

6. Public Transport Conditions

6.1 Present Bus Transport System

(1) Urban Buses and Microbuses

There are 17 urban bus companies/associations operating 1,417 units for 81 routes and 13 microbus companies/ associations operating 799 units for 52 routes besides Metrobuses (Figure 6.1). There is no definite difference between urban buses and microbuses except that the buses are operated only by the drivers while each microbus customarily has an assistant. "Preferential" buses are supposedly of higher quality than ordinary buses. They have to be models of recent 5 years, of large seating capacity (40 seats or more) and with uniform body colors without any special requirements for the routes. In reality, the difference is sometimes not so apparent except for the body color and the fare. On the other hand, out of a total of 3,700 registered urban buses and microbuses, 1,800 or nearly 50 % are 15 years of age or over. This means that many already deteriorated buses and microbuses are still operating. The municipality once started operation of remodeled trailers for peak hour passenger services but ceased operation by the end of 1995 due to the cost over-run.

Table 6.1 Urban Buses and Microbuses in 1995

Urban Buses	No. of Organizations	Ordinary Bus Units	Preferential Bus Units	Total Units Bus Units	No. of Routes
Buses	17	1,138	279	1,417	81
Microbuses	13	729	70	799	52
Metrobus	1	-	-	95	7
Munitrans	1	-	-	17	4
Total	32	1,867	349	2,328	144

Compared to 1990, the total operating fleet decreased by 8.2%. But the number of routes has been increased. Major new routes in 1995 are long distance routes such as those for Amatitlan, Villa Nueva, Villa Canales and San Jose Pinula. In addition, long distance routes for Llano Largo, Villa Hermosa and Lomas de Portugal in Mixco have been added. The newly introduced Metrobuses once ceased operation due to financial problems and resumed by different management. The original idea of the Metrobuses is to convert car users to bus passengers by providing attractive services but so far the idea has not been fully realized.

Table 6.2 Urban buses in 1990

Urban Buses	No. of organization	No. of units	No. of routes
Buses	16	1,634	69
Microbuses	13	1,193	47
Total	29	2,827	116

Urban bus fares in daytime during weekdays are as follows. In December 1990, bus and microbus fares increased from Q0.20 to Q0.40. It is now Q0.65, that is over three times the 1990 fare. During the period, the Quetzal devaluated from Q4.50 per US\$1 to Q.6.00 per US\$1. In US Dollars, the change was from US4.4 cents to US10.8 cents.

Metrobus	= Q 1.00
Preferential	= Q 0.90
Bus	= Q 0.65
Microbus	= Q 0.65
Munitrans	= Q 0.50

Subsidies to the urban bus operation have been a burden on the government's finance. In 1990, the amount was approximately Q0.80 for 10 hours of daily operation of a unit totaling around Q6 million per month. Currently a different system is adopted. Since February 1995, the Ministry of Finance has been compensating bus companies an amount corresponding to the increased diesel price. According to the agreement, the compensation amount is Q1.20 per gallon with a maximum of 23 gallons a day and 28 days a month for each bus. The total amount is approximately Q1.7 million per month. In addition, the 7% value added tax or Q0.04 per ticket is exempted at present. The fares and subsidies have been a controversial issue to passengers, bus operators and the government.

(2) Extra-urban Buses

Regarding the mechanical specifications, the extra-urban buses do not have their own standard, instead, the general operation standards of the traffic police applies to the extra-urban buses.

Currently, approximately 2,800 extra-urban buses are registered with the Municipality as those with one trip end in the Municipality, which include approximately 1200 units connecting destinations inside the Guatemala Department and the Municipality. (Table 6.3)

Table 6.3 Number of Extra-urban Buses by Terminal and Route

Route	CA9 North	National Road 5	CA1 West	CA9 South	Department Road 1	CA1 East	Total
Location of Terminal in Guatemala City							
Zone 4 Terminal		286	255	368	147	342	1,398
for inside Department		286	12	337	147	113	895
for outside Department		0	243	31	0	229	503
Zone 6 Terminal	219					4	223
for inside Department	158					4	162
for outside Department	61					0	61
Zone 1	292		304	226		3	825
for inside Department	0		4	90		0	94
for outside Department	292		300	136		3	731
Avenida Bolivar			220				220
for inside Department			0				0
for outside Department			220				220
Zone 4			5			30	35
for inside Department			0			0	0
for outside Department							
Zone 3				1			1
for inside Department				0			0
for outside Department				1			1
Zone 9			28				28
for inside Department			0				0
for outside Department			28				28
Zone 11				1			1
for inside Department				0			0
for outside Department				0			0
Unknown	15			1	32		48
for inside Department	0				32		32
for outside Department	16				0		16
Total	527	286	812	596	179	379	2,779
for inside Department	158	286	16	427	179	117	1,183
for outside Department	369	0	796	169	0	262	1,596

The number of intra-departmental units shows an increasing trend.

Among the 6 major routes, CA1 West has the largest number of registered extra-urban buses followed by CA9 South .

For a preliminary analysis of commuter routes and non-commuter routes, the routes are classified into those for inside the Guatemala Department and those for outside the department. In addition, currently a considerable share of extra-urban bus passengers carry agricultural products to the Zone 4 Terminal. In future, some of the extra-urban bus services for sub-urban areas are thought to be converted to the urban bus service to meet the urban expansion.

Integrated with the CENMA project, Guatemala Municipality has a plan of decentralized market places (Figure 6.2). According to the plan, not only the CENMA but also a number of market places are planned to be reorganized including those in Atlantida area and areas along CA 1 West.

6.2 Existing Bus Transport Facilities

(1) Bus Stops

A number of bus stop facilities have been improved along main streets. Further improvement is necessary including construction of bus bays wherever practical. In addition, more orderly use by both buses and passengers is required.

(2) Extra-urban Bus Terminals

The largest terminal at Zone 4 with 86 bus berths and the surrounding area suffer from chronic congestion and confusion. The terminal at Parroquia Zone 6 is not so crowded but the Calle Marti or CA9 North in the urban area is congested partly due to the terminal. There are other off-street extra-urban bus terminals such as those near the FEGUA Central Station, some of which occupy the front road space. Moreover, there are a number of on-street extra-urban bus terminals in Zone 1, some of which degrade the environment.

(3) Bus Inspection and Maintenance

1) Vehicle Inspection System of Guatemala City

Urban buses and minibuses of 5 years of age or older are inspected annually by a team of 5 to 6 members of the municipality staff. Some 8 buses for a day are inspected once or twice a week on the sixth avenue (Avenida Simeon Canas) in Zone 2. Exhaust gas from the engines is tested with a measuring machine and other items are checked by observation according to the check list of a total of 23 items. The check items are as follows but not all the criteria are very specific.

- 1) Seats
- 2) Lights
- 3) Call bells
- 4) Windows
- 5) Window framework
- 6) Painting
- 7) Doors
- 8) Holes in chassis
- 9) Accumulator
- 10) Window wipers

- 11) Rugs
- 12) Inner equipment
- 13) Horn
- 14) Adjustment of chassis
- 15) Front body
- 16) Wheels
- 17) Muffler
- 18) Bumpers
- 19) Engine
- 20) Engine repair
- 21) Brakes
- 22) Exhaust gas
- 23) General cleaning

Without sufficient facilities and equipment, it is difficult to execute thorough and in-depth inspection with substantial effects on improvement of mechanical conditions of the buses. The existing inspection system is not enough to stop deterioration of the mechanical conditions and so the environmental problems caused by buses.

2) Existing Situation of Vehicle Maintenance in Guatemala

a) Vehicle Maintenance Workshops of the Municipality

The municipality operates a workshop for its own vehicles. But its facilities and equipment are not enough for proper maintenance even with availability of the skilled work force.

b) Bus Cooperative/Association with Own Workshops

Only a couple of large scale operators with around 100 buses or more are equipped with their own workshops. In general, responsibility for bus maintenance is with each owner and not with the cooperative/association.

The space for the workshops belong to the cooperative/association and the workshops are leased. These workshops are expected to cover all types of maintenance work. In reality, however, it is difficult to carry out all the work and the main work in the workshop is such routine like changing engine oil. Selection of the workshops is up to the owner. It seems that keeping operation has higher priority than maintenance even when buses are in poor conditions.

c) Independent Workshops

There are many workshops for passenger cars in the City. However, in general, facilities and equipment are scarce. Off road workshop space is also limited and streets are used for maintenance, sometimes causing traffic problems. More importantly, very few workshops deal with buses. Many buses are maintained in an ad hoc way on the roadside. It seems that in most cases buses do not have systematic maintenance practice.

d) Vehicle Dealers Affiliated to Manufacturers

Only the vehicle dealers have high level of functions for maintenance. Some of them have training courses.

6.3 Bus Transport Issues

Major issues of the bus transport are summarized as follows.

- a) Lack of safety and low operation efficiency of buses
- b) Low service level of operation (such as of area, time, speed, etc.) and comfort of buses
- c) Traffic disturbance and congestion by buses
- d) Environmental pollution by buses
- e) Government's financial burdens caused by buses

These issues indicate the following requirements.

- a) Need for restructuring the urban and extra-urban bus system to be a hierarchical structure consisting of urban buses (key route buses, ordinary buses and feeder buses) and inter-regional buses
- b) Need for bus operation support infrastructure and facilities such as busways, a bus transfer center and inter-regional bus terminals
- c) Need for improvement of mechanical conditions of buses especially for environmental improvement by such means like a bus inspection and maintenance center with enforcement of operation and environmental laws and regulations

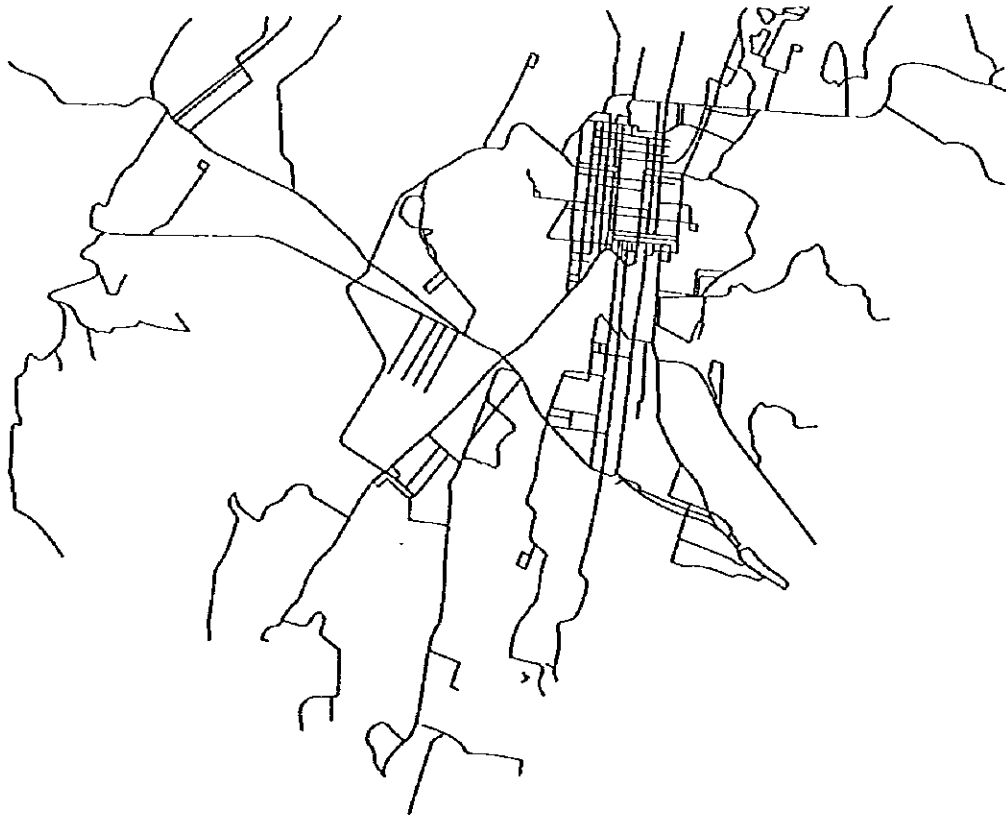


Figure 6.1 Urban Bus and Microbus Network

7. Environmental Conditions

7.1 Institutional Conditions

(1) Background of Environment

Environment as used herein refers to the totality of the surroundings:
Social, Manmade, Physical and Natural.

In case a development project is executed without full attention to the environment and also that control of surrounding natural resources is not taken care of, the basis of the development itself will be negatively affected and the development may not be continued. In addition, it could happen that the lives of resident people and the basis of their living may be unjustly affected. Therefore, in the execution of a development project, attentions to the environment shall be given with the long term view from the earliest stage of the development plan.

In Guatemala, soil erosion is advanced because of deforestation in the highlands and of destruction forest by inappropriate cultivation of the hillsides and steep slopes. As deforestation and agricultural development progressed, the forest area was reduced from 42% in 1980 to 23% in 1990. On the other hand, in the urban zone, water pollution is serious, and in the Amatitulan Lake, 30 km south of Guatemala City, the pollution has been caused by the discharge of urban waste water. Furthermore, in Guatemala City, air pollution caused by the exhaust gas of cars has become a critical problem.

In consideration of the above mentioned situation, the National Environment Committee (CONAMA) was created in the President Office in order to develop environmental administration, and the government has just started actively environmental conservation and improvement program. Especially in the Metropolitan Area, many development projects are planned to cope with the increasing population and the concentration of economic activities, and it is important to maintain a comfortable urban environment. Accordingly, the need for efficient and effective solution of environmental problems and attentions to the environment will become greater and greater.

(2) Environmental Law and Administrative Organization

1) Environmental Law

The Decree by the President No. 68-86, Environmental Protection and Improvement Law exists as an integral law related the environmental protection.

Object of the law:

To raise the national living standard through the conservation of the ecological system and environmental protection

Organization in charge:

CONAMA (National Environment Committee) is a part of the Presidential Office, and advises and coordinates the planning and application of the environmental protection policies. CONAMA is composed of an executive section with a representative president (coordinator) and a technical council.

The technical council consists of the following members:

Representatives of Economic Planning Agency, Ministry of Urban and Rural Development, Ministry of Education, Ministry of Health and Welfare, Coordinating Committee of Agrimining and Finance Association (CACIF), San Carlos University, Journalist Association and the Municipal University.

This law is the principal one for the country's environmental protection, but only regulates items related to environmental protection such as investigation, control, promotion, protection, prevention, analysis, etc.

Other laws and decrees relative to the environment are as follows:

- * Health Law (Decree No. 45-79)
- * Natural Resources (Wild Life, Water, etc.) Control Law: Law for protected areas and their regulation (Decree No. 4-89)
- * Guidelines for Environmental Assessment: Instructions for procedures for the evaluation of the impact of air pollution (May 1994).

The following international conventions, which are usually taken into account when an environmental impact study concerning social-economic infrastructure is to be executed, have been ratified:

- * World Heritage Convention: Convention concerning the Protection of the World Cultural and natural Heritage
- * Washington Convention: Convention on International Trade in Endangered Species of Wild Flora Fauna (CITES)
- * United Nations Convention of the Law of the Sea
- * Basel convention: Basel Convention for the Control of the Trans-boundary Movement of Hazardous Waste across natural boundaries and its disposal
- * Ramsar Convention: Convention on Wetlands of International Importance especially as Waterfowl Habitats

2) Administrative Organizations

CONAMA revises the environmental law system, and at the same time receive environmental claims or requests for legal action from the public (See Figure 7.1). CONAMA implements the following four basic environmental policies of Guatemala:

- a) Reinforcement of the system (modification of organization, infrastructure development, personnel training, etc.)
- b) Coordination between organizations and individual plans
- c) Promotion of environmental production techniques relative to environmental conservation
- d) Promotion of assistance from international organization

Moreover, CONAMA reorganized and integrated the General Direction of Forest and Wild Life (DIGEBOS) of the Ministry of Agriculture and Forests which is an important environmental control organization, and also newly founded the National Council for Protected Areas (CONAP). DIGEBOS is an organization which plans and executes national policies relating to the usage of natural resources cooperating with other related ministries and agencies, and now is preparing a plan for the promotion of environmental education through participation of local inhabitants in reforestation projects. CONAP organizes groups with governmental organizations and NGO's related to the protected areas, and in order to appropriately manage these areas, coordinates and leads the environmental policies related to many ministries and agencies. Furthermore, CONAP is in charge of protection and control of natural resources such as wild life, water, etc., and the Maya wild life park. The air quality is controlled by the Ministry of the Interior.

Apart from the above-mentioned governmental organizations, there are the Association of Local Government (ANAM) and Environmental Protection Department of the Social Welfare Council as principal environmental organizations.

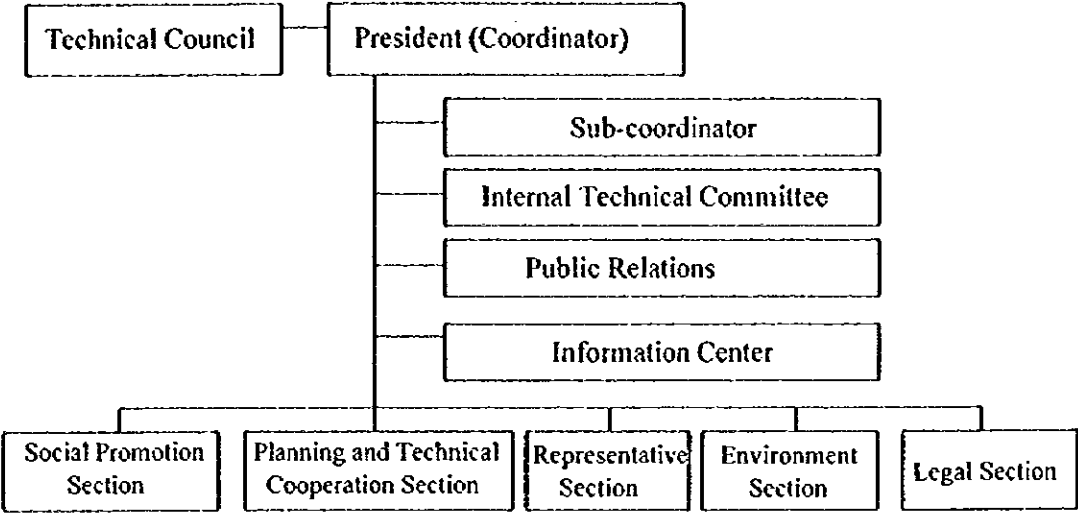


Figure 7.1 Organization Structure of CONAMA

(3) Operation System

The regulations on Environmental Assessment are described in the above mentioned Presidential Decree No. 68-86 Environmental Protection and Improvement Law. Article 8 prescribes that all enterprises and industries that may have an impact on the environment shall execute in advance an environmental impact study in accordance with the guidelines designated by CONAMA. Guidelines for environmental assessment (Instructions on Procedure for Environmental Impact Assessment, May 1994) are classified into three categories, depending on the volume and impact of the enterprises and industries which have an impact on the environment.

Category 1: Businesses which are judged to have little influence on the environment from their characteristics; flour milling, bakeries except factory level, lumber and cork product mills, assembly of home electric apparatus, construction of buildings not higher than 4 stories, repair of automobiles/bicycles and other repair workshops, etc.

Category 2: Businesses whose influence on the environment is suspected or unknown; agricultural projects, stone and sand quarrying, manufacturing and assembly of automobiles, water supply and sewage works, development of housing lots and urban development, distribution center, bus terminals and workshops, etc.

Category 3: Businesses whose influence on the environment is expected to be strong; utilization and operation of forestry resources, manufacturing of chemical fertilizers and pesticides, electric power infrastructure projects, land reclamation using solid waste, repair of roads, airports, urban developments, etc.

Consequently, such projects as urban transportation are classified in Category 2 and 3. Those who plan to do business in Category 2 shall submit Terms of Reference (T/R) related to the environmental influence of the business to CONAMA, and must do a full environmental assessment, only when CONAMA judges it necessary. In case of Category 3, environmental assessment shall be carried out in all cases. The main items stipulated in the guideline are shown below:

- CONAMA can summon the person responsible for the project and the survey, to a meeting to explain the contents. Whatever agreed at the meeting shall become binding with the signature of all the members.
- The report of environmental assessment shall be examined publicly at the office of CONAMA after the technical evaluation and procedure for approval. In this case, a summary of less than 15 pages is necessary.
- The period of evaluation by CONAMA shall be more than 30 days and less than one third of the period taken for the environmental assessment.
- When some shortage is found in the evaluation of the environmental assessment report, CONAMA shall provide an opportunity for explanation of questions or supplementary explanations.

The consultant who may execute the environmental assessment shall be selected from among 30 or more companies registered in the SEGEPLAN.

7.2 Social Environment

(1) Resettlement

There are many squatters settling in Guatemala City as shown in Figure 7.2. The number of the areas occupied illegally is about 200, and the number of squatters inhabiting there is 425,000.

For squatters around right of way of the FEGUA, the resettlement plan has been executed. The relocation plan is shown in the Figure 23.1. But this resettlement program has not been implemented well because of the poor conditions of areas to be transferred to.

(2) Traffic and Public Facilities

The public transport within the project area consists of the following types. Compared to the buses, the contribution of taxis to the urban transport is marginal.

- Buses (Urban buses, Urban minibuses, Extra-urban buses)
- Taxis

The condition of buses is bad, because most of the units are 20-30 years old. The average production year of the buses is 1976, and the actual life is as long as 25 years.

The seats are in most cases of wood and the buses have to be repaired almost every week. Mufflers are not attached to the units, resulting in adverse environmental effects.

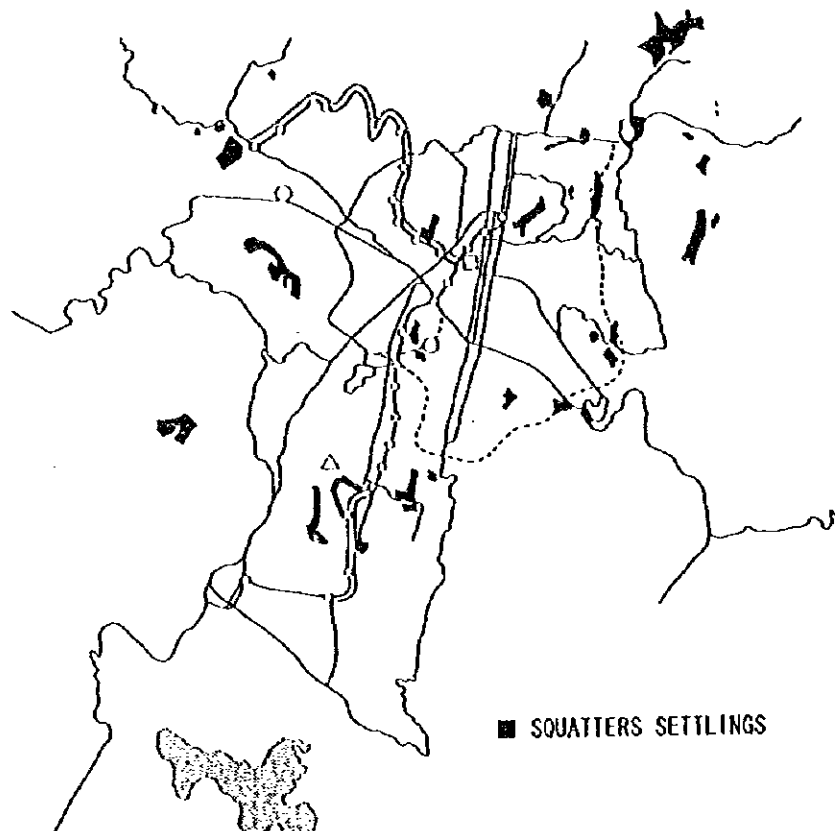


Figure 7.2 Squatters Settlement

(3) Historical Heritage

Guatemala City is developed after the transfer of the capital city from Antigua in 1773, but there is much ancient historical heritage there.

The most famous one is Kaminal Juyu, engulfed today in a western suburb of the city, but formerly was an important ancient city. In fact, it was once the largest city in the country's highlands, with a sophisticated level of the art and the writing as early as 400 BC. In later centuries, the city is believed to have had close links with the great city state of Teotihuacan, and declined around the same period soon after AD 600. The archaeological remains of Kaminal Juyu have only been partly excavated, and the present-day visitors unfortunately can get little sense of the scale or importance because what can be seen is mainly mounds of overgrown earth.

(4) Waste

Solid waste collected in the Metropolitan Area of Guatemala represents 60% of the generated waste (1,650 ton/day), the remaining 40% is thrown into open dumps, over 500 clandestine dumps, alongside the roads, bridges, and lakes and river shores. The main waste disposal site in the Metropolitan Area is the Zone 3 (El Trebol) rubbish dumps, where there is no separation between domiciliary waste and waste coming from industries or hospitals.

Solid waste collection is mainly done by nearly 250 small companies operating in the Metropolitan Area. With a fleet of 300 trucks, the majority of which are inadequate, 15 or 20 manual carts, 40 animal traction carts and 930 people are employed. The charge for the service is imposed on households and the rates are determined individually.

(5) Disaster

The greatest disaster Guatemala City has ever experienced is landslides generated by the earthquake. The great Guatemala earthquake with a magnitude of 7.5 on February 4, 1976, which generated more than 10,000 landslides throughout the Area in an approximate area of 16,000 km². These landslides caused hundreds of fatalities as well as extensive property damage. Landslides disrupted both highways and the railroad system and serious damages and losses of life were caused due to ground failure beneath dwellings built too close to the edges of steeply incised canyons. The highest density of landslides occurred in the western highlands of Guatemala City.

The landslide distribution was observed to be dependent on five major factors: (1) seismic intensity; (2) lithology, 90 percent of all landslides were within Pleistocene pumice deposits; (3) slope steepness; (4) topographic amplification of seismic ground motion; and (5) regional features. The presence of pre-earthquake landslides did not have apparent effects on the landslide distribution, and landslide concentration in the Guatemala City does not correlate with the local seismic intensity data.

7.3 Natural Environment

(1) Topography and Geology

The orography and morphology of the Guatemala Valley is the result of deformation caused by natural climatic agents (rock destruction) and erosion of volcanic deposits, sedimentation and Plutonic rocks which existed before the volcanic activities.

The western border of the Guatemala Valley to is the Mexico Fault, which runs from San Juan Sacatepequez to the western coast of Amatitlan Lake. In the northern part, the limits are the raised blocks of Cretaceous limestone, limited mainly by intrusive and metamorphic rocks of the Paleozoic. The distribution of Mesozoic group is limited by the Jalpatagua Fault which traverses through this region from the south-west to the north-east; clearly importing some part of its vertical movement to formations involved in the northern escarpment of the Amatitlan Lake. In the southern part of this fault, an eruption complex of the Pacaya Volcano and the Agua Volcano stratum can be seen. The distribution of the geology is shown in the Figure 7.3.

(2) Soil Erosion

1) Susceptibility to erosion

The area which is highly susceptible to erosion covers about 23% of Guatemala Department and includes the towns of Mixco, Villa Nueva, Amatitlan, Villa Canales, Fraijanes, San Jose Pinula, Chinautla and Guatemala, as shown in Figure 7.4

2) Landslides Areas

The landslide area are shown in Figure 7.5

(3) Ground Water

The Underground water is stored in the materials formed by the tectonic depression or graben, known as the Guatemalan Valley.

(4) Hydrological Situation (River Basins)

The Metropolitan Area is divided into two basins by the watershed boundary. In the northern basin the Las Vacas River runs, and the Michatoya River flows the in the southern basin.

The boundary of the watersheds crosses Guatemala City, with a direction from the north-east to the south-west, following the direction of the Calzada San Juan - El Trebol - Puerta Parada, dividing the city into two parts, the northern part of which is geologically the oldest (Ministry of Transportation, Communications and Public Works (MTCP), 1978). The limits of the northern basin have been marked by the basin of the Las Vacas River up to the hydrometer station of San Antonio Las Flores (Chinautla town). This river is flowing to the Motagua River (MTCP 1978). The southern basin limit follows the basin of the Villalobos River, the Amatitlan River and the Michatoya River, up to the hydrometric station of Palin (town of Palin, Escuintla). The Michatoya River is flowing to the Maria Linda River.

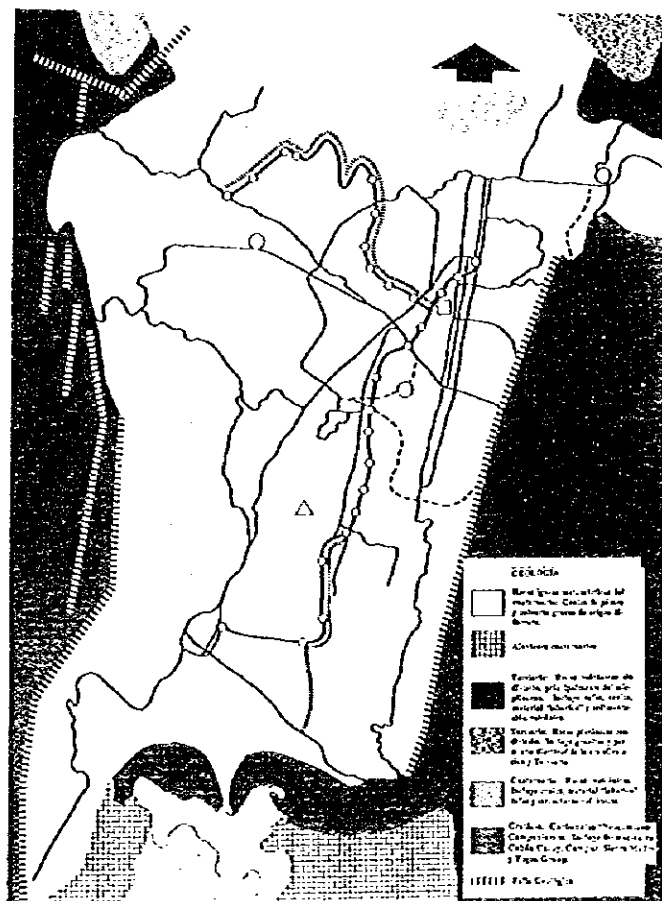


Figure 7.3 Geology

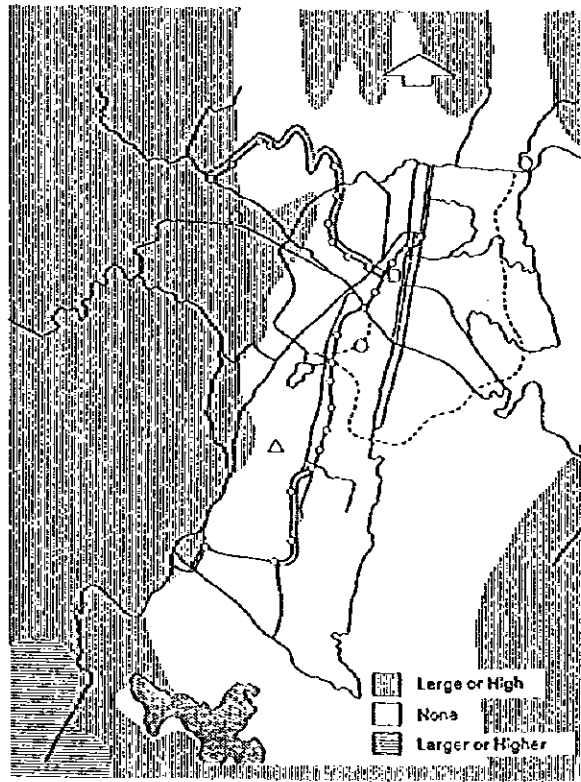


Figure 7.4 Susceptibility to Erosion

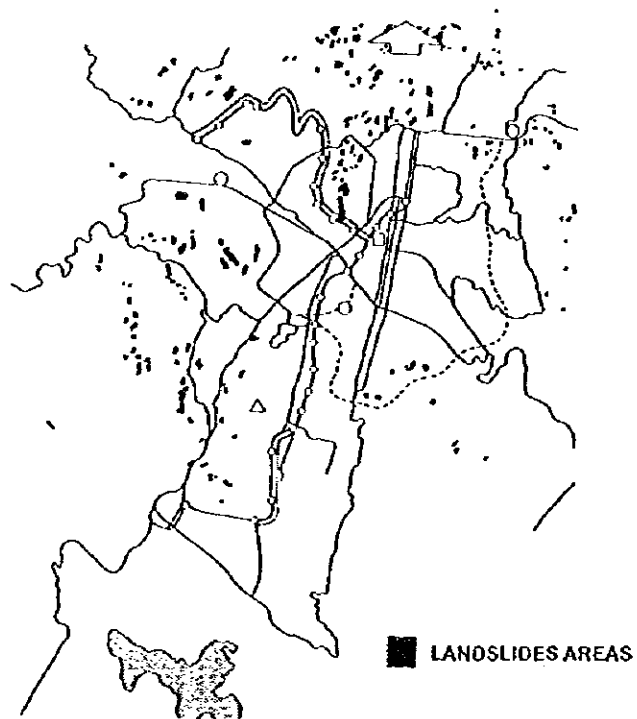


Figure 7.5 Landslide Area

(5) Flora and Fauna

1) Life Zone

The life zone in the Suty Area is shown in the Figure 7.6. The Metropolitan Area has four zones of life. In each zone vegetal formations grow corresponding to the climatic factors.

The zone with more intense growth is the mild sub-tropical humid forest bh-S (t), with an area of approximately 6%. This zone is located in Guatemala City, Amatitlan, San Miguel Petapa and Villa Nueva, where it covers almost the whole town. The zone also covers a large part of San Raimundo, San Pedro Ayampuc, Chinautla and San Juan Sacatepequez. The Project is planned in this zone.

The natural vegetation is mainly consists of the *Pinus Oocarpa* (red pine tree), *Curatella americana* (cow's tongue), *Quercus sp.* (Oak tree), *Byrsonimia Crassifolia* ("Nance" fruit) among others (De La Cruz, 1982).

2) Forest

According to the report of Escobar (1989), the area with forest cover for the Metropolitan Area is 498 km² of pine trees and 45 km² of "latifoliadas" leaves. During the years 1976 to 1988, reforestatus has been come out in this region: 5,185 ha. through Government projects and 126.65 ha. by projects with fiscal incentives of the Government.

In the Metropolitan Area predominant areas without forest (61%) are the towns of San Miguel El Golfo, Chuarrancho, San Pedro Ayampuc, San Raymundo, Chinautla, San Juan Sacatepequez, San Pedro Sacatepequez, Mixco, Villa Nueva, Amatitlan, Villa Canales, San Miguel Petapa, and Santa Catarina Pinula. Open forests share 37% of the Area, located in Palencia, San Jose Pinula, Fraijanes, San Miguel Petapa, Villa Canales and almost all of Guatemala City.

The region of San Juan Sacatepequez has dense forests of 2.2% of its area. In Guatemala City, 90% of the forest covers are located mainly in the ravines of the northern basin, such as those near the rivers of Zapote, Zelaya, Las Guacamayas, El Naranjo, La Barraca and Las Vacas. In the southern basin there are important ravines of the Pinula River, Guadron, Molino and Villa Lobos.

3) Fauna

A study on birds was made during the period from 1942 to 1947, near the surroundings of Amatitlan Lake, Fraijanes, Villa Nueva and Guatemala City. The report indicates that it was Amatitlan Lake where most of the species grow. A study made in 1971 did not cover all the national wild fauna, reporting that the following species grow in the Department of Guatemala (IGM. 1972):

Birds: frontino or white gula pecho duck, chano, short duck, collarejo, espumui dove, woodpecker, cheje, owl, water zenzontle.

Wild Mammals: deer, rabbit, squirrel, taltuza, wild cat, weasel, jaguar, puma, tacuazin, leopard.

Reptiles: cantil, mazacuata, vigor, sabanera.

Campbell and Vannini (1989) divided the Metropolitan Area into the five fauna zones which include 180 amphibian species and reptiles. The fauna zones in the Area are shown in Figure 7.7.

The main zone of fauna is located in the eastern highlands of Guatemala City (Jalapa Area) which is used as a dispersion route. This zone contains many species adapted to the arid conditions. The Las Vacas River demarcates a sudden rupture between this zone and the sub-area of Chimaftenango.

The sub-area of Chimaltenango is also a subdivision of the Huehuetenango Area and includes the highlands in the western part of Guatemala Department (San Juan Sacatepequez, San Raymundo, Chuarrancho, San Pedro Sacatepequez and Mixco). The Huehuetenango Area has some endemic species, mainly amphibians and among them various salamanders.

The Fuego Zone represents steep slopes located in to the southern part of the Department of Guatemala (Villa Canales, Amatitlan, Villa Nueva and Petapa). The number of species in this zone is moderate. There are some species of salamanders and frogs. The Escuintla Zone is located in the southern part of the Department (Villa Canales) and does not have endemic species. The upper and middle part of the Motagua Valley and its tributaries includes a small area of the northern part of the zone. The corridor of Jafapa Zone has contributed to the dispersion of many species to the Motagua Valley. In the Villar study (1991), 92 bird species are reported in the Capital City. Among them, are included; doves, tortolita, guirguiras, gorrións, woodpecker, chipitos, calandrias, quitriques and chorchas.

Among the micro-fauna studies of the Metropolitan Area there is one made by Peckman (s.f) in 1951, which reports the diversity of zoo-plankton in the Amatitlan Lake represented by several groups:

- Copepod (the most important group) represented by *Mesocyclops Inversus*, *Diaptomus*, *Amatitlan Ensis*.
- Rotatoria with the species of *Keratella*, *Cochlearis*, *Asplanchnia*, *Brightwellii*.
- Cladocera with the species of *Daphnia*, *Longispina*, *Ceriodabnhia Lacustris*, *Ceriodaphnia pulchella*.
- Protozoa with few species predominates *Centropyxis Aculeata*.

4) Flora

The Stanley study (1970) reports 28 family species of endemic plants with 47 species in the Area .

The Amatitlan Lake is the most studied region in the Area. Studies on Fitoplankton of the lake indicate a large diversity in species (CATIE, 1987), among them; *Cyanothiceae*, *Microcystis*, *Areuginosa*, *Microcystis* sp, *Lymngbya Limnetica*, *Merismopedia* sp, *Nostoc* sp.

5) Threatened Species

In the Metropolitan Area, with the decrease of densely forested areas (today only 2% of the Department), habitats of animal and vegetal species have been reduced. Therefore, with the loss of forests, the biodiversity has faded away. Among the main causes of the phenomena is urbanization.

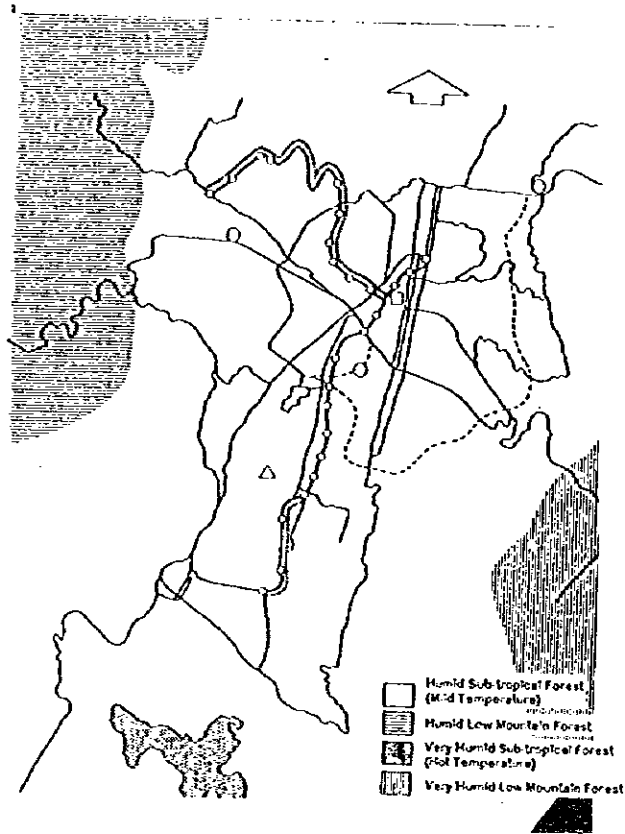


Figure 7.6 Life Zones

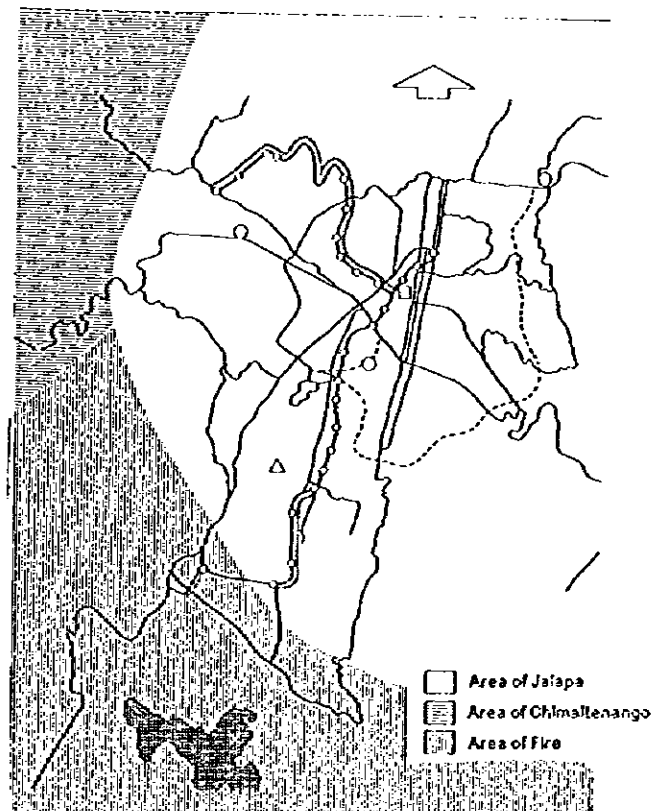


Figure 7.7 Area of Fauna

6) Climate

According to Thornwaite (IGN, 1975), the following climate division can be seen over the Metropolitan Area:

- In the northern part, the climate is dry and hot with a benign dry winter. This division includes a part of Chuarrancho, San Juan Scatepequez, San Raimundo, San Pedro Ayampuc and San Jose El Golfo.
- In the north-eastern and southern part, the climate is humid semi-hot with a benign dry winter. Among the towns which are located in this division are; San Juan Sacatepequez, San Pedro Sacatepequez, Mixco, Guatemala City, Villa Nueva, Petapa, Villa Canales and Santa Catarina Pinula.
- In the eastern part, the climate is humid semi-hot with a benign dry winter. This type of climate spreads on all the towns of; San Jose Pinula, and a part of Fraijanes, Santa Catarina Pinula and Guatemala City.
- In the southern part of Amatitlan Lake, the climate is semi-hot without a well-defined cold season, humid with dry winter.

(6) Landscape

The Green Area for Protection is shown in Figure 7.8

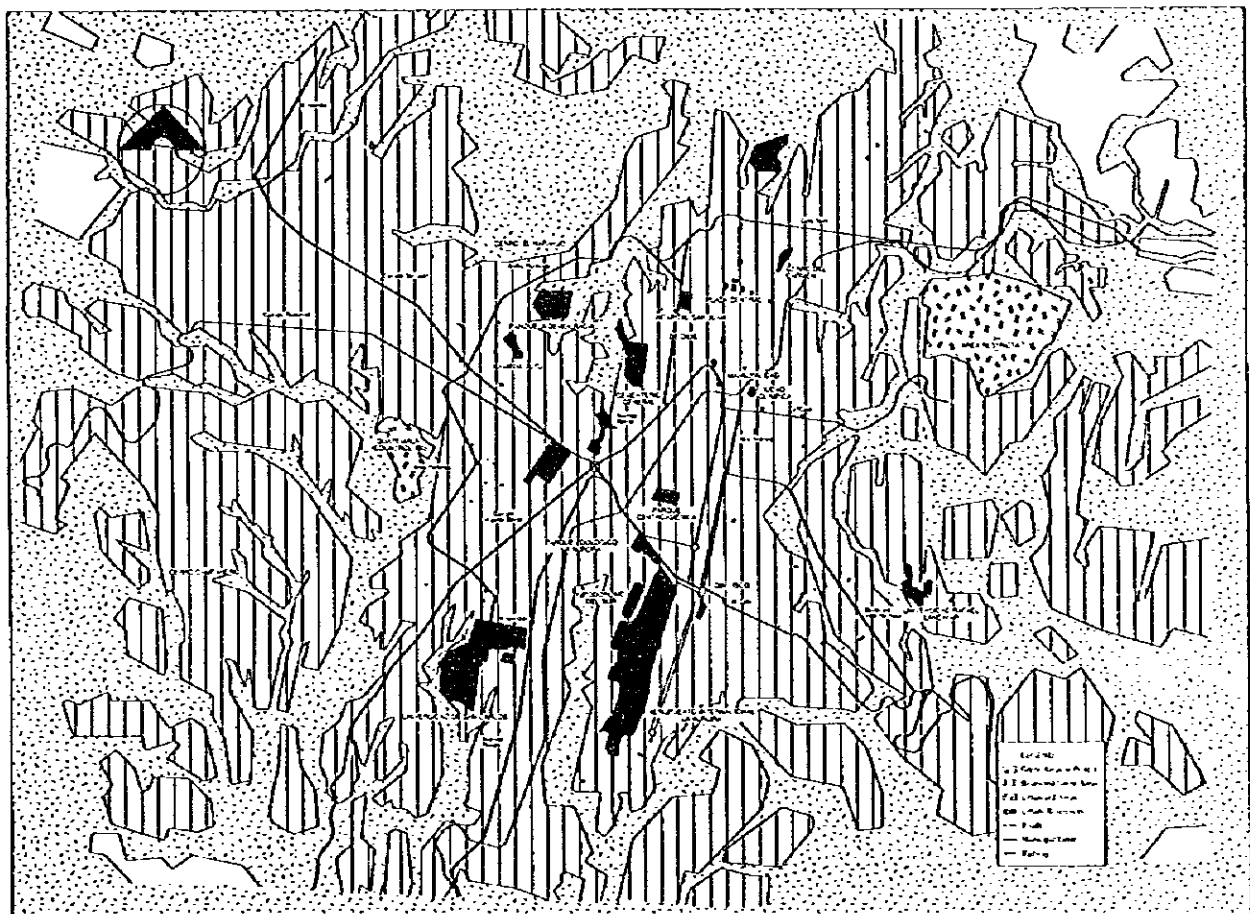


Figure 7.8 The Green Area for Protection

7.4 Pollution

(1) Air Pollution

1) Air Pollution

Field surveys were carried out as indicated in Table 7.1, and at the locations indicated in Table 7.2 and Figure 7.9.

Table 7.1 Summary of Measured Items

Measured Items	No. of Measuring points	Measuring Interval
SPM (Suspended Particulate Matter)	10	3 days
Pb (Lead)		
No _x		
Weather Condition (Climate, Wind speed, Wind direction)		

Table 7.2 Date of Measurement

Point	Localization	Measuring Date	
		Air pollution	Noise
1	Fire Station (Anillo Periferico)	14th-17th Nov.	14th Nov.
2	School Lindo Arcoiris (Nueva Monserrat)	14th-17th Nov.	14th Nov.
3	Shell Gas Station (Zone 7, Carr. Roosevelt)	14th-17th Nov.	15th Nov.
4	Central de Mayoreo (Zone 12, Villalobos I)	8th-11th Nov.	8th Nov.
5	Shell Gas Station (Zone 12, Av. Petapa)	8th-11th Nov.	9th Nov.
6	Taller EMPAGUA (Zone 7, Col. Landivar)	8th-11th Nov.	8th Nov.
7	Burger King (Zone 18, Metronorte)	14th-17th Nov.	15th Nov.
8	Metropolitan Gas Plant (End of Petapa)	14th-17th Nov.	16th Nov.
9	Terminal of Buses (Zone 4)	8th-11th Nov.	9th Nov.
10	Municipality of Guatemala (Zone 4)	21st-24th Nov.	10th Nov.

* Measurements of noise and traffic volume were executed from 7:00 A.M. to 6:00 P.M.

a) SPM

SPM is extremely high at point 8 (end of Petapa Road) on an unpaved road.

SPM is low at Point 4 (CENMA) where influence of roads is small. Compared with the U.S. Environmental Standards, it exceeds the limit at all points except point 4 and Calzada Roosevelt. The reasons are considered to be dust from the unpaved roads and the exhaust gas from diesel vehicles and from factories, and garbage burning. Compared with the Environmental Standards, the pollution by SPM is the most serious.

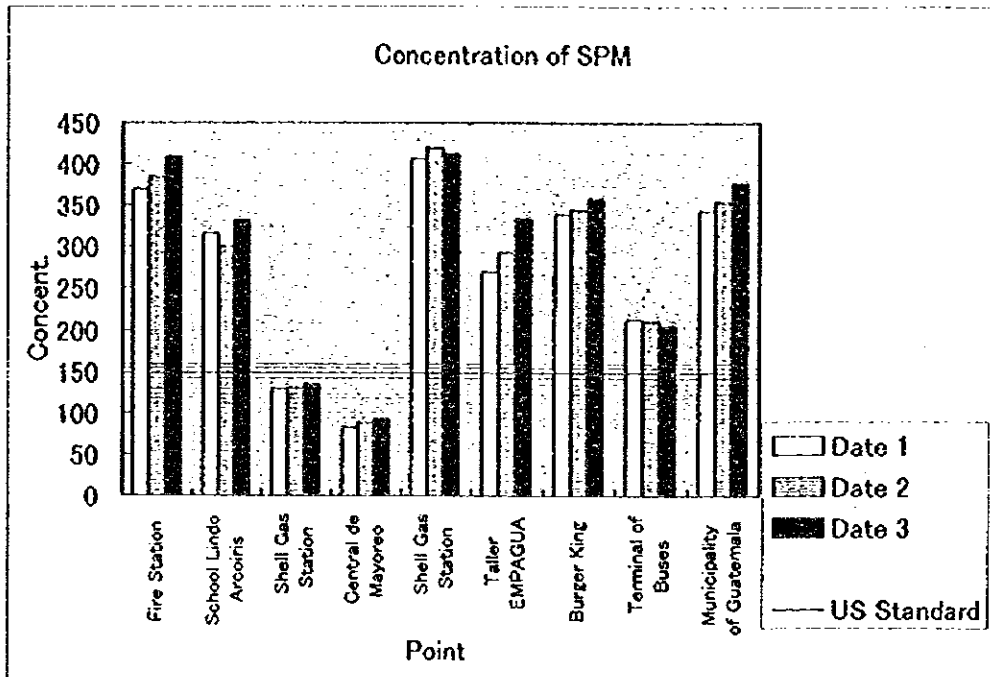


Figure 7.9 Measured Result of SPM ($\mu\text{g}/\text{m}^3$)

b) NO_2

Although the daily average is not indicated in the Environmental Standards of the United States, assuming that double value of the yearly average is the daily average, measured results at Points 1, 5, 7, 10, located along the principal road and point 9 at a bus terminal are above the standard. This means that the influence of exhaust gas from vehicles is large.

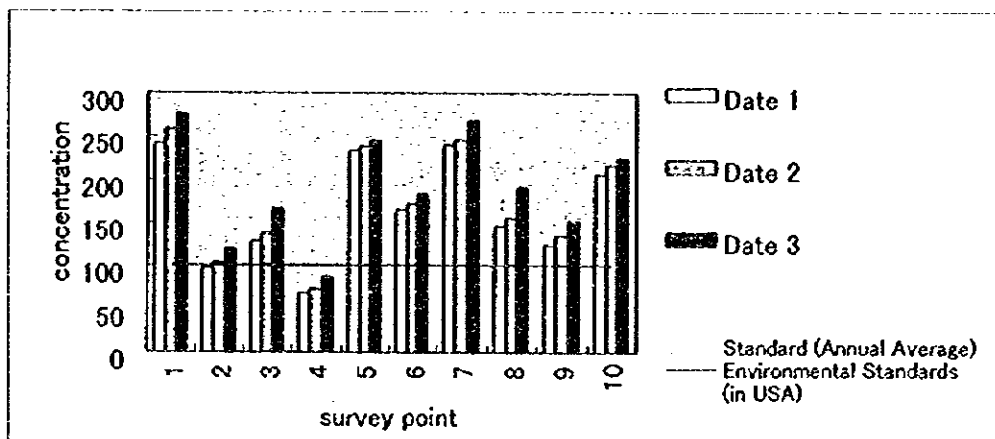


Figure 7.10 Measured Result of NO_2 ($\mu\text{g}/\text{m}^3$)

c) SO_2

SO_2 is high at Points 1, 3, 5, 7 and 10 located along the roads of heavy traffic. It is low at points 4 (CENMA) and 2 (School Lindo Arcoiris) where there is little influence of roads.

Compared with the U.S. Environmental Standards, the results satisfy the standards at all points for the present. The reasons are considered to be that there are no large scale factories and that heating is not required because of the climate.

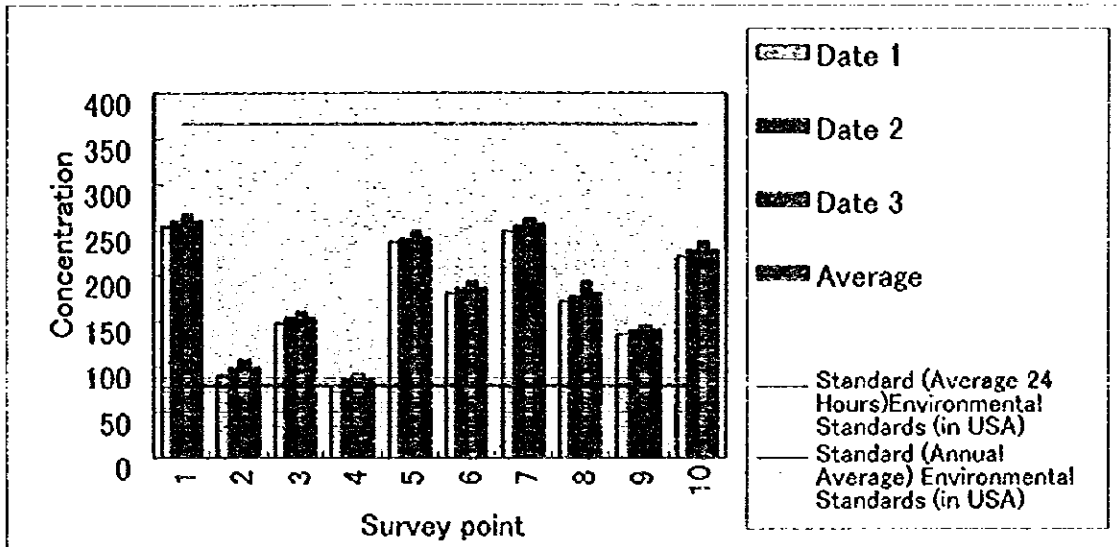


Figure 7.11 Measured Result of SO₂ (µg/m³)

2) Issues on the Air Pollution

Both nitrogen dioxide and sulfur dioxide are in high concentration at principal arterial roads with heavy traffic and at bus terminals. From this fact, it is clear that the influence of exhaust gas from vehicles is large. The value of SPM is generally high, meaning that the City is generally dusty. It is considered that this is due to the influence of vehicle exhaust, especially that from diesel and of dust particles from unpaved roads.

At present SPM and sulfur dioxide are above the U.S. Environmental Standard. The SPM is above the standard at all points on the roads. This is a serious problem. The situation is considerably worse than the level in developed countries like Japan, and urgent countermeasures are required.

With respect to nitrogen dioxide, the condition, except on principal arterial roads, is not serious yet, compared with the conditions in Japan, but the pollution in future is forecast to become heavier with the increase of number of vehicles and traffic, so urgent countermeasures should be expected.

Due to the low level of Pb measured in the surveys, it can be said that fuel in Guatemala is free of any lead additives. On the other hand, SO₂ levels measured were below the limits established by the U.S. Environmental Standards. Unfortunately, the same cannot be said of NO₂ levels, which were mostly above the limits set by the Environmental Standard. As can be seen from the SPM measurements, the factor that affects the level is the type of environment (road roughness, nearby factories, etc.) close to the points, not the type of vehicles passing by, nor their number.

The behavior of the pollution levels of SO₂ and NO₂ at each of the points was identical even on different dates, probably because the both have common sources. This is verified by a statistical analysis, which gave a 0.993 value of Peasons's r, showing a high correlation between these two parameters

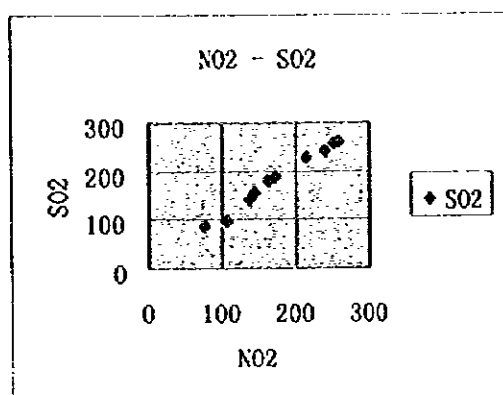


Figure 7.12 Correlation between SO₂ and NO₂ Levels

The statistical analysis showed that the SO₂ and NO₂ pollution levels have little to do with the SPM levels or with vehicular density.

3) Results of Air Pollution Monitoring in Proeco

Proeco is an environmental improvement program which is conducted in Central America by Swisscontact, and air pollution monitoring is executed in Guatemala City in cooperation with San Carlos University. The number of measurement points are 6, as illustrated in Figure 7.14, and measured items are SPM, NO₂, O₃ and CO.

NO₂ and O₃ almost satisfy the Standard, but SPM and CO are above the Standard at "PN" near Trebol and at "EFPEM" near Petapa, which means the influence of vehicle traffic is important. Concerning the variation of density with season, a clear tendency cannot be discerned with the one-year measurement results.

According to the studies made in Proeco, between 60 and 70% of the pollutants discharged to the atmosphere came from vehicles in Guatemala City. The problem is getting worse due to the import of a large number of used vehicles, and there is no major of control, especially for cars, and most of circulated vehicles contaminate the air with gas, particles and fumes.

The emission limits regulated by law are given as below.

- 4.5% Vol. of CO and 800ppm of HC (for gasoline)
- 6.0 UB (for diesel)

According to the examination in Proeco in 1995, 68% of gasoline powered vehicles and 30% of diesel powered vehicles are within the legal limits established. as shown in Table 7.4.

Table 7.3 Measured Result of Exhaust Gas Conditions

Item Type	No. of samples		for gasoline		for diesel	% of approval	
	Gasoline	Diesel	CO(%)	HC(ppm)	U.B.	Gasoline	Diesel
Sedan	2974	48	2.45	300.0	7.30	65.16	2.08
Bus	77	12	2.44	290.0	6.90	63.64	25.00
Pick up	518	52	2.00	270.0	8.00	65.06	21.15
Truck	4	13	4.5	384	3.7	50.0	92.31
Jeep	69	5	2.70	250.0	5.24	72.46	20.00

(2) Water Pollution

Wastewater generated in the northern part of Guatemala City is discharged to rivers and valleys without treatment and the rivers function as open sewage channels. There is hardly any sign of the existence of flora and fauna in the rivers.

Water quality and flow-rate survey carried out in the vicinity of the proposed site of central waste water treatment plant along the Las Vacas River, the Chinautla River, and the Tzalja River, and near the Gran Collector North Out-fall near Belice Bridge, during December 1995 to February 1996 (dry season) show the average water quality of six measurements on different days. Average BOD of the Las Vacas River in downstream of Gran Collector Out-fall is 309 mg/liter, which is reduced to 227 mg/liter just before the confluence with the Chinautla River due to natural purification. BOD of the Chinautla River and the Tzalja River are 190 and 150 mg/liter, respectively. Due to dilution with river water and natural purification, average BOD of the Las Vacas River near the proposed plant site is 178 mg/liter.

(3) Noise

To identify the present noise level from vehicle in Guatemala City, A survey was carried out.

Table 7.4 Summary of Noise Measurement

Measured Item	10 points * 12 times	Noise Level (LAeq)
No. of measuring Points and times		10 points each 12 times
Measured traffic condition		Traffic volume, Traveling speed

Noise levels at sampling points are indicated in Table 7.5. The point numbers is the same as those for the air pollution survey. At Points 1, 5 and 7 on the principal roads, the daily average noise level is over 80 dB(A). At these points, the level is high all day, and hardly varies. At Points 2 and 4 where the influence of vehicle traffic is small, the level is considerably lower. Although there is no adequate standards for comparison, a daily average over 80 dB(A) is abnormally high. The reason is considered to be a lack of mufflers of heavy vehicles.

Table 7.5 Measured Result of Noise (Unit: dB(A))

No. of measure	Time	Point									
		1	2	3	4	5	6	7	8	9	10
1	(7:00)	85	59	73	57	81	70	79	76	76	75
2	(8:00)	80	58	73	56	80	68	81	67	72	80
3	(9:00)	86	58	74	63	78	65	82	69	72	76
4	(10:00)	81	58	75	67	80	72	80	66	75	74
5	(11:00)	80	58	75	67	83	70	80	66	75	75
6	(12:00)	80	58	75	65	81	71	82	67	73	75
7	(13:00)	77	57	74	66	81	72	80	66	75	75
8	(14:00)	80	58	74	65	80	70	81	67	76	73
9	(15:00)	81	57	74	58	81	73	82	67	78	76
10	(16:00)	81	57	74	55	83	75	81	66	82	74
11	(17:00)	80	63	74	56	80	75	82	64	70	77
12	(18:00)	80	63	75	63	81	71	82	65	81	77
Average		81	59	74	62	81	71	81	67	75	76

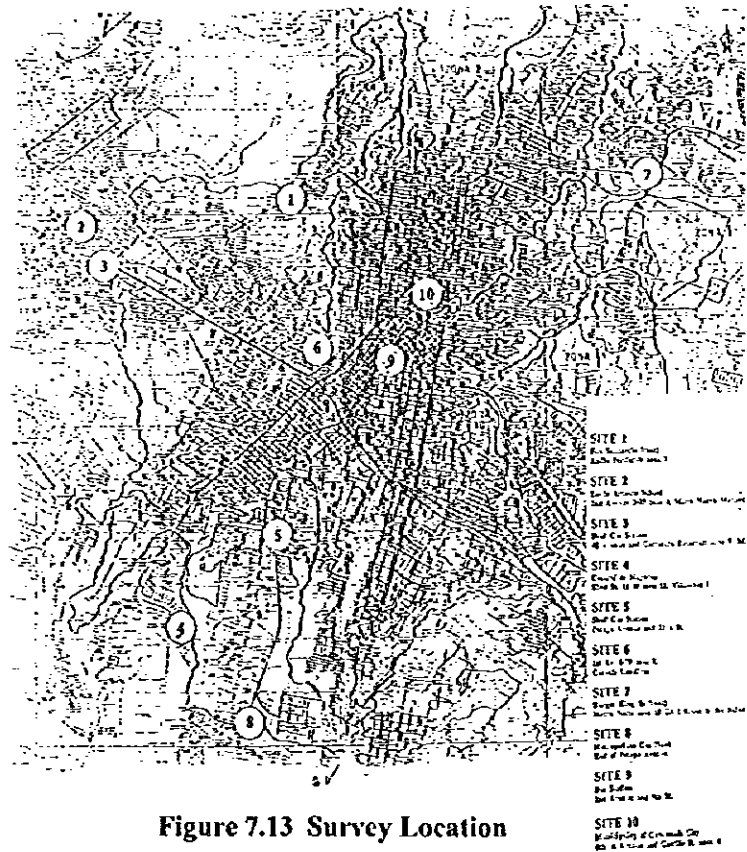


Figure 7.13 Survey Location

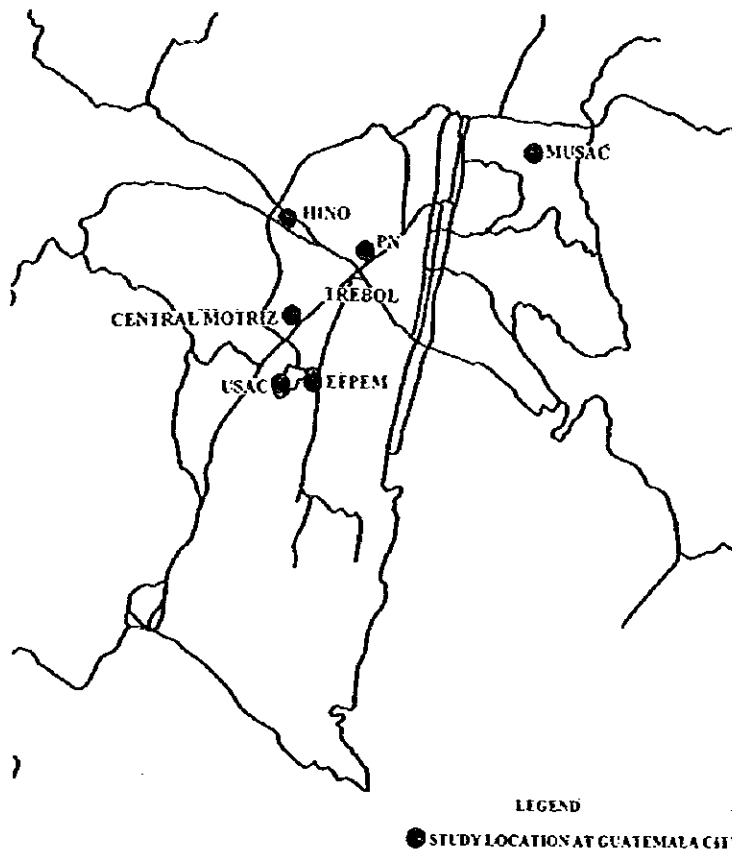


Figure 7.14 Air Pollution Monitoring Points in Proeco

7.5 Present Environmental Issues

(1) Summary

1) Resettlement

For the construction of the East West Corridor, Petapa Road, the Exclusive Busway-FEGUA Route, and the Urban Bus Center, it is necessary to remove the existing houses.

The occupation in some part of right of way of the FEGUA site, where a exclusive busway route is proposed, started in 1917 and the population has continued to increase after repeated evacuation and invasion. During the last two decades, the increase was very sharp due to the disaster by earthquake in 1976, refugee from armed conflict and lack of appropriate housing program. The last evacuation was enforced in June 1996 when the inhabitants there had reached 1,973 families. This evacuation was executed based on an agreement between representatives of the government and the group of inhabitants. However, situation did not change and the vacant area was occupied immediately by other groups. It is reported that some of transferred families had returned to the same place because of traffic inconvenience in newly prepared land.

The present population of the place is estimated at 20% more than the previous population. Although FEGUA intends early solution including legal procedure, the government policy is to promote voluntary displacement by offering substitutive lands. The representatives of inhabitant group are consent of this policy. A transversal committee composed by interested government authorities has been organized and various alternatives of substitutive settlements are being studied by this committee.

Spread of slums in Guatemala City including occupation of right of way of the FEGUA is one of social problem of the country, strong policies of the government not only to provide housing program but also to eradicate poverty is necessary for the solution of this problem. There is national consensus in this county to recognize this social problems and to eradicate such problems. The Peace Process is a step to alleviate social problems. The success of the Peace Process may decrease the pressure of inflow of the people to the City such as refugee from conflict area and immigration by economic reason which is one of main reasons of urban slum problem.

Thus, it is expected that the transfer of illegal residents along FEGUA may be executed shortly and the site for Exclusive Busway-FEGUA Route will be vacated without further invasion.

Also concerning the East West Corridor, 450 houses are included in the project site, even in Alternative B, and resettlement measures will be necessary for the implementation.

Similarly in the project site of the Urban Bus Center, there are many illegal stalls, the number of which is not yet known. Detailed consideration of a removal plan will be necessary before carrying out the project.

2) Economic Activity

In the project site for the Urban Bus Center, economic activities such as shops are prevailing. Concerning these shops, some space for shops, etc., should be included in the planning to make the commercial activities possible. The plan should correspond to the CENMA project.

3) Traffic and Public Facilities

In the sites of the road and facility projects, principal urban facilities do not exist. For the exclusive busway, the use of the right of way of the FEGUA is planned. Coordination with FEGUA shall be made before the implementation of the project. At the crossing points of the FEGUA Route and existing roads, it is forecast that traffic jams on the existing roads will occur in the future. The traffic jams may possibly become worse and also traffic accidents may be caused in case of at grade intersection.

4) Splitting of Community

The project site of the planned roads are designed mostly along existing roads or on the existing railway, and so the existing community will not be split. However, the FEGUA railway is not actually in frequent operation. Accordingly, at the principal crossing points of the Route with other pedestrian or vehicle traffic, consideration should be given to the planning of important intersections by grade separation.

5) Ruins and Historical Sites

In the project sites, existence of ruins and buried cultural heritage have not been confirmed. However, the project site of the East West Corridor is contiguous to Kaminal Juyu ruins. A detailed survey will be necessary before the construction.

6) Water Rights and Common Rights

There is no river which has water rights in the vicinity of the project roads and facilities.

7) Health and Sanitation

It is judged that the planned projects will not negatively affect health and sanitation, provided that adequate measures are taken if food markets are introduced in the bus terminals.

8) Waste

Some effects due to the removal of surplus soil during construction can be expected. Consideration of waste management will be necessary.

9) Hazards

There are places of landslide risk in the cut section of the Petapa Road. Measures for safe structures and construction shall be considered.

10) Topography and Geology

According to the existing data, the detailed position of the fault in the Guatemala Metropolitan Area is identified. Consequently it is very important to study in detail the results of geological survey and standards at the stage of detailed design.

11) Soil Erosion

In the Petapa Road project and the Exclusive Busway-FEGUA Route project, cut slopes are designed because of the longitudinal alignment. In these sections, erosion control by planting on slopes or slope protection and drainage will be necessary.

The East West Corridor is planned to cross some steep valleys. For the construction in those areas, adequate slope protection against soil erosion shall be considered and adopted.

12) Ground Water

It is possible that the ground water aquifer at the steep valley section is cut off by the banking structure of the East West Corridor and also that the aquifer is cut by the cut section of the Petapa Road. Because of lack of available existing data on the aquifer, a survey such as a boring survey shall be necessary at the implementation stage.

13) Hydrological Situation

There is no large-scale river improvement project. The Petapa Road will cross the river, and measures to minimize the influence on the river will be necessary at the design and implementation stages of the bridge piers.

14) Flora and Fauna

According to the existing literature, flora and fauna of special importance have not been observed in the Guatemala Metropolitan Area.

In Guatemala City several zones are designated to be planted, and the East West Corridor passes some of these zones. Transplanting of the trees removed during construction and planting and restoration after the completion of construction should be taken care of.

15) Climate

The implementation of the planned project will not influence the climate.

16) Landscape

In the project sites, there are no famous viewing sites of special importance. However, in elevated sections and bridge areas, attentions to the landscape shall be necessary to for harmonize with the surrounding buildings.

17) Air Pollution

Because of use of project roads and transportation facilities, the surrounding residents may experience air pollution. If the existing poor maintenance conditions of vehicles is not improved, it can be easily surmised that air pollution in Guatemala City will become worse from now on, too.

Against these conditions, overall measures will be necessary to promote the improvement of the maintenance and the observance of the exhaust gas standards by the spread of vehicle maintenance facilities such as the Bus Inspection and Maintenance Center, a part of the project, and also to promote decreasing the exhaust gas quantity.

Through the construction of the project, roads such as the East West Corridor, Petapa Road, Exclusive Busways, and the Urban Bus Center and the three Inter-regional Bus Terminals, traffic jams caused by the concentration of traffic on main roads in the City will be reduced. There may also be improvement in the total exhaust gas quantity due to the reduction of the total running kilometers per unit.

18) Water Pollution

Some effects on the water quality can be forecast at the banking and the river near crossing points in the steep valleys during construction.

Furthermore some treatment measures for waste water and oils and greasy components caused by operation of the Bus Inspection and Maintenance Center shall be necessary.

19) Soil Contamination

Soil contamination along the roadside caused by exhaust gas due to the projected roads may possibly be considered, but this will not be a problem because of the lead-free gasoline in use.

20) Noise and Vibration

Actually mufflers of almost all heavy vehicles (buses, trucks) which operate in the City are not maintained well or removed. Even now the noise level caused by vehicle traffic is very high. Even if the vehicle traffic is dispersed by implementation of the project, a big change in noise level will not be realized unless the conditions of mufflers are improved.

Therefore, raising the engine maintenance standards and levels, and the obligation of attaching mufflers, which are basic points, for air pollution as well, should be emphasized.

21) Ground Subsidence

At the banking structures of the East West Corridor at the steep valleys, ground subsidence may be unavoidable in the long run, so measures and maintenance will be necessary.

22) Offensive Odors

There will be the influence of exhaust gas from vehicles caused by imperfect combustion.

Similarly against the noise and air pollution, there is no effective countermeasure without identifying the cause in each vehicle. It is desirable that general measures for vehicle engine maintenance, for which the Bus Inspection and Maintenance Center represents a model, shall be promoted.

(2) Preliminary Results of Initial Environmental Examination

The preliminary results of the initial environmental examination by the Study are summarized as shown in Table 7.7. The evaluation made through the surveys, analyses of the existing information and the site investigation was classified into the following four grades:

- A: Serious impacts can be anticipated.
- B: Impacts can be more or less anticipated.
- C: Unknown (Further investigation will be required.)
- D: No impact be anticipated.

It is considered that the environmental impacts and the mitigation measures should be further studied for the items marked with 'A', 'B' and 'C'.

Table 7.6 Summary of Environmental Condition

Project Environmental Item	E-W Corridor (include Bus Way)	Avenida Petapa	Bus Way (on FEGUA)	Urban Bus Center	Interregional Terminal			Bus Inspection Center
					North	West	South	
Resettlement	A	C	A	C	C	C	D	
Economic Activity	D	D	D	B	D	D	D	
Traffic and Public Facilities	B	B	B	B	B	B	B	
Split of Community	B	C	B	D	D	D	D	
Ruins and Cultural Heritages	B	D	D	D	D	D	D	
Water Right and Right of Common	D	D	D	D	D	D	D	
Health and Public Hygiene	D	D	D	D	D	D	C	
Waste	D	D	D	C	C	C	B	
Natural Disaster	C	C	C	D	D	D	D	
Topography and Geology	C	C	C	D	D	D	D	
Soil and Erosion	B	B	B	D	D	D	D	
Ground Water	C	C	D	D	D	D	D	
Hydrological Situation	B	C	C	D	D	D	D	
Flora and Fauna	B	D	D	D	D	D	D	
Climate	D	D	D	D	D	D	D	
Landscape	B	C	B	B	C	C	D	
Air Pollution	B	B	B	B	B	B	B	
Water Pollution	C	C	C	C	D	C	B	
Noise and Vibration	B	B	B	B	B	B	B	
Soil Contamination	D	D	D	D	D	D	D	
Ground Subsidence	C	D	D	D	D	D	D	
Offensive Odors	C	C	C	C	C	C	C	

- A Serious impact will be anticipated.
- B Impact will be more or less anticipated.
- C Unknown (it is necessary to investigate)
- D No impact will be anticipated.

III PROJECT FORMATION

III PROJECT FORMATION

8. Premises for Planning

8.1 Planning Policy

The principle planning policies of the Study are same as the ones of the Urban Transport Master Plan.

The objectives of the Plan are as follows;

- a) Support the socio-economic development of the Guatemala Metropolitan Area.
- b) Secure fair access to the transport services for all citizens.

In order to realize the above objectives following targets and policies were established.

- a) The development of the transportation network shall be capable of growing as an integral part of the future urban land structure.
- b) Coping with the future transportation demand.
- c) Correcting the differences in the transportation services by area and society of income level.
- d) Securing the citizens' safety and maintenance of good environment.
- e) Effectiveness with reasonable investment.

8.2 Premises

The following premises are considered for project formulation:

- a) Planning year for the evaluation of the projects is the year 2010, the same as for the Urban Transport Master Plan

Although the subject projects of the Study are recommended as the short term plan projects or mid term plan projects, the planning year should be same as the one of the Master Plan, because of demand forecast and evaluation of their big size and big effect.

- b) Traffic demand restriction policies shall be introduced.

In the case if the government leaves the recent tendency of vehicle owning and usage, rapid and sharp increase of vehicle traffic shall cause serious traffic problem in Guatemala Metropolitan Area. Thus some kind of restriction policy of vehicle owning or usage should be introduced.

- c) The part of the right of way of the FEGUA can be used for the exclusive busway, even if the cargo transport is operated by private sector.

Although FEGUA has the schedule for the concession bid of the cargo transport operation, it is recognized that the Municipality of Guatemala and FEGUA has reached the agreement of the use of the right of way of FEGUA for the urban public transport.

- d) The function of the wholesale market for agricultural products shall be transferred to CENMA.

Since the CENMA project has own schedule for the concession bid, the wholesale market in Zone 4 shall be replaced to the site of CENMA within a couple of years.

- e) The urban residential development project in Naranjo area shall be implemented.

Since the development plan of Naranjo has been concrete and the access road began to be constructed already, it can be a premise that the construction of the principal road in Naranjo area shall be implemented by the developer itself.

- f) Some part of the Master Plan network, such as Periferico Tramo and Periferico Intermedio shall be constructed in early stage.

Because of lack of financial resources, the implement of the projects recommended in the Master Plan has been delayed from the original schedule. However Guatemala Municipality has completed some projects such as the intersection grade separation projects, and has the intention to complete the development of the Periferico. Therefore some sections shall be implemented in the near future.

- g) Extra urban bus will be classified into two categories; neighboring city commuter bus and inter-regional bus.

Because of the expansion of the urbanized area, the one half of existing extra-urban buses have origins and destinations of their trips within the Guatemala Department and the people use them as commuter transport means. On the other hand long distance transport buses exist and the people use them as the important transport means between the regions. Therefore they should be classified clearly into two categories.

The boundary of commuter bus is shown in Figure 8.1.

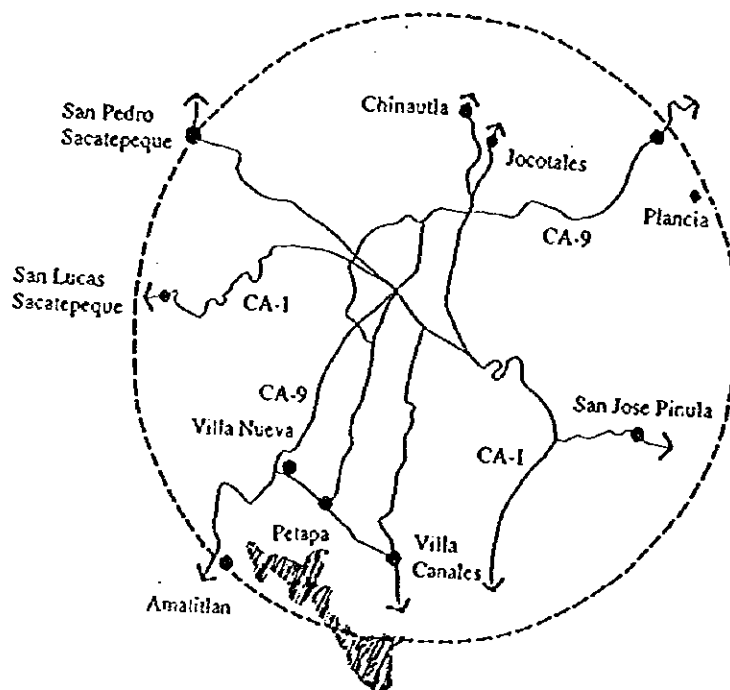


Figure 8.1 Boundary of Commuter Buses

9. Alternative Study of the Project

9.1 Alternative Formation

Considering the purposes and roles of the projects recommended in the Urban Transport Master Plan, project alternatives are formulated from the following viewpoints.

- Position in the urban development of the Metropolitan Area
- Functions as a transport facility
- Location or route
- Structure type
- Project cost

After examination of preliminary alternatives combining various aspects, practically and simply, two types of alternatives are proposed;

- A. Improvement oriented types
- B. New development oriented types

Table 9.1 General Characteristics of Alternatives

	Improvement type	New development type
Grade of facilities/structure	Low	High
Functions	Single-functional	Multi-functional
Land requirement	Minimum requirement	Large requirement
Project impact	Weak impacts	Strong impacts
Change of transport system	Minor changes	Major changes
Project benefit	Small	Large
Project cost	Small	Large
Realistic or idealistic	Realistic (usually)	Idealistic (usually)
Project life	Temporary nature	Permanent nature
Location	Already determined location	New location to be identified

(1) East-West Corridor

Alt. A: Upgrading and extension of the existing Pararela Road

Alt. B: New road construction including the road section planned by the Naranjo development

(2) Petapa Road

Alt. A: Upgrading of unpaved Petapa Road with less new road sections
(Improvement oriented)

Alt. B: Upgrading of unpaved Petapa Road with more new road sections
(New central route)

Alt. C: Upgrading of unpaved Petapa Road with more new road sections
(New west route)

(3) Exclusive Busway (East West Route)

Alt. A: Establishment basically along the existing Pararela Road

Alt. B: Construction as part of the newly constructed East West Corridor

(4) Exclusive Busway (FEGUA Route)

Alt. A: Development with a minimum number of new structures

Alt. B: Development with a medium number of new structures

Alt. C: Development with a maximum number of new structures

(5) Urban Bus Center in Zone 4

Alt. A: Development with low cost facilities (ground level)

Alt. B: Development with large scale facilities (more than one level)

(6) North Inter-regional Bus Terminal

Alt. A: Development as a part of a commercial center development project of the private sector

Alt. B: Development as an independent inter-regional bus terminal

(7) West Inter-regional Bus Terminal

Alt. A: Development as a part of a commercial center development project of the private sector

Alt. B: Development of an independent inter-regional bus terminal
(at the border between Guatemala City and Mixco City)

Alt. C: Development of an independent inter-regional bus terminal
(at the intersection between CA1 and Outer Ring Road)

(8) South Inter-regional Bus Terminal

Alt. A: Development in the CENMA project site

Alt. B: Development of an independent inter-regional bus terminal

(9) Bus Inspection and Maintenance Center

1) Functional Alternatives

Alt. I: Development of functions for inspection and maintenance for pollution control

Alt. II: Development of functions for inspection, and full scale maintenance, repair and additional services

2) Locational Alternatives

Alt A: Development in the CENMA project site

Alt B: Development in a newly identified site

9.2 Alternative Selection Method

In order to select the optimum alternative for each project, a comparative study is carried out. In the study, effects and impacts are examined. The effects and impacts by alternative plans are compared and evaluated in the following aspects.

- Traffic aspect
- Economic aspect
- Environmental aspect

(1) Traffic aspect

The alternative plans are evaluated in terms of traffic impacts. The traffic demand is estimated for each alternative plan and the following traffic impacts are examined.

- Traffic volume
The traffic demand is calculated by using the revised models shown in a former chapter. The traffic demand of projected roads is calculated to provide information for project evaluation, and the traffic volume of a parallel road reflects impact of a projected road.
- Travel time and travel distance
Travel time and travel distance are indicators to evaluate the impact of a project to whole network. Moreover, both indicators are used to calculate benefits of alternative plans.

(2) Environmental aspect

Alternative plans give various environment impacts not only to the natural conditions but also to the daily living conditions of citizens. Since it is difficult to quantify the environment impact precisely, the quality comparison among the alternatives is studied for the following two environment aspects.

- Impact to the natural conditions
- Impact to the daily living conditions

(3) Economic aspects

The benefits of the alternatives are assumed as the difference of transportation costs between the case without any projects and the case with each alternative of a project. For selection of the optimal alternative, savings in vehicle operation costs (VOC) and travel time (TT) are estimated in monetary terms among various benefits generated by projects. For the comparison and selection of the alternatives, the B/C ratio and the NPV are calculated.

9.3 Alternative Study

9.3.1 East-West Corridor

(1) Objectives of Road

The East West Corridor is a new radial trunk road. The East West Corridor with the bus way for strengthening of public transportation will cope with remarkable increase of the east-west traffic volume and mitigate the burden of Calzada San Juan Sacatepequez. The project route is between the bus terminal in Zone 4 and the planned outer ring road to the crossing of Calzada San Juan. The planned outer ring road will be widening of 49 Avenida in Colonia Monserrat and San Nicolas road.

Guatemala City and Mixco area are connected with CA1 (6 lanes) and Calzada San Juan (4 lanes). Connecting roads such as Periferico (4 lanes), Avenida Bolivar (4 lanes), 6a Avenida (4 lanes), 7a Avenida (4 lanes) and Avenida Reforma (4 lanes with service roads) are linking to the Centro area and the other commercial centers.

In the near future Calzada San Juan would suffer from traffic congestion and the increasing traffic would not be managed. Priorities should be put on public transport facilities to shift the traffic demand to public transportation. Under these circumstances, the new 4 lane road will be constructed and the exclusive busway will be provided from the bus terminal in Zone 4 along with the road.

(2) Alternative Proposals

In consideration of the location of the Naranjo hill, the two alternative routes are studied in the section between Periferico and the planned outer ring road:

1) Alternative A: Improvement of the existing road (southern route)

The existing road running approximately parallel with Calzada San Juan would be improved to a 4 lane trunk road with a 2 lane busway. As the area along the road has been urbanized, most of the intersections will be at grade crossings and the design speed will be as low as 40 km/hour.

-	New road construction section: Existing bus terminal to the disposal site	1.3 km
	Rio Naranjo to Avenida San Nicolas	2.2 km
-	Improved section: Disposal site to Sitio Arqueologica (from 4 lanes to 6 lanes)	2.4 km
	Sitio Arqueologica to Periferico (from 2 lanes to 6 lanes)	1.0 km
	Periferico to Rio Naranjo (4 lanes to 6 lanes)	1.3 km
	Avenida San Nicolas to 49 Calle (4 lanes to 6 lanes)	0.7 km

2) Alternative B: New road construction (northern route)

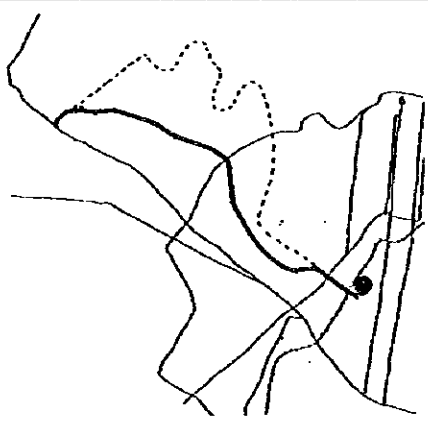
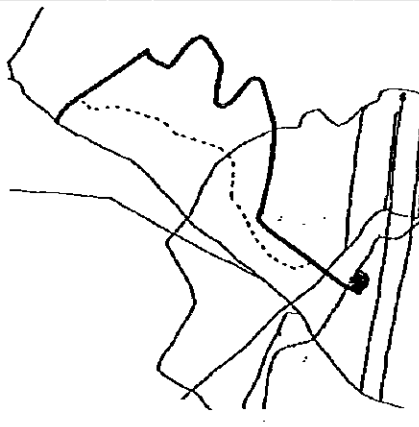
The northern route will be made in coordination with the on-going urban development around the Naranjo hill and the new route will run on slopes of the hill. The project road of the urban development will be used. This route gives minimum affects to the existing urban areas. There are few existing roads between Periferico and the planned outer ring road and grade separation will be made at the intersections with Periferico. The design speed can be set as 60 km/hour.

- New road construction: Existing bus terminal to the disposal site 1.3 km
Disposal site to Periferico 3.5 km
- Coordination with the on-going development project in Naranjo hill area:
Periferico to Avenida San Nicolas intersection 5.2 km
- Improvement of existing roads: Avenida San Nicolas to 49 Calle
(4 lanes to 6 lanes) 2.5 km

3) Selection and Comparison of Alternatives

The comparison of the two alternatives was made as shown in the following table;

Table 9.2 Comparison of Alternatives for East West Corridor

Item	Alternative A	Alternative B
Location		
Road function	Arterial in the build up area	Arterial for new urban development
Traffic aspect	Design speed: 40 km/h No major increase in capacity	Design Speed: 60 km/h Problems in traffic flow at the intersection with Periferico
Route	Widening of existing Paralela road	New construction road
Bus exclusive way	Introduction is possible	Introduction in median has problems
Future traffic volume	Vehicles: 27,900 (veh) Bus: 15,700 (veh)	Vehicles: 29,600 (veh) Bus: 12,500 (veh)
Benefit	Distance: 14,272 (Q1,000/year) Time: 40,770 (Q1,000/year)	Distance: -25,560 (Q1,000/year) Time: 179,452 (Q1,000/year)
Affected house	880 houses	450 houses
Project cost	Construction cost: Q188 million Compensation cost: Q242 million Project cost: Q430 million	Construction cost: Q318 million Compensation cost: Q68 million Project cost: Q385 million
Benefit/cost ratio (Discount rate of 12%)	0.79	2.72
Environmental impact	Nature: not exist Social impact: resettlement, noise and air pollution	Nature: affect little Social impact: relatively less

According to the above comparison, Alternative B was selected for further study.

9.3.2 Petapa Road

(1) Objectives of Road

Petapa Road is one of the important radial arterials connecting the city center with the southern part of the Metropolitan Area. Recently in this southern part such as Villa Nueva, Petapa and Villa Canales, the population has grown very rapidly and this tendency will continue to be same or more in future. Therefore the role of this road will be very important to cope with future traffic demand, especially for commuter traffic.

Existing paved section with four or six lane carriage ways connects the intersection with Ave. Liveracion to the entrance of Ciudad Real. Beyond Ciudad Real the existing unpaved road has two narrow lanes and poor geometric design.

Between the entrance of Ciudad Teal and the Villalobos River, the route of the Exclusive Busway will run on the route of the improvement of Avenida Petapa.

(2) Alternative Proposal

There is no alternative route between Ciudad and the intersection with Exclusive Busway, since there exists topographic restriction. However, between Villalobos river and Department Road 2N (Villa Nueva-Petapa Road), three alternative routes can be considered.

Alternative A: Widening existing road (eastern route)

Alternative B: New route (central route)

Alternative C: New route (western route)

(3) Comparison and Selection of Alternative

Among the three alternatives, benefit/cost ratio of the Alternative A is lower than those of the other alternatives. Alternatives B and C show nearly equal figures. Considering the less social problem with fewer people to be resettled, Alternative B is recommended for more detailed studies.

The comparison table of the alternatives is as follows;

Table 9.3 Comparison of Alternatives for Petapa Road

Item	Alternative A	Alternative B	Alternative C
Route	Widening existing road	New route	New route
Location	East	center	West
Road length	2.2 Km	2.5 Km	2.6 Km
Traffic aspect	Design speed: 40Km/h	Design speed: 60Km/h	Design speed: 60Km/h
Future traffic volume	46~71,000 pcu	50~71,000 pcu	50~71,000 pcu
Benefit	Q168 million/year	Q212 million/year	Q212 million/year
Affected houses	Apr. 60 houses	Apr. 5 houses	Apr. 40 houses
Construction cost	Q74.7 million	Q74.7 million	Q74.7 million
Compensation cost	Q9 million	Q0.8 million	Q6 million
Project cost	Q83.7 million	Q122.1 million	Q122.3 million
Benefit/Cost Ratio	6.17	6.46	6.41
Net present value	Q714 million	Q893 million	Q891 million
Environmental impact	Resettlement	Less social problem	Resettlement

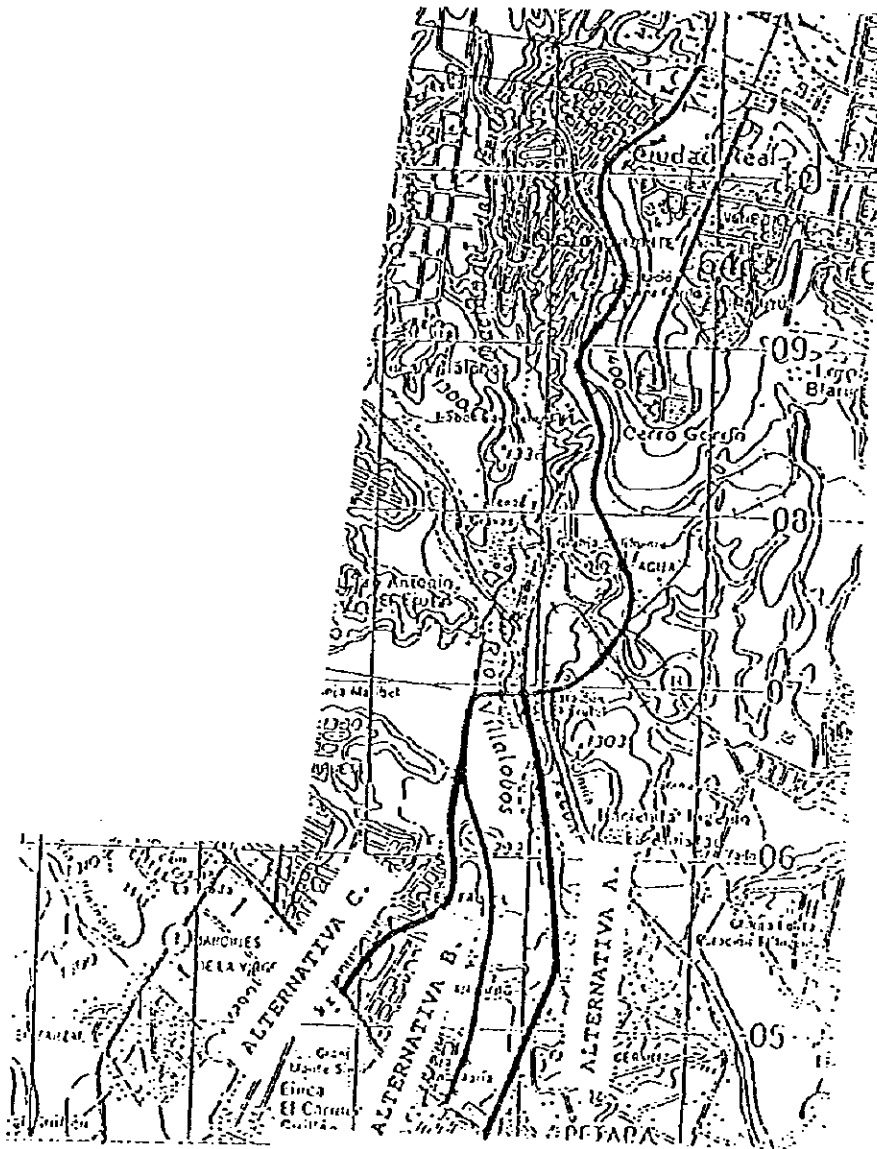


Figure 9.1 Alternative Routes for Petapa Road

9.3.3 Exclusive Busways

Exclusive busways are to serve for a key route of mass transportation and to make the most use of buses. In the Master Plan, they were to be introduced along two routes, namely the east west route and the FEGUA route. The major objective is to serve commuters from population centers in the western and southern suburbs to the central business district (CBD) of the Metropolitan Area.

It is expected that the busway will improve the traveling time and conditions of passengers, promote the use of public transportation services and contribute a lot to reducing congestion in the directions of the busway.

(1) East West Corridor Route

1) Objectives

The route is expected to serve large trip demand between the CBD and the western core of population. In the Master Plan, the route is one of the radial arteries of the transport network and also constitutes a part of the outer ring road.

2) Alternative Proposals

Two alternatives are formed based on two ways of development approach, corresponding to the alternatives of East West Corridor. One is to improve existing infrastructure, more specifically, to expand the existing east west road to establish a busway. The other is to construct new infrastructure in newly developing areas. Their characteristics for physical planning are as follows:

Table 9.4 Alternatives for East-West Route Busway

	Alternative A	Alternative B
Alignment	Basically along Existing East-West Road as in the Master Plan	Shifted to north from the alignment in the Master Plan, passing through the Naranjo Development area
Target users	OD pairs between CBD and Lo de Ban, Lo de Fuentes and passengers along the route south of Rio Naranjo	OD pairs between CBD and Lo de Ban, Lo de Fuentes and passengers to/from newly developed areas along the route north of Rio Naranjo
Spacing of stops	approx. 500m	approx. 600m due to uninhabited areas such as deep valleys
Access points of buses	at 6 major intersections	at 6 major intersections
Design speed	40 km/h	60 km/h
Position of bus way	Road center	Road center

3) Comparison and Selection

Two alternatives were compared and evaluated:

Table 9.5 Comparison of Alternatives for Exclusive Busway - East West Corridor Route

		Alternative A	Alternative B
Demand (bus units)		6,500 - 9,800	8,800 - 9000
Passenger services		Relatively high share of short trips	Relatively high share of long trips
Reduction of traffic volume (pcu)	CA-1	minus 14,100	minus 15,500
	San Juan	minus 9,500	minus 3,200
Saving of overall vehicle operating costs and travel time cost (million Q/year)		55	154
Initial Cost (Q.million) (with E-W Corridor Project)		430	385
Economic aspects (with East West Corridor Project)	B/C	1.36	2.72
	NPV (Q.million)	126	493
Impacts on the environment		The valleys will be reclaimed on the project route.	The forest will be developed. Landscape design should be considered
Social aspects		Relocation of relatively more residents will be required. Segregation of the community in the northern part of the road is anticipated.	Relocation of relatively fewer residents will be required. The community will be developed on condition of existence of the Bus Way.
Operational aspects		Reducing traveling time	Acquiring new passengers from newly developed areas.
Integration with the road development project		Different from the selected alignment	Integration is possible
Future possibility of introduction of rail transit		Relatively difficult	Possible

The economic analysis shows that Alternative B is more advantageous. Alternative A is anticipated to give negative influence to the environment and the community along the route such as segregation of the community.

Based on the above comparison, Alternative B was selected for further study and preliminary design.

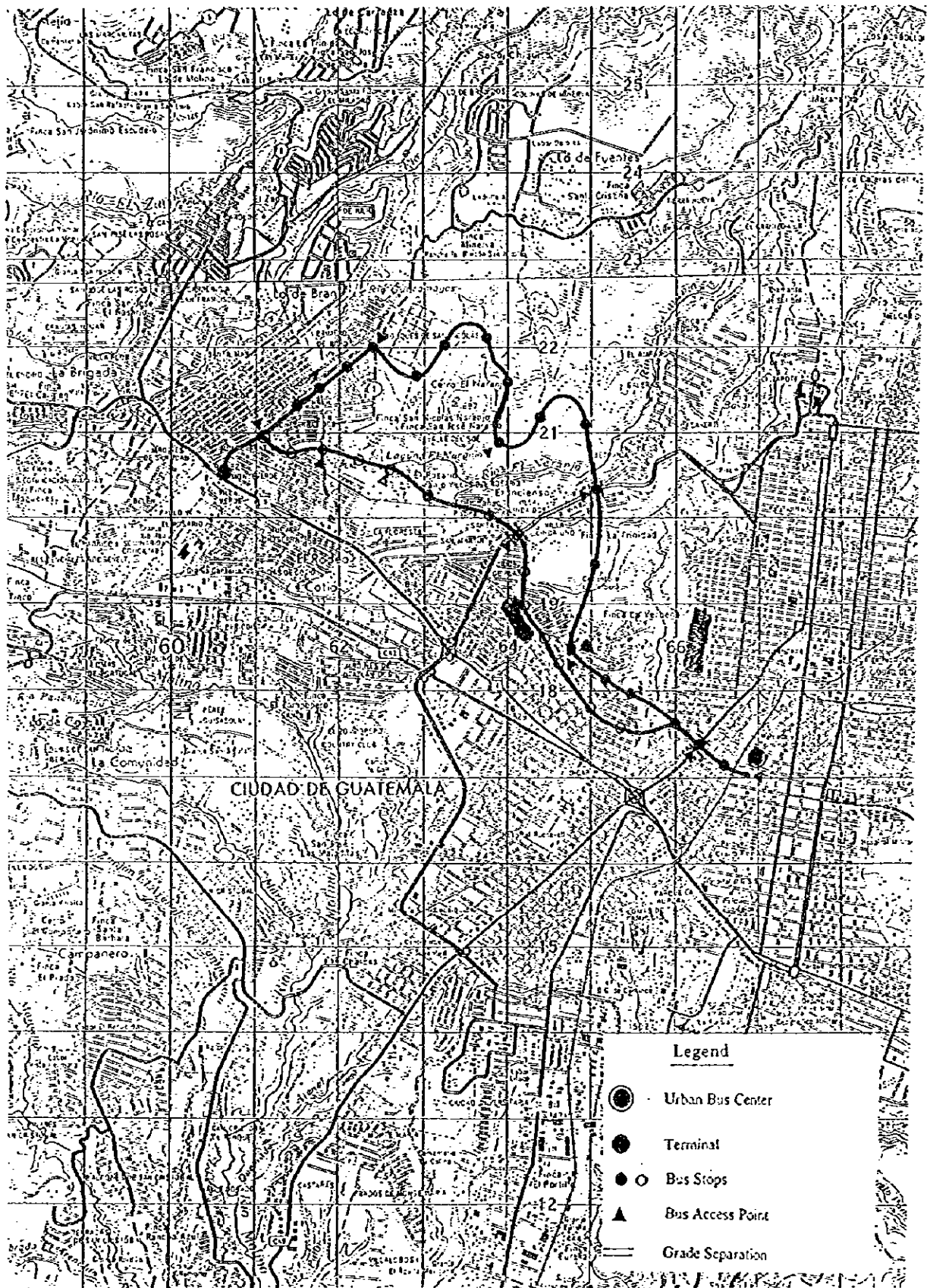


Figure 9.2 Alternatives for Exclusive Busway-East West Corridor Route

(2) FEGUA Route

1) Objectives

The busway route is to utilize the right of way of FEGUA for bus operation between the FEGUA Central Station and Ciudad Teal and to construct a new busway to Villa Nueva. The route is expected to serve large trip demand between the CBD and the southern core of population such as Villa Nueva, Petapa and Villa Canales.

In case that the South Inter-regional Bus Terminal is located along Periferico, the busway route can also serve for inter-regional buses to the south direction.

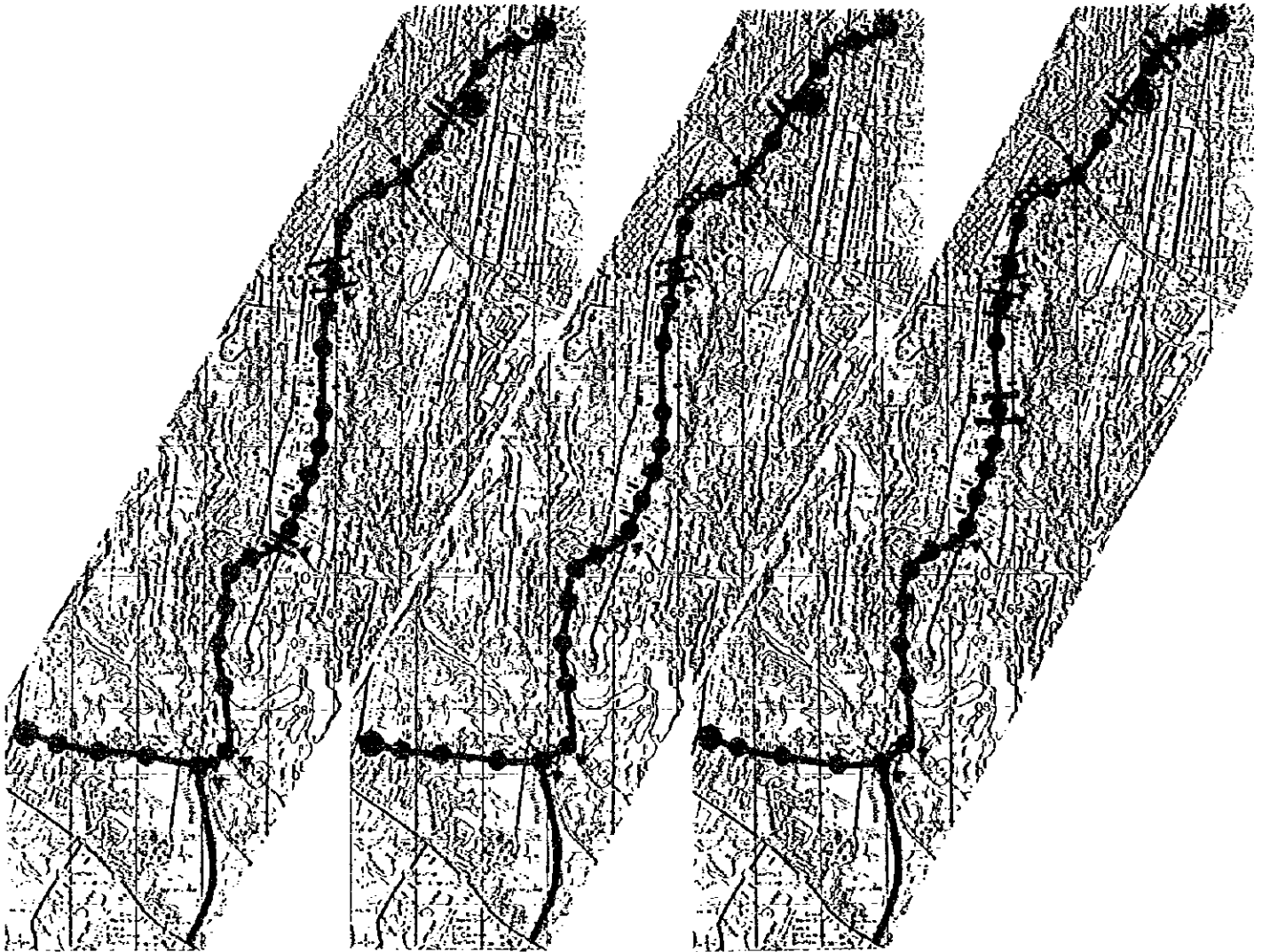
2) Alternative Proposals

Three alternatives are formed corresponding to the grade of infrastructure to be newly constructed, varying from an alternative with a minimum construction to another with fully developed infrastructure.

The three alternatives have a common alignment, the average spacing of 600m between bus stops, and 6 access points. The busway is located on the west side of the railway in the sections north to Ruta 2 of Zone 4 or 24 Calle of Zone 1, on the east side between the Calle and Ciudad Real and at the center of the Petapa Road. Between Rio Villalobos and Villa Nueva, only the bus way is planned with no ordinary road integrated together (Figure 9.4 - 9.6).

Table 9.6 Alternatives of FEGUA Route Busway

	Alternative A	Alternative B	Alternative C
Planned operation speed	30 km/h	35 km/h	40 km/h
Intersections with crossing roads	Minimum number of grade separations	Medium number of grade separations	Maximum number of grade separations
New bridges parallel to existing FEGUA's bridges	Existing bridges are shared by trains and buses	New bridges are constructed next to FEGUA's bridges at 6a Av. and 7a Av. in Zone 1 and CA1 in Zone 8.	Same as Alternative B



Alternative A

Alternative B

Alternative C

Legend









-  Urban Bus Center
-  Terminal
-  Bus Stops
-  Bus Access Point
-  Grade Separation
-  Viaduct
-  Bridge Construction
-  South Inter-regional Bus Terminal

Figure 9.3 Alternatives for Exclusive Busway-FEGUA Route

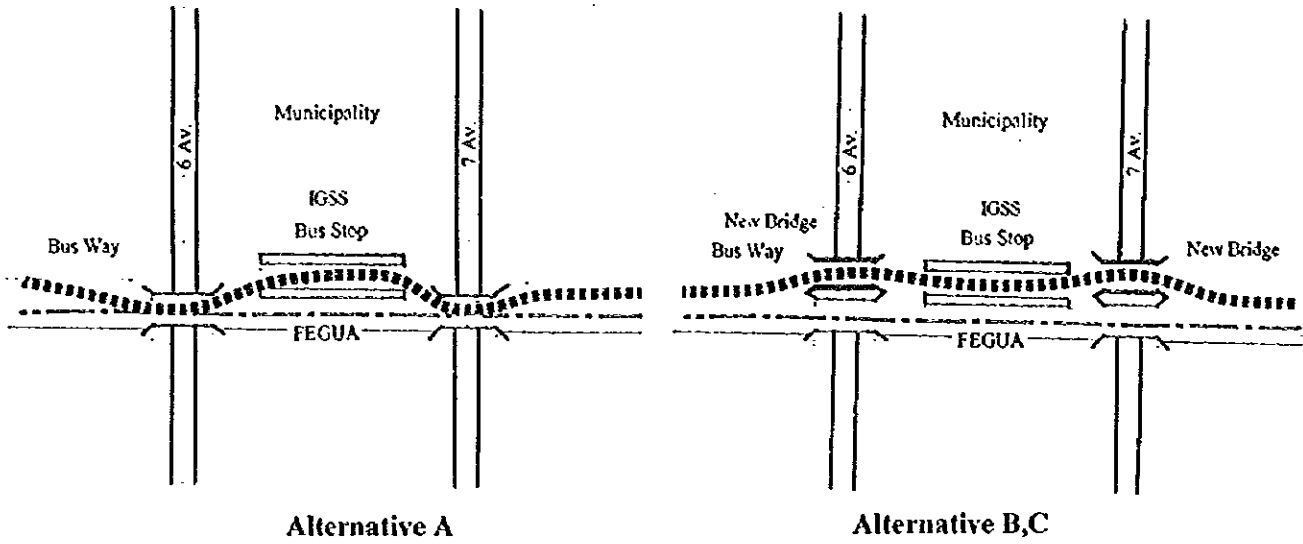


Figure 9.4 Alternative of Bridges over 6a and 7a Avenida

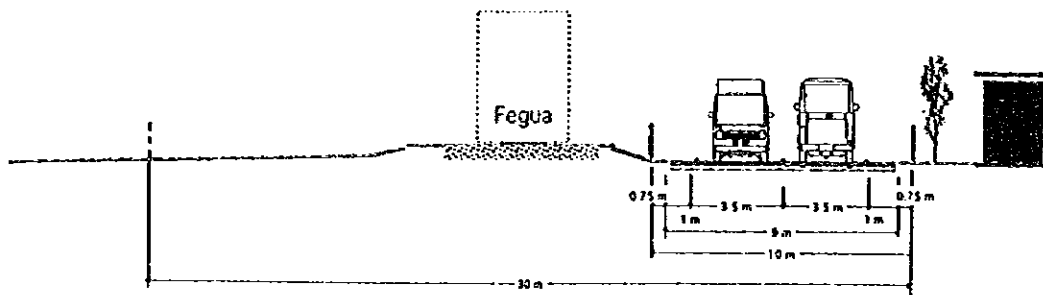


Figure 9.5 Cross Section of FEGUA Route at Grade

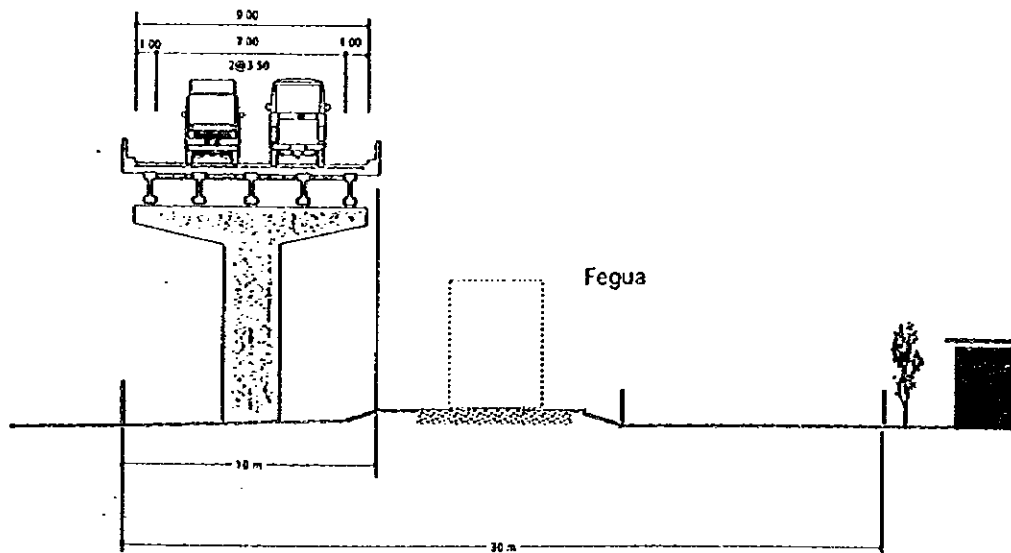


Figure 9.6 Cross Section of FEGUA Route - Viaduct

3) Comparison and Selection

The following comparison was made:

Table 9.7 Comparison of Alternatives for Busway FEGUA Route

		Alternative A	Alternative B	Alternative C
Demand (bus unit)		4,200 - 11,800	5,500 - 11,800	6,000 - 13,300
Bus operation time		Relatively long	Between the other two alternatives	Relatively short
Impacts on environment		Traffic congestion in the north-south axis will be mitigated. Exhaust gas and noise from vehicles will increase near the site.	Same as alternative A	Same as alternative A
Saving of overall vehicle operating cost and travel time cost (million Q/year)		215	255	274
Cost (Q.million)		201	270	286
Economic aspects	B/C	7.44	6.62	6.72
	NPV (Q.million)	945	1,097	1,180
Social aspects		Disturbance by the traffic in Zone 12 is anticipated. Noise problems for the residents along the way is anticipated.	Between the other two alternatives	Traffic in Zone 12 will be relatively smooth. Noise problems for the residents along the viaduct will be alleviated
Future possibility of introduction of rail transit		Relatively difficult	Between the other two alternatives	Relatively easy

From the view point of safe and smooth traffic of vehicles and trains, Alternative C is considered to be the most recommendable and selected for further study and preliminary design.

9.3.4 Urban Bus Center

(1) Objectives

In the Master Plan, new hierarchy or structure of bus system was proposed (extra-urban bus - key route bus - ordinary bus - feeder bus). To cope with various OD pairs, many passengers should transfer to the buses. The Urban Bus Center and the Inter-regional Bus Terminals will serve to facilitate and make efficient and comfortable the transfer of buses. The center is to be a hub of major urban bus routes for smooth transfer among them. It is also a new urban center to integrate various urban functions, such as commercial and business, retail market and culture center.

(2) Required Bus Berths

Based on preliminary estimation of future bus routes and their traffic demand, the required capacity of the center is estimated to have approximately 50 berths, consisting of about 25 berths for the Busway FEGUA Routes including inter-regional buses through CA1 East and about 25 berths for the Busway East West Routes and other urban bus routes.

(3) Alternative Proposals

Two alternative proposals are formed. One is an improvement type and the other is a new development type. In both cases the location is to be in the western part of the preset market/bus terminal site because the busway should be connected to the bus center. In coordination with relocation of the tenants in the market carried out in relation to the CENMA project and the project of the Inter-regional Bus Terminals, the urban bus center can be started.

Table 9.8 Alternatives for Urban Bus Center

	Alternative A	Alternative B
Structure	Arrangement of bus berths at the ground level	Multi-story building to accommodate bus berths
Passenger service and amenity functions	Passenger service and amenity functions are distributed and located around the transport facilities	Passenger service and amenity functions are concentrated in the center and integrated with the transport facilities
Layout of bus berths	Parallel type	Island type

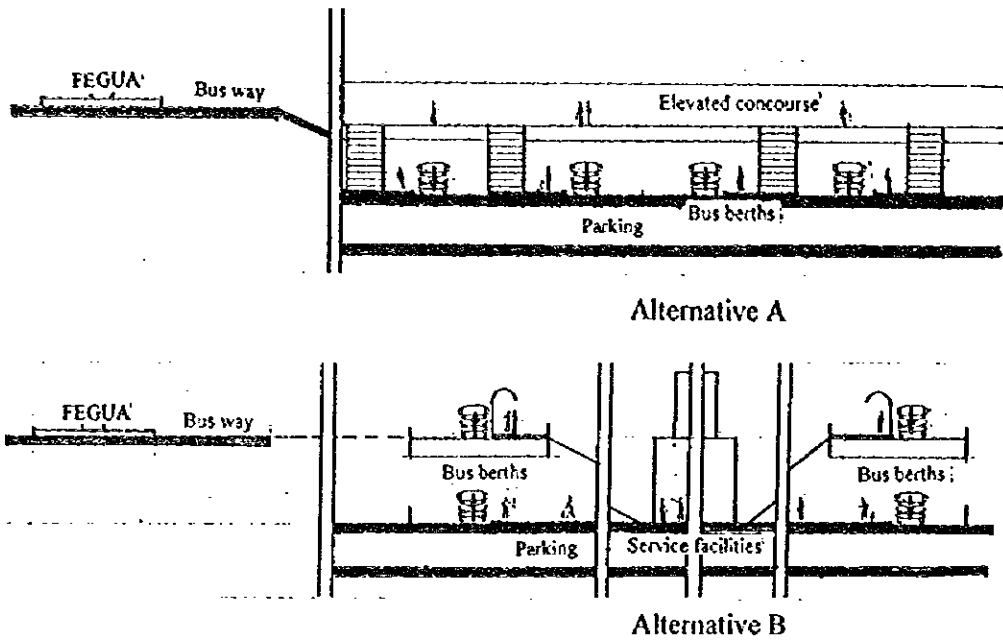


Figure 9.7 Sectional Scheme of Alternative

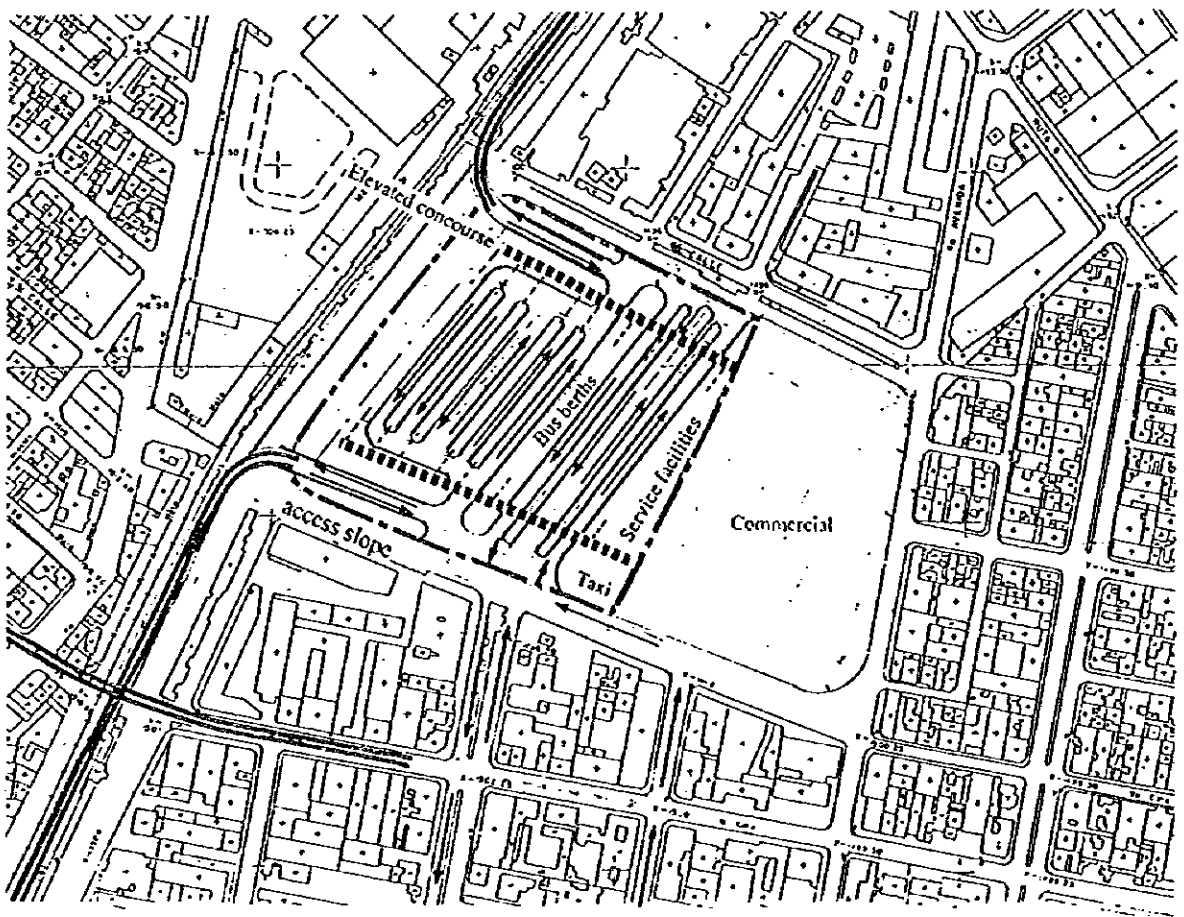
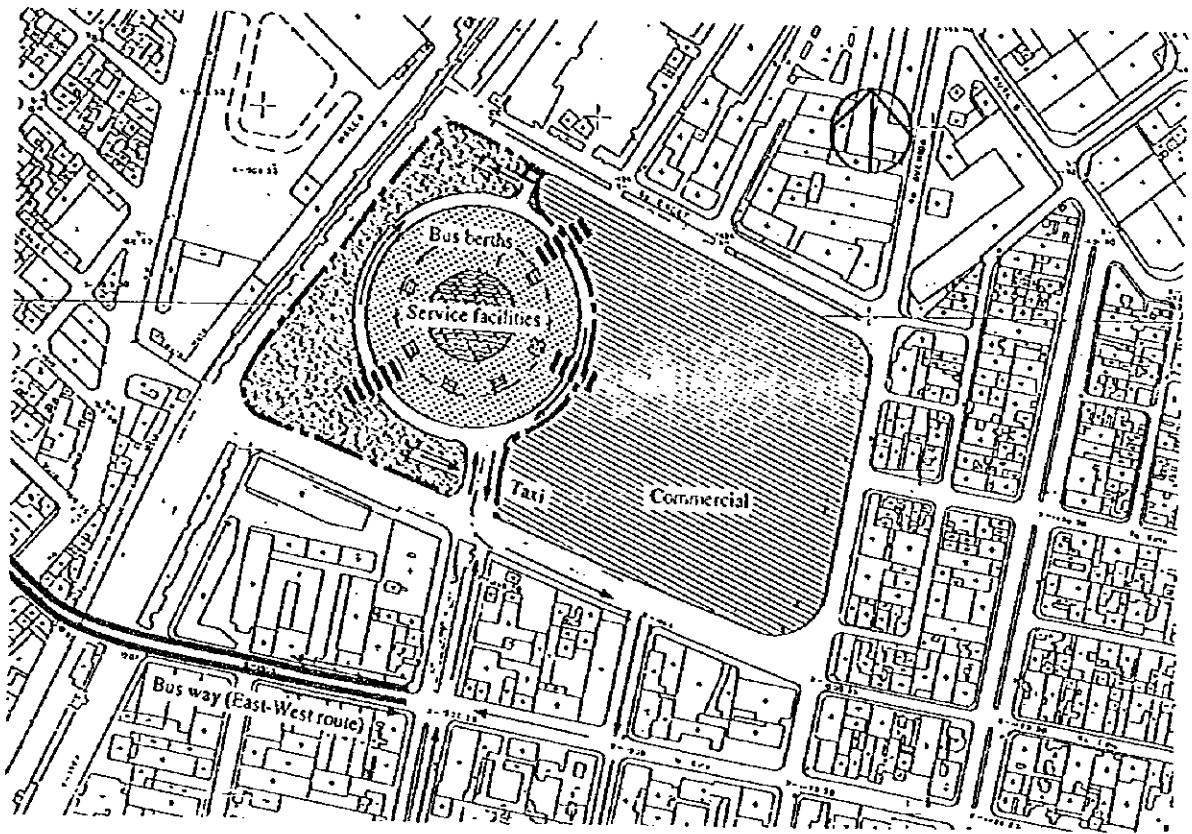
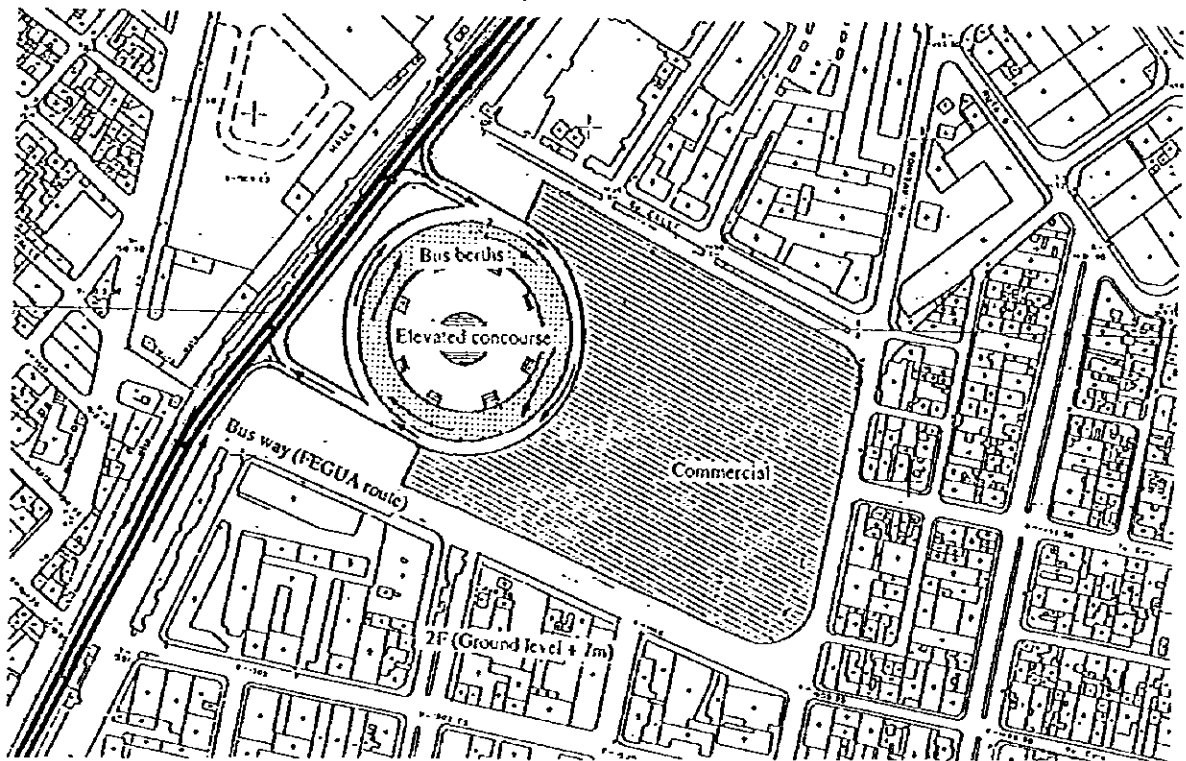


Figure 9.8 Layout of Urban Bus Center - Alternative A



Ground Level



2F Level (Ground Level + 7m)

Figure 9.9 Layout of Urban Bus Center - Alternative B

(4) Comparison and Selection

The following comparison is made;

Table 9.9 Comparison of Alternatives for Urban Bus Center

	Alternative A	Alternative B
Transfer	Less smooth transfer because the platforms may have to be changed.	Smother transfer in the island.
Passenger service and amenity functions	Passenger service facilities will be distributed on the ground level. Parking lots on basement	It can be concentrated in the center of the island with easy use for passengers. Parking lots on basement
Cost aspects	Less construction cost (Q25 million) Less operation cost	Higher construction cost (Q.40 million) Higher operation cost
Traffic arrangement	No crossing of routes occurs.	Crossing between the routes of the busway (FEGUA Route) occurs.
Existing road	The existing road between the market and FEGUA should be used for the bus center for more effective use.	2a and 3a Avenida should have one way system northward and southward, respectively.
Economic benefit	Less time saving Lower operation efficiency Less saving opportunity cost of land	More time saving Higher operation efficiency More saving opportunity cost of land
Environmental impacts	The economic activities will be reformed. Air pollution caused by exhaust gas is anticipated but less than the present condition.	Same as Alternative A
Land utilization	Lower	Higher
Area	Bus center: 3.4 ha Green zone: 0.4 ha Total: 3.8 ha	Bus center: 1.7 ha Green zone: 0.7 ha Total: 2.4 ha

As a lot of berths are provided in the bus center, easiness of transfer, safety in transfer, clear orientation of location of the berth should be required.

Alternative B is superior in guidance of location of the berths. A passenger van easily finds the berth and transfer time will be shorter than Alternative A. Shops and passenger service facilities prepared in the center of the island are convenient for all passengers and much more rent from the tenants is expected. About an area of 2.4 ha will be required including 0.7 ha of green zone. The shape of bus berths will form a circle with about diameter of 140m.

Alternative A can be made with less construction cost than Alternative B. However most transfer should require coming up to the elevated concourse and down from there, and location of the berth will be more difficult to find and more transfer time will be taken. Shops and passenger service facilities will be prepared on the elevated level or distributed on the ground level and it will be less convenient. The berths for the FEGUA route are located on the ground level and the access slope will be constructed east-west in the length of about 120m. The layout of bus berths is affected by the slope and the area will be about 3.8 ha using the angular pattern is smaller commercial area. And the part of the existing road between FEGUA and the bus center shall be closed and used for the site. Based on the above comparison, Alternative B is recommended for further study and preliminary design.

9.3.5 Inter-regional Bus Terminals

(1) Objectives and Approach

1) Objectives

Traffic congestion in the CBD and the bus terminal in Zone 4 is becoming a serious bottleneck for buses and other vehicles. Congestion on Calle Marti (CA9 North) is also chronic and still worsening. An efficient extra-urban bus system to alleviate the congestion and improve the service level is required. The Inter-Regional Bus Terminals will reduce the traffic volume going to the CBD and make bus transfer more efficient and comfortable. Also they will contribute to decentralization of concentrated urban functions and will serve for the residents in the vicinity.

In the Master Plan, terminals at the north, west and south were recommended. Regarding the east direction, it was recommended that inter-regional buses to/from the east use the urban bus center in Zone 4 for the time being instead of building an east terminal because of insufficient demand and no major traffic problems compared to other arteries such as Calle Marti.

2) Estimated Demand

The required number of berths and the terminal area are preliminary estimated as follows:

Table 9.10 Estimated Demand of the Terminals

Terminal	North	West	South
Number of berths	20	34	30
Design site area	approx. 0.8 ha	approx. 1.3 ha	approx. 1.2 ha

3) Approach to set Alternatives

Inter-regional Bus Terminals can be developed as integral parts of private commercial area developments near the intersections of regional arteries and Periferico. Therefore one set of alternatives are terminals located at the intersections to be developed in such a way. The other set of alternatives are located outside Periferico. In the latter case, if the terminals are remote from good access, they may have to be developed by the public sector's initiatives. The locations of the candidate sites are shown in Figure 9.13.

(2) North Inter-regional Bus Terminal

1) Alternative Proposals

Alternatives are set based on location in the transport network that affects the development scheme.

Table 9.11 Alternatives of North Inter-regional Bus Terminal

	Alternative A	Alternative B
Location	Atlantida close to the intersection of CA9 North and the planned Middle Ring Road	Near Rodriguitos at the site of Adoana (custom house)
Development scheme	Private developer's initiative on privately owned land	Public sector's initiative on the government land

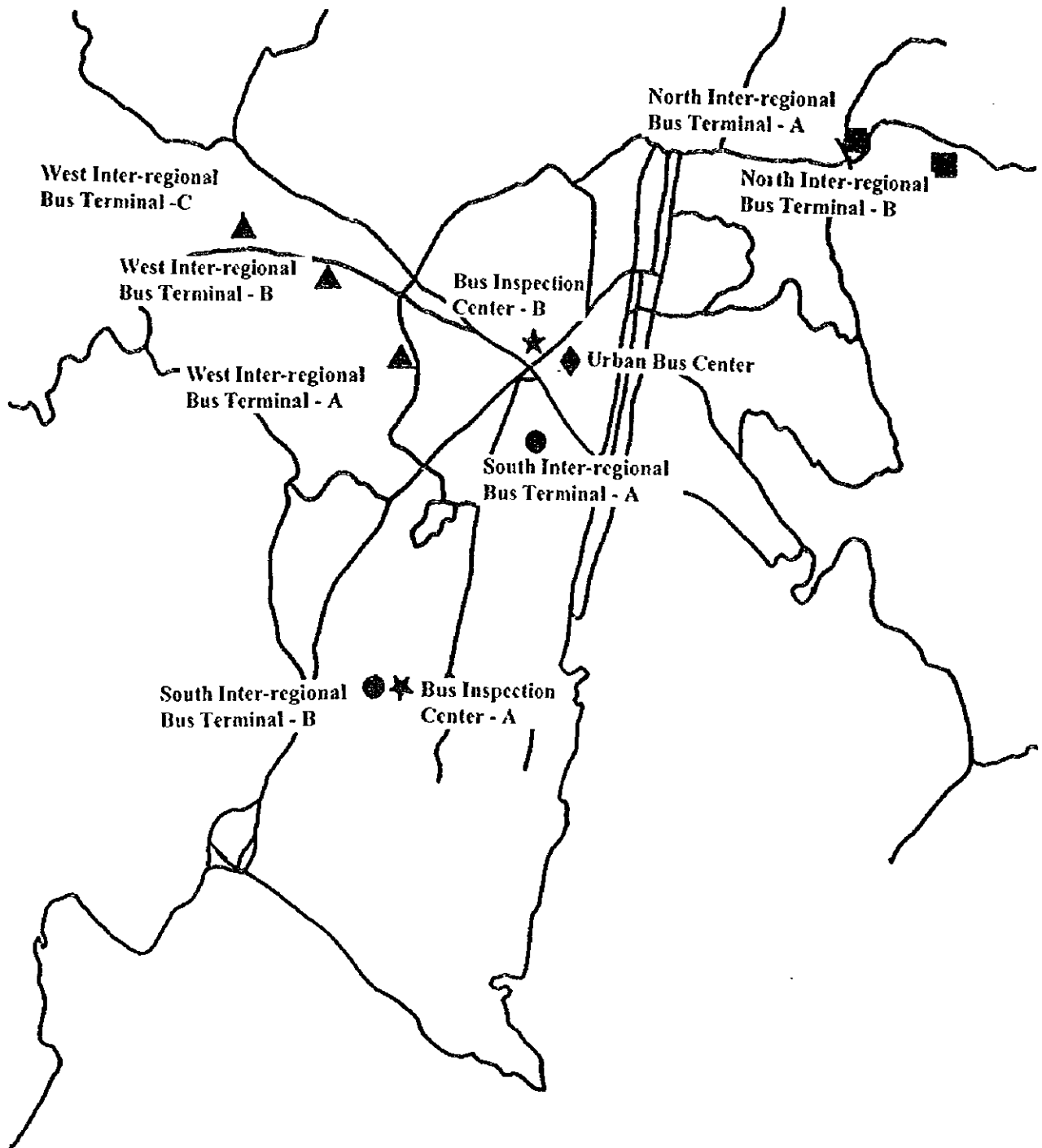


Figure 9.10 Location of Alternatives Bus Terminals and Inspection Center

2) Comparison and Selection

The following comparison is made:

Table 9.12 Comparison of Alternatives for North Inter-regional Bus Terminal

	Alternative A	Alternative B
Accessibility and traffic conditions	Good	Need improvement of access Two intersections on CA9 will be required, which is not advantageous for traffic flow.
Development of urban center functions	Development is already on-going	Not advantageous for development
Land availability	There is already a plot designated for a terminal to be developed by a private sector.	A consensus is necessary for conversion of the planned land use.
Cost aspects	The developer pays for construction cost of commercial center. No need for compensation	Construction cost of commercial center will be required. Need to transfer the land among the public sectors.

Alternative B has disadvantage in the access to the remote location and in urban development. Alternative A would be developed in cooperation with the private commercial development.

Based on the above comparison, Alternative A is considered to be more recommendable than Alternative B.

(3) West North Inter-regional Bus Terminal

1) Alternative Proposals

Alternatives are proposed based on location in the transportation network that affects the development scheme.

Table 9.13 Alternatives of West Inter-regional Bus Terminal

	Alternative A	Alternative B	Alternative C
Location	Open site close to the intersection of CA1 West and Periferico	Depressed site at the boundary between Guatemala and Mixco Municipalities along CA1 West	Open site owned by a church (seminario) neighboring the planned Outer Ring Road
Development scheme	Cooperation between private developer and public sector (Municipalities)	Development by a mixed entity of the public and private sectors	Public sector's initiative in cooperation with the private sector

2) Comparison and Selection

The following comparison is made:

Table 9.14 Comparison of Alternatives for West Inter-regional Bus Terminal

	Alternative A	Alternative B	Alternative C
Accessibility and traffic conditions	Good	Good except that relatively small number of inter-regional buses to/from National Road 5 need to shift to CA1 West	Not very good, especially before completion of the Outer Ring Road
Development of urban center functions	Advantageous. The location is west nodal point of transportation system. The area is becoming a new sub-center.	Located on the development corridor, the site can be a new sub-center.	The site is not surrounded by residential areas directly, so it is less advantageous.
Land availability	The candidate site is owned privately.	The candidate site is resided by some 10 families in rather simple houses.	The candidate site is owned by a church.
Cost aspects (Necessary costs)	Construction cost, land acquisition or land development involving the land owner.	Construction cost, land acquisition and compensation for relocation	Construction cost and land acquisition

The Alternative A has good access to Periferico and is advantageous for transfer to urban buses and for commercial development in cooperation with the private sector. However, very high potential of the area being realized for high level urban center development would not allow the owners to avail the land for the public bus terminal, while the Alternative C is disadvantageous as a location of a new terminal. Therefore, the Alternative B is considered to be best practical site.

(4) South Inter-regional Bus Terminal

1) Alternative Proposals

Alternatives are proposed based on location in the transportation network that affects the development scheme.

Table 9.15 Alternatives for South Inter-regional Bus Terminal

	Alternative A	Alternative B
Location	Annex to CENMA	The intersection of the planned Periferico Tramo Road and 7A Avenida, Zone 13 (Avenida del Observatorio)
Development scheme	Public sector's initiative in cooperation with private sector	Development by a mixed entity of the Municipality and private sectors on a publicly owned site.

2) Comparison and Selection

The following comparison is made:

Table 9.16 Comparison of Alternatives for South Inter-regional Bus Terminal

	Alternative A	Alternative B
Accessibility and traffic conditions	Access to CA9 South and not to the Bus way (FEGUA route). Inter-regional buses to/from southern part use CA9 South. The urban bus routes are to be extended to the terminal. Mixture of bus and cargo traffic may occur.	Good access to Periferico and the Busway (FEGUA Route). Inter-regional buses to/from south use the Bus way
Development of urban center functions	Comparatively low potential due to remoteness from the center except in the vicinity of CENMA.	The location has high potential for development due to the nodal location in the transportation network and proximity to the city center.
Land availability	Land to be transferred from the central government to the municipality.	Open public space is available near the bicycle race track and the bullring.
Cost aspects	Land preparation and construction cost	Only construction cost
Social impact	Traffic congestion may be caused along the CA9 South and the access road.	Being close to the city center. Possible rapid development of the surrounding area should be well regulated from an urban environmental point of view.

Alternative A has shortcomings in location in the bus network, as it is not connected to the busway and is remote from the city center.

Alternative B is in a good location in the network. If the terminal and sub-urban center are prepared, it would also have good impact on the areas in the southern part of the city center such as Zones 11 and 12, as well as the western side of the airport in Zone 13.

Based on the above comparison, Alternative B is selected for further study and preliminary design.

9.3.6 Bus Inspection and Maintenance Center

(1) Objectives

Deterioration of mechanical condition of buses causes problems for passenger service, bus operation, traffic conditions and the urban environment. Passengers are uncomfortable when the bus is in bad condition, the exhaust gas contaminates the air, bus operation rate is lower, slow and troubled buses cause traffic congestion and the repair cost increases. The existing bus inspection system and introduction of the preferential bus system have limited results for the improvement of the mechanical condition of buses.

The planned Bus Inspection and Maintenance Center aims at improvement of the mechanical conditions of buses by establishing a better inspection system and enforcing adequate maintenance standards. It is necessary to encourage improvement in mechanical conditions and not to allow buses to operate in bad conditions. The Preferential buses or buses operating on the busway will have to meet higher standards. The integration of the inspection system with bus supporting measures will be effective in realizing the above. Moreover strict bus inspection will provide a good example for the control of other vehicles in mechanical condition. It may be possible to expand the inspection system to inter-regional buses and other type of vehicles.

(2) Candidate Major Functions

The following items are candidate major functions of the center.

- Urban bus inspection
- Bus maintenance and repair
- Sales of spare parts
- Information service
- Training, instruction

(3) Estimated Demand

At present a total of 2,311 units including urban buses and micro buses are operated and 3,677 units have been registered since 1995. The models of 28 manufactures are in use.

The following is a preliminary estimation of the number of buses for inspection. Some 4,300 vehicles would be inspected in 2010 annually.

(4) Alternative Proposals

1) Functional Alternatives

Considering the candidate major functions and management, the following functional alternatives are compared:

Table 9.17 Functional Alternatives for Bus Inspection and Maintenance Center

	Alternative I	Alternative II
Main functions	Inspection, maintenance and capacity building with emphasis on environmental considerations	Inspection, maintenance, repair and sale of spare parts, with related information service on a commercial basis
Management	Municipality	Private concessionaire or association

Considering availability of a number of private workshops and competition with them, the center should limit its roles to inspection, protection from diseconomies caused by poorly conditioned buses, and dissemination of knowledge and skill required for sound operation of buses. Therefore Alternative I is selected.

The inspection system is to be extended to all kinds of vehicles to promote better traffic and environmental conditions. The inspection center should be a pilot project for that purpose. Therefore the office should have rooms and facilities for instruction on the inspection system. On the other hand, the private sector would not favor non-profitable maintenance such as for exhaust gas quality. The inspection center may have the function of maintenance for environmental reasons and lead to adjustment of the engines to control and alleviate air pollution.

Registration and control system of buses should be linked to the inspection system and only buses that pass inspection should be allowed to operate. The sticker or seal is to be issued for such buses and it should be displayed on the body so as to be easily recognized. Data base system for control of registration and reservation of inspection will be required.

Very old buses more than 20 years old are unlikely to pass the inspection in which case they will be rejected and abandoned.

Based on the above comparison, basically Alternative I is considered more recommendable than Alternative II on condition that instruction/PR of the inspection system and maintenance of the environment should be included.

2) Alternative Locations

There are two candidate locations.

Table 9.18 Location Alternatives for Bus Inspection and Maintenance Center

	Alternative A	Alternative B
Location	Annex to CENMA	Road section of Avenida 1, Zone 7, north to Trebol
Present land use	Unused gentle slope	Road closed from traffic
Land ownership	Central government	Municipality

3) Comparison and Selection

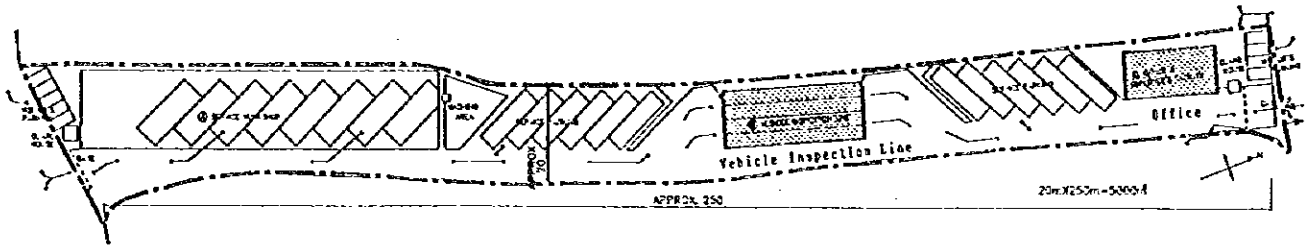
The following comparison was made:

Table 9.19 Comparison of Alternatives for Bus Inspection and Maintenance Center

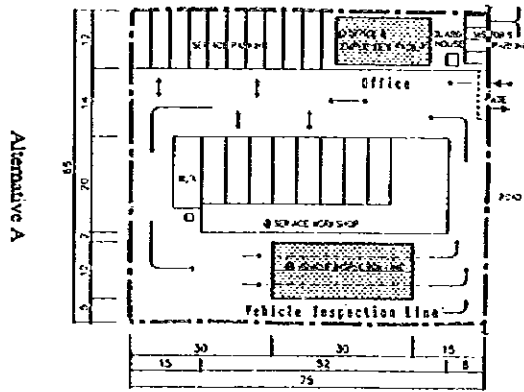
	Alternative A	Alternative B
Accessibility	Good : located next to CENMA, to the city center.	Very good : located near Trebol in the central area
Access to the bus related industries	Good Access to CA9 South	Good Access to CA9 South etc.
Land availability	Land to be transferred from the Central Government to the Municipality.	Road should be converted to a building site. Consent of the residents on the site (road) is required for the conversion.
Area size	Sufficient including expansion. The total area of the Annex of CENMA is approx. 10 ha.	Very tight. Possible for inspection function. Expansion needs extra acquisition of land. About 20m x 250m = 0.5 ha.
Alternative use	Remoteness from the city center is a constraint for certain alternative use.	Suitable for urban service facilities for citizens owing to the central location.
Social impact	The site is separated from the existing community.	The frontage of the land on the road will be interrupted by conversion of road to site. Bus traffic will have a negative impact on the residents.
Cost aspects	Land preparation and construction cost	Construction cost

The long and narrow shape and small area of Alternative B are total shortcomings. The environmental impact to the neighborhood and the disturbance of land use along the site is also to be avoided. On the other hand, Alternative A has adequate area even for extension and good access from CA9 South. Considering the possibility to expand the inspection system to vehicles other than buses, availability of reserved land or extension will be important.

Based on the above comparison, Alternative A is considered more recommendable.



Alternative B



Alternative A

Figure 9.11 Alternative Plans of Bus Inspection and Maintenance Center