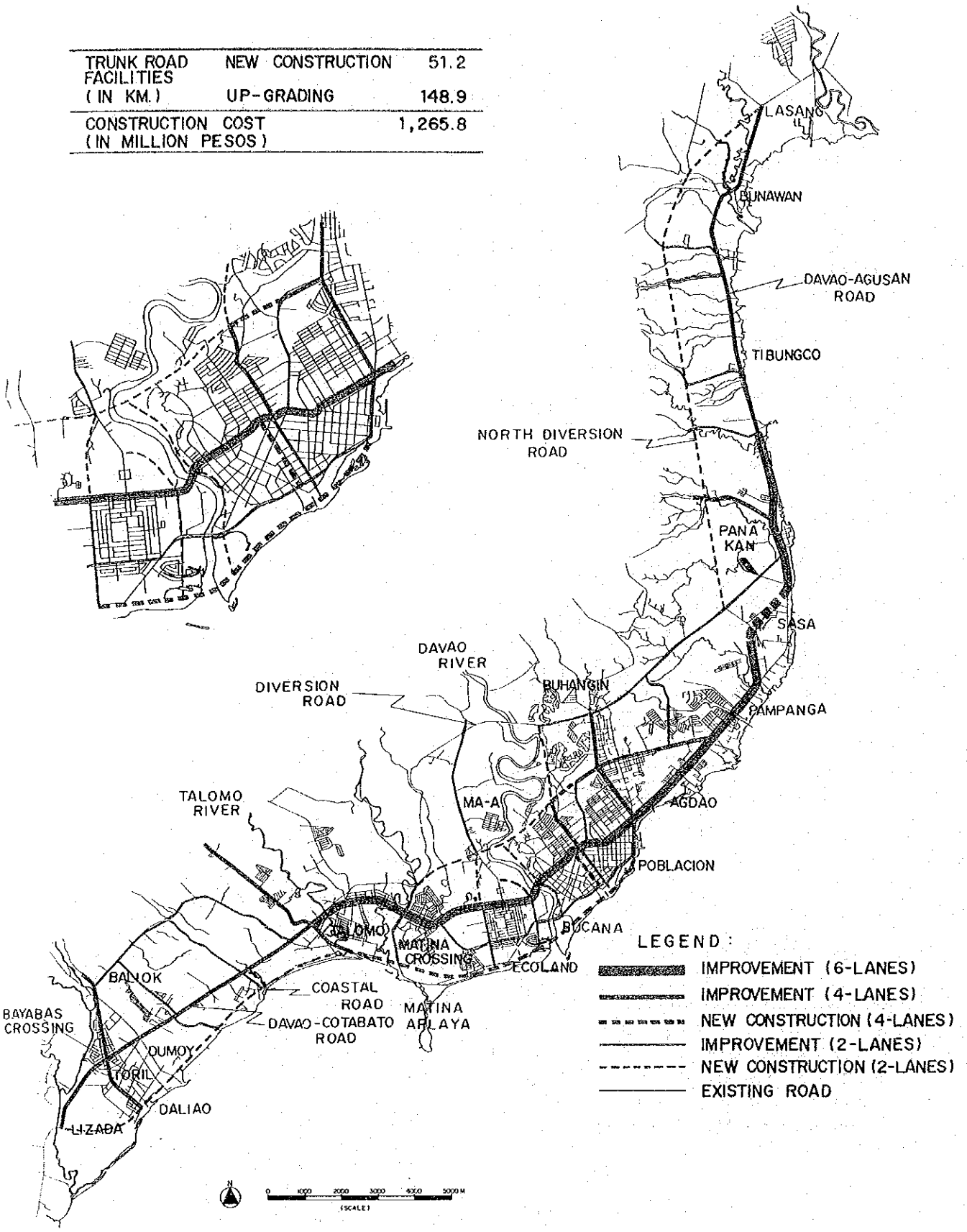


Figure 5.12 Plan–B

TRUNK ROAD FACILITIES (IN KM.)	NEW CONSTRUCTION	51.2
	UP-GRADING	158.9
CONSTRUCTION COST (IN MILLION PESOS)		1,441.1

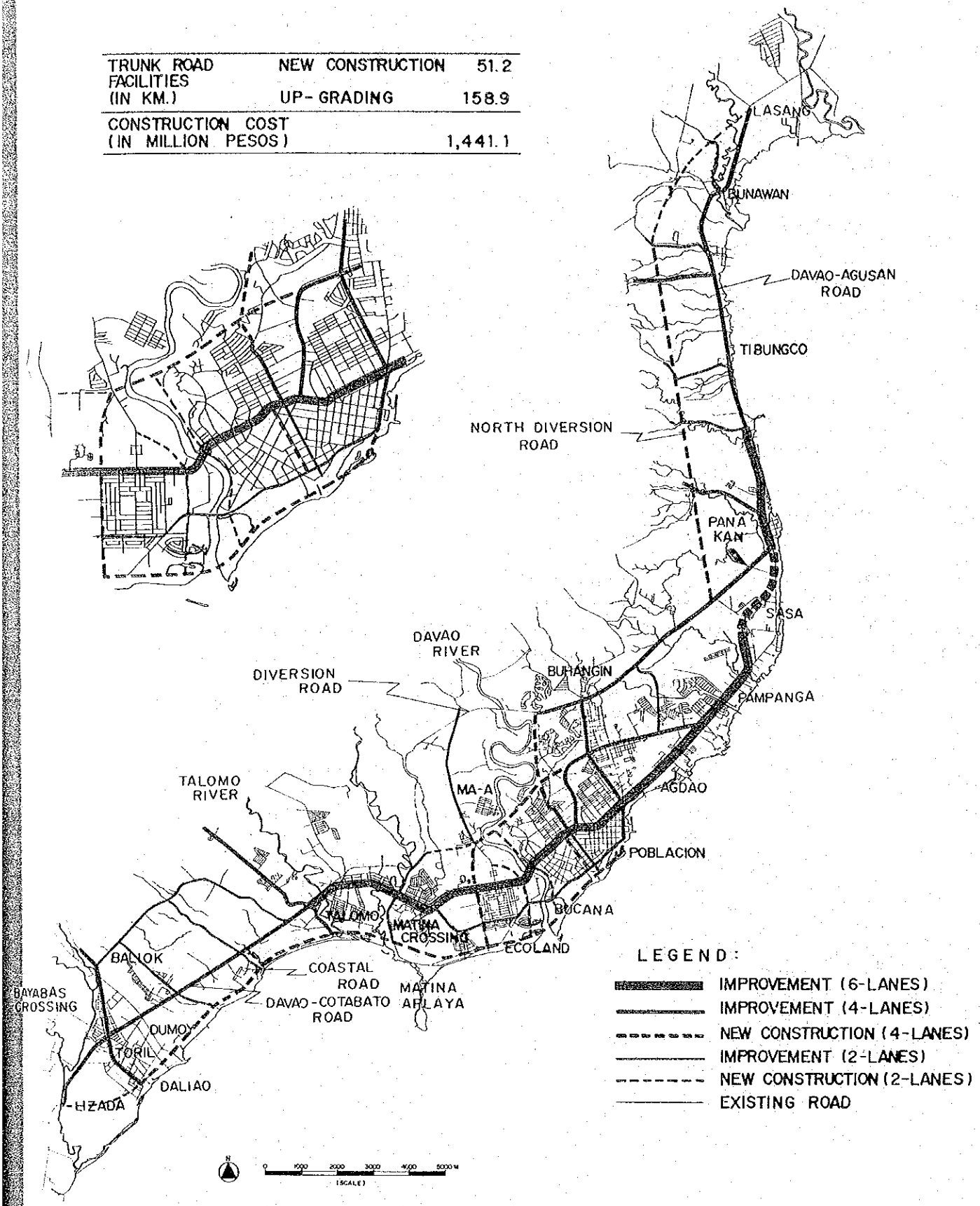


Figure 5.13 Plan–C

5.4.3 Implementation Cost

The amount of construction cost required for the implementation of each of the Alternative Plans (excluding road maintenance and railroad operation maintenance costs) has been roughly estimated in 1980 constant prices, as presented in Table 5.4, using:

i) The unit construction cost data per kilometer obtained from the records of the Bureau of Construction, Ministry of Public Highways, as modified by market prices in Davao obtained from Davao Construction Contractors, the planned road cross section, and the topography of the work area.

ii) The concrete pavement of roads in view of traffic volume and less maintenance work (although pavement structure is to be determined through a soil survey and the analysis of the existing pavement surfaces upon the feasibility study and/or the detailed designing).

iii) The existing road upgrading cost of a 90% of new road construction cost, taking into consideration the cost of existing pavement surface removal and the cost of relocation of draining facilities and so forth, as well as saving to be realized by the use of existing roadbed.

iv) The unit cost of land acquisition, as calculated by the Davao City Assessor's Office.

v) The cost of compensation for houses and other buildings to be demolished, as determined by applying the assessed value of buildings by the Davao City Assessor's Office to the inventory of existing buildings as revealed through aerial photographic survey map.

vi) The railroad construction cost, estimated based on the similar type of vehicle of the light rail transit system planned for Metro Manila.

Table 5.4 Cost Estimate of Highway and Railway Facilities

			Plan A	Plan B	Plan C
Highway Facility[1] (in km.)	New Construction	6-lane	–	3.0	3.0
		4-lane	11.1	9.1	30.9
		2-lane	38.8	39.1	17.3
		Sub-total	49.9	51.2	51.2
	Up-grading	6-lane	–	19.1	19.1
		4-lane	43.1	47.0	62.3
		2-lane	44.1	31.6	26.3
		Sub-Total	87.2	97.7	107.7
		Total	137.1	148.9	158.9
Railway Facility (in km.)		at Grade	31.7	–	–
		Elevated	4.0	–	–
		Total	35.7	–	–
Highway Construction Cost[2] (In Million Pesos)	New Construction		294.2	387.4	476.1
	Up-grading		285.5	403.6	449.5
	Land Acquisition		349.5	474.8	515.5
	Sub-Total		929.2	1,265.8	1,441.1
Railway Construction Cost[2] (In Million Pesos)	Civil Work		561.2	–	–
	Rolling Stocks		459.2[3]	–	–
	Power Supply, Signalling, etc.		237.4[4]	–	–
	Land Acquisition		58.1	–	–
	Sub-Total		1,315.9		
Total Cost[2] (in Million Pesos)			1,785.9	1,265.8	1,441.5

Note: [1] Trunk roads only, collector and local roads are excluded.

[2] Cost at 1980 constant prices

[3] Not included in the total for the convenience of comparing Plans A, B, and C.

[4] Workshop equipments and spare parts costs of ₱64.7 Million are excluded.